Pinellas Suncoast Transit Authority



FLORIDA ELECTRIC TRANSIT BUSES WITH CHARGING AND ASSOCIATED EQUIPMENT

RFP 21-980369 - SEPTEMBER 21, 2021

GILLIG

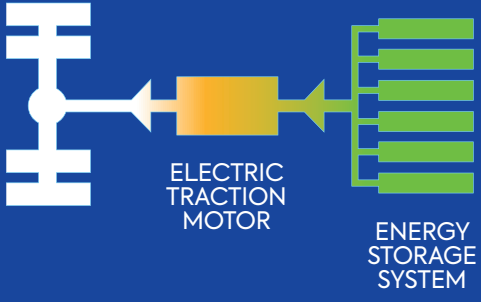
BUILDING AMERICA'S ZERO EMISSIONS FUTURE



Electrify Your Fleet

Our new battery electric offering joins GILLIG's industry-leading Low Floor bus platform to bring the most comprehensive, advanced battery electric bus to the market. GILLIG's Zero-Emission Battery Electric bus incorporates the Cummins electrified powertrain, which provides the advantage of full local service support with hundreds of service centers throughout the country to provide the necessary training, warranty administration, and after-market parts. Designed, built, and supported right here in the United States.

Cummins Electrified Powertrain



GILLIG BATTERY ELECTRIC ZEROEMISSIONS

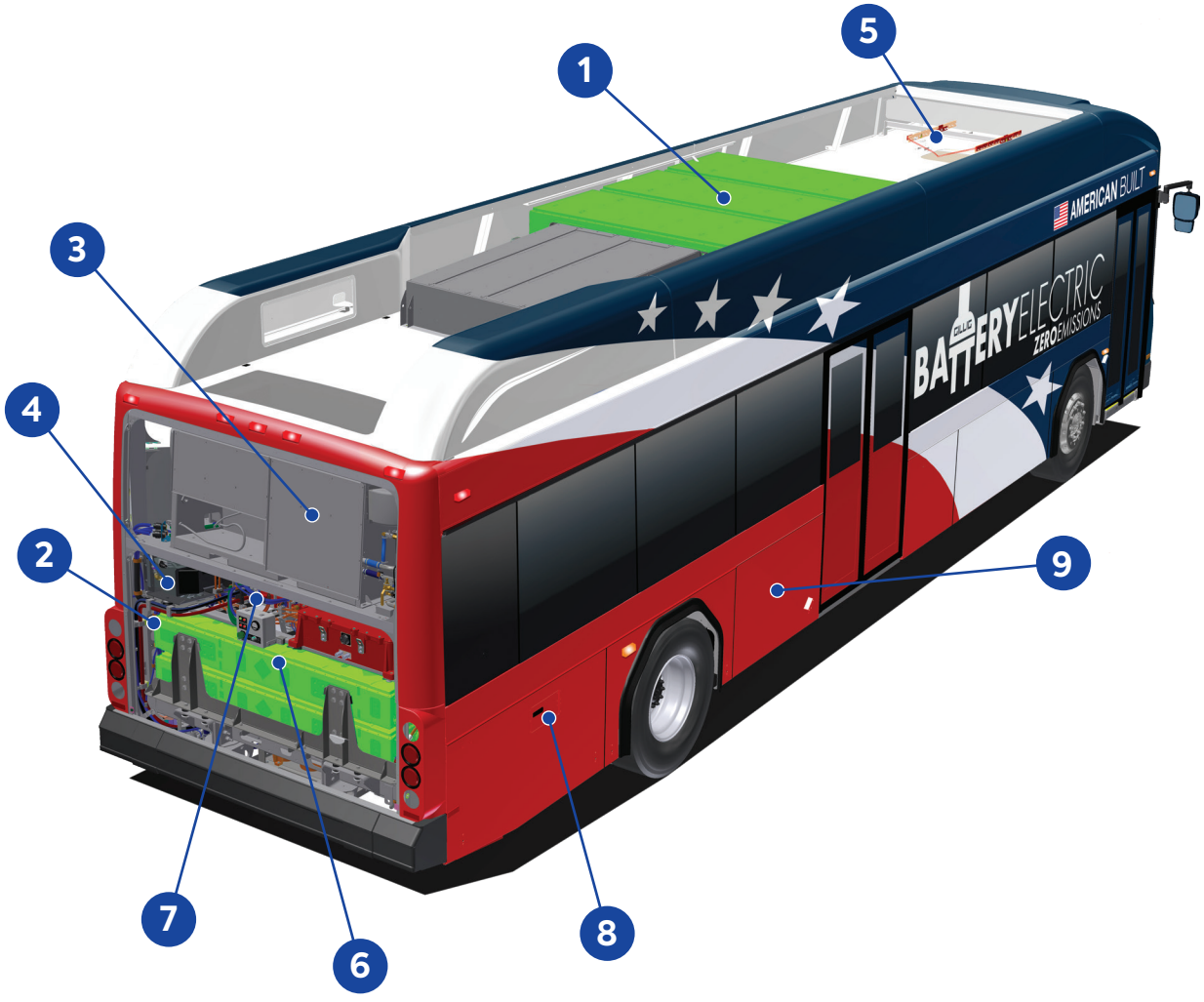
Specifications:

- Low Floor Battery Electric with Contoured-style Roof Fairings
- Cummins EV Drivetrain: Traction Motor and Inverter, High and Low Voltage Power Supplies, Modular Energy Storage System, Charge Controller
- Meritor 79000 Series Rear Axle
- Air Disc Brakes
- Standard Transit Size Tires
- Acceleration/Handling similar to conventional power train options
- Plug-in Charging – SAE J1772 DC CCS Type 1
- Thermo King Electric HVAC with Integrated Thermal Management System
- 24V DC Power Steering Pump
- Fuel-fired Coolant Heater Option for Cold Weather Operation

LOW FLOOR BATTERY ELECTRIC
Features and Benefits

COMPONENT LOCATIONS:

1. Roof-mounted Energy Storage System (ESS), up to 3 battery packs
2. Electronics Cooling Package (ECP)
3. Thermo-King HVAC with integrated Battery Thermal Management System
4. Air Compressor
5. Optional roof-mounted charge rails
6. Two battery packs mounted in the power train compartment directly above the frame rails
7. Power train component assembly consisting of: High-Voltage DC junction box with disconnect switch, two DC-DC convertors, and System Control Unit (SCU)
8. Standard Plug-in-charge location, rear curbside (optional additional locations available)
9. Battery pack forward of rear axle



Rear panels not shown for clarity. Specifications and features are for reference only and subject to change without notice or obligation.

QUALITY WITHOUT COMPROMISE

THE GILLIG WAY



GILLIG



THE GILLIG WAY

GILLIG is the leading heavy-duty transit bus manufacturer and aftermarket parts supplier in the United States. From initial design through final assembly, each and every GILLIG bus is designed and built by dedicated employees who have a passion for quality and customer satisfaction.

Our industry leading Low Floor bus platform incorporates a broad range of drive systems, including clean diesel, compressed natural gas, diesel-electric hybrid, and zero-emission battery-electric.

GILLIG is committed to building buses that connect communities, eliminate congestion, and contribute to a greener environment. For over 125 years, GILLIG has been a family-owned American business with a long history of creating well-paying, dependable American jobs. Our 100% U.S. presence recycles tax dollars back into the community to further support public transportation.

To meet growing customer demand, GILLIG recently moved into our new headquarters and purpose-built production facility in Livermore, California.





First Production Deliveries
Livermore, California

QUALITY WITHOUT COMPROMISE

GILLIG believes that quality is more than a process – it is a commitment throughout our entire company to produce the most reliable, durable, and cost-effective bus in the industry and support it for life. It is a decision to never compromise on excellence and to ensure that you always receive the attention, service, and performance that you deserve. It begins with a detailed focus on your individual requirements, and culminates in a steadfast partnership that you can count on.

As demand for transit services outpaces your financial resources, you need a quality bus that minimizes your costs while providing the on-time service that your customers expect. GILLIG's industry-leading reliability has been documented at the Altoona test track and proven in daily operation throughout U.S. cities.

Our broad product offering and expertise, coupled with our customer-focused design, afford a bus platform that is customized to your specific requirements. Our modular design allows you to select the propulsion system, length, and styling package for individual service requirements while still maintaining fleet commonality.

Quality you can count on — THE GILLIG WAY.



Timeless Styling for Your Fleet Workhorse

The Low Floor bus is the fleet workhorse for transit throughout the U.S., and the foundation for each of GILLIG's designs. Durable, reliable, and cost-effective to maintain and operate, the stainless steel chassis and aluminum body equate to a light-weight, high-strength bus with timeless styling.

Our Low Floor is available in 29', 35', and 40' lengths, powered by Clean Diesel, Diesel-Electric Hybrid, or Compressed Natural Gas.





LOW FLOOR DIESEL



LOW FLOOR HYBRID



LOW FLOOR CNG



A Stylish Evolution with Contemporary Flair

Update your brand and impress your community without compromising operational performance. The modular BRT design allows you the aesthetic flexibility to select the look you desire.

Our BRT is available in 29', 35', and 40' lengths, powered by Clean Diesel, Diesel-Electric Hybrid, or Compressed Natural Gas.



LOW FLOOR BRT DIESEL



LOW FLOOR BRT HYBRID



LOW FLOOR BRT CNG





LOW FLOOR BRTPLUS

Streamlined Elegance Adds Sophisticated Style

This sleek, aerodynamic design incorporates a raised, raked-back front cap blended into a full-length, contoured roofline. Its modern profile makes a distinguished statement to your community.

Our BRTPLUS is available in 29', 35', and 40' lengths, powered by Clean Diesel, Diesel-Electric Hybrid, or Compressed Natural Gas.





LOW FLOOR BRTPLUS DIESEL



LOW FLOOR BRTPLUS HYBRID



LOW FLOOR BRTPLUS CNG



LOW FLOOR 29'

Efficient Agility & Convenience

Our 29' Low Floor is a heavy-duty, transit-proven bus with the agility and style you want in a smaller vehicle. The 29' Low Floor is designed to operate for a minimum of 12 years or over 500,000 miles. The heavy-duty components ensure you will experience the same operational and maintenance savings, durability, and support for which GILLIG has become renowned.

Our 29' Low Floor is powered by Clean Diesel, Diesel-Electric Hybrid, or Compressed Natural Gas. When combined with GILLIG's modular BRT, BRTPLUS, or Trolley designs, the 29' offers you the opportunity to build a fleet customized to your needs!



29' LOW FLOOR



29' LOW FLOOR BRT



29' LOW FLOOR BRTPLUS





LOW FLOOR HYBRID

Proven Reliability, Cleaner & Quieter Technology

GILLIG has been building diesel-electric hybrid buses for nearly two decades, and we offer the best and most complete hybrid product line. Altoona test results show that the GILLIG Hybrid is quiet, reliable, and fuel efficient. Our customers attest to its smooth acceleration, quiet operation, and the ease of assimilating our Hybrids into their fleets. With rising fuel prices and increased environmental awareness, GILLIG hybrids are a smart addition to any fleet.

Our Hybrid is available in 29', 35', and 40' lengths with optional BRT, BRTPLUS, or Trolley styling.



Allison Hybrid

BAE SYSTEMS

GILLIG HYBRID



LOW FLOOR HYBRID

Features and Benefits

GIVES YOU OPTIONS

- GILLIG Hybrid with Allison Parallel Drive and optional Vanner HBA
- GILLIG Hybrid with BAE Series Drive and Auxiliary Power System

EFFICIENT STOP-AND-GO DRIVING

- Hybrid technology is ideally suited to the demands of transit stop-and-go duty cycle. Electric motors develop maximum torque at slow speed during frequent starts, and regenerative braking converts and stores energy in the roof-mounted batteries during braking.
- Engine start/stop technology allows engine-off operation when the vehicle is stopped, and electric-only propulsion and zero emissions when the battery state of charge is sufficient.

SAVES ENERGY

- GILLIG Hybrids use approximately 25% less fuel than diesel buses.*
- GILLIG Hybrids allow for the use of electric components that reduce fuel consumption.

REDUCED EMISSIONS

- GILLIG Hybrids can be approximately 90% cleaner than the 12-year-old buses they replace.
- GILLIG Hybrids can also run on domestic B20 biodiesel for greener performance.

REDUCES OPERATING COSTS

- GILLIG Hybrids help reduce fuel expense.
- GILLIG Hybrids help reduce the frequency of brake changes.
- Electric accessories reduce wear and tear on engine components and eliminate some maintenance items from the bus.

* Results may vary depending on application.



LOW FLOOR CNG

CNG is a Natural Alternative

With GILLIG's maintenaince-friendly CNG design, our CNG bus recorded the best fuel economy and reliability to date at Altoona testing. With this fuel option, you can now combine GILLIG's product reliability, corporate stability, and friendly support with the latest CNG technology.

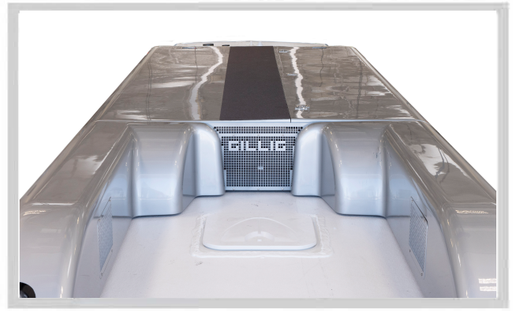
Our CNG is available in 29', 35', and 40' lengths with optional BRT and BRTPLUS styling.





LOW FLOOR CNG
Features and Benefits

Encapsulated Designed Enclosure



CNG Tank Valves Centrally Located for Ease of Servicing



Integrated CNG Fuel Management Panel

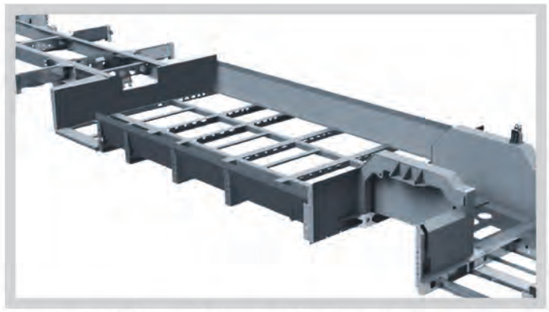


Maintenance-friendly Mounting Locations for CNG Serviceable System Components



SAFETY, PERFORMANCE, AND VALUE

Quality by Design



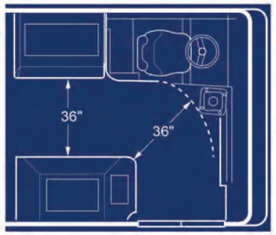
A unitized stainless steel chassis with unique side impact barrier adds strength and corrosion resistance to the Low Floor bus and protects passengers in the event of a collision.



GILLIG's Low Floor body structure of lightweight, high-strength aluminum with anodized side posts resists corrosion and greatly simplifies collision repairs. Its reduced weight saves on fuel costs and its aluminum components are recyclable.



The Driver's Station is comfortable and ergonomic. Controls are convenient, easy-to-read, and logically located to ensure better vehicle control, ride comfort, and safety.



The Front Vestibule Area is designed for quick and easy entry and is one of the largest in the industry. A 1:6 ramp makes access even easier and reduces dwell time.



Quick-Change Skirt Panels keep the bus out of the body repair shop and back on the road for a potential collision repair savings of $10,000/bus over 12 years.



Standard-Sized Tires last up to 60% longer than low profile tires, and their lower rolling resistance saves fuel. Coupled with a lighter body and an efficient drivetrain, the labor and fuel savings could equal $24,000/bus over 12 years.

Bus Length - Low Floor	29'	35'	40'
Maximum Seating	28	34	42
Maximum Height	(D) 122", (H) 131", (C) 133"	(D) 123", (H) 133", (C) 133"	(D) 123", (H) 133", (C) 133"
Outside Turning Radius	30'	37'	44'
Maximum Fuel Capacity	75 gal / 21,600 scf	120 gal / 25,000 scf	120 gal / 25,000 scf
GVWR (lbs.)	34,500	39,600–41,600 *	39,600–41,600 *

(D) = Diesel (H) = Hybrid (C) = CNG

* GVWR varies with brake type: 14.5x10" Drum = 39,000 lbs., 16.5x8.625" Drum = 41,000 lbs., Disc = 41,000 lbs.

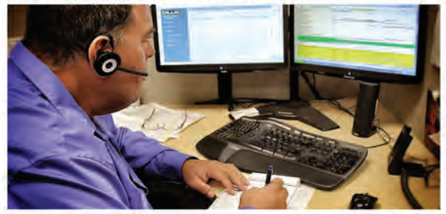
Specifications and features are for reference only and subject to change without notice or obligation.

SUPPORT FOR LIFE

Contact Parts 800.735.1500

Customer Service

Our Commitment to You



Access us by phone, mail, email, or fax. Our dedicated Parts Sales Representatives are experienced, friendly, and ready to assist you with all your parts needs.

Performance

Our Core Capability



All priority or bus-down orders ship the same day. Standard orders typically ship within 24 hours. Our state-of-the-art ERP system and dedicated team ensure that your parts ship quickly and accurately.

Massive Parts Inventory

The Right Parts at the Right Time



Our large deicated Parts warehouse is a true "Class A" facility, stocked with a huge assortment of the right parts to keep your buses on the road.

Service

You Can Count on Us



Our knowledgeble and experienced service technicians are domiciled throughout the country to resolve your technical matters.

Non-GILLIG Bus Parts

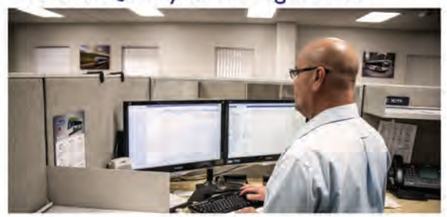
Full Service Parts Department



We stock parts for many other major brands. Call us to compare our pricing, parts availability, and our friendly, responsive service.

Quality and Price

The Best Quality at the Right Price



We supply only the best quality Original Equipment and Premium aftermarket parts. Our parts are competitively priced to provide you the best value.



SAN FRANCISCO 1890–1937



HAYWARD 1937–1968



HAYWARD 1968–2017



LIVERMORE TODAY

SUPPORT FOR LIFE –THE GILLIG WAY

GILLIG was founded in 1890 with a commitment to customer satisfaction and value. That commitment continues today. We still have time for trust and friendships and those "old-fashioned" values of honor, integrity, and giving our best.

Our continuous improvement program is heavily influenced by customer input and our products are defined by years of experience and customer focus groups. Development programs include input from suppliers, employees, and industry trends—all so we can continue to bring you the best now and in the future.

GILLIG buses are proudly made in America by dedicated Americans—recycling your tax dollars and generating more tax revenue funding for you.

American buses are technology leaders: they have the cleanest engines and were the first to incorporate multiplexing, GPS, IVS, and hybrid technologies. Buying American buses provides you with the best product, backed by local accountability and support. Promoting domestic jobs helps to strengthen our nation. You get great buses from GILLIG and keep America working!

GILLIG

451 DISCOVERY DRIVE | LIVERMORE, CA 94551

GILLIG

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Pinellas Suncoast Transit Authority



EXECUTIVE SUMMARY

GILLIG

GILLIG respectfully submits this Executive Summary to assist the **PSTA** in its deliberations selecting the proposal with the best overall value. We are confident **PSTA's** evaluation will identify GILLIG as the most responsive and responsible bidder in this procurement and developed a summary of salient points to highlight the key elements of our proposal.

BACKGROUND

Founded in San Francisco, CA in 1890, GILLIG made its start manufacturing buggies and carriages. With a 130-year legacy manufacturing transportation vehicles, we are now the largest heavy-duty bus provider of 35' and 40' transit buses to cities throughout the United States. GILLIG possesses the necessary resources and expertise to manufacture, deliver, and support **PSTA**.

GILLIG is now located in a **new, purposely build bus production facility** in Livermore, CA, where we manufacture 100% of our customers' heavy-duty transit buses from this single location. With a single production facility such as ours, all company departments (Sales, Engineering, Purchasing, Production, Publications and Service) are located at one site, which promotes a unique centralized focus to the bus production process, ensuring the manufacture of the highest quality buses. It is important to point out that GILLIG does not subcontract any work for our bus builds, so the complete responsibility for the success of your bus delivery resides at our Livermore facility. It should also be noted that the GILLIG organization, owners and key personnel remain much the same as it has been over the many GILLIG bus orders supplied to **PSTA**.

OUR PROPOSAL

GILLIG greatly appreciates this opportunity to submit our proposal to the **PSTA**. Our proposal is divided into four separate groups: the Technical proposal, the Price proposal, the GILLIG corporate Qualification's proposal and the Proprietary/Confidential information package requirements. For your convenience navigating the proposal, we have included a Table of Contents.

In the Technical proposal, you will identify information which defines the bus components, highlights its operation and expected performance, and details the applicable vehicle data sheets. This section also identifies our organizational project support team, which yields significant benefits to **PSTA**, namely access to our superb Engineering, Production, Service and After-Market Parts departments. Customer references and testimonials demonstrating the extraordinary preference for GILLIG are also contained in the Technical proposal.

In addition to the bus pricing, our Pricing proposal includes the costs for such items as spare parts, additional training and test equipment, if required.

Our Qualifications package includes Pre-Award evaluation data (when required at this stage), insurance coverages, all required proposal forms and federal certification documents.

Any Proprietary/Confidential information submitted with GILLIG's proposal will be inserted in a separate, clearly marked package.

PROVIDING LONG-TERM VALUE

We commend **PSTA**'s procurement process, which **emphasizes long term value and total cost of ownership vs the cheapest purchase price.** We maintain that a product's design and features, as well as its reliability, durability, quality and total cost of ownership are all components which comprise its overall value; with the weight of each of these factors being determined by each customer's unique requirements.

In addition to product value, the other factors critical for a satisfying purchase are **on-time delivery, training and field support, and a long-term partnership with the manufacturer**. These latter items may prove difficult to evaluate, but are as important as the initial acquisition cost, particularly for a high-cost, severe duty, purpose-built product like a transit bus. **GILLIG has the integrity, commitment, resources, stability and customer satisfaction**, to deliver on these other factors also. Consequently, we are confident our proposal offers both the **BEST product value** and the **BEST partner to ensure a successful build,** as outlined below.

REDUCING THE RISK

We believe that –

a) Bus purchasing can be risky because **buses are a complicated, purpose built product and not a commodity,** so the performance of the vehicles may not be evident until the buses have been in service for some time, perhaps years after the purchase decision is made; and with the frequent failures/ownership changes in the North American bus manufacturing industry, support is not always a given.
b) An informed buyer makes a better decision and so becomes a more satisfied customer, and an **informed buyer always selects long term value and avoids unnecessary risk – which means GILLIG,** because we've always maximized long term value and minimized risk; and
c) **Two thirds of BUS is us,** so when buying a bus it's critical to know about the US part – the company's reputation, its integrity and commitment, its capabilities and performance and its' long-term and customer strategies – because this can be the riskiest aspect of a bus procurement.

EVALUATION AREAS

To facilitate the evaluation of GILLIG's proposal, we have expanded on the following areas below –

- **COMPANY HISTORY** – Possessing a long-term focus with over 130 year's experience manufacturing transportation vehicles.
- **RELIABILITY AND MAINTAINABILITY** – The best mean distance between failure (MDBF) in the industry.
- **PRODUCT FEATURES** – Unique designs and benefits.
- **DRIVER AND PASSENGER COMFORT** – Advanced features.
- **MILEAGE** – More miles of everything.
- **INITIAL AND LIFE CYCLE COSTS** – Lower overall cost means better value.
- **DELIVERY** – Incident free and we're never late.
- **REPUTATION AND PERFORMANCE** – Consistent and unbeatable.
- **FINANCIAL SECURITY** – Privately held with extensive financial resources
- **MANAGEMENT PLAN** – To ensure successful completion of contract.
- **SUMMARY** – Value you can count on.

COMPANY HISTORY

GILLIG has an **unbeatable history of long-term stability, continuous improvement, state-of-the-art technology, unfaltering integrity and responsibility, great customer satisfaction** and a passion for performance. We demand and promise the highest levels of performance from our people, our products and our company -- and we have a history of converting this performance into satisfaction for our customers.

More details of our history are explained elsewhere in our submission, but the highlights are: Over 130 years of continuous success, with an impressive array of design firsts, an unblemished record of financial stability, **an unequaled record of organizational stability, the most transit experienced people and management, unquestionable integrity and trust**, and an unbeatable level of performance. The combination of this history, this experience, these skills and this performance, yields a product renowned for its reliability, durability and economy, resulting in the highest levels of customer satisfaction -- not our words -- please read the many customer testimonials included with our proposal.

GILLIG is a privately held company, with materially the same management, physical and financial resources which insured GILLIG's successful execution on previous **PSTA** contracts. Our ownership is dedicated to strengthening those capabilities, so we are confident we will exceed your expectations for this new contract.

Our history proves -- **YOU CAN COUNT ON US**.

RELIABILITY AND MAINTAINABILITY

These are the heart and soul of any commercial equipment and **certainly the strengths of GILLIG's transit buses**. We know that your performance is measured by up time and operating expense, so **our buses are designed and built to maximize up time and minimize operating expense**.

Our Low Floor bus has a proven history of excellent performance and incorporates **significant features which improve its operating performance**. We use this same Low Floor platform for all our power modes including our electrified power train to provide you with the standardization of parts and training on the remaining 80% of the bus that you have and already know. The foundation of the GILLIG bus starts with a **robust stainless-steel structure** for strength, durability and maximum corrosion resistance. Compare that to some competitors' standard carbon steel structure and it is evident our stainless-steel chassis design is 130 times more resistant to corrosion. That stainless-steel chassis design also incorporates a clever and **unique side impact barrier to enhance the safety** of the passengers. The body is constructed with an all-aluminum, bolt-together structure, which (1) **reduces weight** significantly, (2) is easy and **inexpensive to repair** because of its simple bolt-together design, and (3) is **corrosion resistant**. The use of **standard tires extends tire life and cuts replacement costs**, as well as provides for traditional approach and departure angles. The use of Meritor's proven axles and brakes also **reduces costs and avoids additional training** for mechanics. Large access doors and simple skirt panels improve operating performance because of **reduced maintenance hours and lower parts costs**.

The GILLIG BEB has recently completed Altoona testing with a score of 86.3 (Report #LTI-BT-R2020-05). The final report is included in our Technical bid submission as requested.

Please read the included customer testimonials and other **reliability and maintainability data, proof that our transit bus is great and getting better**. We are proud of our products and our achievements and believe **an informed purchaser will make the right choice – GILLIG!**

PRODUCT FEATURES

We believe this proposal will demonstrate that our vehicles have the best features and technologies to meet your requirements and that our designs result in the most reliable, durable, and cost-effective battery electric low floor bus to maintain and operate.

Our Low Floor bus uses **forward-looking technology with some unique ideas to avoid the inherent compromises found in most other low floor designs**.

Our Low Floor **interior and exterior designs are functional and practical.** Our concern for easy maintenance and lower repair or replacement costs, keeps the exteriors and interiors simple and uncluttered. Our **Low Floor's exterior is pleasing, functional, practical and safe**, while its interior is also **pleasing, functional, safe and comfortable**.

Passenger and driver safety also play a big part in our design strategy. Our Low Floor has a very robust structure, and **many customers will attest to its strength**. So, in accidents, or after hard transit usage, the driver and passengers are always safe and protected. Our unique stainless-steel side impact protection barrier provides a safe enclosure for your passengers and drivers.

GILLIG's unique bus electrification solution includes the use of the Cummins' Electrified Power System. As a result of our strategic partnership with Cummins, this electrified power system brings state of the art technology to the bus electrification industry and is supported by their local distributor network for quick response to service, warranty and training requirements.

DRIVER AND PASSENGER COMFORT

Ergonomics dictate the design of the driver's workstation and controls in the GILLIG bus. Our engineers went well beyond sufficient seat adjustment and a tilt/telescoping steering wheel, to include the placement of displays and controls, driver's storage box, sun visors, etc.

During the various design phases, we concentrated particularly on the driver's compartment. **Visibility and comfort are key factors of our design, as is vehicle control,** (which depends

a lot on the vehicles' ride and handling). GILLIG's Low Floor design incorporates a bulged, tilted-back windshield feature to further reduce reflections. Customer feedback indicates that drivers
prefer driving GILLIG electric buses, because they have better visibility and they ride and handle better, so drivers are more in control and more confident. We also provide the necessary space and comfort, along with superior heating and cooling -- **a total environment for the driver to work efficiently, safely, and comfortably**.

Passenger safety and comfort are enhanced by a robust welded stainless-steel understructure (torsionally rigid body ensures a smoother ride) and low floor side impact steel beams, a unique safety feature in the industry. Passenger comfort is further ensured with a **4 air bags rear suspension**, along with advanced frequency selective shock absorbers. Wide doors and aisles, and the largest windows (total square inches) and narrow window posts add to the comfort level, and large tires smooth out the bumps (they don't drop as far into potholes and have more air to cushion the bumps). Overall a great ride for the driver and passengers.

INITIAL AND PROJECTED LIFE COST

The initial price is obviously important; however, we respectfully point out that our pricing history has always been consistent and low. We do not "gouge" customers in a seller's market, as that would be unfair and irresponsible, and **our integrity and your trust are more important than a short-term profit**.

The projected life cycle cost is less definable, but we think more important, however it is more difficult to assess in this relatively new electrification industry where these buses haven't yet reached their complete life cycle. It is also more prone to abuse from irresponsible manufacturers who make inflated claims that would take years to disprove and are impossible to enforce. While we agree that duty cycle and maintenance practices greatly affect life cycle costs, we believe our other customer's experiences should still be a good guide for **PSTA**.

Our customers confirm that **GILLIG buses have lower operating costs, require fewer man-hours to maintain, and have the best road call mileage**. Also, GILLIG service parts are usually lower cost (because of vehicle design) and our stocking and administration of that department ensures quick delivery and minimizes your inventories.

DELIVERY

An early delivery promise is only half the story. Keeping that promise has proved impossible for our competitors -- **but we always deliver on time**. We have a 20+ year history of never being late and have never been required to pay any liquidated damages. Please ask around -- **you will find we are the only bus manufacturer to consistently deliver on-time** and we are certain you will be pleased with our proposed delivery schedule.

GILLIG is extremely proud of its delivery record. Our on-time delivery performance Is exceptional and our new, purposely built, state of the art production facility in

Livermore CA will continue that reputation. This new production facility gives GILLIG the ability to schedule many difference customers' builds simultaneously so all delivery expectations can be met. Please reference the various customer testimonials and delivery documentation within our proposal to gauge our on-time delivery experience.

GILLIG's refined processes and procedures that are developed through our continuous improvement process also insure the accurate and timely delivery of our buses. From the initial documentation of the customer specifications to the final QA checks as the bus leaves our facility, GILLIG's accountability for the specific bus build and production process continues to lead the industry.

Please take our history of being the only manufacturer to consistently deliver on-time into account when evaluating all delivery proposals in this procurement.

MANUFACTURER'S REPUTATION AND PERFORMANCE

We believe these are very important factors because they are the main measures of how a manufacturer will perform. **Without the necessary qualifications, experience, resources, and integrity, the promise of low price, specification compliant product, and statements of field support could turn into hollow promises**.

GILLIG is the most respected and responsible bus manufacturer in the US and has proven our ability to consistently perform on bus manufacturing contracts time and time again. GILLIG's flat organization and single production facility provides many unique benefits in fulfilling bus contracts such as this one. With 130 years of transportation experience coupled with over four decades of FTA and heavy-duty bus building experience, GILLIG's contractual performances have far surpassed that of any competitors. Our excellent industry reputation Is documented by many customer testimonials within this proposal.

GILLIG's qualifications are based on a proven history of **Performance**, an extensive and proven **Engineering Expertise**, extensive and proven **Manufacturing Expertise**, proven **Plant Facilities**, proven **Management Expertise** and a proven **Management Plan**.

GILLIG's measure of our Quality Assurance performance is ultimately based on both short term, as well as long-term performance of our product in service. GILLIG has in place a full Quality Control Department and Quality Assurance Program to meet or exceed all customer and industry requirements. Remember, the only guarantee of quality is the manufacturer's reputation; ISO 9000 or similar certifications are only indications that a **quality system exists, NOT a measure of production quality** – output quality is best gauged by reputation, and it depends on attitude and capability.

In the end, our financial strength, our consistent delivery performance, our products' reliability, our responsive field support and most of all, our friendly customer relationships all go to **making us the best and most responsible bus manufacturer**, and we sincerely hope you agree with this conclusion.

We believe reputation is very important when making a long-term purchase decision (15 to 20 years) because products and proposals can be "doctored" to look good, but a reputation can't. Reputations of good attitude, commitment, or performance history take years to build and so, are the best gauge for a long-term decision.

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INTEGRITY AND EXPERIENCE

Integrity is one of GILLIG's key core values that we focus upon and is consistently discussed at the Executive team and the Managerial team level meetings. As a privately-owned company, GILLIG is uniquely positioned to make those right decisions that positively impact our customers and our outstanding reputation. And because we are privately held, GILLIG is not subject to questions and statements from financial analysts who are more concerned with short term gains instead of the long-term reputation. Accountability within the appropriate levels of our organization is an important ingredient to our success and we are confident that our accountability has been proven over many years of our partnership with **PSTA**.

As to experience, **GILLIG is the number one 35'/40' heavy duty bus builder** in all North America, even though we only sell buses to United States transit agencies, not Canadian. GILLIG's vast experience with small, medium and large transit agencies gives us a very unique perspective on various requirements from the agencies' side. We currently have approximately 500 cities in the US that operate GILLIG heavy duty transit buses in a wide variety of ambient temperatures, terrains, environments and operating conditions. Transit agencies from the east coast to the west coast, Alaska to Florida, Maine to California (and Hawaii) enjoy the high reliability and durability of the GILLIG design. GILLIG's experience includes the design and manufacture of clean diesel, CNG, Hybrid Electric and Battery Electric buses.

QUALITY OF PERFORMANCE OF PREVIOUS CONTRACTS

Over the last few decades, GILLIG has delivered many different bus contracts to **PSTA**. These contracts include diesel, CNG and Hybrid buses. The GILLIG quality of performance for each of these contracts, we believe, has been exceptional and we hope that you agree as well. Whether quality is determined on the product design, the manufacturing process, on-time delivery, service, aftermarket parts supply or overall performance of the contract, GILLIG **delivers on the entire bus supplier program**. After many multi-year procurements with **PSTA**, GILLIG is proud of our performance with you, as well as the many thousands of other contracts we successfully completed in every case over many years in business.

COMPLIANCE WITH LAWS, ORDINANCES AND FTA REGULATIONS

Compliance to existing laws, ordinances and regulations is not new to GILLIG. Over the years and through GILLIG's vast bus design and building experience, we have become experts in the understanding and execution of the regulations from EPA, ADA, FMVSS, FTA and various state laws, just name a few. GILLIG is a certified TVM with the FTA and meets all the DBE, Buy-America and other FTA requirements.

Also, GILLIG's Engineering and Compliance teams implement the **highest safety standards** and the subsequent designs into our buses to meet and exceed those regulations. This is particularly important with high voltage electrification systems and GILLIG leads the industry in the safety precautions and designs of those systems.

HAVING THE ESSENTIAL FINANCIAL RESOURCES

GILLIG is by far the **most financially secure bus manufacturer in North America**, and we have been so for many decades. It is important to note that GILLIG has **no long-term debt** and has the necessary cash to run a very capital-intensive manufacturing organization. GILLIG does not request, nor desire, progress payments from our customers as that financial responsibility should be placed solely on the bus builder. It would not seem prudent from a buyer's perspective to even consider a supplier that would even request progressive payments!

Additionally, a business practice in the bus industry unique to GILLIG is that we always **pay our suppliers in a timely manner**, and that is one of the important reasons why GILLIG is their preferred OEM to support.

GILLIG also has **unlimited bonding opportunities** because of our consistent ability to perform on our contracts. Even if large Performance Bonds or other types of bonds are required in contracts, our cost for those bonds are so low that such costs would not even be included in our contract/bus prices.

GILLIG's consolidated financial statements are audited by a multinational professional auditing firm that has been performing our audits for many decades. Our audited financial statements consistently **confirm GILLIG's excellent and stable financial condition** and thus ensure our capability to fully satisfy your bus manufacturing requirements.

GILLIG has been, and continues to be, in good standing with all their contracts. GILLIG has never been debarred or suspended by any governmental agency. Our **ability to consistently perform on our contracts is second to none**, and we trust the **PSTA** will positively evaluate GILLIG as the most prudent choice for this contract.

Be assured, **GILLIG is your ZERO RISK CHOICE**, with relationships you know **you can trust** — and we will stake our reputation on that!!

MANAGEMENT PLAN

GILLIG's proven management plan is the result of refining the sales and production processes of heavy-duty buses based upon our many years of transit experience. Directed by our highly experienced Executive Team, our **management plan stresses continuous measurable improvements in processes and procedures** to make sure our buses are delivered timely, and to the highest quality standards, to exceed our customers' expectations.

GILLIG truly understands the importance to **PSTA** of this electrification conversion and commits to the following to ensure project success. Although **PSTA** is already very familiar with the GILLIG team and the management plans that we have implemented on previous contracts,

GILLIG wishes to assure **PSTA** that similar successful management plans will be used here as well, with of course, the appropriate refinements that are necessitated for an electric bus build.

Our **Executive Management Team for this PSTA project will consist of the VP Sales, VP Engineering, Executive VP Manufacturing and Customer Support, and the VP Parts.** Each has a very defined role in the launch, execution and completion of the contract. Each of these executives has a **team of highly skilled professionals** and has the human and physical resources currently in-house that will be committed to this **PSTA** project. Various Directors/Managers in each group will oversee the daily activities for the project who report to the various VPs. Since GILLIG does not subcontract any work regarding the building of the buses, GILLIG has complete responsibility and control!

Our Management Plan starts with the receipt of the **procurement documents that get examined thoroughly** by an extremely knowledgeable Sales team and Project Sales Management team who initiate the complex process of electric bus building with you, so the **contract can be precisely documented and executed** to assure we exceed your expectations. A pre-production meeting occurs usually within 8-9 months prior to production start of the first bus to finalize the Sales Work Order. Upon release of the Sales Work Order internally at GILLIG, it is transferred to the highly experienced Purchasing and degreed Engineering teams to develop the proper Bills of Materials and proceed with any unique customer design requirements so the required material can be purchased. The GILLIG Production and QA teams then **manufacture your buses to the exact build sheet of your specification** to provide you with the high quality and reliable buses that you are accustomed to and expect from GILLIG. The production time of each bus is only about ten days and our current order backlog and order processing time results in an estimated start of delivery within 12-14 months. After delivery of the vehicle from our Livermore, CA facility, our fully qualified aftermarket Service and Parts teams help you place the buses in service quickly with a seamless PDI process and help keep them in service with timely delivery of spare parts at very competitive prices.

It should also be noted that **GILLIG embraces a unique partnering philosophy** with our customers. We believe this partnering approach allows for sincere discussions to avoid conflict and allows us to **collectively exceed our mutually agreed goals**. GILLIG has routinely demonstrated with all our customers our openness, accessibility and willingness to support our product and provide the highest level of respect.

Please see our specific **PSTA** Management Plan in the appropriate section of this proposal for your specific timeline.

SUMMARY

We believe we are the best manufacturer for **PSTA** and are confident that you will agree. Our product, our life cycle cost, our qualifications and our past performance are second to none. **PSTA** can be secure in the knowledge that a contract with GILLIG for this purchase will provide the best product and support, as well as a valued long-term partner.

Please take a moment to read the included **customer testimonials -- positive statements from customers about our company, our products, and our people.**

WE BELIEVE PRICE IS IMPORTANT, BUT NOT AS IMPORTANT AS TOTAL LIFE CYCLE COSTS, PERFORMANCE, RELIABILITY, EXPERIENCE AND LONG-TERM CUSTOMER SATISFACTION.

FOR LONG-TERM VALUE --- YOU CAN COUNT ON US.

As the leader in the US heavy-duty transit bus market, you can be assured that GILLIG is your best choice for your Electric, CNG, Hybrid and Diesel bus needs. We thank you for your consideration and hope this Summary has demonstrated that we are the BEST choice for your operation.

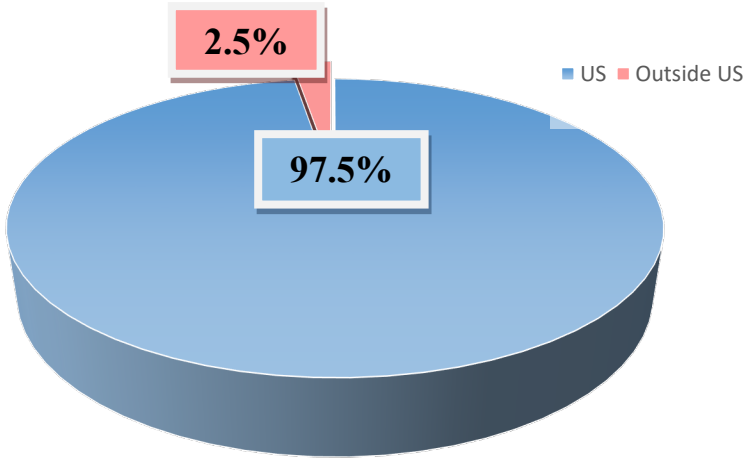
GILLIG

GILLIG SUPPORTS AMERICAN JOBS

GILLIG LLC is a privately owned American manufacturer of heavy duty low floor transit buses located in Livermore, CA. and is the leading supplier of heavy duty transit buses in cities throughout the United States. 100% of GILLIG's manufacturing process is completed in America by American workers, who in turn reinvest those tax dollars back into the American economy to help strengthen our nation and support American jobs. This is not a new practice for GILLIG, we have been manufacturing transportation equipment in America for over 129 years and we are proud to be part of the solution to build our nation's economy and be a strong supporter of American jobs.

- ✓ 100% of GILLIG employees live in the U.S.
- ✓ 100% of GILLIG employees pay U.S. taxes
- ✓ Your tax dollars get recycled into the U.S. economy

GILLIG DOMESTIC SPEND ANALYSIS



CUSTOMER REFERENCE LIST (BEB)

Our **ZERO EMISSIONS BATTERY ELECTRIC BUS (BEB)** offering joins GILLIG's industry leading Low Floor bus platform to bring the most comprehensive, advanced battery electric bus to the market.

GILLIG's Zero Emission Battery Electric bus incorporates the Cummins electrified powertrain, which provides the advantage of full local service support with hundreds of service centers throughout the country to provide the necessary training, warranty administration, and after-market parts. All designed, built, and supported right here in the United States.

Please see the below reference list for current Battery Electric Bus customers. GILLIG has built and delivered well over 60 Battery Electric Buses to over 25 different customers.

Customer: **Santa Monica, CA (Big Blue Bus)**
Address: 1660 7TH Street Santa Monica, CA 90401
Contact: Adrian H. Garcia, Transit Maintenance Vehicle Supervisor
Phone: (310) 633-1852
Email: adrian.garcia@smgov.net

Customer: **Tucson, AZ (Sun Tran)**
Address: 3920 N. Sun Tran Blvd. Tucson, AZ 85705
Contact: Jim Gleason, Director Maintenance
Phone: (520) 206-8891
Email: james.gleason@tucsonaz.gov

Customer: **Honolulu, HI (The Bus)**
Address: 650 South King St. Third Floor Honolulu, HI 96813
Contact: Adam Tamayoshi, VP of Maintenance
Phone: 808-768-9463
Email: adam.tamayoshi@thebus.org

Customer: **Kansas City, MO (Kansa City Area Transit Authority)**
Address: 1350 East 17TH St. Kansas City, MO 64108
Contact: Chuck Ferguson, VP, Bus Operations
Phone: (816) 346-0353
Email: cferguson@kcata.org

Customer: **Kitsap, WA (Kitsap Transit)**
Address: 60 Washington Ave, Ste. 200, Bremerton, WA 98337
Contact: Dennis Griffey, Vehicle & Facilities Maintenance Director
Phone: (360) 478-6229
Email: dennisg@kitsaptransit.com

CUSTOMER REFERENCE LIST (BEB)

Customer: **Bellingham, WA (Whatcom Transportation Authority)**
Address: 4111 Bakerview Spur, Bellingham, WA 98226
Contact: Michael Bozzo, Director of Fleet and Facilities
Phone: (360) 788-9351
Email: mikeb@ridewta.com

Customer: **Portland, OR (Trimet)**
Address: 1800 SW 1st Avenue, Suite 300, Portland, OR 97201
Contact: Samuel Rumhizha, Director, Bus Maintenance
Phone: (503) 962-5840
Email: rumhizhs@trimet.org

ATHENS CLARKE COUNTY

MEMORANDUM FOR RECORD

To Whom It May Concern; Date: March 2, 2021

Letter of Reference for Gillig LLC

I have been working in various positions in the public transit industry for the last 25 years. I started as a bus mechanic, then, worked as a back –up driver, in Operations, Maintenance Management and Administration. I have been the Director of Athens-Clarke County Transit department since October of 2001.

Over the years, I have either worked on, driven, or helped facilitate the purchase more than 300+ Gillig buses. The various 30, 35, and 40-foot standard and low-floor heavy-duty transit buses, with diesel, hybrid, and/or electric propulsion systems have been reliable vehicles for this system, as well as many other transit systems across this county. Gillig's customer services from product order, though production and delivery, to their after the sale, replacement parts and repair programs, their staff and services have always been exemplary.

I believe that Gillig builds the best heavy-duty transit buses in the industry. From their sales staff, the engineers, the workers on the assembly line, to the parts department folks, they all are reliable partners to our organization and they stand behind their products as a company and as a member of the team.

I would highly recommend Gillig LLC, their staff and their products to any system in the industry.

Thank you,



Butch McDuffie
Director,
Athens-Clarke County Transit Department
Athens, GA 30601
706-621-0667

Big Blue Bus
Transit Maintenance
1660 7th Street
Santa Monica, CA 90401

City of
Santa Monica®

September 14, 2020

Mr. Joe Policarpio
Vice President of Sales and Marketing
GILLIG LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Policarpio,

Big Blue Bus (BBB) would like to thank GILLIG for helping us provide safe and reliable buses that represent the latest in bus technology and clean fuel sources. Since 2012, you have helped us maintain the highest quality fleet and become the first transit agency in Southern California to purchase buses with near-zero compressed natural gas (CNG) engines. With GILLIG, BBB crossed a historic threshold in August 2019: the in-service deployment of our first zero-emission battery-electric bus, which is performing beautifully.

Our GILLIG battery-electric bus has exceeded our expectations and those of our customers. It performs as well as our other 124 GILLIG buses. Your cutting-edge bus uses state-of-the-art battery-electric technology, design features, and power capabilities while offering an unparalleled quiet and smooth ride. Because of the incredible reliability and serviceability of our in-service GILLIG battery-electric bus, BBB will be deploying 18 additional GILLIG zero-emission battery-electric buses by 2021.

Our GILLIG battery-electric bus deployment also marks a significant step toward preserving our environment and protecting our communities as we complete the transition to a zero-emissions fleet by 2030. We can't think of a better partner to provide safe, reliable, and efficient transportation services that improve and enhance our community's quality of life. We look forward to a long, mutually beneficial partnership with GILLIG.

Sincerely,

Getty Modica
Transit Maintenance Manager

tel: 310 458-1975 • fax: 310 399-6275 • e-mail: TransitMaintenance@smgov.net

September 14, 2020

Mr. Joe Policarpio
Vice President of Sales and Marketing
GILLIG LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Policarpio,

We couldn't be prouder to partner with GILLIG on 2 FTA Lo or No Emission Grant programs as we invest in creating an innovative and smart transportation system through our in-service GILLIG zero-emission battery-electric bus.

For almost 20 years, GILLIG has provided Tucson with the most reliable buses—diesel-electric hybrid, near-zero emission compressed natural gas, and clean-diesel—all designed on the proven GILLIG Low Floor platform to maximize fleet commonality.

In April 2020, our first zero-emission electric bus from GILLIG hit the streets, and we couldn't be more impressed with its performance. Our bus performs as well as our current GILLIG fleet and now confirms our perception that GILLIG is providing the safest, highest quality, most reliable, and best-supported battery-electric bus on the market. With its advanced technology, our GILLIG electric bus also provides a quieter and more comfortable ride for our passengers. Sun Tran looks forward to receiving our 10 additional GILLIG electric buses as we build a more sustainable community and cleaner air.

Thank you for providing market-leading, dependable solutions as we begin our zero-emissions journey, electrifying our city's vehicle and transit fleet. With the help of GILLIG buses, Sun Tran is an industry leader in safe, reliable, and sustainable transportation solutions.

Sincerely,

Kevin Faulkner
Director of Procurement
Sun Tran

Oahu Transit Services, Inc.
811 Middle St. Honolulu, HI 96819-2316
telephone (808) 848-4400 facsimile (808) 848-4419
www.thebus.org

TheBus
TheHandi-Van

June 23, 2020

Mr. Joe Policarpio
Vice President of Sales and Marketing
Gillig L.L.C.
451 Discovery Drive
Livermore, CA 94511

Dear Mr. Policarpio,

I would like to express my eagerness on taking this momentous step towards the electrification of mass transit with Gillig. There is absolutely no other manufacturer that I would prefer to partner with on such an important endeavor. Your dependable product and outstanding customer support are the cornerstones of the strong relationship that has continued over the years between the City and County of Honolulu, Oahu Transit Services, Inc. and your Corporation.

Currently, the City and County of Honolulu operates a fleet of 367 Gillig buses. The durability and dependability of your buses are evident in our oldest fleet aged at 23 years and in our most utilized fleet having traveled over 1,000,000 miles. Impressionably, we consistently witness your revolutionary advancements with improved fuel economy and lowered operational cost. Reinforcing our reasons why we have confidence in your new electric bus. We know that it will be reliable, well-engineered and environmentally beneficial.

The only factor that surpasses your amazing product is the outstanding customer support that we consistently receive. It is obvious from working with your staff throughout the company, how strongly Gillig is dedicated to their clients and how much they believe in their product. Everyone on staff has proven to be extremely knowledgeable, courteous, and always willing to go the extra mile.

As we anxiously wait for the arrival of our first electric bus, we are anticipating that it will to be a success. I am confident that these buses will provide reliable and efficient public transportation for the people of Honolulu for many years to come. I foresee a promising future with a continued partnership between the City and County of Honolulu and Gillig.

Sincerely,

Adam Tamayoshi
Vice President of Maintenance

GWINNETT COUNTY
DEPARTMENT OF TRANSPORTATION
GWINNETT COUNTY TRANSIT DIVISION

75 Langley Drive | Lawrenceville, GA 30046-6935
770.822.7446
www.gwinnettcounty.com | www.gctransit.com

Karen Winger AICP CCTM, Transit Division Director
Gwinnett County Department of Transportation
770.822.7422
Karen.winger@gwinnettcounty.com

To Whom It May Concern,

This letter is for the recommendation of GILLIG bus manufacture. Gwinnett County purchased the first set of 28 forty-foot long local buses in 2015 as part of the Athens-Clarke County bus consortium. We have since purchased an additional 10 buses with GILLIG through this same contract, receiving our final 3 buses as recently as June of 2020.

Since our first bus arrived, GILLIG has always been prompt, professional and courteous at every step of the process. Whether it be from the presale to finalizing the order, all the way to delivery of our brand new bus, GILLIG has always been responsive to our needs and concerns, in addition to being quick to rectify any issues.

When it comes to sales and service, not only is the GILLIG product a quality and dependable product in the best of times but it is also a product that can come through when need them the most. During the height of the COVID-19 pandemic, GILLIG was able to ship us operator barriers for our entire fleet in less than a month of request.

I am happy to recommend GILLIG to anybody who is looking for a quality bus product.

Karen A Winger

Karen Winger AICP CCTM
Transit Division Director, Gwinnett County

Indianapolis Public Transportation Corporation
1501 W. Washington Street
Indianapolis, IN 46222
317.635.3344
www.IndyGo.net
@IndyGoBus

June 9, 2020

Mr. Jim Ryan
Regional Sales Manager
Gillig Sales
GILLIG LLC
25800 Clawiter Road
Hayward, CA 94545

Dear Mr. Ryan,

I'm writing today to thank you and the Gillig team for your continued partnership and service in providing vehicles for the Indianapolis Public Transportation Corporation (IndyGo).

IndyGo currently operates a fleet of 172 Gillig buses. The Gillig team recently provided exceptional service by working with IndyGo to expedite an order of thirteen additional buses to assist with the future implementation of system changes. Gillig's dedication to customer service is evident, and felt even more so as we navigate a new environment for both businesses and transit agencies. We are proud to have partnered with Gillig for over twenty-five years.

Our Operators and riders know they can rely on Gillig's vehicles to transport them around the city. In a time when most travel is for essential trips, we know how important it is to have vehicles we can count on. The Gillig team continues to provide excellent customer service and high-quality products to our agency. We look forward to our continued partnership.

I would be happy to recommend Gillig's products and services to prospective customers.

Sincerely,

Inez Evans
President and CEO
IndyGo

METRO REGIONAL TRANSIT AUTHORITY

June 2, 2020

Mr. Jim Ryan
Regional Sales Manager
GILLIG LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Ryan;

For more than 30 years, the METRO Regional Transit Authority has been doing business with GILLIG. I have personally had the pleasure of being able to use GILLIG vehicles at all three transit properties with whom I have been associated. From the time, I was a bus operator in Akron, Ohio to overseeing the maintenance department in Nashville to managing Knoxville's transit system in Tennessee one bus company has remained the focal point of these transit systems, GILLIG.

GILLIG has an outstanding product they stand behind and a customer service driven mission that is the best in the industry. From the day the bus comes off the production line to the day the bus runs its final mile into retirement, GILLIG provides superior quality, training, service, and support to this organization. Their business model shows their passion, integrity, and quality for their customers. You are truly never alone when you have made the commitment to purchase GILLIG vehicles. You become part of the family. They seek out your input into future ideas and projects while advancing the bus technology that makes their buses the ones operators want to drive, passengers want to ride, and organizations want to buy.

Top this all off with the amazing dedication and assistance my organizations have always received from you as our sales representative and you have what I consider to be the best of the best. It is with great pleasure that I provide this letter of recommendation to perspective customers of the GILLIG Corporation.

Yours in accessible transportation,

Dawn Distler
Chief Executive Officer

416 KENMORE BOULEVARD AKRON, OHIO 44301
phone: 330.762.7267 / *fax:* 330.762.0854

web: AKRONMETRO.ORG

Jeff Mundstock
Interim Director of Fleet and Facilities
1401 Bank Street
Cincinnati, OH 45214
(513) 632-7612 PH
(513) 513-632-7505 FAX
jmundstock@go-metro.com

June 2, 2020

Mr. Jim Ryan
Regional Sales Manager
Gillig LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Ryan,

I have had the pleasure in working with Gillig for almost 10 years. SORTA/Metro as an organization has participated with Gillig in over 10 builds, totaling over 550 buses in recent decades for heavy duty transit coaches.

In my experience, Gillig has been paramount in build quality and customer service. From the preproduction meeting, to support years after the coach is in service, right down to replacement parts, Gillig has always focused on being customer-driven and has supported SORTA as an organization through the entire time we have been partners. SORTA has had other bus manufacturers in recent years, and I will personally say that Gillig well exceeds rival manufacturers in regards to customer service, support, and quality.

Within the past year, Gillig sent a team of engineers and production managers to our facility to inspect older buses that we still had in service well past their 12 year useful life. We took them out to see some of our 2004 Phantoms we still had in service at the time. The purpose of this visit was to investigate how the buses held up over time in our climate, and how that information will help them in future designs and builds. This process demonstrates Gillig's attention to detail and commitment to building a product to last well past the FTA useful life expectancy.

Our relationship with Gillig will extend well into the future of our organization, as we have recently started yet another 5 year contract for the purchase of 40' heavy duty transit buses. I am looking forward to our future endeavors as a partnership and would be pleased to recommend Gillig to any future potential customers.

Sincerely,

Jeff Mundstock
Interim Director of Fleet and Facilities

KRT KANAWHA VALLEY REGIONAL TRANSPORTATION AUTHORITY
P.O. Box 1188
Charleston, WV 25324
1550 Fourth Avenue
Charleston, WV 25387
PHONE 304.343.3840
FAX 304.343.3877
WEB RIDEONKRT.COM

June 2, 2020

Mr. Jim Ryan
Regional Sales Manager
Gillig L.L.C.
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Ryan:

On behalf of the Kanawha Valley Regional Transportation Authority (KVRTA), I would like to take this opportunity to thank you and the entire Gillig team for the excellent service, support and buses that have been afforded to KVRTA over the past seventeen years. Our entire organization feel that the Gillig buses are the finest buses that we have ever operated at KVRTA. During my thirty-eight-year career in public transit, the relationship established with you, David Clawson and others at Gillig has been unmatched, and makes my life as Executive Director of the Authority much easier knowing I don't have to worry about our Gillig fleet.

KVRTA appreciates the fact that Gillig and its employees pride themselves on being a customer-driven organization and has always exceeded our expectations. The assistance that you, David, and others at Gillig provide not only KVRTA, but all the transit systems in West Virginia is truly unparalleled. Keeping us updated on industry trends, technological advancements and changes in the industry further demonstrates Gillig's dedication to meeting its customer needs as well as the needs of others.

Industrywide, Gillig is highly respected and undoubtably is a leader in the bus manufacturing field and is known for producing quality vehicles. Our operators, maintenance staff and passengers all reap the benefits by KVRTA purchasing quality products from Gillig.

It has been a pleasure to work with you, David and the entire Gillig team over the years. I am more than willing to recommend Gillig to any of your prospective customers.

Sincerely,

J. Douglas Hartley
Executive Director

Cc: David Clawson

Western Reserve Transit Authority
WRTA
People On The Move.

Phone 330•744•8431 Fax 330•744•7611

604 Mahoning Avenue • Youngstown, Ohio 44502

June 2, 2020

Mr. Jim Ryan
Regional Sales Manager
Gillig LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Ryan,

I have had the pleasure of doing business with Gillig for over 30 year. During this time, I have found Gillig and its employees to be a customer-driven organization that has provided the highest levels of customer support. Gillig employees are dedicated and knowledgeable about their products, whether it is the coaches they produce or parts they provide to maintain the coaches.

Part of the success Gillig and WRTA have had is the continued support that is provided from the day a purchase order is issued until the day the coach is retired from service. The whole procurement and production process are well thought out and completed in a very effective manner. Gillig's coach manufacturing facility is one of the best examples in how to build a heavy-duty transit coach.

We appreciate the input Gillig seeks from WRTA and others in the transit industry as they continually make advancements in the design of the coach to provide a better product each year to meet the needs of its customers.

It is always a pleasure to work with you and your team. I would highly recommend Gillig to any of your prospective customers.

Sincerely,

Dean J Harris
Executive Director

Carm Basile
Chief Executive Officer
518-437-6840
carmb@cdta.org

May 27, 2020

Mr. Joseph Policarpio, Vice President
Sales & Marketing
GILLIG, LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Policarpio:

The Capital District Transportation Authority (CDTA) is in the final year of our third five-year contract with Gillig for the purchase of transit vehicles.

Gillig consistently delivers a quality product, on time and according to our specifications. The Gillig staff are professional, attentive, and top-notch representatives of your company. We know that buses will be delivered in accordance with the contract requirements, and any issues which are usually few and minor in nature, are attended to in a timely manner.

We appreciate Gillig's ability to stay at the forefront of the latest developments in transit technology and the fact that these developments are consistently communicated to us. Jerry Sheehan has been our principal contact for close to 15 years, and we appreciate his efforts on our behalf.

Cordially,

Carm Basile
Chief Executive Officer

Jayme B. Lahut
Chairman
Schenectady County

Michael J. Criscione
Vice Chairman
Albany County

Mark Schaeffer
Secretary
Albany County

David M. Stackrow
Treasurer
Rensselaer County

Georgeanna M. Nugent
Saratoga County

Jaclyn Falotico
Schenectady County

Denise A. Figueroa
Albany County

Patrick M. Lance
Labor Representative

Carm Basile
Chief Executive Officer

Jeremy Peterson
Chief Executive Officer

ERIE METROPOLITAN TRANSIT AUTHORITY

127 East 14th Street
Erie, Pennsylvania 16503

May 21st 2020

Mr. Jerry Sheehan
Regional Sales Manager
GILLIG LLC
451 Discovery Drive
Livermore, CA 94551

Mr. Jerry Sheehan:

The Erie Metropolitan Transit Authority has maintained a multi-decade strong relationship with Gillig as a result of outstanding customer service, performance reliability and toughness.

If anyone knows anything about Erie, Pennsylvania is that Erie is annually in competition for snow capitol U.S.A. Despite the toughest of blizzards that have at times dropped five, six, and even seven feet of snow over a period of a few days, EMTA has been able to and will continue to rely on our fleet of Gillig buses. The Gillig bus has performed superbly under the harshest of conditions over the decades. As a result, Erie has gained a reputation as the Authority within our Commonwealth to 'never shutdown' operations despite our notorious Erie winter weather.

The Erie Metropolitan Transit Authority highly values our relationship with Gillig as we continue to expand and outfit our fleet with Gillig buses. I highly recommend the Gillig team and product to any Authority in search of reliability, performance and great service.

Sincerely,

Jeremy Peterson
CEO

CITY OF GAINESVILLE

Regional Transit System

May 21, 2020

Joe Policarpio
Vice President, Sales & Marketing
GILLIG LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Policarpio:

I would like to express my most sincere appreciation to you and your staff for the outstanding service to the City of Gainesville Regional Transit System (RTS). I am impressed not only by the level of quality service, but also the consistency of that quality year after year. For over 20 years, RTS has done business with GILLIG because we trust the vehicles, the parts and the people who help make our operation a success.

I want also to commend your staff for the training, technical, and warranty support that has allowed our team to place a good product and service on the road. The Sales and Parts staff has been extremely responsive to our demands and needs.

It is through Gillig's performance and reliability that RTS pursued the goal to be have a 100% GILLIG fleet. Looking toward the future, GILLIG's reputation for quality vehicles and services made it easy to take the next big step and embark on a new partnership project - Electric buses. We are eager to begin our new chapter in transportation, knowing that we can trust the GILLIG brand to deliver safe, comfortable, reliable vehicles to convey our passengers.

Sincerely,

Jesus Gomez, Transit Director
Regional Transit System

May 21, 2020

Mr. Derek Maunus
President and CEO
Gillig LLC
451 Discovery Drive
Livermore, CA 94551

Derek,

I would like to take a moment to express my sincere appreciation to the entire Gillig organization for the many years of your unwavering support, highest degree of integrity, expertise and product quality that has been and continues to be provided to our agency.

Sun Tran is a small 14 bus agency providing fixed route transit service on seven routes in Ocala, Florida. Subsequently, it is of paramount importance that we have the most reliable and dependable buses available to serve our community and that's why we purchased and operate Gillig buses.

Twenty plus year ago when Sun Tran was determining the best manufacturer to supply our buses, there were several very important factors that need to be considered. Of primary importance to us was having the confidence and assurance to choose a manufacturer with the corporate stability, integrity, commitment, experience and financial capability to support us in a long-term partnership that will span far beyond the life of purchase. Gillig has demonstrated their ability to successfully meet and exceed those expectations and continue to do so.

It is very comforting to place an order with a manufacturer knowing the buses will be built to specification and delivered on time. The reliability of the Gillig Low-Floor bus has enabled us to

City of Ocala
Growth Management Department

201 SE 3rd Street (2nd Floor)
Ocala, FL 34471
Phone: 352-629-8287

maintain high bus availability with minimal operating costs. The high-performance standards of the Gillig Low-Floor can be attributed to Gillig's on-going commitment to product improvement.

Gillig has consistently demonstrated that you are a world class organization and we are truly honored to be your partner.

Sincerely,

Steven Neal
Transportation Director
Growth Management Department
City of Ocala

City of Ocala
Growth Management Department

201 SE 3rd Street (2nd Floor)
Ocala, FL 34471
Phone: 352-629-8287

May 20, 2020

GILLIG
451 Discovery Drive
Livermore, CA 94551

To whom it may concern,

The City of Albany is a long-standing customer of GILLIG. As former owners of model years 2005, 2006, 2009 to currently owning 2016 (4), 2018 (3), and 2020 (8), the customer service & support *before* and *after* delivery remains phenomenal.

I evaluate customer service delivery in both, professional and personal settings. I attest that the customer service and support statements of GILLIG are not just words written on paper; moreover, it is **action** willingly, or better yet, generously performed by dedicated GILLIG employees. Since 2015, I have been a witness to this action from not just the sales and administrative staff, but also the production team and upward to the President!

In sum, the overall performance and operational enhancements of a GILLIG bus meets the need of our organizational requirement.

Angela S Calhoun
Angela S Calhoun
Superintendent
Fleet Management Department

JACKSONVILLE TRANSPORTATION AUTHORITY

July 13, 2018

Mr. Joseph Policarpio, Vice President
Gillig LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Policarpio:

I want to take this opportunity to thank you and your team. I have had the pleasure of doing business with Gillig over the past twenty years. Gillig is now on their fourth five-year contract for the State of Florida.

During this time, I have found Gillig and its employees to be a customer-driven organization that exceeds our expectations. Employees are dedicated, knowledgeable, and professional whether they are dealing with new bus orders or when dealing with routine matters.

I appreciate the input sought by Gillig as they continually advance in the area of technology in an effort to meet the needs of the JTA and other industry customers.

Gillig buses are highly regarded throughout the transit industry and Gillig has a solid reputation of building a quality product. The JTA is one that has certainly benefited by purchasing those quality products from Gillig. Satisfying your customers, including delivering on your promises is exemplary.

It is a pleasure to work with you and your team. I would be pleased to recommend Gillig to any of your prospective customers.

Sincerely,

Lisa Darnall
Vice President/CTO

Administration
121 West Forsyth St.,Suite 200
Jacksonville, Fl 32202

Main: (904) 630-3181
www.jtafla.com

Operations
P.O. Drawer "0" 100 N. Myrtle Ave.
Jacksonville, FL 32203

GILLIG

SECTION 1: TECHNICAL PROPOSAL

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GILLIG

SECTION 1: TECHNICAL PROPOSAL

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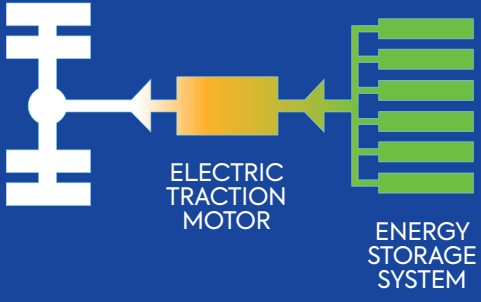
BUILDING AMERICA'S ZERO EMISSIONS FUTURE



Electrify Your Fleet

Our new battery electric offering joins GILLIG's industry-leading Low Floor bus platform to bring the most comprehensive, advanced battery electric bus to the market. GILLIG's Zero-Emission Battery Electric bus incorporates the Cummins electrified powertrain, which provides the advantage of full local service support with hundreds of service centers throughout the country to provide the necessary training, warranty administration, and after-market parts. Designed, built, and supported right here in the United States.

Cummins Electrified Powertrain



GILLIG BATTERY ELECTRIC ZEROEMISSIONS

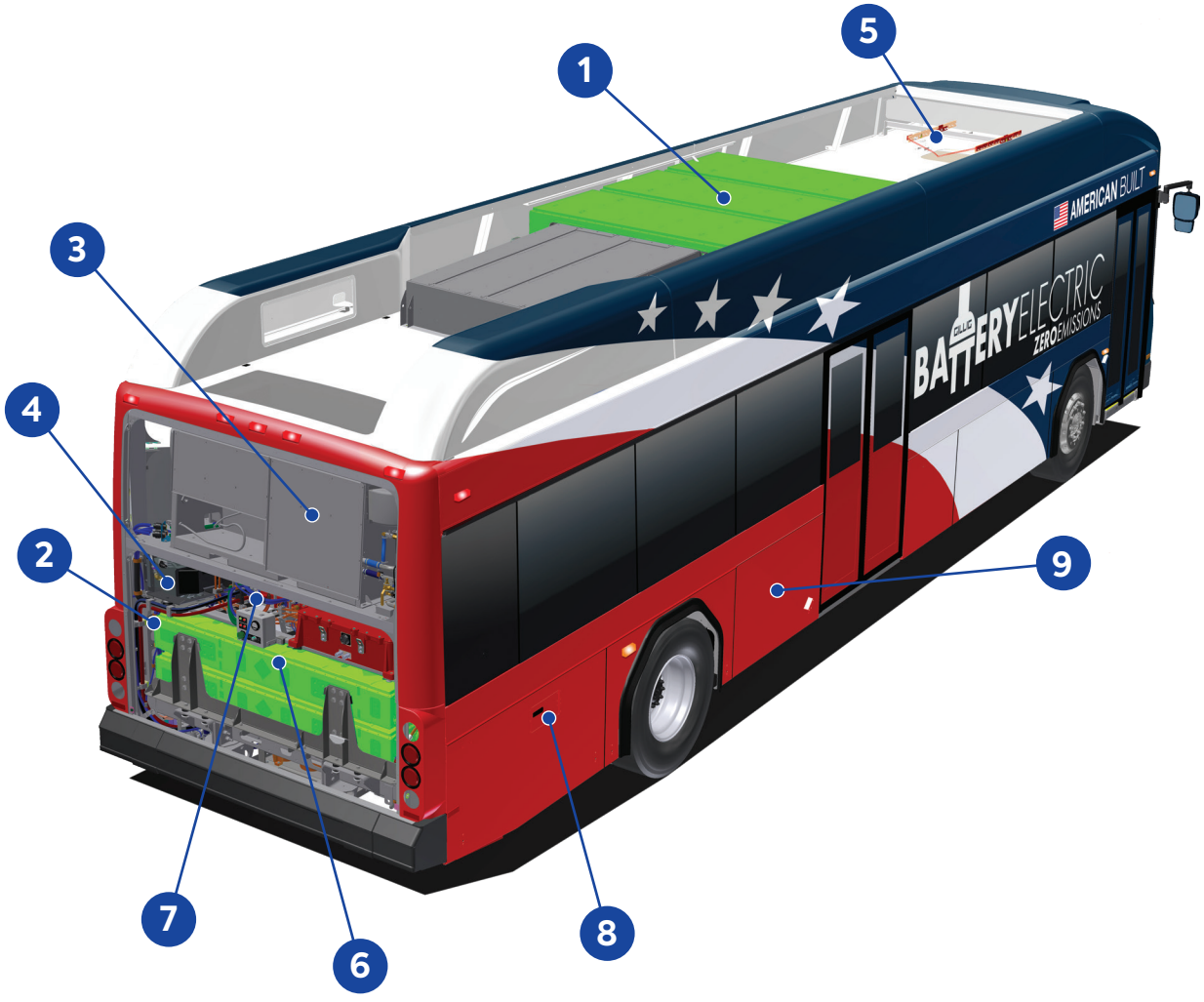
Specifications:

- Low Floor Battery Electric with Contoured-style Roof Fairings
- Cummins EV Drivetrain: Traction Motor and Inverter, High and Low Voltage Power Supplies, Modular Energy Storage System, Charge Controller
- Meritor 79000 Series Rear Axle
- Air Disc Brakes
- Standard Transit Size Tires
- Acceleration/Handling similar to conventional power train options
- Plug-in Charging – SAE J1772 DC CCS Type 1
- Thermo King Electric HVAC with Integrated Thermal Management System
- 24V DC Power Steering Pump
- Fuel-fired Coolant Heater Option for Cold Weather Operation

LOW FLOOR BATTERY ELECTRIC
Features and Benefits

COMPONENT LOCATIONS:

1. Roof-mounted Energy Storage System (ESS), up to 3 battery packs
2. Electronics Cooling Package (ECP)
3. Thermo-King HVAC with integrated Battery Thermal Management System
4. Air Compressor
5. Optional roof-mounted charge rails
6. Two battery packs mounted in the power train compartment directly above the frame rails
7. Power train component assembly consisting of: High-Voltage DC junction box with disconnect switch, two DC-DC convertors, and System Control Unit (SCU)
8. Standard Plug-in-charge location, rear curbside (optional additional locations available)
9. Battery pack forward of rear axle



Rear panels not shown for clarity. Specifications and features are for reference only and subject to change without notice or obligation.

GILLIG

September 21, 2021

ELECTRONIC SUBMISSION
https://psta.bonfirehub.com/portal

PINELLAS SUNCOAST TRANSIT AUTHORITY
St. Petersburg, Florida

RE: FLORIDA ELECTRIC TRANSIT BUSES WITH CHARGING & ASSOCIATED EQUIPMENT – RFP 21-980369

DATE DUE: September 23, 2021 at 10:00 AM EST

Gentlemen:

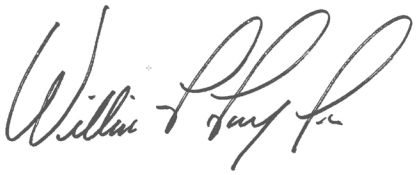
GILLIG is pleased to submit the enclosed documentation covering our **SECTION 1: TECHNICAL PROPOSAL** response to the above solicitation for your review and consideration.

Please do not hesitate to contact us if any questions about the submittal arise:

WILLIAM F. FAY, JR., VICE PRESIDENT, SALES
PHONE: 800-735-1500 or 510-785-1500
EMAIL: sales@gillig.com

We appreciate this opportunity and look forward to a successful bid opening.

Very truly yours,



William F. Fay, Jr.
Vice President, Sales
Phone: 800-735-1500
Email: sales@gillig.com

Encs.

Cc: Arminder Dhillon, Director, Sales Operations
Javier Hernandez, Jr., Director National Sales
Butch Sibley, Regional Sales Manager

MINUTES OF A SPECIAL MEETING
OF THE MANAGERS OF
HCC MANAGER LLC

A special meeting of the managers of **HCC MANAGER LLC**, an Illinois limited liability company (the "Company"), was held at 222 N. LaSalle Street, Chicago, IL 60601, on December 15, 2020. All of the Company's managers, namely A. Steven Crown, James S. Crown and William H. Crown, and the Company's Secretary, David M. Rubin, were present either in person or by phone. William H. Crown acted as Chairman of the meeting and David M. Rubin acted as Secretary of the meeting.

The Chairman stated that the purpose of the meeting was to acknowledge the retirement of Joseph Policarpio and the appointment of William Fay, Jr. as officers of Gillig LLC, a California limited liability company (the "LLC"), in the Company's capacity as Manager of the LLC. Upon motion duly made, seconded and unanimously carried, the following resolutions were adopted:

RESOLVED, that, effective as of January 1, 2021, WILLIAM FAY, JR. shall be elected to serve as the LLC's Vice President – Sales until such further action by the Company.

FURTHER RESOLVED, that, effective as of January 6, 2021, and resulting from his retirement, JOSEPH POLICARPIO, shall be removed as the LLC's Vice President – Sales and Marketing.

FURTHER RESOLVED, that for sake of clarity, subsequent to the actions as hereinabove set forth, the officers of the LLC will be as set forth below:

DEREK MAUNUS	President and Chief Executive Officer
MICHAEL S. CANMANN	Vice President and Assistant Secretary
CHRISTOPHER TURNER	Executive Vice President – Operations
BRIAN SHEPHERD	Vice President – Finance and Chief Financial Officer
MARLA LOAR	Vice President – Human Resources
CHARLES E. O'BRIEN	Vice President – Aftermarket Parts
WILLIAM FAY, JR.	Vice President – Sales
GREG VISMARA	Vice President – Engineering
DAVID M. RUBIN	Vice President, General Counsel and Secretary
MAUREEN FLYNN	Vice President, Controller, Treasurer and Assistant Secretary
AMY BLUMENTHAL	Assistant Secretary
BRIAN B. GILBERT	Assistant Secretary

FURTHER RESOLVED, that the above named officers be, and are hereby, authorized to execute any and all instruments for and on behalf of the LLC which are required in the usual and ordinary conduct of the business, including, but not limited to, Bid Documents, Sales Contracts, Purchase Contracts, Lease Purchase Agreements, assignments to such Lease Purchase

Agreements, together with any documents which may be or become necessary to support such transactions of Gillig.

Upon motion duly made, seconded and unanimously carried, the meeting was adjourned.

Respectfully submitted,

David M. Rubin
Secretary of the Meeting
4850-8412-6420, v. 2

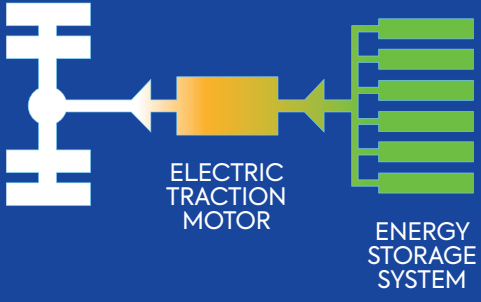
BUILDING AMERICA'S ZERO EMISSIONS FUTURE



Electrify Your Fleet

Our new battery electric offering joins GILLIG's industry-leading Low Floor bus platform to bring the most comprehensive, advanced battery electric bus to the market. GILLIG's Zero-Emission Battery Electric bus incorporates the Cummins electrified powertrain, which provides the advantage of full local service support with hundreds of service centers throughout the country to provide the necessary training, warranty administration, and after-market parts. Designed, built, and supported right here in the United States.

Cummins Electrified Powertrain



GILLIG BATTERY ELECTRIC ZEROEMISSIONS

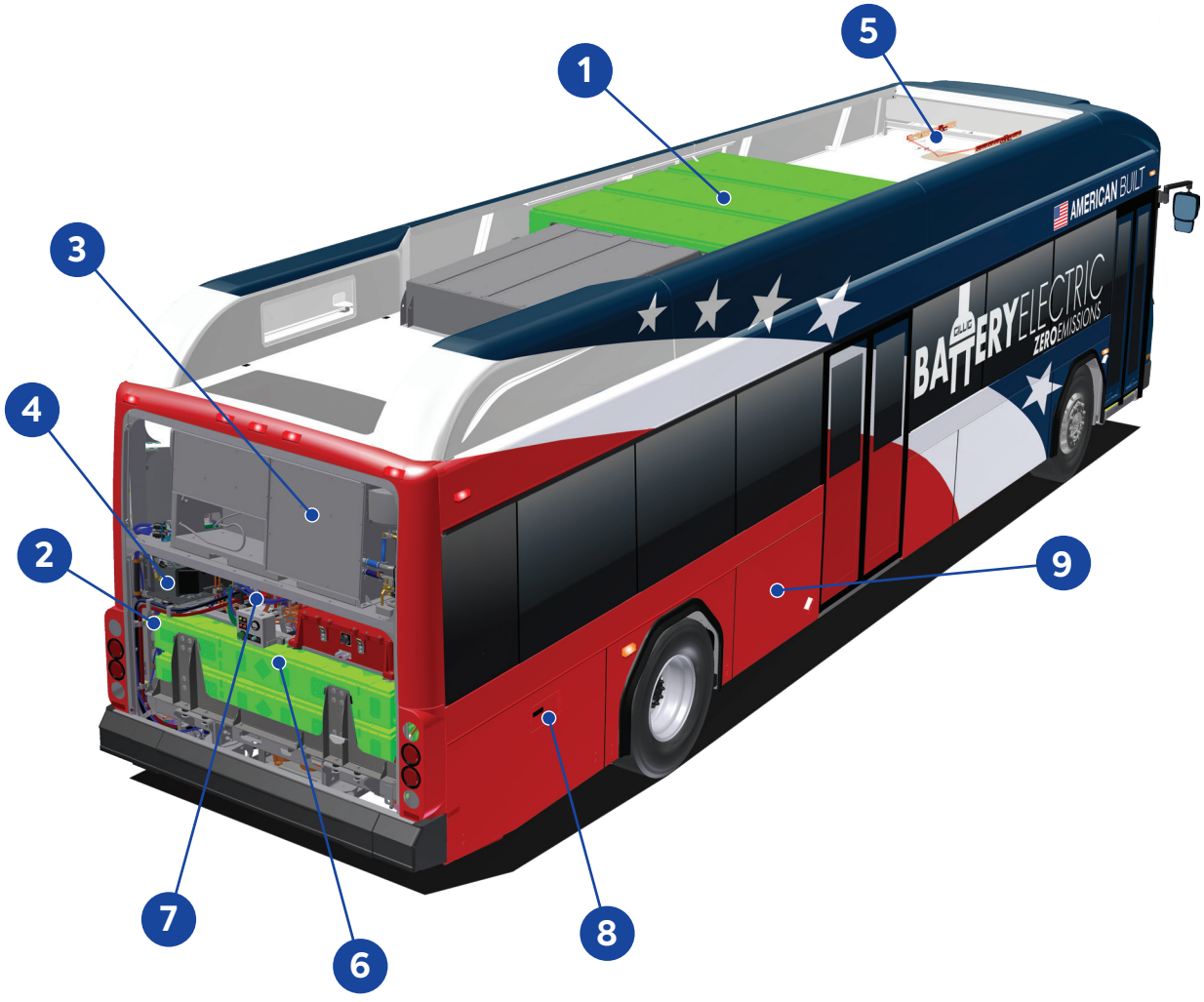
Specifications:

- Low Floor Battery Electric with Contoured-style Roof Fairings
- Cummins EV Drivetrain: Traction Motor and Inverter, High and Low Voltage Power Supplies, Modular Energy Storage System, Charge Controller
- Meritor 79000 Series Rear Axle
- Air Disc Brakes
- Standard Transit Size Tires
- Acceleration/Handling similar to conventional power train options
- Plug-in Charging – SAE J1772 DC CCS Type 1
- Thermo King Electric HVAC with Integrated Thermal Management System
- 24V DC Power Steering Pump
- Fuel-fired Coolant Heater Option for Cold Weather Operation

LOW FLOOR BATTERY ELECTRIC
Features and Benefits

COMPONENT LOCATIONS:

1. Roof-mounted Energy Storage System (ESS), up to 3 battery packs
2. Electronics Cooling Package (ECP)
3. Thermo-King HVAC with integrated Battery Thermal Management System
4. Air Compressor
5. Optional roof-mounted charge rails
6. Two battery packs mounted in the power train compartment directly above the frame rails
7. Power train component assembly consisting of: High-Voltage DC junction box with disconnect switch, two DC-DC convertors, and System Control Unit (SCU)
8. Standard Plug-in-charge location, rear curbside (optional additional locations available)
9. Battery pack forward of rear axle



Rear panels not shown for clarity. Specifications and features are for reference only and subject to change without notice or obligation.

GILLIG

BATTERY ELECTRIC BUS VEHICLE CONFIGURATION

Our Battery Electric Bus represents the culmination of years of hard work and innovation to bring the best-in-class bus to market. Offering a smooth ride and quiet acceleration, our bus enhances the customer experience while providing sustainable public transportation. Based on our proven Low Floor platform, every GILLIG Battery Electric bus is designed, built, and supported in the same facility by the same team that you've come to know and trust. As such, we can ensure parts, training, maintenance, and operations commonality with existing GILLIG fleets for seamless integration. The stainless-steel chassis and aluminum body create a lightweight, high-strength bus, while the integrated crash barrier protects riders from side impacts during a collision. In addition, Altoona testing has proven our buses to be the safest, highest quality, and most reliable bus on the market.



In developing our all-electric powertrain, GILLIG performed an exhaustive search for systems and components that maximize performance, durability, reliability, and cost-effectiveness. Additionally, we sought a partner who could provide world-class aftermarket service, support, and training for the new powertrain. We are proud to partner with Cummins Inc. on the electrified powertrain based on their extensive experience with U.S. transit operations, their vast support infrastructure, and their cross-industry focus on developing efficient, reliable, and cost-effective components.

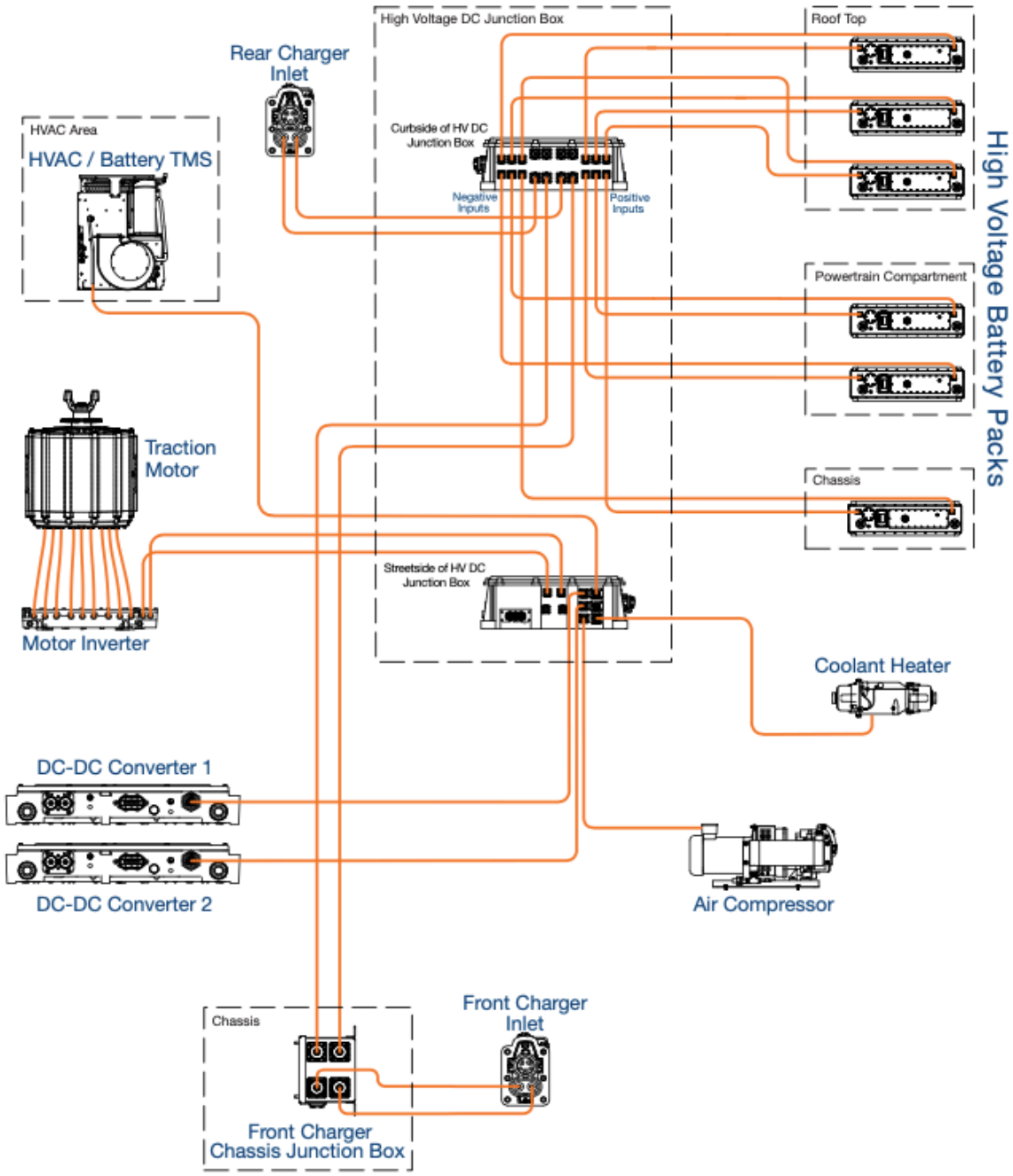
GILLIG | Cummins

Partners you can trust.

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BATTERY ELECTRIC BUS VEHICLE CONFIGURATION

Our zero-emission battery electric transit bus has an all-electric drive system with a single chassis-mounted traction motor powered by on-board high-voltage batteries. The high-voltage energy storage system consists of high-voltage battery packs connected in parallel to the high-voltage junction box. This provides power for the traction motor inverter, which in turn supplies power to the traction motor and to high-voltage DC-powered accessories.



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The modular high-voltage battery system allows for various capacity configurations, with battery-mounting locations on the roof, in the rear powertrain compartment, and on the chassis. Depending on customer specifications, battery capacity can provide a full day of driving range on a single charge. Alternatively, high-voltage battery configurations can be set up to use opportunity charging to allow for lower capacity, cost, and weight.

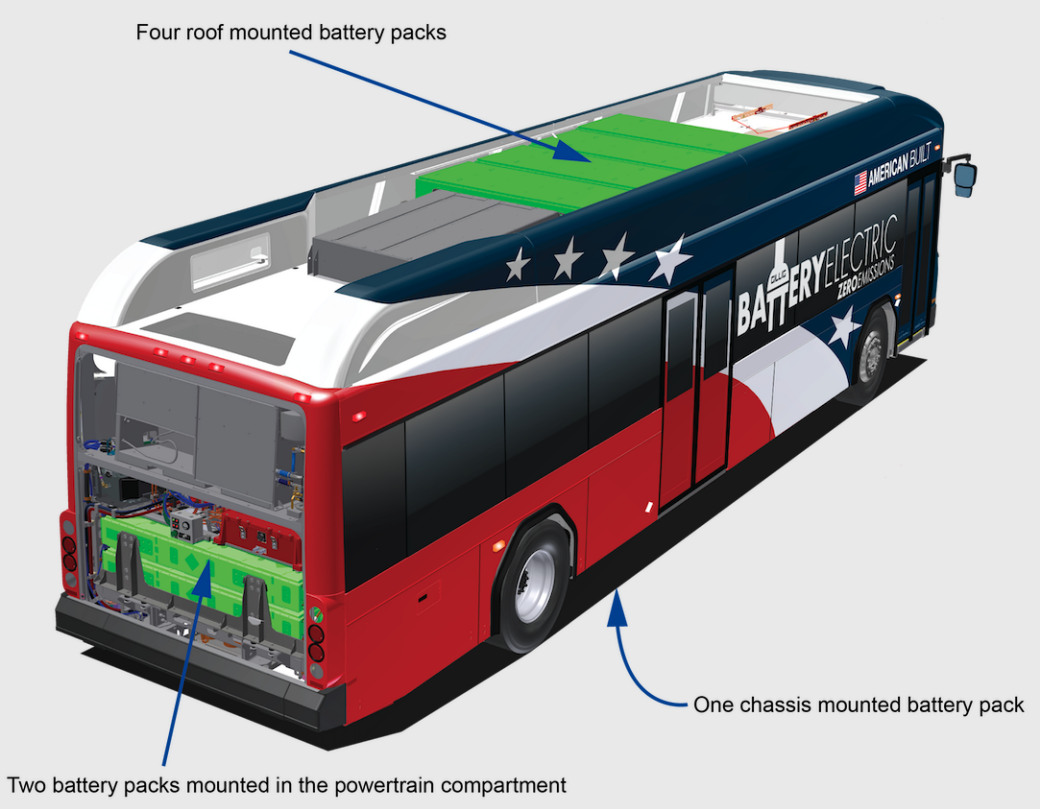
Industry standard J1772-Combo Charging System (CCS), also known as CCS-Type 1, DC plug-in charging is provided on every GILLIG Battery Electric bus. Optional roof-mounted charging rails and chassis-mounted inductive charging solutions are available as an option.

The system control module (SCM) controls the vehicle's motor speed, torque, and direction, depending on driver request and operating conditions. This is a low-voltage electronic module that connects to the throttle and other systems and communicates with the traction motor inverter to propel the bus.

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The energy storage system (ESS) consists of multiple high-voltage battery packs connected in parallel to achieve the required system energy storage capacity and includes the battery management system to control the discharging and charging of all the battery packs.

Up to seven battery packs can be provided, as shown below: up to four roof-mounted battery packs; up to two battery packs in the powertrain compartment; up to one battery pack chassis-mounted forward of the rear axle. These batteries use a high-energy nickel-manganese-cobalt (NMC) cell chemistry, which was selected because its lifespan, specific power, and safety characteristics make it ideal for a heavy-duty application. The battery packs are liquid-cooled and kept at optimal operative temperature through the battery thermal management system, which provides both heating and cooling as necessary.



The architecture of the ESS provides full system operating voltage at each battery pack and utilizes parallel battery connections. This means that the vehicle level voltage is achieved regardless of the number of packs connected and therefore each additional pack simply increases the energy storage capacity. This also means that should a single battery pack experience an issue which requires it to be taken off-line, the bus would still be able to operate on the remaining packs.

All battery packs are the same in size, capacity, and electrical connections so one common battery pack can be used in any location. This interchange-able design simplifies replacement and inventory requirements.

HIGH-VOLTAGE BATTERY PACKS

The AKASOL-designed and American-built 9AKM150CYCUHE high-voltage battery pack utilizes Li-ion technology with a high energy density and proprietary control technology to maintain a high battery performance for a longer zero emission range. A single pack design is utilized for all locations on the bus. This provides reduces the complexity of servicing and inventory requirements.

Maintenance & Service Concept
- maintenance free operation
- servicable contactor box

High Energy and Performance
- 98 kWh
- energy density > 180Wh/kg
- long cycle life up to 4,000 cycles

Standard & Compatible Interfaces
- AK4/HVP800
- AMPSEAL 23 pole
- VDA coolant connectors
- CAN communication

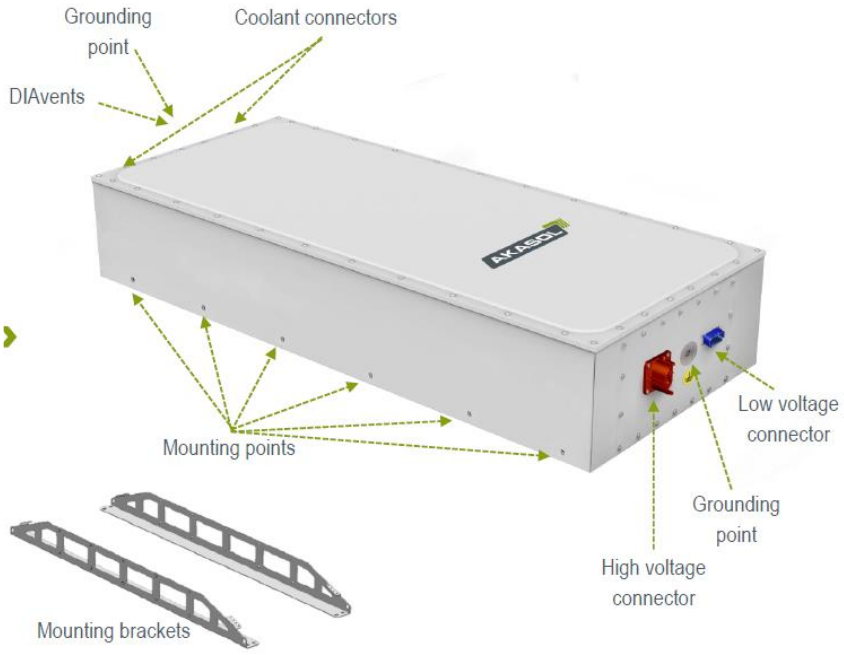


Maximum Stiffness
- „ladder design" of module orientation
- usage of double-T aluminum profiles in modules for pack stability

Reduction of Complexity on System Level
- highly automated production of UHE modules
- low complexity in battery pack design

Optimized Thermal Management
- efficient thermal insulation
- active liquid cooling
- module integrated cooling system

Flexibility by AKASOL Module Design
- well established cell standard format 21700
- further energy and power increase based on future cell developments



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HIGH-VOLTAGE BATTERY PACKS

Structure: The exterior case is constructed of corrosion resistant stainless steel. Internal double 'T' aluminum crossmembers provide structural strength and stiffness. Individual battery modules are secured in place by a ladder frame of aluminum. This design balances the need for the pack to be as light as possible while also providing the strength and rigidity necessary for the harsh duty cycle of a bus. The battery packs meet an IP rating of IP67 & IP6K9K.

Safe service disconnect: In a non-operating mode, all contactors of the battery system are opened so the battery system is voltage free. Additionally, the electrical system within the battery has high voltage interlock loop (HVIL). The HVIL is a continuous low voltage circuit which passes through every high voltage connector so that if a LV or HV connector is unplugged, the circuit will be opened and the HV system will be disconnected by the battery management system. Maintenance on the battery system will be safe when the HV connector is unplugged.

Battery cells: The basic building block of the high-voltage battery pack is the individual cell. AKASOL has conducted a world-wide evaluation to identify the optimal battery cell for the transit duty cycle, and continues to seek out better cells as the technology improves.

Battery module: Cells are combined into battery modules which are connected in series within the pack. Each module also has voltage and temperature sensors that are communicated to a pack battery management module for full pack monitoring and control.

Battery management system: The battery management system (BMS) in each high voltage battery pack monitors all cell voltages, temperature, and other battery conditions and provides detection of any battery faults or damage. The pack BMS connects to the Multi-String Manager (MSM+), which is mounted on the powertrain compartment platform. The MSM+ monitors all the high-voltage battery packs, controls charging and discharging, and provides warnings of battery faults.

Battery cooling system: All high-voltage battery packs are liquid cooled or heated using ethylene glycol coolant. Coolant from the thermal management system is circulated through a cooling plate, which then cools or heats each module. The BMS monitors the battery cell temperatures and uses coolant flow control valves with the battery thermal management system to ensure all packs are maintained at the proper temperatures.

High-power contactors: Each high-voltage battery pack includes high-power electric contactors on both the positive and negative battery outputs. These contactors are used during normal operation to turn the high-voltage batteries on and off. In the event of a high-voltage interlock loop (HVIL) open circuit, these contactors disconnect the pack stored energy from the high-voltage system. When requested and all conditions are functioning properly, the contactors close and allow power to flow from the high-voltage battery. When the 24-volt supply is removed from the contactors—by the driver turning off the bus, by the HVIL system or high-voltage control system detecting a fault, by turning

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off the low-voltage battery disconnect switch, or by the high-voltage emergency disconnect switch in the rear of the bus—all contactors open to disconnect the high voltage stored energy of the batteries from the system.

Specifications:	
Supplier	AKASOL, Inc.
Rated capacity	98 kWh.
Usable capacity SOL (start of life)	Duty Cycle Dependent TBD
Warranty (see warranty agreement for terms and conditions)	Standard, 6 years (300,000 miles); optional, extended to total 12 years (500,000 miles).

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GILLIG BATTERY ELECTRIC BUS
NEXT GENERATION BATTERY PACK SPECIFICATIONS



Chemistry	NMC Lithium Ion
Dimensions	1720 mm x 700 mm x 300 mm (excluding connectors)
Energy Nominal Usable BoL	98 kWh 88 kWh
Time to full charge	For 6 pack setup: 150 kW Plug-In Charge, 0-100% in ~4.5 Hrs 350 kW Plug-In Charge, 0-100% in ~2.5 Hrs 450 kW Pantograph, 0-100% in ~1.5 Hr
Operating voltage	540 – 756 V
Cooling	H_2O & Ethylene Glycol, 50:50
Ingress protection	IP67 / IP6K9K
Charging	Plug In, Pantograph, Inductive

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GILLIG

GILLIG BATTERY ELECTRIC BUS
AKASOL BATTERY WARRANTY

Base Warranty

Available Depth of Discharge		80%
Warrantable End of Life (SOH)		80%
Warranty Term (whichever occurs first)	Time	72 Months
	Low Power Charging (up to 60A / pack)	200 MWh / pack
	High Power Charging (up to 120A / pack)	115 MWh / pack

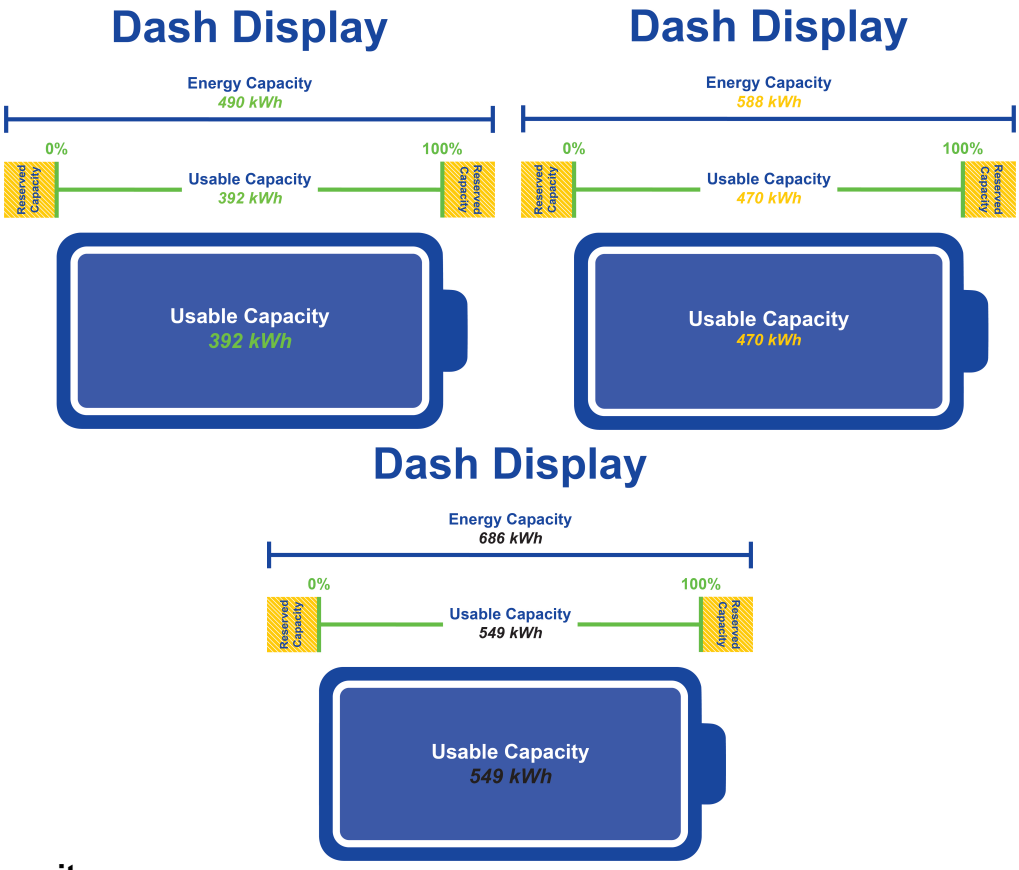
Extended Coverage

Proactive scheduled replacement of batteries at midlife (parts and labor) to achieve same total usable capacity as originally installed. Replacement batteries to include 6-year warranty with same or better terms as above.

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ENERGY CAPACITY AND RANGE

Many factors determine the real-life range of an electric vehicle, which is derived from the net usable energy (or capacity) and the rate of energy consumption.



Rated Capacity

The rated capacity of a battery is the amount of total energy that can be stored in and discharged from the battery. Battery capacity reduces over the life of the cells as the impact of charging and discharging reduces the ability for the cells to reach full charge. Battery health is monitored by the battery management system and reported via telematics. The State of Health (SOH) is communicated as a percentage of the rated capacity at the start of life.

Reserved Capacity

Battery life is negatively impacted when cells are overcharged or when the depth of discharge is too low. In order to maximize high-voltage battery life, the capacity of the battery is limited to prevent discharge below 10% and charging above 90% of rated capacity. The charge controller prevents the batteries from being charged above the top limit, and derating protocols are in place to prevent the batteries from reaching the bottom limit.

Usable Capacity

The result of reserving some high-voltage battery capacity is that 80% of the rated capacity is available to power the vehicle. This is the usable capacity, and it is used for all range calculations. The State of Charge (SOC) reported on the dashboard and via telematics represents the usable capacity remaining until a recharge is necessary.

Energy Consumption

Many factors impact the actual range of electric buses in operation. The duty cycle, route profile, and passenger loading determine how much energy is necessary to drive the traction motor and how much energy is captured through regenerative braking. Drivers can have a significant impact on energy consumption through how effectively they apply throttle and use regenerative braking to slow the bus. The HVAC system is also a significant use of energy on a bus, and settings (temperature set-points, fan speeds, etc.) can be optimized to reduce energy consumption.

Customer-specified equipment (passenger seats, windows, CAD/AVL, and video equipment, etc.) can have a large impact on total vehicle weight, which can also impact energy consumption. GILLIG has developed a Smart Spec that optimizes the range of the bus through component selection. More details are available for discussion during the pre-production meeting.

Range Estimates

Many factors determine the real-life range of an electric vehicle, consumption is derived from the net usable engery (or capacity) and the rate of energy consumption.

Configuration	High-Voltage Battery Packs, Qty	Total Rated Capacity	Range at 2.3 kWh/mile*
5 battery pack	5, each with 98 kWh	490 kWh	170 miles
6 battery pack	6, each with 98 kWh	588 kWh	205 miles
7 battery pack	7, each with 98 kWh	686 kWh	239 miles
*2.3 kWh is a conservative average energy consumption rate.			

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Base: 5 pack 490 kWh Range & Weight



Vehicle Specifications:

- 40’
- 5 pack configuration 490 kWh
- 315 tires
- Gen 2.5 Design

Vehicle Weights:

Curb Weight: 32,900
Seated Weight: 38,760
Gross Weight: 44,300
GVWR: 47,180

5 pack CW	Manhattan	Orange County	HD-UDDS
Ambient 110degF - HVAC On	101	145	180
Ambient 68defF - HVAC On (Minimal)	158	202	207
Ambient 60degF - HVAC Fans Only	177	216	214

5 pack SW	Manhattan	Orange County	HD-UDDS
Ambient 110degF - HVAC On	95	133	172
Ambient 68defF - HVAC On (Minimal)	141	179	200
Ambient 60degF - HVAC Fans Only	154	191	207

5 pack GW	Manhattan	Orange County	HD-UDDS
Ambient 110degF - HVAC On	88	122	161
Ambient 68defF - HVAC On (Minimal)	128	162	194
Ambient 60degF - HVAC Fans Only	140	172	202

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Option: 6 pack 588 kWh Range & Weight



Vehicle Specifications:

- 40’
- 6 pack configuration 588 kWh
- 315 tires
- Gen 2.5 Design

Vehicle Weights:

Curb Weight: 34,710
Seated Weight: 40,860
Gross Weight: 46,560
GVWR: 47,180

6 pack CW	Manhattan	Orange County	HD-UDDS
Ambient 110degF - HVAC On	122	175	217
Ambient 68defF - HVAC On (Minimal)	188	239	249
Ambient 60degF - HVAC Fans Only	209	257	256

6pack SW	Manhattan	Orange County	HD-UDDS
Ambient 110degF - HVAC On	113	161	198
Ambient 68defF - HVAC On (Minimal)	168	216	239
Ambient 60degF - HVAC Fans Only	184	232	249

6pack GW	Manhattan	Orange County	HD-UDDS
Ambient 110degF - HVAC On	106	147	194
Ambient 68defF - HVAC On (Minimal)	152	193	233
Ambient 60degF - HVAC Fans Only	166	205	242

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Option: 7 pack 686 kWh Range & Weight



Vehicle Specifications:

- 40’
- 7 pack configuration 686 kWh
- 315 tires
- Gen 2.5 Design

Vehicle Weights:

Curb Weight: 35,887
Seated Weight: 42,037
Gross Weight: 47,137
GVWR: 47,180

7 pack CW	Manhattan	Orange County	HD-UDDS
Ambient 110degF - HVAC On	139	198	248
Ambient 68defF - HVAC On (Minimal)	211	269	286
Ambient 60degF - HVAC Fans Only	235	289	295

7 pack SW	Manhattan	Orange County	HD-UDDS
Ambient 110degF - HVAC On	129	181	235
Ambient 68defF - HVAC On (Minimal)	189	241	277
Ambient 60degF - HVAC Fans Only	208	258	287

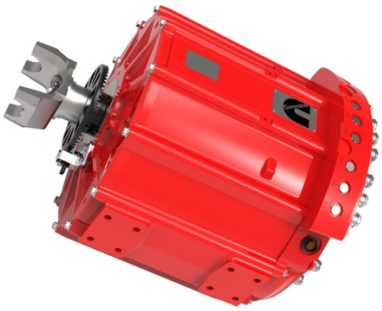
7 pack GW	Manhattan	Orange County	HD-UDDS
Ambient 110degF - HVAC On	120	166	222
Ambient 68defF - HVAC On (Minimal)	171	217	269
Ambient 60degF - HVAC Fans Only	186	231	280

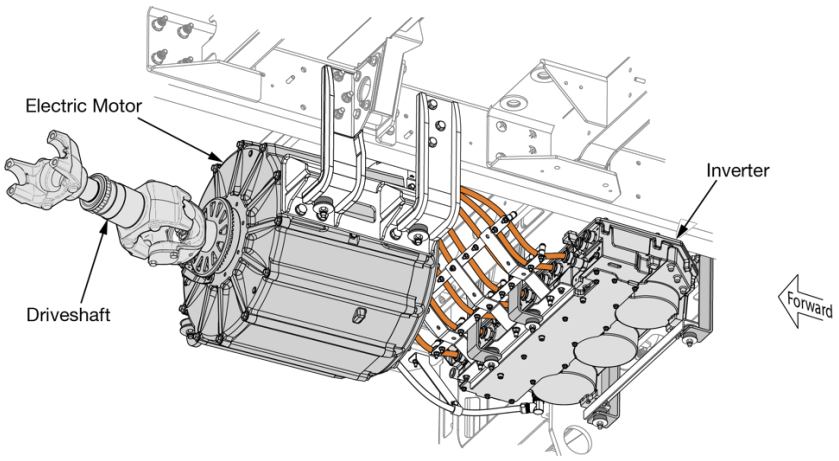
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TRACTION MOTOR

The GILLIG Battery Electric Bus is driven by the Cummins electric traction motor. The high-torque, direct-drive, 9-phase permanent magnet alternating current (PMAC) traction motor drives a single-reduction rear axle and achieves high power density and power efficiency. The electric traction motor is coupled directly to a standard driveline and rear axle to provide traction power and regenerative braking. With the direct drive system, there is no motor-mounted gear reduction or transmission required.

The traction motor is located behind the rear axle to offer easy vertical installation/removal of motor and inverter. It is liquid-cooled by the electronics cooling package using ethylene glycol coolant. It also requires significantly less maintenance than conventional engines—this means no more oil changes, air filter changes, emissions after-treatment services.





Specifications	
Supplier	Cummins.
Motor type	9-phase permanent magnet alternating current (PMAC).
Drive type	Direct drive.
Operating voltage	Nominal 660 VDC; operating range 610 to 750 VDC.
Maximum mechanical output torque	2,582 ft lb (3,500 N-m) for 30 seconds.
Continuous output torque	1,519 ft lb (2,060 N-m).
Maximum mechanical output power	470 hp (350 kW) for 30 seconds.
Continuous mechanical output power	262 hp (195 kW).
Normal operating range	0 to 3,400 rpm.
Peak power	245 kW (328 hp).
Derating range	3,400 to 3,600 rpm.
Ingress protection	IP67.
Warranty (see warranty agreement for terms and conditions)	Standard: 3 years (100,000 miles).

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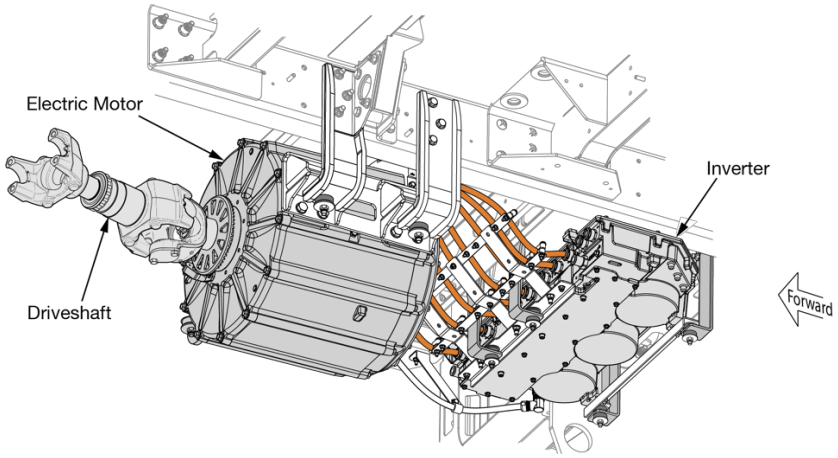
TRACTION MOTOR INVERTER

The Cummins traction motor inverter controls the motor speed and power per the driver's actions. It converts high-voltage DC power from the batteries, via the junction box, into 9-phase AC power for the traction motor to drive the bus.

The traction motor inverter also works in regenerative braking mode to convert 9-phase AC from the traction motor back to high-voltage DC, which is then used to recharge the high-voltage batteries.

The traction motor inverter has a cast aluminum housing and is chassis-mounted directly behind the traction motor. Cooling of the traction motor inverter is provided by the electronics cooling package (ECP).



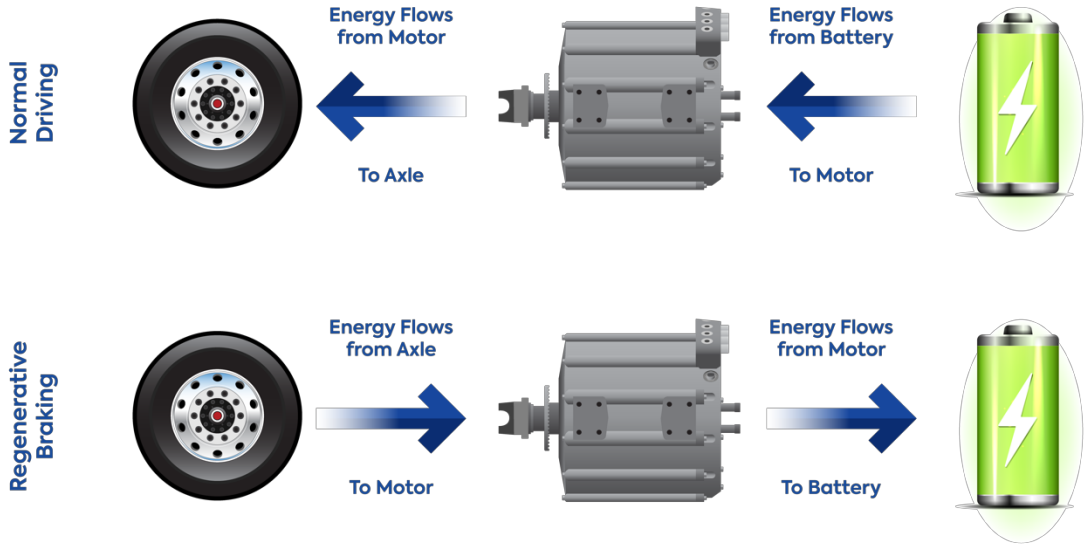


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REGENERATIVE BRAKING

The GILLIG Battery Electric Bus uses regenerative braking (regen) to extend braking system life as well as to improve vehicle range and efficiency.

Under normal driving conditions, the high-voltage batteries provide energy to the traction motor to propel the bus. During regen, this energy flow is reversed, and the traction motor uses the vehicle's momentum when it is coasting, slowing down, or braking to recover energy. By driving the traction motor with the rear axle, the traction motor functions as a generator and recharges the high-voltage batteries.



This contrasts with conventional braking systems, where the excess kinetic energy is converted to wasted heat in the brakes, and with transmission retarders, where energy is converted to heat and immediately dissipated by the radiator.

Regen is controlled through the throttle pedal position. When the pedal is at the 10% position, the regen begins to apply. The amount of regen increases until the throttle pedal pressure is fully released and 100% of the regen is applied. As the bus coasts, the resistance created by the traction motor as it recovers the energy slows the bus. As a result of this slowing, less energy must be captured by the service brakes and, as such, the life of the braking system on a vehicle utilizing regen is longer than that of an equivalent vehicle without regen.

Regen programming is calibrated to provide the maximum amount of energy recovery while maximizing driveablity and passenger comfort. The driving practices of operators also have a significant impact on how much energy the bus can recover through regen because smooth stops and slow decelerations maximize energy recovery.

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Regen Disable Switch

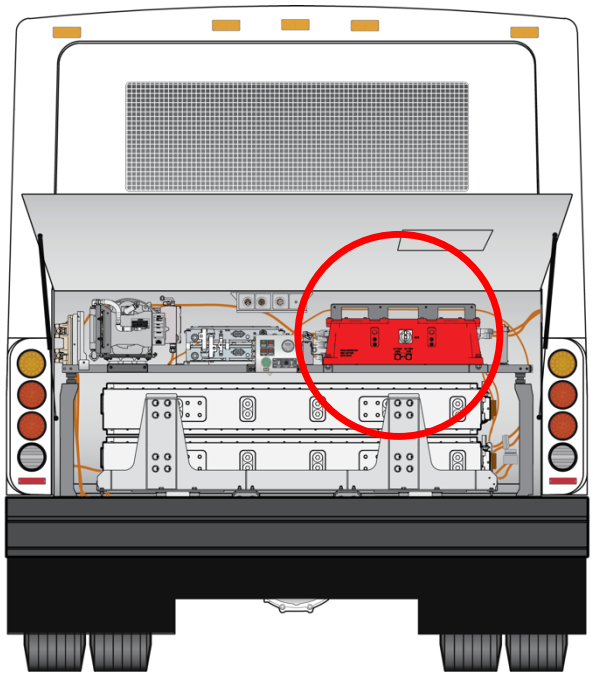
The regen disable switch allows the driver to deactivate regen when road conditions dictate that its use should be limited. However, use of the regen disable switch should be minimized to take full advantage of the energy recovery benefits of regen.

The regen disable switch is located just rear of the driver's seat on the left dash panel. It is out of the direct view of the driver, providing both ready access as well as a location that discourages use unless required. An indicator lamp on the dash is illuminated when regen is disabled and also tracked through the telematics system for additional monitoring.

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HIGH-VOLTAGE DC JUNCTION BOX

The Cummins-supplied high-voltage DC junction box connects all the high-voltage battery packs in parallel, provides connections to all the charge inlets (plug-in and, if equipped, overhead or chassis-mounted inductive), and distributes high-voltage DC to the traction motor inverter and all high-voltage DC power accessories such as the HVAC, the air compressor, DC/DC converters, and the coolant heater. The box is located in the powertrain compartment.



The cast-aluminum housing has toolless high-voltage DC connectors, which are keyed to prevent incorrect connections. Keyed connections have keys or ribs on the receptacle on the junction box connectors that match keys or ribs on the connectors on the cable.

The high-voltage junction box has a high-voltage disconnect switch, which provides a method to manually disconnect the high-voltage batteries in case of an emergency and as part of the lockout/tagout (LOTO) procedure. If required due to an emergency, the switch can safely disconnect the high-voltage batteries under a full load condition. No personal protective equipment is required to operate this two-position rotary switch, with its ON and OFF position.



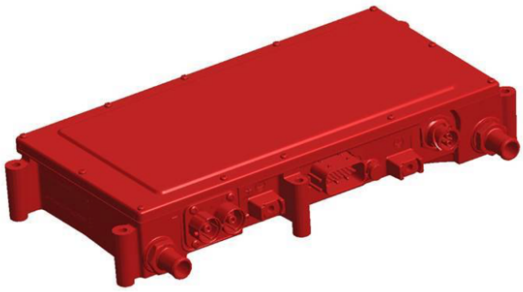


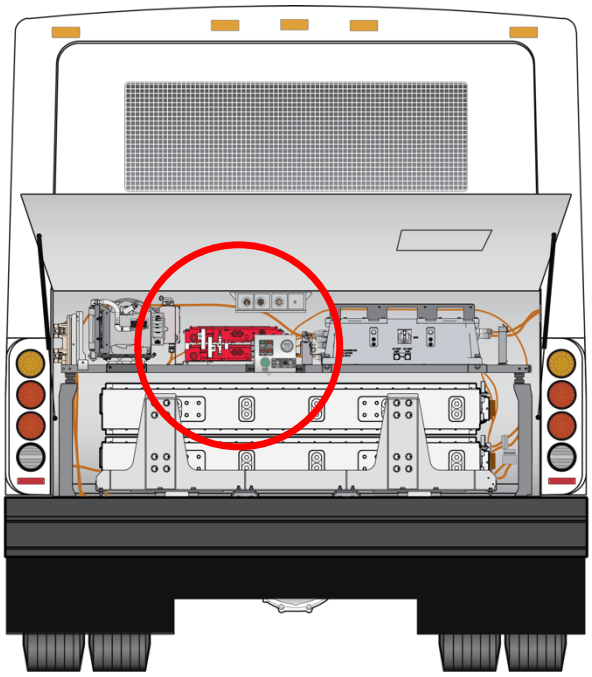


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DC/DC CONVERTER

The DC/DC converter converts high-voltage direct current from the high-voltage batteries to low-voltage 24 VDC to supply the 12- and 24-volt systems, such as low-voltage batteries, the power steering pump, and the electronics cooling package (ECP).





Two DC/DC converters are wired in parallel to provide the required low-voltage system capacity. The DC/DC converters are liquid-cooled by the ECP using ethylene glycol coolant.

The two units are located together on the powertrain compartment platform.

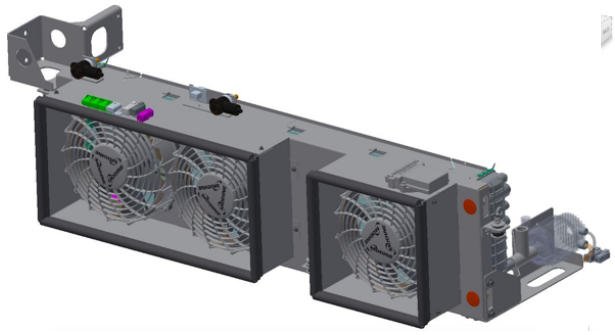
Specifications	
Supplier	Cummins.
Input	Voltage: 450 to 750 VDC. Current: 10 A each; 20 A for both.
Output	Voltage: Adjustable 27–29 VDC voltage from the DC/DC converters is adjustable to meet the voltage requirements of the low-voltage batteries being used. Power: Continuous, 7.5 kW per converter; 15.0 kW total. Current: 270 A per converter; 540 A total.
Cooling	Liquid cooled by the ECP with ethylene glycol coolant.
IP rating	IP6K9K.
Warranty	3 years/100,000 miles.

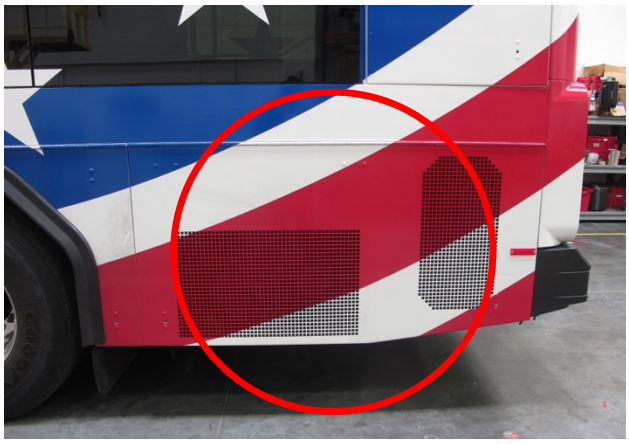
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ELECTRONICS COOLING PACKAGE

The power electronics that convert between AC and DC and various voltages (high voltage, 12 V, 24 V) generate waste heat due to the inefficiencies of the conversion process. In order to cool these components, pressurized coolant is circulated through a streetside, rear-mounted electronics cooling package (ECP). A 24 VDC coolant pump circulates the coolant through the traction motor, traction motor inverter, and DC/DC converters.

The coolant flows through these components capturing the waste heat and is then fed into a single-pass aluminum-core, air-cooled Modine radiator. Hot coolant enters the radiator through the forward tank, circulates through the core, and returns to the pump through the rear tank. The system utilizes three 12-inch, 24 VDC variable-speed brushless electric fans to pull ambient air from outside the bus over the radiator fins to dissipate the heat as directed by the System Control Module. The use of ambient air to cool the coolant rather than via refrigerant decreases overall vehicle energy consumption as less energy is required to run the fans than would be required for an HVAC-style compressor. Furthermore, the variable fan speeds are managed carefully to provide the necessary level of cooling with the least amount of energy required.





The ECP assembly is mounted on chassis outriggers on the streetside of the bus behind the rear axle, where rubber vibration mounts isolate it from chassis vibrations. This location is consistent with the location of the radiator package utilized on GILLIG conventional engine buses and has proven to be an effective location for capturing relatively clean ambient air for this application.

The ECP is built upon Modine's vast experience with engine radiators and electronic cooling. The fans are fully sealed to prevent water intrusion, the aluminum core and body construction are designed to minimize corrosion exposure, and the system is constructed for minimal weight. Similar to conventional radiators, the ECP includes a fan reverse feature to allow for debris to be blown out of the system, and fans are programed to stay on for a minimum of 30 seconds at a time to prevent excessive thermal cycling.

A three-quart, stainless-steel surge tank located behind an access panel above the radiator is integrated into the system to maintain pressure within the system and release

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excess pressure as the coolant heats. A manual pressure relief valve allows for safe relief of system pressure to perform system maintenance and inspections, and the surge tank can be used to top up coolant levels when the integrated sight tube shows such a fill is necessary. The bus also includes provisions for a pressurized coolant fill when a full system fill is required.

Specifications	
Supplier	Modine.
Radiator core	Modine louvered fin, 14 fin/in., aluminum core face area. Single pass with horizontal coolant flow. Coolant inlet at forward edge, coolant outlet at rear edge.
Surge tank	Remote-mounted, streetside, above ECP. Stainless steel; capacity 3 quarts. Access by hinged door with square key lock.
Coolant	Ethylene glycol.
Electric cooling fans	Pusher type, mounted outside radiator cores, pushing air through core. Electrical specifications: 24 VDC, brushless, variable speed via CAN. Fan diameter: 12 in. Fan quantity: 3.
Coolant fill	Bottom pressure fill. Coolant fill connector: quick coupler type.
Warranty	3 years, parts and labor.

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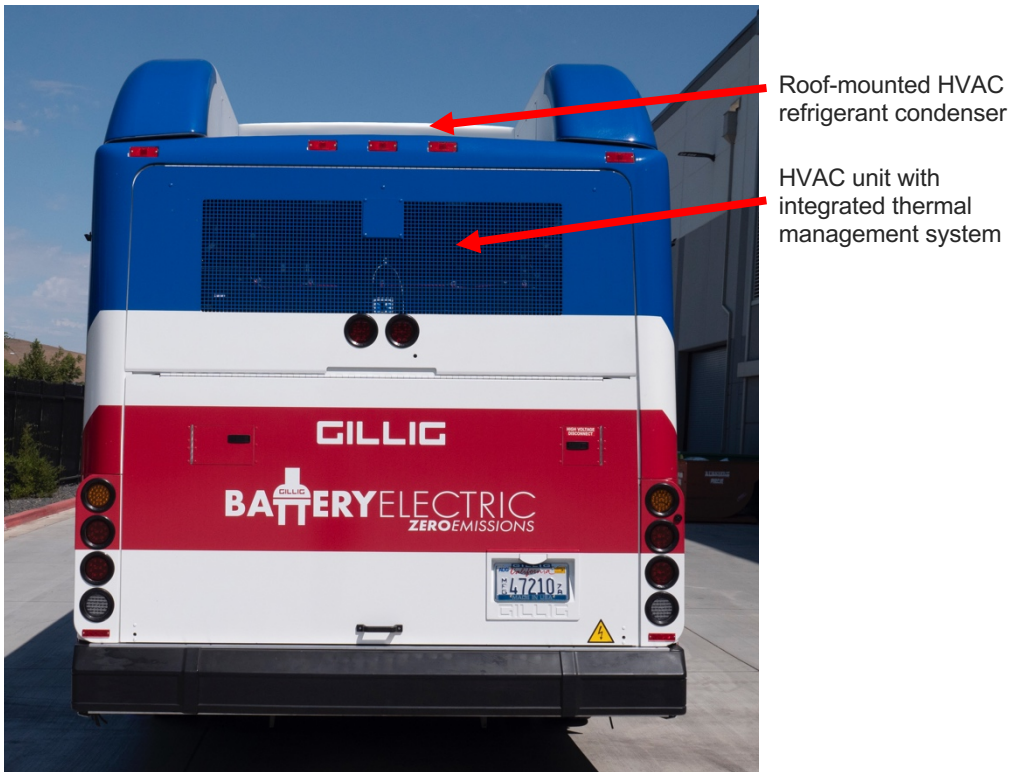
HVAC AND THERMAL MANAGEMENT SYSTEM

During the development of the GILLIG Battery Electric Bus, we identified the HVAC and the high-voltage battery cooling as two systems requiring additional focus, given the significant impact they have on the overall energy consumption of the vehicle. We partnered with Thermo King to develop a single unit that integrates the battery thermal management and HVAC systems. Through this integration, the compressor, condenser, and heating elements can be shared for both systems, reducing redundant components and allowing more efficient use of the systems.

This system provides heating and cooling for both the passenger compartment and the high-voltage battery packs during driving and charge cycles.

The air conditioning and heating system is designed to maintain a pleasant environment in the bus by providing cooled and heated air, reducing humidity, and supplying an adequate amount of draft-free air.

The battery thermal management system is designed to automatically heat or cool the coolant that is supplied to all the high-voltage batteries as required. The coolant will warm the batteries in very cold ambient temperatures and cool the batteries in warm ambient temperatures while charging and during bus operation.



Air conditioning systems use a refrigerant that changes states between a liquid and a gas at different places in the system. The liquid refrigerant absorbs a great amount of heat when it boils and becomes a gas. When this gas is compressed and condensed back to a liquid state, the absorbed heat is given up. With the proper closed system of evaporator,

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condenser, compressor, expansion valve, and temperature control, the refrigerant becomes a very effective medium for heat transfer. The system utilizes R470C refrigerant. The following are the major components of the air conditioning system.

Evaporator and Heater Core: Several heat exchangers are integrated in the main HVAC unit. The HVAC and battery thermal management system each have their own refrigerant evaporator and coolant heater cores to cool and heat their respective circuits (air for the passengers and coolant for the high-voltage batteries). Heated coolant is provided by the chassis-mounted coolant heater.

One evaporator transfers heat from the bus interior to the refrigerant. Interior air is drawn from the bus through the return air grille in the rear bulkhead, passed through a washable filter, then travels through the evaporator coil and heater core, where it is cooled, heated, and/or dehumidified, according to the selected mode of system operation. Dehumidification occurs when humid air is passed over the cold evaporator, so that moisture in the air condenses on its surface. This water drips off the evaporator and is channeled to drain hoses in the powertrain compartment. Conditioned air is then discharged out to the passenger area through the air ducts on both sides of the bus interior.

The other evaporator transfers heat from the battery coolant to the refrigerant, keeping the high-voltage batteries at their optimal operating temperature even in warm environments and/or high-current situations. The battery TMS has a second heat exchanger that transfers heat from the heated HVAC coolant to the battery coolant to maintain battery temperatures in cold environments. By utilizing heat from the HVAC coolant, a dedicated battery heater is not required. This saves weight, cost, and improves overall vehicle efficiency. The unit is capable of switching between cooling and heating the batteries depending on operating conditions and independently of HVAC demands.

Condenser: Transfers heat from the refrigerant to the outside air by drawing cool ambient air through both sides of the roof-mounted condenser and circulating the air through the condenser coil. The hot air is then exhausted out the top of the condenser unit.

The roof-mounted condenser is sized for full cooling capacity up to 120ºF (49ºC) ambient temperature; that is, the unit can maintain 70ºF (21ºC) interior temperatures and proper battery coolant temperatures simultaneously. The roof-mounted location provides unrestricted airflow through the cores, improving performance.

Compressor: Raises the pressure and temperature of the refrigerant and forces it into the condenser.

The electric scroll compressor supplies both the passenger and high-voltage battery cooling circuits. An integrated electric high-voltage DC/AC inverter allows the compressor output to be automatically adjusted to match the required load, which improves energy efficiency.

Expansion Valve: Reduces the temperature of the refrigerant and meters the flow of refrigerant to each evaporator. One expansion valve regulates the output of the HVAC evaporator, and one regulates the battery TMS evaporator.

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A single variable-speed 24 VDC pump provides coolant flow to all of the high-voltage battery packs. Each battery pack can individually modulate the pack coolant flow using the flow control valve in the battery pack.

All electric fans and the blower use brushless 24 VDC motors rated at a minimum of 40,000 hours.

The HVAC system is controlled by the Thermo King IntelligAIRE III, an advanced bus climate-control system that can be programmed for either manual or automatic operation. The IntelligAIRE's modular configuration, connected via CAN to the vehicle's J1939 network, offers the user great flexibility for configuration, reduces the number of electrical connections, and significantly reduces vehicle weight.

The HVAC system is one of the largest users of energy on an electric vehicle, and agency-specific decisions can greatly impact the energy consumption of the bus. By reducing the heating and cooling load requirements by adjusting the temperature set points closer to the outside temperature, agencies can significantly increase their operational range.

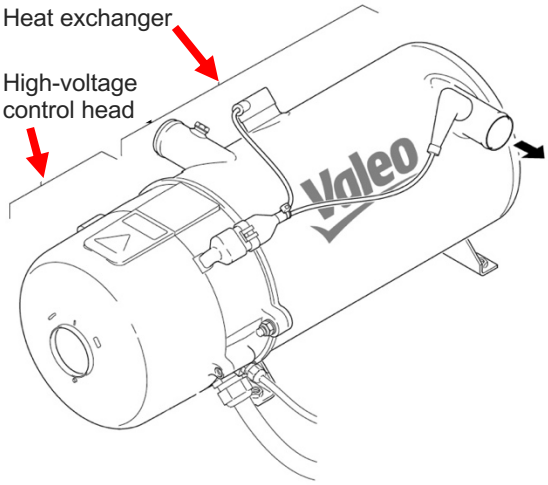
Specifications	
Supplier	Thermo King.
Model	TE18.
Cooling capacity	91,000 Btu/hr total system capacity (71,000 to 96,000 Btu/hr for passengers and up to 25,000 Btu/hr for batteries)
Heat capacity	68,000 to 94,000 Btu/hr (actual output depends on coolant heater selection)
Air flow	2,400 CFM at full speed.
Refrigerant type	R407C.
Warranty	3 years, parts and labor.

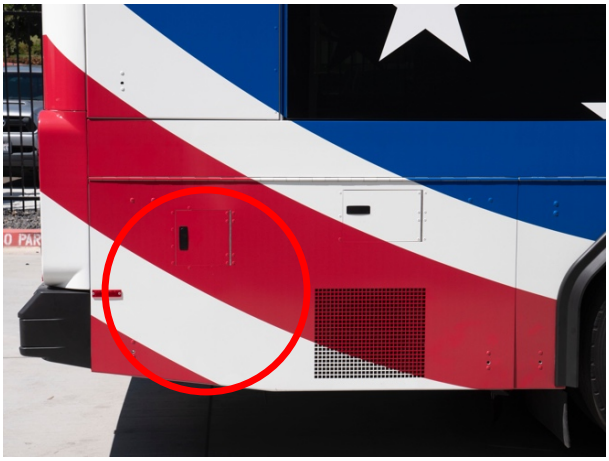
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ALL-ELECTRIC COOLANT HEATER

Early in the development of GILLIG's Battery Electric Bus, the passenger compartment and high-voltage battery heating strategy was an area of focus. As electric heating can account for a significant portion of the overall energy consumption of an electric vehicle, GILLIG wanted to ensure that the vehicle was able to deliver the level of heating performance necessary to meet transit demand in the most economical manner possible.

The battery thermal management system, the main HVAC unit, the auxiliary driver's heater, and optional floor-mounted and threshold heaters all require heat output. GILLIG weighed the relative benefits of electric, grid-based heaters in each of these applications against a heated coolant-based system with a centralized, independent heat source and determined that from a safety, efficiency, fleet commonization, cost and packaging standpoint, the coolant-based system was optimal. GILLIG selected the Valeo Thermo DC 200 all-electric heater to provide the coolant heat.





The electric head is 100% emission-free, allowing for both quiet operation and heating in enclosed spaces without exhaust fumes. The heater is suitable for heating at very low temperatures down to 0°F (–18°C).

Heating cartridges are responsible for the generation of heat by electric current flowing into the unit and are part of the heat exchanger. They are therefore integrated directly into the coolant circuit and, as a result, the generated heat can pass into the cooling circuit without loss.

This heater is located on the rear curbside of the bus, chassis-mounted below the powertrain compartment batteries. This location provides for impact protection and access for service and inspections.

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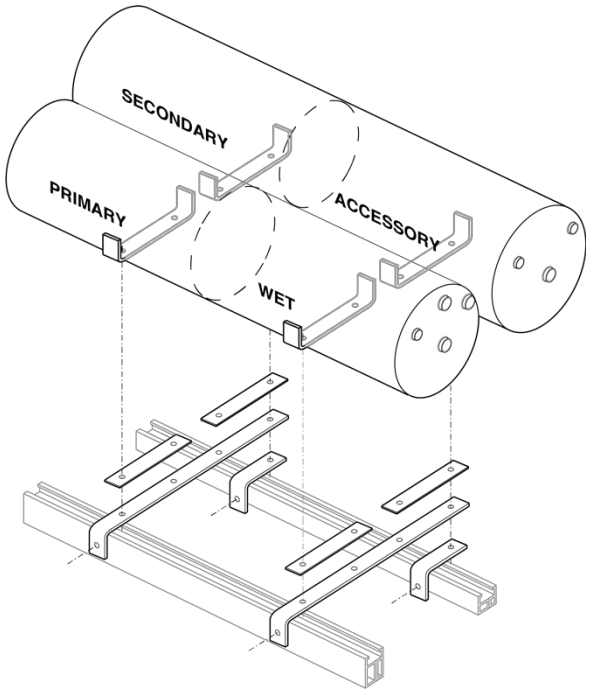
Specifications	
All-electric coolant heater	Supplier: Valeo. Model: Thermo DC 200. Heat output: 20 kW (68,280 Btu/hr). Supply voltage (HV): 600–750 VDC. Supply voltage (LV): 24 VDC.
Warranty	2 years.
A dual-mode electric/diesel coolant heater is also available.	

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AIR SYSTEM OVERVIEW

The air system provides and maintains compressed air to operate the service brakes, emergency/parking brakes, suspension system, passenger door, and the driver's seat. The system is composed of an air compressor, air governor, air dryer, air reservoir tanks, overpressure (relief) and check valves, and the tubing, hoses, and fittings necessary to connect all the components.

The air compressor provides compressed air to the air dryer. The air governor senses the air pressure in the air reservoirs and operates to maintain pressure in the system. When the air pressure reaches a preset lower limit, the air governor turns on the air compressor until the preset upper limit is reached and the air compressor is shut off. The air dryer removes moisture from the compressed air. Accumulated moisture is regularly expelled from the air dryer onto the ground beneath the bus.



The four air reservoirs are located in a ceiling compartment in the front section of the bus. There are two tanks, each partitioned into two separate reservoirs, providing four separate reservoirs. These reservoirs are, in order of priority, the wet tank, the primary tank, the secondary tank, and the accessory tank. The primary and secondary tanks supply the rear and front brakes, respectively. Air from the accessory supply tank operates the suspension system, the passenger doors, and the driver's seat. The air reservoirs also serve to cool the air and condense water and oil vapors out of the compressed air. Most of this condensation takes place in the air dryer and the wet supply reservoir. The GILLIG air system is FMVSS 121, Air Brake Systems compliant.

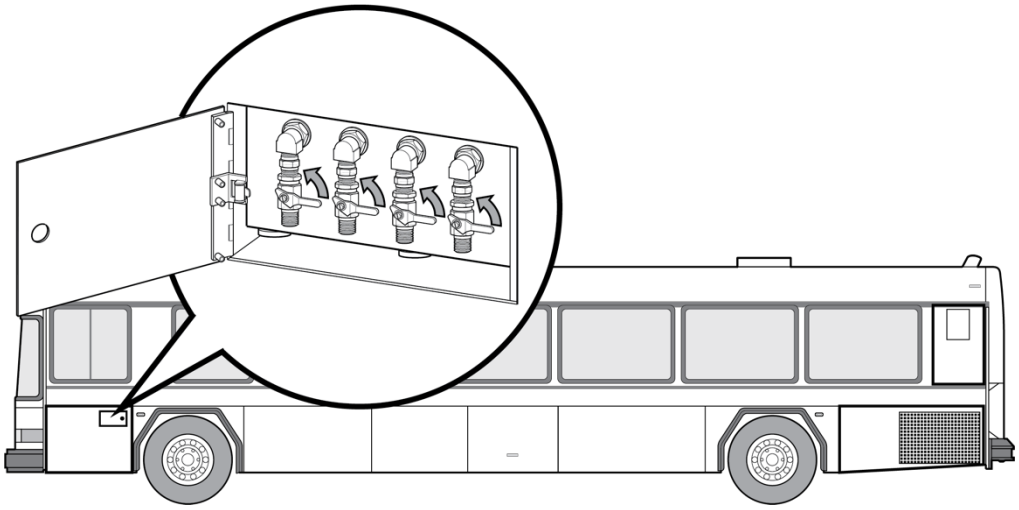
Most of the air system uses nylon air brake tubing. This tubing meets SAE J844, Non-metalic Air Brake System Tubing and FMVSS 106, Brake Hoses, requirements and is flexible, durable, and weather resistant. GILLIG utilizes the following hose colors:

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- Green indicates primary system, which supplies the rear axle brakes
- Red indicates secondary system, which supplies the front axle brakes
- Brown indicates parking brake system
- Yellow indicates air compressor governor signal
- Black indicates accessories and drain lines

GILLIG utilizes a #16 Teflon hose for the air delivery line from the air compressor to the air dryer. Nylon tubing cannot be used due to the high temperature of the air delivered by the air compressor.

Each reservoir has a check valve at the supply port to maintain pressure in that tank if other reservoirs or air lines were to leak. Each tank is also fitted with a standard manual drain valve. These quarter-turn drain valves are mounted streetside and conveniently located waist high for ease of maintenance, just below the driver's side window with access through a door located in the front streetside skirt panel. The drain lines discharge at street level below the floor of the bus.

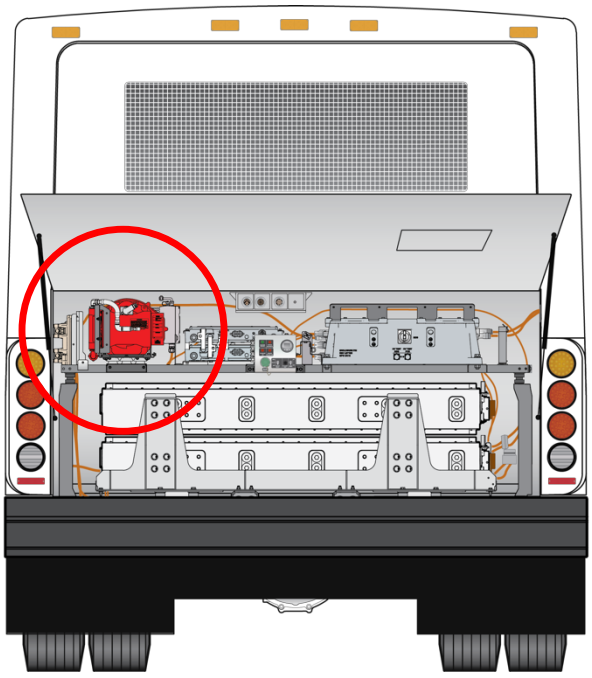


Specifications		
Air Reservoir	**Purpose**	**Volume**
Wet	Cool and dry the air prior to filling other reservoirs	1,450 in.³
Primary	Supplies air to rear service brakes and parking/emergency brake system	1,716 in.³
Secondary	Supplies air to front service brakes and parking/emergency brake system	2,095 in.³
Accessory	Supplies air to the suspension system, the passenger doors and the driver's seat	1,090 in.³

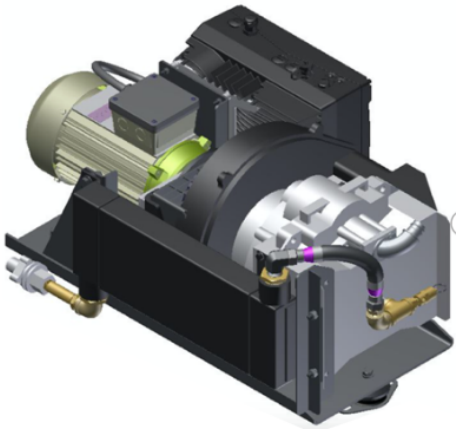
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AIR COMPRESSOR

An air compressor is driven by an electric motor and provides compressed air to the air dryer. The Powerex air compressor uses an oil-less scroll compressor. A scroll compressor pushes air through increasing smaller air pockets, increasing the pressure with each successive pocket. Scroll compressors are quieter and smoother than reciprocating compressors because they have only one moving part: an orbital scroll. This also makes the scroll compressor more efficient, reliable, and durable than a reciprocating compressor. By using an oil-less compressor, the air does not become contaminated with oil or oil vapor that would have to be cleaned by the air dryer. This results in less demand on the dryer and therefore lower lifecycle costs and power consumption.



The air compressor is mounted on a vibration-dampened bracket on the powertrain compartment platform in the rear of the bus. The air compressor is supplied with high-voltage DC from the high-voltage DC junction box. A DC/AC inverter is integrated into the compressor assembly to provide 350-V three-phase power to the electric motor.



Specifications	
Supplier	Powerex
Compressor type	Oil-less scroll
Input voltage	600–750 VDC
CFM capacity	12 CFM @ 120 PSIG

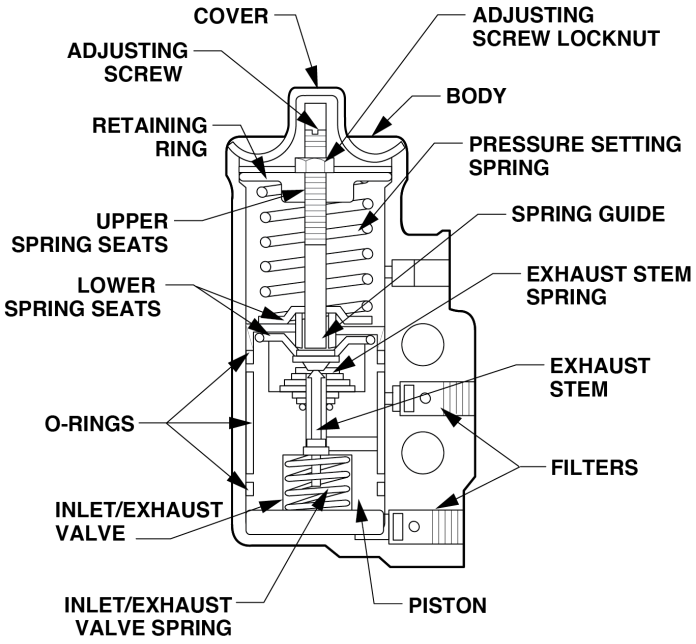
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AIR GOVERNOR

The Bendix D-2 air governor, operating in conjunction with the air compressor unloading mechanism, automatically controls air pressure in the air brake or air supply system between the predetermined maximum (cut-out) and minimum (cut-in) pressures. The air compressor is controlled by the governor, which stops or starts compression when the maximum or minimum reservoir pressures are reached.

Reservoir air pressure enters the Bendix D-2 governor at one of its reservoir ports and acts on the piston and inlet/exhaust valve. As the air pressure builds up, the piston and valve move together against the resistance of the pressure-setting spring. When the reservoir air pressure reaches the cut-out setting of the governor, the exhaust stem seats on the inlet/exhaust valve, closing the exhaust passage, and then opens the inlet passage. Reservoir air pressure then flows around the inlet valve, through the passage in the piston, and then pressurizes the unloader port. A pressure switch connected to the unloader port measures this pressure; when it is pressurized, it turns off the air compressor.

As the system reservoir air pressure drops to the cut-in setting of the governor, the force exerted by the air pressure on the piston is reduced so that the pressure-setting spring moves the piston down. The inlet valve closes, and the exhaust opens. With the exhaust open, the air in the unloader line escapes back through the piston, through the exhaust stem, and out the exhaust port.



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The Bendix AD-IP (Integral Purge Air Dryer) collects and removes air system contaminants in solid, liquid, and vapor form so that clean, dry air is delivered to the wet tank reservoir and then to the other three air reservoir tanks. Because clean, dry air is used through the system, component life is increased, which reduces maintenance costs.

The AD-IP Air Dryer consists of a desiccant cartridge secured to a die-cast aluminum end cover with a single, central bolt. The end cover contains a check valve assembly, safety valve, heater, and thermostat assembly; three pipe thread air connections; and the purge valve assembly. The removable purge valve assembly incorporates the purge valve mechanism. The dryer is chassis-mounted, curbside, and is accessible from either under the bus or through the hinged skirt panel; all replaceable assemblies can be replaced without removal of the air dryer from its mounting on the vehicle.

The AD-IP air dryer alternates between two operational modes or cycles during operation: the charge cycle and the purge cycle.

When the compressor is loaded (compressing air), compressed air, water, and water vapor flow through the compressor discharge line to the supply port of the air dryer body. As air travels through the end cover assembly, its direction of flow changes several times, reducing the temperature, causing contaminants to condense and drop to the bottom or sump of the air dryer end cover.

After exiting the end cover, the air flows into the desiccant cartridge. Once in the desiccant cartridge, air first flows through an oil separator located between the outer and inner shells of the cartridge. The separator removes water as well solid contaminants.

Air, along with the remaining water vapor, is further cooled as it exits the oil separator and continues to flow upward between the outer and inner shells. Upon reaching the top of the cartridge, the air reverses its direction of flow and enters the desiccant drying bed. Air flowing down through the column of desiccant becomes progressively drier as water vapor adheres to the desiccant material in a process known as adsorption. The desiccant cartridge, using the adsorption process, typically removes most of the water vapor from the pressurized air.

Dry air exits the bottom of the desiccant cartridge and flows through the center of the bolt used to secure the cartridge to the end cover. Air flows down the center of the desiccant cartridge bolt, through a cross-drilled passage, and exits the air dryer delivery port through the delivery check valve.

Dry air flowing through the center of the desiccant cartridge bolt also flows out the cross-drilled purge orifice and into the purge volume.

The air dryer remains in the charge cycle until the air system pressure builds to the governor cut-out setting.

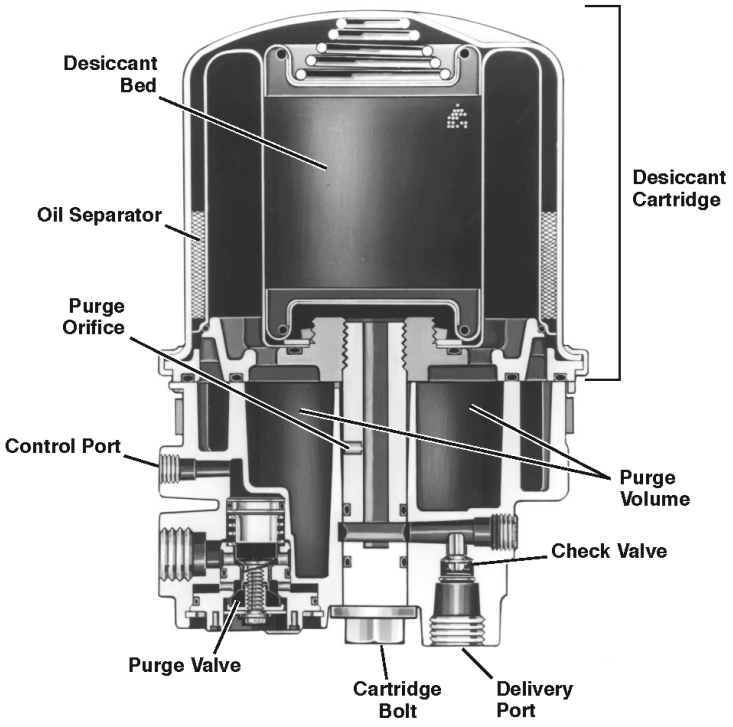
As air system pressure reaches the cut-out setting of the governor, the governor unloads the compressor (air compression is stopped) and the purge cycle of the air dryer begins. When the governor unloads the compressor, it pressurizes the compressor unloader mechanism and the line connecting the governor unloader port to the AD-IP end cover

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control port. The purge piston moves in response to air pressure, causing the purge valve to open to the atmosphere and the turbo cut-off valve to close off the supply of air from the compressor. Water and contaminants in the end cover sump are expelled immediately when the purge valve opens. Also, air that was flowing through the desiccant cartridge changes direction and begins to flow toward the open purge valve. Solid contaminants collected by the oil separator are removed by air flowing from the purge volume through the desiccant drying bed to the open purge valve.

The initial purge and desiccant cartridge decompression lasts only a few seconds and is evidenced by an audible burst of air at the AD-IP exhaust.

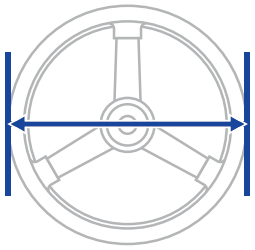
The actual reactivation of the desiccant drying bed begins as dry air flows from the purge volume through the purge orifice in the desiccant cartridge bolt, then through the center of the bolt and into the desiccant bed. Pressurized air from the purge volume expands after passing through the purge orifice; its pressure is lowered, and its volume increased. The flow of dry air through the drying bed reactivates the desiccant material by removing the water vapor adhering to it.



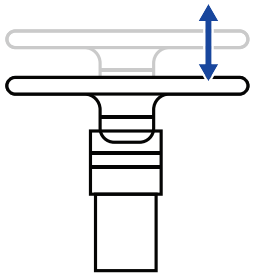
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ZF REAX-C STEERING COLUMN

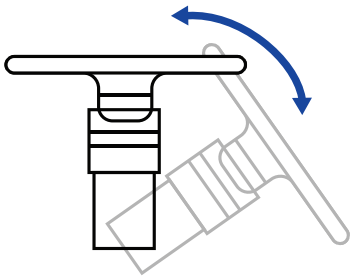




STEERING WHEEL SIZES:
20" DIAMETER OR
16" DIAMETER WHEEL

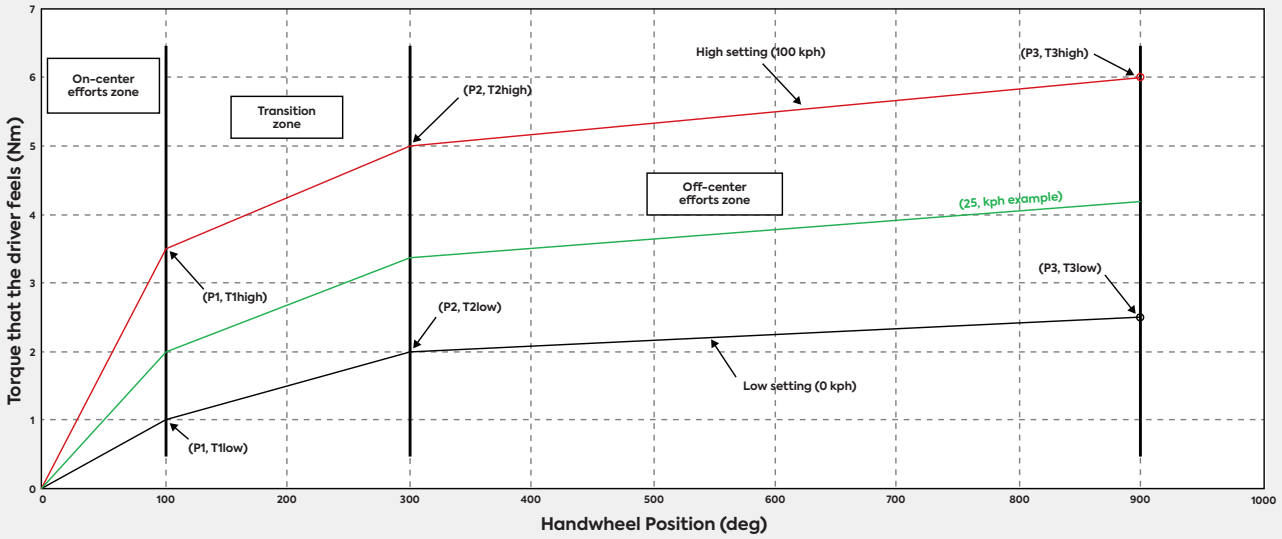


TELESCOPE:
1.8 INCHES OF TOTAL
TELESCOPE



TILT:
60° TOTAL, ± 30° FROM
NEUTRAL POSITION

EFFORT CHART



ACTUALS

AT MIN TELESCOPIC HEIGHT ADJUSTMENT

Angle of slope	Height (20" wheel)	Height (18" wheel)	Height (16" wheel)
0°	33.4	33.1	31.8
15°	30.7	30.6	29.7
25°	28.8	28.8	28.1
35°	26.7	26.9	26.4
44° (max down tilt)	24.3	27.7	24.6

AT MAXIMUM TELESCOPIC HEIGHT ADJUSTMENT

Angle of slope	Height (20" wheel)	Height (18" wheel)	Height (16" wheel)
0°	35.2	33.8	33.8
15°	32.5	32.3	31.4
25°	30.5	30.5	29.8
35°	28.4	28.6	28.2
44° (max down tilt)	26.1	26.5	26.3

APTA TARGETS

AT MIN TELESCOPIC HEIGHT ADJUSTMENT (29 IN.)

Angle of slope	Height
0°	29.0 in.
15°	26.2 in.
25°	24.6 in.
35°	22.5 in.

AT MAXIMUM TELESCOPIC HEIGHT ADJUSTMENT (5 IN.)

Angle of slope	Height
0°	34.0 in.
15°	31.2 in.
25°	29.6 in.
35°	27.5 in.

NOTES:

1. INSTALLATION PROCEDURE:

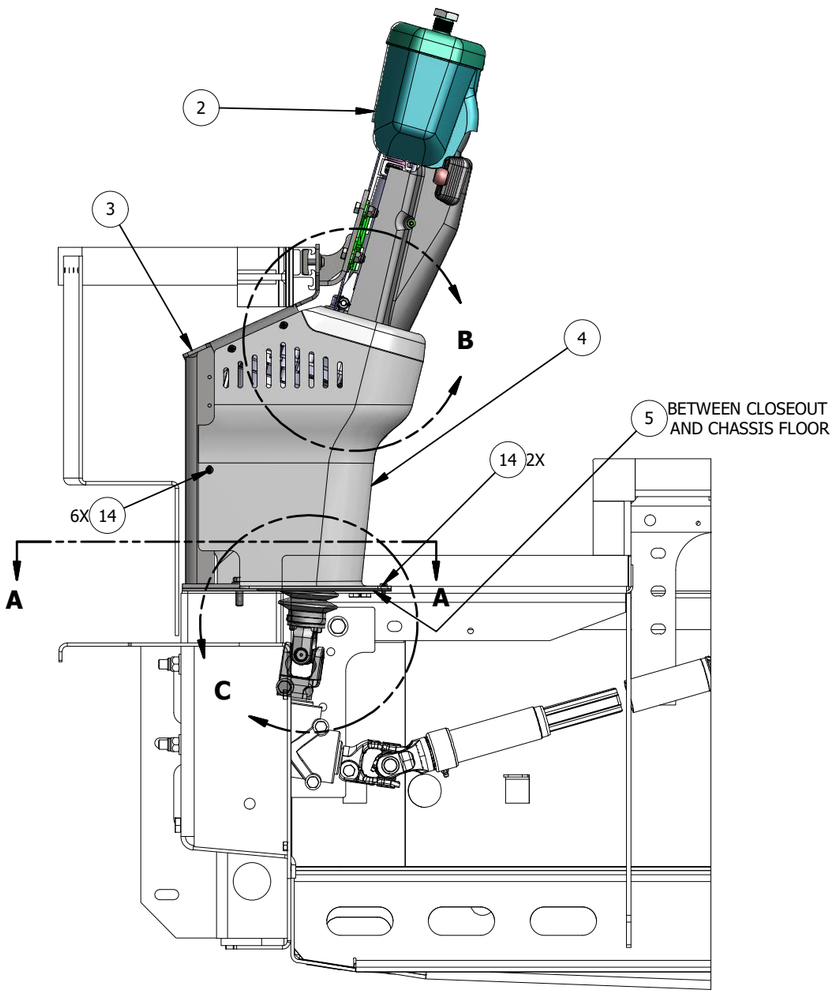
   1.1 ALIGN AND MOUNT COLUMN BRACKET TO NUTS WELDED IN DRIVER'S PLATFORM.
   1.2 ATTACH UPPER UNIVERSAL JOINT OF STEERING SHAFT TO OUTPUT SHAFT OF STEERING COLUMN.
   1.3 ATTACH LOWER UNIVERSAL JOINT OF STEERING SHAFT TO MITER BOX INPUT SHAFT.
   1.4 MOUNT STEERING COLUMN TO COLUMN BRACKET.
   1.5 MOUNT CLOSEOUT TO COLUMN BRACKET. ROTATE STEERING WHEEL TO FULL LEFT AND RIGHT TRAVEL TO CONFIRM ADEQUATE CLEARANCE BEFORE INSTALLING ALL CLOSEOUT MOUNTING SCREWS.

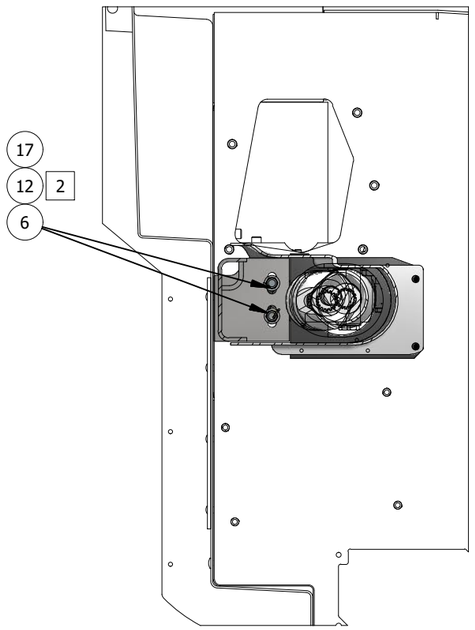
[2] TORQUE 3/8-16 GR. 8 HDW TO 37 FT-LB

[3] TORQUE 3/8-24 GR. 8 PINCH BOLT TO 44 FT-LB AT THE NUT

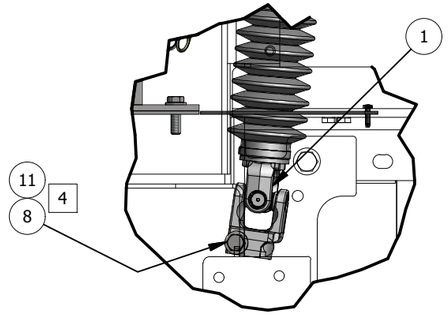
[4] TORQUE 7/16-20 GR. 8 PINCH BOLT TO 70 FT-LB AT THE NUT

[5] TORQUE M8 X 20 BOLTS TO 15.5 FT-LB

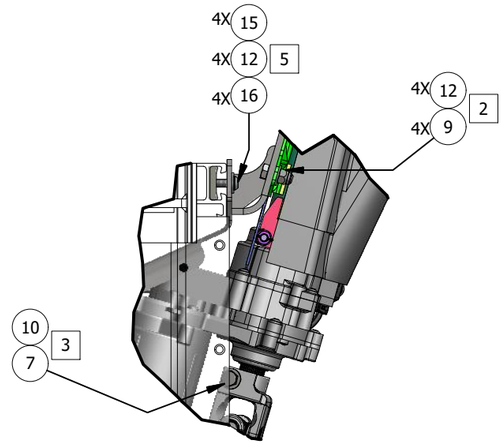




VIEW A-A
1/8



DETAIL C
SCALE 1/6
CLOSEOUT NOT SHOWN



DETAIL B
SCALE 1/6
CLOSEOUT NOT SHOWN

REVISION HISTORY

REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	REI	DATE
A	RELEASED FOR PRODUCTION	NIH	ETH	AVH	140369	11/9/2020

ITEM	QTY	PART NUMBER	TITLE
17	A/R	65-39908N054	ADHESIVES/SEALANTS, LOCTITE 243 BLUE THREADLOCKER
16	4	54-37359-002	BOLT, BUTTON TORX HEAD M8 X 20MM, COBALT
15	4	54-37358-000	NUT PLATE, COBOLT M8
14	8	54-13119-003	SPECIAL SCREWS, , #10-24 X 0.75 TAPTITE PHCR W/CAM GRIP
13	2	54-12601-009	WASHER, FLAT, HARD 7/16, TYPE A SAE
12	12	54-12601-008	WASHER, FLAT 3/8 HARD
11	1	54-12551-008	NUT, HEX UNC, 7/16-20 NYLON INSERT GR8
10	1	54-12551-007	LOCKNUT - HEX
9	4	54-12541-007	NUT, HEX UNC, 3/8-16 NYLON INSERT GR8
8	1	54-11347-007	BOLT, HXHD, HEX CAP SCREW 7/16-20 X 2.00 GR8
7	1	54-11345-007	BOLT, HXHD, HEX CAP SCREW 3/8-24 X 2.00 GR8
6	2	54-11321-004	STEEL, 3/8-16 X 1.25 LG UNC GRADE 8
5	1	05-82917-001	SEAL, RUBBER
4	1	05-82257-001	CLOSEOUT, STEERING COLUMN
3	1	05-82250-000	BRKT ASM, STRG COLUMN MTG
2	1	05-61586-XXX	COLUMN, ELECTR. DRIVE STEERING, SEE BOM FOR P/N
1	1	05-59998-003	SHAFT ASM, STEERING

PARTS LIST

MARK PART WITH PART NUMBER PER DB370.002
PART TO BE FREE OF BURRS AND SHARP CORNERS
UNLESS OTHERWISE SPECIFIED DIMENSIONS AND TOLERANCES ARE IN INCHES
X.X = ±.1
X.XX = ±.03
X.XXX = ±.010
ANGULAR = ±1°
THIRD ANGLE PROJECTION

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MAT'L: SEE PARTS LIST
QAC DB240.000A: 2
ORIG REI #: 140369
DRAWN: NIH 11/9/2020
CHECKED: ETH 11/9/2020
APPROVED: AVH 11/9/2020
WEIGHT: N/A
DIMENSIONING AND TOLERANCING PER ASME Y14.5-2009

GILLIG

TITLE: INSTL, STEERING COLUMN REAX

SIZE: B | SCALE: 1/8 | DWG NO: 10-82924-002 | REV: A
IST S.O.:
SHEET: 1 OF 1

HYDRAULIC SYSTEM

The hydraulic system furnishes hydraulic pressure to the steering gear to steer the front wheels. The system consists of a fluid reservoir, power steering hydraulic pump, steering gear, and associated hoses. These components can be accessed through the streetside battery box compartment.

Hydraulic fluid is stored in the hydraulic reservoir. The hydraulic pump provides constant flow to the steering gear at variable pressure. Fluid leaving the steering gear is returned directly to the reservoir.

The 24 V electric hydraulic power steering pump provides hydraulic pressure to the power steering gear. The hydraulic pump mounts to, and is driven from, the electric motor.

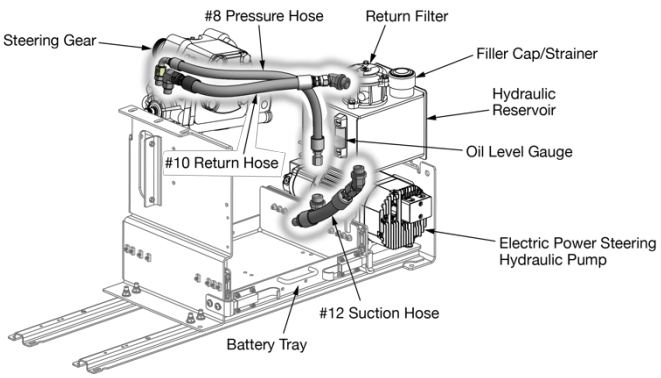
The fluid in the hydraulic system is selected to accomplish all of the various demands placed on it by the system performance parameters. Only OEM-approved fluids can be used.

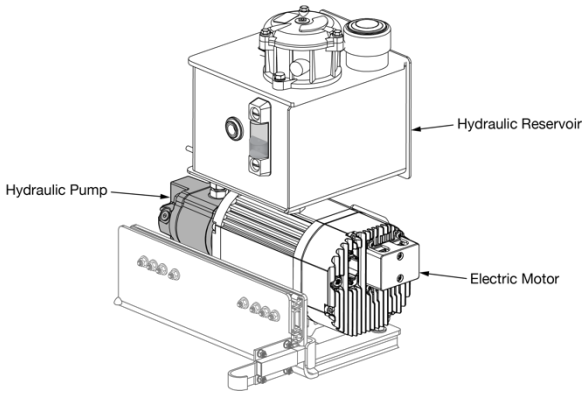
The reservoir is mounted in the streetside front corner of the bus, in the battery compartment. The drop-in filter element keeps foreign matter and dirt from entering the pump and the steering gear. A protective cover is installed above the low voltage batteries to shield the top of the batteries and the exposed electrical terminals on the batteries from hydraulic fluids.

The power steering system depends on sufficient fluid pressure and flow to enable the steering gear to operate as designed. Fluid pressure reacting on a piston creates the force to cause the piston to move and assist the steering effort.

As the piston moves, it is displaced in the cylinder bore by a volume of fluid under pressure. How fast the piston can be displaced depends on adequate fluid flow and volume.

A pressure gauge that can read at least 3,000 psi (20,685 kPa) and a flow meter with a capacity of 10 GPM are needed to check pressures and flow.





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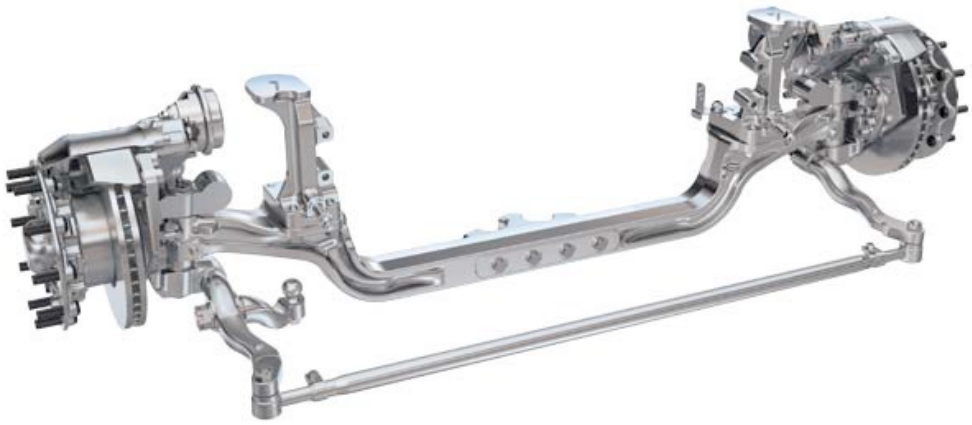
Specifications	
Hydraulic reservoir	Supplier: Helgesen. Model: GILLIG-specific port. Construction: Welded steel construction with black powdercoat finish. Capacity: 5.1 quarts. Filtration: 10-micron replaceable filter element. Level measurement: Sight tube and electric low-level sensor. Drain port: Provided with SAE O ring hex head plug. Tethered fill cap with screen on fill port.
Power steering pump	Supplier: Concentric. Model: EHS. Pump: Gear pump. Pump displacement: 11.3 cc/rev. Electric motor: 24-VDC PM, brushless. With CAN for variable speed capability and fault diagnosis. Pressure relief: 2,175 psi. Flow: 4.19 gpm. Life: 40,000-hour pump and motor. Warranty: 24 months.

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FRONT AXLE

The GILLIG Low Floor utilizes the Meritor FH-946 deep-drop front non-drive steer axle as our standard front axle. The front axle transfers the front weight of the bus to the tires, provides the pivoting mechanism to provide steering, holds the front axle brakes to provide braking, and provides the hubs to hold the wheels and allow the wheels to rotate.

The axle includes suspension rod attachment points that are integrated to the I-beam for simplified bracket design and greater bracket flexibility. The FH-946 also includes Easy Steer king pin bushings and tapered roller thrust, which permit easier steering.



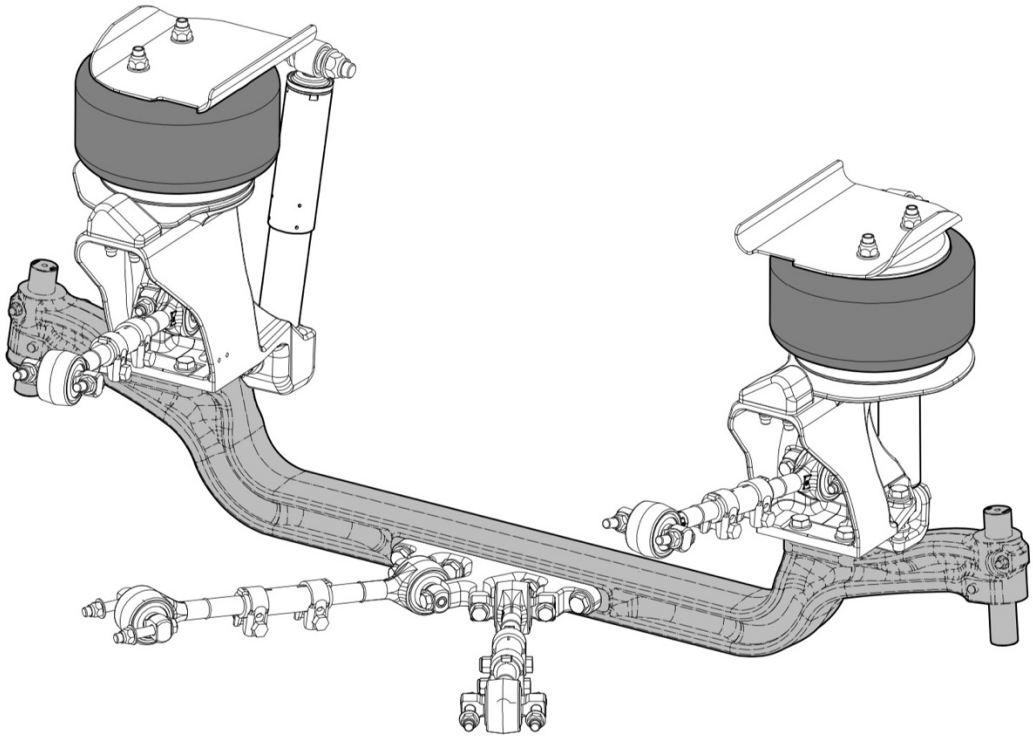
Specifications	
Supplier	Meritor.
Model	FH-946.
Rating	16,000 lb (7,257 kg).
Wheel-end hardware	Hubs: cast iron. Hub lubrication: Oil lubrication, standard. Grease, optional. Wheel mounting: 10-hole bolt circle. 335-mm (13-in.) bolt circle. 281.2 hub bore. Hub pilot.
Turn angle	51 degrees.
Axle warranty	5 years or 300,000 miles.
Brakes	EX225H3 disc brakes.
Rotor diameter	434 mm (171 in.).
Brake linings	Meritor MA703.
Brake chamber	Type 24.
Brake wear indication	Manual (standard), Electric (optional).
Brake warranty	2 years or 100,000 miles.

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The front air suspension is composed of two Firestone air springs with internal bump stops for a smooth ride, shock absorbers to dampen bounce, external roll bumpers to limit suspension roll, and torque rods to maintain axle/frame geometry.

The air system operates automatically to maintain a constant ride height regardless of load or load distribution. The pressure in the air spring bellows is varied automatically by the height control valve in proportion to the bus load. As the bus is loaded, the body settles toward the axles. This movement operates the height control valve, and air is allowed into the air springs. Air pressure in the air springs increases enough to compensate for the additional load. As passengers leave the bus, the height control valves allow air to exhaust from the air springs. The air in the air springs is reduced by the valves in proportion to the weight debarking the bus, which, again, keeps the bus body at normal ride level. The height control valves are designed to operate only when the load in the bus is changed. They do not respond to the rapid relative motion between the axle and body, such as the motion caused by road bumps.

The torque rods hold the axle in a position perpendicular to the axis of the chassis so that the tires track in parallel lines when in operation.



The front suspension kneeling system allows the driver, when the bus is stopped, to override the air suspension height control system and kneel (or lower) the front air suspension. Kneeling the bus reduces the front step height and reduces the wheelchair ramp angle. Reducing the step height or ramp angle makes access into the bus easier for passengers with reduced mobility. The kneeling system allows lowering the front

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suspension and holding it at the lowered height in any position from normal ride height to fully lowered. Brake and throttle interlock prevent movement when the bus is kneeled. To raise the bus back to normal ride height quickly, the kneeling system includes a fast fill feature. This raises the front suspension back from fully lowered to normal ride height in 3 to 5 seconds. If required to facilitate wheelchair ramp deployment, the kneeling system can also be used to over-raise the front suspension to provide a front suspension height above the normal ride height. An indicator mounted on the instrument panel illuminates during the kneeling operation and remains illuminated until the bus is raised to a height adequate for safe street travel.

Specifications	
Height Control Valve	Barksdale.
Kneeling Valve	Parker, manifold-type valve.
Maximum acceleration: kneel/raise	0.2 g.
Maximum jerk: kneel/raise	0.3 g.
Kneeling time	1.5-2.5 seconds from control activation.
Raise time	2 seconds to permit driving, 5 seconds to return to full ride height.

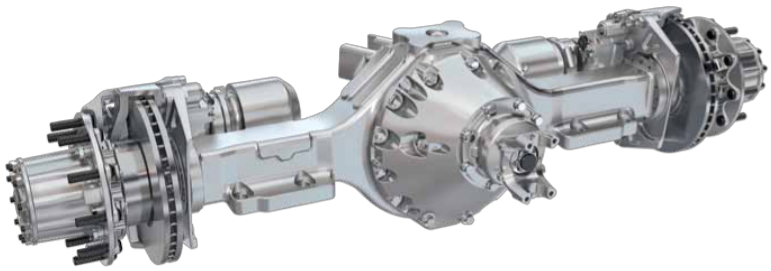
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GILLIG uses the Meritor 79000 series single reduction axle. The full floating rear axle has a one-piece housing with welded bowl. Power is transmitted from (and in regenerative braking to) the traction motor through a propeller shaft to the drive pinion gear and differential assembly, to the axle shafts, and then to the rear wheels. The differential assembly, drive pinion gear, and pinion cage assembly are mounted in the differential carrier. By removing the axle shafts, the carrier can be removed for inspection, adjustment, or replacement without having to remove the axle housing from the vehicle.

The differential is a conventional four-pinion type carried in a two-piece case mounted in tapered roller bearings. The drive (ring) gear is bolted to the flanged half of the differential case. Thrust washers are used between the side gears and differential case and also between the differential pinion gears and case. The case halves are secured by cap screws and hardened washers. The differential assembly provides for gear reduction to reduce the revolutions per minute and to multiply the torque from the traction motor while allowing for wheel speed differences.

The differential is supported in tapered roller bearings, which accept both thrust and radial loads. The bearings are mounted within supports in the carrier, while thrust loads are born by the adjusting rings threaded into the carrier supports and bearing caps.

The axle housing has outer end tubes that are threaded to accept wheel bearing adjusting nuts. The axle shafts are the same for left or right sides. The flange at the outer end is attached to the hub by studs, tapered dowels, and nuts. The inner end is splined to the differential side gears.



GILLIG buses use air-actuated disc brakes. The force introduced from an air chamber push rod is amplified by the mechanism within the floating caliper housing. This mechanism creates a clamping force that is applied to the inboard brake pad. Once the inboard pad has contacted the brake rotor, a reaction force acts through the floating caliper housing and bridge to pull the outboard pad onto the brake rotor. The brakes are released by reducing the input force from the air chamber, which reduces the clamping force of the brake. A return spring within the caliper housing returns the mechanism back to its starting position, leaving the pads with a defined running clearance to the rotor. The small run-out of the brake rotor and hub then creates a small clearance for the outboard pad after a few revolutions of the rotor. An automatic adjuster adjusts the brake pad

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clearance to compensate for pad wear. This adjuster is internal to the caliper housing and is manually readjusted back to its starting position when new brake pads are installed.

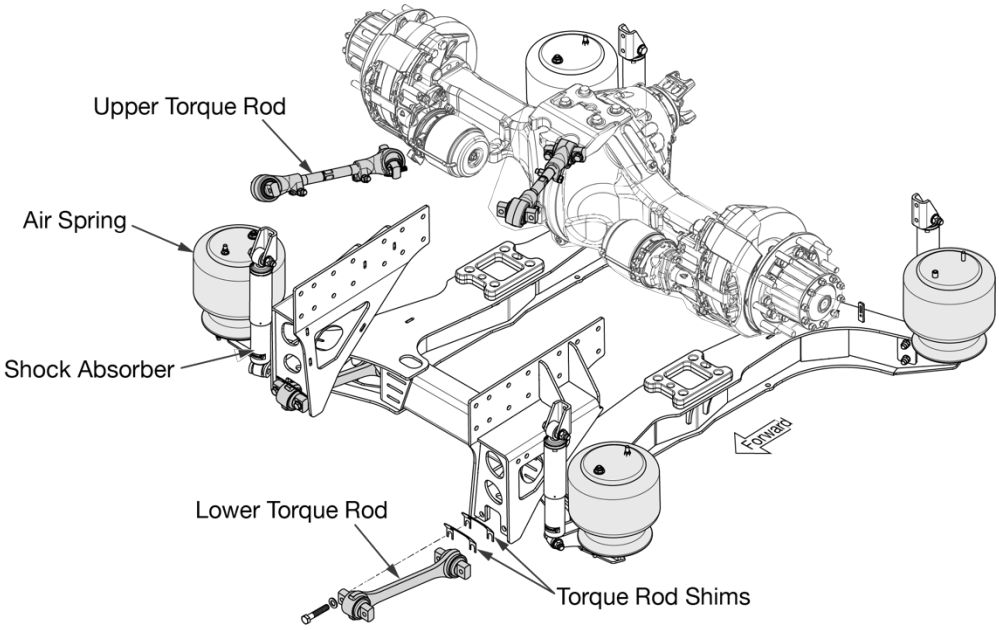
GILLIG provides an anti-lock braking system (ABS) provided by Wabco. The ABS monitors and controls wheel speed during braking. If a wheel starts to lock up during braking, the ABS reduces air pressure to that wheel's brake to keep all wheels turning at the same speed. When the wheel speed enters the stable region again, the air pressure automatically increases.

Specifications for Rear Axle	
Supplier	Meritor.
Model	79163.
Rating	29,000 lb (13,154 kg).
Rear axle ratio	Standard: 6.14:1.
Wheel-end hardware	Hubs: cast iron. Hub lubrication: Oil lubrication, standard. Grease, optional. Wheel mounting: 10-hole bolt circle. 335-mm (13-in.) bolt circle. 281.2 hub bore. Hub pilot only. Stud pilot not available.
Warranty	5 years or 300,000 miles.

Specifications for Brakes	
Supplier	Meritor.
Model	EX225H3.
Rotor diameter	434 mm (17 in.).
Linings	Meritor MA703.
Brake chamber	Type 24.
Brake wear indication	Manual (standard), Electric (optional).
Warranty	2 years or 100,000 miles.

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The Hendrickson 4-bag rear suspension has an H-frame construction, which supports four air springs. The H-frame is a solid piece made up of two pairs of beams perpendicular to each other. The beams are not detachable from one another. The rear axle rests on saddles on two of the suspension beams. The air springs rest on mounting plates at each end of the other two suspension beams. The suspension is connected to the chassis frame by four torque rods. The air springs and shock absorbers form the other connecting points of the suspension and to the chassis frame. Two height control valves automatically maintain correct ride height by controlling air pressure in the air springs. Two upper and two lower torque rods are used to position the axle. The upper torque rods are attached to the axle housing and frame brackets. The lower torque rods are attached to the suspension H-frame and the chassis frame. Each of these rods has rubber bushings with metal inserts to absorb axle deflections. Two pairs of telescoping-type shock absorbers are installed.



Air springs provide passengers with a smooth and comfortable ride. Each end of the flexible member (the air bag) has a reinforced bead that forms an air-tight seal when the spring is inflated. When in operation, the air bag folds over the piston at the bottom of the suspension so that the characteristic lobe shape is produced. The suspension bump/limit stops are located inside the air spring assemblies to support the bus if there is an air spring failure and to prevent damage to the bus understructure from large suspension deflections.

The air suspension height control valves automatically control the air pressure in the air springs to maintain the proper ride height. As the vehicle is loaded, the air springs compress slightly. The height control valve actuating arm moves up from the neutral position to the fill position. This allows air to flow from the air tanks into the air springs, increasing the pressure in the air springs, and bringing the air spring back to the proper

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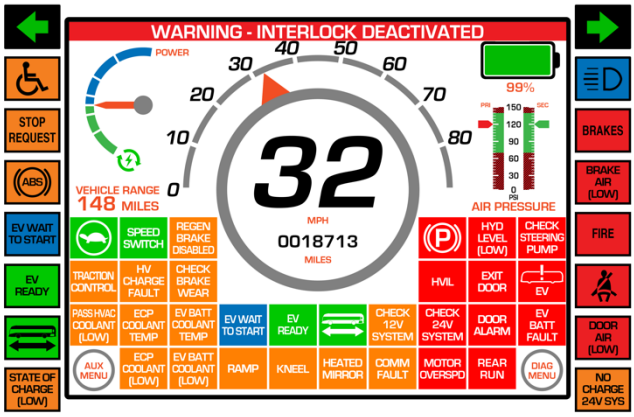
height. When the vehicle is unloaded, the air springs slightly increase in length and the height control valve actuating arm moves from the neutral position to the exhaust position. This exhausts some of the air in the air spring until enough air has been exhausted to bring the air spring back to the proper height.

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A touchscreen Multi-Function Display (MFD) initializes when the bus is turned on using the front run switch. This screen is the default display and displays the same operational information provided by standard gauges, such as speed, odometer reading, and voltage. There are also 16 stationary indicators along either side of the MFD. The primary and secondary screens display vehicle warning/information indicators in an easily visible way.

The indicator lamps (30 in the center and 16 on either side of the MFD) are programmed so some are turned on during normal bus function and others call attention to problems with red (for danger) and yellow (for attention/caution) warnings. Some indicators are connected to buzzers or alarms to serve as both alerts for dangerous situations or reminders during normal operations.

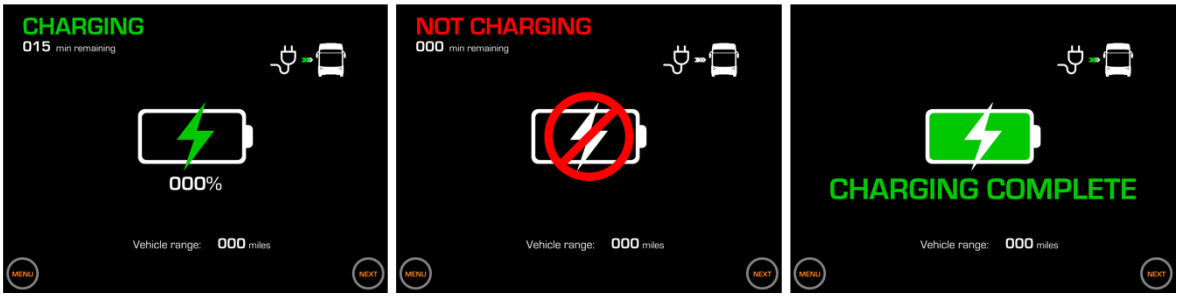




The primary screen is the default display for the driver while in motion. The relevant gauges and indicator lamps are displayed in a central location to allow the operator to quickly review the status while driving.

The MFD also provides a variety of secondary screens to display information during charging, maintenance, or when an alert is required.

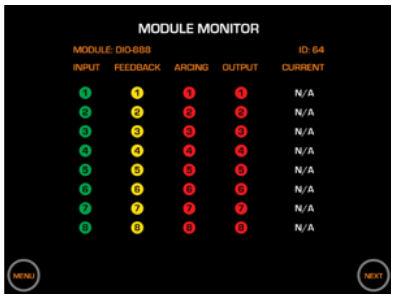
Charging Screens

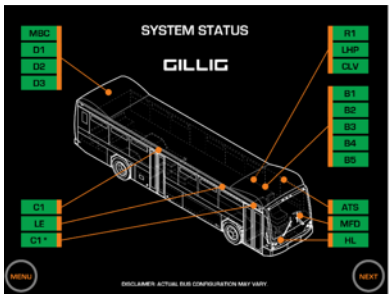


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Sample Maintenance Menus







Sample Alert Screens





If the secondary screen is selected, it will automatically revert back to the primary screen when the bus is accelerated to at least 3 mph.

If equipped with a compatible camera, the MFD can serve as a back-up monitor. Whenever the bus is operational and is shifted into reverse, the MFD displays full-screen video of the area behind the bus. The MFD switches back to the primary screen when the transmission is no longer in reverse. Additionally, the MFD can display the video feed from a compatible rear door camera when the rear door is opened to allow the driver to verify there are no obstructions before closing the doors.

The MFD has two modes for driver convenience: day mode and night mode. In Night Mode, the MFD displays in inverted colors, changing from a white background to a black background, so it is more visible at night and reduces glare and reflection.

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GILLIG's Battery Electric Bus telematics is a web-based system which displays live and historical data from the fleet level down to the individual bus.

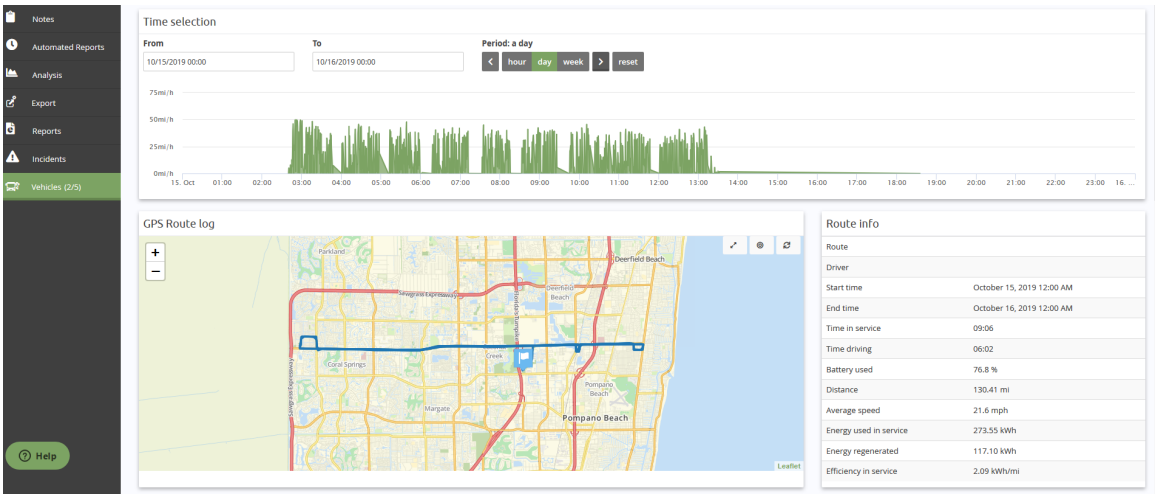
- Organizes data with graph, map, and table views to make goal-based analysis easy.
- Updates with live data every second.
- Resizes to work on both desktop and mobile.
- User-configurable automatic reporting on fleet or individual bus data.
- Report types can be saved for easy online access or emailed automatically.
- User-configurable automatic and immediate alerts such as "Low State of Charge."
- Downloadable raw data in MS Excel format for further processing.

Fleet Dashboard shows live data for all vehicles. There is a map view, a list sorted by battery state of charge, and a list of vehicles that are completely offline.

Vehicle Dashboard shows live data for one vehicle, including State of Charge, location, range remaining, and efficiency per mile that day.

Subsystem tabs show live data, such as HVAC use and temperature, 24 V battery information, door and ramp position, etc.

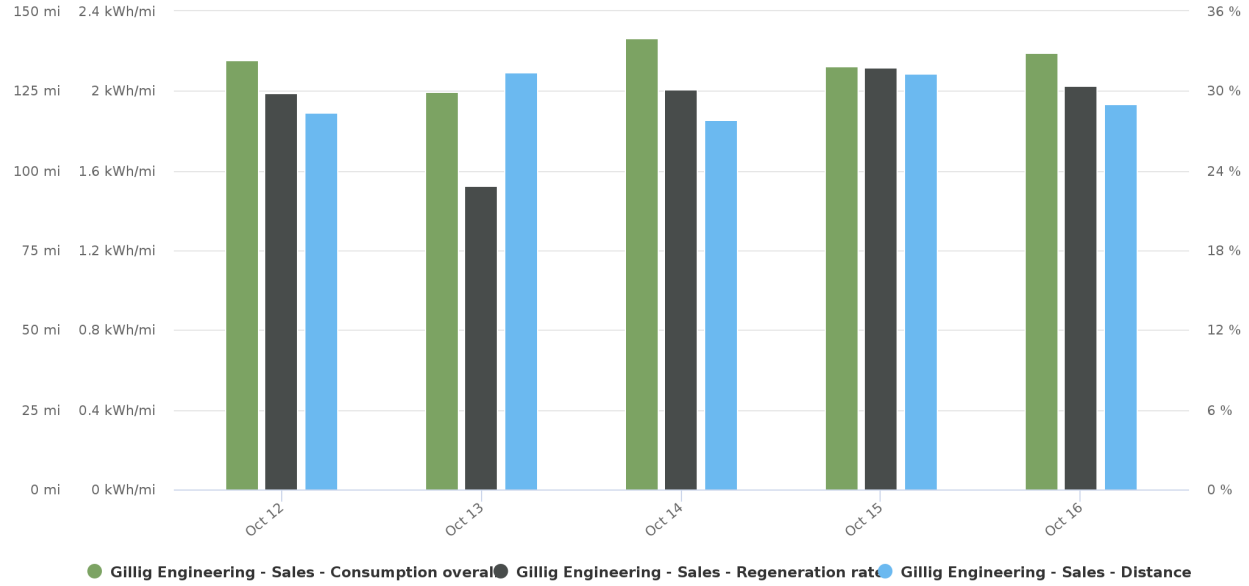
Route Log shows historical data for one vehicle with a map view. It allows you to see metrics of a route or time period with drag-and-drop selection. This can help with estimating the vehicle range on new routes.



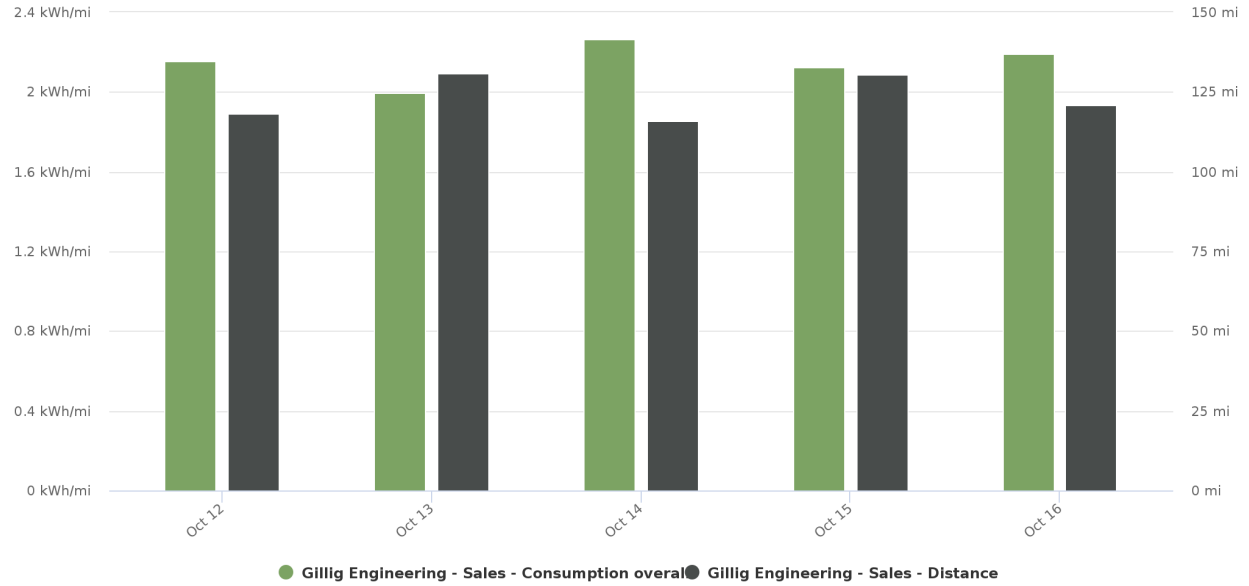
Diagnostic Messages shows recorded and live fault codes, with their descriptions and severity levels.

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Analysis shows historical data for any number of vehicles with a graph view over time. It allows you to see exactly when certain events happen, such as door status, and can assist with troubleshooting.



Reports shows historical data for any number of vehicles with a graph view that is averaged by day/week/month/year. It allows you to see trends in average speed, efficiency, distance traveled, etc.



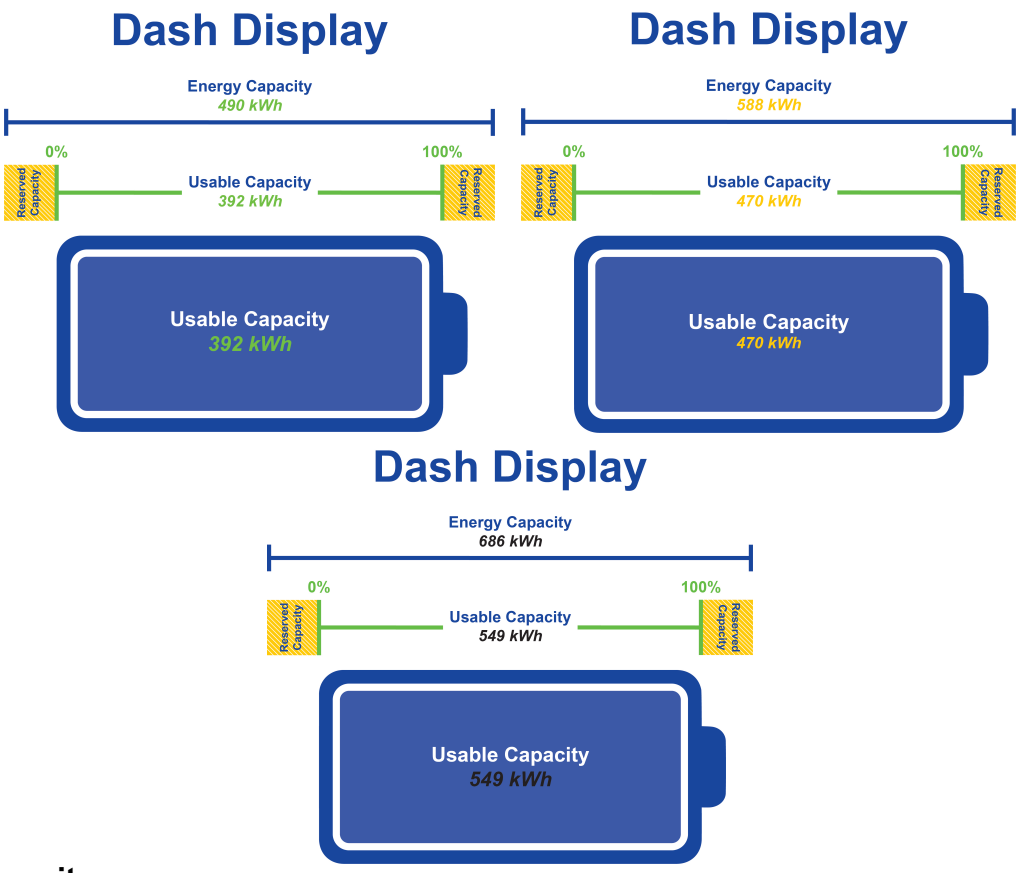
Portal allows administrators to configure access to different users.

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Specifications	
Interfaces, J1939 CAN	Baud rate: 500k. Number of channels: 1. Sampling rate: down to 1 ms. Data compression or loss-rate: lossless data compression allowed.
Analog input data collection capability	Voltage input range: 0–10 VDC. Minimum resolution: 0.01 VDC. Minimum sampling rate: selective 10 ms/100 Hz. Number of channels: 6.
Communications	Wireless LAN, 802.11ac. IR5.3.2. GSM (cellular), LTE.
Onboard storage	8 GB minimum.
Power requirements	Full load 5 W. Standby 1 W. Sleep 0.1 W.
Sensors	GPS, gyro, accelerometer (3-axis), and barometric pressure.
Other	Automatic recovery/crash resilient. Remote configuration management. Wake on CAN and I/O.

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Many factors determine the real-life range of an electric vehicle, which is derived from the net usable energy (or capacity) and the rate of energy consumption.



Rated Capacity

The rated capacity of a battery is the amount of total energy that can be stored in and discharged from the battery. Battery capacity reduces over the life of the cells as the impact of charging and discharging reduces the ability for the cells to reach full charge. Battery health is monitored by the battery management system and reported via telematics. The State of Health (SOH) is communicated as a percentage of the rated capacity at the start of life.

Reserved Capacity

Battery life is negatively impacted when cells are overcharged or when the depth of discharge is too low. In order to maximize high-voltage battery life, the capacity of the battery is limited to prevent discharge below 10% and charging above 90% of rated capacity. The charge controller prevents the batteries from being charged above the top limit, and derating protocols are in place to prevent the batteries from reaching the bottom limit.

Usable Capacity

The result of reserving some high-voltage battery capacity is that 80% of the rated capacity is available to power the vehicle. This is the usable capacity, and it is used for all range calculations. The State of Charge (SOC) reported on the dashboard and via telematics represents the usable capacity remaining until a recharge is necessary.

Energy Consumption

Many factors impact the actual range of electric buses in operation. The duty cycle, route profile, and passenger loading determine how much energy is necessary to drive the traction motor and how much energy is captured through regenerative braking. Drivers can have a significant impact on energy consumption through how effectively they apply throttle and use regenerative braking to slow the bus. The HVAC system is also a significant use of energy on a bus, and settings (temperature set-points, fan speeds, etc.) can be optimized to reduce energy consumption.

Customer-specified equipment (passenger seats, windows, CAD/AVL, and video equipment, etc.) can have a large impact on total vehicle weight, which can also impact energy consumption. GILLIG has developed a Smart Spec that optimizes the range of the bus through component selection. More details are available for discussion during the pre-production meeting.

Range Estimates

Many factors determine the real-life range of an electric vehicle, consumption is derived from the net usable engery (or capacity) and the rate of energy consumption.

Configuration	High-Voltage Battery Packs, Qty	Total Rated Capacity	Range at 2.3 kWh/mile*
5 battery pack	5, each with 98 kWh	490 kWh	170 miles
6 battery pack	6, each with 98 kWh	588 kWh	205 miles
7 battery pack	7, each with 98 kWh	686 kWh	239 miles
*2.3 kWh is a conservative average energy consumption rate.			

CORROSION PROTECTION: OVERVIEW

The design goal of producing a durable vehicle that would provide years of reliable service necessitated a construction that would be as corrosion resistant as possible.

All forms of corrosion were considered in the Low Floor bus designs, from basic oxidation caused by moisture and humidity to surface corrosion caused by chemical attack such as road or atmospheric salt or acid rain. Also considered was simple galvanic corrosion caused by ion transfer in contacting dissimilar metals, as well as the more complex inter-granular, oxygen cell, or metallic ion corrosion.

The corrosion resistance of GILLIG's Low Floor buses continues to increase as newer, more effective materials become available and as field experience in all varieties of conditions and environments is gained. Stainless steel is used extensively in the chassis construction, fuel tank, wheel wells, access door hinges, and electrical boxes, cushion clamps, and other areas. Aluminum extrusions are employed throughout the body construction, and 0.125-in. (0.218-cm) aluminum sheet is used to form the body panels and access doors. Improved undercoating materials, applied both before and after assembly, provide a high level of corrosion resistance to the finished vehicle.

Corrosion protection is achieved by a combination of:

- Careful material selection.
- Rigid process controls.
- Standardized surface preparation before the application of high-quality protective coatings.

Protective Coatings

GILLIG has increased the use of powder coated components, especially those sub-assemblies with moving parts that create nooks and crannies that can hold moisture. All GILLIG manufactured parts and parts that are provided through the supply chain are required to adhere to GILLIG manufacturing standards that specify the proper cleaning, priming, and quality checks that parts must go through. These procedures are in place to reduce areas that may hold moisture and therefore be more susceptible to corrosion.

Improved undercoating materials, such as our durable latex-based anti-corrosion under-coating, which is highly sag-resistant and intended for direct to metal underbody adhesion, has passed over 1,000 hours of salt-spray resistance per ASTM B-117 as well as 100% relative humidity testing per ASTM D-1748. The film is not affected when immersed in aggressive, caustic solutions. This undercoating is environmentally safe and meets the strictest of air quality regulations.

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CORROSION PROTECTION: MATERIALS

The GILLIG Low Floor bus is manufactured to a very high standard of quality and finish. Aircraft-quality materials provide high structural integrity and naturally high corrosion resistance.

- Stainless-steel chassis structure with epoxy corrosion-protective coating applied at all body connection faces
- Type 3 hard anodized aluminum body structure
- Type 2 anodized aluminum mid-rail
- Fiberglass front and rear body panels
- Corrosion-resistant aluminum body skirts
- Aluminum rear and side-skirt hinged engine access doors
- Aluminum rivets on skirt panels and skirt-panel brackets
- Stainless-steel interior trim fasteners, to withstand interior bus wash and tracked-in road salt
- Stainless-steel external body screws with non-metallic galvanic corrosion barrier
- Nylon Sprague wiper spanner lock-nuts and acorn nuts
- Stainless-steel attachment hardware for the four rubber wheel-well fenders
- Stainless-steel compartment floor sheet for HVAC
- Powder coated chassis component-mounting brackets
- Stainless-steel coolant surge tank
- Aluminum radiator to side-door baffle to exclude rear-wheel-thrown road salt and debris from the faces of the turbo-after-cooler and radiator
- Corrosion- and chemical-resistant coating on cooling fan frame
- Stainless-steel cushion hose clamps, all locations
- Stainless-steel wheel wells
- Aluminum powder coated wheel-well stress panels
- Rubber mud guard for wheel arch fenders
- Primary stainless-steel grab handles, stanchions, and fasteners. Cast aluminum pow-der coated tees, hangers, and elbows
- High-solids, aluminum-filled epoxy corrosion protective coating applied to the entire aluminum sidewall body structure before assembly onto chassis
- Specially formulated sealant coatings for all body/chassis connections
- Stainless-steel fuel tank with stainless-steel mounting straps

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CORROSION PROTECTION: MATERIALS

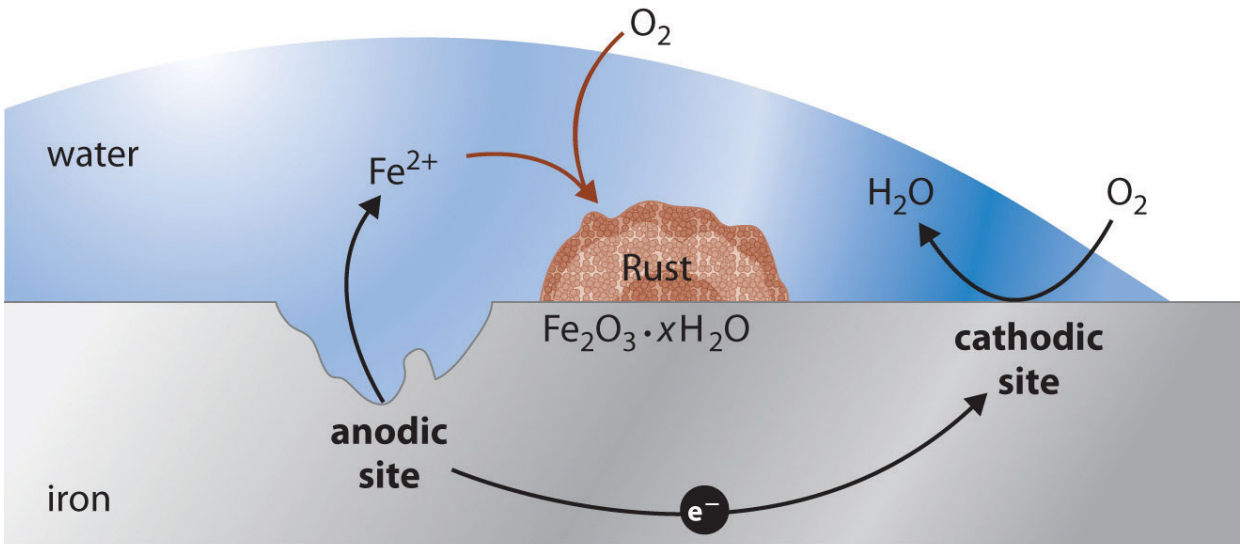
- 7-ply treated marine-grade plywood or optional phenolic composite floor, with under-sides and edges pre-sealed with undercoating
- All wheel-well joints fully sealed with high-performance sealant
- All floor joints sealed with high-performance sealant
- Stainless-steel battery compartment tray
- Stainless-steel with non-metallic battery hold downs (optional)
- Stainless-steel fuse box and seal
- Stainless-steel mounting bracket for battery disconnect and Vanner voltage equalizer
- Non-metallic, high-dielectric-strength barrier tape separates aluminum and steel materials in body and roof to prevent galvanic corrosion
- Stainless-steel rear settee enclosure and access cover
- Entire lower vehicle underbody and exposed chassis are treated with durable latex-based anti-corrosion undercoating
- Optional electrolytic “E” coating of radiator/CAC/hydraulic oil cooler.
- Corrosion-resistant ABS valves with bayonet connectors
- Exterior lamps mounted with rubber-jacketed nuts to prevent galvanic corrosion
- Stainless-steel rear bumper mounting bracket with pre-applied galvanic isolator
- Stainless-steel steel skirt panel hinges isolated with a high-dielectric-strength barrier tape

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Corrosion of Ordinary Carbon Steel

Corrosion is essentially an electrochemical process in which metal ions react with the surrounding environment to form an oxide. Current (electrons) naturally flow between active areas on the metals surface (anodic sites) and other areas (cathodic sites), forming the electrochemical cell. This is essentially same principle that dictates the behavior of a battery.

The figure below describes the reaction of ordinary carbon steel with oxygen (O_2) that is present in the atmosphere. The anodic (active) areas may initially be remnants of mill scale, inclusions, discontinuities, or possibly the effect of pollutant on the oxide film. Electrons migrate away from the anodic sites, producing positively charged iron molecules. Oxygen from the water combines with iron in the steel to form iron oxide (Fe_2O_3), known more commonly as rust.



Typical carbon steel is approximately 98% iron (Fe). Iron oxide on carbon steel does not form a continuous layer on the steel because the iron oxide molecule has a larger volume than the underlying iron atoms. The iron oxide scale is essentially porous in nature, which allows for continued attack of the steel substrate, regardless of the thickness of the overall oxide layer.

Although the layer of iron oxide significantly slows the rate of corrosion and acts as a partial barrier for salts or other corrosive elements, the overall rate of corrosion is still unacceptably high in most applications. Thus, the only way for carbon steels to have true corrosion resistance is to surface them with some type of protective coating—e.g. paint, oil, or galvanizing.

GILLIG has elected to use 3CR12 stainless steel for their chassis instead of ordinary carbon steel.

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Selection of 3CR12

Several factors besides corrosion resistance were considered when selecting GILLIG chassis material. The most crucial factors were strength, ease of fabrication, and toughness throughout the operating temperature range of the vehicle. 3CR12 has a generally higher fatigue and yield strength compared to typical structural grades of carbon steel. It is also easily welded and formed, without upsetting the internal grain structure of steel. 3CR12 has a greater range of temperature stability, avoiding a transition from ductile to brittle fracture behavior at low temperatures.

Corrosion Behavior on 3CR12

In contrast to carbon steel, stainless steels like 3CR12 derive their corrosion resistance from the element chromium: any steel containing at least 10.5% or more chromium is defined as a stainless steel. Chromium in stainless steel results in the formation of a passive layer, which is a thin, non-porous chromium oxide film that acts as a barrier to protect the underlying metal against further reaction with the corrosive atmosphere.

Also, chromium as an alloying element in steel fights corrosion because if the stainless steel surface is damaged and exposed to oxygen, this tightly adherent passive film on its surface reforms itself rapidly, thus maintaining its corrosion protection. This process is called re-passivation.

The chromium oxide prevents further oxidation of the stainless steel. 3CR12 contains approximately 11.5% chromium, which enables the steel to form this stable, corrosion-resistant protective film on its surface.

Quantifying these differences, general atmospheric corrosion testing of 3CR12 has given corrosion rates 115 times slower than that of exposed carbon steel under the same conditions.

Rusting on 3CR12

The presence of contaminants can affect corrosion resistance of stainless steels considerably. One of the most important factors is chloride concentration. If left unattended, chloride ions (from road salts and de-icing chemicals) concentrate on the surface of stainless steels enough to produce very small, local breaks in the passive layer of the stainless steel. At the site of the breaks, where the metal is temporarily unprotected, the wet, chloride-rich environment slows the rate of re-passivation, and the steel can develop micro pits. The development and dispersion of micro pits should not be confused with the general, all-over corrosion on non-alloyed carbon steels.

In practice, for low-alloyed or utility stainless steel materials like 3CR12, exposure to more aggressive or corrosive environments leads to the passive oxide layer growing thicker, forming a uniform rust-colored patina. Wetting the surface with salt water is considered to initiate corrosion, typically in localized areas, as is seen by small rust spots. Drying allows reformation of the passive layer, and subsequent wetting flushes out any remaining

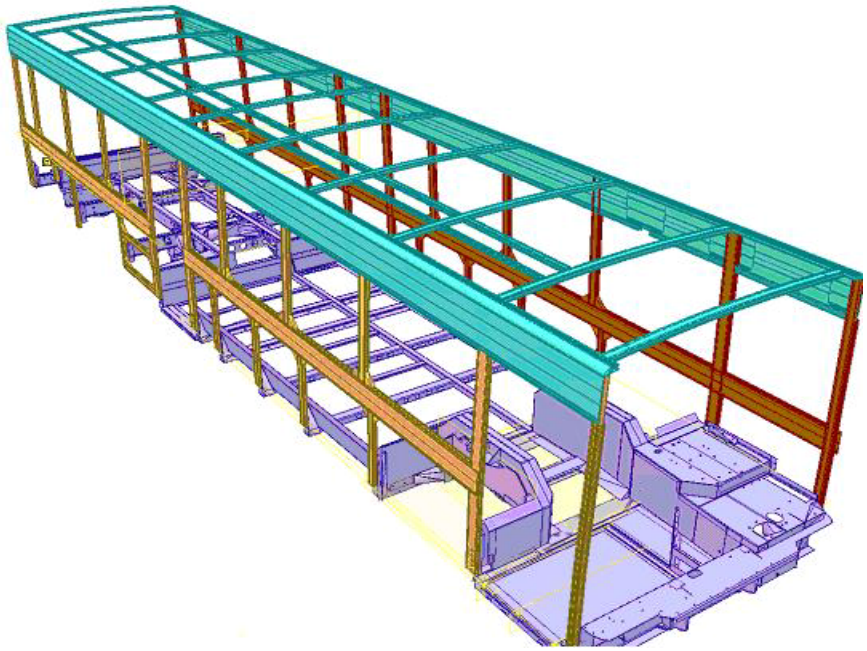
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concentration of chlorides that may have resulted in active areas with micro pits. New areas of local corrosion may form with each wetting and drying cycle.

The build-up of corrosion product—i.e., red rust—covers the metal beneath. This rust layer then acts as a partial barrier to chloride ions and prevents further destruction of the metal below. Underneath the rust layer, the metal interface also has a significant chromium content due to the depletion of iron. Hence, corrosion of the underlying metal is reduced to extremely low rates. This is why it is considered that, while not aesthetically pleasing, the structural integrity of the 3CR12 steel section is not affected. 3CR12 has a proven history of maintaining structural integrity and cross-sectional consistency in corrosive and marine environments for more than 30 years, spanning several industries.

To maintain optimum appearance, frequent neutralization and washing of all chassis/undercarriage areas is important. If desired, areas with surface rust present can be treated by abrading with non-metallic or non-ferrous metal tools, which remove any unsightly surface rust and allow the clean, bare metal to naturally re-passivate.

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The unique chassis platform of a GILLIG Low Floor consists of a stainless-steel structure with integral side impact barriers. The three chassis modules (front, center, and rear) are constructed of both open and tubular section structural shapes that are welded together in specially designed fixtures with common tooling points to those of the body. The final chassis assembly is fastened together using a Huck bolt system.

The robust, integral side impact barrier has been designed to provide maximum collision security to passengers inside the Low Floor section of the bus. This 15-in. (38-cm) high barrier also provides a significant structural element by equipping the center section of the frame with a sturdy perimeter.

The forward chassis structure features a tubular bridge section, which includes a large stainless-steel shear panel, over the front axle. The front structure that supports the bumper and the “A”-posts is a 12-in. (30-cm) high stainless-steel channel. This channel is supported by fabricated I-beams and the stainless-steel driver’s platform.

Corrosion protection is fortified with an application of a durable latex based anti-corrosion undercoating to the entire exposed underside of the completed chassis assembly.

Stainless-Steel Chassis

The GILLIG Low Floor chassis structure is manufactured from 3CR12 stainless steel. The corrosion rate of 3CR12 stainless steel is 115 times less susceptible to corrosion than that of carbon steel. Additionally, whereas carbon steel suffers from an “all over general corrosion”, 3CR12 would only develop micro-pits that do not propagate, and these become passive after some time.

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To put this into perspective, if a plain unfabricated piece of 1/16” thick 3CR12 were left outside in a severe marine atmosphere (that is right on the coastline), it would take a minimum of 700 years to corrode through its thickness, whereas a piece of carbon steel in the same thickness would only take about 6 years to corrode through.

Such a material makes a perfect foundation for a bus chassis that’s subjected to harsh, corrosive atmospheres—and that’s why it was chosen for the GILLIG low floorbus.

Passenger and driver safety features are other important design criteria that have been incorporated into the design of the GILLIG Low Floor. In the Low Floor application, it should be noted that provision must be made to particularly protect the passengers from side impact, as they are located at a lower level than standard floor buses. With this in mind, the GILLIG chassis substructure incorporates a unique side impact protection barrier in the lower level. That side impact barrier combined with the driver’s front protection module provides for a strong and durable structural foundation.

The front stainless steel module design also allows for better ADA accessibility. The enlarged entrance area leads to a wide aisle way between the front wheel wells. It actually provides for a 36” width in that area and allows generous room for maneuvering the larger mobility devices.







Top: Front section of the stainless-steel chassis. Bottom: Center section of the stainless-steel chassis.

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Aluminum Body Frame

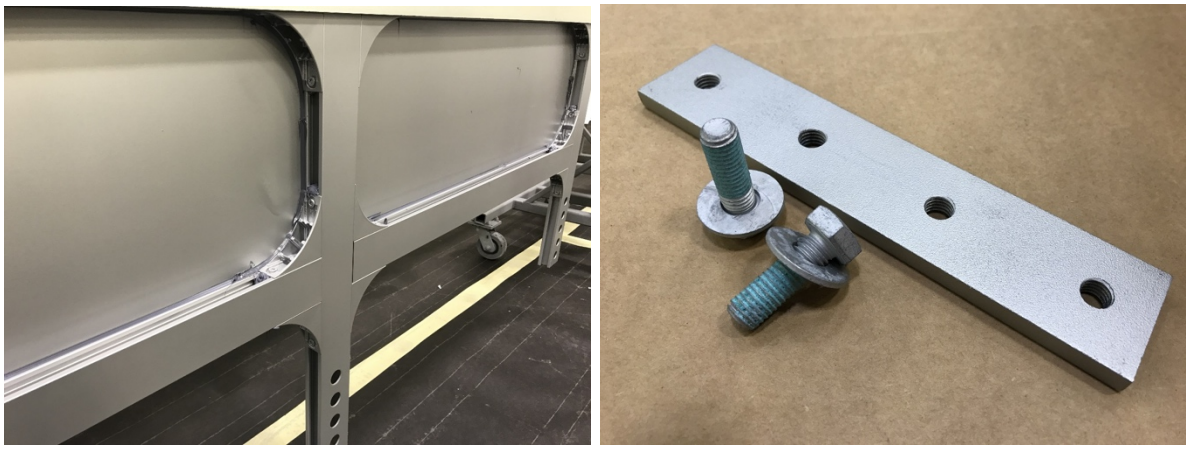
The GILLIG Low Floor body frame is assembled of aluminum extrusions, forgings, and castings. Aluminum is inherently corrosion resistant as formed since surfaces produce a barrier of oxide film within minutes of being produced. To extend this level of performance, all extrusions below the window line are treated with grades of anodizing and sealing which exceed military specifications and produce an exceptional corrosion barrier, and interior shear panels are formed of 5052 aluminum, which is one of the most corrosion-resistant grades of aluminum sheet available.

GILLIG's mid-rail extrusion receives a type 2 anodizing and sealing before assembly, after all machining is performed. The vertical body posts receive a type 3 hard anodizing and sealing. Both processes exceed military specifications.

After assembly and before exterior panel installation, in addition to anodizing, GILLIG sprays a high-solids aluminum-filled epoxy corrosion protection coating throughout the vertical sidewall body structure, from the lower edges of the structure to above the midrail extrusion.

GILLIG also uses a super durable powder coating on the major aluminum shear panels, each fastened with coated aircraft-grade structural rivets. All aluminum body extrusions are assembled with engineered corner gussets, attached with high-strength channel nuts and Geomet coated class 8.8 bolts.

There is no welding on the GILLIG Low Floor body structure.



Left: Coated Body Structure. Right: Geomet-Coated Body Attachment Hardware.

The Low Floor body structure is fastened to the chassis assembly using Geomet coated class 10.9 bolts and hardened washers. The Geomet coating offers excellent corrosion protection not only for the fasteners, but for the aluminum body structure as well. Geomet has 5 times the salt spray protection of a standard zinc-coated fastener.

The body structure/chassis connection is a heavily engineered feature on a GILLIG Low Floor bus. It provides unparalleled safety as well as ease of service, in the event of vehicle damage from a collision.

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Before the body is connected to the chassis with Geomet hardware, a specially formulated hybrid epoxy/sealant coating is applied to the mating surfaces to add mechanical strength and seal out corrosive elements. After the connection is made, all joints are redundantly sealed.



Left: Protected & sealed body/chassis connection. Right: Sealed wheel well and stress panel arch.

The powder coated aluminum wheel arch stress panels are bonded to the side wall structure to create a weather tight seal. The stainless steel wheel wells and attachment rivets are also completely sealed to prevent water from entering the bus.

Roof Structure

The roof structure includes aluminum extrusions and sheet fiberglass-reinforced plastic (FRP), which are joined together with a two-component methacrylate adhesive, producing an incredibly strong structural bond. The FRP is chemically neutral and is not subject to corrosion. The aluminum, which is inherently resistant to corrosion, is painted with exterior paint if it will be exposed to the elements. Non-exposed interior surfaces are covered by insulating material.

Front/Rear Caps

Front and rear body caps are molded fiberglass, which are painted to match the customer's design layout. Fiberglass does not corrode. Embedded tapping plates for installing lights, etc. are 304 stainless steel, to resist any corrosion.

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Skirt Panels

Skirt (side) panels are manufactured from 0.125-in. (0.318-cm) thick sheets of 5052-H32 aluminum. This metal has high resistance to corrosion and is of medium strength. These pieces are high in stiffness to prevent drumming or oil caning. Both sides of the panels are first treated with multiple coats of epoxy primer before being painted with Axalta topcoats per the customer's design. The interior surface edging of the panel is painted with the epoxy primer as well as GILLIG's aluminum-filled epoxy corrosion protective coating.

Each of these processes are inspected and documented. The careful selection of materials and methods ultimately result in a bus that withstands the toughest of operating environments throughout the life of the bus. This is one of the many reasons GILLIG buses have a lower lifetime cost of ownership.

Skirt Panels – Brackets

The lower attachment brackets for the skirt panels are manufactured from corrosion-resistant 5052-H32 aluminum. Additional corrosion resistance is provided by adding a durable powder coating and edge sealing during assembly.

The brackets are installed using aircraft-grade structural aluminum rivets, avoiding any dissimilar metal contact.



Sealed & powder coated aluminum skirt panel bracket

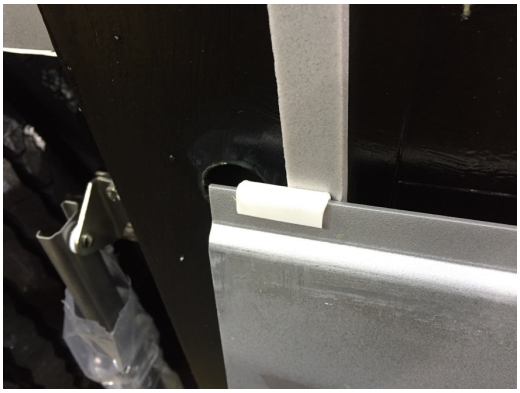
Skirt Panels – Non-Hinged

The skirt panels are manufactured from 0.125-in. (0.318-cm) thick 5052-H32 aluminum. The material comes from a pre-primed aluminum coil that is treated with an epoxy paint.

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After receipt of the panels, GILLIG treats the shear edges and areas that will insert into the mid-rail with our high-solids aluminum-filled epoxy corrosion-protection coating.

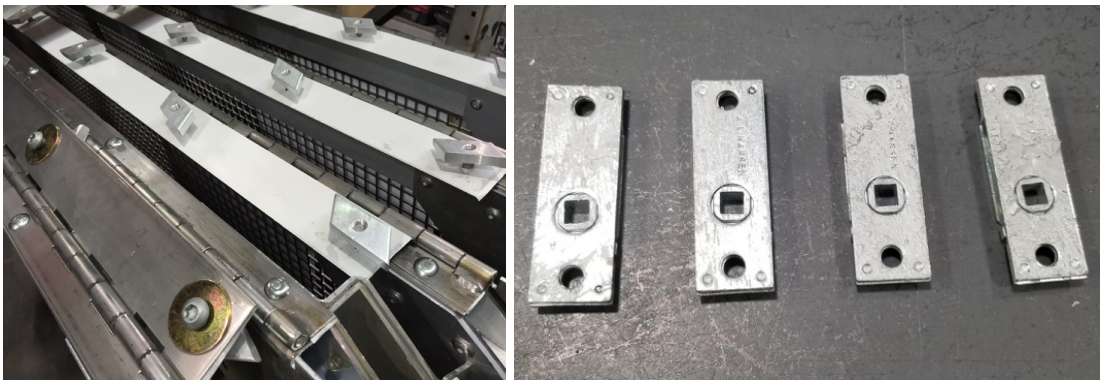
Non-hinged skirt panels have a 2-in. (5-cm) piece of polyurethane foam tape every 12 in. (30 cm) before being inserted into the mid-rail channel. The tape eliminates road rattle and allows air flow inside the mid-rail channel which eliminates moisture saturation. The bottom edge of the skirt panel is bolted to the skirt panel brackets using Dacromet and/or Geomet coated fasteners.



Tape applied to top edge of coated skirt panel

Skirt Panels – Hinged

Hinged skirt panels are attached to the body with stainless steel hinges. The surface of the panel where it is attached to the hinge is coated with epoxy primer. Additionally, a continuous strip of high-dielectric-strength isolating tape is bonded between the hinge and the body attachment for added corrosion protection. These panels are locked in place with 5/16-in. (0.8-cm) stainless square key locks. The back of the stainless-steel lock is coated before being riveted to the panel with aluminum rivets. The body mounted lock catch is also treated.

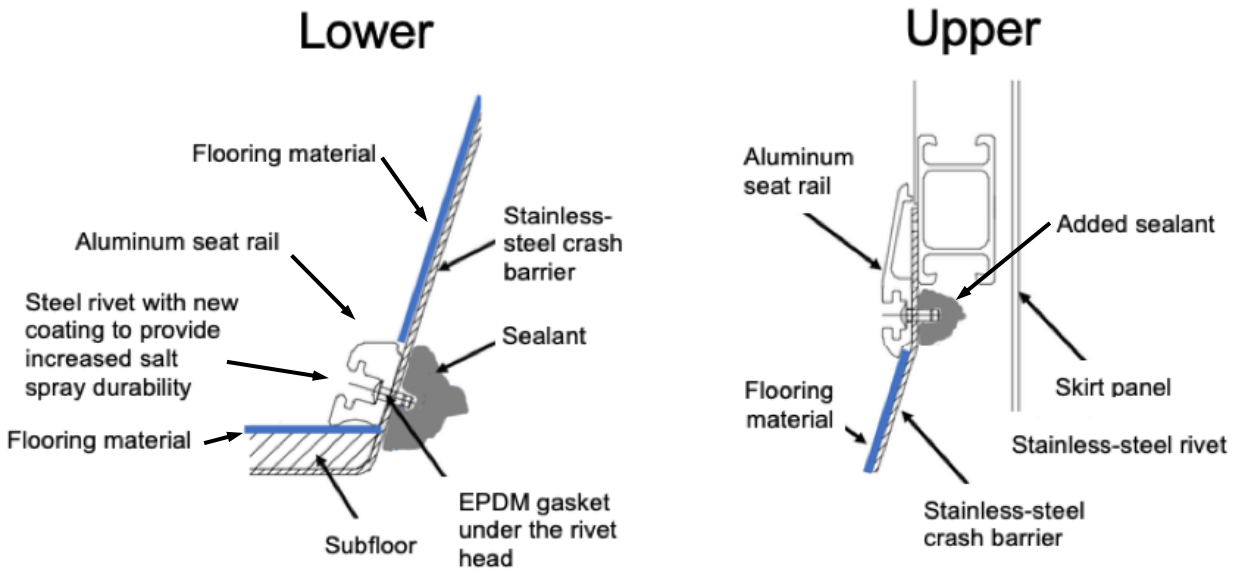


Left: Isolating tape applied over primed hinged panels.
Right: Stainless steel square key locks with pre-applied protective coating.

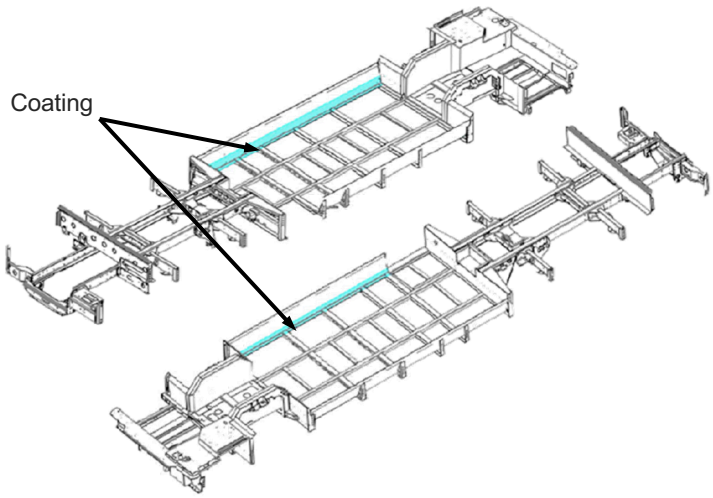
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Seat Rail Mounting

The seat rails are secured to the chassis with rivets. The upper seat rail is mounted to the chassis with a stainless-steel rivet. The backside of the rivet is then sealed with Manus 75AM. The lower seat rail rivet is the same rivet except the coating is zinc-nickel plated that is rated at 2,000 hours of salt-spray testing before red rust is visible. The rivet also has a washer under the head to prevent water intrusion from entering the joint from the inside of the bus.



GILLIG also provides a barrier between the lower seat rail and the crash barrier. A galvanic corrosion coating is applied to the chassis crash barrier prior to the installation of the lower seat rail. The chassis crash barrier is cleaned and primed with an epoxy coating to eliminate the direct contact between the dissimilar metals providing protection against galvanic corrosion.



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GILLIG contracted with a specialty test lab to conduct an evaluation of our current corrosion protection process.

GILLIG and the test lab designed the test protocol to compare the cumulative real-world damage by corrosion, mechanical stresses, and environmental exposure with salt spray testing, which cannot replicate these other stresses.

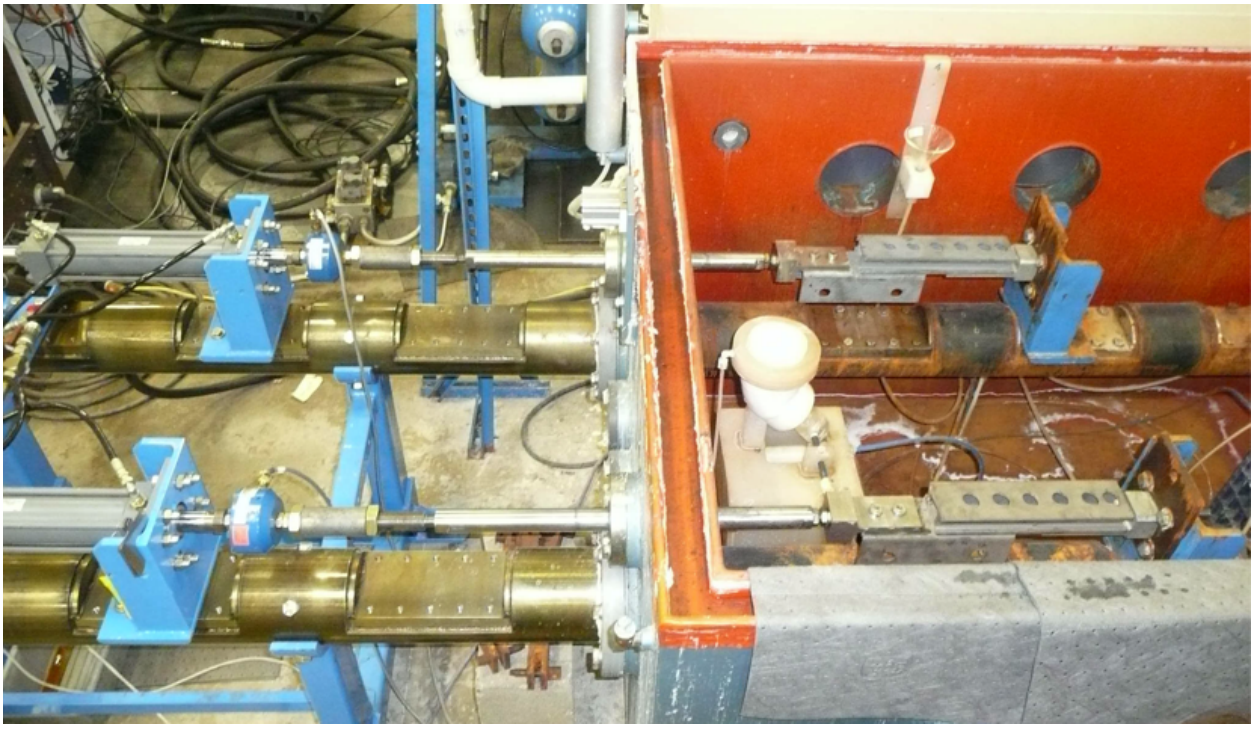
The test protocol combined cyclic mechanical loading and exposure to an array of corrosive substances, including several common de-icing salts. Samples were also pre-conditioned, involving temperature shock, humidity extremes, and abrasive blasting to demonstrate resilience to real-world environmental factors.

The goal was to design a comprehensive test that is aggressive enough to provide a conservative estimate of body /chassis structure protection over a 12-year life of a GILLIG bus.

Summary of Results

The post-test samples showed zero structural flaws; uniform isolation; protection on the aluminum surface mating to the chassis; and significant reduction in corrosion depth and concentration inside the aluminum extrusion gusset channels.

The testing supported an estimated bus life far exceeding the requirement of 12 years.



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PREVENTIVE MAINTENANCE EST. COST: GILLIG Battery-Electric Bus

Customer: Pinellas Suncoast Transit Authority

Per Customers Requirements

Labor Rate per hour	$60.00
Bus Life (years)	12
Annual Mileage	42,000
Bus Lifetime Miles	504,000



Preventative Maintenance Costs

Service Type	Service Interval (miles)	Qty of PM Service Types	Lifetime Est. Service Events	Lifetime Est. Labor Hours	Lifetime Est. Labor Cost	Lifetime Est. Material Cost	Subtotal Service
PM-A Service	1,000 - 6,000	65	5,946	576	34,578.60	28,723.89	63,302.49
PM-B Service	6,001 - 24,000	49	1,524	368	22,066.20	1,215.00	23,281.20
PM-C Service	24,001 - 36,000	20	367	162	9,698.40	3,240.00	12,938.40
PERIODIC Service	36,000+	51	459	256	15,360.60	8,337.90	23,698.50
TOTALS:		185	8,296	1,362	81,703.80	41,516.79	123,220.59

Total Scheduled Service:	$ 123,220.59
Cost Per Mile:	$ 0.24

Additional Costs per Customer RFP

Description	Expected Life	Est. Cost per Mile (per Tire)	Est. Labor Hours per Set	Lifetime Est. Labor Hours	Lifetime Est. Labor Cost	Lifetime Est. Material Cost	Subtotal Additional
Tire Lease (6-Tires)	45,000	0.0076	1.50	16.50	990.00	22,982.40	23,972.40

Total Scheduled Service w/Additional Costs:	$ 147,192.99
Cost Per Mile:	$ 0.29

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One of the design goals of all GILLIG Low Floor buses was to maximize maintenance accessibility. A direct measure of this goal is the number of man-hours required to maintain the vehicle. The GILLIG Low Floor bus was designed with this in mind.

First and foremost, the bus uses the T-drive power train configuration. Leveraging the operating economies experienced with our standard floor bus, the Low Floor has been designed to capture the same benefits.

The large rear engine compartment door, large A/C exterior grill with hinges, street side radiator door, and curbside engine compartment door have been designed to reduce maintenance hours by increasing maintenance access. Large access doors are also mounted for the rear wheel wells to improve access to the suspension componentry. A large battery compartment skirt panel encloses the stainless steel slide out battery tray.

The interior destination sign door allows for quick access to the sign and window cleaning. The multiplex electrical system is also accessed from inside the bus overhead of the driver's area and at the rear bulkhead.

The bus is based on a simple design philosophy but with robust design concepts. Our goal was to duplicate the reliability, durability, and cost effectiveness already achieved with our standard floor Phantom bus. This has been achieved.

Proven transit technology was utilized to keep the bus maintenance friendly, and our simple innovative ideas solved those inherent compromises typically found in other low floor bus designs.

Maintenance Schedule

GILLIG's Preventative Maintenance (PM) schedule is based on intervals of 6,000 miles (except for specific major component requirements) beginning at 6,000 miles. Many properties elect to use intervals of 3,000 miles. GILLIG also recommends a daily inspection to be performed by the assigned driver. The daily inspection checklist is often times drawn from a portion of the PM program.

According to PM information gathered from GILLIG customers, the following are estimates that would apply to the following activities:

- If utilized, the 3,000-mile inspection is estimated to take 5.5 man-hours
- The 6,000-mile inspection is estimated to take 7.5 man-hours
- The 12,000-mile inspection is estimated to take 10 man-hours
- The 18,000-mile inspection is estimated to take 7 man-hours
- The 36,000-mile inspection is estimated to take 22 man-hours

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Curbside Access Doors

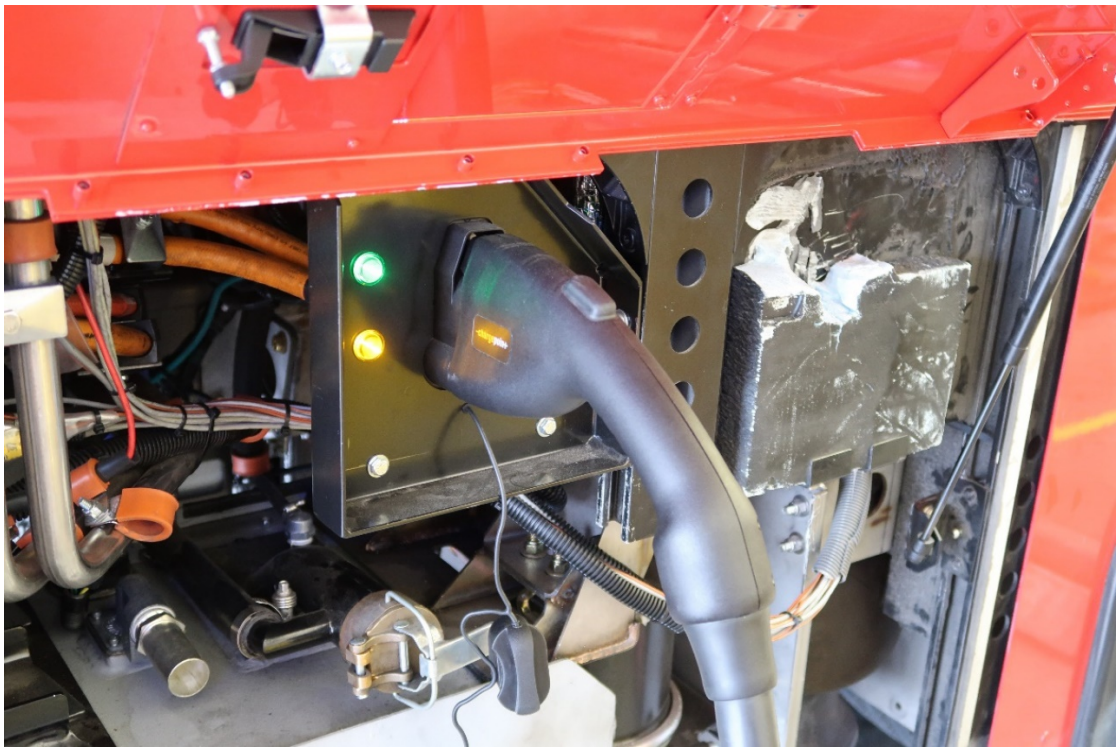




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Curbside Battery Thermal Management System (BTMS)





Curbside – Plug-In Charge Port

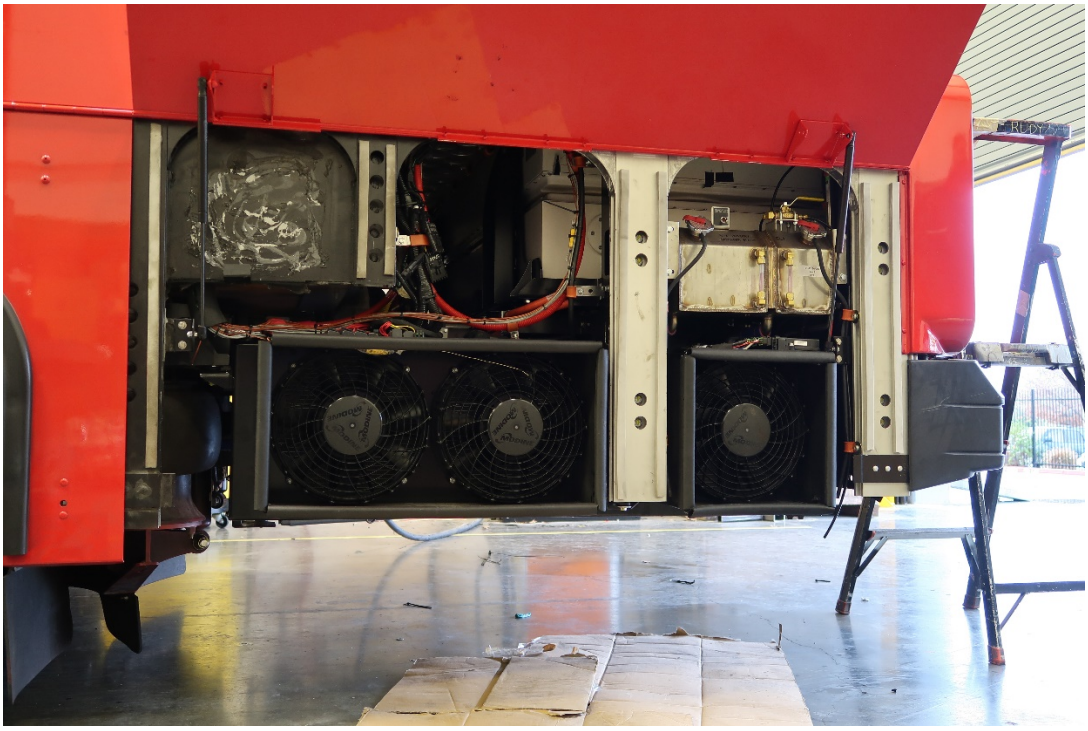
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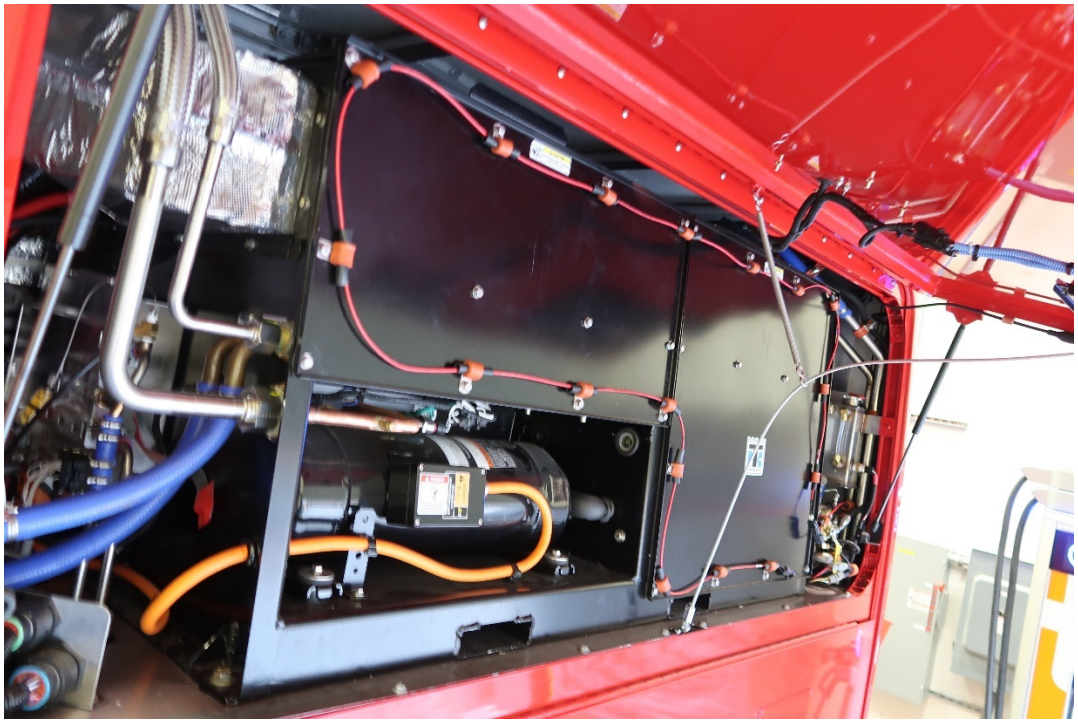
Streetside Access Doors





Streetside Access Door – Cooling System Battery Packs



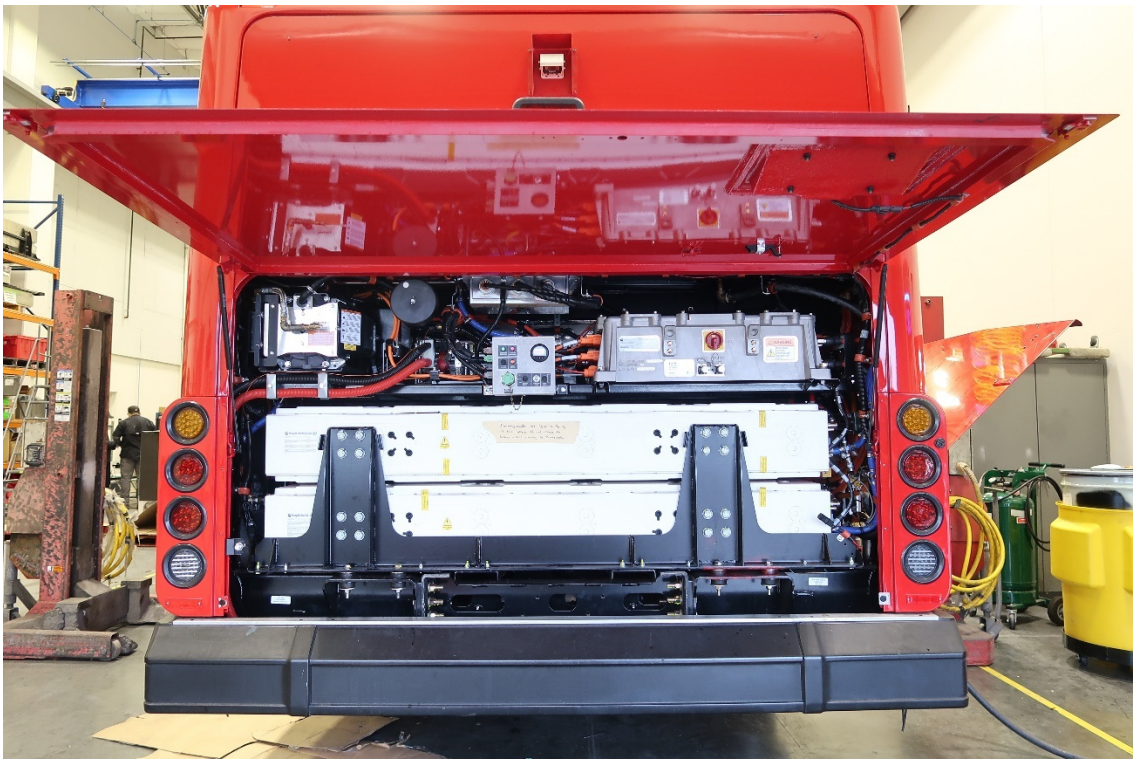


HVAC Access Door

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Rear HVAC and Powertrain Compartment Access Doors





Rear Compartment Access Doors – Battery System

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Rear Wheel Skirt Panel Access





Streetside Battery Access Door

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Battery Low Voltage Disconnect Switch





Streetside - Air Tank Drain Valves and Optional Plug-In Charger Location

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Roof Battery Installation





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Rear Bulkhead Mounted I/O Panel



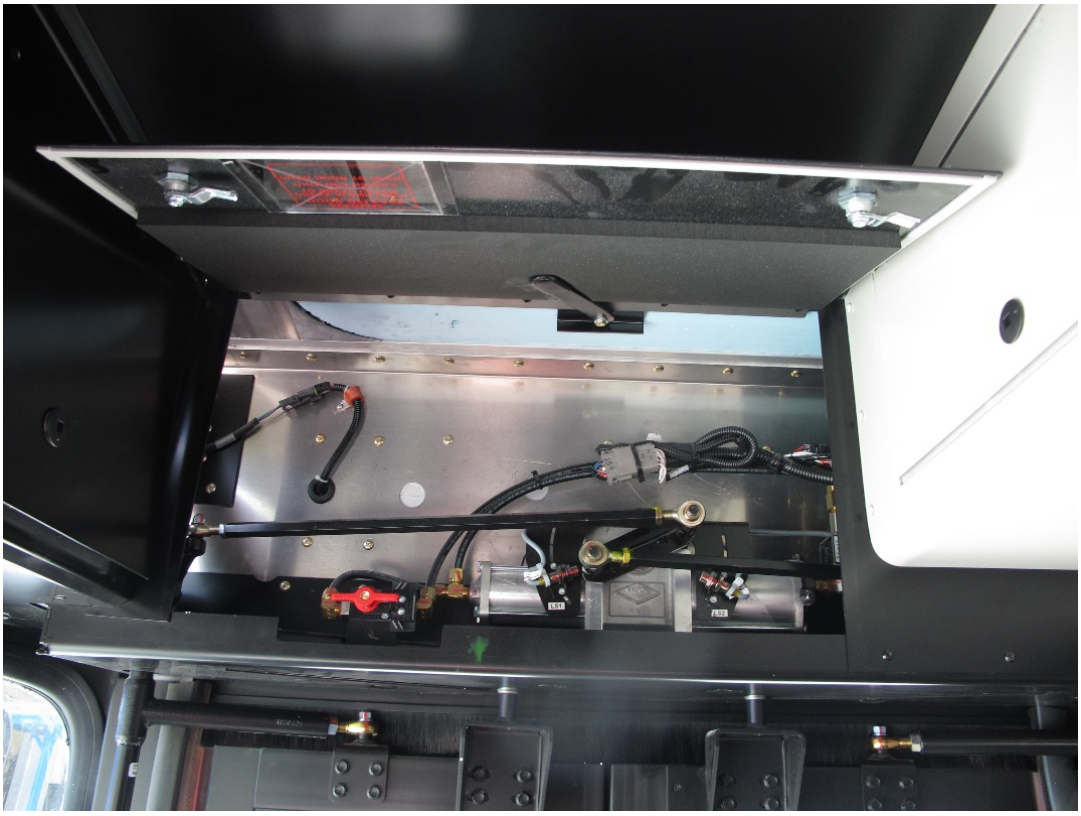


Front Air Tank Compartment Mounted I/O Panel

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Front Door Header Access Door





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Interior Destination Sign Compartment & Access Door





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Interior Driver Storage Box





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Interior Electrical Equipment Box



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TASK DESCRIPTION	SRT
BATTERY ELECTRIC BUS MAIN COMPONENTS	
R&R ESS JUNCTION BOX	2.00
R&R HVAC JUNCTION BOX	2.00
R&R FRONT PLUG-IN CHARGER	4.00
R&R REAR PLUG-IN CHARGER	2.00
R&R HV CABLE	TIME VARIES DEPENDING ON CABLE
R&R BATTERY TMS	4.00
R&R PASSENGER ECOOLANT HEATER	6.00
R&R AIR COMPRESSOR (POWEREX)	2.00
R&R POWER STEERING PUMP	1.50
R&R ELECTRONIC COOLING PACKAGE	5.00
R&R MAIN BATTERY DISCONNECT SWITCH (KISSLING)	2.00
R&R ESS PACKS (ROOF)	1.00
R&R ESS PACK (CHASSIS)	3.00
R&R ESS PACKS (POWERTRAIN COMPARTMENT)	12.00
R&R TRACTION MOTOR INVERTER & TRACTION MOTOR	12.00
R&R DC/AC CONVERTER	4.00
R&R DC/DC CONVERTER	4.00
R&R SYSTEM CONTROL MODULE	1.00
R&R BATTERY MANAGEMENT SYSTEM	1.00
R&R CHARGE CONTROLLER	1.00
R&R PRIMARY HV JUNCTION BOX	6.00
WHEELCHAIR RAMP MECHANICAL	
REMOVE/INSTALL RAMP ASSEMBLY	2.00
CLEAN/REPLACE/ADJUST CHAIN	1.00

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WHEELCHAIR RAMP ELECTRICAL

REPLACE FLASHER FOR RAMP BEEPER	0.50
CLEAN/REPAIR/REPLACE CONTROLLER BOARD	1.00
CLEAN/REPAIR/REPLACE DUETSCH PLUG	0.60
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
REPAIR/REPLACE WIRING	2.50

FRONT AXLE

REPLACE KING PIN/BOTH SIDES	7.90
REPLACE TIE ROD END/BOTH SIDES	1.70
ALIGN FRONT END	0.90
REPLACE TIE ROD ASSEMBLY	1.70
LUBRICATE KING PINS/DRAGLINK/TIE ROD ENDS	0.70
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.30
R&R ABS SENSOR	0.50
ABS CABLE	1.50

REAR AXLE

REPLACE REAR AXLE	8.00
REPLACE DIFFERENTIAL	6.00
REPLACE GASKET, O-RING OR SEAL	6.00
REMOVE/INSTALL REAR AXLE FOR TOWING PURPOSES	0.70
ADD/CHANGE DIFFERENTIAL GREASE	0.40
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
PINION SEAL	2.00
R&R ABS SENSOR	1.00
ABS CABLE	1.50

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GILLIG

STANDARD REPAIR TIMES

AXLE HUB

REPLACE AXLE HUB	4.20
REPLACE AXLE BEARING	0.60
REPLACE AXLE HUB SEAL	1.70
REPLACE WHEEL STUDS/NUTS	0.30
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50

BRAKES

REPLACE BRAKE SPIDER	1.80
REPLACE SLACK ADJUSTER	0.80
REPAIR/REPLACE SLACK ADJUSTER LINKAGE	0.70
LUBRICATE BRAKE PINS	0.90
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
FRONT BRAKE JOB	1.50
REAR BRAKE JOB	3.00
FULL FRONT BRAKE JOB INCLUDING WHEEL SEAL	4.00
FULL REAR BRAKE JOB INCLUDING WHEEL SEAL	4.50
R&R BRAKE CALIPERS ON DISC BRAKES	2.50

SUSPENSION

REPLACE AIR BAG	1.50
REPLACE LEVELER VALVE/LINK	1.10 EA
ADJUST AIR BAG HEIGHT	0.60
REPLACE UPPER AND LOWER TORQUE ROD	0.80
REPLACE UPPER TORQUE ROD MOUNT/BRK	2.00
REPLACE SHOCK ABSORBER/BUSHINGS	0.90
REPLACE LOWER TORQUE ROD MOUNT/BRK	4.00
REPLACE SHOCK MOUNT	1.10
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
KNEELING VALVE	2.00

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STEERING

REPLACE STEERING GEAR	3.00
REPLACE MITER BOX	1.20
REPLACE PITMAN ARM	1.10
REPLACE DRAGLINK/END	1.00
REPLACE STEERING POPPET KIT	1.50
REPLACE STEERING WHEEL	0.80
REPLACE POWER STEERING PUMP	2.00
REPAIR HORN SYSTEM	1.00
RESEAL STEERING GEAR/ANGLE BOX	2.40
REPAIR/REPLACE STEERING COLUMN	2.00
LUBRICATE STEERING COMPONENT	1.00
REPAIR/REPLACE POWER STEERING RESERVOIR	1.50
ADD OIL OR FLUSH SYSTEM	0.50
REPAIR/REPLACE PIPE/HOSE	1.30
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
R&R TRW EASY STEER COLUMN	2.00

TIRES

REPLACE TIRES	1.50
REPAIR TIRE	1.10
BALANCE TIRES	1.00
ROTATE TIRES	1.70

EXTERIOR BODY

REPAIR/REPLACE BODY FRAMEWORK COMPONENT	2.00
REPAIR/REPLACE BULKHEAD	1.80
REPAIR/REPLACE EXTERIOR BODY PANEL	1.00
REPAIR/REPLACE FENDER RUBBER/TRIM	1.00
REPAIR/REPLACE/INSTALL/TIGHTEN MIRROR	0.60

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REPAIR/REPLACE/ADJUST WIPER/WASHER COMPONENT	0.80
REPAIR/REPLACE/TIGHTEN BUMPER	1.00
REPAIR/REPLACE ROOF HATCH	0.80
SAND/PAINT EXTERIOR BODY-LEFT HAND	5.10
SAND/PAINT EXTERIOR BODY-RIGHT HAND	5.10
REPAIR/REPLACE MUD FLAP	0.90
REPAIR/REPLACE RUB RAIL	0.50
SEAL WATER LEAK INTO COACH	2.00
REPAIR/REPLACE BATTERY TRAY	2.80
W/S WIPER MOTOR	1.00
FRONT CAP	20.00

INTERIOR BODY

REPAIR/REPLACE FLOOR	22.00
REPAIR/REPLACE MODESTY PANEL	1.20
REPAIR/REPLACE INTERIOR BODY PANEL	0.90
REPAIR/REPLACE DRIVER'S SEAT/CUSHION	1.10
REPAIR/REPLACE/INSTALL/TIGHTEN MIRROR	0.30
REPAIR/REPLACE/INSTALL FAREBOX	0.80
REPAIR/REPLACE SUN VISOR	0.60
REPAIR/REPLACE WINDOW LATCH	0.80
REPAIR/REPLACE/INSTALL DRIVER'S SEAT BELT	0.60
REPAIR/REPLACE BELLCORD/GUIDE	0.70
REPAIR/REPLACE PASSENGER SEAT/COVER/CUSHION	0.30
REPAIR/REPLACE STEPWELL-FRONT 0252, REAR 0320	0.80
REPLACE COVERING FOR BRAKE/THROTTLE PEDAL	0.80
REPAIR/REPLACE STANCHION/MOUNT	0.50
REPAIR/REPLACE ENGINE HATCH COVER	1.00
REPAIR/REPLACE FLOOR COVERING	16.00

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WINDOWS AND GLASS

REPLACE PASSENGER WINDOW GLASS/LOWFLOOR/BRT PER SIDE	2.00
REPLACE WINDSHIELD GLASS	2.00
REPLACE DOOR GLASS	0.80
REPLACE DESTINATION SIGN GLASS	1.00
REPAIR/REPLACE WINDOW FRAME/RUBBER	0.80
SEAL WATER LEAK INTO COACH	1.30
REPAIR/REPLACE EMERGENCY WINDOW RELEASE	0.80
REPLACE WINDSHIELD GLASS BRT 1 PC	3.00
REPLACE BRT OPERA WINDOW	1.00

PASSENGER DOORS

REPAIR/REPLACE PASSENGER DOOR ASSEMBLY	1.90
REPLACE PASSENGER DOOR MOTOR	1.20
REPAIR/REPLACE/ADJUST PASSENGER DOOR LINKAGE	0.90
REPAIR/REPLACE TOUCH-BAR	1.40
REPAIR/REPLACE ENGINE COMPARTMENT DOOR	0.50
REPLACE LIFT-U MAT	0.60
REPAIR/REPLACE DOOR CONTROL VALVE	0.50
REPAIR/REPLACE FRONT DOOR SHUT OFF VALVE	1.00
REPLACE RELAY	0.60
REPLACE/ADJUST PROXIMITY SWITCH	0.50
REPAIR/REPLACE REAR DOOR SOLENOID	0.70
LUBRICATE DOOR LINKAGE/HINGE	0.50
REPAIR/REPLACE PIPE/HOSE	0.30
REPAIR/REPLACE SENSITIVE DOOR EDGE	1.10
REPAIR/REPLACE WIRING	0.50
RECONDITION PASSENGER DOOR ENGINE	1.50

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COMPARTMENT DOORS (EXTERIOR)

REPAIR/REPLACE ENGINE DOOR	1.10
REPAIR/REPLACE RADIATOR DOOR	0.50
REPAIR/REPLACE BATTERY DOOR	0.80
REPAIR/REPLACE FUEL DOOR	1.00
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50

SPECIAL EQUIPMENT/ACCESSORIES

REPAIR/REPLACE BIKE RACK	0.50
REPLACE/INSTALL REFLECTIVE TRIANGLES	0.30
REPLACE/INSTALL FIRE EXTINGUISHER	0.30
REPAIR/REPLACE/INSTALL ADVERTISING SIGN FRAME (PER)	0.80
REPAIR/REPLACE/INSTALL PASSENGER COUNTER	0.80
REPAIR/REPLACE/INSTALL DRIVERS BOX	0.90
REPAIR/REPLACE/INSTALL WHEELCHAIR RESTRAINTS (ALL)	1.10
INSTA CHAIN REPAIRS-SOLENOID	1.00

TWO WAY RADIO

REPLACE RADIO/CONTROL HEAD	0.90
REPLACE RADIO CONTROL UNIT	1.30
REPAIR/REPLACE RADIO POWER UNIT	1.00
REPAIR/REPLACE ANTENNA	1.30
INSTALL COMPLETE RADIO ASSEMPLY	1.50
REPLACE HANG UP CRADLE ASSEMBLY	0.50
REPAIR/REPLACE WIRING	0.50

HEATER AND DEFROST SYSTEM

REPLACE HEATER CORE	2.00
REPLACE MARINE PUMP	1.00
REPLACE DEFROSTER/HEATER MOTOR	1.50

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REPLACE WATER MODULATOR VALVE	1.00
REPLACE/ADJUST THERMOSTAT/GRADUSTAT	0.30
REPAIR/REPLACE HEAT CONTROL VALVE/CABLE	1.10
CLEAN/REPLACE HEATER FILTER	0.10
REPLACE CIRCUIT BREAKER	0.20
REPLACE SWITCH	0.70
CLEAN/REPAIR/REPLACE AMPHENOL PLUG	1.00
REPLACE HEATER RESISTOR	0.80
REPAIR/REPLACE PIPE/HOSE	1.00
REPAIR LEAK	0.40
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
REPLACE RELAY, SWITCH, DIOD, ETC.	0.60
REPAIR/REPLACE WIRING	0.80

AIR COMPRESSOR AND SUPPLY SYSTEMS

REPLACE AIR COMPRESSOR GOVERNOR	0.90
REPLACE AIR DRYER	1.50
REPLACE SAFETY VALVE	0.50
SERVICE/REPLACE PURGE VALVE	0.90
REPLACE AIR SWITCH	0.50
REPLACE CHECK VALVE	0.50
REPLACE GASKET/O-RING/SEAL	1.40
REPAIR/REPLACE PIPE/HOSE	1.40
REPAIR LEAK	0.90
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50

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AIR BRAKE SYSTEMS

REPLACE BRAKE TREADLE VALVE	1.50
REPLACE BRAKE RELAY VALVE	2.00
REPLACE QUICK RELEASE VALVE	0.50
REPLACE REAR BRAKE CHAMBER	1.00
REPLACE FRONT BRAKE CHAMBER	0.60
REPLACE AIR SWITCH	0.60
REPAIR/REPLACE PIPE/HOSE	0.80
REPAIR LEAK	0.80
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
REPLACE RELAY, SWITCH, DIODE, ETC.	0.50

BRAKE INTERLOCK SYSTEMS

REPLACE/ADJUST AIR REGULATOR VALVE	0.70
SERVICE/REPLACE SOLENOID/SKINNER VALVE	1.10
REPLACE CIRCUIT BREAKER	0.30
REPLACE RELAY	0.50
REPLACE/ADJUST MICRO SWITCH/BRACKET	0.50
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
REPLACE SWITCH	0.60
REPAIR/REPLACE WIRING	0.80

ELECTRICAL ACCESSORIES

REPAIR/REPLACE PASSENGER CHIME	0.50
REPAIR/REPLACE BACK UP BEEPER	0.50
REPLACE/INSTALL AM/FM RADIO/ANTENNA	0.90
REPAIR/REPLACE NEXT STOP COMPONENT	0.90
REPAIR/REPLACE HORN COMPONENT	0.80
REPAIR/REPLACE DRIVER'S FAN	0.70
REPAIR/REPLACE P.A. SYSTEM COMPONENT	1.00

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REPAIR/REPLACE MIRROR SWITCH/MOTOR/WIRING	1.00
DINEX MODULES/MULTIPLEXING	0.50
W/S WIPER MOTOR	1.00
R&R AMEREX CONTROL MODULE	0.50
R&R AMEREX HEAT SENSOR(THERMISTOR)	0.50
R&R GILLIG FIRE DETECTION WIRE	1.00

CHARGING SYSTEMS

REPLACE/ADJUST REGULATOR	0.70
REPLACE VANNER EQUALIZER	1.00
REPLACE CIRCUIT BREAKER	0.30
REPLACE RELAY	0.30
REPLACE DIODE	1.10
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
REPLACE RELAY, SWITCH, DIODE, ETC.	0.50
REPAIR/REPLACE WIRING	0.80
CHECK/TROUBLESHOOT CHARGING SYSTEM	1.50

BATTERY

REPLACE BATTERIES	0.70
SERVICE AND CLEAN OFF BATTERIES	0.50
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.40
DISCONNECT ALL POWER BEFORE WELDING	1.50

INTERIOR LIGHTING SYSTEMS

REPLACE FLOURESCENT TUBE/BULB/LED	0.50
REPAIR/REPLACE LENS	0.30
REPAIR/REPLACE BULB SOCKET/PIGTAIL	0.50
REPLACE LIGHT BALLAST	0.60
REPLACE CIRCUIT BREAKER	0.30

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REPLACE SWITCH	0.50
REPLACE/ADJUST MICRO SWITCH/BRACKET	0.50
REPLACE RELAY	0.20
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
REPLACE RELAY, SWITCH, DIODE, ETC.	0.50
REPAIR/REPLACE WIRING	0.90

EXTERIOR LIGHTING SYSTEMS

REPLACE BULB/SEAL BEAM	0.30
REPAIR/REPLACE LENS	0.40
REPAIR/REPLACE BULB SOCKET/PIGTAIL	0.60
REPLACE CIRCUIT BREAKER	0.30
REPLACE SWITCH	0.50
REPLACE RELAY	0.30
REPLACE DIODE	0.30
CLEAN/REPAIR/REPLACE AMPHENOL PLUG	1.00
REPLACE COMPLETE LIGHT ASSEMBLY	0.90
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
REPLACE REPLAY, SWITCH, DIODE, ETC.	0.50
REPAIR/REPLACE WIRING	0.70
REMOVE AND REPLACE FRONT TURN SIGNAL ASM	0.50
REMOVE AND REPLACE LED HEADLIGHT	0.50

WARNING LIGHTS, BUZZERS, GAUGES

REPLACE GAUGE	0.90
REPLACE LIGHT BULB OR SOCKET	0.50
REPLACE SENDING UNIT	0.90
REPAIR/REPLACE INSTRUMENT PANEL	1.00
REPAIR/REPLACE SPEEDO HEAD/TRANSDUCER/SENSOR	0.50

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REPAIR/REPLACE BLUB SOCKET/PIGTAIL	0.50
REPLACE CIRCUIT BREAKER	0.30
REPLACE SWITCH OR SENSOR	0.50
REPLACE RELAY	0.40
REPLACE WARNING BUZZER	0.40
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
REPLACE REPLAY, SWITCH, DIODE, ETC.	0.60
REPAIR/REPLACE WIRING	0.80

DESTINATION SIGN

REPLACE MESSAGE MONITOR/CONTROL CONSOLE	0.50
REPLACE ENCODER	0.90
REPLACE DISPLAY BOARD	0.80
REPLACE DRIVER BOARD	0.70
REPLACE EPROM CHIP/REPROGRAM CONTROL CONSOLE	0.50
CLEAN DESTINATION SIGN/WINDOW	0.80
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50
REPLACE REPLAY, SWITCH, DIODE, ETC.	0.40
REPAIR/REPLACE WIRING	1.00

SHIFT LINKAGE AND CONTROLS

REPLACE SHIFTER BULB OR LENS (VOITH)	0.70
REPLACE SWITCH	1.30
REPAIR/REPLACE WIRING	1.20

DRIVELINES

REPLACE DRIVELINE	1.20
REPLACE U-JOINT	1.00
TIGHTEN/REPLACE CLAMP, FITTING OR FASTENER	0.50

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TRANSMISSION CONTROL SYSTEMS

REPAIR/REPLACE PUSH BUTTON SHIFT UNIT	0.50
REPLACE BRAKE VALVE PRESSURE SWITCH	0.50
REPAIR/REPLACE WIRING	0.90

CHASSIS

LH FRAME REPAIR	12.00
RH FRAME REPAIR	12.00

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GILLIG

TESTING & DESIGN OPERATING PROFILE VALIDATION

Structural Analysis Validation - Completed

- Design Load Calculations
- Stress Calculations
- Finite Element Analysis
- Computer Simulations

Code and Regulation Compliance Validation

- Design Codes (interior lighting, driver's visibility, etc.)
- Design FMVSS Requirements

Component Application Analysis - Completed

- Component Selections
- Component Application Approvals
- Computer Simulations

Physical Validation Testing – Most Current Completion Date

- Optimization of Ride and Handling – 2011
- Vibration Tests – 2010
- Turning Radius Tests – 2011
- Turning Radius Test - 2020
- Engine Manufacturer Approvals
  - Cummins IQA Approvals 2007
  - Cummins IQA Approvals 2010
  - Cummins IQA Approvals 2013
  - Cummins IQA Approvals 2015 EMP Radiator only
  - Cummins IQA Approvals 2017 ISB BAE Hybrid
  - Cummins IQA Approval 2021 L9 Diesel
  - Cummins IQA Approval 2021 B67 Hybrid
  - Cummins IQA Approval 2021 40' Electric Bus In Process
  - Cummins IQA includes engine/emission system installation approval, cooling system validation and compliance with electrical, AEB's.
- Strain Gauge Validation – 2005
- Loaded Road Dynamic Stress Test – 2006
- TRW Steering Geometry Test – 1998
- TRW Steering Geometry Test -2018
- TRW Steering Geometry Test - 2020
- Crashworthiness Test – 1998
- Crashworthiness Test -2018
- Crashworthiness Test - 2020
- Thermo King Performance Test T14 Unit– 2010
- Thermo King Performance Test T14 High Cooling Capacity -2015
- Thermo King Performance Test E Bus HVAC-2019
- Thermo King Performance Test E Bus HVAC -2020
- Accelerated Durability Test Road simulation/shaker test 40' CNG 2012.

- Accelerated Durability Test Road simulation/shaker test 40’ Electric Bus 2019
- Hot Weather On Road Testing (Death Valley) 40’ Electric Gen 2.0 2019
- Hot Weather On Road Testing (Death Valley) 40’ Electric Gen 2.5 2021
- Cold Weather Chamber and Cold Test Track Testing 40’ Electric Bus 2020
- Cold Temperature Chamber testing 40’ Electric bus 2021
- Vehicle Stability Testing 40’ Electric Bus 2019
- Vehicle Stability Testing 40’ Electric Bus 2020
- Vehicle ESC Testing 40’ Electric 2019
- Vehicle Gradeability On Road Salt Lake City 40’ Gen 2.0 Electric Bus 2019
- Vehicle Gradeability On Road Salt Lake City 40’ Gen 2.5 Electric Bus 2021
- Altoona Style Durability Test Navistar Proving Grounds 40’ Electric 2019
- Altoona Test 40’ Diesel Bus Complete (ISM/Voith) – December 2004
- Altoona Test 40’ Hybrid Bus Complete (ISB/EV40) – October 2004
- Altoona Test 29’ Diesel Bus Complete (S40/B300) – June 2000
- Altoona Test 40’ Hybrid Bus Complete (ISL/Voith Hybrid) – 2010
- Altoona Test 40’ CNG Bus Complete (ISLG/B400R) – May 2011
- Altoona Test 29’ CNG Bus Complete (ISLG/B400R) – January 2012
- Altoona Test 40’ BAE Hybrid – July 2012
- Altoona Test 29’ ISL – June 2010
- Altoona Test 40’ CNG/Disc Brake – June 2013
- Altoona Test 40’ Hybrid Bus (330 ISL/Allison Hybrid) - Feb 2019
- Altoona Test 40’ Hybrid Bus (330L9/BAE Hybrid) – April 2018
- Altoona Test 29’ Electric Bus – May 2018
- Altoona Test 40’ Gen 2.0 Electric Bus- In Process April 2021
- Altoona Test 40’ CNG with Hendrickson Rear Suspension 2019
- Altoona Test 29’ CNG with Hendrickson Rear Suspension 2021
- Altoona Test 40’ Gen 2.5 Electric Bus In Process Completion Q2 2022

- FMVSS 121 Testing – Brakes
  - 2002 - 29 Ft. Low Floor Drum Brakes
  - 1999 - 29 Ft. Low Floor Drum Brake
  - 1998 - 40 Ft. Low Floor Drum Brake
  - 1997 - 40 Ft. Low Floor Drum Brake
  - 2011 - 40 Ft. Low Floor Drum Brake 27,000 Rear GAWR
  - 2013 - 40 Ft. Low Floor Meritor Disc Brakes
  - 2015 - 29’ Low Floor Meritor Disc Brakes
  - 2016 - 29’ Low Floor Drum Brake
  - 2019 - 40’ Low floor Meritor Disc Brakes Electric Bus @ 45,000 Lbs. GVWR
  - 2020 - 40’ Low Floor Meritor Disc Brakes Electric Bus @ 47,180 Lbs. GVWR

- Transmission Installation Approval & Cooling Tests
  - Allison 2007, 2010, 2013
  - Voith 2007, 2010, 2013, 2020
  - ZF 2007, 2010, 2013,2018
  - ZF 2021 Ecolife/L9

- Hybrid Drive
  - ISL 330 hp Allision - 2018
  - L9 330 hp BAE - 2018
- Amerex Fire Suppression Installation Approval 2013
- Amerex Fire Suppression Installation Approval 40’ Electric Bus 2020
- Kidde Fire Suppression Installation Approval 2013
- Fogmaker Fire Suppression Installation Approval 2013
- Fire Trace Fire Suppression Installation Approval 2013
- Fire suppression installation approvals ongoing with new configurations

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
2022 MODEL YEAR
CERTIFICATE OF CONFORMITY
WITH THE CLEAN AIR ACT

OFFICE OF TRANSPORTATION AND AIR QUALITY
ANN ARBOR, MICHIGAN 48105

Certificate Issued To: **GILLIG LLC**
(U.S. Manufacturer or Importer)

Certificate Number: NGLG2VOCVEV1-001

Effective Date: 01/01/2022

Expiration Date: 12/31/2022

Byron J. Bunker, Division Director
Compliance Division

Issue Date: 07/12/2021

Revision Date: 07/12/2021

Model Year: 2022
Vehicle Family: NGLG2VOCVEV1
Vehicle Regulatory Sub-category: Transit and other bus
Averaging Set: Transit and Other bus
This family includes advanced technologies.

CO2 Emission Standard (g CO2/ton-mile): 300
Highest Projected CO2 Family Emission Limit (g/ton-mile): 0
Lowest Projected CO2 Family Emission Limit (g/ton-mile): 0

Pursuant to Section 206 of the Clean Air Act (42 U.S.C. section 7525), 40 CFR Part 1037 and subject to the terms and conditions prescribed in those provisions, this certificate of conformity is hereby issued with respect to the test vehicle which represents the vehicle family, and is subject to the terms and conditions prescribed in those provisions. This certificate of conformity covers only those new motor vehicles which conform in all material respects to the design specifications that applied to those vehicles described in the documentation required by 40 CFR Part 1037 and which are produced during the model year stated on this certificate of the said manufacturer, as defined in 40 CFR Part 1037.

This certificate of conformity is conditional upon compliance of said manufacturer with the averaging, banking and trading provisions of 40 CFR Part 1037, Subpart H. Failure to comply with these provisions may render this certificate void *ab initio*.

It is a term of this certificate that the manufacturer shall consent to all inspections described in 40 CFR 1068 and authorized in a warrant or court order. Failure to comply with the requirements of such a warrant or court order may lead to revocation or suspension of this certificate for reasons specified in 40 CFR Part 1068. It is also a term of this certificate that this certificate may be revoked or suspended or rendered void *ab initio* for other reasons specified in 40 CFR Part 1068.

This certificate does not cover vehicles sold, offered for sale, or introduced, or delivered for introduction, into commerce in the U.S. prior to the effective date of the certificate.

CALIFORNIA AIR RESOURCES BOARD	GILLIG LLC	EXECUTIVE ORDER A-063-0113 New On-Road Heavy-Duty Motor Vehicles

Pursuant to the authority vested in California Air Resources Board by Health and Safety Code Divisions 25.5 and 26, Part 5, Chapter 2; and pursuant to the authority vested in the undersigned by Health and Safety Code Sections 39515 and 39516 and Executive Order G-19-095;

IT IS ORDERED AND RESOLVED: The following on-road motor vehicles with a manufacturer's GVWR over 10,000 pounds are certified as described below. Production vehicles shall be in all material respects the same as those for which certification is granted.

MODEL YEAR	VEHICLE FAMILY NAME	VEHICLE TYPE	VEHICLE SERVICE CLASS	VEHICLE MAKE & MODELS
2021	MGLG2VOCVEV1	Vocational / Other Bus	Heavy HDV	GILLIG LOW FLOOR ELECTRIC (All Electric Heavy-Duty Vehicles)

EMISSION CONTROL SYSTEMS
WR, LRRA, TPMS

*=not applicable; **VSL** = Vehicle speed limiter; **VSLS** = "Soft-top" vehicle speed limiter; **VSLE** = Expiring vehicle speed limiter; **VSLD** = Vehicle speed limiter with both "soft-top" and expiration; **IRT5** = Engine shutoff after 5 minutes or less of idling; **IRTE** = Expiring engine shutoff; **LRRA** = Low rolling resistance tires (all); **LRRD** = Low rolling resistance tires (drive); **LRRS** = Low rolling resistance tires (steer); **ATS** = Aerodynamic side skirt and/or fuel tank fairing; **ARF** = Aerodynamic roof fairing; **ARFR** = Adjustable height aerodynamic roof fairing; **TGR** = Gap reducing tractor fairing (tractor to trailer gap); **ADVH** = Vehicle includes advanced hybrid technology components; **ADVO** = Vehicle includes other advanced-technology components (i.e., non-hybrid system); **INV** = Vehicle includes innovative (off-cycle) technology components; **ATI** = Automatic tire inflation system; **TPMS** = Tire pressure monitoring system; **WR** = Weight reduction

Shown below are: 1) The Greenhouse Gas Exhaust Emission Standard (STD) in g/ton-mile and/or the Family Emission Limit(s) (FEL) of the listed vehicle family in g/ton-mile as applicable under 17 CCR 95663; and 2) the Tire Coefficient of Rolling Resistance (CRR) STD and the corresponding CRR value of the listed vehicle family as provided under 17 CCR 95663(d):

	STD	Highest Projected FEL	Lowest Projected FEL
CO_2 (g/ton-mile)	300	0	0

	STD	Highest Tire CRR Value
Tire CRR (kg/metric ton)	*	*

BE IT FURTHER RESOLVED: The listed vehicle family is certified to the Optional Phase 2 Custom Chassis CO_2 Emissions Standards as specified in 17 CCR 95663(a)(1)4 and Section 1037.105(h) of the incorporated "California Greenhouse Gas Exhaust Emission Standards and Test Procedures for 2014 and Subsequent Model Heavy-Duty Vehicles" (HDV Test Procedures) adopted October 21, 2014, as last amended June 27, 2019.

BE IT FURTHER RESOLVED: The manufacturer has demonstrated certification compliance with the Greenhouse Gas Emission Standards as specified in Title 17 CCR 95663 and the incorporated "California Greenhouse Gas Exhaust Emission Standards and Test Procedures for 2014 and Subsequent Model Heavy-Duty Vehicles" (HDV Test Procedures) adopted October 21, 2014 as last amended June 27, 2019.

BE IT FURTHER RESOLVED: For the listed air conditioning platform(s) in the attachment the manufacturer has demonstrated certification compliance with the AC Leakage Standard specified in 17 CCR 95663(a)(1)(B)7 and Section 1037.115 of the incorporated "California Greenhouse Gas Exhaust Emission Standards and Test Procedures for 2014 and Subsequent Model Heavy-Duty Vehicles" (HDV Test Procedures) adopted October 21, 2014, as last amended June 27, 2019.

BE IT FURTHER RESOLVED: For the listed vehicle models the manufacturer has submitted the materials to demonstrate certification compliance with 13 CCR 1965 (emission control labels), and 13 CCR 2035 et seq. (emission control warranty).

Vehicles certified under this Executive Order must conform to all applicable California emission regulations.

Executed on this 14th day of December 2020.

Allen Lyons, Chief
Emissions Certification and Compliance Division

A/C PLATFORM SUMMARY TABLE

Vehicle family	Date	EO
MGLG2VOCVEV1	12/09/2020	A-063-0113

A/C Platform ID	Refrigerant Type	Refrigerant Capacity (g)	STD (HFC (g/year))	Leak Rate (HFC (g/year))
TE 18	R407C	6350	95.2	7.41

Best-in-Class Bus Endures Thorough Testing

GILLIG buses go through rigorous testing to ensure the highest quality product for our customers.

Since March 2019, we've been testing our five 40-foot Zero-Emission Battery Electric Buses in areas such as maintainability, reliability, safety, performance, structural integrity and durability, fuel/energy consumption, noise, and emissions. Information from these tests enables us to implement constructive changes before the full production of our Zero-Emission Buses in May 2020. So far, we've driven our buses over 40,000 miles and run them through numerous vehicle level tests.

This past year, we have performed five extensive tests on our five Zero-Emission Battery Electric Buses:



HOT ENVIRONMENT TESTING

Death Valley, CA; Laughlin, NV; and Las Vegas, NV

PURPOSE: To test the Battery Thermal Management System (BTMS); Electronics Cooling Package (ECP); and Heating Ventilation and Air Conditioning (HVAC) Systems at ambient temperatures up to 118 degrees Fahrenheit over nine days in August.

- Hill Climb Testing in Death Valley and Laughlin, often climbing 4,000 feet over 13 miles at a constant 6% grade
- Stop/Start Testing in Las Vegas, to simulate a city bus route in 109 degrees Fahrenheit



GRADEABILITY TESTING

Salt Lake City, UT

PURPOSE: To test our bus's ability to navigate steep grades and long hill climbs by driving up to 3,000-4,000 feet on grades as steep as 17% on multiple routes.

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DURABILITY TRACK TESTING

Navistar Proving Grounds
New Carlisle, IN

PURPOSE: To test the durability of the bus by driving on an accelerated durability course with multiple road surfaces (chatter bumps, chuckholes, railroad crossings, and frame twists) for the equivalent distance of 125,000 road miles over seven months.



COLD ENVIRONMENT TESTING

Automotive Enviro Testing (AET) Facility
Baudette, MN

PURPOSE: To test the impact of snow, ice, and frigid temperatures on the performance of our electric bus by driving over 500 miles at a winter proving ground in northern Minnesota. Temperatures were well below zero Fahrenheit, and snow accumulation around the high voltage batteries confirmed that our electric bus platform is robust for operation in extreme climates.



SHAKER (VIBRATION)/ACCELERATED DURABILITY TESTING

Element
Troy, MI

PURPOSE: To test the structural durability of our bus by simulating an entire 500,000 miles of road testing—or four full Altoona durability tests—with a four-post hydraulic shaker system. This shaker durability test was preceded by extensive data collection from over 200 channels of critical structural data.



Test Track in Altoona, PA

FULL ALTOONA TEST CERTIFICATION

Bus Research and Testing Center
Altoona, PA

PURPOSE: Our bus has completed the Federal Transit Administration (FTA) Bus Testing Program for Full Altoona Test Certification. FTA test categories include structural integrity, safety, maintainability, reliability, fuel consumption, emissions, noise, and performance.

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GILLIG

ALTOONA TESTING – CURRENT STATUS



Test Track in Altoona, PA | **Completed Altoona Testing**

PURPOSE: The GILLIG Battery Electric Bus has completed the Federal Transit Administration (FTA) Bus Testing Program for Full Altoona Test Certification. FTA test categories include structured integrity, safety, maintainability, reliability, fuel consumption, emissions, noise, and performance.

GILLIG's Battery Electric bus, based on GILLIG's proven Low Floor platform, has completed the Federal Transit Administration (FTA) Bus Testing Program at the Bus Research and Testing Center in Altoona, PA.

Start Date	Test Miles Completed	Percent Complete
August 18,2020	15,000	100%

GILLIG has included the final test report.

CONFIDENTIAL

CER 8.6 Certificate of Compliance with Bus Testing Requirement

The undersigned certifies that the vehicle offered in this procurement complies and will, when delivered, comply with 49 USC § 5323(c) and FTA's implementing regulation at 49 CFR Part 665 according to the indicated one of the following three alternatives.

Mark one and only one of the three blank spaces with an "X."

1. X The buses offered herewith have been tested in accordance with 49 CFR Part 665 on JUNE 2021 (date). If multiple buses are being proposed, provide additional bus testing information below or on attached sheet. The vehicles being sold should have the identical configuration and major components as the vehicle in the test report, which must be submitted with this Proposal. If the configuration or components are not identical, then the manufacturer shall provide with its Proposal a description of the change and the manufacturer's basis for concluding that it is not a major change requiring additional testing. If multiple buses are being proposed, testing data on additional buses shall be listed on the bottom of this page.

2. _____ The manufacturer represents that the vehicle is "grandfathered" (has been used in mass transit service in the United States before October 1, 1988, and is currently being produced without a major change in configuration or components), and submits with this Proposal the name and address of the recipient of such a vehicle and the details of that vehicle's configuration and major components.

3. _____ The vehicle is a new model and will be tested and the results will be submitted to the Agency prior to acceptance of the first bus.

The undersigned understands that misrepresenting the testing status of a vehicle acquired with federal financial assistance may subject the undersigned to civil penalties as outlined in the Department of Transportation's regulation on Program Fraud Civil Remedies, 49 CFR Part 31. In addition, the undersigned understands that FTA may suspend or debar a manufacturer under the procedures in 49 CFR Part 29.

Company name: GILLIG LLC

Name and title of the Proposer's authorized official: WILLIAM F. FAY, JR., VICE PRESIDENT, SALES

William F Fay Jr

Authorized signature

SEPTEMBER 17, 2021

Date

NOTE: Reference our attached certification.

GILLIG

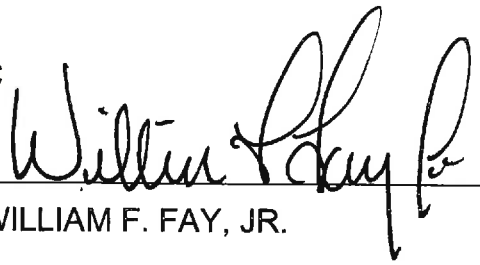
ALTOONA TEST CERTIFICATION

This is to certify that the bus model proposed for your procurement complies with the bus testing regulations required by the Surface Transportation and Uniform Relocation Assistance Act of 1987 as defined in the Interim Final Rulemaking (IFR) by the FTA in the Federal Register 49 CFR Part 665, dated July 28, 1992 and the Final Rule in the Federal Register 49 CFR part 665, dated August 1, 2016.

This statement means that the proposed vehicle complies with one or more of the clauses below, as required by the above IFR:

- was in mass transportation service prior to September 30, 1988, or
- is the same vehicle model that has been previously tested in PTI (Altoona), and that
- any new component(s) has (have) been tested at PTI (Altoona), or
- the installation of any new component(s) did not result in significant structural modification to the vehicle; or
- the installation of the component(s) did not result in a significant change in the data obtained from previous testing of the vehicle model.
- is a new bus model or a bus produced with a major change in components or configuration and shall provide a copy of the final test report to the recipient prior to the recipient's final acceptance of the first vehicle.

GILLIG LLC

By: 

WILLIAM F. FAY, JR.

Title: VICE PRESIDENT, SALES

Date: SEPTEMBER 17, 2021

GILLIG

August 6, 2021

SUBJECT: 35' ALTOONA TESTING CRITERIA LETTER

To Whom it may concern:

The Altoona Bus Testing Regulation 49 CFR Part 665 is a requirement for FTA funded procurements. Once a 40' GILLIG bus has been tested in the 12 year/500,000 mile service life category and the report has been made available to the public then variants on this model are eligible for Partial Testing requirements. Partial Testing requirements would be deemed as those specific portions of the Altoona test where we would expect to obtain significantly different data than in the base model test.

In terms of how this would apply to the question at hand where testing was completed on a 40' eBus 444kWh model Low Floor bus, and the variant is a 35' bus, I would draw the following conclusions regarding Partial Testing:

1) Regarding propulsion system - There is no difference in the electrified powertrain or energy storage system between the 40' and 35' variants. I would not expect testing to produce significantly different data from that obtained in previous maintainability, performance, energy consumption, range or noise testing done in a 40' GILLIG bus.

2) Regarding structural differences – the gross vehicle weight rating and basic vehicle structure are the same between the 35' and 40' GILLIG chassis. In the 35' variant, the overall weight is reduced and the loads in the structure are either the same or less. It would not be expected to obtain significantly different data from additional structural integrity or reliability testing. In general, FTA assumes that the longest-length variant of a bus model typically represents the worst-case scenario for structural durability testing.

The GILLIG 40' Low Floor bus test results LTI-BT-R2020-05 are a very good indicator of the results that would be obtained through testing of a 35' bus. Therefore, our 35' Low Floor variant does not require testing at Altoona.

Sincerely,

Greg Vismara
Vice President, Engineering
Phone: 800-735-1500

FEDERAL TRANSIT BUS TEST

Performed for the Federal Transit Administration U.S. DOT
In accordance with 49 CFR, Part 665

Manufacturer: Gillig
Model: 40-Foot Low Floor Battery Electric Bus

Tested in Service-Life Category
12 Year / 500,000 Miles

June 2021

Report Number: LTI-BT-R2020-05

The Thomas D. Larson
Pennsylvania Transportation Institute
201 Transportation Research Building
The Pennsylvania State University
University Park, PA 16802
(814) 865-1891

Bus Testing and Research Center
2237 Plank Road
Duncansville, PA 16635
(814) 695-3404

PennState
College of Engineering

LTI BUS RESEARCH
AND TESTING CENTER

FEDERAL TRANSIT BUS TEST

Performed for the Federal Transit Administration, U.S. DOT
1200 New Jersey Avenue, SE
Washington, DC 20590

In accordance with 49 CFR Part, 665

Manufacturer: Gillig
Manufacturer's address: 451 Discover Drive
Livermore, CA 94551

Model: 40-Foot Low Floor Battery Electric Bus

Tested in Service-Life Category
12 Year / 500,000 Miles

Report Number: LTI-BT-R2020-05



David Klinikowski	Director, Bus Research and Testing Center	July 2, 2021
Quality Authorization	*Title*	*Date*

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EXECUTIVE SUMMARY

TEST HIGHLIGHTS

The information in this report pertains only to this specific bus, as received from the manufacturer for testing.

The Check-In section of the report provides a description of the bus and specifies its major components. The following table gives the salient specifications.

Manufacturer	Gillig
Model	40 Foot Low Floor Battery Electric Bus
Chassis Make/Model	Gillig / Low Floor
Chassis Modified	No
Length	40 feet, 10 ½ inches
Fuel	Battery - Electric
Service Life	12 Year / 500,000 miles
Number of Seats (including driver)	38 or 32 & 2 wheelchairs
Manufacturer-Designated Standing Passenger Capacity	36 (34 with wheelchairs in place)
Gross Vehicle Weight used for testing	43,630 lb.
Manufacturer Specified Gross Vehicle Weight Rating	45,000 lb.
Mileage at Delivery	9,856 miles
Test Start Date	July 29, 2020
Test Completion Date	April 26, 2021

The measured curb weight was 10,770 lb. for the front axle and 21,720 lb. for the rear axle. These combined weights provided a total measured curb weight of 32,490 lb. There are 38 seats including the driver and free floor space for 36 standing passengers bringing the potential total passenger capacity to 74. Six seats fold away to accommodate two wheelchairs. When the wheelchairs are in place, there is free floor space for only 34 standing passengers. Utilizing the wheelchair positions in place of the seated passengers is the heaviest seated load weight configuration. Gross load weight would be the same with either the wheelchairs in place or the seats in place, due to the extra room for standing passengers. Therefore, the gross load represents 32 seated passengers, two wheelchairs and 34 standees, or 38 seated passenger and 36 standees. Gross load is calculated as (150 lb. x 66) + (2 x 600) = 11,100. At full declared capacity, the measured gross vehicle weight was 43,630 lb.

BUS TESTING BACKGROUND

On August 1, 2016, FTA announced a final rule for bus testing for improving the process of ensuring the safety and reliability of new transit buses. The rule satisfies requirements in MAP-21 to establish minimum performance standards, a standardized scoring system, and a pass-fail threshold based on the score.

FTA's Bus Testing Program (often referred to as "Altoona Testing" due to the location of the main testing center) tests new transit bus models for:

- Maintainability
- Reliability
- Safety
- Performance (including Braking Performance)
- Structural Integrity (including Structural Durability)
- Fuel Economy (Energy Efficiency and Range, for electric buses)
- Noise
- Emissions

Bus models that fail to meet one or more minimum performance standards will "fail" their test and thus be ineligible for purchase with FTA funds until the failures are resolved and validated through further testing. FTA will use this authority to make sure defects are corrected before a bus model can be acquired with FTA funding.

In each application to FTA for the purchase or lease of any new bus model, or any bus model with a major change in configuration or components to be acquired or leased with funds obligated by the FTA, the recipient shall certify that it has received the appropriate full Bus Testing Report and any applicable partial testing report(s) before final acceptance of the first vehicle. In dealing with a bus manufacturer or dealer, the recipient shall be responsible for determining whether a vehicle to be acquired requires full testing or partial testing or has already satisfied the requirements of this part. A bus manufacturer or recipient may request guidance from FTA in making these determinations.

The purpose of the testing is intended set a "Pass/Fail" standard and grade the performance of the buses in order to provide performance information to the transit authorities that can be used in their purchase or lease decisions. The intent of this report is to provide the grantee a relative measure of the performance of a particular model of transit bus against a standard of performance. The passing of this test should ensure a vehicle has a high probability of meeting its service life in the category it was tested.

The data included in this test report and other applicable reports should be reviewed to choose the most suitable bus for a grantee's operation. A higher scoring bus is not necessarily the best bus for a given application. For example, a bus with a powerful engine may score well because of its performance and gradeability, but another bus with a smaller and more fuel-efficient engine could be a better choice for applications in mostly flat areas. It is the responsibility of the grantee to ensure the proper test report or applicable partial report is in their possession and has been thoroughly reviewed.

The score sheet for the subject vehicle of this test report is provided below. **This bus passed the Altoona test, with an aggregate score of 86.6.**

Bus 2020-05 Gillig Electric								
Test category		Standard	Base Pts.	Bonus Pts.	Range	Range	Test Data	Score
1. Maintainability	Unscheduled maint.	< 125 hours	2	14	0	125	36.15	11.95
2. Reliability	# Class 2 failures	< 2 Uncorrected	2	6	0	2	0	8.00
3. Safety	Hazards	No uncorrected Class 1	10	0	P	F	P	10.00
	Stability	Lane change, 45 mph?	2.5	0	P	F	P	2.50
		< 158 feet at 45mph	0.5	2	80	158	121.8	1.43
	Braking	Holds Lane, Split coeffient	2.5	0	P	F	P	2.50
		Parking brake, 20% grade	2.5	0	P	F	P	2.50
	Acceleration 0-30 mph	less than 30 sec	1.5	0	P	F	P	1.50
4. Performance	Gradeability 2.5%	more than 40 mph	1.5	0	P	F	P	1.50
	Gradeability 10%	more than 10 mph	2	0	P	F	P	2.00
5. Structural Integrity	Distortion	Exits are operational	1	0	P	F	P	1.00
	Static Towing	No significant deformation	1	0	P	F	P	1.00
	Dynamic Towing	Towable with std. wrecker	1	0	P	F	P	1.00
	Jacking	Liftable with std. jack	1	0	P	F	P	1.00
	Hoisting	Stable on jacks	1	0	P	F	P	1.00
	Durability-Structural	No uncorrected failures	13	0	P	F	P	13.00
	Durability-Powertrain	No uncorrected failures	12	0	P	F	P	12.00
6. Fuel Economy	Liquid fuels	1-13mpg			1	13	NA	0.00
	CNG	10-50 scf/mi		6	10	50	NA	0.00
	Hydrogen	15-98 cf/mi	1		15	98	NA	0.00
	Electric	1-3 kWh/mi			1	3	2.467	2.60
7. Noise	Int. Noise (0-35 mph)	less than 80 db	0.5	3	30	80	75.8	0.75
	Ext. Noise (0-35 mph)	less than 83 db	0.5	3	50	83	62.5	2.36
8. Emissions	CO_2	0-4000 g/mi		4	0	4000	0	5.00
	CO	0-20 g/mi		0.4	0	20	0	0.40
	Total hydrocarbon	0-3 g/mi	1	0.4	0	3	0	0.40
	NMHC	0-3 g/mi		0.4	0	3	0	0.40
	Nitrogen oxides	0-3 g/mi		0.4	0	2	0	0.40
	Particulates	0-0.1 g/m		0.4	0	0.1	0	0.40
Total			60	40				86.6

Note: The use of the scoring system is not mandatory for procurement. It is only necessary that the bus being procured has received a passing score.

ABBREVIATIONS AND ACRONYMS

ABS - anti-skid braking system
ABTC - Altoona Bus Test Center
A/C - air conditioner, or air conditioning
AC - alternating current
ADA - American Disability Act
CDCTS - chassis dynamometer test control system
CVS - constant volume sampling
CW - curb weight (bus weight including maximum fuel, oil, and coolant; but without passengers or driver)
dB(A) - decibels with reference to 0.0002 microbar as measured on the "A" scale
DC - direct current
DIR - test director
DR - bus driver
EPA - Environmental Protection Agency
GAWR – gross axle weight rating
GVL - gross vehicle load (150 lb. for every designed passenger seating position, for the driver, and for each 1.5 sq ft of free floor space)
GVW - gross vehicle weight (curb weight plus gross vehicle load)
GVWR - gross vehicle weight rating
HD-UDDS – Heavy Duty-Urban Dynamometer Driving Schedule
LTI - Larson Transportation Institute
mpg - miles per gallon
mph - miles per hour
PM - Preventive maintenance
PSTT - Penn State Test Track
rpm - revolutions per minute
SAE - Society of Automotive Engineers
SCF - Standard cubic foot
SCH - test scheduler
SA - staff assistant
SLW - seated load weight (curb weight plus 150 lb. for every designed passenger seating position and for the driver)
TD - test driver
TECH - test technician
TM - track manager
TP - test personnel
Wh - Watt hour

TEST BUS CHECK-IN

I. OBJECTIVE

The objective of this task is to log in the test bus, assign a bus number, complete the vehicle data form, and perform a safety check.

II. TEST DESCRIPTION

The test consisted of assigning a bus test number to the bus, cleaning the bus, completing the vehicle data form, obtaining any special information and tools from the manufacturer, determining a testing schedule, performing an initial safety check, and performing the manufacturer's recommended preventive maintenance. The bus manufacturer certified that the bus meets all Federal regulations.

III. DISCUSSION

The check-in procedure is used to identify in detail the major components and configuration of the bus.

The test bus consisted of a Gillig Company, 40-Foot Low Floor Battery Electric Bus. The bus has a passenger door forward of the front axle and a passenger door between the front and rear axles. The front passenger door is equipped with a Ricon / RISSR-OH6782EY00 fold-out ramp. Power is provided by a Cummins electric traction motor.

The measured curb weight was 10,770 lb. for the front axle and 21,720 lb. for the rear axle. These combined weights provided a total measured curb weight of 32,490 lb. There are 38 seats including the driver and free floor space for 36 standing passengers bringing the *potential* total passenger capacity to 74. Six seats fold away to accommodate two wheelchairs. When the wheelchairs are in place, there is free floor space for only 34 standing passengers. Utilizing the wheelchair positions in place of the seated passengers is the heaviest seated load weight configuration. Gross load weight would be the same with either the wheelchairs in place or the seats in place, due to the extra room for standing passengers. Therefore, the gross load represents 32 seated passengers, two wheelchairs and 34 standees, or 38 seated passenger and 36 standees. Gross load is calculated as (150 lb. x 66) + (2 x 600) = 11,100. At full declared capacity, the measured gross vehicle weight was 43,630 lb.

VEHICLE DATA FORM

Bus Number: 2020-05	Date of Check-In: 07/29/2020
Bus Manufacturer: Gillig	Vehicle Identification Number (VIN): 15GGD2810L3189322
Model Number: 40 Foot Low Floor Battery Electric Bus	Chassis Mfr./Mod. #: Gillig / Low Floor
Personnel: E.D. & E.L.	Starting Odometer Reading: 9,856

WEIGHT:

Individual Wheel Reactions:

Weights (lb.)	Front Axle		Middle Axle		Rear Axle	
	Curb	Street	Curb	Street	Curb	Street
CW	5,400	5,370	N/A	N/A	10,490	11,230
SLW	6,410	6,410	N/A	N/A	12,110	13,590
GVW	7,830	7,760	N/A	N/A	13,430	14,610

Total Weight Details:

Weight (lb.)	CW	SLW	GVW	GAWR
Front Axle	10,770	12,820	15,590	16,000
Middle Axle	N/A	N/A	N/A	N/A
Rear Axle	21,720	25,700	28,040	29,000
Total	32,490	38,520	43,630	GVWR: 45,000 (Declared by Manufacturer)

Dimensions:

Length (ft/in)	40 / 10½
Width (in)	101 ¼
Height (in)	132 ½
Front Overhang (in)	91 ¼
Rear Overhang (in)	109 ¼
Wheelbase (in)	290
Wheel Track (in)	Front: 85.6
	Middle: N/A
	Rear: 77.7

Bus Number: 2020-05	Date: 07/29/2020

CLEARANCES:

Lowest Point Outside Front Axle	Location: Wheelchair ramp frame	Clearance(in): 8.0
Lowest Point Outside Rear Axle	Location: Drive motor	Clearance(in): 9.6
Lowest Point between Axles	Location: Battery Pack	Clearance(in): 10.7
Ground Clearance at the center (in)	11.2	
Front Approach Angle (deg)*	7.5	
Rear Approach Angle (deg)*	8.8	
Ramp Clearance Angle (deg)	4.2	
Aisle Width (in)	Front: 22.3	Rear: 22
Inside Standing Height at Center Aisle (in)	Front: 94.6	Rear: 75.9

*Measurements used to calculate approach and departure angles are taken from the centerline of the axles.

BODY DETAILS:

Body Structural Type	Monocoque		
Frame Material	Steel		
Body Material	Aluminum		
Floor Material	Plywood		
Roof Material	Composite		
Windows Type	■ Fixed	☐ Movable	
Window Mfg./Model No.	Arow / Five Star AR DOT 927 M300 AS5		
Number of Doors	1 Front	1 Rear	
Mfr. / Model No.	Front: Vapor Door International / 50940245-01 (L), 5094025401 (R) Rear: Vapor Door International / 51650770-03 (L), 51650770-02 (R)		
Dimension of Each Door (in)	Front: 75.4 x 32.4	Rear: 77.4 x 45.9	
Passenger Seat Type	■ Cantilever (Front)	■Pedestal (Rear)	☐ Other (explain)
Driver Seat Type	■ Air	☐ Spring	☐ Other (explain)
Mfr. / Model No.	Recaro / Ergo Metro AM80		
Number of Seats (including Driver)	38 or 32 & 2 wheelchairs		

Bus Number: 2020-05	Date: 07/29/2020

BODY DETAILS (Contd.)

Free Floor Space (ft^2)	55.9			
Height of Each Step at Normal Position (in)	Front 1. 13.9	2. N/A	3. N/A	4. N/A
	Middle 1. 14.0	2. N/A	3. N/A	4. N/A
	Rear 1. N/A	2. N/A	3. N/A	4. N/A
Step Elevation Change - Kneeling (in)	Front: 3.3	Middle: 1.1		

POWERTRAIN

Type	☐ C.I.	☐ Alternate Fuel	
	☐ S.I.	■ Other (Battery Electric)	
Air Compressor Mfr. / Model No.	Powerex / SDCS05001PM-GG		
Maximum Capacity (ft^3 / min)	16.1		
Starter Type – N/A	☐ Electrical	☐ Pneumatic	☐ Other (explain)
Starter Mfr. / Model No.	N/A		

BATTERY SYSTEM

Maximum Rated Capacity (kWh)	444 kWh (6 battery packs combined)
Usable Capacity (kWh)	355.2
Nominal Voltage (Vdc)	750

PROPULSION CONTROL SYSTEM (Rear Axle)

Propulsion Control System Mfr. / Model No.	Cummins / 5572390
Traction Motor - Mfr. / Model No.	Cummins / TM4
Traction Motor Power rating (kW)	262.5-562.5

OTHERS

DCDC Converter Mfr. / Model No.	Cummins / 5575274
HV Distribution Box Mfr. / Model No.	Cummins / 5575655

Bus Number: 2020-05	Date: 07/29/2020

SUSPENSION

Number of Axles	2		
Front Axle Type	☐ Independent	■Beam Axle	
Mfr. / Model No.	Meritor / FH946KX46		
Axle Ratio (if driven)	N/A		
Suspension Type	■ Air	☐ Spring	☐ Other (explain)
No. of Shock Absorbers	2		
Mfr. / Model No.	Koni / EVO 4:319		
Middle Axle Type	☐ Independent	☐ Beam Axle	
Mfr. / Model No.	N/A		
Axle Ratio (if driven)	N/A		
Suspension Type	☐ Air	☐ Spring	☐ Other (explain)
No. of Shock Absorbers	N/A		
Mfr. / Model No.	N/A		
Rear Axle Type	☐ Independent	■ Beam Axle	
Mfr. / Model No.	Meritor / 79163KX6-614		
Axle Ratio (if driven)	6.14		
Suspension Type	■ Air	☐ Spring	☐ Other (explain)
No. of Shock Absorbers	4		
Mfr. / Model No.	Koni / EVO 3819		

Bus Number: 2020-05	Date: 07/29/2020

WHEELS & TIRES

Front	Wheel Mfr./ Model No.	Alcoa LVL ONE / 22.5 x 8.25
	Tire Mfr./ Model No.	Michelin X Incity / 305/70R 22.5
Rear	Wheel Mfr./ Model No.	Alcoa LVL ONE / 22.5 x 8.25
	Tire Mfr./ Model No.	Michelin X Incity / 305/70R 22.5

BRAKES

Front Axle Brakes Type	☐ Cam	■ Disc	☐ Other (explain)
Mfr. / Model No.	Meritor / EX225H3		
Middle Axle Brakes Type	☐ Cam	☐ Disc	☐ Other
Mfr. / Model No.	N/A		
Rear Axle Brakes Type	☐ Cam	■Disc	☐ Other (explain)
Mfr. / Model No.	Meritor / EX225H3		

HVAC

Heating System Type	☐ Air	■ Water	☐ Other
Capacity (Btu/hr)	102,000		
Mfr. / Model No.	ThermoKing / TE18		
Air Conditioner	■ Yes	☐ No	
Location	Rear		
Capacity (Btu/hr)	92,500		
A/C Compressor Mfr. / Model No.	Copeland Scroll Emerson Climate Technology / ZRHV81KTE-TX7-502		

STEERING

Steering Gear Box Type	Hydraulic Gear		
Mfr. / Model No.	TRW / TAS85		
Steering Wheel Diameter	20”		
Number of turns (lock to lock)	5 ½		
Control Type	☐ Electric	■ Hydraulic	☐ Other (explain)

Bus Number: 2020-05	Date: 07/29/2020

OTHERS

Wheelchair Ramps	Location: Front	Type: Foldout Ramp
Wheelchair Lifts	Location: N/A	Type: N/A
Mfr. / Model No.	Ricon / RISSR – OH6782EY00	
Emergency Exit	Location: Window Door Roof Hatch	Number: 6 2 1

CAPACITIES

Fuel Tank Capacity (gallons)	N/A
Engine Crankcase Capacity (gallons)	N/A
Drive Motor Capacity (gallons)	3.5
Differential Capacity (gallons)	5.5
Cooling System Capacity (gallons)	Battery: 10 gallons HVAC System: 6 gallons
Power Steering Fluid Capacity (quarts)	5.3

VEHICLE DATA FORM

Bus Number: 2020-05	Date: 07/29/2020

List all spare parts, tools and manuals delivered with the bus.

Part Number	Description	Qty.
IR13-253	Airbag (Goodyear)	2
AS910C-14P 1380	Airbag (Continental)	4
08-70736-000	Bump stop	2
305/70R 22.5 Michelin X Incity	Tire	1
Alcoa LVL ONE 22.5x8.25	Wheel	1

COMPONENT/SUBSYSTEM INSPECTION FORM

Bus Number: 2020-05	Date: 07/29/2020

Subsystem	Checked	Initials	Comments
Air Conditioning Heating and Ventilation	✓	E.D.	None noted.
Body and Sheet Metal	✓	E.D.	Scratch & crack on rear door & door glass
Frame	✓	E.D.	None noted.
Steering	✓	E.D.	None noted.
Suspension	✓	E.D.	None noted.
Interior/Seating	✓	E.D.	None noted.
Axles	✓	E.D.	None noted.
Brakes	✓	E.D.	None noted.
Tires/Wheels	✓	E.D.	None noted.
Exhaust	N/A	E.D.	None noted.
Fuel System	✓	E.D.	Battery Electric
Power Plant	✓	E.D.	Battery
Accessories	✓	E.D.	None noted.
ADA Accessible Lift System	N/A	E.D.	None noted.
ADA Accessible Ramp System	✓	E.D.	None noted.
Interior Fasteners	✓	E.D.	None noted.
Batteries	✓	E.D.	None noted.

CHECK - IN



GILLIG
40 FOOT LOW FLOOR BATTERY ELECTRIC BUS



CHECK - IN CONT.



GILLIG
40 FOOT LOW FLOOR BATTERY ELECTRIC BUS



CHECK - IN CONT.



RICON / RISSR – OH6782EY00 FOLD OUT RAMP

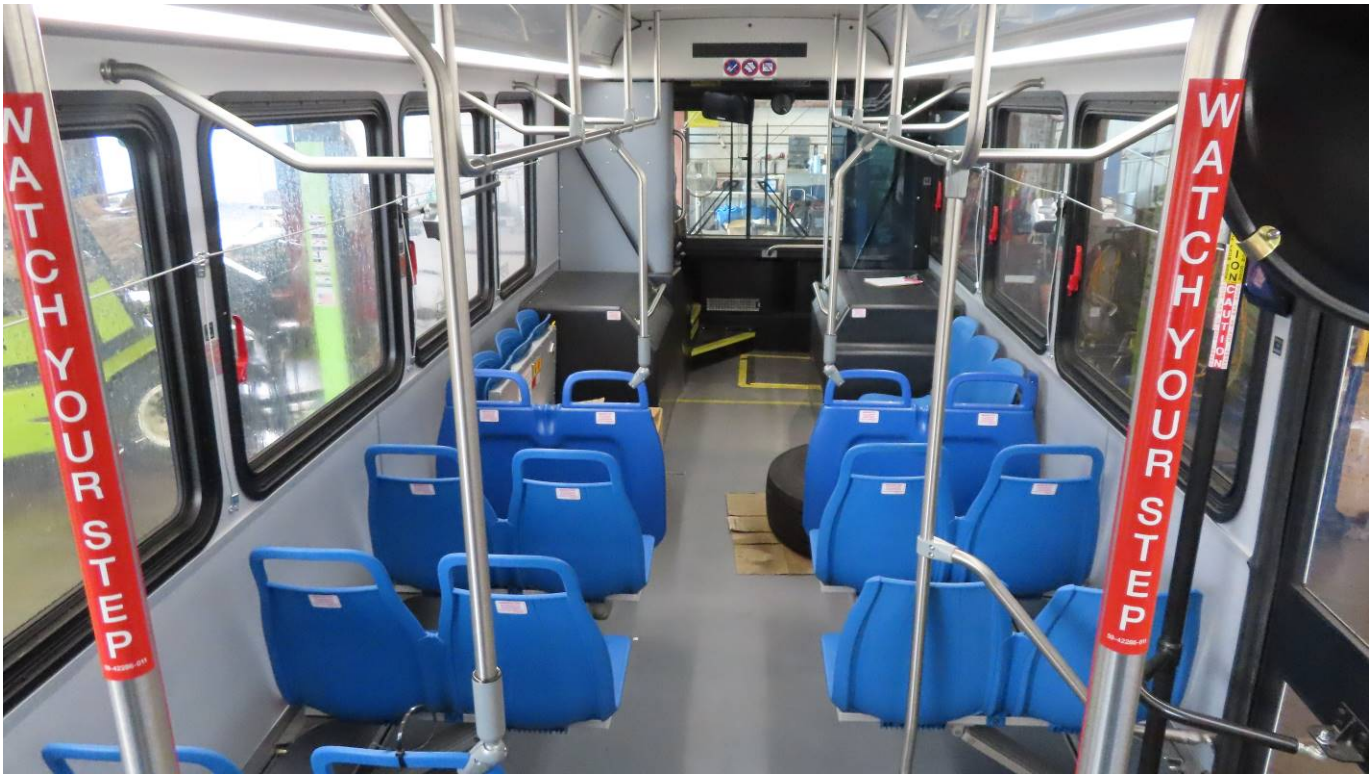


OPERATOR'S AREA

CHECK - IN CONT.

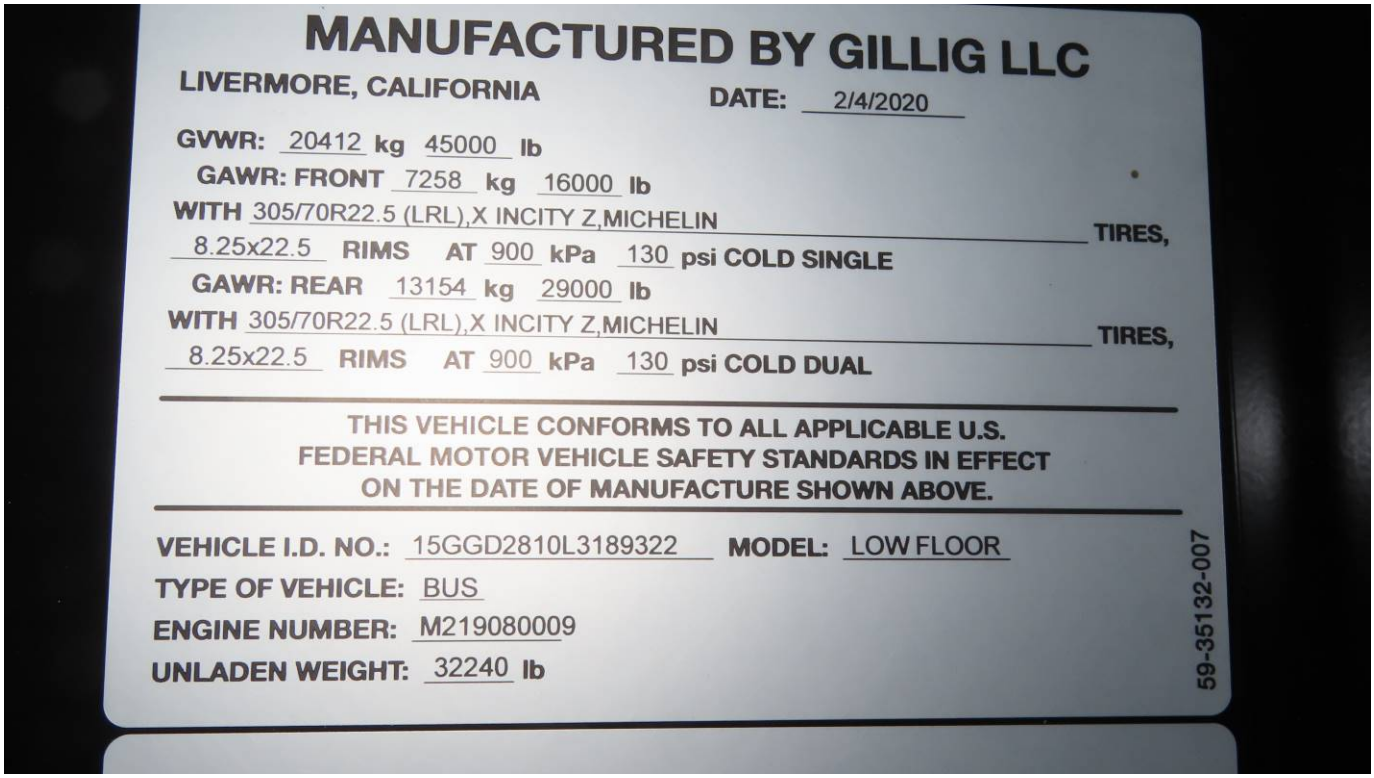


INTERIOR FROM FRONT



INTERIOR FROM REAR

CHECK - IN CONT.



VIN TAG



PLACARD SHOWING MAXIMUM PASSENGERS

CHECK - IN CONT.



REAR COMPARTMENT

1. MAINTAINABILITY

1.1 ACCESSIBILITY OF COMPONENTS AND SUBSYSTEMS

1.1-I. TEST OBJECTIVE

The objective of this test is to check the accessibility of components and subsystems.

1.1-II. TEST DESCRIPTION

Accessibility of components and subsystems was checked, and where accessibility was restricted the subsystem was noted along with the reason for the restriction.

1.1-III. DISCUSSION

Accessibility, in general, was adequate. Components covered in Section 1.3 (repair and/or replacement of selected subsystems), along with all other components encountered during testing, were found to be readily accessible and no restrictions were noted.

ACCESSIBILITY DATA FORM

Bus Number: 2020-05	Date: 04/01/2021

Component	Checked	Comments
ENGINE:		
Oil Dipstick	✓	N/A
Oil Filler Hole	✓	N/A
Oil Drain Plug	✓	N/A
Oil Filter	✓	N/A
Fuel Filter	✓	N/A
Air Filter	✓	N/A
Belts	✓	N/A
Coolant Level	✓	None noted.
Coolant Filler Hole	✓	None noted.
Coolant Drain	✓	None noted.
Spark / Glow Plugs	✓	N/A
Alternator	✓	N/A
Diagnostic Interface Connector	✓	None noted.
TRANSMISSION:		
Fluid Dipstick	✓	N/A
Filler Hole	✓	N/A
Drain Plug	✓	N/A
SUSPENSION:		
Bushings	✓	None noted.
Shock Absorbers	✓	None noted.
Air Springs	✓	None noted.
Leveling Valves	✓	None noted.
Grease Fittings	✓	None noted.

ACCESSIBILITY DATA FORM

Bus Number: 2020-05	Date: 04/01/2021

Component	Checked	Comments
HVAC:		
A/C Compressor	✓	None noted.
Filters	✓	None noted.
Fans	✓	None noted.
ELECTRICAL SYSTEM:		
Fuses	✓	None noted.
Batteries	✓	None noted.
Voltage regulator	✓	None noted.
Voltage Converters	✓	None noted.
Lighting	✓	None noted.
MISCELLANEOUS:		
Brakes	✓	None noted.
ADA Accessible Lifts/Ramps	✓	None noted.
Instruments	✓	None noted.
Axles	✓	None noted.
Exhaust	✓	N/A
Fuel System	✓	Electric
OTHERS:		

1.2 SERVICING, PREVENTIVE MAINTENANCE, AND REPAIR AND MAINTENANCE DURING TESTING

1.2-I. TEST OBJECTIVE

The objective of this test is to collect maintenance data about the servicing, preventive maintenance, and repair.

1.2.-II. TEST DESCRIPTION

The test was conducted by operating the bus and collecting the following data on work order forms and a driver log.

1. Scheduled Maintenance
    a. Bus number
    b. Date
    c. Mileage
    d. Results of scheduled inspections
    e. Description of malfunction (if any)
    f. Repair action and parts used (if any)
    g. Man-hours required

2. Unscheduled Maintenance
    a. Bus number
    b. Date
    c. Mileage
    d. Description of malfunction
    e. Place and time of malfunction (e.g., in service or undergoing inspection)
    f. Repair action and parts used
    g. Man-hours required

The bus was operated in accelerated durability service. While typical items are given below, the specific service schedule was that specified by the manufacturer.

A. Service
    1. Fueling
    2. Consumable checks
    3. Interior cleaning

B. Preventive Maintenance
    1. Brake adjustments
    2. Lubrication
    3. 3,000 mi (or manufacturer recommended) inspection

4. Oil and filter change inspection
5. Major inspection
6. Tune-up

C. Periodic Repairs
1. Brake reline*
2. Transmission change
3. Engine change*
4. Windshield wiper motor change
5. Stoplight bulb change*
6. Towing operations
7. Hoisting operations

*These items are attended to if found necessary, while the others in the list are removed/replaced/tested for all buses undergoing a full test.

1.2-III. DISCUSSION

Servicing and preventive maintenance were performed at manufacturer-specified intervals. The following Scheduled Maintenance Form lists the mileage, items serviced, the service interval, and amount of time required to perform the maintenance.

The Unscheduled Maintenance List along with related photographs is included in Section 5.7, Structural Durability. This list supplies information related to failures that occurred during the durability portion of testing. The Unscheduled Maintenance List includes the date and mileage at which the malfunction was detected, a description of the malfunction and repair, and the time required to perform the repair.

SCHEDULED MAINTENANCE
Gillig Bus# 2020-05
(Page 1 of 2)

DATE	TEST MILES	SERVICE	ACTIVITY/OBSERVATIONS	DOWN TIME	LABOR HOURS
08/26/20	1,034	P.M./Inspection	Steering linkage, tie rods, universals/u-joints all checked and lubed; all fluids checked. Inspected frame, body and suspension. Front street-side hub is leaking. (This bus has a fluid filled front axle with a visible sight glass which can leak.) Front curb-side and street-side bump stops are showing wear.	4.00	4.00
09/25/20	2,238	P.M./Inspection	Steering linkage, tie rods, universals/u-joints all checked and lubed; all fluids checked. Inspected frame, body and suspension.	4.00	4.00
10/12/20	3,614	P.M./Inspection	Steering linkage, tie rods, universals/u-joints all checked and lubed; all fluids checked. Inspected frame, body and suspension.	4.00	4.00
10/26/20	4,760	P.M./Inspection	Steering linkage, tie rods, universals/u-joints all checked and lubed; all fluids checked. Inspected frame, body and suspension. Both front windshields are leaking.	4.00	4.00
11/04/20	6,262	P.M./Inspection	Steering linkage, tie rods, universals/u-joints all checked and lubed; all fluids checked. Inspected frame, body and suspension.	4.00	4.00
11/20/20	7,363	P.M./Inspection	Steering linkage, tie rods, universals/u-joints all checked and lubed; all fluids checked. Inspected frame, body and suspension.	4.00	4.00

SCHEDULED MAINTENANCE
Gillig Bus# 2020-05
(Page 2 of 2)

DATE	TEST MILES	SERVICE	ACTIVITY/FINDINGS	DOWN TIME	LABOR HOURS
12/15/20	9,236	P.M./Inspection	Steering linkage, tie rods, universals/u-joints all checked and lubed; all fluids checked. Inspected frame, body and suspension.	4.00	4.00
01/06/21	10,206	P.M./Inspection Energy Economy Prep	Steering linkage, tie rods, universals/u-joints all checked and lubed; all fluids checked. Inspected frame, body and suspension.	8.00	8.00
01/19/21	11,224	P.M./Inspection	Steering linkage, tie rods, universals/u-joints all checked and lubed; all fluids checked. Inspected frame, body and suspension. Right front leveling valve was found to have a slight leak causing the bus to lean over when shut down. Rear lower radius arm bushings were found to be showing wear. Damaged curb-side and street-side bump stops were noted.	4.00	4.00
01/28/21	12,348	P.M./Inspection	Steering linkage, tie rods, universals/u-joints all checked and lubed; all fluids checked. Inspected frame, body and suspension.	4.00	4.00
03/05/21	13,714	P.M./Inspection	Steering linkage, tie rods, universals/u-joints all checked and lubed; all fluids checked. Inspected frame, body and suspension. It was noted that the stud which secured rooftop side panel on street-side has broken.	4.00	4.00
03/16/21	14,987	P.M./Inspection	Steering linkage, tie rods, universals/u-joints all lubed; all fluids checked. Inspected frame, body and suspension.	4.00	4.00

1.3 REPLACEMENT AND/OR REPAIR OF SELECTED SUBSYSTEMS

1.3-I. TEST OBJECTIVE

The objective of this test is to establish the time required to replace and/or repair selected subsystems.

1.3-II. TEST DESCRIPTION

The test involved components that may be expected to fail or require replacement during the service life of the bus. In addition, any component that failed during testing of the bus was added to this list. Components to be included are:

1. Drive Motor
2. DC to DC Converter
3. Low Voltage Batteries
4. High Voltage Batteries
5. Windshield wiper motor

1.3-III. DISCUSSION

At the end of the test, the items on the list were removed and replaced. The drive motor assembly took 4.50 labor-hours (1 person @ 4.50 hrs.) to remove and replace. The time required for repair/replacement of the other four components is given on the following Repair and/or Replacement Form.

REPLACEMENT AND/OR REPAIR FORM

Subsystem	Replacement Time
Drive Motor	4.50 labor hours
Wiper Motor x 2	0.50 labor hours
DC to DC Converter	3.00 labor hours
Low Voltage Batteries	0.50 labor hours
High Voltage Batteries	10.00 labor hours

It is noted that the battery pack replacement times may vary with the other battery packs due to the location.

During the test, additional components were removed for repair or replacement and the details are available in Section 5.7 in Unscheduled Maintenance.

1.3 REPLACEMENT AND/OR REPAIR OF SELECTED SUBSYSTEMS



DRIVE MOTOR REMOVAL AND REPLACEMENT (3.50 LABOR HOURS)

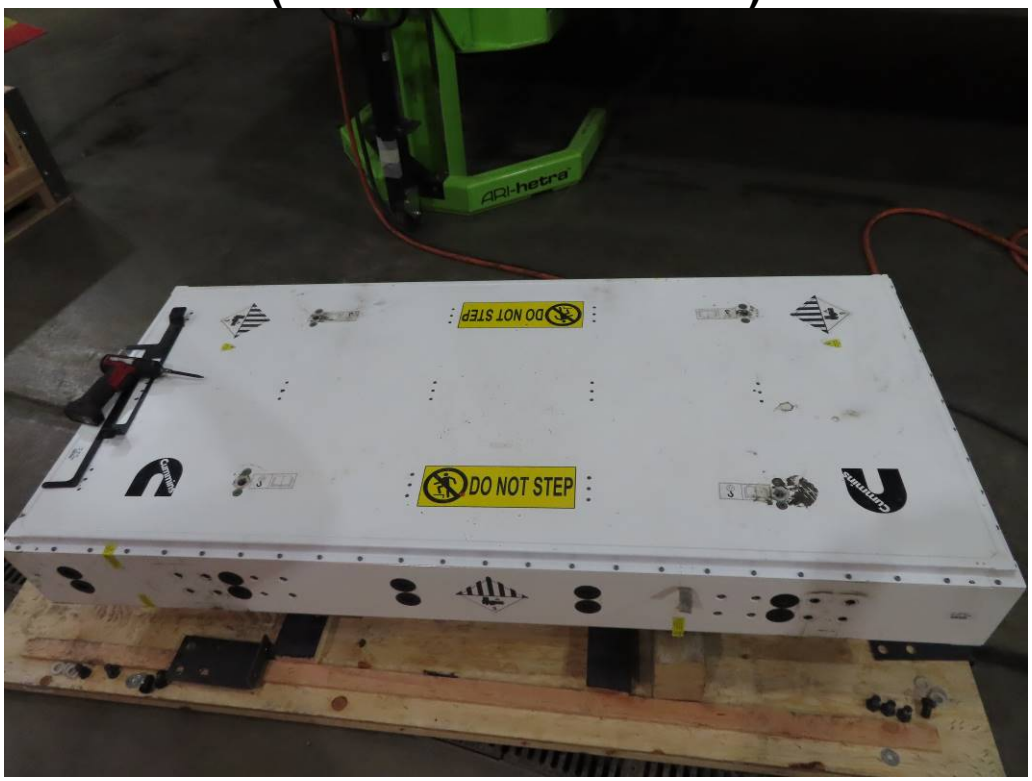


WIPER MOTOR REMOVAL AND REPLACEMENT (0.50 LABOR HOURS)

1.3 REPLACEMENT AND/OR REPAIR OF SELECTED SUBSYSTEMS CONT.



DC TO DC CONVERTER REMOVAL AND REPLACEMENT (3.00 LABOR HOURS)



HIGH VOLTAGE BATTERY REMOVAL AND REPLACEMENT (10.00 LABOR HOURS)

2. RELIABILITY - DOCUMENTATION OF BREAKDOWN AND REPAIR TIMES DURING TESTING

2-I. TEST OBJECTIVE

The objective of this test is to document unscheduled breakdowns, repairs, down time, and repair time that occur during testing.

2-II. TEST DESCRIPTION

Using the driver log and unscheduled work order forms, all significant breakdowns, repairs, labor-hours to repair, and hours out of service were recorded on the Reliability Data Form.

CLASS OF FAILURES

Classes of failures are described below:

(a) Class 1: Physical Safety. A failure that could lead directly to Injury, a crash and/or significant physical damage.

(b) Class 2: Road Call. A failure resulting in an en-route interruption of revenue service. Service is discontinued until the bus is replaced or repaired at the point of failure.

(c) Class 3: Bus Change. A failure that requires removal of the bus from service during its assignments. The bus is operable to a rendezvous point with a replacement bus.

(d) Class 4: Bad Order. A failure that does not require removal of the bus from service during its assignments but does degrade coach operation. The failure shall be reported by driver, inspector, or hostler.

2-III. DISCUSSION

A listing of breakdowns and unscheduled repairs was accumulated during the Structural Durability Test. The following Reliability Data Form lists all unscheduled repairs under classes as defined above.

The classification of repairs according to subsystem is intended to emphasize those systems which had persistent minor or more serious problems. There were 16 reported failures during testing which occurred throughout several subsystems. Of these failures, there was one Class 4 failures, 12 Class 3 failures and three Class 2 failures. There were no Class 1 failures. These failures are available for review in the Unscheduled Maintenance List, located in Section 5.7 Structural Durability.

This bus passed the Structural and Powertrain Durability sections of the test.

RELIABILITY DATA FORMS

Bus Number: 2020-05	Date: 05/26/21
Personnel: B.L.	

	Failure Type					
	Class 4 Bad Order	Class 3 Bus Change	Class 2 Road Call	Class 1 Physical Safety		
Subsystems	Mileage	Mileage	Mileage	Mileage	Labor Hours	Down Time
Hardware		1,034			0.20	0.20
Electrical		1,416			1.00	1.00
		3,390			0.20	0.20
			12,522		1.00	1.00
		12,866			10.00	10.00
Body		2,238			1.00	1.00
		7,748			0.10	0.10
Suspension		7,363			1.00	1.00
	10,206				1.00	1.00
			11,690		8.50	8.50
		12,354			2.00	2.00
Compressed Air		7,363			2.00	2.00
		7,471			2.65	2.65
Compressed Air/Suspension		12,443			1.00	1.00
			12,481		4.00	4.00
HVAC		14,161			0.50	0.50

3.1 SAFETY - A DOUBLE-LANE CHANGE (OBSTACLE AVOIDANCE)

3.1-I. TEST OBJECTIVE

The objective of this test is to determine handling and stability of the bus by measuring speed through a double lane change test.

3.1-II. TEST DESCRIPTION

The Safety Test consisted of an obstacle avoidance maneuver to evaluate the handling and stability of the bus. The test was conducted at the LTI test track on the vehicle dynamics pad. The bus was driven through a double-lane change course at increasing speeds until the test was determined to be unsafe or a speed of 45 mph is reached. The test is determined unsafe if vehicle handling becomes unstable or if any of the tires lose contact with the pavement.

The layout of the test course was defined by placing pylons along painted guidelines that delineated the course. The guidelines marked off two 12-foot center-to-center lanes. Each lane had two 100 foot long gates with a spacing distance of 100 feet between them. The bus entered the test course in one lane, crossed over to the other lane within the 100 foot gate, traveled for 100 feet, and then returned back into the original lane within the next 100 foot gate. This maneuver was repeated from 20 mph with speed increasing in increments of 5 mph. The test was performed starting from both the right and left lanes.

A test run is considered valid if the bus is able to perform the maneuver at a constant speed without deviating from the test course or striking pylons. If the bus is not able to successfully complete the maneuver due to vehicle instability, the test will be terminated. The highest speed at which the maneuver can be successfully performed up to a maximum speed of 45 mph is recorded on the Safety Data Form.

3.1-III. DISCUSSION

The double-lane change was performed in both right-hand and left-hand directions. The bus was able to safely negotiate the test course in both the right-hand and left-hand directions up to the maximum test speed of 45 mph, and therefore, passed this portion of the test.

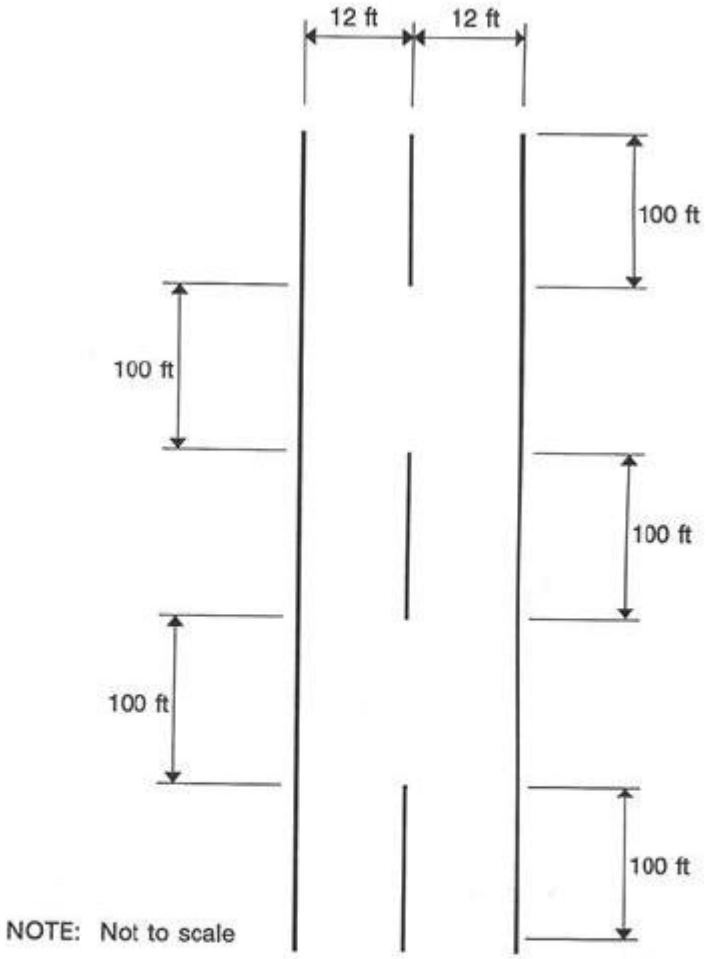


Figure 3.1. Double lane change test course

SAFETY DATA FORM

Bus Number: 2020-05	Date: 11/10/2020
Personnel: S.R., E.D. & M.H.	

Temperature (°F): 72	Humidity (%): 53
Wind Direction: S	Wind Speed (mph): 8
Barometric Pressure (inHg): 30.05	

SAFETY TEST: DOUBLE LANE CHANGE	
Maximum safe speed tested for double-lane change to left	45 mph
Maximum safe speed tested for double-lane change to right	45 mph
Comments of the position of the bus during the lane change:	
The bus maintained a safe profile throughout all portions of testing.	
Comments of the tire/ground contact patch:	
The bus maintained the tire/ground patch throughout all portions of testing.	



RIGHT - HAND APPROACH



LEFT - HAND APPROACH

3.2 Safety - Braking

3.2 I. TEST OBJECTIVE

The objective of this test is to provide, for comparison purposes, braking performance data on transit buses produced by different manufacturers.

3.2 II. TEST DESCRIPTION

The testing was conducted at the LTI Test Track skid pad area. Brake tests were conducted after completion of the GVW portion of the vehicle durability test. At this point in testing the brakes have been subjected to a large number of braking snubs and will be considered well burnished. For buses that have not completed Durability Testing, the brakes will be burnished according to the test procedure. Testing was performed when the bus was fully loaded at its GVW. All tires on each bus were representative of the tires on the production model vehicle and inflated to the bus manufacturer's specified pressures.

The brake testing procedure is comprised of three phases:

1. Stopping distance tests
    i. Dry surface (high-friction, Skid Number within the range of 70-76)
    ii. Wet surface (low-friction, Skid Number within the range of 30-36)
2. Stability tests
3. Parking brake test

3.2-III. DISCUSSION

The results of the Stopping Distance phase of the Brake Test are available in table 3.2-2. There was no deviation from the test lane during the performance of the Stopping Distance phase.

During the Stability phase of Brake Testing the test bus experienced no deviation from the test lane during both approaches to the Split Friction Road surface.

The Parking Brake phase was completed with the test bus maintaining the parked position for the full five-minute period with no slip or roll observed in both the uphill and downhill positions.

This bus passed all three phases of the Safety –Braking Test.

Table 3.2-1. Braking Test Data Forms

Bus Number: 2020-05	Date: 11/09/2020
Personnel: S.R., E.D. & P.D.	
Amb. Temperature (ºF): 70	Wind Speed (mph): 3
Wind Direction: SW	Pavement Temp (°F) Start: 60 End: 69

TIRE INFLATION PRESSURE (psi):

Tire Type: Front: Michelin X Incity 305 70R 22.5
Rear: Michelin X Incity 305 70R 22.5

	Left Tire(s)		Right Tire(s)	
Front	130		130	
	Inner	Outer	Inner	Outer
Middle	N/A	N/A	N/A	N/A
Rear	130	130	130	130

AXLE LOADS (lb.)

	Left	Right
Front	7,760	7,830
Middle	N/A	N/A
Rear	14,610	13,430

Table 3.2-2. Stopping Distance Test Results Form
(longest stopping distance in each test condition in bold)

Stopping Distance (ft)					
Vehicle Direction	CW	CW	CCW	CCW	
Speed (mph)	Stop 1	Stop 2	Stop 3	Stop 4	**Average**
20 (dry)	**33.52**	27.02	24.63	26.56	27.93
30 (dry)	**55.00**	54.34	49.95	53.62	53.23
40 (dry)	**95.44**	90.43	89.47	89.83	91.29
45 (dry)	116.95	121.88	**126.47**	121.91	121.80
20 (wet)	34.99	**36.70**	34.14	33.16	34.75

Table 3.2-3. Stability Test Results Form

Stability Test Results (Split Friction Road surface)			
Vehicle Direction	Attempt	Did test bus stay in 12' lane? (Yes/No)	Comments
Driver side on high friction	1	Yes	None noted.
	2	Yes	None noted.
Driver side on low friction	1	Yes	None noted.
	2	Yes	None noted.

Table 3.2-4. Parking Brake Test Form

PARKING BRAKE (Fully Loaded) – GRADE HOLDING						
Vehicle Direction	Attempt	Hold Time (min)	Slide (in)	Roll (in)	Did Hold	No Hold
Front up	1	5:00	0	0	✓	
	2	N/A	N/A	N/A	N/A	N/A
	3	N/A	N/A	N/A	N/A	N/A
Front down	1	5:00	0	0	✓	
	2	N/A	N/A	N/A	N/A	N/A
	3	N/A	N/A	N/A	N/A	N/A

Table 3.2-5. Record of All Braking System Faults/Repairs.

Date	Fault/Repair	Description
11/09/20	None noted.	None noted.

3.2 Safety - Bus Braking



PARKING BRAKE TEST
PARKING BRAKE HELD FOR 5 MINUTES IN
BOTH 20% UP AND 20% DOWN POSITIONS



4. PERFORMANCE - AN ACCELERATION, GRADEABILITY, AND TOP SPEED TEST

4-I. TEST OBJECTIVE

The objective of this test is to determine the acceleration, gradeability, and top speed capabilities of the bus.

4-II. TEST DESCRIPTION

In this test, the bus was operated at SLW on a chassis dynamometer. The procedure dictates that the test bus be accelerated to a maximum "power-limited"/"governed" or maximum "safe" speed not exceeding 80 mph. The maximum power-limited/governed speed, if applicable, is the top speed as limited by the engine control system. The maximum safe speed is defined as the maximum speed that the dynamometer, the tires or other bus components are limited to. The test vehicle speed was measured using a speed encoder built in the chassis dynamometer. The time intervals between 10 mph increments were recorded using a Data Acquisitions System. Time-speed data and the top speed attained were recorded on the Performance Data Form. The recorded data was used to generate a percent grade versus speed table and a speed versus time curve. All the above are available in the following pages.

4-III. DISCUSSION

This test consisted of three runs from standstill to full throttle on the chassis dynamometer. Speed versus time data was obtained for each run and results are averaged to minimize test variability. The test was performed up to a maximum governed speed of 65.1 mph. The calculated gradeability results are attached. The average time to reach 30 mph was 6.4 seconds. The maximum gradeablity at 10 mph was 52.6% and at 40 mph was 10.5%. This bus passed this section of the test.

PERFORMANCE DATA FORM

Bus Number: 2020-05	Date: 01/13/2021
Personnel: J.S. & S.I.	
Temperature (°F): 71	Humidity (%): 21
Barometric Pressure (inHg): 28.8	

		INITIALS:
Air Conditioning - OFF	✓Checked	J.S.
Ventilation fans - ON HIGH	✓Checked	J.S.
Heater - OFF	✓Checked	J.S.
Defroster - OFF	✓ Checked	J.S.
Exterior and interior lights - ON	✓ Checked	J.S.
Windows and doors - CLOSED	✓ Checked	J.S.

ACCELERATION, GRADEABILITY, TOP SPEED

Recorded Interval Times

Speed	Run 1	Run 2	Run 3
10 mph	1.8	1.8	1.8
20 mph	3.5	3.4	3.5
30 mph	6.5	6.3	6.4
40 mph	10.0	9.7	9.9
50 mph	15.1	14.8	15.0
60 mph	22.8	22.5	22.7
70 mph	N/A	N/A	N/A

Maximum Speed (mph): 65.1 (maximum governed speed reached using chassis dynamometer)

PERFORMANCE SUMMARY SHEET

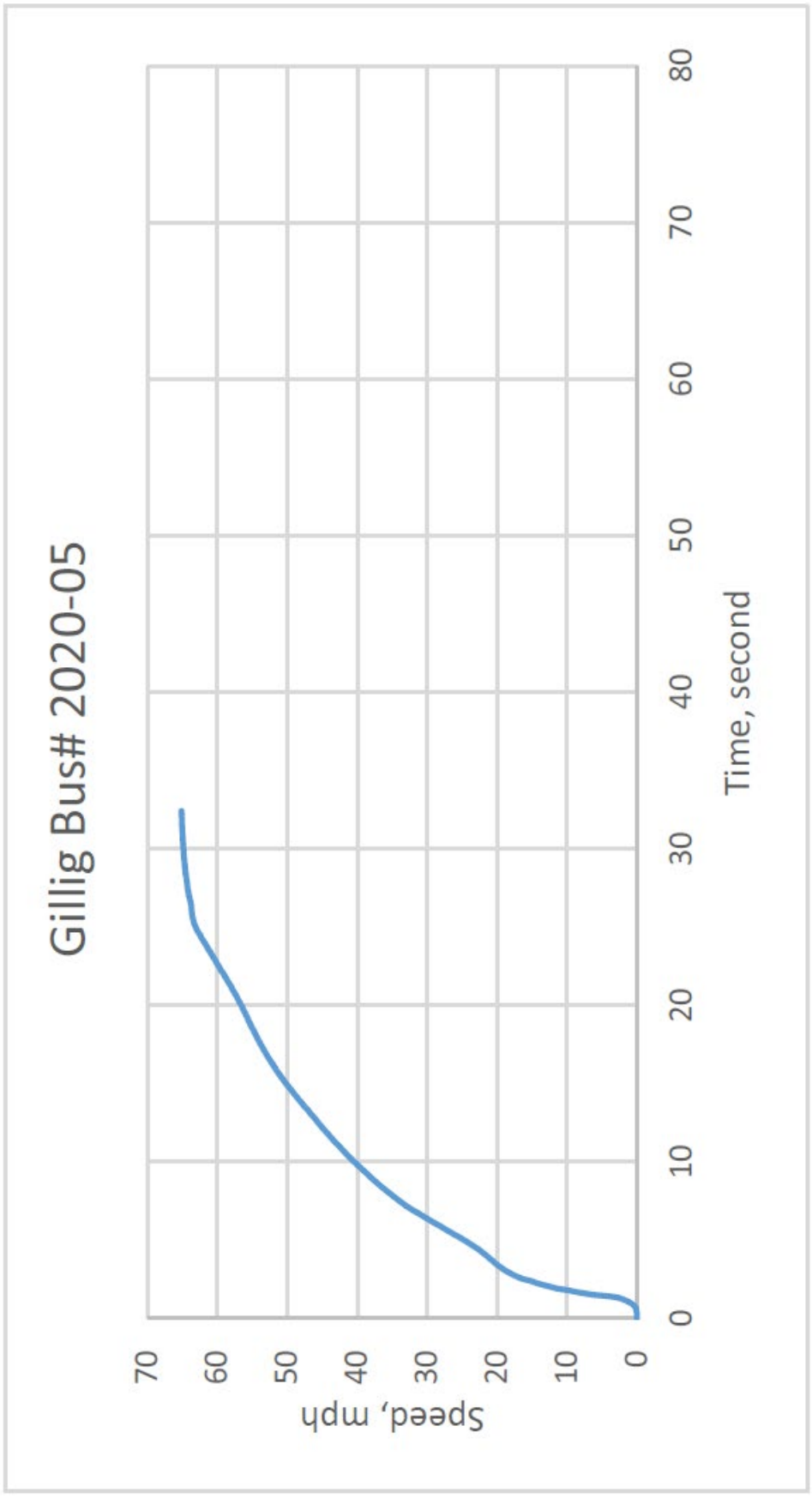
Bus Number: 2020-05	Date: 01/13/2021
Personnel: J.S. & S.I.	

Test Conditions:

Temperature (°F): 71	Humidity (%): 21
Barometric Pressure (inHg): 28.8	

Test Results:

Vehicle Speed (MPH)	Time (SEC)	Acceleration (FT/SEC^2)	Max. Grade (%)
1.0	1.0	9.04	28.1
5.0	1.5	15.79	49.1
10.0	1.8	16.94	52.6
15.0	2.4	10.38	32.3
20.0	3.5	4.32	13.4
25.0	5.1	5.45	16.9
30.0	6.4	5.57	17.3
35.0	7.9	4.18	13.0
40.0	9.9	3.39	10.5
45.0	12.2	2.79	8.7
50.0	15.0	2.48	7.7
55.0	18.6	1.61	5.0
60.0	22.7	2.00	6.2
65.0	31.2	0.19	0.6
65.1	32.4	Maximum Speed	


Gillig Bus# 2020-05
Speed, mph
0
10
20
30
40
50
60
70
Time, second
0
10
20
30
40
50
60
70
80

5.2 STRUCTURAL STRENGTH AND DISTORTION TESTS - STRUCTURAL DISTORTION

5.2-I. TEST OBJECTIVE

The objective of this test is to observe the operation of the bus subsystems when the bus is placed in a longitudinal twist simulating operation over a curb or through a pothole.

5.2-II. TEST DESCRIPTION

With the bus loaded to GVW, each wheel of the bus was raised (one at a time) to simulate operation over a curb and the following were inspected:

1. Body
2. Windows
3. Doors
4. Roof vents
5. Special seating
6. Undercarriage
7. Engine
8. Service doors
9. Escape hatches
10. Steering mechanism

Each wheel was then lowered (one at a time) to simulate operation through a pothole and the same items inspected.

5.2-III. DISCUSSION

The test sequence was repeated ten times. The first and last test is with all wheels level. The other eight tests are with each wheel 6 inches higher and 6 inches lower than the other three wheels.

All doors, windows, escape mechanisms, engine, steering and ADA accessible devices operated normally throughout the test. The undercarriage and body indicated no deficiencies. No water leakage was observed during the test. The results of this test are indicated on the following data forms. This bus passed this section of the test.

DISTORTION TEST INSPECTION FORM

(Note: Ten copies of this data sheet are required)

Bus Number: 2020-05	Date: 07/30/2020
Personnel: S.R., E.D., E.L., T.G. & P.D.	Temperature(°F): 77

Wheel Position: (check one)		
All wheels level	■ before	□ after
Left front	□ 6 in higher	□ 6 in lower
Right front	□ 6 in higher	□ 6 in lower
Right rear	□ 6 in higher	□ 6 in lower
Left rear	□ 6 in higher	□ 6 in lower
Right center	□ 6 in higher	□ 6 in lower
Left center	□ 6 in higher	□ 6 in lower

	Comments
Windows	No Deficiencies.
Front Doors	No Deficiencies.
Rear Doors	No Deficiencies.
Escape Mechanisms/ Roof Vents	No Deficiencies.
Engine	No Deficiencies.
ADA Accessible/ Special Seating	No Deficiencies.
Undercarriage	No Deficiencies.
Service Doors	No Deficiencies.
Body	No Deficiencies.
Windows/ Body Leakage	No Deficiencies.
Steering Mechanism	No Deficiencies.

DISTORTION TEST INSPECTION FORM

(Note: Ten copies of this data sheet are required)

Bus Number: 2020-05	Date: 07/30/2020
Personnel: S.R., E.D., E.L., T.G. & P.D.	Temperature(°F): 77

Wheel Position: (check one)		
All wheels level	□ before	□ after
Left front	■ 6 in higher	□ 6 in lower
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Right rear	□ 6 in higher	□ 6 in lower
Left rear	□ 6 in higher	□ 6 in lower
Right center	□ 6 in higher	□ 6 in lower
Left center	□ 6 in higher	□ 6 in lower

	Comments
Windows	No Deficiencies.
Front Doors	No Deficiencies.
Rear Doors	No Deficiencies.
Escape Mechanisms/ Roof Vents	No Deficiencies.
Engine	No Deficiencies.
ADA Accessible/ Special Seating	No Deficiencies.
Undercarriage	No Deficiencies.
Service Doors	No Deficiencies.
Body	No Deficiencies.
Windows/ Body Leakage	No Deficiencies.
Steering Mechanism	No Deficiencies.

DISTORTION TEST INSPECTION FORM

(Note: Ten copies of this data sheet are required)

Bus Number: 2020-05	Date: 07/30/2020
Personnel: S.R., E.D., E.L., T.G. & P.D.	Temperature(°F): 77

Wheel Position: (check one)		
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Left rear	□ 6 in higher	□ 6 in lower
Right center	□ 6 in higher	□ 6 in lower
Left center	□ 6 in higher	□ 6 in lower

	Comments
Windows	No Deficiencies.
Front Doors	No Deficiencies.
Rear Doors	No Deficiencies.
Escape Mechanisms/ Roof Vents	No Deficiencies.
Engine	No Deficiencies.
ADA Accessible/ Special Seating	No Deficiencies.
Undercarriage	No Deficiencies.
Service Doors	No Deficiencies.
Body	No Deficiencies.
Windows/ Body Leakage	No Deficiencies.
Steering Mechanism	No Deficiencies.

DISTORTION TEST INSPECTION FORM

(Note: Ten copies of this data sheet are required)

Bus Number: 2020-05	Date: 07/30/2020
Personnel: S.R., E.D., E.L., T.G. & P.D.	Temperature(°F): 77

Wheel Position: (check one)		
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ADA Accessible/ Special Seating	No Deficiencies.
Undercarriage	No Deficiencies.
Service Doors	No Deficiencies.
Body	No Deficiencies.
Windows/ Body Leakage	No Deficiencies.
Steering Mechanism	No Deficiencies.

DISTORTION TEST INSPECTION FORM

(Note: Ten copies of this data sheet are required)

Bus Number: 2020-05	Date: 07/30/2020
Personnel: S.R., E.D., E.L., T.G. & P.D.	Temperature(°F): 77

Wheel Position: (check one)		
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Undercarriage	No Deficiencies.
Service Doors	No Deficiencies.
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Windows/ Body Leakage	No Deficiencies.
Steering Mechanism	No Deficiencies.

DISTORTION TEST INSPECTION FORM

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Bus Number: 2020-05	Date: 07/30/2020
Personnel: S.R., E.D., E.L., T.G. & P.D.	Temperature(°F): 77

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Undercarriage	No Deficiencies.
Service Doors	No Deficiencies.
Body	No Deficiencies.
Windows/ Body Leakage	No Deficiencies.
Steering Mechanism	No Deficiencies.

DISTORTION TEST INSPECTION FORM

(Note: Ten copies of this data sheet are required)

Bus Number: 2020-05	Date: 07/30/2020
Personnel: S.R., E.D., E.L., T.G. & P.D.	Temperature(°F): 77

Wheel Position: (check one)		
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Escape Mechanisms/ Roof Vents	No Deficiencies.
Engine	No Deficiencies.
ADA Accessible/ Special Seating	No Deficiencies.
Undercarriage	No Deficiencies.
Service Doors	No Deficiencies.
Body	No Deficiencies.
Windows/ Body Leakage	No Deficiencies.
Steering Mechanism	No Deficiencies.

DISTORTION TEST INSPECTION FORM

(Note: Ten copies of this data sheet are required)

Bus Number: 2020-05	Date: 07/30/2020
Personnel: S.R., E.D., E.L., T.G. & P.D.	Temperature(°F): 77

Wheel Position: (check one)		
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Undercarriage	No Deficiencies.
Service Doors	No Deficiencies.
Body	No Deficiencies.
Windows/ Body Leakage	No Deficiencies.
Steering Mechanism	No Deficiencies.

DISTORTION TEST INSPECTION FORM

(Note: Ten copies of this data sheet are required)

Bus Number: 2020-05	Date: 07/30/2020
Personnel: S.R., E.D., E.L., T.G. & P.D.	Temperature(°F): 77

Wheel Position: (check one)		
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ADA Accessible/ Special Seating	No Deficiencies.
Undercarriage	No Deficiencies.
Service Doors	No Deficiencies.
Body	No Deficiencies.
Windows/ Body Leakage	No Deficiencies.
Steering Mechanism	No Deficiencies.

DISTORTION TEST INSPECTION FORM

(Note: Ten copies of this data sheet are required)

Bus Number: 2020-05	Date: 07/30/2020
Personnel: S.R., E.D., E.L., T.G. & P.D.	Temperature(°F): 77

Wheel Position: (check one)		
All wheels level	□ before	■ after
Left front	□ 6 in higher	□ 6 in lower
Right front	□ 6 in higher	□ 6 in lower
Right rear	□ 6 in higher	□ 6 in lower
Left rear	□ 6 in higher	□ 6 in lower
Right center	□ 6 in higher	□ 6 in lower
Left center	□ 6 in higher	□ 6 in lower

	Comments
Windows	No Deficiencies.
Front Doors	No Deficiencies.
Rear Doors	No Deficiencies.
Escape Mechanisms/ Roof Vents	No Deficiencies.
Engine	No Deficiencies.
ADA Accessible/ Special Seating	No Deficiencies.
Undercarriage	No Deficiencies.
Service Doors	No Deficiencies.
Body	No Deficiencies.
Windows/ Body Leakage	No Deficiencies.
Steering Mechanism	No Deficiencies.

5.2 STRUCTURAL DISTORTION TEST



RIGHT REAR WHEEL SIX INCHES HIGHER



RIGHT REAR WHEEL SIX INCHES LOWER

5.3 STRUCTURAL STRENGTH AND DISTORTION TESTS - STATIC TOWING TEST

5.3-I. TEST OBJECTIVE

The objective of this test is to determine the characteristics of the bus towing mechanisms under static loading conditions.

5.3-II. TEST DESCRIPTION

Utilizing a load-distributing yoke, a hydraulic cylinder was used to apply a static tension load equal to 1.2 times the bus curb weight. The load was applied to both the front and rear, if applicable, towing fixtures at an angle of 20 degrees with the longitudinal axis of the bus, first to one side then the other in the horizontal plane, and then upward and downward in the vertical plane. Any permanent deformation or damage to the tow eyes or adjoining structure was recorded.

5.3-III. DISCUSSION

The load-distributing yoke was incorporated as the interface between the Static Tow apparatus and the test bus tow hook/eyes. The test was performed to the full target test weight of 38,988 lb. (1.2 x 32,490 lb. CW). No damage or deformation was observed during all four pulls of the test.

STATIC TOWING TEST DATA FORM

Bus Number: 2020-05	Date: 04/26/2021
Personnel: T.S., S.R., E.L., E.D. & J.M.	Temperature (°F): 60

Inspect right front tow eye and adjoining structure.
Comments: No damage observed.
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments: Welds inspected.
Inspect left front tow eye and adjoining structure.
Comments: No damage observed.
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments: Welds inspected.
Inspect right rear tow eye and adjoining structure.
Comments: N/A
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments: N/A
Inspect left rear tow eye and adjoining structure.
Comments: N/A
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments: N/A
General comments of any other structure deformation or failure: All 4 pulls
were performed to the target test load of 38,988 lb. with no damage or deformation
observed.

5.3 STATIC TOWING TEST



20° DOWNWARD PULL



20° LEFT PULL

5.4 STRUCTURAL STRENGTH AND DISTORTION TESTS - DYNAMIC TOWING TEST

5.4-I. TEST OBJECTIVE

The objective of this test is to verify the integrity of the towing fixtures and determine the feasibility of towing the bus under manufacturer specified procedures.

5.4-II. TEST DESCRIPTION

This test required the bus to be towed at curb weight using the specified equipment and instructions provided by the manufacturer and a heavy-duty wrecker. The bus was towed for 5 miles at a speed of 20 mph for each recommended towing configuration. After releasing the bus from the wrecker, the bus was visually inspected for any structural damage or permanent deformation. All doors, windows and passenger escape mechanisms were inspected for proper operation.

5.4-III. DISCUSSION

The bus was towed using a heavy-duty wrecker. The towing interface was accomplished by incorporating a hydraulic under-lift. A front lift tow was performed. No problems, deformation, or damage was noted during testing. This bus passed this section of the test.

DYNAMIC TOWING TEST DATA FORM

Bus Number: 2020-05	Date: 01/08/2021
Personnel: T.S. & T.G.	

Temperature (°F): 28	
Wind Direction: Calm	Wind Speed (mph): 0

Inspect tow equipment-bus interface.

Comments: No problems encountered.

Inspect tow equipment-wrecker interface.

Comments: No problems encountered.

Towing Comments: A heavy duty hydraulic wheel lift wrecker was used to perform this tow test. There were no problems encountered

Description and location of any structural damage: None noted.

General Comments: None noted.

5.4 DYNAMIC TOWING TEST



TEST BUS IN TOW

5.5 STRUCTURAL STRENGTH AND DISTORTION TESTS – JACKING TEST

5.5-I. TEST OBJECTIVE

The objective of this test is to inspect for damage due to the deflated tire and determine the feasibility of jacking the bus with a portable hydraulic jack to a height sufficient to replace a deflated tire.

5.5-II. TEST DESCRIPTION

With the bus at curb weight, the tire(s) at one corner of the bus were replaced with deflated tire(s) of the appropriate type. A portable hydraulic floor jack was then positioned in a manner and location specified by the manufacturer and used to raise the bus to a height sufficient to provide 3-in clearance between the floor and an inflated tire. The deflated tire(s) were replaced with the original tire(s) and the jack was lowered. Any structural damage or permanent deformation was recorded on the test data sheet. This procedure was repeated for each corner of the bus.

5.5-III. DISCUSSION

During the deflated tire portion of the test, the jacking point clearances ranged from 3.8 inches to 11.2 inches. No deformation or damage was observed during testing. A complete listing of jacking point clearances is provided in the Jacking Test Data Form. This bus passed this section of the test.

JACKING CLEARANCE SUMMARY

Condition	Frame Point Clearance
Front axle – one tire flat	5.4
Rear axle – one tire flat	11.0
Rear axle – two tires flat	8.1

JACKING TEST DATA FORM

Bus Number: 2020-05	Date: 07/30/2020
Personnel: E.D. & E.L.	Temperature (°F): 81

Record any permanent deformation or damage to bus as well as any difficulty encountered during jacking procedure.

I= Inflated D= Deflated

Deflated Tire	Jacking Pad Clearance Body/Frame (in)	Jacking Pad Clearance Axle/Suspension (in)	Comments
Right front	9.1“I 5.4“D	7.3“I 4.1” D	Body & Axle
Left front	11.0“I 9.7“D	7.3“I 4.7“D	Body & Axle
Right rear—outside	11.9“I 11.2“D	6.4“I 5.9“D	Body & Suspension
Right rear—both	11.9“I 8.1“D	6.4“I 3.8“D	Body & Suspension
Left rear—outside	11.7“I 11.0“D	6.4“I 6.0“D	Body & Suspension
Left rear—both	11.7“I 8.4“D	6.4“I 4.0“D	Body & Suspension
Right middle or tag—outside	N/A	N/A	N/A
Right middle or tag—both	N/A	N/A	N/A
Left middle or tag—outside	N/A	N/A	N/A
Left middle or tag—both	N/A	N/A	N/A

Additional comments of any deformation or difficulty during jacking:

None noted.

5.5 JACKING TEST



JACK IN PLACE – FRONT



JACK IN PLACE – REAR

5.6 STRUCTURAL STRENGTH AND DISTORTION TESTS - HOISTING TEST

5.6-I. TEST OBJECTIVE

The objective of this test is to determine possible damage or deformation caused by the jack/stands.

5.6-II. TEST DESCRIPTION

With the bus at curb weight, the front end of the bus was raised to a height sufficient to allow manufacturer-specified placement of jack stands under the axles or jacking pads independent of the hoist system. The bus was checked for stability on the jack stands and for any damage to the jacking pads or bulkheads. The procedure was repeated for the tag/middle axles (if equipped), and rear end of the bus. The procedure was then repeated for the front, tag/middle (if equipped) axles, and rear simultaneously.

5.6-III. DISCUSSION

The test was conducted using four posts of a six-post electric lift and 19-inch jack stands. The bus was hoisted from the front wheels and then from the rear wheels, and then from the front and rear wheels simultaneously and placed on jack stands.

The bus accommodated the placement of the vehicle lifts and jack stands and the procedure was performed without any instability noted. This bus passed this section of the test.

HOISTING TEST DATA FORM

Bus Number: 2020-05	Date: 07/30/2020
Personnel: E.D. & P.D.	Temperature (°F): 75

Comments of any structural damage to the jacking pads or axles while both the front wheels are supported by the jack stands:
None noted.
Comments of any structural damage to the jacking pads or axles while both the rear wheels are supported by the jack stands:
None noted.
Comments of any structural damage to the jacking pads or axles while both the tag axle wheels are supported by the jack stands:
N/A
Comments of any structural damage to the jacking pads or axles while the front and rear wheels are supported by the jack stands:
None noted.
Comments of any problems or interference placing wheel hoists under wheels:
None noted.

5.6 HOISTING TEST



JACK STANDS IN PLACE –REAR



JACK STANDS IN PLACE – FRONT AND REAR

5.7 STRUCTURAL DURABILITY TEST

5.7-I. TEST OBJECTIVE

The objective of this test is to perform an accelerated durability test that approximates 25 percent of the service life of the vehicle.

5.7-II. TEST DESCRIPTION

The test vehicle was driven a total of 15,575 miles; approximately 12,500 miles on the LTI Durability Test Track and approximately 3,075 miscellaneous other miles. The test was conducted with the bus operated under three different loading conditions. The first segment consisted of approximately 6,250 miles with the bus operated at GVW. The second segment consisted of approximately 2,500 miles with the bus operated at SLW. The remainder of the test, approximately 6,250 miles, was conducted with the bus loaded to CW. The loads on both axles and GVW were within their ratings with the bus loaded as specified by the manufacturer. All subsystems were running during these tests in their normal operating modes. All manufacturer-recommended servicing was followed and noted on the vehicle maintainability log. Servicing items accelerated by the durability tests were compressed by 10:1; all others were done on a 1:1 mi/mi basis. Unscheduled breakdowns and repairs were recorded on the same log as are any unusual occurrences as noted by the driver. Once a week the test vehicle was washed down and thoroughly inspected for any signs of failure.

5.7-III. DISCUSSION

The Structural Durability Test was started on August 18,2020 and was conducted until April 5, 2021. The first 6,250 miles were performed at a GVW of 43,630 lb. and completed on November 9, 2020. The next 2,500-mile SLW segment was performed at 38,520 lb. and completed on December 10, 2020 and the final 6,250-mile segment was performed at a CW of 32,490 lb. and completed on April 5, 2021.

The following mileage summary presents the accumulation of miles during the Structural Durability Test. The driving schedule is included, showing the operating duty cycle. A detailed plan view of the LTI Test Track Facility and Durability Test Track are attached for reference. Also, a durability element profile detail shows all the measurements of the different conditions. Finally, photographs illustrating some of the failures that were encountered during the Structural Durability Test are included. This bus passed this section of the test, as there were no uncorrected Class 1 or Class 2 failures and the unscheduled maintenance of 36.15 hours was less than 125 hours.

Gillig Bus# 2020-05

MILEAGE DRIVEN/RECORDED FROM DRIVER'S LOGS

DATE	TOTAL DURABILITY TRACK	TOTAL OTHER MILES	TOTAL
08/17/20 TO 08/23/20	593.00	77.00	670.00
08/24/20 TO 08/30/20	714.00	32.00	746.00
08/31/20 TO 09/06/20	0.00	0.00	0.00
09/07/20 TO 09/13/20	0.00	0.00	0.00
09/14/20 TO 09/20/20	222.00	11.00	233.00
09/21/20 TO 09/27/20	610.00	25.00	635.00
09/28/20 TO 10/04/20	589.00	58.00	647.00
10/05/20 TO 10/11/20	490.00	133.00	623.00
10/12/20 TO 10/18/20	496.00	185.00	681.00
10/19/20 TO 10/25/20	423.00	78.00	501.00
10/26/20 TO 11/01/20	970.00	43.00	1013.00
11/02/20 TO 11/08/20	143.00	370.00	513.00
11/09/20 TO 11/15/20	762.00	95.00	857.00
11/16/20 TO 11/22/20	452.00	19.00	471.00
11/23/20 TO 11/29/20	151.00	7.00	158.00

Gillig Bus# 2020-05

MILEAGE DRIVEN/RECORDED FROM DRIVER'S LOGS

DATE	TOTAL DURABILITY TRACK	TOTAL OTHER MILES	TOTAL
11/30/20 TO 12/06/20	194.00	8.00	202.00
12/07/20 TO 12/13/20	806.00	225.00	1031.00
12/14/20 TO 12/20/20	401.00	18.00	419.00
12/21/20 TO 12/27/20	345.00	15.00	360.00
12/28/20 TO 01/03/21	0.00	0.00	0.00
01/04/21 TO 01/10/21	593.00	123.00	716.00
01/11/21 TO 01/17/21	270.00	349.00	619.00
01/18/21 TO 01/24/21	642.00	29.00	671.00
01/25/21 TO 01/31/21	585.00	124.00	709.00
02/01/21 TO 02/07/21	39.00	2.00	41.00
02/08/21 TO 02/14/21	0.00	0.00	0.00
02/15/21 TO 02/21/21	0.00	0.00	0.00
02/22/21 TO 02/28/21	400.00	16.00	416.00
03/01/21 TO 03/07/21	837.00	37.00	874.00
03/08/21 TO 03/14/21	773.00	33.00	806.00

Gillig Bus# 2020-05

MILEAGE DRIVEN/RECORDED FROM DRIVER'S LOGS

DATE	TOTAL DURABILITY TRACK	TOTAL OTHER MILES	TOTAL
03/15/21 TO 03/21/21	0.00	453.00	453.00
03/22/21 TO 03/28/21	0.00	397.00	397.00
03/29/21 TO 04/04/21	0.00	47.00	47.00
04/05/21 TO 04/11/21	0.00	66.00	66.00
TOTAL	12500.00	3075.00	15575.00

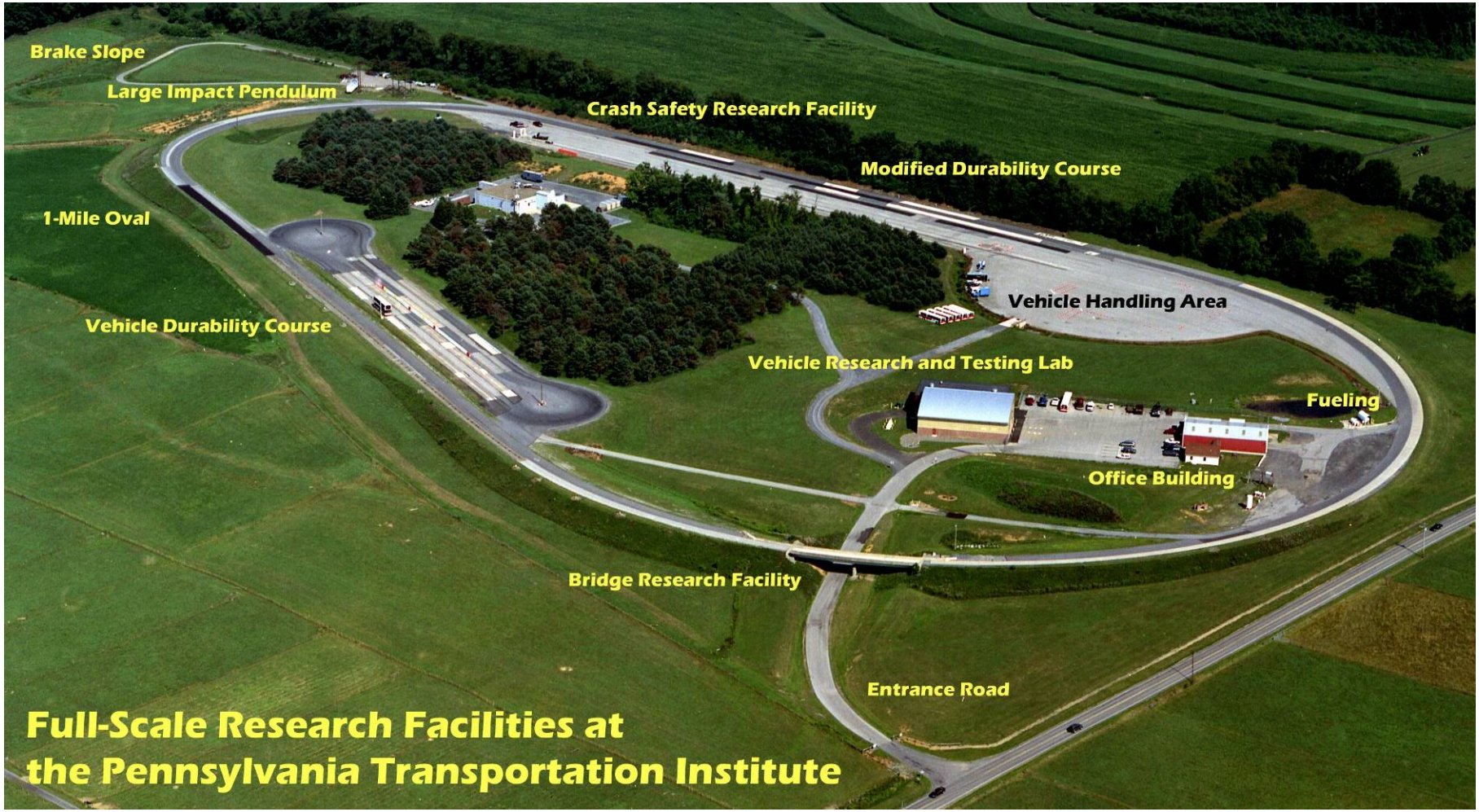
Driving Schedule for Bus Operation on the Durability Test Track.

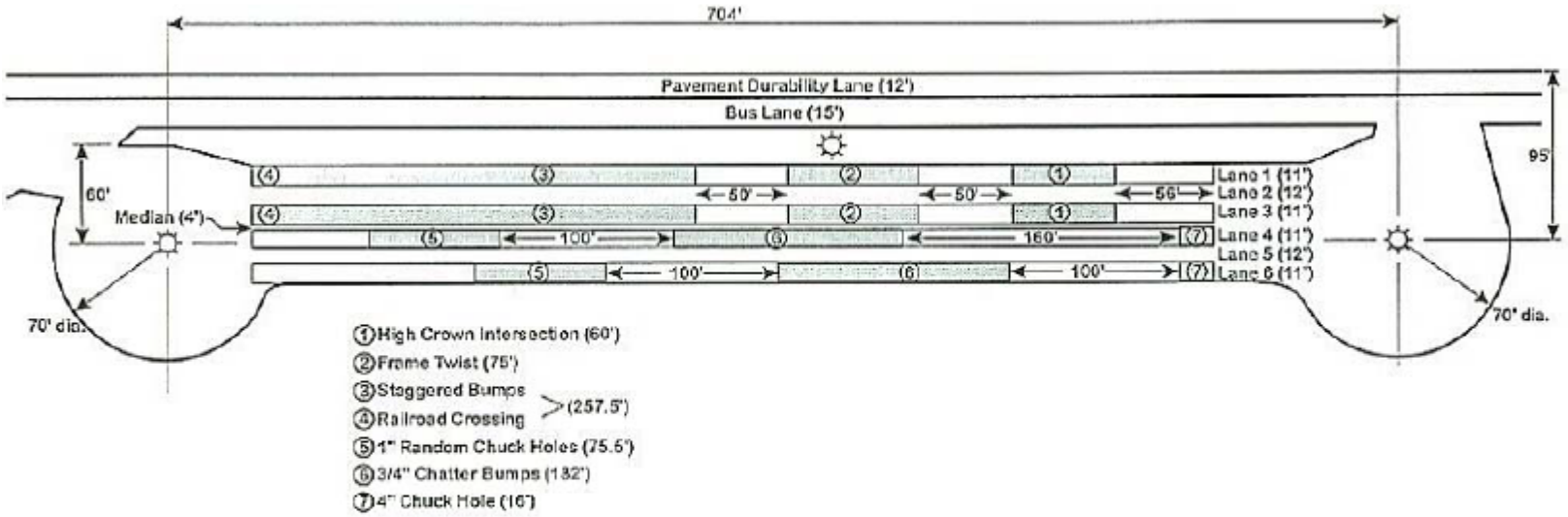
STANDARD OPERATING SCHEDULE

Monday through Friday

	HOUR	ACTION
Shift 1	midnight	D
	1:40 am	C
	1:50 am	B
	2:00 am	D
	3:35 am	C
	3:45 am	B
	4:05 am	D
	5:40 am	C
	5:50 am	B
	6:00 am	D
	7:40 am	C
	7:50 am	F
Shift 2	8:00 am	D
	9:40 am	C
	9:50 am	B
	10:00 am	D
	11:35 am	C
	11:45 am	B
	12:05 pm	D
	1:40 pm	C
	1:50 pm	B
	2:00 pm	D
	3:40 pm	C
	3:50 pm	F
Shift 3	4:00 pm	D
	5:40 pm	C
	5:50 pm	B
	6:00 pm	D
	7:40 pm	C
	7:50 pm	B
	8:05 pm	D
	9:40 pm	C
	9:50 pm	B
	10:00 pm	D
	11:40 pm	C
	11:50 pm	F

B—Break
C—Cycle all systems five times, visual inspection, driver's log entries
D—Drive bus as specified by procedure
F—Fuel bus, complete driver's log shift entries


Brake Slope
Large Impact Pendulum
Crash Safety Research Facility
Modified Durability Course
1-Mile Oval
Vehicle Handling Area
Vehicle Durability Course
Vehicle Research and Testing Lab
Fueling
Office Building
Bridge Research Facility
Entrance Road
Full-Scale Research Facilities at
the Pennsylvania Transportation Institute



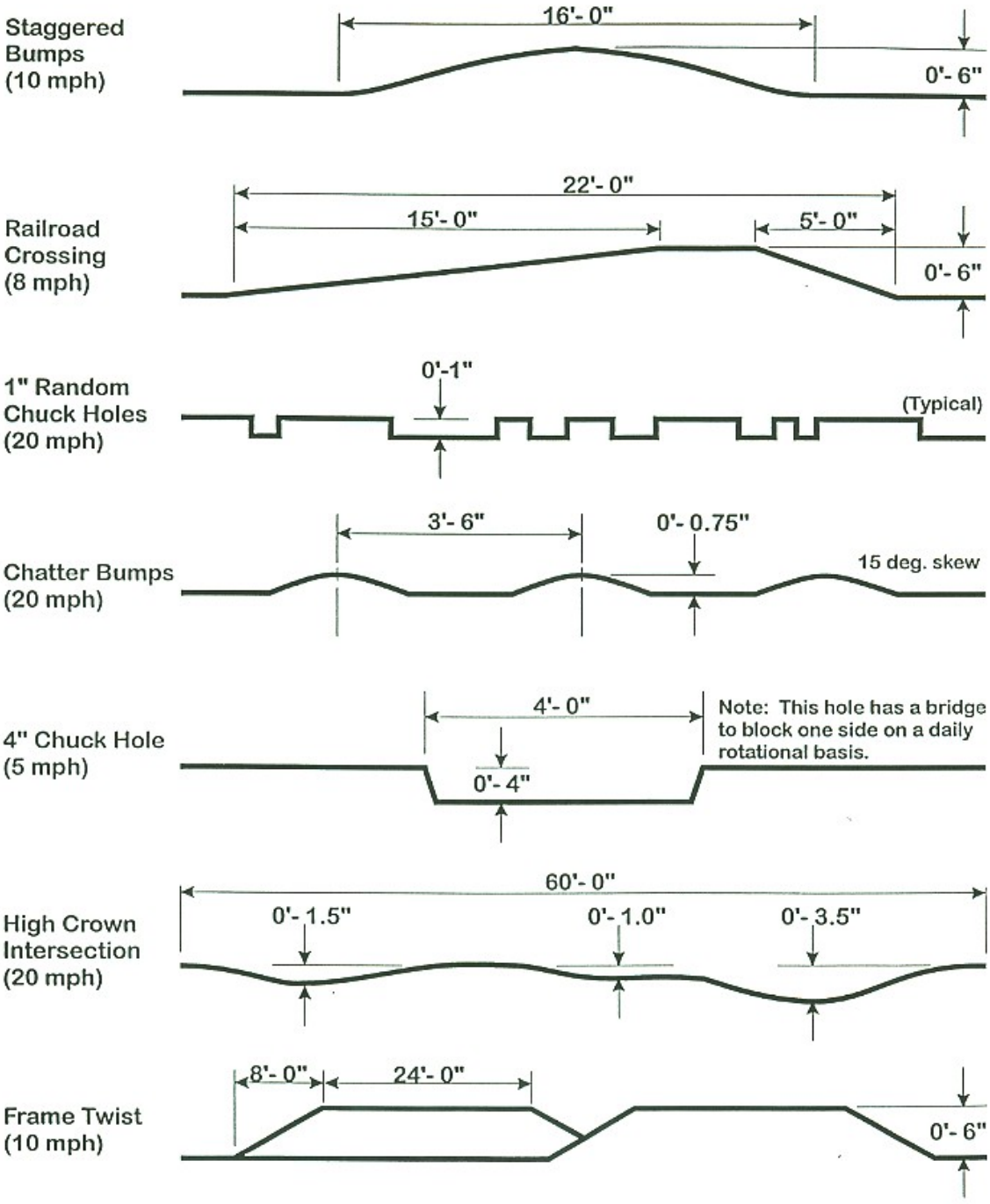
Plan View

Vehicle Durability Test Track

Track 1 (Track 2 has similar layout)

The Larson Transportation Institute

Penn State



Durability Element Profiles

The Pennsylvania Transportation Institute
Penn State

Unscheduled Maintenance
Gillig Bus# 2020-05
(Page 1 of 3)

Date	Test Miles	Issue	Action	Labor Hours	Sub-system	Class
08/26/20	1,034	Two bolts came loose on the ECM wiring connector latch.	Tightened latch bolts.	0.20	Hardware	3
08/28/20	1,416	Bus will not connect to charger.	Problem was identified as communication issue between bus and charger. Bus software was updated by Cummins.	1.00	Electrical	3
09/25/20 to 11/19/20	2,238 to 7,363	The rear cowling on the curb side right rear has broken the rivets on the inside of the cowling.	Threaded nutserts were installed in the roof for the cowling brackets. New ¼" bolts were installed and caulk was used to seal the area from weather.	1.00	Body	3
10/08/20	3,390	Bus would not start. EV wait to start light would not go out.	Cycled 24v batteries three times. Bus started.	0.20	Electrical	3
11/19/20	7,363	The front bump stops are damaged.	Damaged bump stops were removed and the new ones were installed by the bus manufacturer's representative.	1.00	Suspension	3
11/20/21	7,363	Bolts broken on power box and broken ground wire on air compressor (Bolts vibrated loose).	Replaced air compressor assembly and new ground wire.	2.00	Compressed Air	3
11/21/20 to 01/11/20	7,471 to 10,658	Bus would not build air pressure.	Had to cycle 24v batteries then bus built up air. This occurred on several different occasions. The air compressor unit was replaced and software was updated.	2.65	Compressed Air	3
12/04/20	7,748	Sheet metal/plating behind the Dynex power modules at the forward bulkhead compartment (above the driver's head) had become loose after 7 of the sheet metal screws had fallen.	Bus manufacturer's representative replaced the sheet metal screws with (7) ¼-20 screws and locknuts to secure plate.	0.10	Body	3

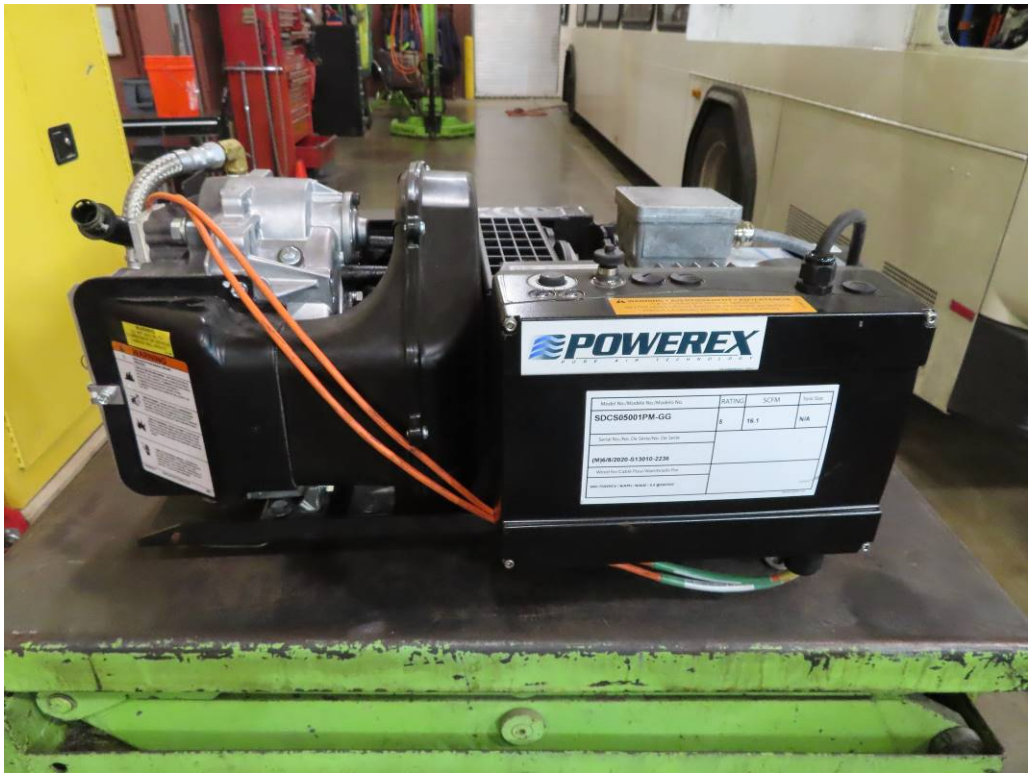
Unscheduled Maintenance
Gillig Bus# 2020-05
(Page 2 of 3)

Date	Test Miles	Issue	Action	Labor Hours	Sub-system	Class
01/06/21	10,206	Front curb side shock is leaking.	A new front, curb side shock was installed. New bolts at the bottom were installed including a new castle nut on the bottom bolt.	1.00	Suspension	4
01/22/21 to 02/23/21	11,690 to 12,522	Bus not building air pressure. On 02/04/21 the air compressor on the bus stopped working due to failure within the unit itself. It was making a very loud noise before it quit working.	The manufacturer's representative replaced the failed unit with a new one. A representative from Powerex replaced the power inverter on the compressor and validated function.	8.50	Suspension	2
01/28/21	12,354	Lower rear torque arm bushings are worn out.	Removed and replaced both lower torque arms for rear axle assembly. Installed anti-seize to bolts and torqued to manufacturer's specifications.	2.00	Suspension	3
01/29/21	12,443	A 3/8" x 3" brass pipe was broken on the supply side of the air compressor causing the bus to not build air pressure.	The broken pipe was removed and a new pipe was installed.	1.00	Compressed Air / Suspension	3
02/04/21	12,481	The brass nipple between the air compressor and check valve broke at the threads going into the valve.	The new brass nipple, p-clip and fabricated bracket were installed per manufacturer's instructions. The air line was attached making sure it was pointing down.	4.00	Compressed Air / Suspension	2
02/24/21	12,522	The bus will turn on, but the bus will not start and go into EV mode, after replacing the compressor on 02/23/2021.	The HV cable from the HV junction box to the inverter was bad. This was replaced and that resolved the problem.	1.00	Electrical	2
02/25/21 to 03/22/21	12,866 to 15,159	Bus is charging inconsistently and never charging to 100%. Check EV light is coming on. Sometimes the audible alarm is also coming on.	Battery pack # 3 had a bad cell in it. This battery pack was replaced on 03/16/21, but this did not resolve the issue. Cummins reprogrammed battery pack on 03/22/21 and the issue was resolved.	10.00	Electrical	3

Unscheduled Maintenance
Gillig Bus# 2020-05
(Page 3 of 3)

Date	Test Miles	Issue	Action	Labor Hours	Sub-system	Class
03/10/21	14,161	Air supply hose from the air compressor to the air cooler is leaking around one collar.	The damaged air hose was removed and replaced. The bus was started and no leaks were found.	0.50	HVAC	3

UNSCHEDULED MAINTENANCE

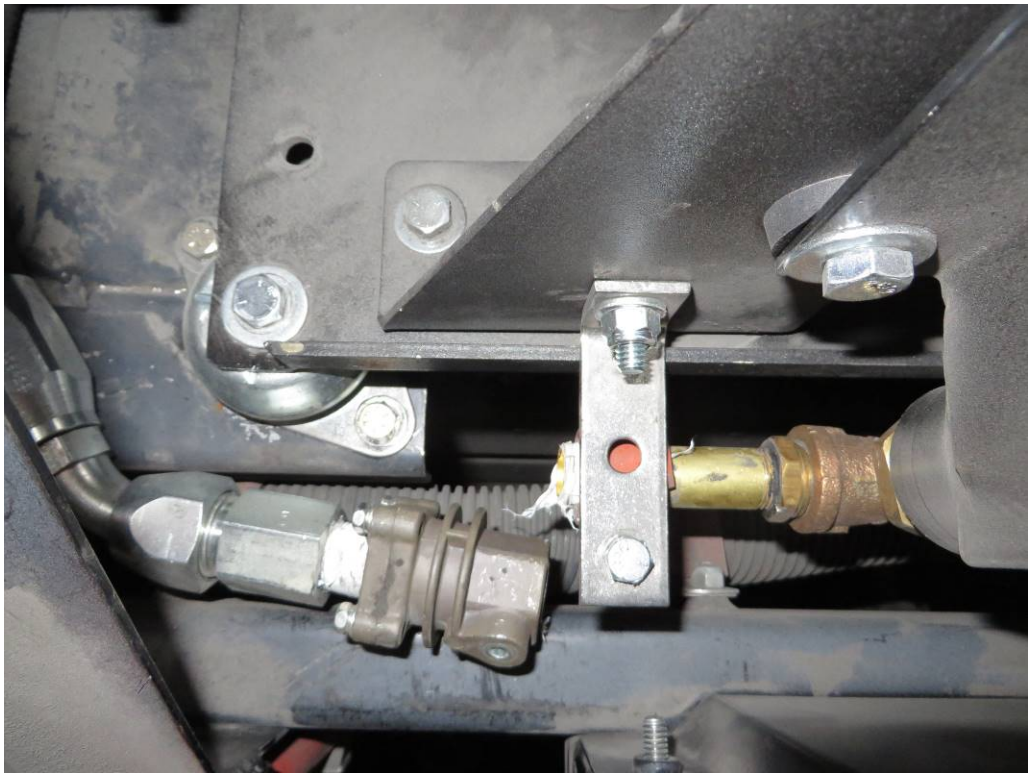


AIR COMPRESSOR REPLACEMENT
(7,748 TEST MILES)



LOWER REAR TORQUE ARM BUSHINGS ARE WORN OUT
(12,354 TEST MILES)

UNSCHEDULED MAINTENANCE CONT.



BRASS PIPE BROKEN ON SIDE OF AIR COMPRESSOR (12,443 TEST MILES)

6. ENERGY ECONOMY AND RANGE TEST – AN ENERGY CONSUMPTION AND RANGE TEST FOR BATTERY ELECTRIC BUSES USING APPROPRIATE OPERATING CYCLES

6-I. TEST OBJECTIVE

The objective of this test is to provide accurate comparable energy consumption data on battery electric transit buses produced by different manufacturers. This energy economy test bears no relation to the calculations done by the Environmental Protection Agency (EPA) to determine levels for the Corporate Average Fuel Economy Program. EPA's calculations are based on tests conducted under laboratory conditions intended to simulate city and highway driving. This energy economy test, as designated here, is a measurement of the energy consumed by a vehicle traveling a specified test operating profile, under specified operating conditions that are typical of transit bus operation. The results of this test will not represent actual energy usage but will provide data that can be used by FTA Grantees to compare buses tested using this procedure.

6-II. TEST DESCRIPTION

This test is performed in the emissions bay of the LTI Vehicle Testing Laboratory. The Laboratory is equipped with a Schenk Pegasus 300 HP, large-roll (72 inch diameter) chassis dynamometer suitable for heavy-vehicle emissions testing. The driving cycles are the Manhattan cycle, a low average speed, highly transient urban cycle (Figure 1), the Orange County Bus Cycle which consists of urban and highway driving segments (Figure 2), and the EPA HD-UDDS Cycle (Figure 3). This test is conducted at seated load weight.

This test is conducted generally as per the methods described in the SAE standard J 1634-2017. The light-duty test cycles specified in this standard are replaced by transit bus test cycles mentioned above.

The Single-Cycle test (SCT) procedure is adopted for this bus. The end of test is determined when the bus cannot keep up with the speed trace of the test cycle, as recommended by the bus manufacturer. The battery system is recharged to full SOC at the end of the test, following procedures specified in SAE J 1634-2017. During the recharge, the DC energy (into the battery system) and the AC energy (into the charger) are recorded. From these data, the average AC energy consumption, the charger efficiency (DC Energy, kWh/AC Energy, kWh) and range (miles) for each test cycle is calculated.

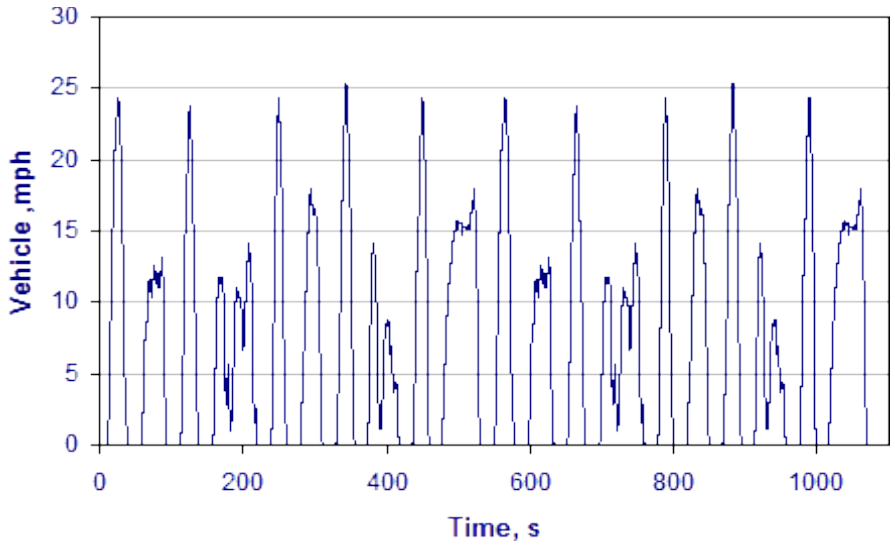


Figure 1. Manhattan Driving Cycle (duration 1089 sec, Maximum speed 25.4 mph, average speed 6.8 mph)

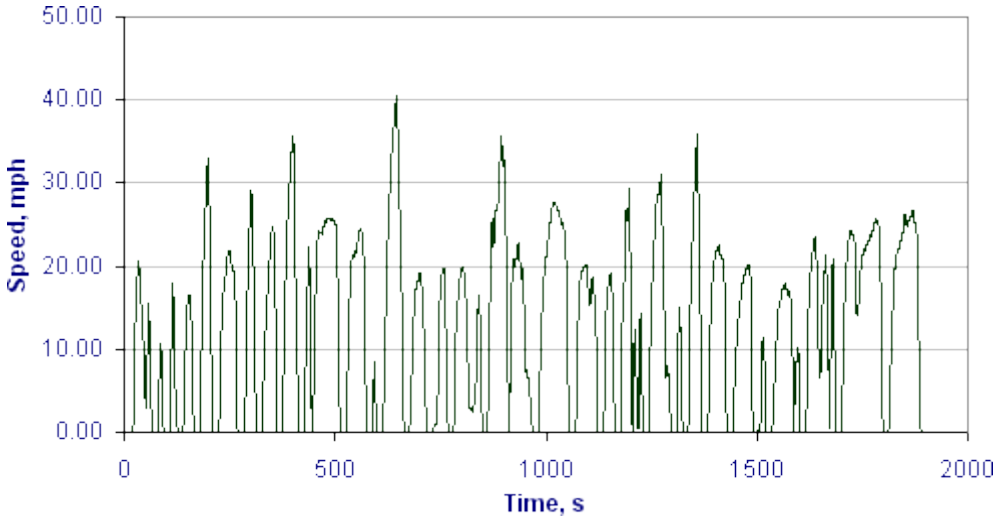


Figure 2. Orange County Bus Cycle (Duration 1909 Sec, Maximum Speed 41 mph, Average Speed 12 mph).

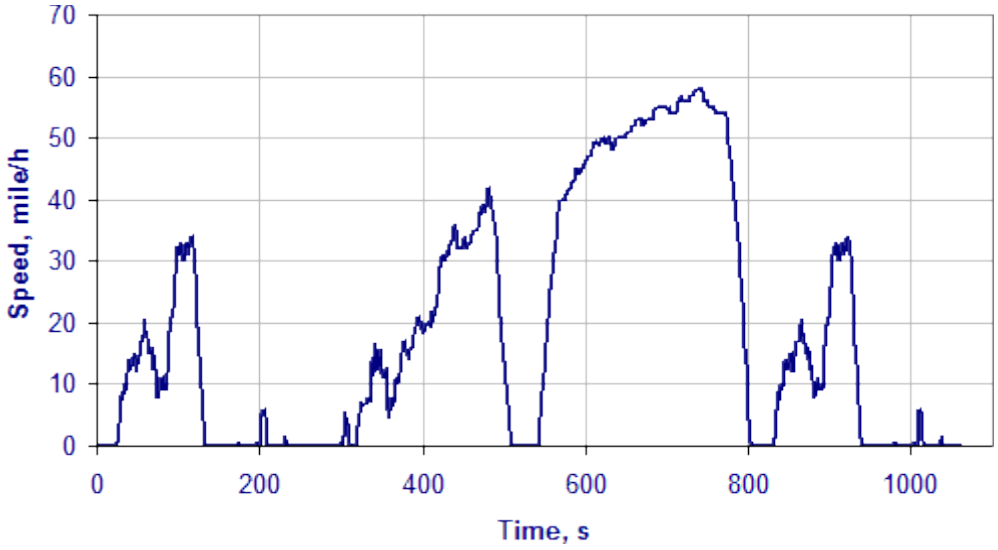


Figure 3. HD-UDDS Cycle (duration 1060 seconds, Maximum Speed 58 mph, Average Speed 18.86 mph).

6-III. DISCUSSION

The driving cycle consists of three simulated transit driving cycles: Manhattan, Orange County Bus Cycle and the HD-UDDS, as described in 6-II.

An extensive pretest maintenance check is conducted including the replacement of all lubrication fluids, if applicable. The details of the pretest maintenance are given in the first three Pretest Maintenance Forms. The fourth sheet shows the Pretest Inspection Form. Finally, the summary sheet provides the average energy consumption and range of bus for the three test cycles. The test was conducted at a seated load weight of 38,520 lbs. The average AC energy consumption for the Manhattan, OCBC and the HD-UDDS were 3,039 Wh/mile, 2,269 Wh/mile and 2,093 Wh/mile respectively. The range for the three driving cycles were 129 miles, 172 miles and 187 miles respectively.

This bus was tested using the Manhattan, Orange County and UDDS driving cycles. The energy economy and range results for buses tested using these cycles are not directly comparable to buses tested under the earlier protocol that uses the CBD, Arterial and Commuter driving cycles.

ENERGY ECONOMY PRE-TEST MAINTENANCE FORM

Bus Number: 2020-05	Date: 03/16/2021	SLW (lb.): 38,520
Personnel: T.S., E.L. & T.G.		

ENERGY SYSTEM	OK
Install fuel measurement system	✓
Remarks: None noted.	
BRAKES/TIRES	OK
Inspect hoses	✓
Inspect brakes	✓
Check tire inflation pressures (mfg. specs.)	✓
Check tire wear (less than 50%)	✓
Remarks: None noted.	
BATTERY COOLING SYSTEM	OK
Check hoses and connections	✓
Check system for coolant leaks	✓
Remarks: None noted.	

ENERGY ECONOMY PRE-TEST MAINTENANCE FORM

Bus Number: 2020-05	Date: 03/16/2021
Personnel: T.S., E.L. & T.G.	

ELECTRICAL SYSTEM	OK
Check battery	✓
Inspect wiring	✓
Inspect terminals	✓
Check lighting	✓
Remarks: None noted.	

DRIVE SYSTEM	OK
Drain transmission fluid	N/A
Replace filter/gasket	N/A
Check hoses and connections	N/A
Replace transmission fluid	N/A
Check for fluid leaks	N/A
Remarks: Drive motor	

LUBRICATION	OK
Lube all chassis grease fittings	✓
Lube universal joints	✓
Replace differential lube including axles	N/A
Remarks: Refer to manufacturer’s maintenance specifications for service.	

ENERGY ECONOMY PRE-TEST MAINTENANCE FORM

Bus Number: 2020-05	Date: 03/16/2021
Personnel: T.S., E.L. & T.G.	

OTHER ITEMS	OK
Replace air filter	N/A
Inspect air compressor and air system	✓
Inspect vacuum system, if applicable	N/A
Check and adjust all drive belts	N/A
Remarks: None noted.	
STEERING SYSTEM	OK
Check power steering hoses and connectors	✓
Service fluid level	✓
Check power steering operation	✓
Remarks: None noted.	
	OK
Ballast bus to seated load weight during Coast Down	✓
TEST DRIVE	OK
Check brake operation	✓
Check transmission operation	✓
Remarks: None noted.	

ENERGY ECONOMY PRE-TEST INSPECTION FORM

Bus Number: 2020-05	Date: 03/24/2021
Personnel: T.S. & F.T.	

PRE WARM-UP	If OK, Initial
Fuel Economy Pre-Test Maintenance Form is complete	T.S.
Cold tire pressure (psi): Front 130 Middle N/A Rear 130	T.S.
Energy economy instrumentation installed and working properly.	T.S.
WARM-UP	**If OK, Initial**
Interior and exterior lights on, evaporator fan on	F.T.
Air conditioner off	F.T.
Defroster off	F.T.
Windows and doors closed	F.T.
Do not drive with left foot on brake	F.T.

ENERGY ECONOMY DATA FORM
(Battery Electric Buses)

Bus Number: 2020-05	Manufacturer: Gillig	Date: 03/25/2021
Fuel Type: Electric	Personnel: F.T. & S.I.	
Temperature (°F): 75.2	Humidity (%): 55	Barometric Pressure (inHg): 28.8
SLW (lb.): 38,520	Charger: Charge Point Express 250	

	Manhattan	**Orange County**	**UDDS**
AC Energy (Wh/mile)	3039	2269	2093
Range (miles)	129	172	187

Comments: None noted.

6.0 ENERGY ECONOMY



BUS TESTED ON CHASSIS DYNAMOMETER FOR PERFORMANCE AND FUEL ECONOMY



CHARGE POINT CHARGER

7. NOISE

7.1 INTERIOR NOISE AND VIBRATION TESTS

7.1-I. TEST OBJECTIVE

The objective of these tests is to measure and record interior noise levels and check for audible vibration under various operating conditions.

7.1-II. TEST DESCRIPTION

During this series of tests, the interior noise level was measured at several locations with the bus operating under the following three conditions:

1. With the bus stationary, a white noise generating system provided a uniform sound pressure level equal to 80 dB(A) on the left, exterior side of the bus. The engine and all accessories were switched off and all openings including doors and windows were closed. This test was performed at the LTI Test Track Facility.

2. The bus was accelerated at full throttle from a standing start to 35 mph on a level pavement. All openings were closed and all accessories were operating during the test. This test was performed on the track at the LTI Test Track Facility.

3. The bus was operated at various speeds from 0 to 55 mph with and without the air conditioning and accessories on. Any audible vibration or rattles were noted. This test was performed on the test segment between the LTI Test Track and the Bus Testing Center.

All tests were performed in an area free from extraneous sound-making sources or reflecting surfaces. The ambient sound level as well as the surrounding weather conditions were recorded in the test data.

7.1-III. DISCUSSION

For the first part, the overall average of the six measurements was 49.4 dB(A); ranging from 48.0 dB(A) at the rear passenger seats to 50.7 dB(A) at the driver's seat. The interior ambient noise level for this test was less than 30 dB(A).

For the second part, the interior noise level ranged from 71.5 dB(A) at the middle passenger seats to 75.8 dB(A) at the driver's seat. The overall average was 73.1 dB(A). The interior ambient noise level for this test was less than 30 dB(A).

No vibrations or rattles were noted during the third part of this test. This bus passed this section of the test.

INTERIOR NOISE TEST DATA FORM
Test Condition 1: 80 dB(A) Stationary White Noise

Bus Number: 2020-05	Date: 12/15/2020
Personnel: S.R., E.D., E.L. & T.G..	
Temperature (°F): 34	Humidity (%): 44
Wind Speed (mph): 7	Wind Direction: NNW
Barometric Pressure (inHg): 30.29	
Interior Ambient Noise Level dB(A): less than 30	Exterior Ambient Noise Level dB(A): 41.3
Microphone Height During Testing (in): 45.5	

Reading Location	Measured Sound Level dB(A)
Driver's Seat	50.7
Front Passenger Seats	49.5
In Line with Front Speaker	49.1
In Line with Middle Speaker	49.9
In Line with Rear Speaker	49.4
Rear Passenger Seats	48.0

Comments: None noted.

INTERIOR NOISE TEST DATA FORM
Test Condition 2: 0 to 35 mph Acceleration Test

Bus Number: 2020-05	Date: 12/10/2020
Personnel: S.R., E.L. & T.G.	
Temperature (°F): 43	Humidity (%): 60
Wind Speed (mph): 3	Wind Direction: WNW
Barometric Pressure (inHg): 30.13	
Interior Ambient Noise Level dB(A): less than 30	Exterior Ambient Noise Level dB(A): 40.3
Microphone Height During Testing (in): 45.5	

Reading Location	Measured Sound Level dB(A)
Driver's Seat	75.8
Front Passenger Seats	73.0
Middle Passenger Seats	71.5
Rear Passenger Seats	72.1

Comments: None noted.

INTERIOR NOISE TEST DATA FORM
Test Condition 3: Audible Vibration Test

Bus Number: 2020-05	Date: 12/10/2020
Personnel: S.R. & E.L.	
Temperature (°F): 45	

Describe the following possible sources of noise and give the relative location on the bus.

Source of Noise	Location	Description of Noise
Engine and Accessories	N/A	N/A
Windows and Doors	Front/ Rear Entry	Road Noise
Seats and Wheelchair lifts	N/A	N/A
Other	N/A	N/A

Comment on any other vibration or noise source which may have occurred
that is not described above: None noted.
Comments: More than usual road noise at highway speed, 65 mph. inside the bus.

7.1 INTERIOR NOISE TEST



TEST BUS SET-UP FOR 80 dB(A)
INTERIOR NOISE TEST

7.2 EXTERIOR NOISE TESTS

7.2-I. TEST OBJECTIVE

The objective of this test is to record exterior noise levels when a bus is operated under various conditions.

7.2-II. TEST DESCRIPTION

In the exterior noise tests, the bus was operated at a SLW in three different conditions using a smooth, straight and level roadway:

1. Accelerating at full throttle from a constant speed starting from 35 mph.

2. Accelerating at full throttle from standstill.

3. Stationary, with the engine at low idle, high idle, and wide-open throttle, where applicable. In addition, the bus was tested with and without the air conditioning operating.

The test site is at the Larson Transportation Institute Test Track and the test procedures were performed in accordance with SAE Standards SAE J366b, Exterior Sound Level for Heavy Trucks and Buses. The test site is an open space free of large reflecting surfaces. A noise meter placed at a specified location outside the bus was used to measure the noise level.

During the test, special attention was paid to:

1. The test site characteristics regarding parked vehicles, signboards, buildings, or other sound-reflecting surfaces
2. Proper usage of all test equipment including set-up and calibration
3. The ambient sound level

7.2-III. DISCUSSION

The Exterior Noise Test determines the noise level generated by the vehicle under different driving conditions and at stationary low and high idle, with and without air conditioning and accessories operating. The test site is a large, level, bituminous paved area with no reflecting surfaces nearby.

With an outside ambient noise level of 38.0 dB(A), the average of the two highest readings obtained while accelerating from a constant speed was 65.8 dB(A) on the right side and 65.8 dB(A) on the left side.

When accelerating from a standstill with an exterior ambient noise level of 42.1 dB(A), the average of the two highest readings obtained were 62.5 dB(A) on the right side and 62.3 dB(A) on the left side.

With the vehicle stationary and the engine, accessories, and air conditioning on, the measurements averaged 41.7 dB(A) at low idle. With the accessories and air conditioning off, the readings averaged 40.9 dB(A) at low idle. The exterior ambient noise level measured during this test was 41.4 dB(A). This bus passed this section of the test.

EXTERIOR NOISE TEST DATA FORM
Accelerating from Constant Speed

Bus Number: 2020-05	Date: 12/10/2020
Personnel: S.R., E.L. & T.G.	
Temperature (°F): 40	Humidity (%): 61
Wind Speed (mph): 5	Wind Direction: WNW
Barometric Pressure (inHg): 30.15	

Verify that microphone height is 4 feet, wind speed is less than 12 mph and ambient temperature is between 30°F and 90°F: ■

Initial Sound Level Meter Calibration: 94.0 dB(A)

Exterior Ambient Noise Level: 38.0 dB(A)

Accelerating from Constant Speed Curb (Right) Side		Accelerating from Constant Speed Street (Left) Side	
Run #	Measured Noise Level dB(A)	Run #	Measured Noise Level dB(A)
1	65.7	1	64.8
2	62.1	2	65.7
3	62.9	3	65.8
4	65.8	4	N/A
5	65.6	5	N/A
6	N/A	6	N/A
7	N/A	7	N/A
8	N/A	8	N/A
9	N/A	9	N/A
10	N/A	10	N/A
Average of two highest actual noise levels = 65.8 dB(A)		Average of two highest actual noise levels = 65.8 dB(A)	

Final Sound Level Meter Calibration Check: 94.0 dB(A)

Comments: None noted.

EXTERIOR NOISE TEST DATA FORM
Accelerating from Standstill

Bus Number: 2020-05	Date: 12/10/2020
Personnel: S.R., E.L. & T.G.	
Temperature (°F): 40	Humidity (%): 62
Wind Speed (mph): 6	Wind Direction: W
Barometric Pressure (inHg): 30.15	
Verify that microphone height is 4 feet, wind speed is less than 12 mph and ambient temperature is between 30°F and 90°F: ■	
Initial Sound Level Meter Calibration: 94.0 dB(A)	
Exterior Ambient Noise Level: 42.1dB(A)	

Accelerating from Standstill Curb (Right) Side		Accelerating from Standstill Street (Left) Side	
Run #	Measured Noise Level dB(A)	Run #	Measured Noise Level dB(A)
1	62.9	1	61.9
2	62.1	2	62.7
3	N/A	3	N/A
4	N/A	4	N/A
5	N/A	5	N/A
6	N/A	6	N/A
7	N/A	7	N/A
8	N/A	8	N/A
9	N/A	9	N/A
10	N/A	10	N/A
Average of two highest actual noise levels = 62.5 dB(A)		Average of two highest actual noise levels = 62.3 dB(A)	

Final Sound Level Meter Calibration Check: 94.0 dB(A)
Comments: None noted.

EXTERIOR NOISE TEST DATA FORM
Stationary

Bus Number: 2020-05	Date: 12/10/2020
Personnel: S.R., E.L. & T.G.	
Temperature (°F): 41	Humidity (%): 62
Wind Speed (mph): 8	Wind Direction: W
Barometric Pressure (inHg): 30.15	
Initial Sound Level Meter Calibration: 94.0 dB(A)	
Exterior Ambient Noise Level: 41.4 dB(A)	

Air Conditioning ON

Throttle Position	Engine RPM	Curb (Right) Side dB(A)	Street (Left) Side dB(A)
		Measured	Measured
Low Idle	N/A	42.3	41.1
High Idle	N/A	N/A	N/A
Wide Open Throttle	N/A	N/A	N/A

Air Conditioning OFF

Throttle Position	Engine RPM	Curb (Right) Side dB(A)	Street (Left) Side dB(A)
		Measured	Measured
Low Idle	N/A	41.1	40.7
High Idle	N/A	N/A	N/A
Wide Open Throttle	N/A	N/A	N/A

Final Sound Level Meter Calibration Check: 94.0 dB(A)

Comments: No high-idle or wide-open throttle available on this test vehicle.

Fully battery/electric powered.

7.2 EXTERIOR NOISE TESTS

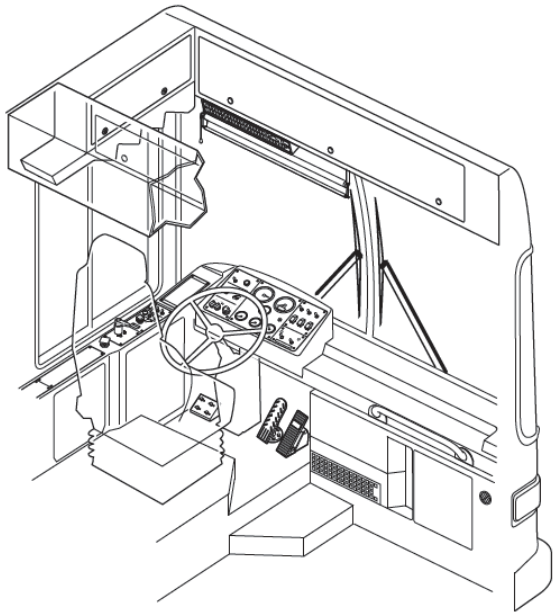


TEST BUS UNDERGOING EXTERIOR NOISE TESTING

OPERATORS AREA INSTRUMENTATION

The GILLIG Low Floor bus uses forward-looking technology combined with some unique ideas to avoid the inherent compromises found in most other low floor designs. Our concern for low cost, easy maintenance keeps the exterior and interior simple and uncluttered. This has led to an overall design that is pleasing, functional, practical, and safe.

Ergonomics dictate the design of the driver's workstation. Our design group went well beyond providing only sufficient seat adjustments and a tilt/telescoping steering column. Additional features include the functional placement of displays and controls, a driver's storage box, sun visors, etc. to fit within a driver's comfortable range of motion.

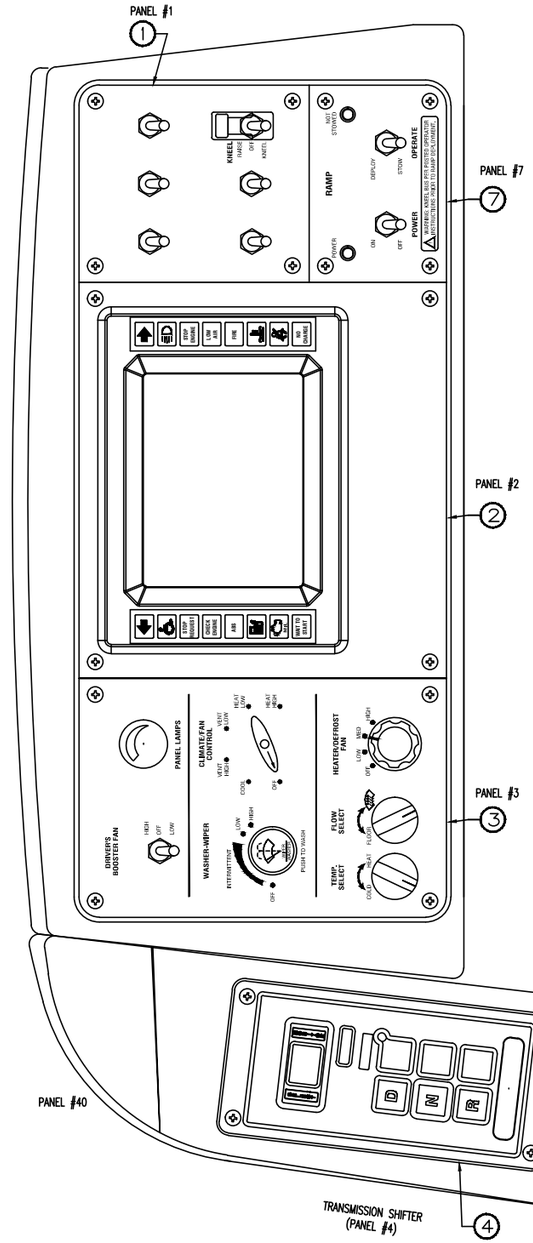


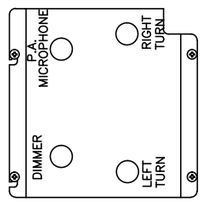
The driver's position has been designed to provide maximum comfort to drivers from the 95th percentile male to the 5th percentile female. To maximize the driver's comfort, additional ventilation is provided to the driver by a booster fan that delivers air through two overhead ventilators. Additional fresh air can be allowed into the bus through the full slider type driver's window.

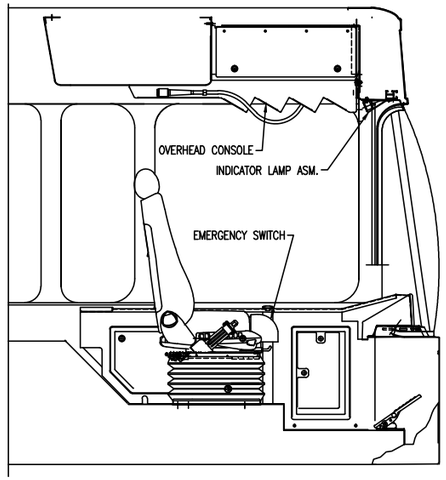
Visibility, comfort, and vehicle control are other key factors of our design. GILLIG's Low Floor design incorporates a bulged, tilted back windshield to reduce interior glare and reflection. Customer feedback indicates that drivers prefer driving our buses because the bus provides better visibility, a smoother ride, and better handling. These factors leave the driver feeling more in control and more confident. We also provide the necessary space and comfort features, including superior heating and cooling that gives the driver an efficient, safe, and comfortable environment to work in.

The attached dash layout is a typical dash layout for your review. This is intended to show basic layout configuration only and not specific details. GILLIG will provide a custom layout for the Agency's review during the preproduction meeting.

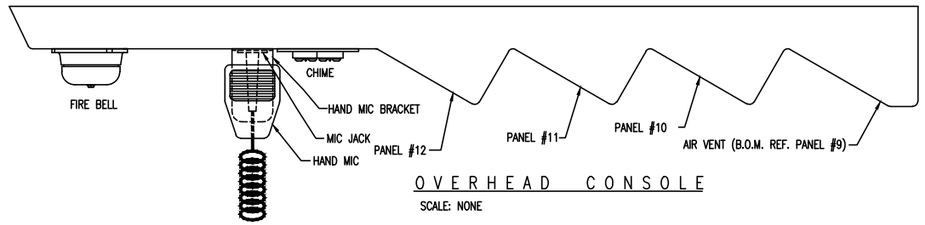
INDICATOR LIGHT BAR NOT REQUIRED WITH MFD



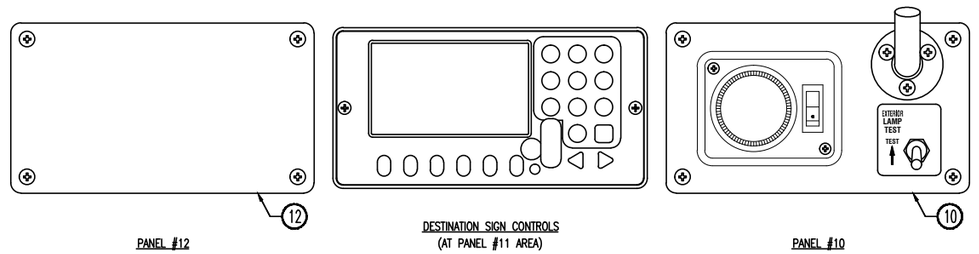




DRIVER'S AREA
SCALE: NONE

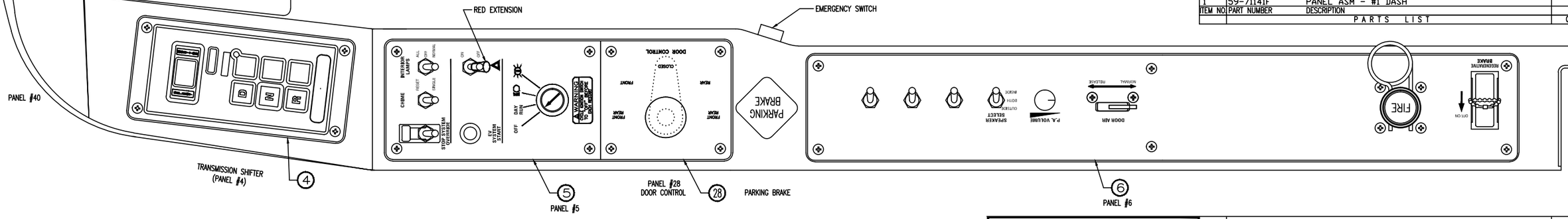


OVERHEAD CONSOLE
SCALE: NONE



PANEL #12 — DESTINATION SIGN CONTROLS (AT PANEL #11 AREA) — PANEL #10

OVERHEAD CONSOLE PANELS
SCALE: NONE



NOTES:
1.PANELS #3 AND #5 HAVE INCANDESCENT BACKLIGHTING PER FMVSS 101.
2. SOME FEATURES ARE FOR GRAPHIC PURPOSES ONLY AND DO NOT REFLECT ACTUAL CUSTOMER REQUIREMENTS. REFERENCE BILL OF MATERIAL FOR ORDER CLARIFICATION

REVISIONS					
SYM	DWN	ZONE	DESCRIPTION	REL.	DATE
A			CUSTOMER APPROVAL & PRODUCTION RELEASE	REI	
A	KRM		CREATE FORM DRAWING	141023	10/11/19

ITEMS 1, 2, 3, 5 & 6 ARE PART OF THE DASH LAYOUT BILL OF MATERIALS (DL-#####-000).
ALL OTHER ITEMS ARE SHOWN FOR REFERENCE ONLY.

ITEM NO	PART NUMBER	DESCRIPTION	QTY
54			
53			
52			
51			
50			
45			
44			
43			
42			
41			
40			
33			
32			
31			
30			
29			
28	20-53886N000	DOOR CONTROL, VAPOR, ANALOG	REF
27			
26			
25			
24			
23			
22			
21			
15			
14			
13			
12	30-37207F003	PANEL - OVERHEAD CONSOLE	1
11			
10	30-37207F052	PANEL - OVERHEAD CONSOLE	1
7	59-71147F	PANEL ASM - #7 DASH	REF
6	59-71146F	PANEL ASM - #6 DASH	1
5	59-71145F	PANEL ASM - #5 DASH	1
4	30-39344F000	PANEL - SHIFTER MOUNTING	REF
3	59-71143F	PANEL ASM - #3 DASH	1
2	30-60541F	PANEL - #2 DASH	1
1	59-71141F	PANEL ASM - #1 DASH	1
12	59-71150F	PANEL ASM - SAWTOOTH	1
11	59-71150F	PANEL ASM - SAWTOOTH	1
10	59-71150F	PANEL ASM - SAWTOOTH	1
7	N/A	DECAL ASM - #7 DASH (4:1 RAMP CONTROL)	1
2	59-71142F	PANEL ASM - #2 DASH	1

PARTS LIST

SIGNATURE ON THIS DRAWING INDICATES CUSTOMERS APPROVAL OF LAYOUT AND AGREEMENT THAT SAME IS IN COMPLIANCE WITH CUSTOMER'S SPECIFICATIONS. ONCE SIGNED THIS DRAWING BECOMES A PART OF

CONTRACT #_____

PURCHASE ORDER #:_____

SIGNED BY:_____
ACTING ON BEHALF OF AND WITH THE AUTHORITY OF

_____

GILLIG LLC
LIVERMORE, CA

MARK PART W/PN PER GIL DB #370.002
LH SHOWN, RH OPPOSITE — NONE

PROPRIETARY
THIS DRAWING AND THE INFORMATION CONTAINED THEREON SUBMITTED CONFIDENTIALLY AND IS THE PROPERTY OF GILLIG LLC. USE, REPRODUCTION, OR DISCLOSURE OF THE CONTENT OF THIS DRAWING OR ANY PORTION THEREOF FOR ANY PURPOSE MUST BE APPROVED IN WRITING BY GILLIG LLC.

REMOVE ALL BURRS, BREAK SHARP EDGES

DIMENSIONING AND TOLERANCING ARE PER ANSI Y14.5M-1982
UNLESS OTHERWISE SPECIFIED TOLERANCES ARE IN INCHES

DECIMALS .X ± .06 .XX ± .03 .XXX ± .010
ANGULAR ± .5°
THIRD ANGLE
1ST SIZ:

TITLE: INSTL - DASH/CONSOLE SWITCHES SSLF BATTERY ELECTRIC FORM

DWN: KRM	DATE: 10/11/19	MATER'L SPEC:	
CHK'R'S INIT:	DATE:	M'F'G STD:	
APPR'S INIT:	DATE:	FMVSS COMPL:	FMVSS 101
ORIG REL #: REI 141023	SIZE: D	DOCUMENT NO.	DL-81538-000
CAD SCALE: 2 = 1			

RECARO Ergo M

Standard Adjustment Features





1 Dual Recliner Gears
Dual recline gears make adjusting the seat-back smooth and easy.



2 4 Way Adjustable Headrest
Manually adjustable headrest moves up, down, forward and backward providing optimum comfort and safety.



3 Thigh Extension & Tilt
Seat cushion extends and tilts upward and downward, allowing for fit from a 5th percentile female up to a 95 percentile male.



4 11" Fore / Aft Seat Travel
Manual or Air Track Release for seat travel adjustment.



5 Dual Shock / Adjustable
Pneumatic suspension with 6" suspension travel. Allows operator to adjust the suspension to individual comfort needs.



6 Pneumatic Adjustable Lumbar
3 separate chambers fill with air independently allowing for individually optimized lumbar support.

Standard Quality and Durability Features



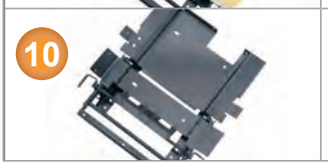
7 Solid Steel Back
High quality solid steel back for the best in strength and durability.



8 Plastic Seat-Back Protector
Plastic seat-back keeps the seat looking good for years.



9 High Density Foam
Quality high density foam keeps its shape over time and provides superior comfort and firm support.



10 Fully Supported Seat Cushion
The seat pan fully supports the seat cushion for long lasting durability comfort.

- 2 Point ALR or 3 Point ELR Seat Belt (Black or Orange Webbing)
- Full Travel Seat Belt System
- Left or Right Hand Air Controls
- Track Stop
- 12 or 25 Degree Recline Stop
- Seat Belt Alarm
- Mounting Risers (varying heights & mounting configurations)
- Two Year Warranty
- Various fabrics and vinyl seat covers
- 400 lb + Seat Capacity

RECARO Ergo M

Optional Features



- LiquiCell®
- RECARO Silicone Foam
- Adjustable Seat Belt D Ring
- FR Treated Foam for Low Smoke / Low Flame
- Seat Heat (Backrest & Seat Cushion)
- Seat Cushion Alarm Switch
- Adjustable Armrests
- RH Remote Shock
- Stainless Steel Risers
- Various treated fabrics and specialty covers available

Quality & Expertise





RECARO is the global leader in mobile seating. World renowned for our ergonomics, innovative safety technology and quality.

Our seats are built in the U.S.A. to our customers specifications. Quality ends with quality manufacturing.

Our dedicated engineering team supports our customers from the design phase through production.

Customer Service, located in Auburn Hills, Michigan supports our customers throughout the products lifecycle.

Assembled in the U.S.A.



Meets "Buy America" Guidelines



Contact Us:
(248) 364-3818
www.recaro-automotive.com


INSIGHT®
AMERICAN SEATING

Your **INSIGHT**® drives our innovation

The **INSIGHT** product offering combines lightweight design with superior strength, durability and comfort.



INSIGHT®
Cushion Onserts



INSIGHT-PRIME+®
Color Inserts



INSIGHT-PRIME®
Textured Module



INSIGHT-PRIME+

Color-coordinating inserts available in seven standard colors. No back panel required.



INSIGHT-PRIME

Seat module specifically engineered for cleanability.

INSIGHT's Construction

A large, sophisticated injection mold is able to produce a sleek, one-piece seat module made of a super-dense, composite resin with an integral grab handle. Each seat module hooks over the back side of the upper extrusion and is securely held in place by two front bolts. On two-pass transverse seats, one bolt secures the front V-filler to the back side of the upper extrusion. This five-bolt assembly simplifies any retrofit opportunities or rare cases of maintenance needs.

INSIGHT-PRIME and **INSIGHT-PRIME+** model types are built with a one-piece seat module, while **INSIGHT** adds a single back insert with a seat and a back cushion onserts that accept permanently bonded foam and/or upholstery. The back panel insert is held in place by six fasteners hidden by the cushion onserts. These onserts are secured to the perimeter of the seat with a quick-release system of hardware technology that does not require tools to efficiently remove and replace when required.



Options


Cushion Onserts


Back Extension


Textured Seat Module


Color Inserts


Grab Rail Cover


Without Grab Rail


Plastic Back Panel


Stainless-Steel Back Panel

	INSIGHT	PRIME	PRIME+
Cushion Onserts	•		
Back Extension	•		
Color-Coordinating Inserts			•
Drain Hole (Excludes Plush Pad)	•	•	•
Grab Rail	•	•	•
Grab Rail Cover	•	•	•
Without Grab Rail	•	•	•
Back Panel (18" only)	•		
Docket 90A	•	•	◉

(Standard Materials FMVSS 302 Compliant)

◉ *Prime+ Module: Docket 90A, Prime+ Inserts: Small components are exempt*

Cushion Onsert Selection

Standard 1/2" padded cushion with optional drain hole
Plush padded cushion (1-1/4" seat, 1/2" back)
VR-50® Vandal-resistant cushion with optional drain hole
CR-50® Cut-resistant cushion; available on standard and plush padded
Docket 90A foam and fabric available

Features

Contemporary Styling

Individual sculpted seat module with integral grab rail and back panel in complementary colors, with no unsightly welds or exposed fasteners.

Modular Design

Replacement of a single seat or major component if necessary is quicker and more economical. The one-piece molded seat module with minimal parts is unmatched in the industry.

Superior Comfort

Ergonomic seat design features the largest personal seating area, increased spaciousness in legroom and back height, and padded seat and back cushions for enhanced comfort.

Superior Vandal and Corrosion Resistance

Seat module constructed of advanced technology composite resin that is colored throughout and corrosion resistant materials. Mounting design incorporates anodized aluminum.

Module Color Selection

1471 Charcoal | 980 Grey | 989 Blue

Back Panel Selection

Thermoplastic

1471C Charcoal | 980C Grey | 989C Blue | Textured Stainless Steel

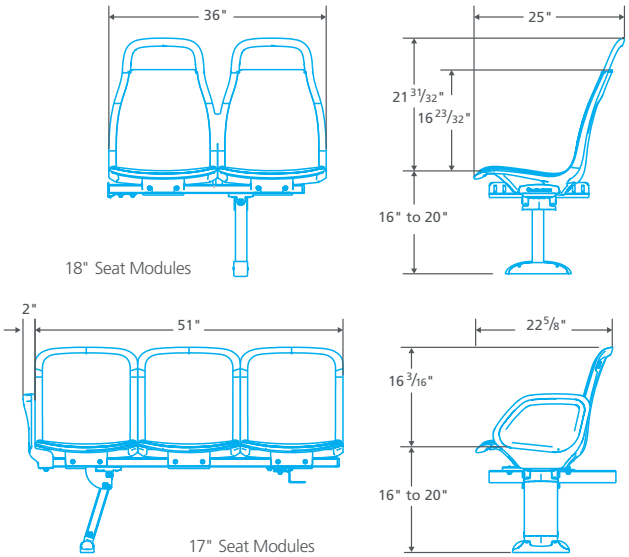
Insert Color Selection

Custom colors also available, minimum order quantities and additional costs may apply

2283 Red | 2169 Dark Cool Grey | 321C Teal | 533C Navy | 368C Go

980 Grey | 989 Blue

Dimensions



Model Types

- Transverse
- Transverse Flip-up
- Individual (Seat) Transverse Flip-up
- Longitudinal (17" & 18")
- Longitudinal Flip-up (17" & 18")
- Back-to-back
- Rear Cross

Detailed reference document available for each model type.

Our Mission

Since 1886, American Seating has set the standard for product design, durability and comfort. Our first transportation seat was introduced in 1931, and today we remain committed to exceeding the expectations of our customers. Our achievements serve as the platform for new and innovative products that are the benchmarks of our industry.

InSight is an iF Product Design award winner

All products designed, engineered, manufactured, and tested in the USA.

American Seating is committed to lessening our impact on the planet through responsible stewardship of our environment.

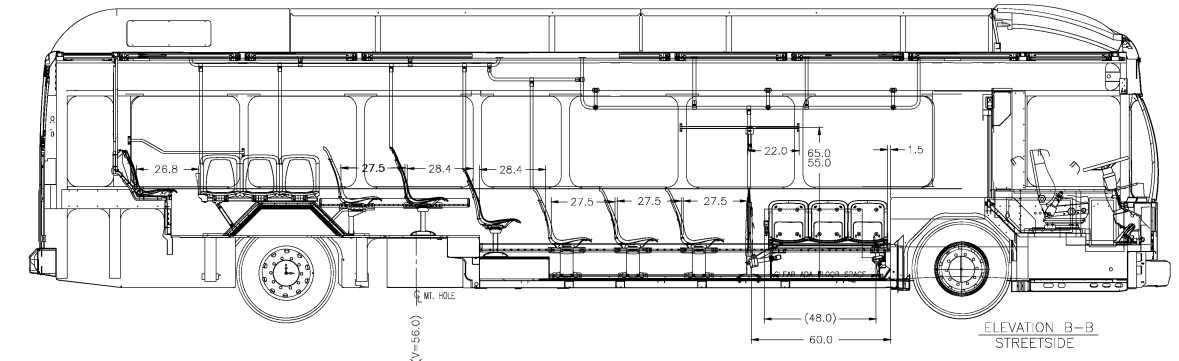
AMERICAN SEATING

801 Broadway Avenue NW, Grand Rapids, MI 49504-4499
Phone 616-732-6600 800-748-0268 FAX 616-732-6401
americanseating.com

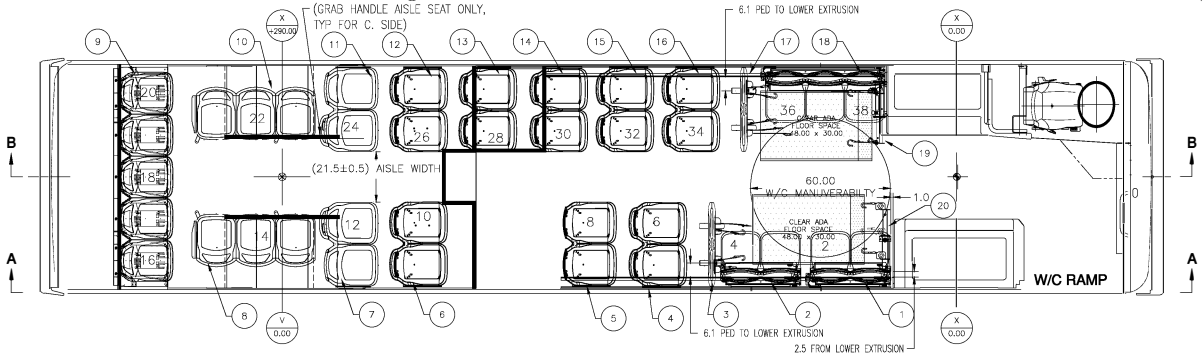
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Form No. T-INSIGHT-20 ©2020 American Seating Company

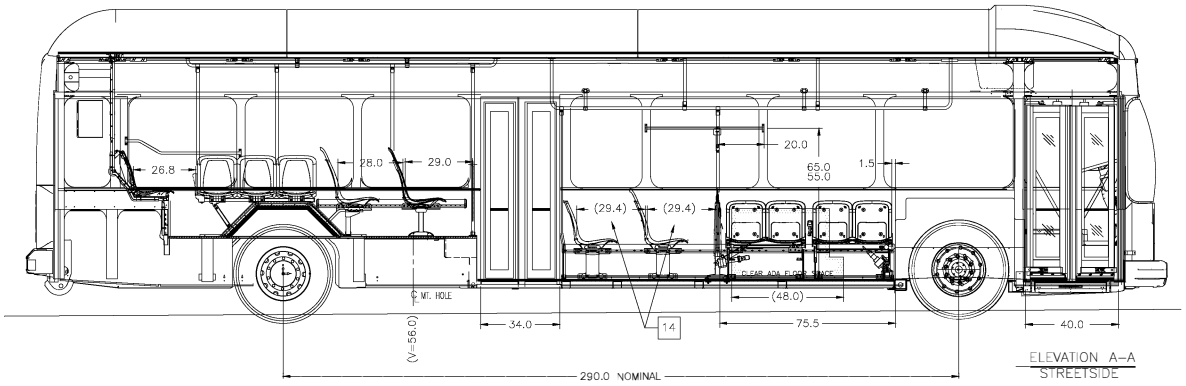
GILLIG PARTS	QTY	GILLIG PARTS	QTY
STANCHION, REAR LONGITUDINAL	4	STRAPS, O/H GRAB	—
STANCHION, TRVS. @ 3RD STEP	2	PANEL, MODESTY, 3RD STEP, C. SIDE	1
STANCHION, TRVS. @ 2ND STEP	1	STANCHION, 1.0 SINGLE OFFSET FWD RD	1
STANCHION, TRVS. @ 1ST STEP	1	BAR, WINDOW, 46.0	2
STANCHION, W/C BARRIER	2		

REVISIONS					
SYM	DWN	ZONE	DESCRIPTION	REL.	DATE
A	APP		RELEASED FOR PRODUCTION	156042	07/08/21



ELEVATION B–B
STREETSIDE





ELEVATION A–A
STREETSIDE

NOTES:

1. ***TO MAXIMIZE OCCUPANT CRASH PROTECTION AND REDUCE THE POTENTIAL FOR SIGNIFICANT INJURY TO PASSENGERS SEATED IN THE FIRST FORWARD FACING SEATS IMMEDIATELY REARWARD OF THE ADA AREA, GILLIG REQUIRES EITHER: 1.1 THE PLACEMENT OF A BARRIER FORWARD OF THESE SEATS. 1.2 USE OF A GRAB/STANCHION POLE FOR THE AISLE SEAT AND WALL MOUNTED GRAB HANDLE FOR THE OUTBOARD SEAT OR 1.3 SEAT BELTS ON BOTH THESE SEATS.***
2. ALL DIMENSIONS ARE IN INCHES.
3. FLOORING LAYOUT: FL–80124R017 (FULL COMPOSITE).
4. THIS DRAWING IS TO BE USED FOR SEAT INSTALLATION. ALL OTHER GRAPHICS ARE SHOWN FOR REFERENCE ONLY. SEE BOM/ PAINT LAYOUT FOR EXTERIOR GRAPHICS AND GLAZING. FOR APPLICABLE O/H RAILS, TRANSMISSION HATCH AND STANCHIONS, RACKS AND HANDLES ON WHEEL WELL SEE BOM/MEETING NOTES.

SEAT AND RESTRAINT NOTES:

10. SEATS & RESTRAINT BELTS MUST MEET FMVSS 209 & 302 STANDARDS.
11. ALL SEATS WITH T–PEDESTALS SHALL HAVE AN OPEN CHANNEL DESIGN. ALL SEATS WITH DIMENSION E=6.12 SHALL HAVE 3.0 LONG MOUNTING SLOTS.
12. W/C BELTS AND RETRACTORS: SEE SPEC SHEET, ALSO AFFECTS REMOTE BELT RELEASE TYPE IF REQUIRED
    A. Q' STRAINT = Q' STRAINT PULL HANDLE LEVER
    B. SURE–LOK = SURE–LOK DUAL AUTO LOK (NOT AVAILABLE FOR OPTION P).
13. FOR EACH W/C LOCATIONS WITH FLOOR ANCHORAGE DISTANCES GREATER THAN 60 INCHESSHALL INCLUDE (2) Q'STRAINT WEBBING LOOPS.TOTAL QTY SHIPPED LOOSE: 2 (REQUIRED FOR CURB SIDE ADA AREA)
14. HIP TO KNEE DIMENSIONS SHOWN ARE NOMINAL. SEATS WILL BE EQUALLY SPACED.
15. REF: FOR SEAT SPECIFICATION OPTIONS AND OTHER SEAT DETAILS NOT SHOWN, SEE PURCHASING ORDER SPECIFICATION SHEET.
16. FOR ADA AISLE FACING FLIP–UP SEATS: SEE SPEC SHEET, OPTIONS ARE AS BELOW.
    A: INSIGHT = W/NARROW OR W/O NARROW
    B: INSIGHT PRIME AND PRIME+ = ALWAYS NARROW

ITEM NUMBER	VENDOR PART NUMBER	(#) PASSENGER SEAT SIZE	(P) PEDESTAL (C) CANTILVER	(G) GRAB HANDLE	(F) FLAT BACK PANEL	(QTY) STANCHION CUP	NOTES AND COMMENTS
20		—	—	—	—	—	OPTION H, RH
19		—	—	—	—	—	OPTION H, LH, WHEELWELL MOUNTED
18		3	C	—	—	—	W/C FLIP–UP, AFT ARMREST, STOP REQ.
17		—	P	G	—	1	W/C BARRIER, (2) PED, P1=10.00, P2=16.00, E=8.0, SEE NOTE 12
16		2	C	G	—	—	
15		2	C	G	—	—	
14		2	C	G	—	1	
13		2	P	G	—	1	(2) PED, P1=9.42, P2=16.55, E=6.12
12		2	P	G	—	1	(1) PED, Po = 26.25, E=6.12
11		2	P	G	—	—	FLOOR AND W–WELL MTD, GRAB HANDLE ON AISLE SEAT ONLY
10		3	P	—	—	2	AFT ARMREST, E=6.12
9		5	—	—	—	—	SETTEE, (3) CENTER SEATS REMOVABLE
8		3	P	—	—	2	AFT ARMREST, E=6.12
7		2	P	G	—	—	FLOOR AND W–WELL MTD, GRAB HANDLE ON AISLE SEAT ONLY
6		2	P	G	—	1	(1) PED, Po = 26.25, E=6.12
5		2	C	—	—	—	
4		2	C	G	—	—	
3		—	P	G	—	1	W/C BARRIER, (2) PED, P1=10.00, P2=16.00, E=8.0, SEE NOTE 12
2		2	C	—	—	—	W/C FLIP–UP, STOP REQ. @ SEAT POSITION 3
1		2	C	—	—	—	W/C FLIP–UP, AFT ARMREST, STOP REQ. @ SEAT POSITION 2

38 PASSENGERS

PASSENGER SEAT SUPPLIER:
AMERICAN SEATING CO.
PASSENGER SEAT MODELS:
INSIGHT 18.0 WIDE FWD FACING
INSIGHT 17.0 WIDE AISLE FACING

FIRST CHASSIS
SEE PRODUCTION BOM

SIGNATURE ON THIS DRAWING INDICATES CUSTOMERS APPROVAL OF LAYOUT AND AGREEMENT THAT SAME IS IN COMPLIANCE WITH CUSTOMER'S SPECIFICATIONS. ONCE SIGNED THIS DRAWING BECOMES A PART OF

CONTRACT #_____

PURCHASE ORDER #:_____

SIGNED BY:_____
ACTING ON BEHALF OF AND WITH THE AUTHORITY OF

STANDARD REVISION _ DATE _

DESIGNER A. PATIL DATE 07/08/21

GILLIG LLC
LIVERMORE, CA

GILLIG DESIGN BULLETIN REQUIREMENTS: UNLESS OTHERWISE SPECIFIED

DESCRIPTION	DB NUMBER	REV
SETTEE:	DB 158.015	C
UPPER SECTION:	DB 158.015	C
CENTER SECTION:	DB 158.001	C
W/C RESTRAINT OPTION:	DB 152.014	AN
ADA CLEAR FLOOR SPACE:	DB 152.000	A
SEAT DIMENSIONAL SPEC.:	DB 152.001	D

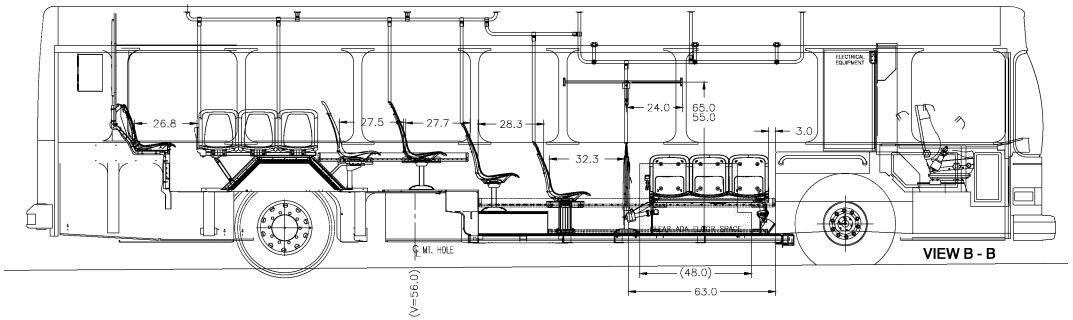
DIMENSIONING AND TOLERANCING ARE PER ANSI Y14.5M-1982, UNLESS OTHERWISE SPECIFIED:
HIP TO KNEE TOLERANCE
NON PADDED SEATS : ±0.25
PADDED SEATS: ±0.50
LINEAR: .X ±.3 ANGULAR ±5°
.XX ±.12
.XXX ±.060
THIRD ANGLE
CAD SCALE: 1:51
SIZE: B

KIT & DIAGRAM, SEAT
LF2010 40' X 102", E-BUS, GEN 2

PART NUMBER
SL-82661-195560

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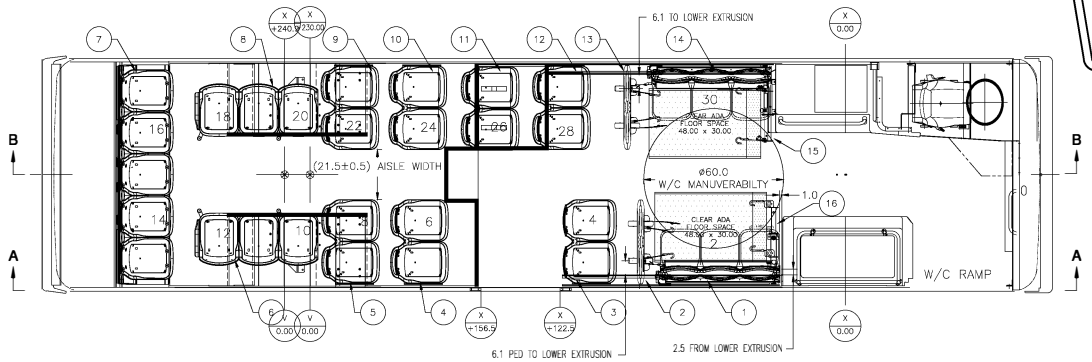
REVISIONS					
SYM	DWN	ZONE	DESCRIPTION	REL.	DATE
A	NSH		RELEASED FOR BID	137173	03/26/19

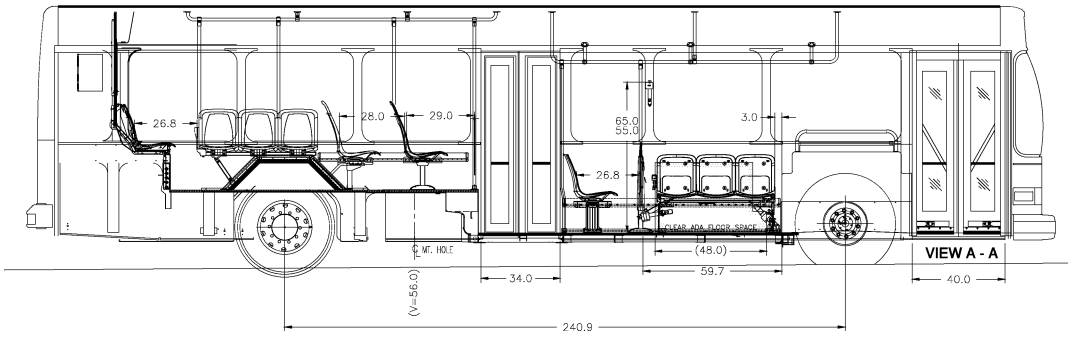


NOTES:

1. *TO MAXIMIZE OCCUPANT CRASH PROTECTION AND REDUCE THE POTENTIAL FOR SIGNIFICANT INJURY TO PASSENGERS SEATED IN THE FIRST FORWARD FACING SEATS IMMEDIATELY REARWARD OF THE ADA AREA, GILLIG REQUIRES EITHER: 1.1 THE PLACEMENT OF A BARRIER FORWARD OF THESE SEATS. 1.2 USE OF A GRAB/STANCHION POLE FOR THE AISLE SEAT AND WALL MOUNTED GRAB HANDLE FOR THE OUTBOARD SEAT OR 1.3 SEAT BELTS ON BOTH THESE SEATS.*
2. ALL DIMENSIONS ARE IN INCHES.
3. SEATS & RESTRAINT BELTS MUST MEET FMVSS 209 & 302 STANDARDS.
4. GRAPHICS ARE SHOWN FOR REFERENCE ONLY AND THE FINAL DESIGN MAY VARY.

PRELIMINARY RELEASE ONLY





ITEM NUMBER	VENDOR PART NUMBER	(#) PASSENGER SEAT SIZE	(P) PEDESTAL (C) CANTILEVER	(G) GRAB HANDLE	(F) FLAT BACK PANEL	(QTY) STANCHION POLE	NOTES AND COMMENTS
16		—	—	—	—	—	OPTION H, RH
15		—	—	—	—	—	OPTION H, LH, WHEELWELL MOUNTED
14		3	C	—	—	—	W/C FLIP-UP, AFT ARMREST, TOUCH PAD
13		—	P	G	—	1	W/C BARRIER, (2) PED, P1=10.00, P2=16.00, E=8.0, REMOTE BELT REL
2		—	P	G	—	1	W/C BARRIER, (2) PED, P1=10.00, P2=16.00, E=8.0, REMOTE BELT REL
1		3	C	—	—	—	W/C FLIP-UP, AFT ARMREST, TOUCH PAD

31 PASSENGERS

PASSENGER SEAT SUPPLIER:
AMERICAN SEATING CO.
PASSENGER SEAT MODELS:
INSIGHT 18.0 WIDE FWD FACING
INSIGHT 17.0 WIDE AISLE FACING

FIRST CHASSIS
000000 – 000000 (00) MM/DD/YY
000000 – 000000 (00) MM/DD/YY

SIGNATURE ON THIS DRAWING INDICATES CUSTOMERS APPROVAL OF LAYOUT AND AGREEMENT THAT SAME IS IN COMPLIANCE WITH CUSTOMER'S SPECIFICATIONS. ONCE SIGNED THIS DRAWING BECOMES A PART OF

CONTRACT #_____

PURCHASE ORDER #:_____

SIGNED BY:_____
ACTING ON BEHALF OF AND WITH THE AUTHORITY OF

STANDARD REVISION — DATE —

DESIGNER N. HOM DATE 03/18/19

GILLIG LLC
HAYWARD, CA

GILLIG DESIGN BULLETIN REQUIREMENTS: UNLESS OTHERWISE SPECIFIED

DESCRIPTION	DB NUMBER	REV
SETTEE:	DB 157.000	D
UPPER SECTION:	DB 157.001	C
CENTER SECTION:	DB 158.007	B
W/C RESTRAINT OPTION:	DB 152.014	AK
ADA CLEAR FLOOR SPACE:	DB 152.000	A
SEAT DIMENSIONAL SPEC.:	DB 152.001	D

KIT & DIAGRAM, SEAT
LF2010 35' X 102", E-BUS, GEN 2

DIMENSIONING AND TOLERANCING ARE PER ANSI Y14.5M-1982, UNLESS OTHERWISE SPECIFIED:
HIP-TO-KNEE TOLERANCE NON PADDED SEATS: ±0.25 PADDED SEATS: ±0.50
LINEAR: .X ±.3 .XX ±.12 .XXX ±.060
ANGULAR ±5°
CAD SCALE: 1:51
SIZE B
THIRD ANGLE

PART NUMBER
SL-71513-157-BID

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GILLIG

WHEELCHAIR RAMP DESIGN

The **Lift-U model LU-18 "Dual Mode" fold-out ramp** is provided for ease of accessibility and to meet ADA requirements.

This ramp offers an industry leading **1:8 maximum slope** and the platform area measures 30" x 49" which provides excellent on/off maneuverability.

Our 36" front aisle width allows ease of movement in and out of the bus.

The ramp controls are **all electric (no hydraulics),** and are conveniently located on the right side of the drivers dash. The fold-out mechanism is simple and includes provisions for a manual deploy override.

The ramp is located at the front entrance door for better driver control. The GILLIG installation of the Lift-U ramp **meets all ADA slope requirements**.





LIFT-U®
Division of Hogan Manufacturing, Inc.

"DUAL-MODE" MODEL LU18 LOW FLOOR RAMP

LIFT-U introduces the new curb-smart "Dual-Mode Ramp".
This ramp offers a two-position interior floor, that when deployed to most curbs maintains a level entrance into the bus; and when deployed to street level a portion of the interior floor automatically lowers on an incline to offer a 1:6 slope for easier passenger boarding.

Good to the Road …. Better to the Curb!

1:8 Slope When Deployed to a 6-inch Curb; Maintaining a Level Entrance



The LU18 "two-position" interior floor automatically lowers on an incline when the outer ramp reaches a pre-determined angle. Operator involvement is not required.

Ramp Removal is Not Required for Maintenance

Extended Length Outside the Bus is Only 48-inches

1:6 Slope When Deployed to Street Level



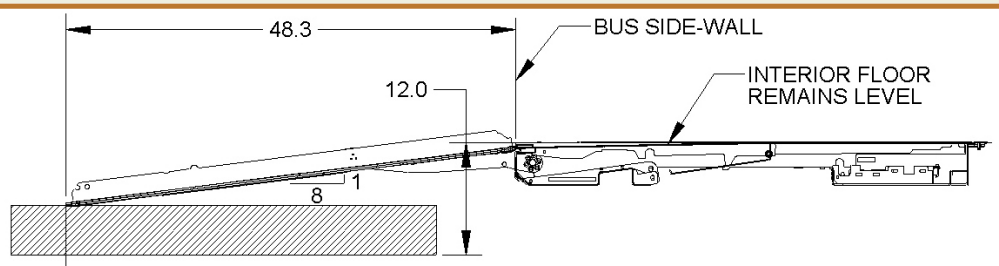
For More Information Call (209) 838-2400
or Email liftusales@lift-u.com

200114G

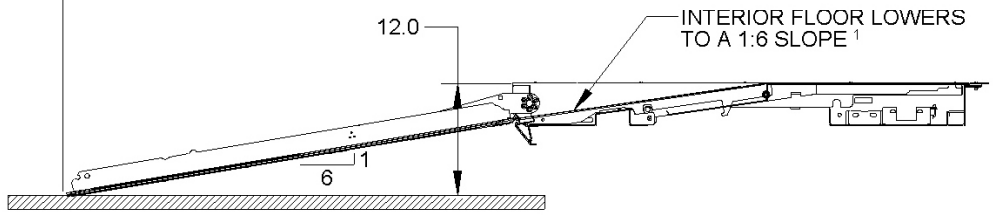
LIFT-U®

Division of Hogan Manufacturing, Inc.

- **Mechanism tray components are similar if not the same as our previous LU11 model.**
- **<u>Rated load capacity is 1,000 pounds.</u>**
- **Ramp is electrically operated and controlled. No hydraulics required.**
- **Ramp meets or exceeds ADA and DOT requirements.**
- **Self-contained module. Unit can be changed out in less than 30 minutes. No ramp components located outside of the ramp mechanism.**
- **Tensioned controlled to prevent "free falling" of ramp platform in any direction.**
- **Ramp comprises an internal "rising floor" for easier passenger transition to/from the bus aisle. No depressed pockets to negotiate.**
- **The LU18 includes an object detection feature. As the unit is electrically deployed or stowed, should the ramp encounter an obstruction, the drive motor is disabled and ramp motion stops. Simply releasing the operator switch will automatically reset functionality.**



POSITION ONE
DEPLOYED TO 6 in. CURB; KNEELED



POSITION TWO
DEPLOYED TO GROUND; KNEELED

[1] The interior floor lowers to a fixed incline angle when the angle of the outer ramp exceeds the fixed angle of the interior floor. For example, on level ground the interior floor will lower to its inclined position when the outer ramp exceeds 9.5° (1:6).

- **The LU18 ramp incorporates soft-touchdown technology. As the unit is electrically deployed, the ramp decelerates before it contacts the sidewalk or roadway.**
- **Watertight sealed electrical control enclosure.**
- **30 inch ramp width.**
- **<u>Ramp is manufactured from stainless steel for corrosion resistance. Aluminum is not used to avoid galvanic corrosion.</u>**
- **The LU18 is designed using materials that provide high structural rigidity to prevent "oil canning" or "permanent deformation" of the ramp surface.**
- **Manual operation requires <u>less than 20 pounds</u> of force to articulate ramp in any direction.**
- **To further facilitate serviceability, the "rising floor" on the LU18 can either be pivoted up out of the way or simply removed.**
- **The counterbalance chain/spring system on the LU18 ramp is located in the interior of the ramp frame. This offers greater protection for the chain/spring system from the elements; but more importantly, provides easy access for servicing the mechanism from the interior of the vehicle.**

<u>Standard Warranty – 2 Years Parts and Labor.</u>

PATENT INFORMATION REFER TO: <u>www.lift-u.com/patents.pdf</u>

HIGH-VOLTAGE BATTERY PACKS

The AKASOL-designed and American-built 9AKM150CYCUHE high-voltage battery pack utilizes Li-ion technology with a high energy density and proprietary control technology to maintain a high battery performance for a longer zero emission range. A single pack design is utilized for all locations on the bus. This provides reduces the complexity of servicing and inventory requirements.

Maintenance & Service Concept
- maintenance free operation
- servicable contactor box

High Energy and Performance
- 98 kWh
- energy density > 180Wh/kg
- long cycle life up to 4,000 cycles

Standard & Compatible Interfaces
- AK4/HVP800
- AMPSEAL 23 pole
- VDA coolant connectors
- CAN communication

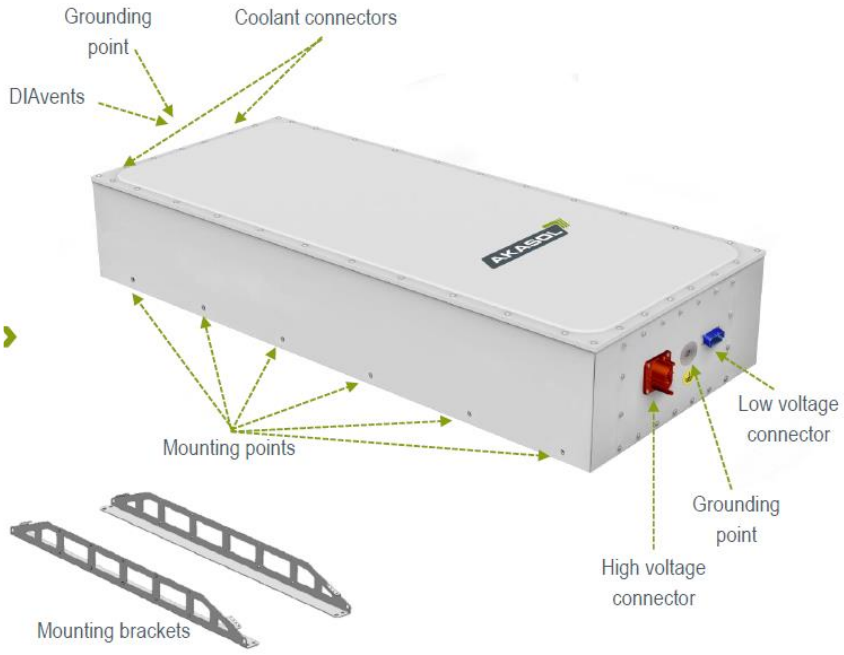


Maximum Stiffness
- „ladder design" of module orientation
- usage of double-T aluminum profiles in modules for pack stability

Reduction of Complexity on System Level
- highly automated production of UHE modules
- low complexity in battery pack design

Optimized Thermal Management
- efficient thermal insulation
- active liquid cooling
- module integrated cooling system

Flexibility by AKASOL Module Design
- well established cell standard format 21700
- further energy and power increase based on future cell developments



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HIGH-VOLTAGE BATTERY PACKS

Structure: The exterior case is constructed of corrosion resistant stainless steel. Internal double 'T' aluminum crossmembers provide structural strength and stiffness. Individual battery modules are secured in place by a ladder frame of aluminum. This design balances the need for the pack to be as light as possible while also providing the strength and rigidity necessary for the harsh duty cycle of a bus. The battery packs meet an IP rating of IP67 & IP6K9K.

Safe service disconnect: In a non-operating mode, all contactors of the battery system are opened so the battery system is voltage free. Additionally, the electrical system within the battery has high voltage interlock loop (HVIL). The HVIL is a continuous low voltage circuit which passes through every high voltage connector so that if a LV or HV connector is unplugged, the circuit will be opened and the HV system will be disconnected by the battery management system. Maintenance on the battery system will be safe when the HV connector is unplugged.

Battery cells: The basic building block of the high-voltage battery pack is the individual cell. AKASOL has conducted a world-wide evaluation to identify the optimal battery cell for the transit duty cycle, and continues to seek out better cells as the technology improves.

Battery module: Cells are combined into battery modules which are connected in series within the pack. Each module also has voltage and temperature sensors that are communicated to a pack battery management module for full pack monitoring and control.

Battery management system: The battery management system (BMS) in each high voltage battery pack monitors all cell voltages, temperature, and other battery conditions and provides detection of any battery faults or damage. The pack BMS connects to the Multi-String Manager (MSM+), which is mounted on the powertrain compartment platform. The MSM+ monitors all the high-voltage battery packs, controls charging and discharging, and provides warnings of battery faults.

Battery cooling system: All high-voltage battery packs are liquid cooled or heated using ethylene glycol coolant. Coolant from the thermal management system is circulated through a cooling plate, which then cools or heats each module. The BMS monitors the battery cell temperatures and uses coolant flow control valves with the battery thermal management system to ensure all packs are maintained at the proper temperatures.

High-power contactors: Each high-voltage battery pack includes high-power electric contactors on both the positive and negative battery outputs. These contactors are used during normal operation to turn the high-voltage batteries on and off. In the event of a high-voltage interlock loop (HVIL) open circuit, these contactors disconnect the pack stored energy from the high-voltage system. When requested and all conditions are functioning properly, the contactors close and allow power to flow from the high-voltage battery. When the 24-volt supply is removed from the contactors—by the driver turning off the bus, by the HVIL system or high-voltage control system detecting a fault, by turning

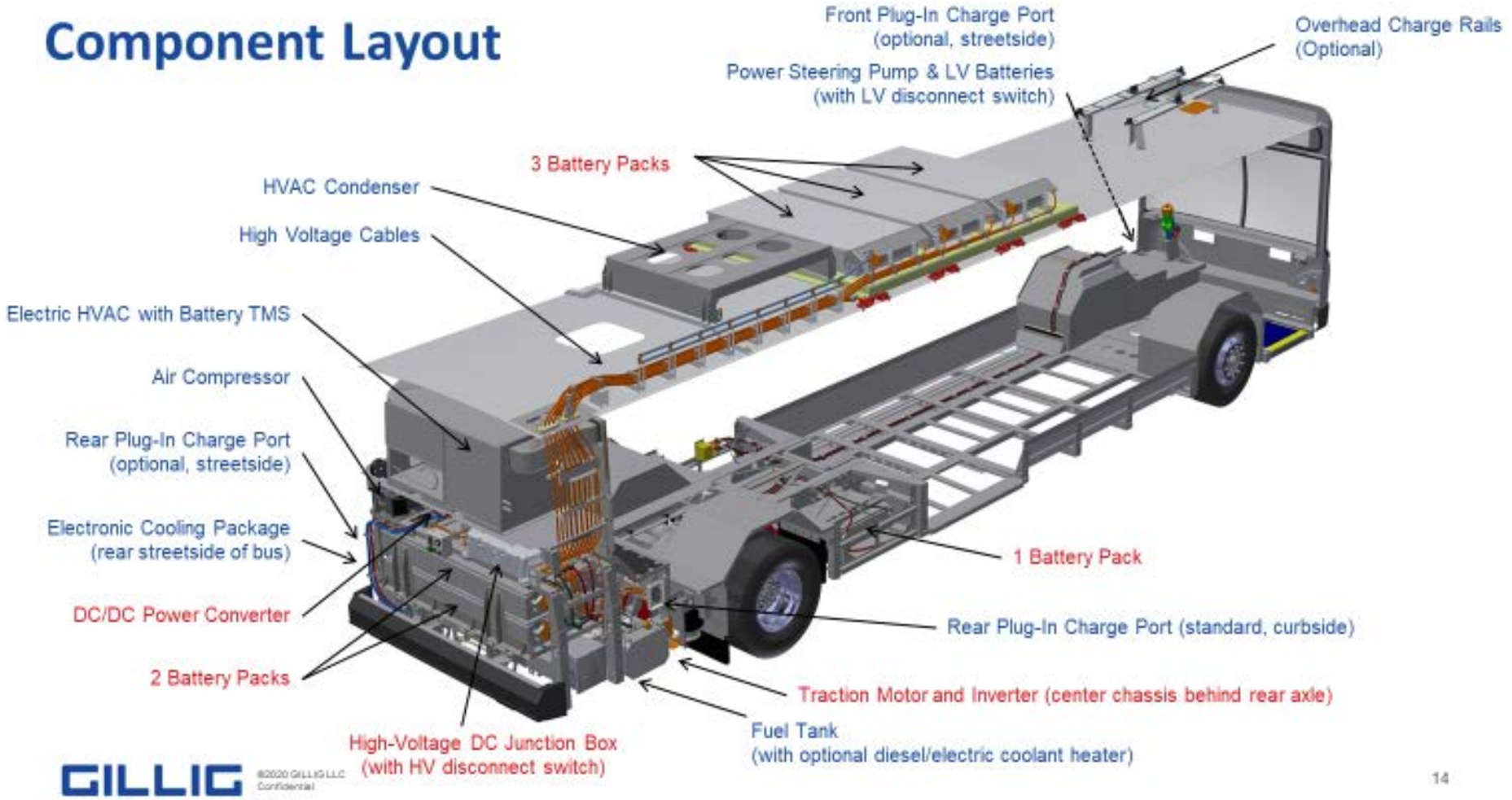
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off the low-voltage battery disconnect switch, or by the high-voltage emergency disconnect switch in the rear of the bus—all contactors open to disconnect the high voltage stored energy of the batteries from the system.

Specifications:	
Supplier	AKASOL, Inc.
Rated capacity	98 kWh.
Usable capacity SOL (start of life)	Duty Cycle Dependent TBD
Warranty (see warranty agreement for terms and conditions)	Standard, 6 years (300,000 miles); optional, extended to total 12 years (500,000 miles).

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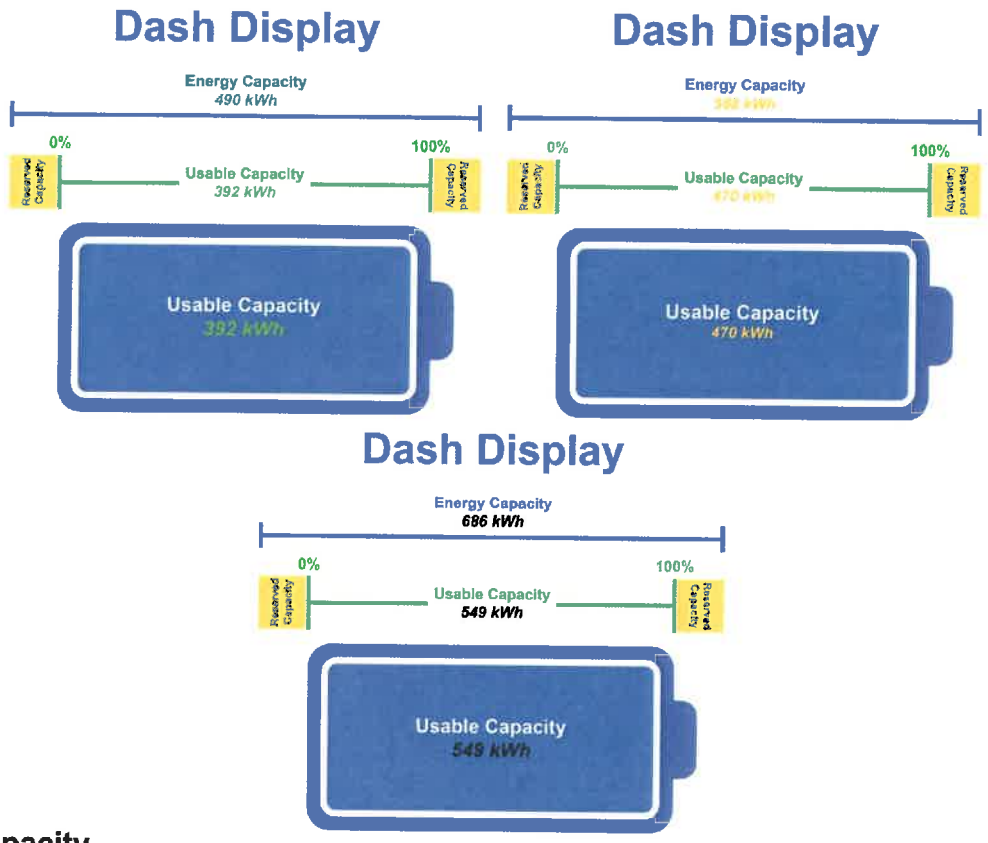
Component Layout (General locations for illustration purposes)



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ENERGY CAPACITY AND RANGE

Many factors determine the real-life range of an electric vehicle, which is derived from the net usable energy (or capacity) and the rate of energy consumption.



Rated Capacity

The rated capacity of a battery is the amount of total energy that can be stored in and discharged from the battery. Battery capacity reduces over the life of the cells as the impact of charging and discharging reduces the ability for the cells to reach full charge. Battery health is monitored by the battery management system and reported via telematics. The State of Health (SOH) is communicated as a percentage of the rated capacity at the start of life.

Reserved Capacity

Battery life is negatively impacted when cells are overcharged or when the depth of discharge is too low. In order to maximize high-voltage battery life, the capacity of the battery is limited to prevent discharge below 10% and charging above 90% of rated capacity. The charge controller prevents the batteries from being charged above the top limit, and derating protocols are in place to prevent the batteries from reaching the bottom limit.

Usable Capacity

The result of reserving some high-voltage battery capacity is that 80% of the rated capacity is available to power the vehicle. This is the usable capacity, and it is used for all range calculations. The State of Charge (SOC) reported on the dashboard and via telematics represents the usable capacity remaining until a recharge is necessary.

Energy Consumption

Many factors impact the actual range of electric buses in operation. The duty cycle, route profile, and passenger loading determine how much energy is necessary to drive the traction motor and how much energy is captured through regenerative braking. Drivers can have a significant impact on energy consumption through how effectively they apply throttle and use regenerative braking to slow the bus. The HVAC system is also a significant use of energy on a bus, and settings (temperature set-points, fan speeds, etc.) can be optimized to reduce energy consumption.

Customer-specified equipment (passenger seats, windows, CAD/AVL, and video equipment, etc.) can have a large impact on total vehicle weight, which can also impact energy consumption. GILLIG has developed a Smart Spec that optimizes the range of the bus through component selection. More details are available for discussion during the pre-production meeting.

Range Estimates

Many factors determine the real-life range of an electric vehicle, consumption is derived from the net usable engery (or capacity) and the rate of energy consumption.

Configuration	High-Voltage Battery Packs, Qty	Total Rated Capacity	Range at 2.3 kWh/mile*
5 battery pack	5, each with 98 kWh	490 kWh	170 miles
6 battery pack	6, each with 98 kWh	588 kWh	205 miles
7 battery pack	7, each with 98 kWh	686 kWh	239 miles
*2.3 kWh is a conservative average energy consumption rate.			

2 Hardware overview

2.1 HVC-C Overnight/Depot Charging Solutions

The HVC -C charger equipped with CCS-1 depot charge box enables charging buses with a CCS-1 connector up to 150kW DC based on the (inter)national standards IEC 61851-23 and DIN70121.

This system offers:

- Flexibility as the depot charge box can be installed up to 20 meters from the HVC -C charger and even at 150 meters with the long-distance optional package;
- Limited space in the bus parking zone. The depot charge box is small size enabling easier installation in a bus depot and preventing accidents with charging equipment;
- Future proofing. Battery capacity and charging power are expected to increase over time. The 100C cabinet can be upgraded in the field up to 150kW by adding an extra power module of 50kW

2.1.1 Depot Charge Box

The Depot Charge Box is used to interface the HVC Power Cabinet with an electric vehicle using a Combo Type 1 (CCS-1) cable. The depot charge box minimalist design allies both small footprint and ease of use. The interface consists of one CCS cable, a LED indicator, an E-stop button and stop button.



- Connection standard — Combo Type 1 (CCS-1)
- Weight — 58 kg excl. CCS cable
- Dimensions (H x W x D) — 940 x 699 x 240 mm (37.01 x 27.52 x 9.45 in)
- CCS cable length — 3.5 m (11.5 ft) Optional: 7 m (23 ft)

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2.1.2 Heavy Vehicle Charger (HVC Power Cabinet)



The Heavy Vehicle Charger (HVC) is the heart of the charging system. It converts and provides power to the Depot Charging Box and Pantograph interfaces. The HVC offers a modular system consisting of 50kW internal building blocks that can be used to expand up to 150kW of charging power using the same cabinet.

- Dimensions: 1170 x 770 x 2030 mm (W x D x H)
  Approx. 46.1 x 30.3 x 82.2 in (W x D x H)
- Weight 1340 kg
- Housing: IP54 (Type 3R) Powder-coated stainless-steel enclosure
- Enclosure color RAL 9002 (Grey white)
  RAL 7012 (Basalt grey) – top fan inlet
- Supported Network Connection GSM/2G/3G/4G
  Ethernet Base 10/100T

2.1.3 Depot Charging Sytem Specifications

AC Input Specifications:

- AC Connection Configuration 3-phase; L1, L2, L3, GND
- Input Voltage Range 480/277V AC ±10%
- Input Frequency Range 60Hz ±1%
- Power Factor (cos ϕ) ≥ 0.95 (> 0.97 at full load)
- Input Current (Nominal)
  - HVC-150C 198A AC (480VAC input)
  - HVC-100 480 VAC Input: 132A AC

DC Output Specifications:

- Output Power (Maximum) HVC-100C: 100kW
  HVC-150C: 150kW
- Output Voltage Range 150-850VDC
- Output Current Range HVC-100C: 0-166 ADC
  HVC-150C: 0-200 ADC (limited by cable)

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Environmental Specifications

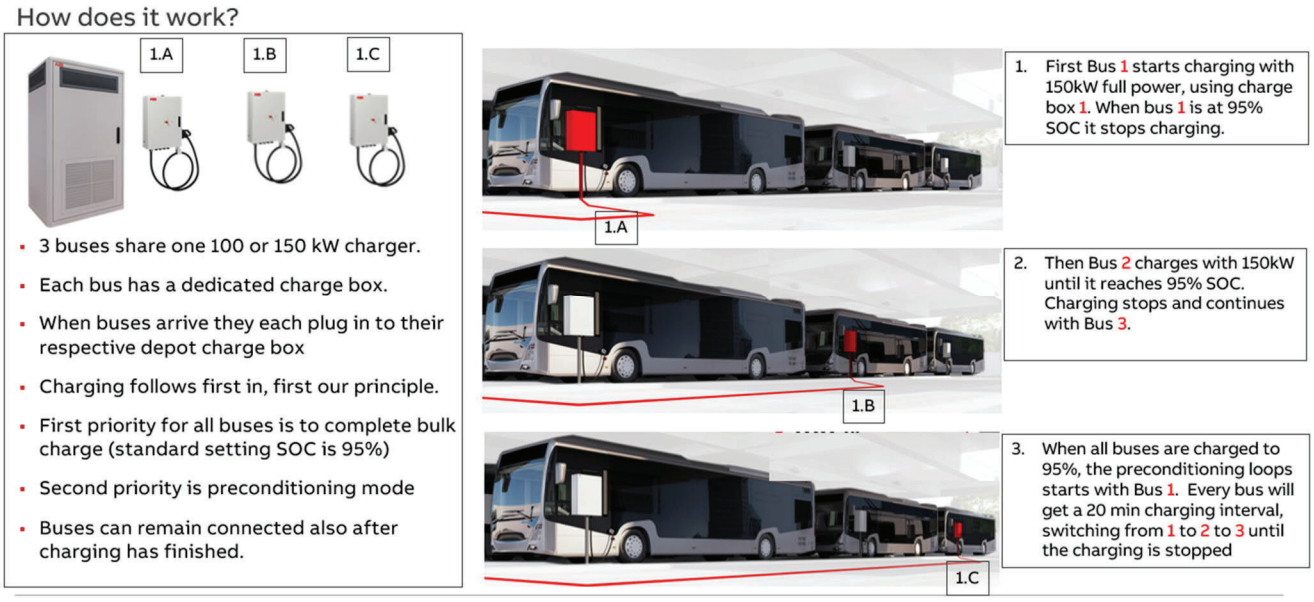
• Ingress Protection	Depot Charge Box: IP65 (eq. NEMA 4X)
	HVC Power Cabinet: IP54 (eq. NEMA 3R)
• Mechanical Impact Protection	IK10
• Humidity	5-95% RH (non-condensing)
• Altitude (Maximum)	2500 m (8202.1 ft)
• Temperature Range (Operation)	-10°C to +45°C (14°F to +113°F)
	-35°C to +50°C (-31°F to +122°F) with Robustness package
• Operating Conditions	Indoor / outdoor
• Temperature Range (Storage)	-10°C to +70°C (14°F to +158°F)
• Storage Conditions	Indoors, Dry

Standards & Certifications

• TUV-Certified to UL2202	HVC150: Certificate No. TU 72180445
	Depot Charge Box: Certificate No CU 72182376 01
• TUV-Certified to CSA C22.2 No. 107.1—16	HVC150 Certificate No. CA 972180446 01
	Depot Charge Box: Certificate No CU 72182376 01
• EMC	FCC Part 15

Sequential Charging

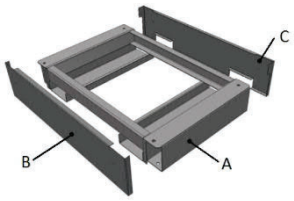
It is possible to connect 1 to 3 depot box dispensers to each HVC power cabinet. See example of how sequential charging works.



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2.1.4 Available Options

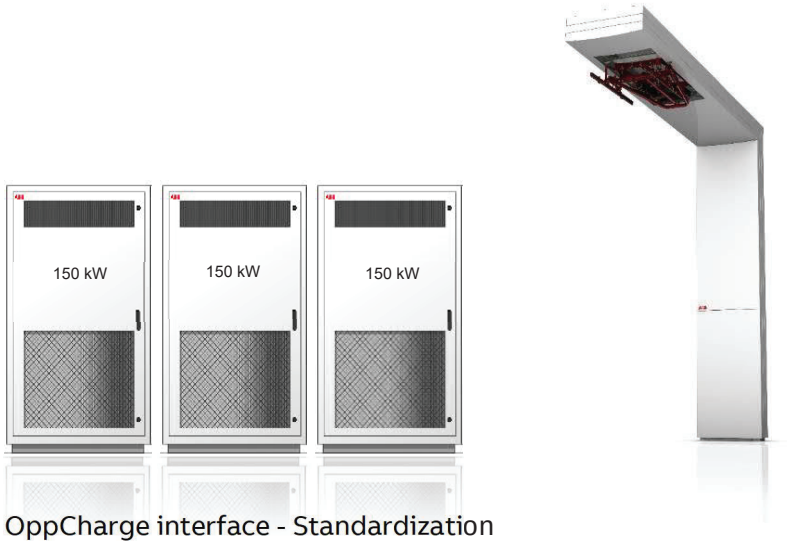
The following options are available on the Depot Charging Systems:

HVC long distance support package	To increase distance between HVC and Bus Connection interface up to max. 150 meters. • Data communication enhancer module; • Overvoltage protection system; • 1 package needed per cabinet; Cable between charger and Bus Connection not included.
HVC Robustness Package	Package to further increase robustness: • Redundant auxiliary power supply; • Low temperature option: integrated Heating system for extension of the operating temperature to -35 °C to +50 °C • Active temperature measurement and control; • Intelligent air filter system; • Intelligent fuse control.
Sequential Charging Package	Enables connection of up to 3 depot charge boxes per (each) HVC-100/150 Power Cabinet: • Full power to 1 of each depot charge boxes at a time. • Smart charging (sequential) software included to enable automatic switching between outlets
Depot Charge Box Pedestal	Standard pedestal design to support floor-mounted installations • Indoor/outdoor • Powder coated galvanized steel • Integrated cable raceway to allow bottom conduit entry • See general layout drawing for more details 
Cable Management System (Must be ordered with pedestal)	A cable management system consists of a retractable cord reel attached to the middle of the charge cord that retracts the charging cable when not in use, thus preventing the cable from touching the ground. (Note: the cable management system is designed to fit the ABB depot charge box pedestal) 
HVC-100/150 Metal Support Frame	Standard metal frame designed to install HVC Cabinet on existing concrete floor. • Cable raceway entry points (See “C”) • See fabrication drawings for more details 
Cabinet Color Customization	Cabinet Color can be customized at additional cost. Min. quantity of 10 cabinets.
Other	Contact ABB Sales Department for additional requests

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2.2 HVC-450PD - Opportunity Charge

The On-route Opportunity Charging System is typically used for end point opportunity charging of electric city buses, enabling zero emission public transport in cities with an attractive Total Cost of Ownership. With its automated rooftop connection and typical charge time of 3–6 minutes the system can easily be integrated in existing bus lines by installing chargers at endpoints and/or terminals. ABB`s Automated Connection Systems can be combined with up to 3 HVC power cabinets enabling a charging power of up to 450 kW.



2.2.1 OppCharge interface - Standardization

In the market for charging electric passenger vehicles various IEC standards have been developed in the period from 2008 to 2014, and as such a good framework of rules and practices exists to ensure safety and compatibility (for example IEC 61851-23, ISO 15118, IEC 62196-3). ABB has been a key contributor to the aforementioned standards and continuous to be so.

In the market for charging electric busses global standardization has also begun, and several new standardization groups are being formed at the moment. ABB is part of the most important standardization initiatives to share requirements, experiences and other inputs and formulate proposal documents regarding physical interface, safety systems and communication protocols. For bus charging ABB complies with OppCharge for opportunity charging.

Until more formal standardization is in place together with 3rd party validation of compatibility ABB offers charging systems that are validated and tested with individual brands/vehicles on the standards mentioned above. This quotation assumes that the e-bus that will be charged with it has been validated by ABB. A list of validated vehicles is available upon request. If a different e-bus is selected it is possible that additional costs for integration and testing apply.

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Heavy Vehicle Charger (HVC) Specifications



- Connection voltage: 480 VAC, 3-phase, 60 Hz
- Max power system: 450 kW system
- System 450kW Weight: 8863 lbs
- Dimensions: (inches) 138.3 (W) x 30.3 (D) x 82.2 (H)

Housing:	IP54 (Type 3R) Powder-coated stainless-steel enclosure
Enclosure color	RAL 9002 (Grey white)
	RAL 7012 (Basalt grey) – top fan inlet
Supported Network Connection	GSM/2G/3G/4G
	Ethernet Base 10/100T

Pantograph Specifications



- Connection standard: OppCharge SAE J3105-1*
- Voltage range: 150-850 VDC
- Max output power & current: 450 kW – 600 A
- Weight: 364 kg
- Dimensions (inches): 79.1 x 35.4 x 19.3 mm (W x D x H)
- Distance between HVC & ACM Max 20 meters. (Long range option available – up to 150 m)
- Distance between ACM and pantograph shall not exceed 10m.

** SAE J3105-1 standard is a work in progress*

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ACM Control Module Specifications

- Weight ~125 lbs
- Dimensions (inches) 24.0 x 8.7 x 33.1 (W x D x H)
- Color RAL 9003

Ambient Conditions

The equipment being offered in this proposal is designed for the following ambient conditions without de-rating.

- Operating temperature: -10 to +50 °C (OPTIONS for -35degC)
- Humidity: 5 % to 95 %, RH – non-condensing

Customization

Stainless Steel enclosure with Pure White RAL 9010 powder coat for simple customization with decals and/or labeling to be put somewhere else.

Standards & Certifications

• UL/CSA certified: UL 2202, UL 2231-1, UL 2231-2, CAN CSA C22.2 n. 107-1, CAN CSA C22.2 n. 281-1, CAN CSA C22.2 n. 281-2.

• DIN 70121 and OppCharge compatible.

2.2.2 Available Options

The following options are available on the Pantograph Charging Systems:

HVC long distance support package	To increase distance between HVC and Panto up to max. 150 meters. • Data communication enhancer module; • Overvoltage protection system; • 1 package needed per cabinet; Cable between charger and Bus Connection not included.
HVC Robustness Package	Package to further increase robustness: • Redundant auxiliary power supply; • Low temperature option: integrated Heating system for extension of the operating temperature to -35°C to +50°C • Active temperature measurement and control; • Intelligent air filter system; • Intelligent fuse control.

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3 Connectivity

Being the global industry leader in deploying and managing nationwide EV charging networks, ABB has made Internet connectivity a crucial part of its EV charging strategy and offering which ensures:

- Reliable & cost-effective way to connect charger to the Internet
- Minimal upfront investment and customization on customer IT infrastructure and SW solutions
- Future proof infrastructure with maximum interoperability also with latest EV models
- Optimized remote service process, reducing time to repair and minimizing need for site visits
- Smart controlled charging to reduce costly demand charges

3.1 Local Service Capability & Robustness

ABB proactively manages its charger network through its on-line, cloud-based monitoring platform. The proactive management and supervision of chargers throughout North America is done by a local service teams in North America. This team also handles technical support questions with short response times.

More than 75% of charger issues experienced are resolved remotely. With quick response times from ABB personnel and successful remote troubleshooting, the chargers in Canada and the US benefit from robust and greatly improved customer service satisfaction.

3.2 Web Tool Solutions: Operator Pro

ABB Web solution “Operator Pro” is an on-line management tool providing operators of charging infrastructure with real-time status information and usage statistics on their equipment.

Infrastructure providers can now gather detailed charge session statistics, configure HVC chargers on their sites according to their preferences and obtain valuable insights through charger usage statistics. All charge session data can be exported and managed directly from this Internet based application.

This web solution consists of several modules:

Status

The status functionality provides viewing the real-time charger network status via a comprehensive map view. Looking up the actual status per charger or per outlet is also possible. It is even possible to see which outlets are currently charging.

Statistics

The statistics feature is key to gain insight in the usage of the equipment. It provides you with information on the number of sessions and kWh delivered. Statistics can be viewed over the last 7 days per charger and give an excellent quick glance on how the network is being used. Discovering more details about your charging sessions over flexible time frames is provided by the export function (for example to an MS Excel file) for further processing.

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Configuration

The configuration module allows for remotely configuring settings of a charger, remote restarting if needed and disabling or enabling chargers when desired. The latest feature “off-line behavior” allows customers to define how the charger will work in case connection with the back-end system is lost.

Access management

Access control is made easy by allowing infrastructure operators to use and manage RFID cards and PIN codes themselves. All transactions related to an RFID card or PIN code can be exported for further processing.

Cases

Cases support issue solving. This functionality helps finding an answer to a problem quickly, raising a case to trigger the service organization and tracking a case to be able to provide the end customers full insight in the progress of a problem.

Notifications

The notifications module offers your driver care center the possibility to receive an alert by e-mail in case a charger reports a certain event, for example when the emergency button is pressed.

Please contact your ABB representative for pricing.

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4 Commissioning & Service

4.1 Project Management and Engineering Support

This offer includes a Project Manager who is the main point of contact throughout the project execution.

4.2 Commissioning and onsite training

This system requires an onsite commissioning activity by an ABB trained and certified person.

The following activities are executed:

- Commissioning of charger system to be fully operational with the selected e-bus
- Customer to make a compatible e-bus available during commissioning
- Performance tests for each system including five (5) successful charges and continuous bulk charge
- Post-installation checking of operational correctness
- Noise measurement
- Alignment and calibration of pantograph
- Configuration of remote connectivity and remote management features
- Safety tests including emergency shutdown test
- User/operator Training (on-site training during/after commissioning)
- Travel & lodging in included

4.3 Service Level Agreements (SLA)

To get the most out of your charging infrastructure we recommend an SLA (Service Level Agreement) to look after your business critical assets. The exact offer may depend on the region and scope of your project. All ABB Service Level Agreements are configured for EV Charger owners that demand a network of robust, reliable equipment. Benefits include:

- 24/7 SoS call center support
- Assured warranty AND technical support response time
- 1 preventive maintenance visit per year, scheduled in 12-month cycles from start-up
    - Includes air filter replacement

Please contact your ABB representative for pricing.

4.4 Recommended Spare Parts

Please contact your ABB representative for pricing.

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4.5 Extended Warranty

Extended warranty is available when a Service Level Agreement is in place. In case of an extended warranty, the decision for extended warranty must be taken at moment of purchase of the involved fast charging system(s). Please contact your ABB representative for more details.

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PRODUCT LEAFLET

Electric Vehicle Infrastructure

HVC-C UL depot charging for electric fleets



ABB HVC-C UL Depot Charging systems offer a highly reliable, intelligent and cost-effective solution to charge large EV fleets such as buses, trucks and other commercial vehicles.

—
HVC Depot Boxes and power cabinets, lined up at a depot site.

A practical solution for busy depots
ABB Heavy Vehicle Charger (HVC) products enable electric buses and trucks to charge at the depot ensuring flexibility and scale for every fleet operation that is transitioning to zero-emission transportation.

Key Benefits
+ Smart charging
+ Small infrastructure footprint at vehicle interface
+ Flexible design for roof and floor mounting
+ SAE J1772 CCS and OCPP 1.6 compliant
+ Remote diagnostics and management tools

Sequential Charging
Improving total cost of ownership is easy using the sequential charging feature offered by ABB's depot chargers. This feature allows connection of up to three depot charge boxes with a single power cabinet and vehicles are charged sequentially over time. The system can follow an embedded, predefined charging process or remote triggers sent by a fleet management system via OCPP 1.6.

- Vehicles are charged with high power, maximizing vehicle availability
- The required grid connection is smaller, reducing upfront investments and operational costs
- The compact depot box is easy to install at sites with space constraints
- Optimal utilization of installed infrastructure meaning lower investments in charging equipment.

Buy America
ABB can offer the HVC-C Depot Charging Solution with compliance to the Buy America Act Rule 49 CFR Part 661.5.

Future-proof modular design
Power cabinets can be upgraded from 100 or 150 kW in the field, as well as add additional depot charge boxes, allowing operators to scale their operation and to spread investments over time.

Safe and reliable operation
ABB fast chargers are designed to the highest international electrical, safety, and quality standards, and are certified by notified bodies - guaranteeing safe and reliable operation.

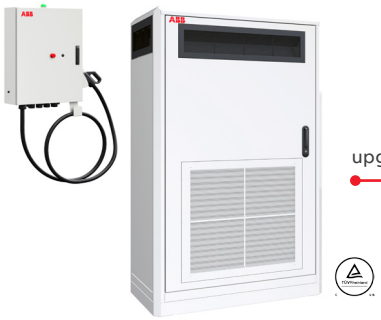
Connectivity and remote services
ABB chargers come with an extensive suite of connectivity features including remote services such as monitoring, management, diagnostics and software upgrades. These advanced services provide equipment owners with powerful insights into their charging operations while enabling high uptime.

ABB is your experienced partner
ABB HVC products are based on a decade of high power experience in EV charging solutions. ABB has installed over 17,000 fast charging systems in more than 80 countries – and is the leading EV infrastructure technology supplier globally.

Overnight charging 100 kW - 150 kW

A field upgradeable system with future proof reliability

HVC 100C

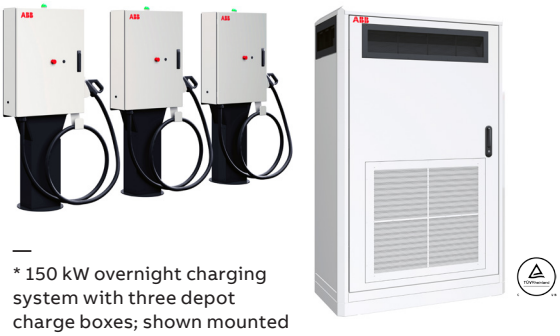


upgradable

HVC 150C



HVC 150C*



A power upgrade can be done in the field by adding an extra power module. No groundworks, digging and disturbance to the site are required.

* 150 kW overnight charging system with three depot charge boxes; shown mounted on pedestal option.

Technical specifications

Configurations		**HVC 100C**	**HVC 150C**
Maximum output power		100 kW	150 kW
AC Input voltage		UL: 3-phase, 480Y/277 VAC +/- 10% (60 Hz) CSA: 3-phase, 600Y/347 VAC +/-10% (60 Hz)	
AC Input connection		L1, L2, L3, GND (no neutral)	
Rated input power		117 kVA	170 kVA
Rated input current		UL: 132 A / CSA: 108 A	UL: 198 A / CSA: 168 A
Recommended upstream circuit breaker(s)		UL: 1 x 200 A / CSA: 1 x 150 A	UL: 1 x 250 A / CSA: 1 x 250 A
Output voltage range		150 – 850 VDC	
Maximum DC output current		166 A	200 A
Vehicle connection interface		CCS/Combo Type 1 Connector	
Cable length		3.5 m (11.5 ft) standard; 7 m (23 ft) optional	
DC connection standard		SAE J1772 - IEC 61851-23 / DIN 70121 - ISO 15118	
Environment		Indoor/Outdoor	
Operating temperature		Standard: -10 °C to +50 °C (de-rating characteristic applies) Optional: -35 °C to +50 °C	
Protection		Power Cabinet: IP54 – IK10 (equivalent to NEMA 3R) Depot Charge Box: IP65 - IK10	
Network connection		GSM/3G modem | 10/100 base-T Ethernet	
Compliance and Safety		CSA No. 107.1-16 and UL 2202 certified by TUV BA Rule 49 CFR Part 661.5 (Optional)	
Dimensions			
Power Cabinet	Dimensions (H x W x D)	2030 x 1170 x 770 mm / 79.9 x 46.1 x 30.3 in	
	Weight	1340 kg / 2954 lbs	
Depot Charge Box (without pedestal)	Dimensions (H x W x D)	800 x 600 x 210 mm / 31.5 x 23.6 x 8.3 in	
	Weight	61 kg / 134.5 lbs (with 7 m / 23 ft cable)	
Depot Charge Box (with pedestal)	Dimensions (H x W x D)	1914 x 600 x 400 mm / 75.4 x 23.6 x 16.3 in	
	Weight	181 kg / 398 lbs (with 7 m / 23 ft cable)	

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PRODUCT LEAFLET

Electric Vehicle Infrastructure

HVC-PD UL opportunity charging for electric buses



ABB's HVC-PD opportunity charging system offers high-power charging via an automated rooftop connection. With typical charge times of 3 to 6 minutes the system can be easily integrated in existing operations by installing chargers at endpoints, terminals and intermediate stops.

—
The HVC-PD charging system leverages an automated connection to enable extremely fast charge times.

A practical solution for route charging
ABB's Heavy Vehicle Charger (HVC) system architecture offers an ideal solution for opportunity charging, ensuring zero-emission public transit during the day without impacting daily route operations.

Key Benefits
+ Charge in 3 to 6 minutes
+ One charger serves many vehicle makes and models
+ Safe and reliable fully automated connection
+ SAE J3105-1 and OCPP 1.6 compliant
+ Remote diagnostics and management tools

Future-proof modular design
Additional power cabinets can be installed at any time, allowing operators to scale their operation and flexibly spread out infrastructure investments as their fleet grows.

Safe and reliable operation
ABB fast chargers are designed to the highest international electrical, safety, and quality standards, and are certified by notified bodies - ensuring safe and reliable operation.

Interoperability
ABB HVC chargers are based on international standards for operational compatibility with multiple vehicle types and brands. This allows operators to select vehicles from multiple vendors and not be locked into a single supplier.

Connectivity and remote services
ABB chargers come with an extensive suite of connectivity features including remote services such as monitoring, diagnostics and software upgrades. These advanced services provide equipment owners with powerful insights into their charging operations while delivering high uptime.

OCPP 1.6
ABB HVC-PD charging systems can be connected to standardized charging infrastructure management platforms using OCPP 1.6. ABB's HVC suite supports OCPP 1.6 Core and Smart Charging Profiles.

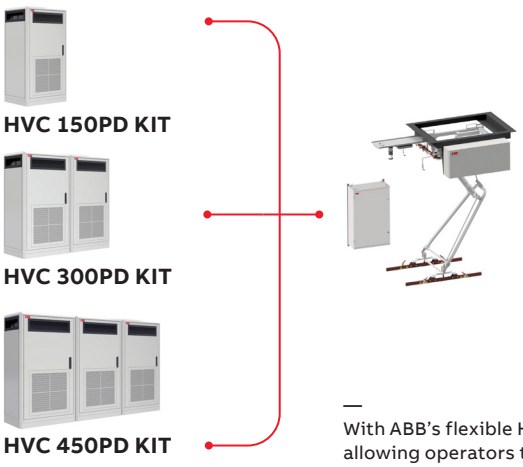
Buy America
ABB can offer the HVC-PD Depot Charging Solution with compliance to the Buy America Act, Rule 49 CFR Part 661.5.

ABB is your experienced partner
ABB HVC products are based on a decade of high-power experience in EV charging solutions. ABB has installed over 20,000 fast charging systems in more than 85 countries – and is the leading EV infrastructure technology supplier globally.

Opportunity charging 150 kW to 450 kW

A scalable system with future-proof reliability

Charging on existing structure



Charging on route



With ABB's flexible HVC architecture, power capability can be expanded over time, allowing operators to spread out infrastructure investments as their fleet grows.

Technical specifications

Configurations		HVC 150PD	HVC 300PD	HVC 450PD
Maximum output power		150 kW	300 kW	450 kW
Input AC connection		UL: 3-phase, 480Y/277 VAC +/- 10 % (60 Hz); CSA: 3-phase, 600Y/347 VAC +/-10% (60 Hz)		
Rated input power		170 kVA	2x 170 kVA	3x 170 kVA
Rated input current		UL: 198 A CSA: 168 A	UL: 2x 198 A CSA: 2x 168 A	UL: 3x 198 A CSA: 3x 168 A
Recommended upstream circuit breaker(s)		1 x 250 A	2 x 250 A	3 x 250 A
Output voltage range		150 – 850 VDC		
Maximum DC output current		250 A	500 A	600 A*
Vehicle connection interface		Inverted crossrail pantograph - OppCharge		
DC connection standard		SAE J3105-1 - IEC 61851-23-1** - ISO 15118		
Environment		Indoor/Outdoor		
Operating temperature		Standard: -10 °C to +50 °C (de-rating characteristic applies); Optional: -35 °C to +50 °C		
Protection		IP54 – IK10 (NEMA 3R)		
Network connection		GSM/3G/4G modem | 10/100 base-T Ethernet		
Compliance and safety		CSA No. 107.1-16 and UL 2202, certified by TUV BA Rule 49 CFR Part 661.5 (Optional)		
Dimensions				
Power cabinet (each)	Number of Power Cabinets	1	2	3
	Dimensions (H x W x D)	2030 x 1170 x 770 mm / 79.9" x 46.1" x 30.3"		
	Weight	1340 kg / 2954 lbs		
Charge pole (includes Pantograph & ACM)	Dimensions (H x W x D)	5240 x 1040 x 300 mm / 206.3" x 40.9" x 11.8"		
	Outreach	4670 mm / 183.9" x 30.3"		
	Weight	1706 kg / 3762 lbs		
ACM Control Module KIT	Dimensions (H x W x D)	1600 x1000 x 476.9 mm / 63" x 39.4" x 18.8"		
	Weight	193 kg / 425 lbs		
Pantograph KIT	Dimensions (H x W x D)	(resting position / bolt-hole pattern) 574 x 1300 x 900mm / 22.6"H x 51.2"W x 35.4"D		
	Weight	387 kg / 854 lbs		

* Limited by inverted pantograph contact ratings
** IEC 61851-23-1 in draft status

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9AKK107991A0428 C

PRODUCT PORTFOLIO

Electric Vehicle Infrastructure
WEBTOOLS USER GUIDE



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Version Control

Documents data	
Title	Electric Vehicle Infrastructure - WEBTOOLS USER GUIDE
Author	Zakaria Botros – ABB Montreal Campus
Version	1.0
Version Date	2020-01-16
Status	released

Version	Date	Remarks
V1.0	2020-01-16	Initial release
V1.1	2020-01-20	Enhance the image quality in the document

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1 Introduction

ABB EV Webtools are designed to secure the availability, performance and safety of your EV chargers. By connecting chargers, service solutions and people, ABB has been able to diagnose more than 90 % of the service cases remotely, solving over 60 % of these cases without any site intervention in the past two years. This results in significant savings on down-time, travelling, transportation, man-hours and resources.

There are two types of ABB Webtools: Driver Care, Charger Care, Operator Pro. The Driver Care and Operator Pro are offering the same service for both E-Cars and E-Buses respectively, the service is including but not limited to: Real time monitoring for the Chargers, statistics, EV chargers map, Card management, Pin management, Cases and Solutions.

The Charger Care Can provide real time configuration modification for the parameters of the charger, remote troubleshooting, access to advanced setting and remote actions and access to solution library and technical documentation.

1.1 Intended document users

This document is intended to be used by certified customers who purchased ABB webtools for EVCI or are in the process of ordering and want to know in more detail how to useand befit from ABB webtools “charger cared, Driver care, Operator pro”.

Technical personnel must be certified by ABB to perform any action using charger care webtool.

1.2 Contact information

ABB Montreal Campus	
Address	800 Boul. Hymus Saint-laurent, QC Canada H4S 0B5
E-mail	evci-caservice@ca.abb.com
Service Hotline	1-800-HELP365

2 Webtools “Driver Care/Operator Pro”

2.1 Benefit

- Understand network status and how it is used.
- Manage access without using OCPP.
- Improved EV driver satisfaction due to a fast & competent driver support.

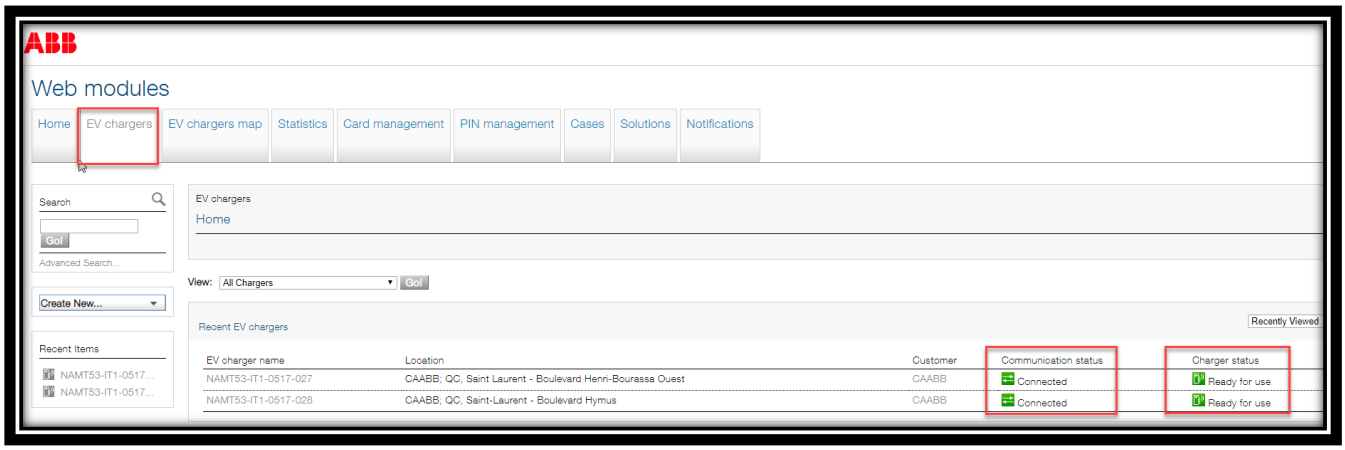
2.2 Main features

- Monitoring status of network and on EV charger level
- Gain insight by standard reports
- Customer export of complete data sets
- Access management
- PIN and RFID card management
- Solutions & Cases
- Diagnosis and repair guidelines
- Escalate cases to ABB Service in tool
- Notifications
- Works for all products (past, now and future)



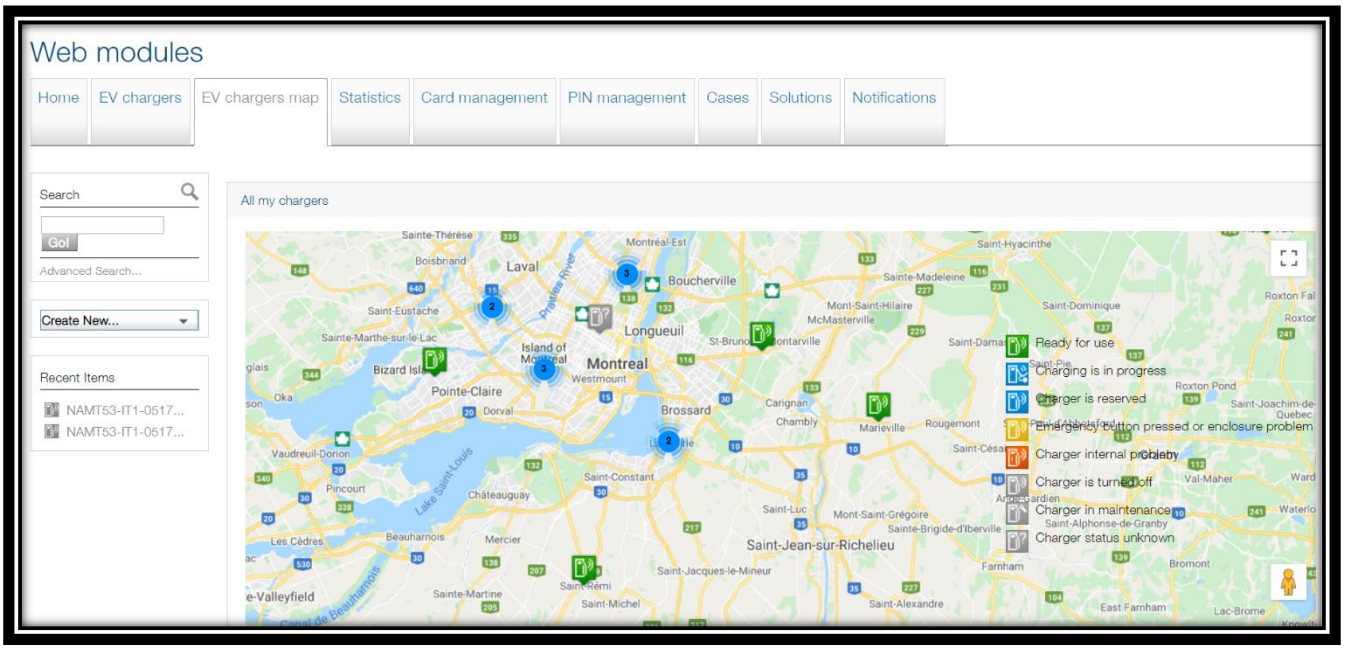
2.3 Real-time monitoring

For all connected chargers the communication status and the Charger status are always updated in real-time. All communication status messages and Charger status wording are included in Appendix I and II at the end of this guide.



2.4 EV Charger map

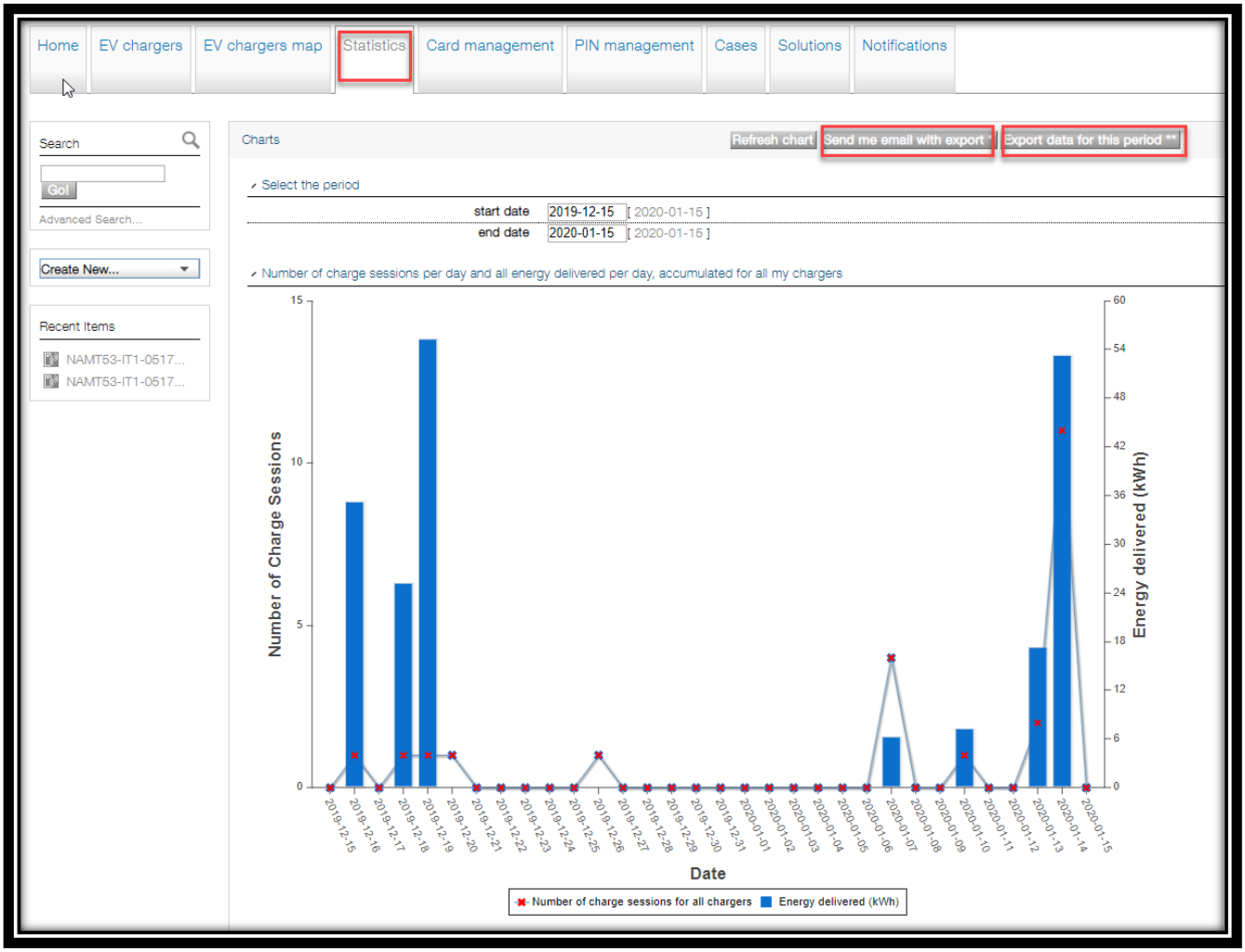
Mentoring Chargers position over the map, and indication the Charger status using the icons.



2.6 Statistics

A Chart demonstrating the number of Charge sessions and Energy delivered (kWh) per day. The operator can choose the start date and the end date parameters.

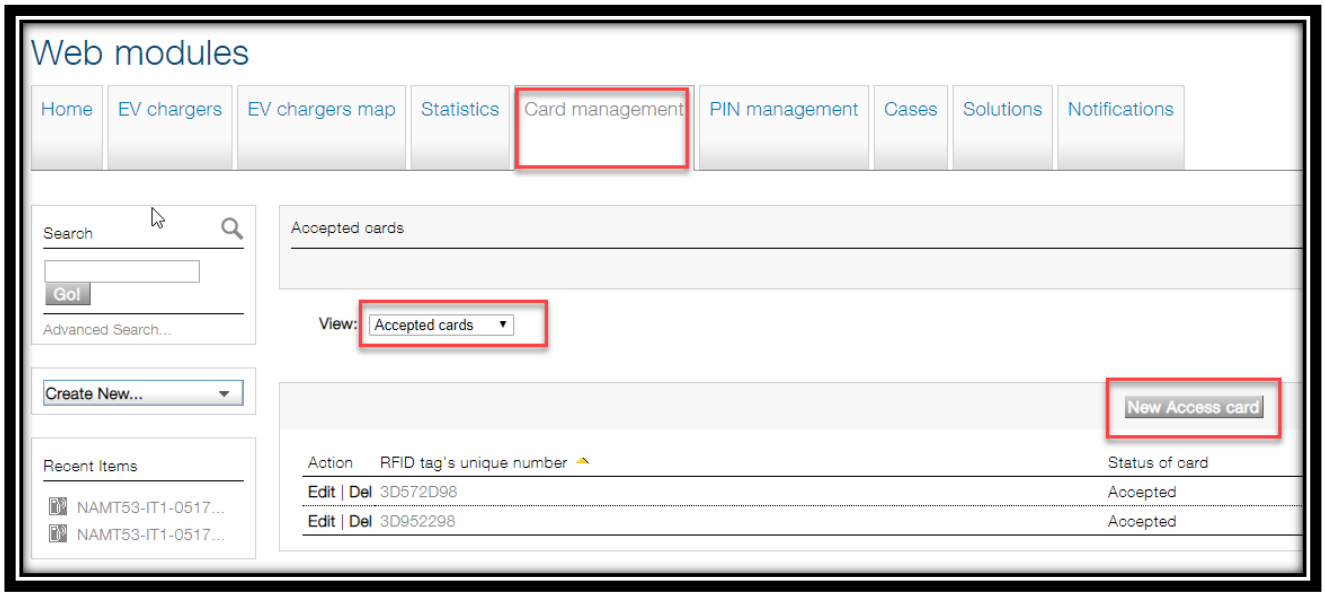
The statistics data can be sent by email or exported to excel sheet by clicking on one button.

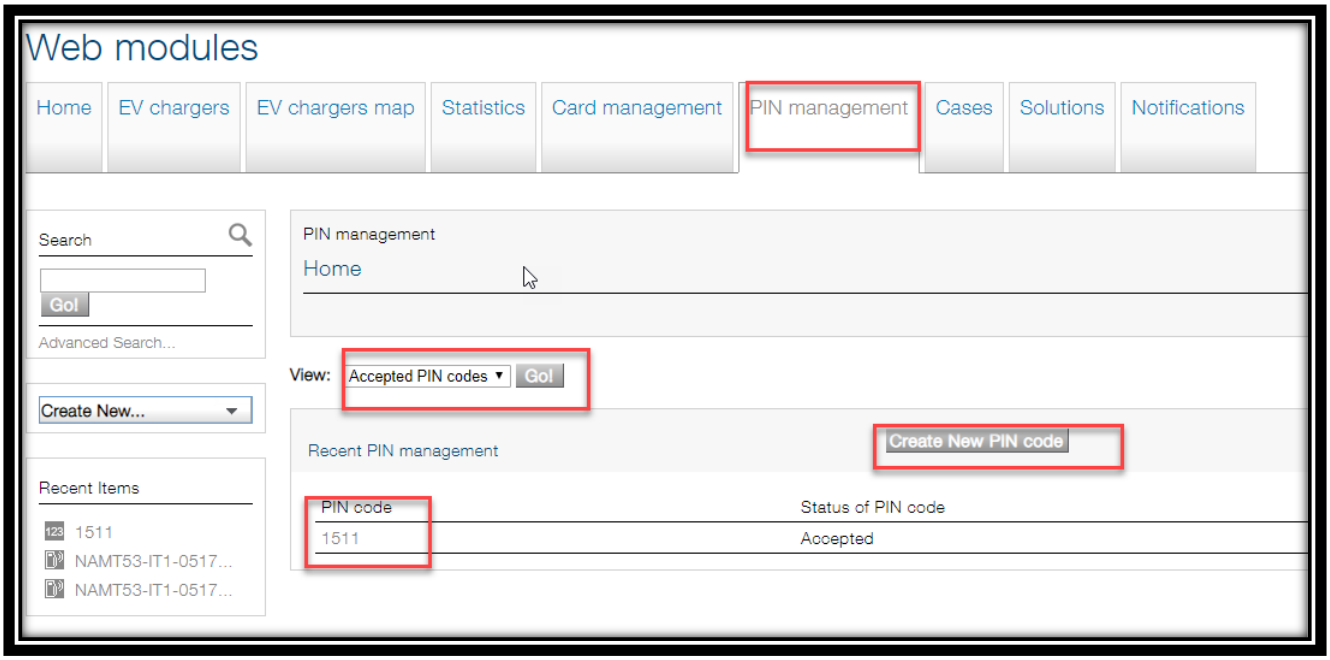


2.7 Access management via RFID Card or PIN module

This feature is available for customer who operate Car chargers only where the charge sessions can be authenticated by using RFID membership card or PIN code.

If the user doesn't have the RFID that is registered in the Webtools the Charger will decline the charge session as this client is not authorized, the same result if wrong PIN code typed on the Charger screen.





2.8 Detailed information for every Charger

By clicking on the Charger name or serial number in the **EV chargers** tab, the Charger page will be opened where the operator can find all the details about this charger as:

a) Communication status for last 24 hours.

b) Charger status for last 24 hours.

c) Chart for last week charge sessions.

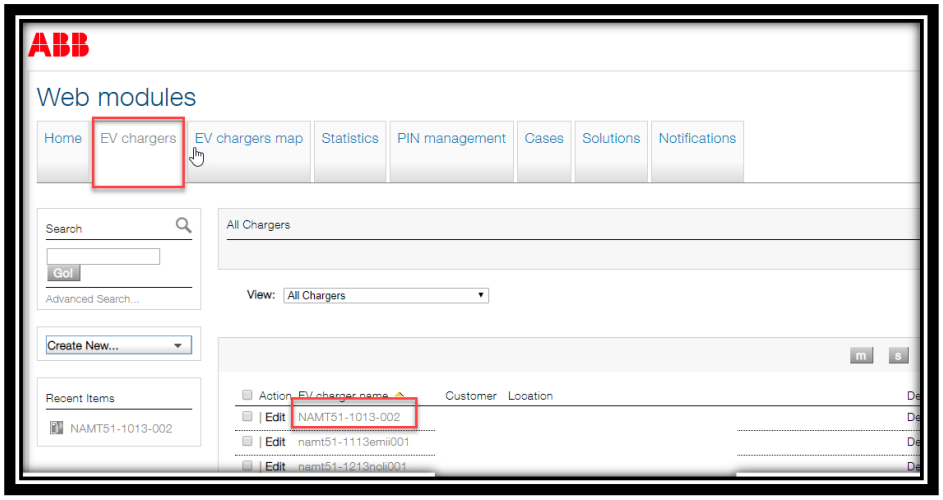
d) Pie chart for the stop reason of the Charge sessions.

e) Charger session page to restart the charger or disable/enable the charger.

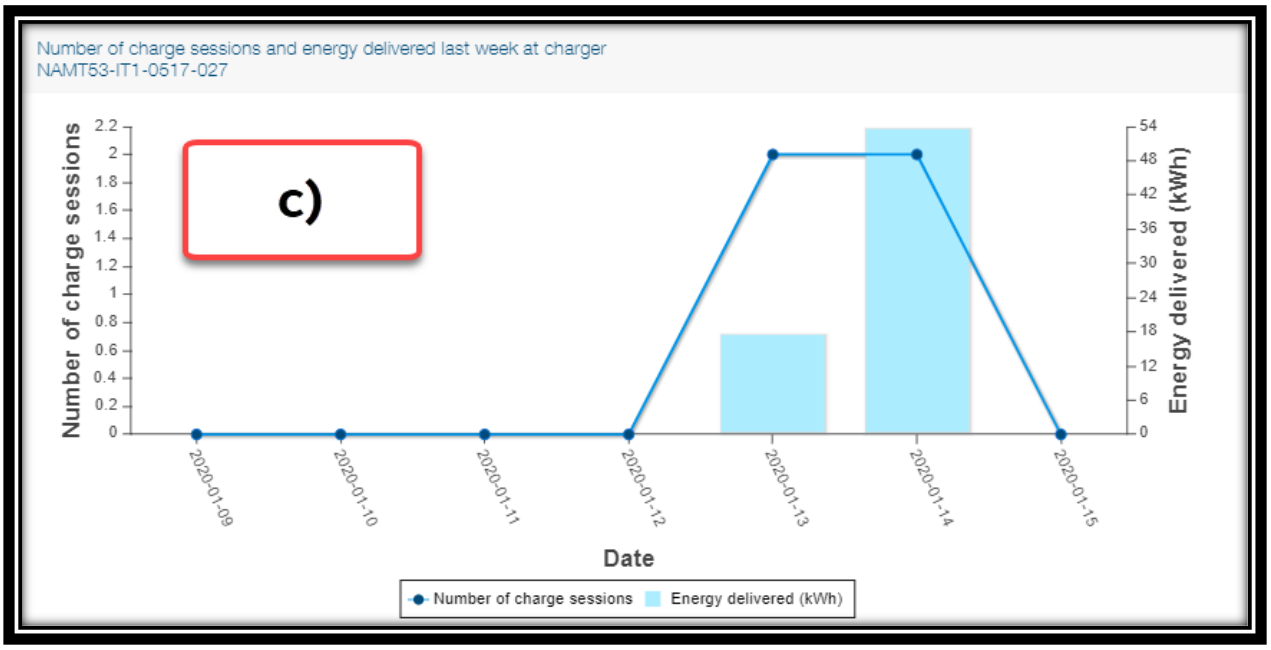
f) Connectors identifications.

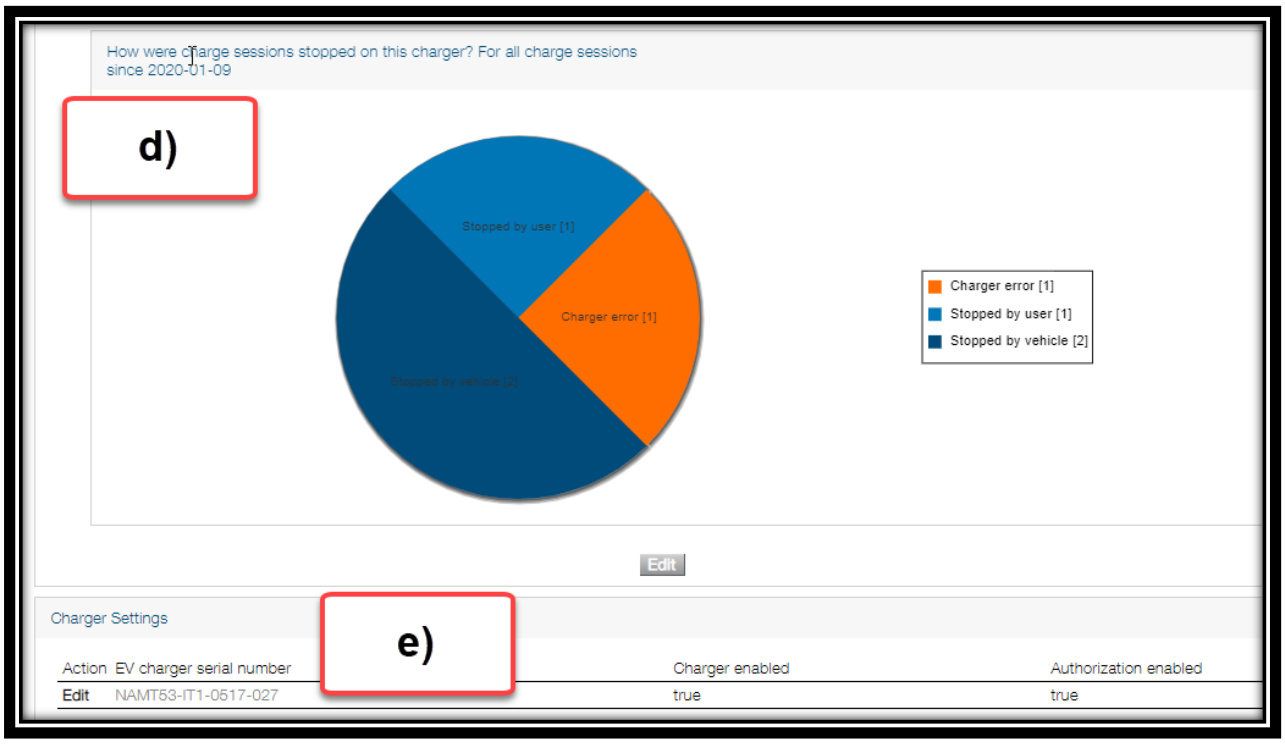
g) Charge sessions history that indicates start time, duration, Energy delivered, stop reason and stop reason detailed.

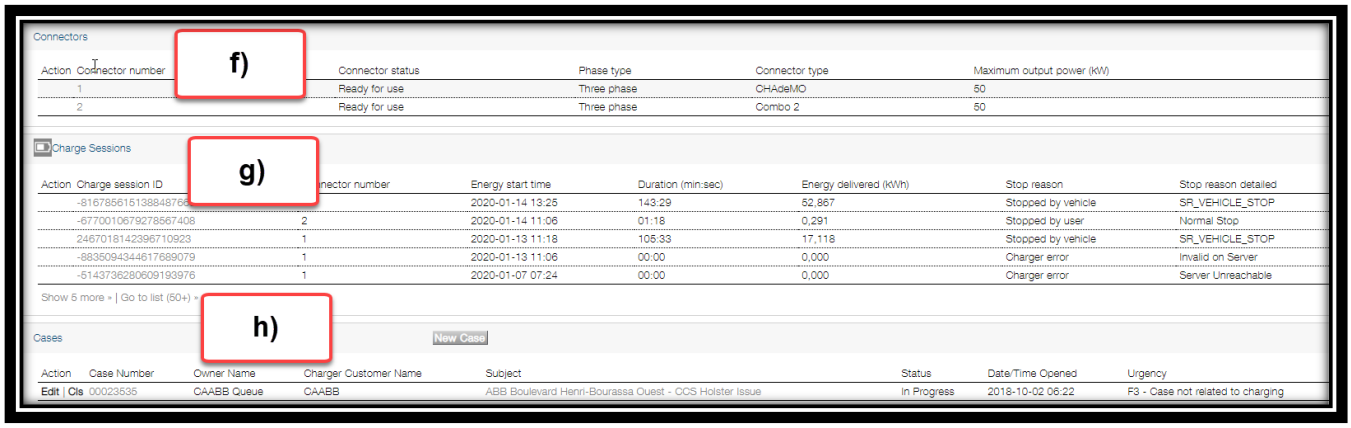
h) Cases related to this specific charger.






Number of charge sessions and energy delivered last week at charger NAMT53-IT1-0517-027
c)
Number of charge sessions
Energy delivered (kWh)
Date
2020-01-09
2020-01-10
2020-01-11
2020-01-12
2020-01-13
2020-01-14
2020-01-15
Number of charge sessions
Energy delivered (kWh)


How were charge sessions stopped on this charger? For all charge sessions since 2020-01-09
d)
Stopped by user [1]
Charger error [1]
Stopped by vehicle [2]
Charger error [1]
Stopped by user [1]
Stopped by vehicle [2]
Edit
Charger Settings
e)
Action
EV charger serial number
Charger enabled
Authorization enabled
Edit
NAMT53-IT1-0517-027
true
true

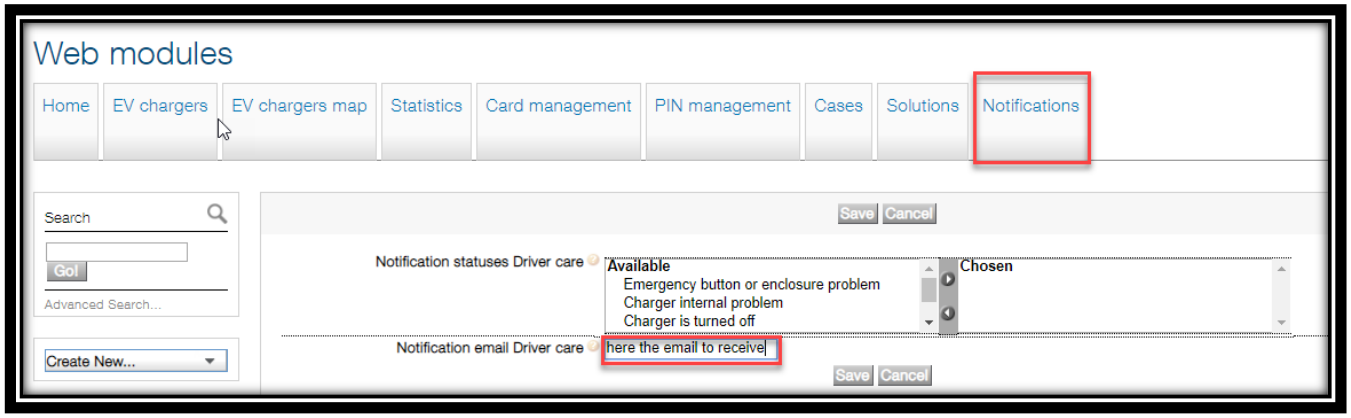


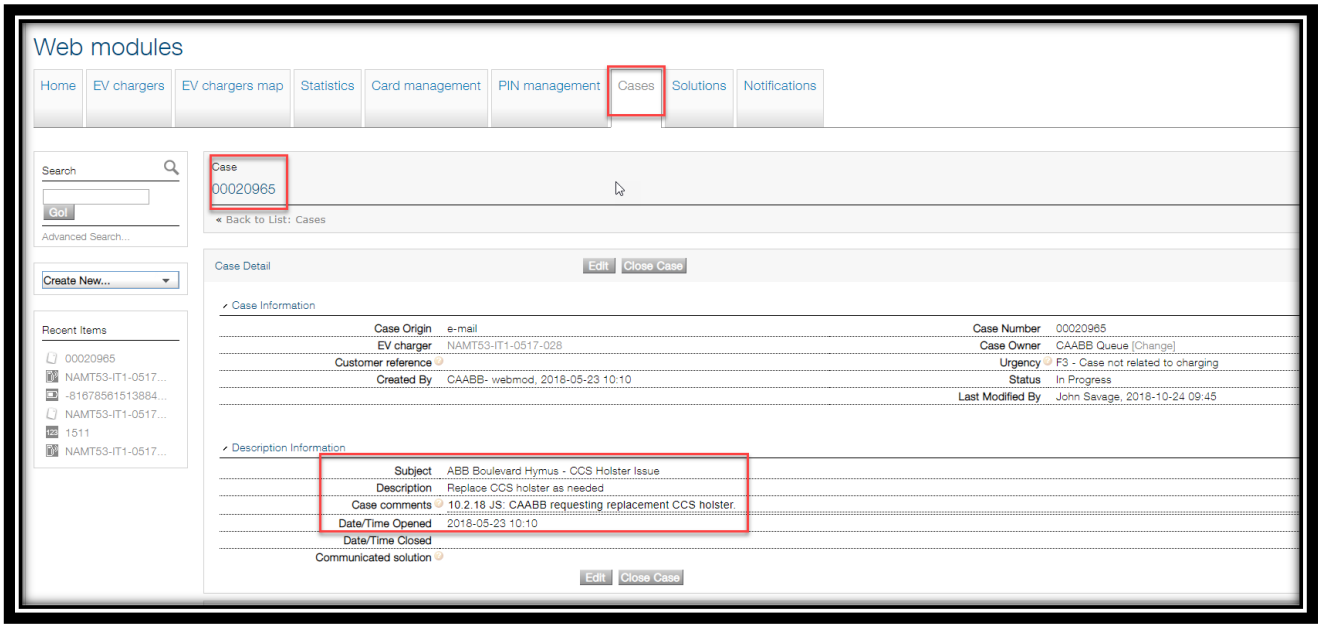
2.9 Notifications, Solutions and Cases

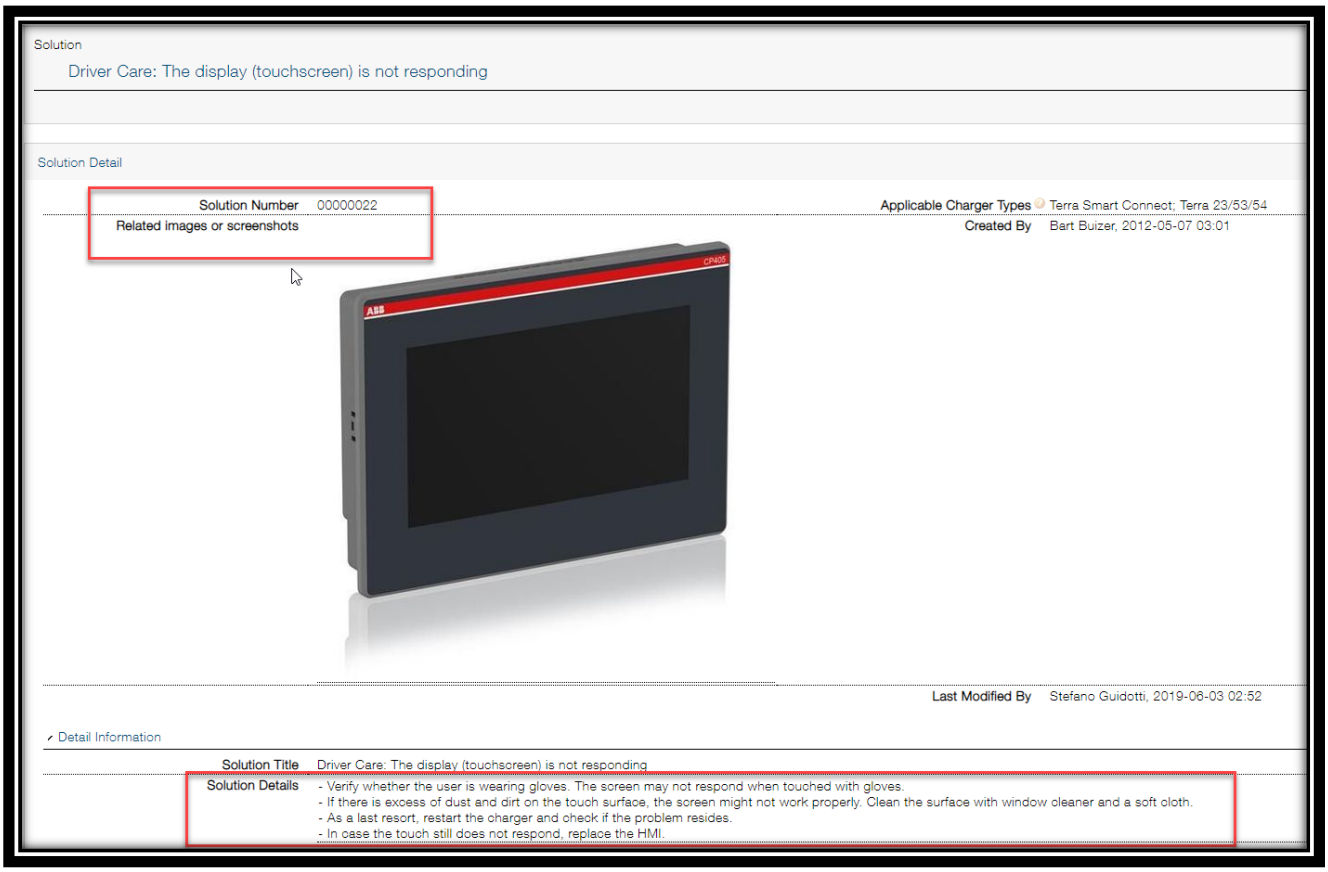
Notifications: This to be used to configure the webtools to send automatic notifications to a certain email address if one or more events happened.

Cases: The operation can create a case to request the technical support to information related to a specific Charger, this case will be directed to the local ABB technical support team who will respond to the case to solve the technical problem remotely or plan a site visit.

Solutions: Where the Operator and the technical team on the customer side can search for similar issues occurred in the past that is fixed by certain actions that called solution. Consulting solutions tab can save time through finding the correct action to solve the problem instead of reporting the problem and waiting for a feedback from the support team.




Web modules
Home
EV chargers
EV chargers map
Statistics
Card management
PIN management
Cases
Solutions
Notifications
Search
Go!
Advanced Search...
Create New...
Recent Items
00020965
Case
00020965
« Back to List: Cases
Case Detail
Edit
Close Case
Case Information
Case Origin e-mail
EV charger NAMT53-IT1-0517-028
Customer reference
Created By CAABB- webmod, 2018-05-23 10:10
Case Number 00020965
Case Owner CAABB Queue [Change]
Urgency F3 - Case not related to charging
Status In Progress
Last Modified By John Savage, 2018-10-24 09:45
Description Information
Subject ABB Boulevard Hymus - CCS Holster Issue
Description Replace CCS holster as needed
Case comments 10.2.18 JS: CAABB requesting replacement CCS holster.
Date/Time Opened 2018-05-23 10:10
Date/Time Closed
Communicated solution
Edit
Close Case


Solution
Driver Care: The display (touchscreen) is not responding
Solution Detail
Solution Number 00000022
Related images or screenshots
Applicable Charger Types Terra Smart Connect; Terra 23/53/54
Created By Bart Buizer, 2012-05-07 03:01
Last Modified By Stefano Guidotti, 2019-08-03 02:52
Detail Information
Solution Title Driver Care: The display (touchscreen) is not responding
Solution Details - Verify whether the user is wearing gloves. The screen may not respond when touched with gloves.
- If there is excess of dust and dirt on the touch surface, the screen might not work properly. Clean the surface with window cleaner and a soft cloth.
- As a last resort, restart the charger and check if the problem resides.
- In case the touch still does not respond, replace the HMI.

3 Webtool “Charger Care”

Charger Care webtool is advance service tool for operators and service providers, which provide more technical tools to diagnose and troubleshoot the charger, in addition it is featured by the documents tab where the operator can find useful updated documents about EV charging. Spare parts are a very beneficial component of Charger Care where the certified service engineers can learn about the spare part list for any model.

3.1 Benefit

- Reduced time to repair → charger uptime.
- Efficient and optimized own service operation.
- Improved service level of network due to optimized charger support.

3.2 Main features

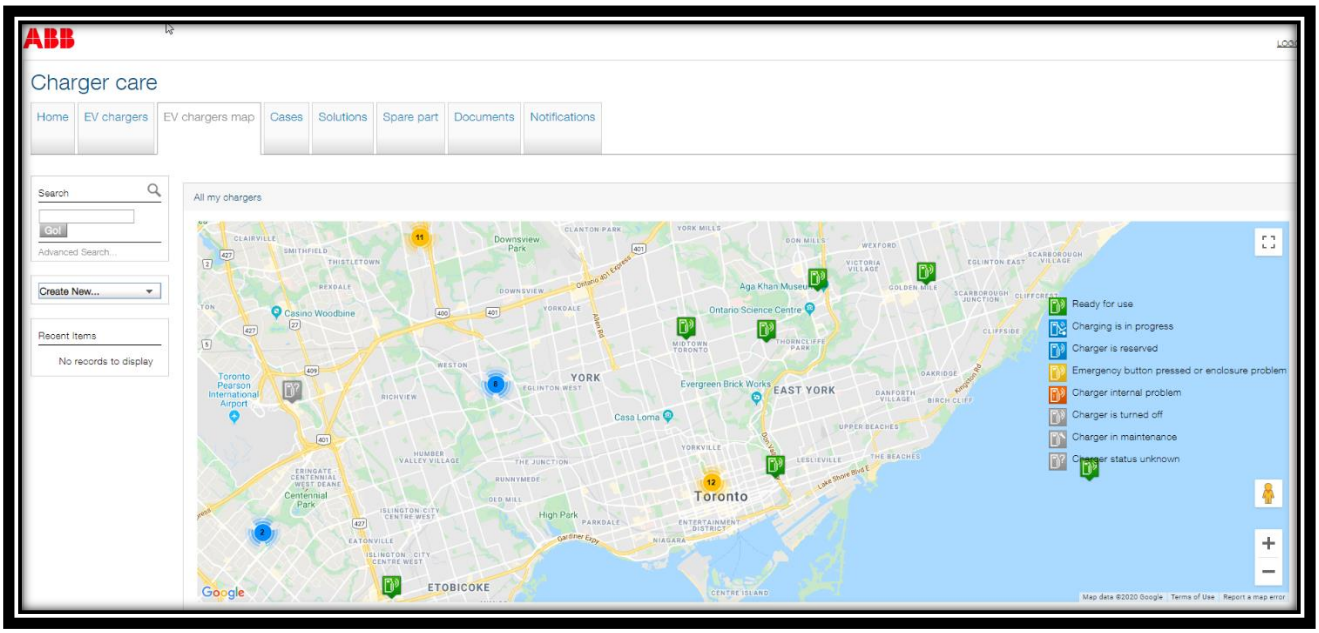
- Remote monitoring and advanced diagnostics features
  - Charger network overview.
  - Status & statistics on charger level.
  - Real time insights on component level status, parameters and HW versions.
- Access to advanced settings and remote action
  - Changing parameters and configurations
  - Rebooting individual boards
- Spare part data and ordering instruction.
- Access to solution library and technical documentation.
- Case Management and automatic notifications.
- For Terra 53, Terra 54, Bus, Wallbox and HPC (not for T51).

3.3 Requirements

- Can only be operated by certified service engineers.

3.4 Real-time monitoring / EV charger map

For all connected chargers the communication status and the Charger status are always updated in real-time. All communication status messages and Charger status wording are included in Appendix I and II at the end of this guide.

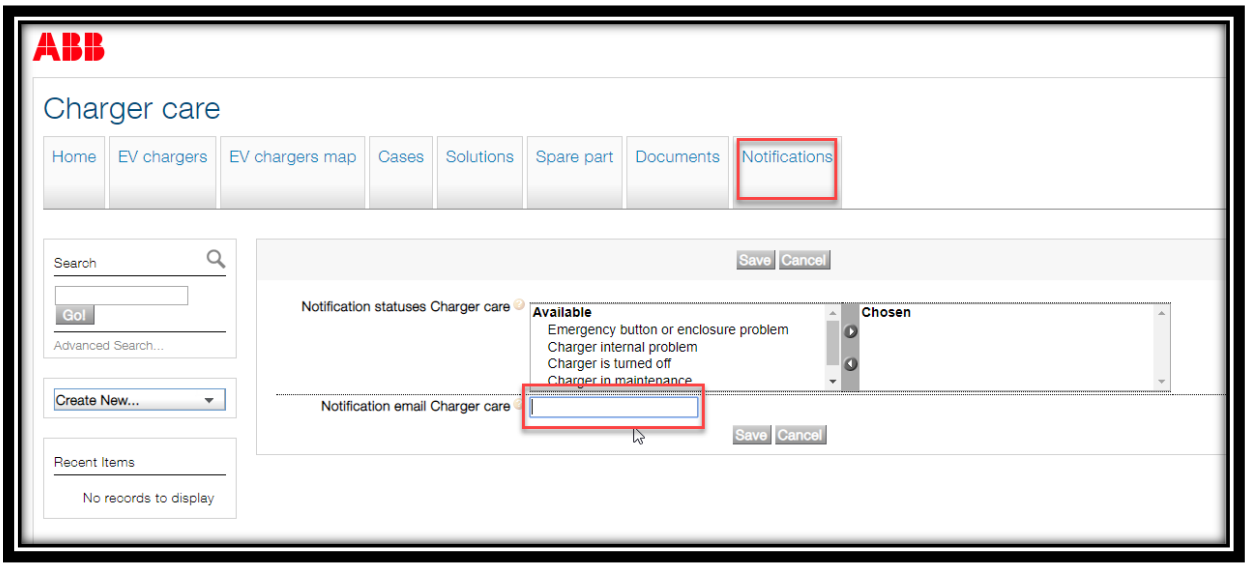


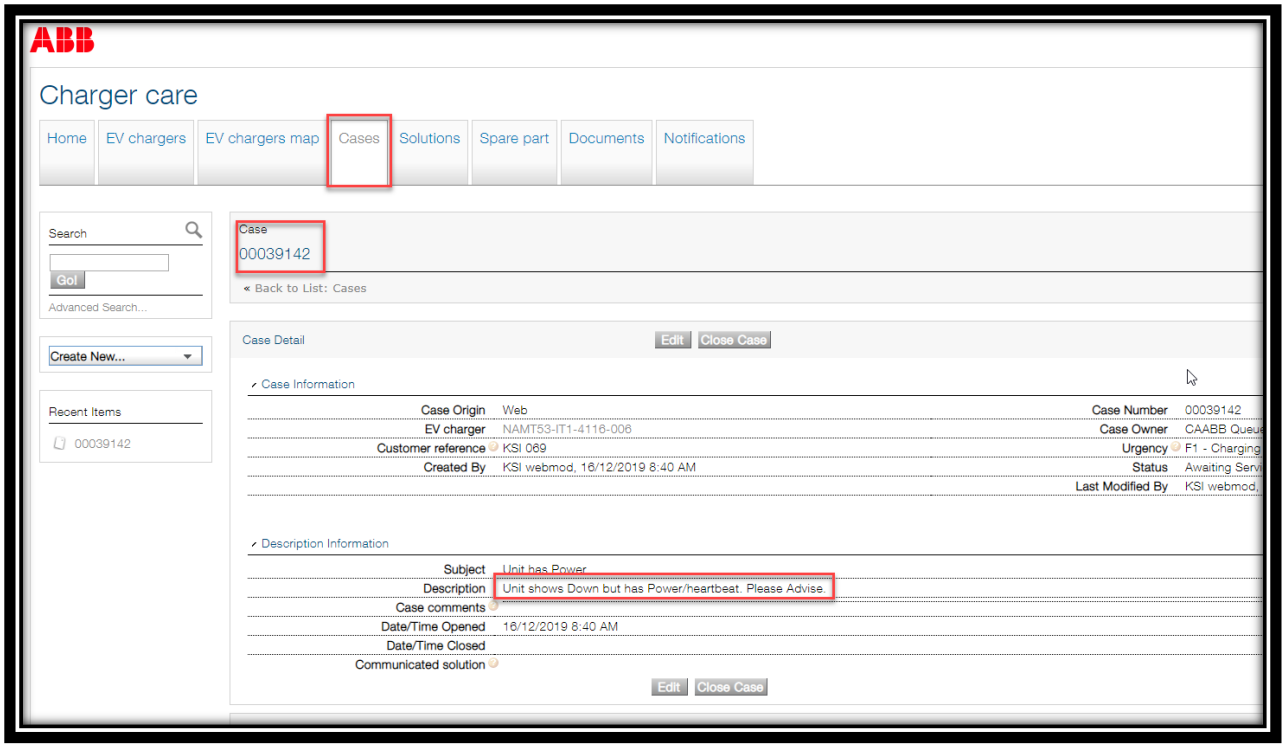
3.5 Notifications, Solutions and Cases

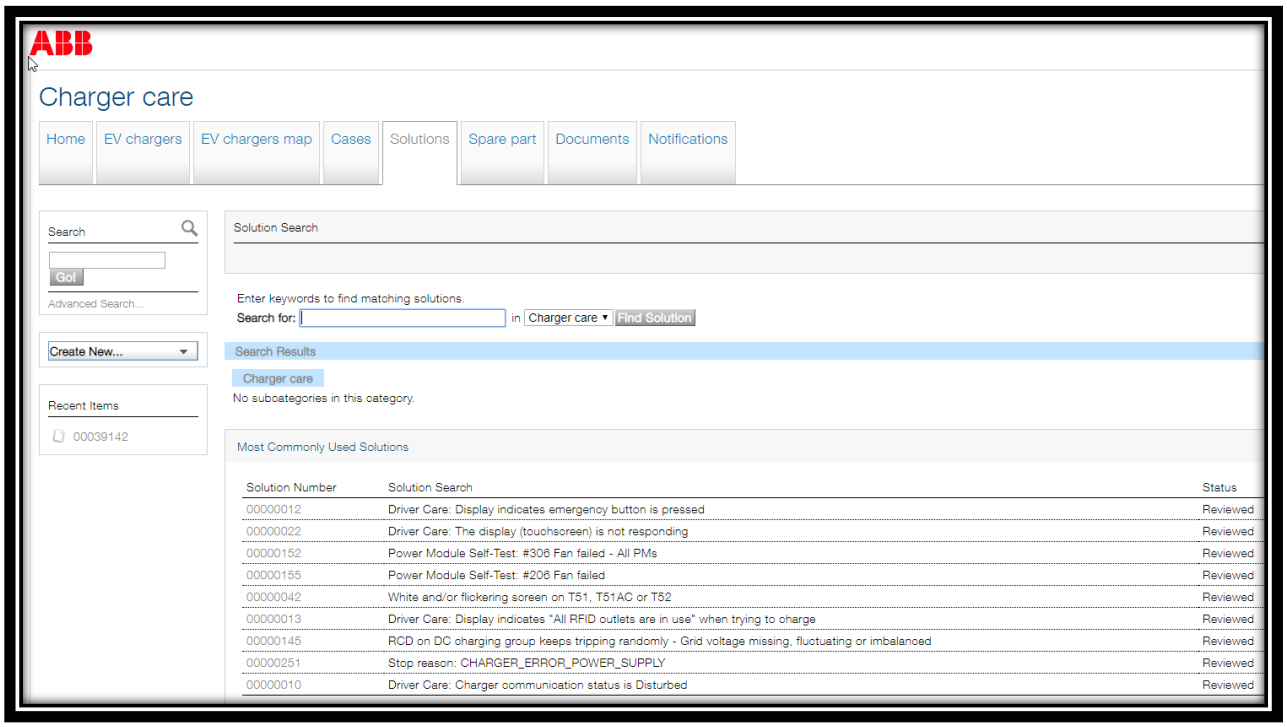
Notifications: This to be used to configure the webtools to send automatic notifications to a certain email address if one or more events happened.

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Solutions: Where the Operator and the technical team on the customer side can search for similar issues occurred in the past that is fixed by certain actions that called solution. Consulting solutions tab can save time through finding the correct action to solve the problem instead of reporting the problem and waiting for a feedback from the support team.




Charger care
Home
EV chargers
EV chargers map
Cases
Solutions
Spare part
Documents
Notifications
Search
Go!
Advanced Search...
Create New...
Recent Items
00039142
Case
00039142
« Back to List: Cases
Case Detail
Edit
Close Case
Case Information
Case Origin Web
EV charger NAMT53-IT1-4116-006
Customer reference KSI 069
Created By KSI webmod, 16/12/2019 8:40 AM
Case Number 00039142
Case Owner CAABB Queue
Urgency F1 - Charging
Status Awaiting Servi
Last Modified By KSI webmod,
Description Information
Subject Unit has Power
Description Unit shows Down but has Power/heartbeat. Please Advise
Case comments
Date/Time Opened 16/12/2019 8:40 AM
Date/Time Closed
Communicated solution
Edit
Close Case


Charger care
Home
EV chargers
EV chargers map
Cases
Solutions
Spare part
Documents
Notifications
Search
Go!
Advanced Search...
Create New...
Recent Items
00039142
Solution Search
Enter keywords to find matching solutions.
Search for:
in Charger care
Find Solution
Search Results
Charger care
No subcategories in this category.
Most Commonly Used Solutions
Solution Number | Solution Search | Status
00000012 | Driver Care: Display indicates emergency button is pressed | Reviewed
00000022 | Driver Care: The display (touchscreen) is not responding | Reviewed
00000152 | Power Module Self-Test: #306 Fan failed - All PMs | Reviewed
00000155 | Power Module Self-Test: #206 Fan failed | Reviewed
00000042 | White and/or flickering screen on T51, T51AC or T52 | Reviewed
00000013 | Driver Care: Display indicates "All RFID outlets are in use" when trying to charge | Reviewed
00000145 | RCD on DC charging group keeps tripping randomly - Grid voltage missing, fluctuating or imbalanced | Reviewed
00000251 | Stop reason: CHARGER_ERROR_POWER_SUPPLY | Reviewed
00000010 | Driver Care: Charger communication status is Disturbed | Reviewed

3.6 Advanced technical information and diagnosis tools for every charger

For a Charger care account holder, all the parameters are available to be modified, for both technical parameters and administrative parameters.

Technical parameters can be modified though EV charger page, where the operator modify a value for a variable and this modification takes place in the same exact moment to affect the charger in the field. Examples for that:

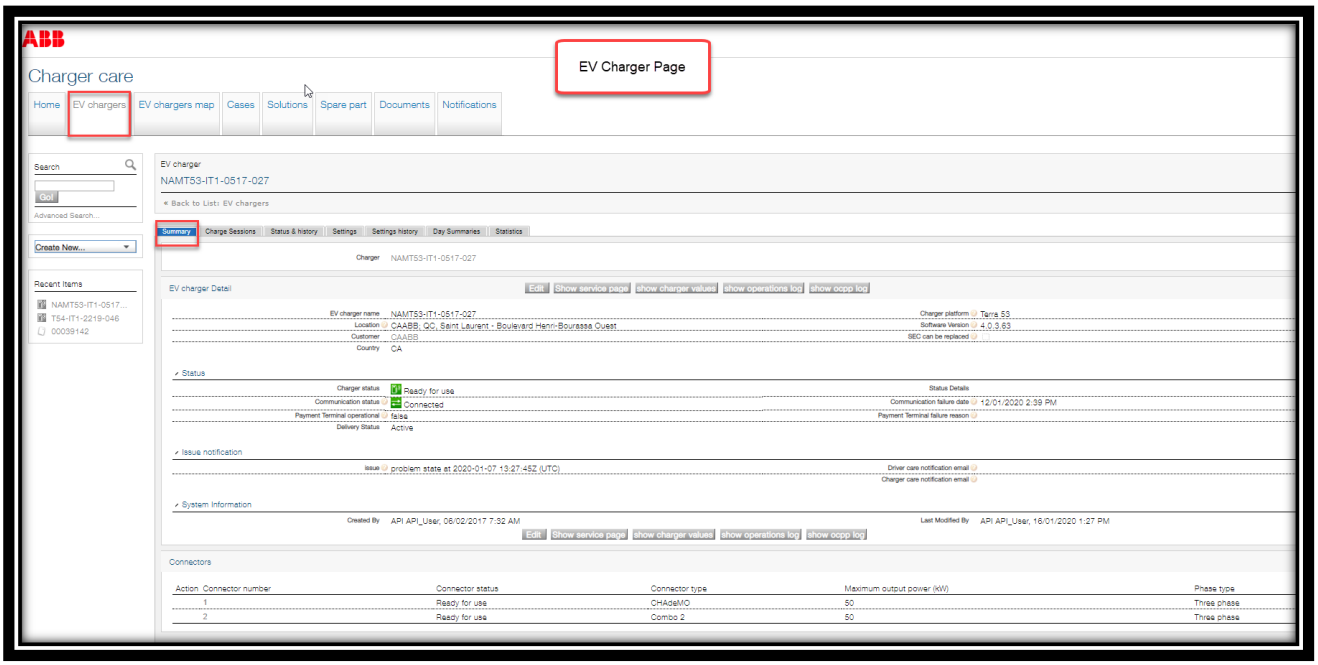
- Maximum input current for the charger (to control the load that a charger can apply on the electric gird).
- Language of the screen.
- Authorization method(s): OCPP, PIN, RFID.
- Payment terminal Authorization enabling/disabling.
- Fall back mode.
- Auto Charge feature.
- Monitoring the power modules status and the number of active power modules, executing self-test.
- Day summary reports.

Administrative fields can be controlled through Charger page, where the operator can modify the location parameters, customer name, attach a document or a report, setting the address and assign a location remark to this charger.

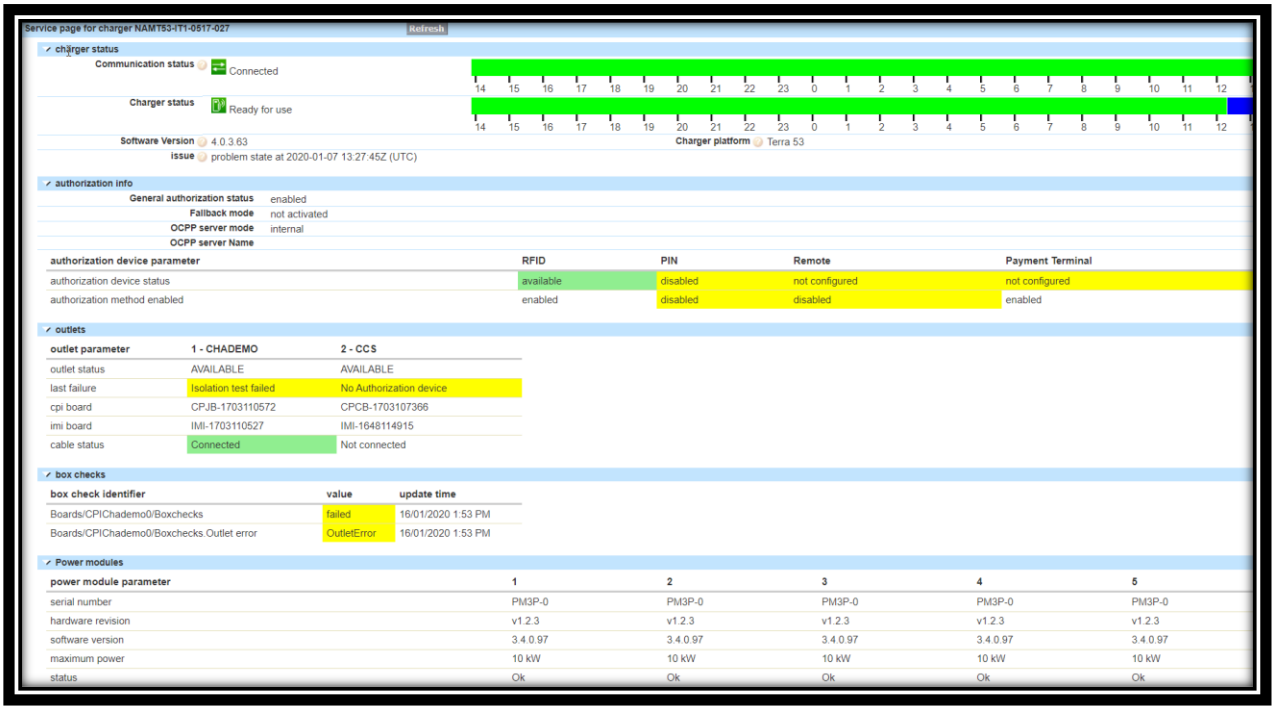
Below some images from both EV charger page and Charger page showing the different parameters that can be modified.

3.6.1 EV Charger page

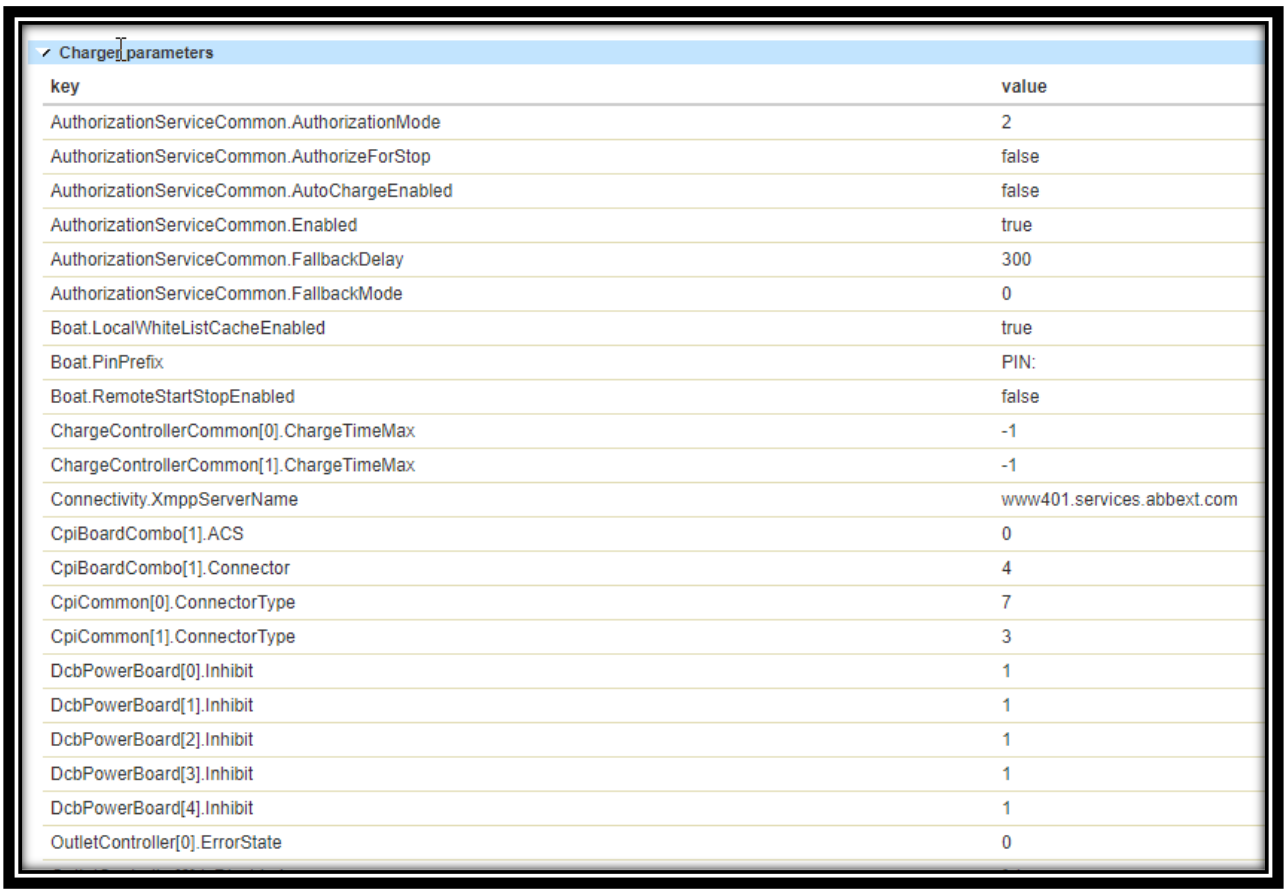
3.6.1.1 EV Charger Page -> Summary



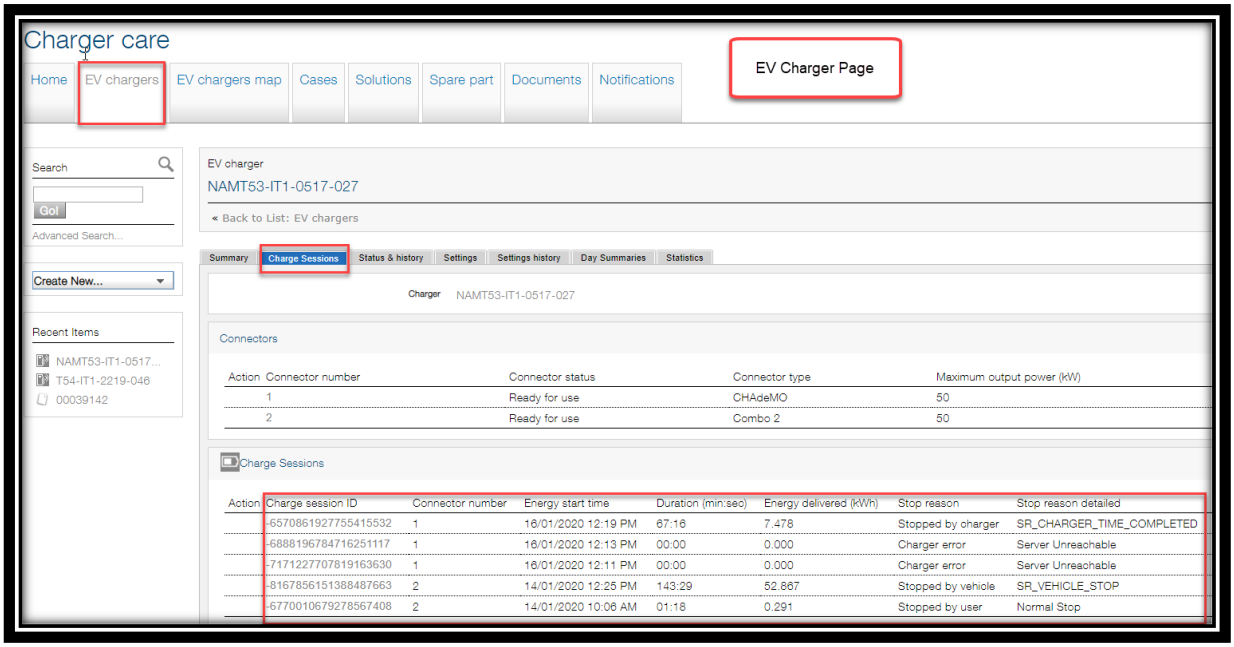
3.6.1.2 EV Charger Page -> Summary -> Show Service Page



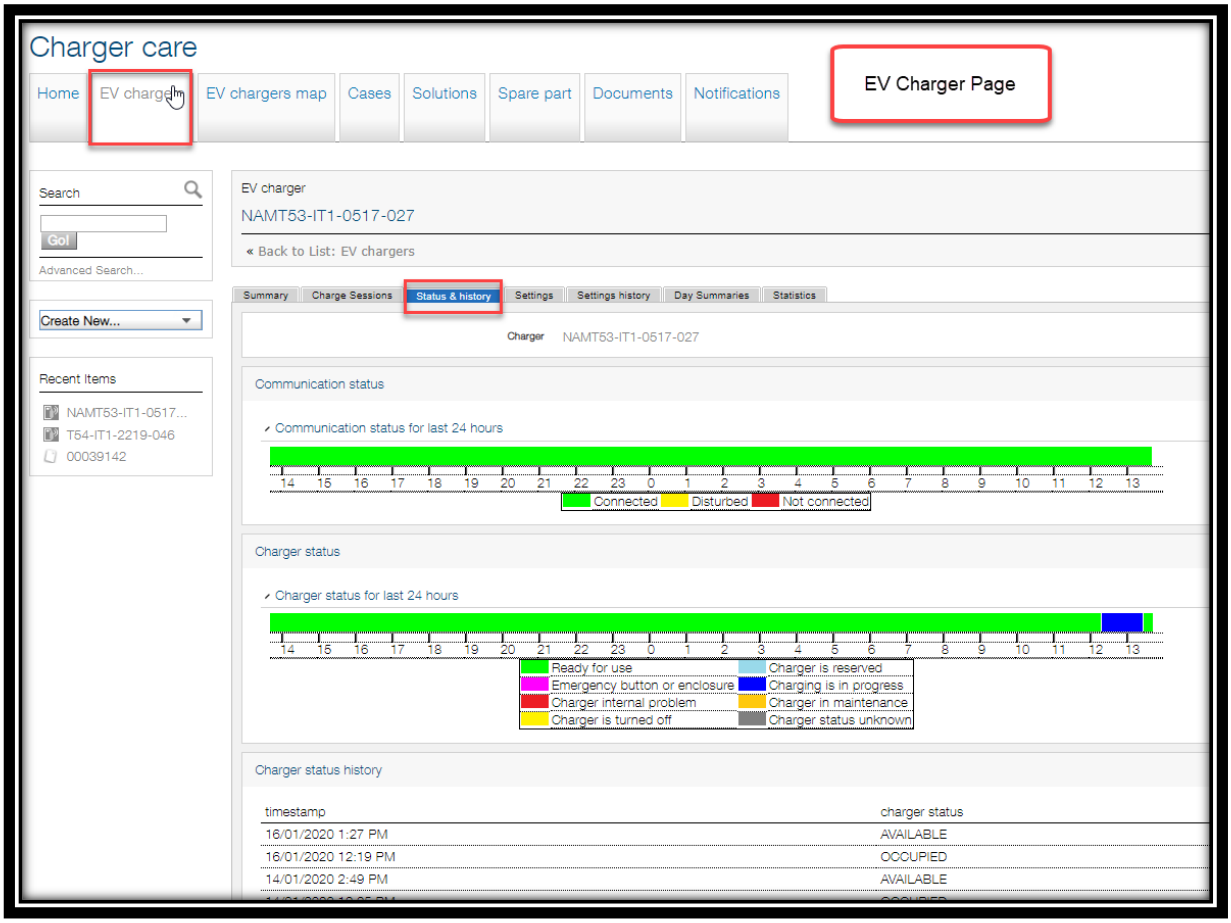
3.6.1.3 EV Charger Page -> Summary -> Show Charger values



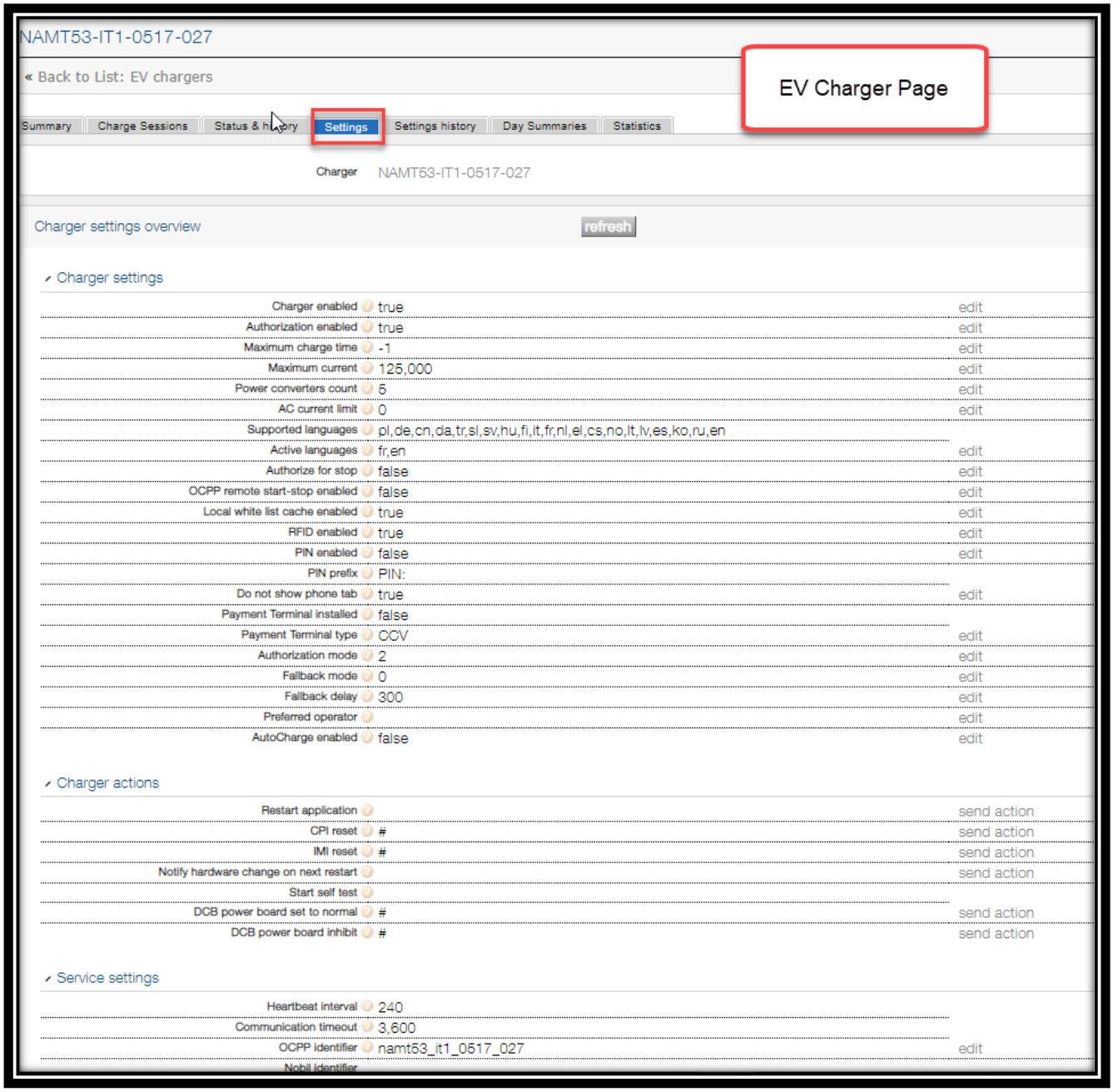
3.6.1.4 EV Charger Page -> Charger Sessions



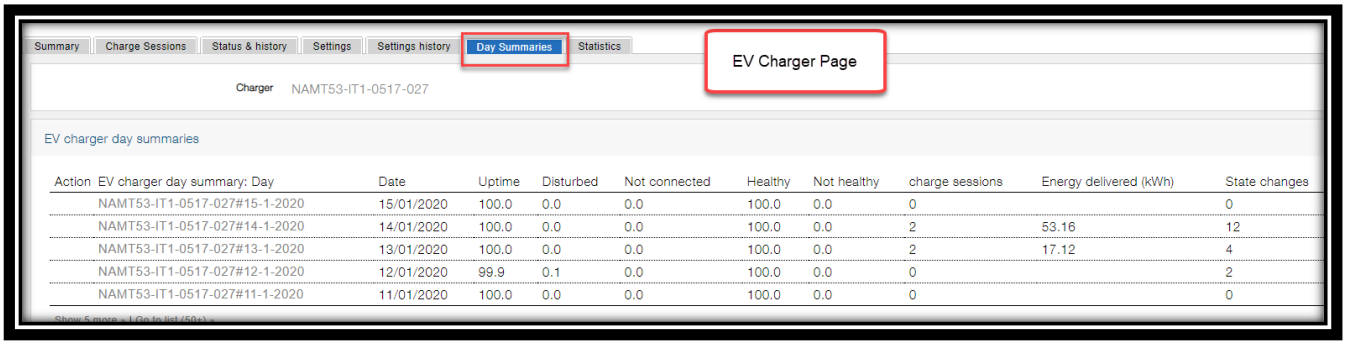
3.6.1.5 EV Charger Page -> Status & history



3.6.1.6 EV Charger Page -> Settings

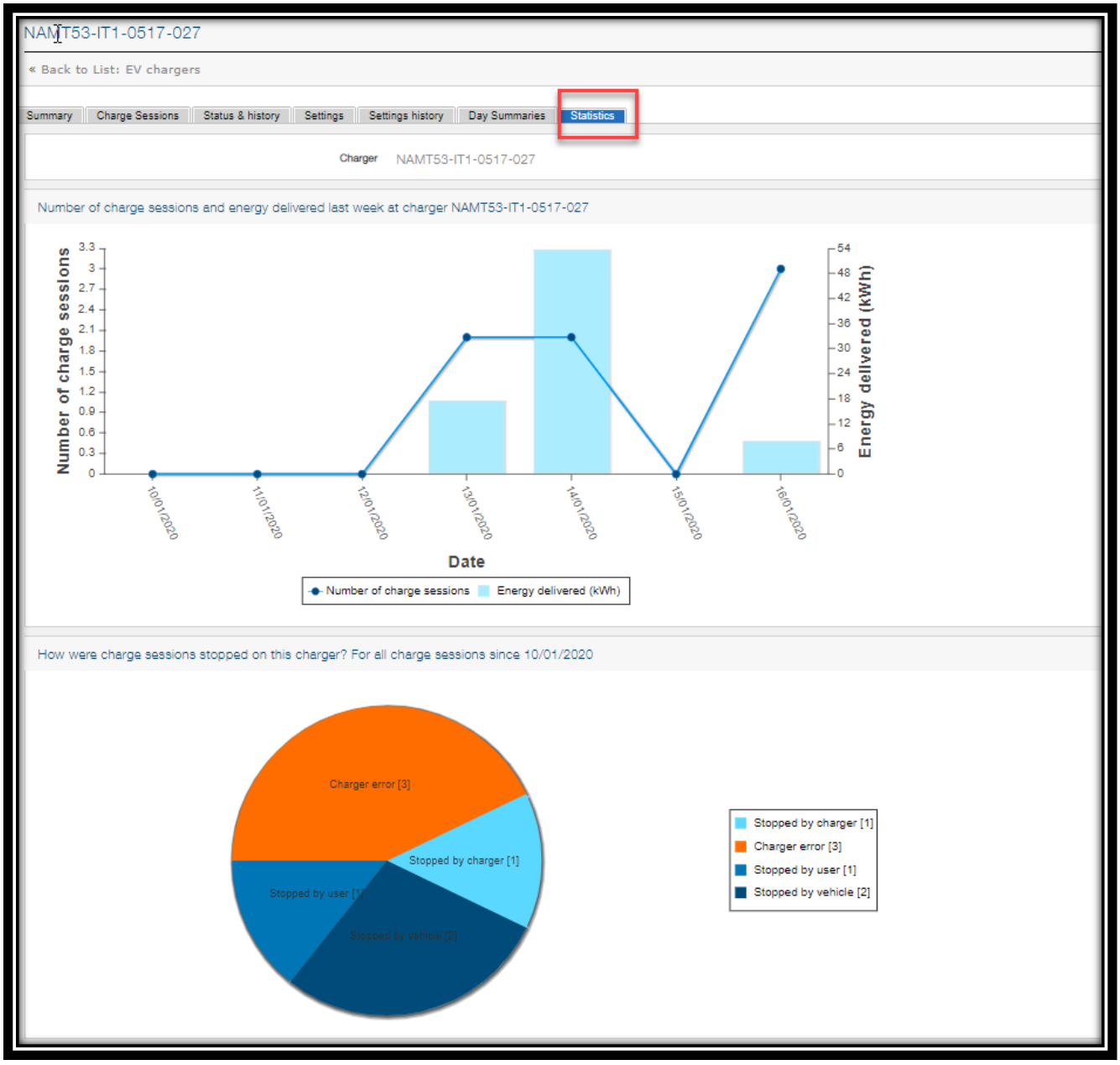


3.6.1.7 EV Charger Page -> Day Summaries

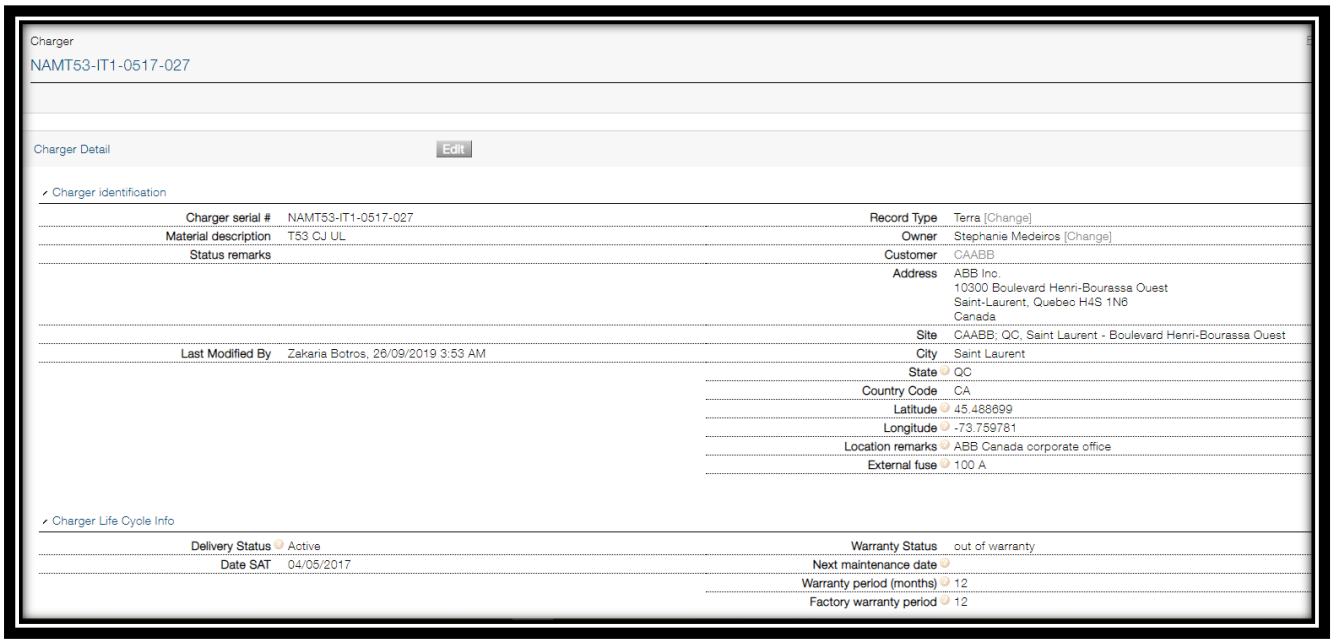


Action	EV charger day summary: Day	Date	Uptime	Disturbed	Not connected	Healthy	Not healthy	charge sessions	Energy delivered (kWh)	State changes
	NAMT53-IT1-0517-027#15-1-2020	15/01/2020	100.0	0.0	0.0	100.0	0.0	0		0
	NAMT53-IT1-0517-027#14-1-2020	14/01/2020	100.0	0.0	0.0	100.0	0.0	2	53.16	12
	NAMT53-IT1-0517-027#13-1-2020	13/01/2020	100.0	0.0	0.0	100.0	0.0	2	17.12	4
	NAMT53-IT1-0517-027#12-1-2020	12/01/2020	99.9	0.1	0.0	100.0	0.0	0		2
	NAMT53-IT1-0517-027#11-1-2020	11/01/2020	100.0	0.0	0.0	100.0	0.0	0		0

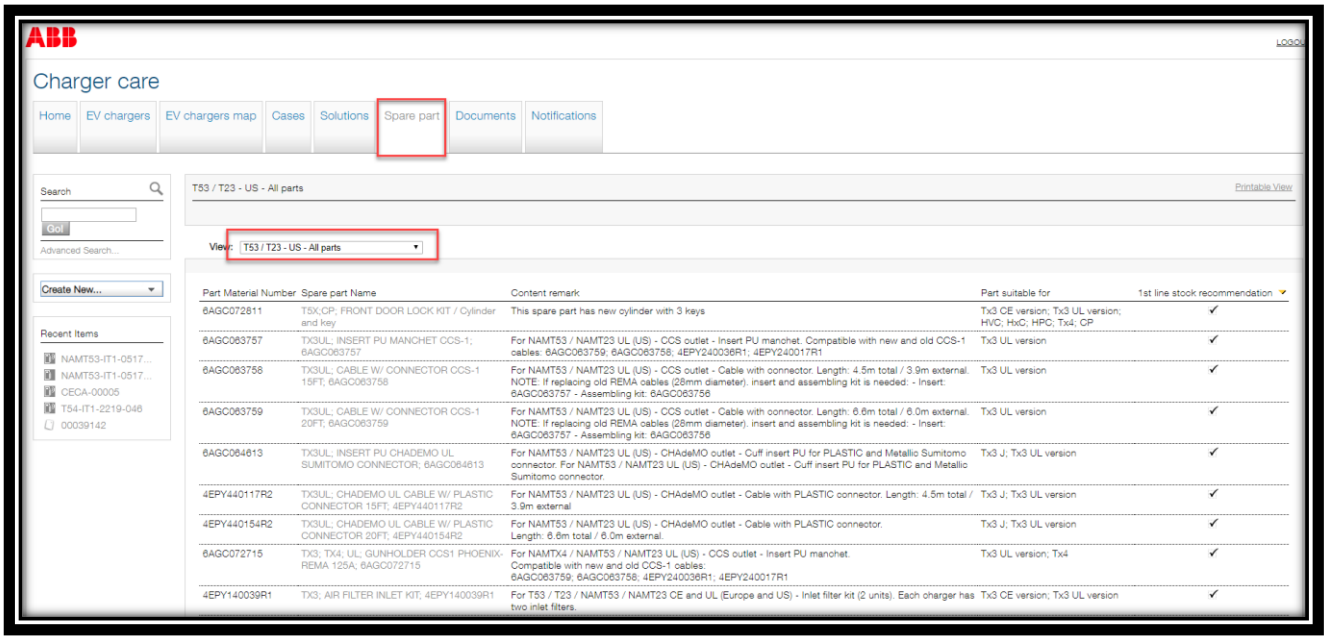
3.6.1.8 EV Charger Page -> Statistics



3.6.2 Charger page



3.7 Spare part



From the Drop down list the operator can choose the model to have all the spare parts related to this model. This is very beneficial for service team to forecast their inventory and order directly the replacement for the faulty part.

3.8 Documents

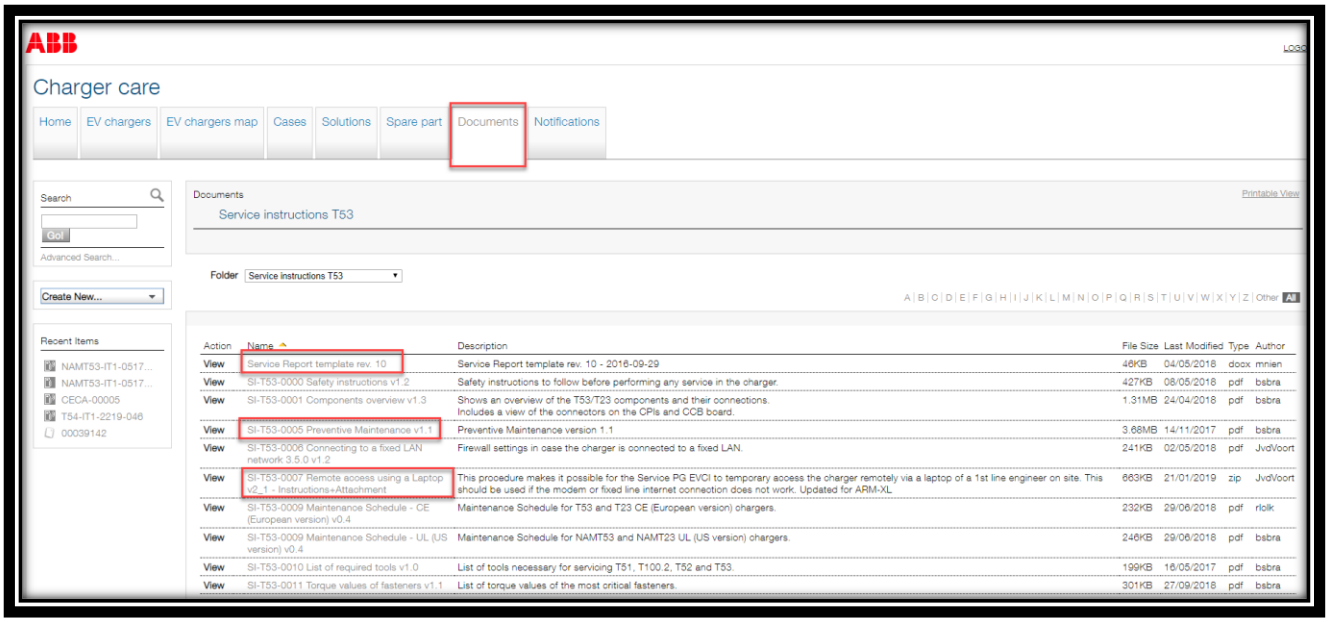


ABB Charger care tool contains a lot of documents related to service and gathering technical experience we had from the field. Also, documentations about required step to perform a task to repair a specific technical problem. In addition, the service instructions is a very useful document to inform the team about finding related to the product that they might face in the field.

Example for service instruction document:



SI-T53-0107	Replace 3G antenna						
		C	J	G	T	Pages	1
Subjected chargers	T53	X	X	X	X	Version	2.2
						Date	15-05-2017
Estimated Time						Assistance 2nd line support required?	No
	part description					Quantity	
Required parts	TX3; 3G ANTENNA; 4EPY230065R1					1	
Required tools	Wrench size 8 mm and 24 mm						
Preparation	Make sure no water can leak into the charger when removing the old antenna						

Purpose of the instruction and short description:
Instruction to replace the 3G antenna if the old one is damaged

Specific risks and attention points:
When the old antenna is damaged or removed, water can leak into the charger. Check for signs of water damage before turning the charger back on.

Contact 2nd line support reason:
No remote assistance by 2nd line support needed to complete this Service Instruction

Procedure:

1) Before performing any work, follow the procedure **SI-T53-0000 Safety instructions**.
2) Unscrew the SMA connector on the HMI module (A).
3) Release the antenna wire from the wiring harness.
4) The antenna is attached to the top of the cabinet. Loosen the nut and remove the old antenna.
5) Install the new antenna and tighten the nut against the cabinet (torque value is 5,0 Nm).
6) Make sure the seal is watertight.
7) Route the cable to the HMI module and connect the SMA connector.
8) Switch on the charger and check if the charger comes online in the Helios suite.

4 Communication status, Charger status and error codes list

ABB webtools are using a list of words to express the status of the charger, error codes related to a charge session “stop reason” and the communication status between the charger and the server.

Error codes	Charger status	Communication status
Stop reason detailed	Charger status	Connected
SR_VEHICLE_STOP	Ready for use	Connected
SR_GLOBAL_INTERLOCK_FAIL	Ready for use	Not connected
SR_VEHICLE_STOP	Ready for use	
SR_GLOBAL_INTERLOCK_FAIL	Outlet(s) turned off	Not connected
SR_VEHICLE_STOP		
		Connected

4.1 Communication status list

status	Meaning	Action to do
Connected	The Charger is online and well connected to the server.	N.A
Not connected	The charger is offline	If the charger is powered up and show offline on the Webtool, you can reset the modem through rebooting the charger.
Disturbed	The charger was online, and the communication just interrupted	If the charger has powered the status will be connected soon. this status is usually seen when we reboot the charger.
Migrated	The charger just had a SW update and could not connect to the server	Contact ABB local support team

4.2 Charger status list

status	Meaning	Action to do
 Ready for use	Charger is available for charging	Connect your Vehicle to the charger to start charging
 Charging in progress	There is a session in progress, a summary for this session will be logged into the charge sessions tab	N.A
 Charger is reserved	The charger is reserved according to a schedule according to the programmed configuration.	Contact the operator for this Charger for more info.
 Unavailable - emergency button pressed	The emergency button is pressed mechanically	Release the emergency button if there is no emergency or contact the Operator for more info.
 Charger in error	There is internal error in the Charger	Contact the local ABB service department.
 Outlet(s) turned off	The charger is disabled	Contact the operator for more info.
 Charger in maintenance	If there is a current maintenance activity in the charger	Contact the operator for more info.
 Status unknown	There is no communication between the charger and the server	You can power cycle the charger if this did not help contact ABB local service point.
 Unavailable - door open	One or more door(s) of the charger is open, or the sensor is faulty.	Close the door if it is not needed to be open, if the issue still the same contact local ABB service center.

4.3 Error codes list

ABB charger declare the stop reason for every single charging session occurred on ABB chargers, the stop reason columns is listed in the EV Charger page in any webtool account.

Here a list of error codes or stop reason for charge sessions with an explanation for possible reason and the action to be considered in such situation.

Error code	Meaning / reason behind	Action to do
NORMAL STOP	Normal charge session which ended by the normal behavior as expected	N.A
SR_VEHICLE_STOP	The Vehicle requested to stop the session, through the operator request or internal trigger in the controller of the Vehicle	If the Vehicle operator requested to stop then no action required, if the vehicle stop the session unexpectedly contact the vehicle manufacturer service center. at any time you can consult local ABB service center for more details if needed.
REMOTE STOP REQUEST	The remote back end of the Charger operating company sent a stop request through the OCPP communication channel.	If this trigger to stop the session is not as expected , please contact your OCPP back end support.
SR_ACS_ERROR_ALIGNMENT	The Pantograph did not find the BUS rails when it full extended	The driver is required to step out of the Vehicle to visually check if the Bus well located under the Pole to have the Pantograph rails contact the bus rails or not. if the error repeated while the bus is well located under the pantograph, contact local ABB service center.

Error code	Meaning / reason behind	Action to do
SR_ACS_ERROR_EXTENDING	Problem happened that prevent the Pantograph from Extending	Try another charging session if the error is repetitive contact local ABB service Center.
SR_ACS_EXTENDED_TIMEOUT	The time allocated to the pantograph to extend is finished before the pantograph is fully extended, Probably an internal problem in the mechanism of the pantograph	Contact local ABB service center
SR_ACS_RETRACTED_TIMEOUT	The time allocated to the pantograph to retract is finished before the pantograph is fully retracted, Probably an internal problem in the mechanism of the pantograph	Contact local ABB service center
SR_CHARGER_CONNECTOR_PRESENCE_LOST	The Charging cable lost the signal for the connectivity with the Vehicle modem.	Try another charge session, if the problem repeated contact vehicle's service support team. at any time, you can consult local ABB service center for more details if needed.
SR_CHARGER_ERROR	Internal error in the charger	Contact local ABB service center
SR_CHARGER_MAX_VOLTAGE	The voltage measured by the charger on the vehicle side or requested by the Vehicle is exceeding the max voltage value listed in the charge session log.	Contact local ABB service center or Vehicle's service support team.
SR_CHARGER_VOLTAGE_DROP	The voltage measured by the charger on the vehicle side is lower than voltage requested by the vehicle or delivered by the power modules.	Contact local ABB service center
SR_CONNECTOR_ERROR	Problem in the connectivity between the charger and the vehicle	Contact local ABB service center

Error code	Meaning / reason behind	Action to do
SR_EMERGENCY_STOP	An emergency stop status raised by either the charger or the vehicle for a reason define din the internal logic of the equipment.	Contact local ABB service center or Vehicle's service support team
SR_GLOBAL_INTERLOCK_FAIL	An error happened in the interlock s=circuit of the charger like opening the door during the charge session or pressing the emergency stop button. in addition this may occurs if the interlock circuit is faulty.	If no one open the door during the charge session or pressed the emergency stop butting during the charger session, Contact local ABB service center
SR_ISOLATION_TEST_FAILED	The isolation monitoring mechanism in the charger found an isolation problem in the charging system overall, it could be the cable that connect the charger to the vehicle or the vehicle internal system.	Contact local ABB service center or Vehicle's service support team
SR_OUTLET_ERROR	Internal problem in the outlet "connector or cable between the vehicle the charger"	Contact local ABB service center
SR_POWERPORT_POWER_ERROR	Internal problem in the charger caused by one or more faulty component	Contact local ABB service center
SR_USER_REQUESTED_STOP	The user clicked or pressed the stop button over the charger screen, or the charger stop button.	If no user pressed the stop button please contact local ABB service center or Vehicle's service support team
SR_VEHICLE_NOT_CONNECTED	The connection between the charger and the vehicle is interrupted	Try to connect the vehicle again if the problem repeated contact local ABB service center
SR_VEHICLE_PROTOCOL_ERROR	The vehicle did an unexpected behavior according to the standards of charging, like change the state unexpectedly, did not reply a message with the expected way in the standards.	Try another charge session, if the problem repeated contact vehicle's service support team. at any time, you can consult local ABB service center for more details if needed.

Error code	Meaning / reason behind	Action to do
SR_CHARGER_ERROR_CURRENT_DIFFERENCE	Internal problem in the charger caused by one or more faulty component	Contact local ABB service center
SR_CHARGER_TIME_COMPLETED	The time, configured for the max charge tine parameters in the charger setting page, finished. The charger must stop the session as per the configuration.	Contact the charger operator for more details or to change the setting
SR_VEHICLE_ERROR	The vehicle did an unexpected behavior according to the standards of charging, like change the state unexpectedly, did not reply a message with the expected way in the standards.	Try another charge session, if the problem repeated contact vehicle's service support team. at any time, you can consult local ABB service center for more details if needed.

ENGLISH

Electrical and electronic equipment to be separately collected in compliance with the Directive on waste electrical and electronic equipment (WEEE - 2012/19/EU)

The symbol (crossed out wheeled-bin) on your product indicates that the product shall not be mixed or disposed with your household waste, at their end of use.

This product shall be handed over to your local community waste collection point for the recycling of the product.

For more information, please contact your Government Waste-Disposal department in your country.

Inappropriate waste handling could possibly have a negative effect on the environment and human health due to potential hazardous substances. With your cooperation in the correct disposal of this product, you contribute to reuse, recycle and recover the product and our environment will be protected.

FRANÇAIS

Équipements électriques et électroniques collectés séparément conformément à la Directive relative aux déchets d'équipements électriques et électroniques (WEEE - 2012/19/EU)

Ce symbole (poubelle interdite) apposé sur le produit indique qu'en fin de vie ce produit ne doit pas être traité avec les déchets ménagers.

Il doit être remis à un point de collecte approprié pour le recyclage des appareils électriques et électroniques.

Pour de plus amples informations, veuillez contacter le service de collecte des déchets ménagers local.

Ce produit contient des substances potentiellement dangereuses qui peuvent avoir des effets néfastes sur l'environnement et la santé humaine. En veillant à la mise au rebut correcte de ce produit, vous contribuerez à assurer le traitement, la récupération et le recyclage de ce produit et à protéger l'environnement.

ESPAÑOL

Aparatos eléctricos y electrónicos recopilados de modo separado en conformidad con la Directiva sobre residuos de aparatos eléctricos y electrónicos (WEEE - 2012/19/EU)

Los productos identificados con este símbolo (papelera tachada) no deben eliminarse como residuos domésticos una vez finalizada su vida útil.

Este producto debe entregarse a un punto de recogida de la comunidad local para su recuperación y reciclado.

Para mayor información, sírvase ponerse en contacto con el Departamento de Disposición de Desechos de su Ayuntamiento.

El manejo inadecuado de los residuos supone riesgos para la salud humana o el medio ambiente. Con la reutilización, el reciclado de los materiales u otras formas de valorización de tales productos usted contribuye de manera importante a la protección de nuestro medio ambiente.

NEDERLASNDS

Elektrische en elektronische apparatuur worden afzonderlijk ingezameld in naleving van de vereisten van de Richtlijn betreffende afgedankte elektrische en elektronische apparatuur (WEEE - 2012/19/EU)

Het symbool (doorgekruisde afvalbak op wielen) op het product geeft aan dat het product aan het einde van haar levensduur niet samen met of in de vorm van huishoudafval mag worden weggegooid.

Het product moet naar een verzamelplaats (milieudepot) worden gebracht waar dergelijke producten worden gerecycled.

Neem voor meer informatie contact op met de relevante overheidsafdeling voor afval/vuilnis die in uw land bestaat.

Het kan nadelige gevolgen hebben op voor mens en milieu als afval op een verkeerde manier wordt behandeld waardoor potentieel schadelijke stoffen vrij komen. Door uw medewerking te verlenen en dit product op de juiste wijze wegwerpt, kunt u een bijdrage leveren aan het herstellen, hergebruiken en recyclen van dit product om zo ons milieu te beschermen.

DANSK

Elektrisk og elektronisk udstyr indsamles særskilt i overensstemmelse med direktiv om affald af elektrisk og elektronisk udstyr (WEEE - 2012/19/EU)

Symbolet (en overstreget affaldsspand med hjul) på produktet angiver, at produktet ikke må blandes med eller bortskaffes sammen med almindeligt husholdningsaffald, når det er udtjent.

Produktet skal afleveres til det lokale affaldsindleveringssted til genbrug.

Kontakt venligst afdelingen for bortskaffelse af affald i din kommune angående yderligere information.

Uhensigtsmæssig bortskaffelse af affald kan have en negativ virkning på miljøet og folks helbred, da det kan indeholde potentielle, farlige substanser. Med din medvirken i henseende til forskriftsmæssig bortskaffelse af dette produkt, kan du bidrage til genbruge, recirkulere og genindvinde produkterne og samtidigt medvirke til, at vores miljø vil blive beskyttet.

DEUTSCH

Elektro- und Elektronikgeräte sind getrennt zu sammeln in Einklang mit der Richtlinie über Elektro- und Elektronik-Altgeräte (WEEE - 2012/19/EU)

Dieses Symbol (ausgekreuzte Mülltonne) auf dem Produkt bezeichnet, dass Altgeräte usw.

nicht wie normaler Haushaltsabfall in den Müll gegeben werden dürfen, sondern zum Recycling an einer hierfür vorgesehenen Annahmestelle abzugeben ist.

Für nähere Informationen wenden Sie sich bitte an die für Müllentsorgung zuständigen örtlichen Behörden.

Bei unsachgemäßer Entsorgung besteht das Risiko nachteiliger Auswirkungen auf Umwelt und Gesundheit durch potentiell gefährliche Substanzen. Durch Ihre Kooperation zur ordnungsgemäßen Entsorgung fördern Sie die Wiederverwendung, das Recycling und die Rückgewinnung von Stoffen und tragen zum Umweltschutz bei.

ITALIANO

Apparecchiatura Elettrica ed Elettronica oggetto di raccolta differenziata in conformità alla Direttiva sui Rifiuti di apparecchiature Elettriche ed Elettroniche (WEEE - 2012/19/EU)

Il simbolo (un bidone sbarrato da una croce) indica che il prodotto non deve essere smaltito con i rifiuti domestici, alla fine della sua vita.

Questo prodotto deve essere consegnato al punto di raccolta rifiuti della propria comunità locale per il suo riciclaggio.

Per ulteriori informazioni, rivolgersi all'organo statale preposto allo smaltimento dei rifiuti nel proprio paese.

Uno smaltimento dei rifiuti inappropriato può avere effetti negativi sull'ambiente e sulla salute umana a causa di sostanze potenzialmente pericolose. Collaborando allo smaltimento corretto di questo prodotto, si contribuisce al riutilizzo, al riciclaggio e al recupero del prodotto, e alla protezione del nostro ambiente.

PORTUGUÊS

Equipamentos Eléctricos e Electrónicos recolhidos seletivamente de acordo com a Diretiva relativa aos resíduos de equipamentos elétricos e eletrónicos (WEEE - 2012/19/EU)

O símbolo (caixote de lixo de rodas com uma linha cruzada) em seu produto indica que o produto, no fim da sua vida útil, não deve ser misturado ou eliminado com o lixo doméstico comum.

Este produto deverá ser entregue a uma estação de recolha de lixo da comunidade local para a reciclagem do produto.

Para mais informações, entre em contacto com o Departamento de Tratamento de Lixo do Governo do seu país.

O tratamento de lixo incorrecto poderia provocar um efeito negativo no meio ambiente e saúde humana devido a substâncias potencialmente perigosas. Com a sua cooperação para a eliminação correcta deste produto, contribuirá para a reutilização, reciclagem e recuperação do produto, e nosso meio ambiente será protegido.

SVENSKA

Elektriska och elektroniska produkter ska samlas in separat i enlighet med direktivet om avfall som utgörs av eller innehåller elektrisk eller elektronisk utrustning (WEEE - 2012/19/EU)

Denna symbol (en överkorsad soptunna) på produkten innebär att produkten ej ska blandas eller slängas med ditt hushållsavfall när den är förbrukad.

Produkten ska lämnas till en lokal insamlingsplats för denna slags produkter för återvinning.Kontakta kommunkontoret för närmare detaljer om var du finner sådana insamlingsplatser.

Olämplig avfallshantering kan få negativa effekter på miljön och på mänsklig hälsa då en produkt kan innehålla farliga ämnen.

Vi ber om ditt samarbeta i bortskaffningen av denna produkt för att bidra till återvinning, återanvändning och en hälsosammare miljö.

SUOMI

Sähkö- ja elektroniikkalaitteet on kierrätettävä erikseen sähkö- ja elektroniikkalaiteromusta annetun direktiivin (WEEE - 2012/19/EU) mukaisesti

Tuotteeseen merkitty symboli (ylitse ruksattu jätesäiliö) osoittaa, että tuotetta ei saa sekoittaa eikä hävittää talousjätteiden kanssa.

Tuote on luovutettava sopivaan tällaisten laitteiden kierrätyksestä huolehtivaan keräyspisteeseen.

Pyydä lisätietoja jäteasioista vastaavilta paikallisilta viranomaisilta.

Tämän tuotteen asianmukaisen hävittämisen varmistamisella autetaan estämään sen mahdolliset ympäristöön ja terveyteen kohdistuvat haittavaikutukset, joita voi aiheutua muussa tapauksessa tämän tuotteen epäasianmukaisesta käsittelystä. Hävittämällä tuotteen asianmukaisesti autat varmistamaan, että tuote uudelleenkäytetään, kierrätetään ja kerätään ja ympäristöä suojellaan.

BCA.00165.0

NOTES

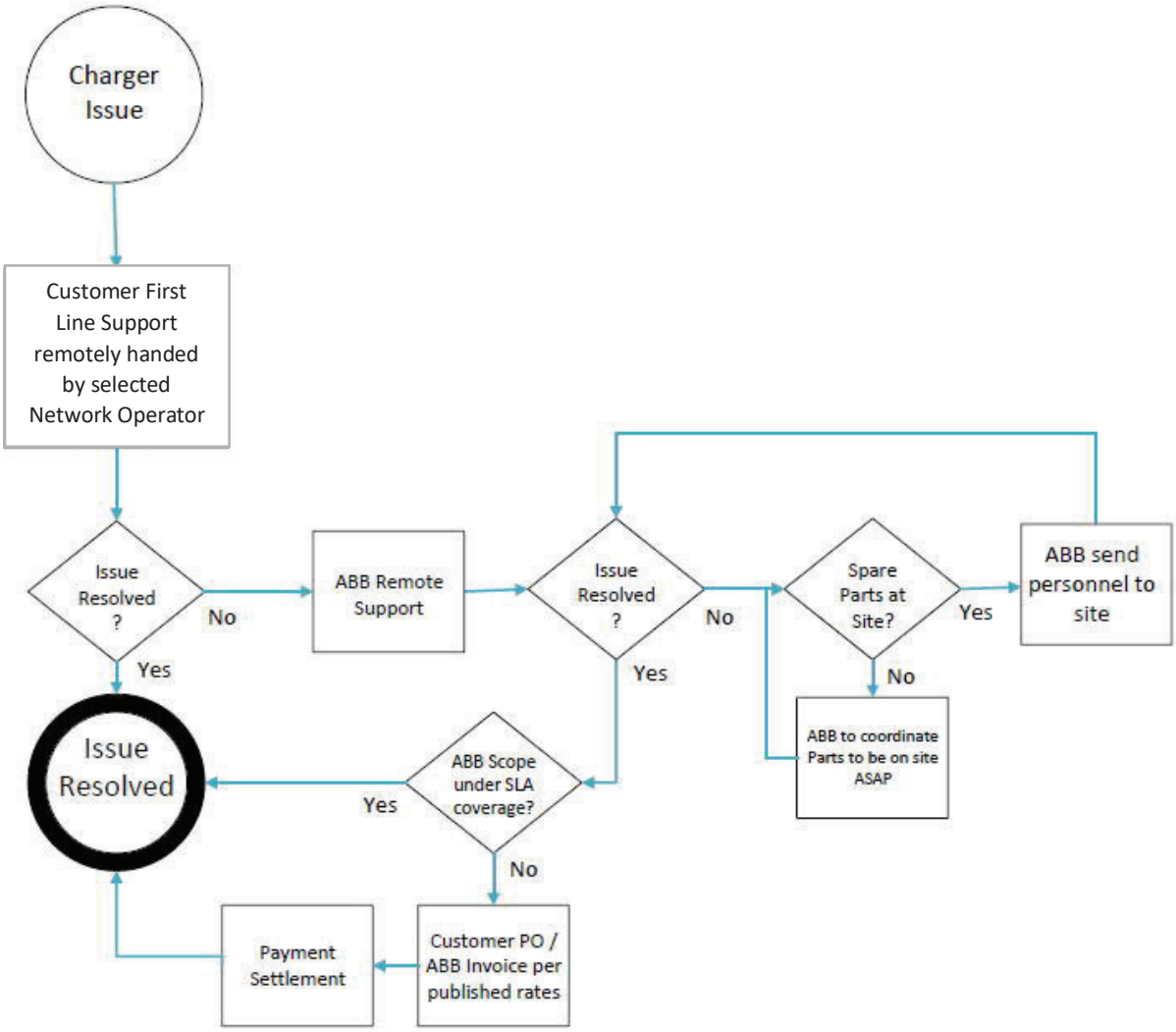


What is the ABB Service Level Agreement?

ABB offers professional life cycle services for your installed products and systems. The solutions ABB provides will help you gain the information required for cost effective long-term decisions concerning overall system operation, maintenance, and personnel development.

Process and Scope

All SLAs shall be governed by the following process. The below flowchart shall be amended according to the options selected in this contract and the expertise gained by the customer through training. A final revision shall be issued upon the signing of this contract.



For any service inquiry, please start by

Service Hotline: +1 (800) 825-2556 option 2

Service Email: us.evci.techteam@abb.com

Note – For SLA's ABB can activate a ticketing or Email to Ticketing system as allowed by options selected below.

Charger Support Request Response Time

ABB defines response time as the maximum allotted time requested for ABB to react to customer inquiries, acknowledge receipt by the EV charging service team, and begin the remote troubleshooting process. The response times mentioned below are for business hours only which is 7AM to 7PM CET Monday to Friday. Option 4 below adds a 24/7 Remote Response.

Charger Support Request Response Time Options:

- CSRT1. Standard - Twenty-four (24) hours
- CSRT2. Eight (8) hours
- CSRT3. Four (4) hours
- CSRT4. Under one (1) hour during 7AM to 7PM CET Monday to Friday; (2) hours outside operating hours. (Customer needs to call 1-800 number to enable the 1 & 2 hour response)

Remote Diagnostics Response / Resolution

ABB defines Remote Diagnostic Response time as the maximum allotted time requested for ABB to provide a remote response after receiving a charger support request. The response times mentioned below are for business hours only which is 7AM to 7PM CET Monday to Friday. Option 4 below adds a 24/7 Remote Response. *(Note, in an instance where the charger error is flagged as a level 3 issue and the support issue must be elevated to the Global Service Desk, the final response time may be delayed)*

Remote Diagnostic Response Time Options:

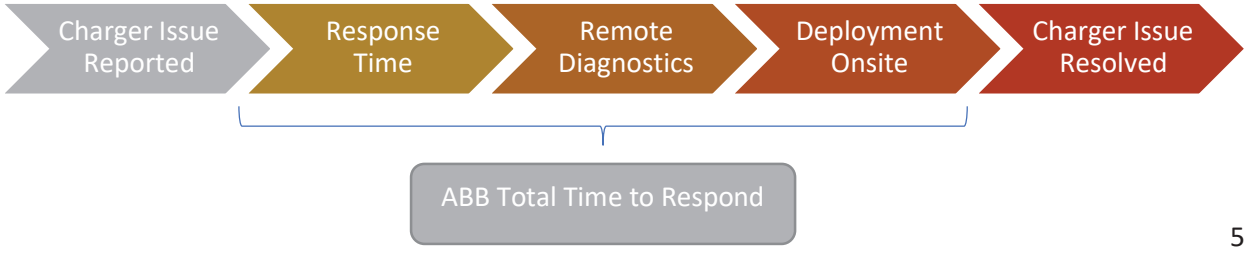
- RDRT1. Standard – One Hundred and Twenty Hours (120) hours
- RDRT2. Seventy-Two (72) Hours –
- RDRT3. Twenty-Four (24) Hours

Deployment Time of Onsite Service

ABB defines deployment time as amount of time allowed to lapse after the remote diagnostic response process is complete to the dispatching of an engineer/tech to site. If the issue cannot be resolved via remote support and it is mutually agreed that ABB support is needed onsite and spare parts are either at site or confirmed for delivery to site, then an ABB service personnel will be dispatched to be onsite. The timing of site work must be communicated and prioritized based on urgency of issue. This will need to be mutually agreed upon by parties involved. *(Note, this response may be limited by parts availability as selected in the options table in this document)*

Deployment Time of Onsite Service Response Time Options:

- DTOS1. Standard – Ninety Six (96) hours
- DTOS2. Forty-eight (48) hours
- DTOS3. Twenty-four (24) hours *(Parts must be stored onsite or in forward stocking inventory to achieve this response time)*



Customer Block of Time (CBOT)

ABB offers the option of pre-purchasing ABB time to provide an all-included troubleshooting service for the installed chargers, remote assistance, on site repairs, spare parts and travel time/expenses to be converted and deducted. This bank of hours is accrued annually upon the renewal of this contract. By selecting to bank hours, the customer will no longer be charged on a time and material basis and, instead, will have hours converted and deducted from their bank, as desired. If the hours consumed or converted exceed the banked time, the customer will be charged the delta.

Customer Block of Time Options:

- CBOT1. Twenty (20) hours
- CBOT2. One hundred (100) hours
- CBOT3. Two hundred fifty (250) hours
- CBOT4. Five hundred (500) hours

(NOTE – If an SLA is purchased a minimum of 20 hours of CBOT must be purchased. The purchase of these hours is to allow ABB to quickly respond to all technical and charger support inquiries)

Preventative Maintenance

Preventive maintenance can be scheduled at multiple intervals from the commissioning of each charger. This work shall be completed by an ABB EVCI qualified service engineering per the following maintenance schedules according to technology. The prices reflected in the pricing matrix do not include expenses and travel time, those will be charged at standard rates. The preventative maintenance includes a visual inspection of internal and external components, an air filter change, and testing. All additional necessary recommended repairs during preventative maintenance will be advised to the customer, and are not included. It is recommended that the customer follow the maintenance schedule as advised below, and replace all other parts (such as fans, power modules, etc) as per their recommended time frame at their own cost. The only spare part included in the PM price is the air filter.

Preventative Maintenance Options:

- PM1. One (1) every two (2) years.
- PM2. One (1) per year (recommended and required if extended warranty is purchased).
- PM3. Two (2) per year.
- PM4. Site Preventive Maintenance Calculated per project

HVC-C and HVC-PD Overview:

SI-HVC-0000	Maintenance Schedule				
		P	C	Pages	4
Subjected chargers	HVC	X	X	Version	1.2
				Date	18-12-2018

Procedure:	
Performance of on-site work (commissioning, tests, measurements or other activities)	**P**
Replacement of component (see related service instruction)	**R**

	Years from start up															
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Start-up / Commissioning	P															
SERVICE																
RCD tests		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
RMS measurement (Country dependent)		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Isolation measurements (Country dependent)		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Grounding system measurement		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Visual inspection		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Improvements Based on Service Letters																
MAIN CABINET																
FILTER INLET KIT - 6AGC063809			R		R		R		R		R		R		R	
FILTER OUTLET KIT – 6AGC064101						R					R					R
FAN POWER MODULE – 6AGC063801						R					R					R
MIDDLE FAN CABINET – 6AGC064204						R					R					R
AC FUSE (Only for Sample A and B) – 6AGC063799						R					R					R
CCB – 6AGC063811											R					
POWER SUPPLY;24VDC;240W (2X) – 6AGC063817						R					R					R
POWER MODULE – 6AGC063800											R					
HVC HMI Assy 7" – 6AGC063855						R					R					R
DEPOT BOX - Preliminary																
Gunholders – As per product model						R					R					R
CCB – Not released											R					
CPI COMBO CCS - 6AGC072189											R					
IMI COMBO CCS – 6AGC072311											R					
POWER SUPPLY;24VDC;120W (2X) - 6AGC076541						R					R					R

POLE ACM																
	Years from start up															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Fan - 6AGC063808						R					R					R
CCB - 6AGC063811											R					
CPI COMBO CCS - 6AGC063814											R					
IMI COMBO CCS - 6AGC063813											R					
POWER SUPPLY;24VDC;480W - 6AGC063818						R					R					R
POWER SUPPLY;24VDC;120W - 6AGC063816						R					R					R
Pantograph (Stemmann)																
	Years from start up															
Cycles per day up to 70	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Tooth belt - 6AGC076677									R							
Plug-in relays - 6AGC072492									R							
Bridging strand - 6AGC072493									R							
Connection cable set - 6AGC072494									R							
Leaf spring + plastic plate + Pin - 6AGC072495									R							
Electric motor – 6AGC076678									R							
Contact rails – 6AGC072497		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	Years from start up															
Cycles per day up to 140	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Tooth belt - 6AGC076677					R				R				R			
Plug-in relays - 6AGC072492							R						R			
Bridging strand - 6AGC072493							R						R			
Connection cable set - 6AGC072494							R						R			
Leaf spring + plastic plate + Pin - 6AGC072495							R						R			
Electric motor – 6AGC076678							R						R			
Contact rails – 6AGC072497		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Overhaul / Main Inspection*													R			

*Overhaul / Main Inspection cannot be performed on site and shall be carried out in a suitable workshop; we recommend obtaining a spare pantograph for replacement during the maintenance and/or considering redundant charging poles in the project.

The Maintenance Schedule for the HVC Power Cabinet is defined based on the following charging cycle options:

- Ambient temperature = 25°C and every day 8 consecutive hours charging at full load.
- Ambient temperature = 25 °C and cycles of 6 minutes charging at full load every 15 minutes for 8 hours a day.

Consumables are parts that will wear with the use, degrade faster based on weather, number of charging sessions and customer handling. They are not covered under warranty unless approved after RMA and are not included in the calculations. See table below for applicable consumables.

Consumables	Notes
Cables with connectors (CCS, Chademo and AC)	Replace after 10.000 mattings
Gunholders	Yearly inspection, replace after 5 years
Contact rails	Inspection every 3 months / Cleaning / Replacing

The contact rails must be replaced if one of any following condition are present:

- Minimum height of copper of 3mm over the whole length
- Deformation or damages due to arcs

Inspection Cycles:

Periodic maintenance and cleaning

Pantograph:

- Removal of any accumulation on rails.

Every 3 months

Contact rails:

- Functional testing / Visual inspection of the rail, cleaning, sanding or replacing if needed.
- Recommended interval, this may vary based on usage, weather conditions, bus design and operation.
- Failing to inspect and cleaning the Contact rails may cause additional wearing that requires an early replacement.
- Earlier need to perform this action can be monitored remotely via ABB tools by analyzing the increase in disconnection during charging sessions.
- The wear of the contact rails is expected during the operation and therefore must be monitored by the operator acc. to their operational experience.

Every 6 months

Testing and greasing:

- Check of spring force and contact force
- Cycle time and cleaning
- Greasing as per service instruction
- Recommended interval, this may vary based on usage, weather conditions and bus design.

Environment characteristic and number of charging sessions may require additional replacement of the air filter during the lifetime of the charger.

ELECTRIC VEHICLE INFRASTRUCTURE USA

Service Level Agreements

Supporting best-in-class uptime



Charging infrastructure must operate with the highest utilization and lowest downtime. ABB's service level agreements meet that demand, incorporating a decade of experience with thousands of intelligent fast chargers deployed across the globe.

Services ensure operational excellence
Operational excellence starts with reliable chargers. ABB's family of EV chargers are modularly designed to withstand heavy operation under rugged conditions.

In addition, ABB's fast chargers are the easiest in the market to service, with 24/7 connectivity for remote diagnostics, and accessible designs that expedite maintenance and field service.

ABB's EV charging infrastructure service offering includes remote and software services as well as training in addition to parts and warranty services.

Remote services

- 24/7 connectivity
- Remote services
- Remote diagnostics
- Firmware upgrades
- ABB Web tools

On-site service and parts availability

- Standard warranty execution
- Extended warranty options
- Service level agreements
- Preventive service and maintenance
- Spare parts programs

Custom software services

- OCPP integration
- Autocharge integration testing
- Interoperability testing and validation
- Customized software integration support

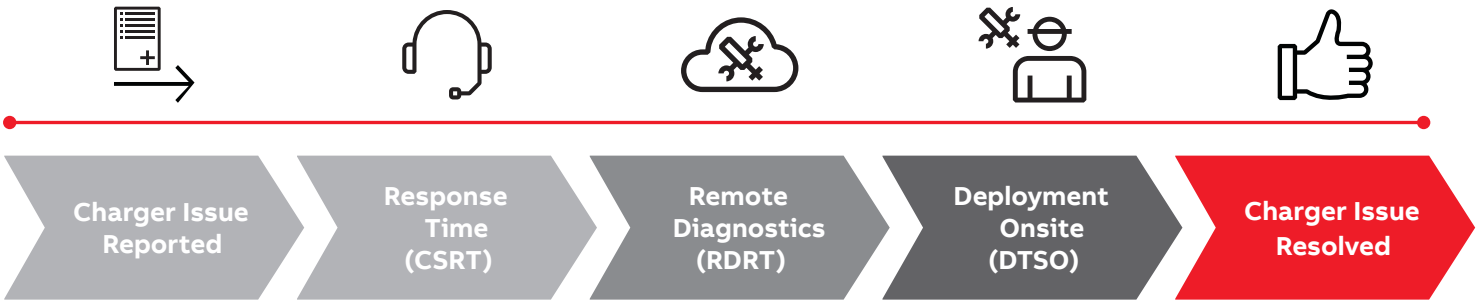
Training

- Standardized online training
- Customized service training
- Third-party service training programs

E-mobility Service Level Agreements

High utilization requires maximum uptime.

ABB's service level agreements optimize charger uptime for faster remote and on-site response times, from the industry's most experienced service team – committed to customer success.



Ticket initiated
A ticket is initiated via ABB's E-mobility Service and Resource Portal.

Options
CSRT1: 24 hours
CSRT2: 8 hours[2]
CSRT3: 4 hours[3]
CSRT4: < 1 hour[1,3]

Options
RDRT1: 156 hours
RDRT2: 72 hours
RDRT3: 24 hours[2]
RDRT4: 12 hours[2]

Options
DTOS1: 96 hours
DTOS2: 48 hours
DTOS3: 24 hours[2]

Ticket closed
The ticket is closed in ABB's service portal.

Charger Support Request Response Time (CSRT)
Response time is defined as the maximum allotted time requested for ABB to respond to customer inquiries, acknowledge receipt by the EV charging service team, and begin the remote troubleshooting process.

Remote Diagnostics Response Time (RDRT)
Remote Diagnostic Response time is defined as the maximum allotted time requested for ABB to provide remote response after receiving a charger support request. In cases where the charger error is flagged as a level 3 issue and the support issue must be elevated to the Global Service Desk, the final response time may be delayed.

Deployment Time of On-site Service (DTOS)
Deployment time is defined as the amount of time after the remote diagnostic response process is complete to the dispatching of an engineer/tech to site. If the issue cannot be resolved via remote support and it is mutually agreed that on site support is needed; and spare parts are either at site or confirmed for delivery to site, then ABB authorized service personnel will be dispatched to be on site. The timing of site work must also be mutually agreed upon.

Customer Block of Time (CBOT)
ABB offers the option of pre-purchasing ABB technical support time to provide an all-included troubleshooting service for ABB chargers, remote assistance, on site repairs, spare parts and travel time/expenses to be converted and deducted.

The bank of hours is accrued annually upon the renewal of this contract. By selecting to bank hours, the customer will no longer be charged on a time and material basis and instead will have hours converted and deducted from their balance, as requested. If the hours consumed or converted exceed the banked time, the customer will be billed the difference.

Customer Block of Time Options:
CBOT1: 20 hours
CBOT2: 100 hours
CBOT3: 250 hours
CBOT4: 500 hours

If an SLA is purchased, a minimum of 20 hours of CBOT must be purchased. The purchase of these hours allows ABB to quickly respond to all technical and charger support inquiries.

—
Business hours are 7AM to 7PM CT Monday to Friday.

1) May be 2 hours outside business hours

2) Requires a 4-month ramp up from the date of SLA contract.

3) Requires a 6-month ramp up from the date of SLA contract.

4) Not suggested for high utilization sites where charging sessions may exceed recommended maintenance intervals.

5) Recommended and required if extended warranty is purchased.

6) Dependent on stock availability

Service Level Agreement Options
A flexible menu of services

As the e-mobility market has grown, so have the needs of charging infrastructure owners and operators. To ensure that every site can reach its highest potential, ABB also offers preventive services to support proactive management business models.

Preventative Maintenance (PM)
Preventive maintenance (PM) can be scheduled at regular intervals from the commissioning date of every charger. This work shall be completed by an ABB E-Mobility authorized service technician per listed maintenance schedules and according to product recommendations.

ABB's E-Mobility PM includes a visual inspection of internal and external components, an air filter change and unit testing as well as advising on necessary or recommended repairs which may be additional. Travel expenses will be charged at standard rates.

Preventative Maintenance options
PM1: Once every 2 years[4]
PM2: Once per year[5]
PM3: Twice per year
PM4: Custom Site PM calculated basis project

Spare Parts, Storage and Availability
ABB's E-mobility Center of Excellence (CoE) in the United States manages parts order fulfillment. In addition to our CoE, ABB also has logistics, stocking and storage facilities to support sites across the country. ABB stocks a basic level of recommended spare parts for all customers with availability on a first come, first served basis.

ABB can also store customer-dedicated spare parts at our facility based on 'pallet per year' basis. Pre-selected spare parts in this program can be made available to ship within 24 business hours.

ABB can offer multiple options for spare parts solutions, storage and availability. We encourage our customer to carry routine and critical wear and tear parts as well as those with long lead times to ensure the highest uptime, round-the-clock availability of chargers, and lowest cost to overall operations.

Spare Parts List
For a list of recommended spare parts please contact your ABB sales representative.

Storage of Customer Selected Spare Parts
CSSP1: At the customer site (recommended)
CSSP2: At the ABB facility



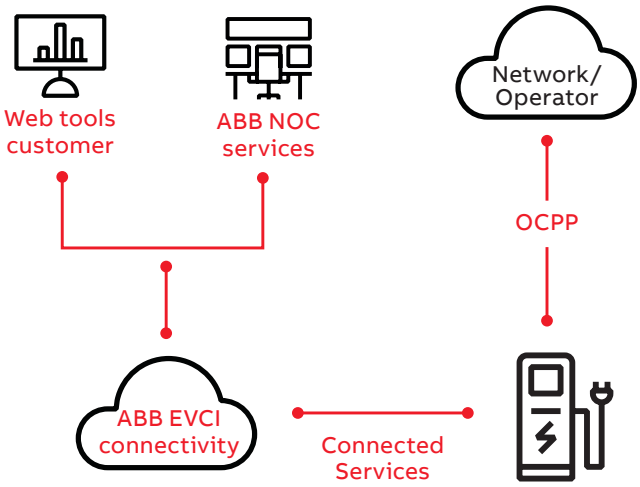
Availability of Replacement of Spare Parts:
ARSP1: Standard lead times - 6-8 weeks
ARSP2: Shipped within 1 week from stock[6]
ARSP3: Shipped within 24 business hours[6]

Standard and Extended Warranty Coverage
ABB offers a standard warranty for all EV charging equipment. Detailed warranty terms by product can be found in ABB's product warranty documentation. Optional extended warranties are available for purchase at the time of the charger purchase to increase coverage length and scope while securing known costs upfront. Standard preventative maintenance packages must be purchased for an extended warranty to be valid.

ABB also offers extended warranties after commissioning during the valid warranty period, which may require an updated proposal from ABB's e-mobility sales team. During the post-warranty period, a Service Contract can be purchased from ABB to enable ongoing service support.

Connected Services and Web Tools
Charger connectivity enables remote service and support. Through ABB's robust platform, our customers have 60% of their service cases solved remotely resulting in very short response times and substantially reducing downtime. Connectivity allows remote software updates including charging protocols, user interface enhancements and back-end solutions for minimal field intervention as well as future-proofing software.

ABB Web Tools provide an online web interface that gives charging infrastructure operators and fleets with real-time status information and usage statistics on their equipment. Owners can gather detailed session statistics, configure chargers according to their preferences and obtain valuable insights through charger usage statistics. All charge session data can be exported and managed directly from this user-friendly application.



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Connected Services
ABB's connectivity solutions link ABB EV chargers to back-end systems as well as ABB's service tools. Connected services are essential to networked charging, upholding warranty, enhancing an SLA and optimizing operational lifetime.

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ABB Inc.
950 W Elliott Rd. Suite 101
Tempe, AZ, 85284
United States
Phone: 800-435-7365
E-mail: US-evci@us.abb.com

abb.com/evcharging

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Appendix A: ABB Service Rates

Customer support: on-demand rates

2020 Standard rate schedule for EV Charging Infrastructure (EVCI) for Field Engineer

SAFETY FIRST!
For safety purposes, ABB reserves the right to limit continuous work of one individual to 12 hours with 8 hours of rest in a hotel prior to starting again.

Service Description	Applicable Standard Rate
EVCI Field Engineer	$217
Office Support	$217
Travel	$217
Standby	$217

Rate Terms	Multiplier
Regular	1.00 x Standard Rate
Overtime 1	1.50 x Standard Rate
Overtime 2	2.00 x Standard Rate
Night Shift Overtime	1.20 x Applicable Standard Rate
Less than 48 hours Notice	1.20 x Applicable Standard Rate

	Weekdays (Monday to Friday)	Saturday	Sunday & Holidays
Day Shift 7:00 – 19:00	**Standard rate**: First consecutive 8 hours **Overtime 1 rate:** After 8 and <12 hours **Overtime 2 rate:** Greater than 12 hours	**Overtime 1 rate**: First Consecutive 8 hours **Overtime 2 rate**: Greater than 8 hours	**Overtime 2 rate**: Any hours
Night Shift* 19:00 – 7:00	**Night Shift Rate**: First consecutive 8 hours **Overtime 1 rate**: After 8 hours	**Overtime 2 rate**: Any hours	**Overtime 2 rate**: Any hours

*Night Shift rates apply to any hours worked from 19:00 to 7:00

Other Costs	
Travel and Living Expenses: Hotel, car rental, airfare, taxi, etc	Actual cost + 10% administration Fee
Meal Allowance	Per Diem: $75/Day
Car Allowance when applicable	$0.60/Miles – minimum charge of 80Miles/day
Tools and Equipment Rental	Actual Cost + 10%

Minimum chargeable time at site 4-hour minimum charge on all service requests

Cancellation All services must be scheduled and confirmed at least 72 hours prior to travel. In the event of any cancellations in less than 72 hours prior to travel, all incurred expenses and an 8-hour cancellation fee will be charged at the applicable rate.

Standby Minimum billing of 8 hours per day at applicable hourly rate for all services provided, including standby during weekdays and weekends.

Premiums Danger pay based on regional risk, daily hardship premiums, out-of-country assignment, in-country remote area allowances, and daily offshore premiums will be applicable following ABB policies and standards.

24/7/365 Technical Phone Support +1 (800) 825-2556 option 2

All the above prices are in USD currency and do not include federal, state/provincial, local or any other taxes (where applicable) and are subject to changes at any time without further notice. All services are performed under ABB Inc. Terms and Conditions of Sale.
The above rates are assumed to be standard labor rates and any additional rate categories will be billed separately including prevailing and union wages.

Appendix B: Additional Services Form

Service Request Form	
ABB Person Requesting the Service:	
Service to be supplied:	
Starting and Ending Date of Service:	
Customer purchase order:	
Project/Sales Order:	
Customer:	
Contact name:	
Phone Number:	
Email:	
Location:	
End User	
On-Site Contact:	
Phone Number:	
Email:	
Location:	
Equipment to Serve	
Description	**Serial Number**
Special Instructions to FSE	
Notes:	
Important: No Service Request will be processed without the mandatory information in red	

Appendix C: Spare Parts

Recommended Spare Parts for HVC-C

Product	Part Number	Description	Price Per Unit (USD)	Quantity	Total (USD)
HVC-C	9601072	HVC Depot Box CCS-1 REMA Cable 200A 7.5m	$3,462.44	1	$3,462.44
HVC-C	6AGC063800	HxC Cabinet Power Module 50kW	$5,150.00	1	$5,150.00
HVC-C	6AGC063801	HxC Cabinet Power Module Fan	$297.00	1	$297.00
HVC-C	6AGC063809	HxC Cabinet Air Filter Inlet KIT	$660.30	4	$2,641.20
HVC-C	6AGC063813	HVC IMI Board	$300.86	1	$300.86
HVC-C	6AGC063817	HxC Cabinet 24VDC Power Supply	$383.00	1	$383.00
HVC-C	6AGC063854	HxC Cabinet Main AC Contactor	$638.00	1	$638.00
HVC-C	6AGC063855	HxC Cabinet HMI Display	$3,549.11	1	$3,549.11
HVC-C	6AGC064024	HxC Cabinet Middle Fan	$122.48	1	$122.48
HVC-C	6AGC064101	HxC Cabinet Air Filter Outlet KIT	$311.51	2	$623.03
HVC-C	6AGC072189	CP/DB/Tx4 CPI+Devolo Assembly	$899.93	1	$899.93
HVC-C	6AGC073734	HVC Cabinet Power Module Breaker KIT	$381.63	1	$381.63
HVC-C	6AGC076541	HVC Depot Box 24VDC Power Supply	$561.79	1	$561.79
HVC-C	6AGC078273	HVC Depot Box DC Contactor	$241.40	2	$482.80
HVC-C	6AGC078358	HVC Depot Box LED	$324.83	1	$324.83
HVC-C	6AGC078418	HVC Depot Box E-Stop Button	$380.74	1	$380.74
HVC-C	6AGC078420	HVC Depot Box Stop Button	$380.74	1	$380.74
HVC-C	6AGC078421	HVC Depot Box CAN to Fiber Converter	$1,972.91	1	$1,972.91
HVC-C	6AGC078422	HxC Ethernet to Fiber Converter	$806.74	1	$806.74
HVC-C	6AGC078427	HVC Fuse SPF003	$31.95	10	$319.50
HVC-C	6AGC078440	HVC Depot Box 120V Breaker MCB	$167.74	1	$167.74
HVC-C	6AGC078444	HVC Depot Box CCB board	$1,070.33	1	$1,070.33

Recommended Spare Parts for HVC-PD

Product	Part Number	Description	Price Per Unit (USD)	Quantity	Total (USD)
HVC-PD	6AGC063800	HxC Cabinet Power Module 50kW	$5,150.00	1	$5,150.00
HVC-PD	6AGC063801	HxC Cabinet Power Module Fan	$297.00	1	$297.00
HVC-PD	6AGC063808	HVC ACM FAN	$58.58	1	$58.58
HVC-PD	6AGC063809	HxC Cabinet Air Filter Inlet KIT	$660.30	4	$2,641.20
HVC-PD	6AGC063810	HVC ACM DC Contactor	$620.36	2	$1,240.73
HVC-PD	6AGC063812	HVC ACS Control Board for CPI	$202.35	1	$202.35
HVC-PD	6AGC063813	HVC IMI Board	$300.86	1	$300.86
HVC-PD	6AGC063814	HVC ACM CPI Combo Board	$620.36	1	$620.36
HVC-PD	6AGC063816	HVC ACM 24VDC Power Supply 120W	$561.79	1	$561.79
HVC-PD	6AGC063817	HxC Cabinet 24VDC Power Supply	$383.00	1	$383.00
HVC-PD	6AGC063818	HVC ACM 24VDC Power Supply 480W	$463.28	1	$463.28
HVC-PD	6AGC063851	HVC Fiber Converters Ethernet+CAN KIT	$2,036.81	1	$2,036.81
HVC-PD	6AGC063854	HxC Cabinet Main AC Contactor	$638.00	1	$638.00
HVC-PD	6AGC063855	HxC Cabinet HMI Display	$3,549.11	1	$3,549.11
HVC-PD	6AGC064024	HxC Cabinet Middle Fan	$122.48	1	$122.48
HVC-PD	6AGC064101	HxC Cabinet Air Filter Outlet KIT	$311.51	2	$623.03
HVC-PD	6AGC072353	HxC ACS/Cabinet CCB Board	$729.53	1	$729.53
HVC-PD	6AGC072492	HVC ACS Stemmann 206.11 Plug-In Relays	$87.86	2	$175.73
HVC-PD	6AGC072493	HVC ACS Stemmann 206.11 Bridging Strand	$210.34	2	$420.68
HVC-PD	6AGC072494	HVC ACS Stemmann 206.11 Cable Connection Set	$8,517.34	1	$8,517.34
HVC-PD	6AGC072495	HVC ACS Stemmann 206.11 Flat Spring Plate KIT	$290.21	2	$580.43
HVC-PD	6AGC072497	HVC ACS Stemmann 206.11 Contact Rail	$484.58	4	$1,938.30
HVC-PD	6AGC073734	HVC Cabinet Power Module Breaker KIT	$381.63	2	$763.25
HVC-PD	6AGC076677	HVC ACS Stemmann 206.11 Tooth Belt	$729.53	1	$729.53
HVC-PD	6AGC076678	HVC ACS Stemmann 206.11 Electric Motor	$5,056.09	1	$5,056.09
HVC-PD	6AGC078427	HVC Fuse SPF003	$31.95	10	$319.50
HVC-PD	6AGC063819	HVC ACS Wi-Fi Modem	$1,235.00	1	$1235.00

Appendix D: ABB General Terms and Conditions of Sale

ABB GENERAL TERMS AND CONDITIONS OF SALE

1. General. The terms and conditions contained herein, together with any additional or different terms contained in ABB's Proposal, if any, submitted to Purchaser (which Proposal shall control over any conflicting terms), constitute the entire agreement (the "Agreement") between the parties with respect to the order and supersede all prior communications and agreements regarding the order. Acceptance by ABB of the order, or Purchaser's acceptance of ABB's Proposal, is expressly limited to and conditioned upon Purchaser's acceptance of these terms and conditions, payment for or acceptance of any performance by ABB being acceptance. These terms and conditions may not be changed or superseded by any different or additional terms and conditions proposed by Purchaser to which terms ABB hereby objects. Unless the context otherwise requires, the term "Equipment" as used herein means all of the equipment, parts, accessories sold, and all software and software documentation, if any, licensed to Purchaser by ABB ("Software") under the order. Unless the context otherwise requires, the term "Services" as used herein means all labor, supervisory, technical and engineering, installation, repair, consulting or other services provided by ABB under the order. As used herein, the term "Purchaser" shall include the initial end use of the Equipment and/or services; provided, however, that Paragraph 13(a) shall apply exclusively to the initial end user.

2. Prices.

(a) Unless otherwise specified in writing, all Proposals expire thirty (30) days from the date thereof.

(b) Unless otherwise stated herein, Services prices are based on normal business hours (8 a.m. to 5 p.m. Monday through Friday). Overtime and Saturday hours will be billed at one and one-half (1 1/2) times the hourly rate; and Sunday hours will be billed at two (2) times the hourly rate; holiday hours will be billed at three (3) times the hourly rate. If a Services rate sheet is attached hereto, the applicable Services rates shall be those set forth in the rate sheet. Rates are subject to change without notice.

(c) The price does not include any federal, state or local property, license, privilege, sales, use, excise, gross receipts, or other like taxes which may now or hereafter be applicable. Purchaser agrees to pay or reimburse any such taxes which ABB or its suppliers are required to pay or collect. If Purchaser is exempt from the payment of any tax or holds a direct payment permit, Purchaser shall, upon order placement, provide ABB a copy, acceptable to the relevant governmental authorities of any such certificate or permit.

(d) The price includes customs duties and other importation or exportation fees, if any, at the rates in effect on the date of ABB's Proposal. Any change after that date in such duties, fees, or rates, shall increase the price by ABB's additional cost.

3. Payment.

(a) Unless specified to the contrary in writing by ABB, payment terms are net cash, payable without offset, in United States Dollars, 30 days from date of invoice by wire transfer to the account designated by ABB in the Proposal.

(b) If in the judgment of ABB, the financial condition of Purchaser at any time prior to delivery does not justify the terms of payment specified, ABB may require payment in advance, payment security satisfactory to ABB, or may terminate the order, whereupon ABB shall be entitled to receive reasonable cancellation charges. If delivery is delayed by Purchaser, payment shall be due on the date ABB is prepared to make delivery. Delays in delivery or nonconformities in any installments delivered shall not relieve Purchaser of its obligation to accept and pay for remaining installments.

(c) Purchaser shall pay, in addition to the overdue payment, a late charge equal to the lesser of 1 1/2% per month or any part thereof or the highest applicable rate allowed by law on all such overdue amounts plus ABB's attorneys' fees and court costs incurred in connection with collection.

4. Changes.

(a) Any changes requested by Purchaser affecting the ordered scope of work must be accepted by ABB and resulting adjustments to affected provisions, including price, schedule, and guarantees mutually agreed in writing prior to implementation of the change.

(b) ABB may, at its expense, make such changes in the Equipment or Services as it deems necessary, in its sole discretion, to conform the Equipment or Services to the applicable specifications. If Purchaser objects to any such changes, ABB shall be relieved of its obligation to conform to the applicable specifications to the extent that conformance may be affected by such objection.

5. Delivery.

(a) All Equipment manufactured, assembled or warehoused in the continental United States is delivered F.O.B. point of shipment. Equipment shipped from outside the continental United States is delivered F.O.B. United States port of entry. Purchaser shall be responsible for any and all demurrage or detention charges.

(b) If the scheduled delivery of Equipment is delayed by Purchaser or by Force Majeure, ABB may move the Equipment to storage for the account of and at the risk of Purchaser whereupon it shall be deemed to be delivered.

(c) Shipping and delivery dates are contingent upon Purchaser's timely approvals and delivery by Purchaser of any documentation required for ABB's performance hereunder.

(d) Claims for shortages or other errors in delivery must be made in writing to ABB within ten days of delivery. Equipment may not be returned except with the prior written consent of and subject to terms specified by ABB. Claims for damage after delivery shall be made directly by Purchaser with the common carrier

6. Title & Risk of Loss. Except with respect to Software (for which title shall not pass, use being licensed) title to Equipment shall remain in ABB until fully paid for. Notwithstanding any agreement with respect to delivery terms or payment of transportation charges, risk of loss or damage shall pass to Purchaser upon delivery.

7. Inspection, Testing and Acceptance.

(a) Any inspection by Purchaser of Equipment on ABB's premises shall be scheduled in advance to be performed during normal working hours.

(b) If the order provides for factory acceptance testing, ABB shall notify Purchaser when ABB will conduct such testing prior to shipment. Unless Purchaser states specific objections in writing within ten (10) days after completion of factory acceptance testing, completion of the acceptance test constitutes Purchaser's factory acceptance of the Equipment and its authorization for shipment.

(c) If the order provides for site acceptance testing, testing will be performed by ABB personnel to verify that the Equipment has arrived at site complete, without physical damage, and in good operating condition. Completion of site acceptance testing constitutes full and final acceptance of the Equipment. If, through no fault of ABB, acceptance testing is not completed within thirty (30) days after arrival of the Equipment at the site, the site acceptance test shall be deemed completed and the Equipment shall be deemed accepted.

8. Warranties and Remedies.

(a) Equipment and Services Warranty. ABB warrants that Equipment (excluding Software, which is warranted as specified in paragraph (d) below) shall be delivered free of defects in material and workmanship and that Services shall be free of defects in workmanship. The Warranty Remedy Period for Equipment (excluding Software, Spare Parts and Refurbished or Repaired Parts) shall end twenty-four (24) months after installation or thirty (30) months after date of shipment, whichever first occurs. The Warranty Remedy Period for new spare parts shall end twelve (12) months after date of shipment. The Warranty Remedy Period for refurbished or repaired parts shall end ninety (90) days after date of shipment. The Warranty Remedy Period for Services shall end ninety (90) days after the date of completion of Services.

(b) Equipment and Services Remedy. If a nonconformity to the foregoing warranty is discovered in the Equipment or Services during the applicable Warranty Remedy Period, as specified above, under normal and proper use and provided the Equipment has been properly stored, installed, operated and maintained and written notice of such nonconformity is provided to ABB promptly after such discovery and within the applicable Warranty Remedy Period, ABB shall, at its option, either (i) repair or replace the nonconforming portion of the Equipment or re-perform the nonconforming Services or (ii) refund the portion of the price applicable to the nonconforming portion of Equipment or Services. If any portion of the Equipment or Services so repaired, replaced or re-performed fails to conform to the foregoing warranty, and written notice of such nonconformity is provided to ABB promptly after discovery and within the original Warranty Remedy Period applicable to such Equipment or Services or 30 days from completion of such repair, replacement or re-performance, whichever is later, ABB will repair or replace such nonconforming Equipment or re-perform the nonconforming Services. The original Warranty Remedy Period shall not otherwise be extended.

(c) Exceptions. ABB shall not be responsible for providing working access to the nonconforming Equipment, including disassembly and re-assembly of non-ABB supplied equipment, or for providing transportation to or from any repair facility, all of which shall be at Purchaser's risk and expense. ABB shall have no obligation hereunder with respect to any Equipment which (i) has been improperly repaired or altered; (ii) has been subjected to misuse, negligence or accident; (iii) has been used in a manner contrary to ABB's instructions; (iv) is comprised of materials provided by or a design specified by Purchaser; or (v) has failed as a result of ordinary wear and tear. Equipment supplied by ABB but manufactured by others is warranted only to the extent of the manufacturer's warranty, and only the remedies, if any, provided by the manufacturer will be allowed.

(d) Software Warranty and Remedies. ABB warrants that, except as specified below, the Software will, when properly installed, execute in accordance with ABB's published specification. If a nonconformity to the foregoing warranty is discovered during the period ending one (1) year after the date of shipment and written notice of such nonconformity is provided to ABB promptly after such discovery and within that period, including a description of the nonconformity and complete information about the manner of its discovery, ABB shall correct the nonconformity by, at its option, either (i) modifying or making available to the Purchaser instructions for modifying the Software; or (ii) making available at ABB's facility necessary corrected or replacement programs. ABB shall have no obligation with respect to any nonconformities resulting from (i) unauthorized modification of the Software or (ii) Purchaser-supplied software or interfacing. ABB does not warrant that the functions contained in the software will operate in combinations which may be selected for use by the Purchaser, or that the software products are free from errors in the nature of what is commonly categorized by the computer industry as "bugs".

(e) THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES OF QUALITY AND PERFORMANCE, WHETHERWRITTEN, ORAL OR IMPLIED, AND ALL OTHER WARRANTIES INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USAGE OF TRADE ARE HEREBY DISCLAIMED. THE REMEDIES STATED HEREIN CONSTITUTE PURCHASER'S EXCLUSIVE REMEDIES AND ABB'S ENTIRE LIABILITY FOR ANY BREACH OF WARRANTY.

9. Patent Indemnity.

(a) ABB shall defend at its own expense any action brought against Purchaser alleging that the Equipment or the use of the Equipment to practice any process for which such Equipment is specified by ABB (a "Process") directly infringes any claim of a patent of the United States of America and to pay all damages and costs finally awarded in any such action, provided that Purchaser has given ABB prompt written notice of such action, all necessary assistance in the defense thereof and the right to control all aspects of the defense thereof including the right to settle or otherwise terminate such action in behalf of Purchaser.

(b) ABB shall have no obligation hereunder and this provision shall not apply to: (i) any other equipment or processes, including Equipment or Processes which have been modified or combined with other equipment or process not supplied by ABB; (ii) any Equipment or Process supplied according to a design, other than an ABB design, required by Purchaser; (iii) any products manufactured by the Equipment or Process; (iv) any patent issued after the date hereof; or (v) any action settled or otherwise terminated without the prior written consent of ABB.

(c) If, in any such action, the Equipment is held to constitute an infringement, or the practice of any Process using the Equipment is finally enjoined, ABB shall, at its option and its own expense, procure for Purchaser the right to continue using said Equipment; or modify or replace it with non-infringing equipment or, with Purchaser's assistance, modify the Process so that it becomes non-infringing; or remove it and refund the portion of the price allocable to the infringing Equipment. THE FOREGOING PARAGRAPHS STATE THE ENTIRE LIABILITY OF ABB AND EQUIPMENT MANUFACTURER FOR ANY PATENT INFRINGEMENT.

(d) To the extent that said Equipment or any part thereof is modified by Purchaser, or combined by Purchaser with equipment or processes not furnished hereunder(except to the extent that ABB is a contributory infringer) or said Equipment or any part thereof is used by Purchaser to perform a process not furnished hereunder by ABB or to produce an article, and by reason of said modification, combination, performance or production, an action is brought against ABB, Purchaser shall defend and indemnify ABB in the same manner and to the same extent that ABB would be obligated to indemnify Purchaser under this "Patent Indemnity" provision. **10. Limitation of Liability.**

(a) In no event shall ABB, its suppliers or subcontractors be liable for special, indirect, incidental or consequential damages, whether in contract, warranty, tort, negligence, strict liability or otherwise, including, but not limited to, loss of profits or revenue, loss of use of the Equipment or any associated equipment, cost of capital, cost of substitute equipment, facilities or services, downtime costs, delays, and claims of customers of the Purchaser or other third parties for any damages. ABB's liability for any claim whether in contract, warranty, tort, negligence, strict liability, or otherwise for any loss or damage arising out of, connected with, or resulting from this Agreement or the performance or breach thereof, or from the design, manufacture, sale, delivery, resale, repair, replacement, installation, technical direction of installation, inspection, operation or use of any equipment covered by or furnished under this Agreement, or from any services rendered in connection therewith, shall in no case (except as provided in the section entitled "Patent Indemnity") exceed one-half (1/2) of the purchase price allocable to the Equipment or part thereof or Services which gives rise to the claim.

(b) All causes of action against ABB arising out of or relating to this Agreement or the performance or breach hereof shall expire unless brought within one year of the time of accrual thereof.

(c) In no event, regardless of cause, shall ABB be liable for penalties or penalty clauses of any description or for indemnification of Purchaser or others for costs, damages, or expenses arising out of or related to the Equipment and/Services.

11. Laws and Regulations. ABB does not assume any responsibility for compliance with federal, state or local laws and regulations, except as expressly set forth herein, and compliance with any laws and regulations relating to the operation or use of the Equipment or Software is the sole responsibility of the Purchaser. All laws and regulations referenced herein shall be those in effect as of the Proposal date. In the event of any subsequent revisions or changes thereto, ABB assumes no responsibility for compliance therewith. If Purchaser desires a modification as a result of any such change or revision, it shall be treated as a change per Article 4. Nothing contained herein shall be construed as imposing responsibility or liability upon ABB for obtaining any permits, licenses or approvals from any agency required in connection with the supply, erection or operation of the Equipment. This Agreement shall be governed by the laws of the State of New York, but excluding the provisions of the United Nations Convention on Contracts for the International Sale of Goods and excluding New York law with respect to conflicts of law. Purchaser agrees that all causes of action against ABB under this Agreement shall be brought in the State Courts of the State of New York, or the U.S. District Court for the Southern District of New York. If any provision hereof, partly or completely, shall be held invalid or unenforceable, such invalidity or unenforceability shall not affect any other provision or portion hereof and these terms shall be construed as if such invalid or unenforceable provision or portion thereof had never existed.

12. OSHA. ABB warrants that the Equipment will comply with the relevant standards of the Occupational Safety and Health Act of 1970 ("OSHA") and the regulations promulgated thereunder as of the date of the Proposal. Upon prompt written notice from the Purchaser of a breach of this warranty, ABB will replace the affected part or modify it so that it conforms to such standard or regulation. ABB's obligation shall be limited to such replacement or modification. In no event shall ABB be responsible for liability arising out of the violation of any OSHA standards relating to or caused by Purchaser's design, location, operation, or maintenance of the Equipment, its use in association with other equipment of Purchaser, or the alteration of the Equipment by any party other than ABB.

13. Software License.

(a) ABB owns all rights in or has the right to sublicense all of the Software, if any, to be delivered to Purchaser under this Agreement. As part of the sale made hereunder Purchaser hereby obtains a limited license to use the Software, subject to the following: (i) The Software may be used only in conjunction with equipment specified by ABB; (ii) The Software shall be kept strictly confidential; (iii) The Software shall not be copied, reverse engineered, or modified; (iv) The Purchaser's right to use the Software shall terminate immediately when the specified equipment is no longer used by the Purchaser or when otherwise terminated, e.g. for breach, hereunder; and (v) the rights to use the Software are non-exclusive and non-transferable, except with ABB's prior written consent.

(b) Nothing in this Agreement shall be deemed to convey to Purchaser any title to or ownership in the Software or the intellectual property contained therein in whole or in part, nor to designate the Software a "work made for hire" under the Copyright Act, nor to confer upon any person who is not a named party to this Agreement any right or remedy under or by reason of this Agreement. In the event of termination of this License, Purchaser shall immediately cease using the Software and, without retaining any copies, notes or excerpts thereof, return to ABB the Software and all copies thereof and shall remove all machine-readable Software from all of Purchaser's storage media.

14. Inventions and Information. Unless otherwise agreed in writing by ABB and Purchaser, all right, title and interest in any inventions, developments, improvements or modifications of or for Equipment and Services shall remain with ABB. Any design, manufacturing drawings or other information submitted to the Purchaser remains the exclusive property of ABB. Purchaser shall not, without ABB's prior written consent, copy or disclose such information to a third party. Such information shall be used solely for the operation or maintenance of the Equipment and not for any other purpose, including the duplication thereof in whole or in part.

15. Force Majeure. ABB shall neither be liable for loss, damage, detention or delay nor be deemed to be in default for failure to perform when prevented from doing so by causes beyond its reasonable control including but not limited to acts of war (declared or undeclared), Acts of God, fire, strike, labor difficulties, acts or omissions of any governmental authority or of Purchaser, compliance with government regulations, insurrection or riot, embargo, delays or shortages in transportation or inability to obtain necessary labor, materials, or manufacturing facilities from usual sources or from defects or delays in the performance of its suppliers or subcontractors due to any of the foregoing enumerated causes. In the event of delay due to any such cause, the date of delivery will be extended by period equal to the delay plus a reasonable time to resume production, and the price will be adjusted to compensate ABB for such delay.

16. Cancellation. Any order may be cancelled by Purchaser only upon prior written notice and payment of termination charges, including but not limited to, all costs identified to the order incurred prior to the effective date of notice of termination and all expenses incurred by ABB attributable to the termination, plus a fixed sum of ten (10) percent of the final total price to compensate for disruption in scheduling, planned production and other indirect costs.

17. Termination. No termination by Purchaser for default shall be effective unless, within fifteen (15) days after receipt by ABB of Purchaser's written notice specifying such default, ABB shall have failed to initiate and pursue with due diligence correction of such specified default.

18. Export Control.

(a) Purchaser represents and warrants that the Equipment and Services provided hereunder and the "direct product" thereof are intended for civil use only and will not be used, directly or indirectly, for the production of chemical or biological weapons or of precursor chemicals for such weapons, or for any direct or indirect nuclear end use. Purchaser agrees not to disclose, use, export or re-export, directly or indirectly, any information provided by ABB or the "direct product" thereof as defined in the Export Control Regulations of the United States Department of Commerce, except in compliance with such Regulations.

(b) If applicable, ABB shall file for a U.S. export license, but only after appropriate documentation for the license application has been provided by Purchaser. Purchaser shall furnish such documentation within a reasonable time after order acceptance. Any delay in obtaining such license shall suspend performance of this Agreement by ABB. If an export license is not granted or, if once granted, is thereafter revoked or modified by the appropriate authorities, this Agreement may be canceled by ABB without liability for damages of any kind resulting from such cancellation. At ABB's request, Purchaser shall provide to ABB a Letter of Assurance and End-User Statement in a form reasonably satisfactory to ABB.

(c) Client agrees to adhere to all applicable import and export control laws, regulations, orders and requirements, including but not limited to those of the United States and the jurisdictions to or through which the purchased goods are transported.

(d) With respect to orders that have been accepted by ABB but not delivered, ABB commits (i) to full transparency in regard to the cost increases associated with any legislation or tariffs; and (ii) that any increases resulting from changes in legislation or tariffs will solely reflect the additional costs incurred as a result of legislation or tariffs and will not include any additional overhead costs or profits.

19. **Assignment.** Any assignment of this Agreement or of any rights or obligations under the Agreement without prior written consent of ABB shall be void.

20. **Nuclear Insurance – Indemnity.** For applications in nuclear projects, the Purchaser and/or its end user customer shall have complete insurance protection against liability and property damage resulting from a nuclear incident to and shall indemnify ABB, its subcontractors, suppliers and vendors against all claims resulting from a nuclear incident.

21. **Resale.** If Purchaser resells any of the Equipment, the sale terms shall limit ABB's liability to the buyer to the same extent that ABB's liability to Purchaser is limited hereunder.

22. **Entire Agreement.** This Agreement constitutes the entire agreement between ABB and Purchaser. There are no agreements, understandings, restrictions, warranties, or representations between ABB and Purchaser other than those set forth herein or herein provided.

ABB Statement of Qualifications for Low-No Emission Grant Projects

ABB Experience

The ABB Group of companies dates back to the founding of ASEA (Sweden) in 1883 and Brown Boveri & Cie (Switzerland) in 1891. ABB's US entity, ABB Inc. was established in 1980. This means we have been in the electrical engineering field for approximately 138 years.

ABB is a publicly held corporation with global headquarters in Zurich, Switzerland and U.S. Corporate headquarters in Cary, North Carolina. The ABB group of companies is recognized as one of the world's most innovative companies, with focus on grid-edge electrification, reliable power distribution, energy efficiency and sustainable transportation. We provide thousands of products, systems, software and services for customers in the utility, automation, transportation and infrastructure segments, supporting 'source to socket' electrification for diverse industries and markets.

ABB has a solid credit rating with an S&P rating of A. The ABB Group annual report consists of one volume containing the corporate governance report, remuneration report and financial review. These documents are located at http://new.abb.com/media/group-reports.

The safety and good health of our employees and contractors are a top priority for ABB. Our safety goal is always to achieve zero incidents. Given the diversity of our global operations, across many locations, this represents a significant challenge, and why we have uniform processes and best practices in place to continuously improve our performance in health and safety. Our policy aims for excellence through Group-led programs as well as regional and business-specific initiatives. As part of these efforts, we have regular in-depth safety training, scheduled monitoring of work conditions at all manufacturing sites, and comprehensive business responsibility and accountability for our performance. Please see greater detail at http://new.abb.com/sustainability/society/health-safety-and-security

Sustainability is an integral part of ABB's corporate strategy and business success. Our sustainability policies cover how we design and manufacture products, what we offer customers, how we engage suppliers, how we assess risks and opportunities, and how we behave in the communities where we operate, while striving to ensure the health, safety and security of our employees, contractors and communities affected by our activities. Comprehensive information and sustainability reporting is available at http://new.abb.com/sustainability

Responsible Sourcing is prioritized among ABB's sustainability objectives, committing our company to manage the social and environmental risks and impacts of sourcing practices. Through collaboration with our business partners, we aim to ensure the highest quality standards and create a sustainable supply chain. With a large and complex supply chain, this is a considerable undertaking, but we consider it central to our success. Our efforts are underpinned by governance measures such as ABB's Supplier Code of Conduct and Supplier Sustainability Development program.

As part of responsible sourcing, ABB seeks sourcing materials that do not endanger vulnerable societies or habitats, contribute to environmental degradation or lead to conflict and exploitation in the countries that produce them. In practice, this means that we have systems in place to monitor the source of certain minerals more closely and phase out the use of hazardous substances in ABB products and processes. ABB expects suppliers to actively support ongoing efforts to manage and demonstrate product compliance with regulations such as REACH, RoHS and Conflict Minerals. We encourage our suppliers and sub-contractors to adopt similar standards and to comply with regulatory requirements.

Our organization continues to support responsible minerals sourcing and industry initiatives, while working with our suppliers to facilitate conflict-free sourcing that contributes to economic growth. In addition, ABB is a member of the Responsible Minerals Initiative (RMI) and adheres to the OECD guidelines to increase the transparency of conflict minerals in our supply chain. More details can be found at: https://new.abb.com/sustainability/responsible-business/responsible-sourcing

Statement on Diversity and Inclusion

At ABB, we are committed to solving some of the biggest global challenges of our time. This is only possible through our exceptional people who work every day towards this endeavor. A culture of diversity, inclusion and equal opportunity is critical to our business success and makes us stronger. At ABB we strive for a culture where individual differences are not only welcomed but celebrated. A full view of ABB's diversity and inclusion commitments can be found at ABB's diversity and inclusion web portal.

In the United States, ABB's Diversity & Inclusion Council focuses on employee concerns such as flexible work practices and permissive vacation to enable employees to have a greater integration between work and home life; employee resource groups like Encompass, a network of employee groups that seeks to promote an environment inclusion, equity and belonging. ABB's Encompass groups include women, young professionals, military & allies, pride, Hispanic/Latin X and black professionals; diversity organization partnerships where ABB serves as a corporate sponsor for important diversity organizations including the Society of Women Engineers (SWE), National Society of Black Engineers (NSBE), and the Society of Hispanic Professional Engineers (SHPE) and Out 4 Undergrad, an organization for LGBTQ+ early career professionals; and University partnerships to promote inclusivity in recruitment with a focus on Historically Black Colleges and Universities (HBCU) and Hispanic Serving Institutions (HSI).

Supplier Diversity

ABB's supplier diversity commitment means that we strive for a world where people of all backgrounds can fairly compete in business. As a public corporation, ABB is not a DBE firm, however, ABB has a proactive supply-chain program promoting diverse and DBE enterprises. ABB maintains a corporate policy and commitment to support and grow with certified minority, woman, veteran owned, and other disadvantaged business enterprises by executing an advanced supplier diversity process that is engrained into our corporate culture of sustainability. Contact ABB if a letter/statement of support for DBE is required.

Statement on ethics and integrity

ABB sets the highest standards for integrity and ethical compliance which are expected of every employee and in every country where we do business. We have implemented a systematic approach, designed to foster a culture of integrity. This is done through leadership and business accountability, supported by strong training tools and processes, and a zero-tolerance policy for violations. ABB has stringent directives covering bribery and corruption; the use of third-party representatives; political and charitable contributions; gifts, entertainment and expenses; suppliers, subcontractors and consortium partners; mergers and acquisitions and antitrust guidance; all underscored by mandatory training for all employees with multiple reporting channels supported. In addition, ABB employs more than 440 integrity and antitrust resources globally. Please see our integrity portal for more information: http://new.abb.com/about/integrity

R&D Investments

ABB's EV charging systems incorporate the latest in reliable and redundant power electronics, grid-intelligent architectures and secure, intelligent software to support site host and driver needs. ABB spends 1.5 BUSD per year on R&D and is engaged in constant advanced development of improved software services, power delivery systems, power electronics and optimal electrical solutions for transportation and infrastructure, utility and facility customers.

ABB's EV Infrastructure team members in North America and globally have leadership positions on committees such as CharIN, NEMA, SAE, IEEE and other relevant standards development organizations.

ABB's E-Mobility Experience

ABB has extensive experience with a wide portfolio of charging hardware as well as deployment in projects around the world. ABB is the global leader in DC fast charging infrastructure having deployed more high-power charging systems, over more years and in more countries than any other company. ABB's key values include our high quality, reliable and future-proof technology; our advanced connectivity services for always online charging systems; and our reputation as a committed and experienced partner in EV infrastructure deployment. The following list highlights the many values and attributes where ABB leads in the EV infrastructure market:

Solution excellence

- High quality, environmentally rugged systems built to customer needs, meeting UL/ADA compliance
- Industry-leading modular power electronics architecture for greater redundancy and uptime
- Intuitive, daytime readable touchscreen displays
- Access designs provide extremely fast and easy service and maintenance
- Low noise due to distributed fan cooling systems
- Strict Class B EMC designs, suitable for residential areas, with highest safety near medical devices
- Safety excellence, third-party testing and certifications, always to latest standards

Best-in-class connectivity

- Secure, flexible connected services supported by ABB software engineers and analysts
- Experience integrating many types of back office systems and APIs
- Remote monitoring, diagnostics and software upgrades
- Flexible user access and payment options enabled (RFiD, PIN, smart phone, credit cards and contactless payments)
- Compatible with OCPP 1.6, Autocharge, ISO 15118 and smart energy APIs
- Supporting full interoperability from hardware to software, for optimal owner, operator and host choice

Experienced, bankable partner

- More than a decade of deploying 20,000+ DC chargers in all regions, environments and site types
- Extensive OEM co-development, performance validated at labs and test tracks around the world
- Fast delivery times for standard products
- 24/7/365 network with support by ABB's own experienced engineers and service professionals
- Leading with high power technology, ready for the most advanced EVs coming to the market
- Focused R&D centers for power electronics and grid interconnect technologies
- Companywide mandates for safety, sustainability and OpEx
- Fully committed to e-mobility industry with a proactive roadmap for the next generation of EVs

ABB has partnered with all major car, truck and bus manufacturers for many years, ensuring that EV charging infrastructure meets the industry demand and leading new technologies and industry standards development. Evolving in a fast growing and dynamic market, ABB`s charging solutions are designed to conquer time with a future proof and open-standard approach.

In the United States and Canada alone, ABB has deployed over 2500 DC fast chargers and has a robust in-house service team – all across North America – and service cloud platform to ensure quick response time and increased uptime of the chargers. Because of this global and local expertise, ABB has become the go to for bus and car manufactures as well as key stakeholders locally and worldwide.

ABB has a 24/7/365 global and local NOC (network operating center), manned by direct employees providing remote monitoring and charging system diagnostics. With remote monitoring, diagnostics and software updates, maintenance costs are minimized. For example, ABB diagnoses more than 90% of service cases remotely, while solving over 60% of these cases without any on-site intervention.

ABB's connectivity services have been engineered to support owners, operators, networks and sites to enable any chosen business model. Using ABB's web tools or OCPP network integration, notifications can be set for each charger or fleet of chargers (for example, when an e-stop is depressed). These notifications can be set as alerts via email or SMS (SMS via carrier email address protocol). Alerts can be set up to send reports, specific error messages or charging events.

ABB's EVCI Product Portfolio

ABB offers passenger vehicle to heavy vehicle charging, and the charging solutions span from 20kW to 600kW opportunity charging. All are DC Fast Charging today but more is coming soon.



DC Wallbox 24 kW DC	Terra 54 50 kW	Terra 94/124/184 90-180 kW	High power 175-350 kW	HVC Bus/Truck 50-600 kW

In 2021, ABB will release an AC Level 2 charger as shown below to help provide more options for our customers to support their various use cases:

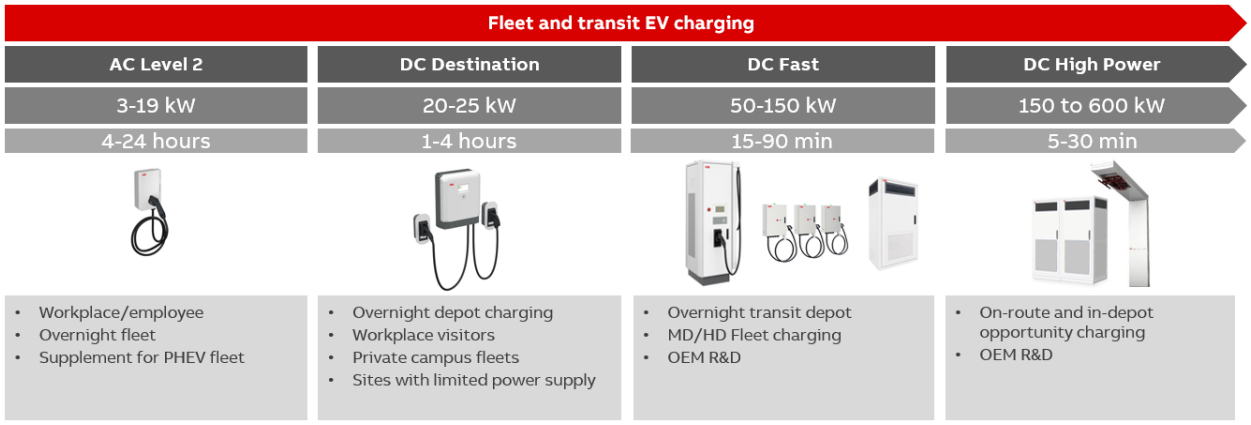


ABB Transit Electrification

Many transit projects would be utilizing ABB`s Heavy Vehicle Charger (HVC), a modular fast charging solution that is equipped with either a Pantograph or satellite depot charge box(es) with CCS connector(s) to fast charge plug in hybrid- and full electric busses with high power on route or at depot. Compliant with both OppCharge, SAE J3105 and Combined Charging System (CCS) SAE J1772 standards, ABB`s HVC systems are compatible with almost all major bus OEM and ensure a future-proof infrastructure development because of their systems modularity and upgradability as well as open-standard approach.

The charger and its software are built based on a modular design that gives many advantages for servicing and adding new functionality. As an example, the 150kW charging power of one power cabinet is generated from 3 internal power modules of 50kW, creating redundancy. In the event a module fails, the system can be remotely reconfigured to work with the remaining operative module(s) at any time resulting in increased system uptime. All software and all key hardware modules are developed and produced by ABB itself. This means ABB's ability to diagnose and support enhancements to the system much easier and more in depth. Spare parts and product life cycle support can be made available easier and is fully under ABB control.

ABB HVC chargers feature a robust hardware design using high quality components to provide high reliability. The chargers are designed for a functional life of at least 15 years based on normal use. The cabinets are made from stainless steel (AISI 430), and coated using powder coating. This gives an extremely durable, easy to maintain finish, with no corrosion hazards, also well suited for salty climates.

All of our charger technology is rated to handle a wide DC voltage range, 200 to 850VDC which allows customers to use this platform with cars, trucks, fleets, bus, etc. As our customer's fleet grows, the HVC charger should be able to allow charging with the new vehicles as they come on board.

ABB offers Sequential Charging for its HVC utilizing CCS protocol which are the plug in connectors as well as the Pantograph UP (SAE J3105-2). This allows the system to have more dispensers per HVC charger cabinet. With smart charging the power is distributed intelligently over a maximum of 3 dispensers (depot charge boxes or PU Charge Domes) for maximum charge rates, lower demand capacity required and space saving with less HVC cabinets which creates cost savings.

As a global EVCI supplier, ABB has been performing interoperability with all of the major bus OEM's including bus OEM's who are members of OppCharge and/or CCS for bus charging include Volvo/Nova Bus, New Flyer, Proterra, Gillig (Cummins), BYD, GreenPower Motor, MAN, Scania, Vanhool (ABC Bus), Solaris, Iveco Bus, Heuliez Bus, etc.

Buy America

ABB provides a charging infrastructure solution that meets the FTA requirements for Buy America. More specifically ABB complies with USDOT FTA Buy America Rule 49 CFR Part 661.5 – General Manufactured Products. These products are manufactured in Portland, OR.

Reference experience

This list of highlights ABB's recent and ongoing major public, transit and fleet deployment projects that serve many e-mobility applications. This list is not inclusive of the many EV Infrastructure projects ABB has been engaged with that are subject to non-disclosure agreements.

Customer Name and Location	Date started
Southern California Edison (SCE), United States: ABB sold two 175 KW Terra HP high power, HV systems for SCE's Irwindale, CA facility that warehouses utility equipment used across the region - supporting Daimler's Frieghtliner eCascadia Class 8 truck.	2020
NYPA, United States: ABB is supporting New York's EVolveNY program to deploy Terra HP 350 kW high power chargers across the State of New York, connecting the upstate regions to New York City.	2020
Taiga Motors, Global: ABB partners with Taiga Motors to electrify recreational vehicles with safe, reliable and compact Terra AC Wallbox and Terra DC Wallbox charging stations.	2020
Lion Electric, North America: In a sales and service partnership, ABB will collaborate with Lion Elecric, a leader in electric school buses as well as other commercial vehicles, to strengthen the transition to zero-emissions transport throughout North America.	2020
DREEV (EDF/Nuvve), Europe: ABB will provide its V2G bi-directional charging solution, integrated with DREEV software technology, to enable V2G delivery of surplus power back to the grid – and accelerate V2G commercialization.	2020
Audi and JET Charge, Australia: Audi has selected ABB's Terra HP high power charger for its main Audi Customer Centres in Melbourne and Sydney.	2020
Porsche, Saudi Arabia: ABB High Power 175 kW DC Chargers installed for Porsche dealerships in Riyadh to serve high power charging needs of the Porsche Taycan and future EV models.	2020
Ryder, United States: Through ABB's partnership with In-Charge Energy, ABB is the preferred DC fast charger for all Ryder sites to support their MD/HD vehicle deployments	2020
Daimler, United States: Deployed 20+ HVC-150's and Terra HP's to support Daimler's pilot program for eCascadia and eM2	2020
Edmonton Transit, Canada: ABB has delivered 26 ABB HVC 150kW overhead charging systems in an innovative "in depot" application for opportunity charging.	2020
GRIDSERVE, United Kingdom: ABB high power EV chargers selected for the company's first 'Electric Forecourt' centered in Braintree, Essex.	2020
ASKO, Norway: ABB has will supply charging infrastructure with Norway's largest grocery wholesaler for its growing fleet of electric trucks. Currently, ASKO has 600 trucks on the road each day and has a goal to achieve zero emissions distribution of groceries by 2026.	2020
Audi, New Zealand: ABB has supplied a range of charging systems to Audi Dealerships which will contribute to the country's objective of becoming carbon neutral by 2050	2020
eMP, Japan: ABB's Terra 184 electric vehicle chargers have been selected to modernize charging infrastructure for the country's electric vehicle market.	2020
Volvo, United States: Chosen as the DC fast charging supplier for the Volvo LIGHTS project using Greenlots OCPP Network. Currently deploying DC fast chargers to support about 25 heavy duty trucks.	2020
Lane Transit / Eugene, OR, United States: multiple ABB HVC Depot chargers to enable overnigh charging of New Flyer buses.	2020
Jönköping Energi, Sweden: ABB awarded 10+ 450 kW pantograph chargers for Vy Bus. This project began in 2020 and all systems will be fully operational by mid-2021.	2020

Toronto Transit Commission (TTC): ABB HVC Depot chargers deployed to deliver CCS charging for all-electric and hybrid electric buses.	2019
ST Engineering Land Systems, Singapore: 450kW systems for port charging site supporting Automated Guided Vehicles (AGV) that transport heavy shipping containers at the port terminal. ABB grid-connected equipment also supplied.	2019
Redbus Urbano, Chile: 8 HVC 150kW chargers for terminals in Nueva Bilbao and El Salto. These chargers are the first eBus chargers to be supplied in Latin America.	2019
Qbuzz, The Netherlands: ABB installed 62, 100kW high-power, high voltage charging stations for overnight fleet charging, 38 Terra 54 HV 50kW depot-fast chargers, and six HVC-300 300kW pantograph on-route chargers.	2019
TriMet / Portland, United States: ABB HVC Depot and Overhead Pantograph charging systems in eBus pilot; in partnership with Portland General Electric and New Flyer.	2019
BP, China: In cooperation with 66 iFuel, is deploying ABB DC fast chargers for its charging network on the Yangtze River Delta and the Pearl River Delta.	2019
NTU, Singapore: Nanyang Technological University (NTU) and the Land Transport Authority (LTA), along with Volvo Buses chose ABB's Heavy Vehicle Chargers (HVC) for the world's first fully electric, autonomous bus.	2019
Shell / Greenlots, Singapore: 50kW sites for public fueling locations.	2019
Hamburger Hochbahn, Germany: ABB powers first fully electric bus depot with 44 150kW chargers plus turnkey switchgear and transformer solution.	2019
Electrify America, United States: ABB deploying hundreds of 150-350kW systems throughout the US including the first 350kW public systems in the Americas.	2018
Ionity, Europe: Charging network with several hundred 350kW ABB high power charging systems to be deployed across EU over the next couple of years.	2018
Hydro Quebec, Canada: ABB chosen to supply DC fast charging stations for its Electric Circuit network of stations.	2018
Tide Buss / Trondheim, Norway: Eight ABB HVC 450kW overhead pantograph charging systems to serve more than 60 electric buses from Volvo and Heuliez.	2018
Audi/VW/Porsche, global: VW Group dealerships equipped with hundreds of ABB 50kW chargers across the EU and Canada	2018
ChargeFox, Australia: ABB 150-350kW high power charging systems.	2018
EnBW, Germany: with 200+ DCFC systems in Germany along the Autobahn	2017
Reykjavik Energy, Iceland: ABB 50kW systems deployed in ring formation fully connecting the island to enable emission free transportation; ABB is sole supplier.	2017
Copec, Chile: ABB DC fast chargers are networked from Santiago down to the Pacific coast.	2017
Vattenfall, Sweden: Ongoing partnership with 40+ DC fast chargers across Sweden with ABB grid connected equipment supporting these systems.	2017
Lidl, Europe: Fast charging at Lidl's stores in multiple countries across Europe with 240+ ABB DCFC systems.	2016
OEM bus/truck development, Global: Multiple pantograph and CCS e-Bus/truck pilot projects with Volvo/Nova Bus, New Flyer, MAN, Scania, Proterra and other OEMs across Europe, Asia, and North America	2016
E.ON, Europe: ABB networked DC fast chargers across multiple EU countries: 200+ DCFC.	2015
Grønn Kontakt, Norway: 225+ ABB 50kW networked DCFC systems.	2015

EVgo, United States: 800+ public DCFC sites across the US, including collaborative work on the first CCS and 150kW public charger sites in the Americas.	2014
Fastned, Netherlands, UK and Germany: 250+ roadside fast charging stations ranging from 50kW-350kW.	2013
Fortum, Norway, Sweden and Finland: Networked fast chargers across EU; 320+ DCFC systems now deployed.	2013
ELMO, Estonia: The world's first DCFC network, 200+ ABB fast charging systems connecting the nations highways.	2012





ABB is the product of choice for the world's high power charging networks and eBus/MD/HD charging sites. Above (L to R): Ionity, Electrify America and EVgo have chosen ABB Terra high power systems as the mainstay technology on their networks. Below (Clockwise from top): ABB eBus charging in Sweden, Volvo LIGHTS in California and a pilot MD/HD fleet depot charging site in the US; Fastned high power sites in the Netherlands and UK, Audi dealer deployments in Australia and Daimler's eCascadia charging at a Southern California Edison location.









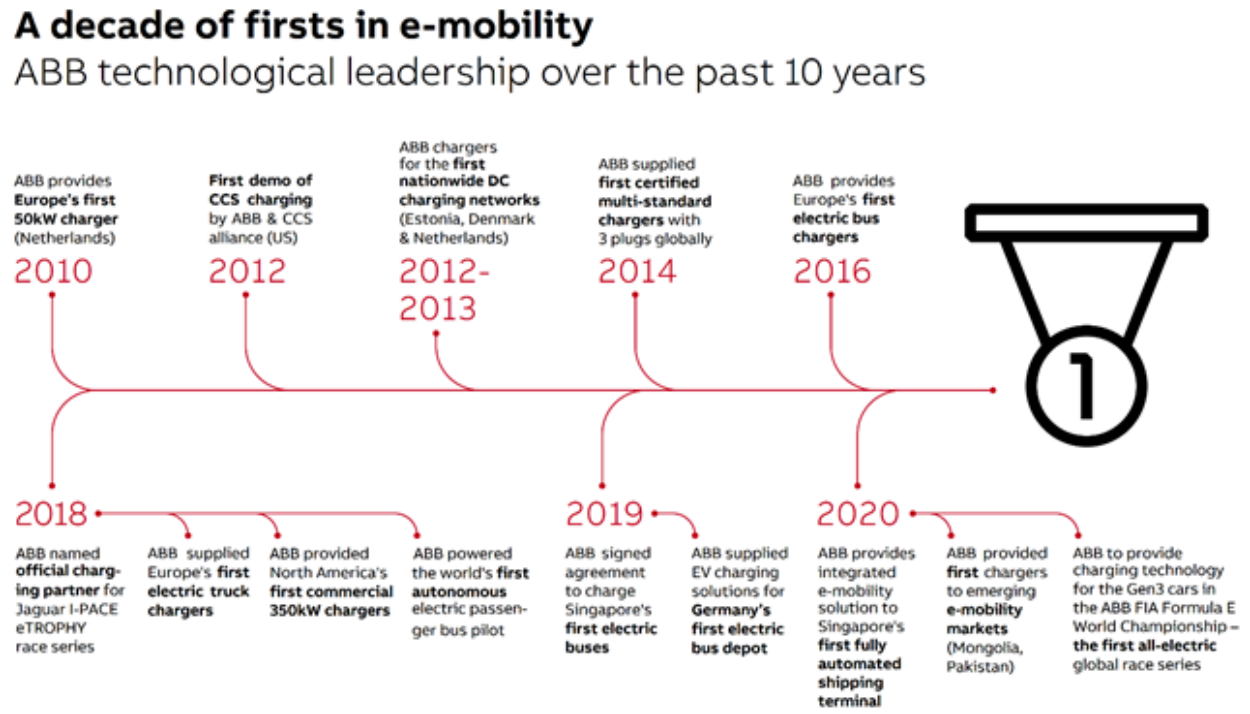


ABB Formula E





ABB is the title sponsor of the Formula E Championship racing series, shining a spotlight on global pioneers using technology to help create a more sustainable future. ABB leverages learnings for extreme charging usage and has worked closely with racing teams to develop EV infrastructure solutions that can be scaled commercially.

ABB has announced that it will provide the charging technology for the Gen3 cars in the ABB FIA Formula E World Championship. The new vehicles are set to debut in 2022.

ELECTRIC VEHICLE INFRASTRUCTURE USA

Warranty and Services

Supporting best-in-class uptime



Charging infrastructure backed by a warranty must offer the highest utilization and lowest downtime. ABB's warranty services are enhanced by remote and real-time connectivity to ensure seamless operation and longest equipment lifetime.

Services ensure operational excellence
Operational excellence starts with reliable chargers. ABB's family of EV chargers are modularly designed to withstand heavy operation under rugged conditions.

In addition, ABB's fast chargers are the easiest in the market to service, with 24/7 connectivity for remote diagnostics, and accessible designs that expedite maintenance and field service.

ABB's EV charging infrastructure service offering includes remote and software services as well as training in addition to parts and warranty services.

Remote services

- 24/7 connectivity
- Remote services
- Remote diagnostics
- Firmware upgrades
- ABB Web tools

On-site service and parts availability

- Standard warranty execution
- Extended warranty options
- Service level agreements
- Preventive service and maintenance
- Spare parts programs

Custom software services

- OCPP integration
- Autocharge integration testing
- Interoperability testing and validation
- Customized software integration support

Training

- Standardized online training
- Customized service training
- Third-party service training programs

Standard warranty and SLA programs
Services for every charging site

Every ABB EV charger is backed by a standard warranty and an experienced service team committed to customer success. ABB's service level agreements optimize charger uptime and ensures faster remote and on-site response times.

Scope for USA	Standard warranty execution	Optional SLA offering
Spare parts delivery	Within 7 days after diagnostics for standard parts	Next-day shipping of standard parts
Corrective Maintenance	Included	Included
Remote Support	Within 7 days	Within 48 hours
Onsite Support	Within 14 days *	Within 96 hours
Preventive Maintenance	Available on demand	Included

* See standard warranty provisions by product, including travel and labor, on the following page of this document.

—
Standard Warranty vs Optional SLA
ABB's standard warranty provides a foundation for operational planning. However, proactive planning should include service level agreements which significantly enhance charger reliability and uptime.



Standard warranty

ABB Product line	Parts	Labor	Travel	Logistics	Preventive Maintenance	Extended Warranty*
Terra AC Wallbox UL	3 years	—	—	Shipping for RMA	—	—
Terra DC Wallbox UL (20-24 kW)	2 years	—	—	Shipping for RMA	Optional*	Option up to 5 years
Terra DC Fast All-in-One UL (50-180 kW)	2 years	2 years	major metros	Shipping for RMA	Optional*	Option up to 5 years
Terra DC High Power UL (175 kW, 350 kW)	2 years	2 years	major metros	Shipping for RMA	Optional*	Option up to 5 years
HVC-C Depot Fleet UL Charging Systems	2 years	2 years	major metros	Shipping for RMA	Optional*	Option up to 5 years

Terms and conditions

- Warranty terms outlined in ABB Standard Terms & Conditions at time of sale apply
- The standard warranty covers labor and parts as cited in the chart above
- Limited travel included for warranty claims within metro locations of 1M+ population as applicable in the chart above
- Standard parts can be available on site within 7 working days
- Standard path to ticket resolution is typically within 7 working days (service tech or part dispatched)
- Warranty response times contingent on active Charger Connect for remote connectivity

Warranty exclusions

- Used for purposes other than to charge an EV
- Use outside specified ambient conditions
- Acts of nature, vandalism, misuse, normal wear and tear
- Overvoltage due to lightning strike or grid imperfections; grid instability
- Unauthorized opening, demounting or moving
- ABB chargers must be maintained and/or stored according to ABB instructions; and may not be left without power for an extended period of time
- After-hours travel and labor
- Consumable parts

Warranty service terms

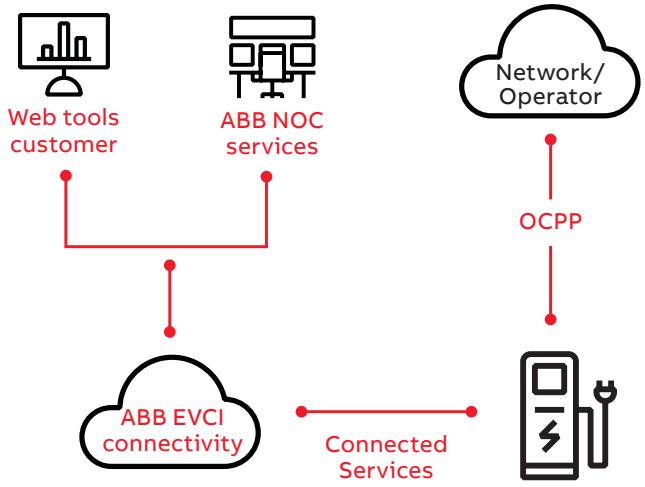
- Service personnel must be considered qualified personnel according to NFPA 70E
- Certificate of training attendance for ABB EV charging products and services must be on file for each person servicing ABB charging equipment
- Acceptable training programs include one conducted by ABB or an ABB certified trainer
- To validate warranty, equipment must be maintained and serviced by ABB approved qualified personnel

Warranty claim process

- Troubleshooting may be conducted by the network provider or CPO (Charge Point Operator) as applicable before submitting a warranty claim
- If the issue cannot be resolved via basic troubleshooting, ABB can be contacted via the E-Mobility Service & Resource Portal via the "Submit a request" ticketing function
- An ABB E-Mobility Service Team member will assist with diagnosis and validate warranty claim
- When validated, an ABB Service Provider will be assigned to visit the charger and replace any non-functioning parts that are under warranty; corrective maintenance may also be required

—
* Preventive maintenance (PM) is required with the purchase of an extended warranty.

An extended warranty package may be purchased at the time the charger is purchased. ABB can also offer an extended warranty during the valid warranty period which would require an updated proposal.



—
Connected Services
ABB's connectivity solutions link ABB EV chargers to back-end systems as well as ABB's service tools. Connected services are essential to networked charging, upholding warranty, enhancing an SLA and optimizing operational lifetime.



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Prepared for:

August 25, 2021





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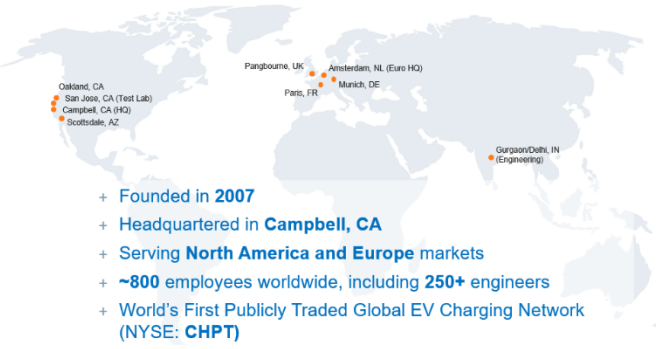
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1 ChargePoint Overview



For more than a decade, ChargePoint has been building the fueling network of the future. ChargePoint started in 2007 before electric vehicles even hit the road, and today ChargePoint is now one of the largest, "pure-play" EV charging companies with over 5,000 unique commercial customers and over 112,000 active places to charge on the ChargePoint Network. ChargePoint provides EV charging solutions throughout North America and Europe and our 800+ employee workforce is dedicated to designing the most innovate and reliable EV charging platform.

In March of 2021, ChargePoint became the world's first publicly traded global EV charging network when we were listed on the New York Stock Exchange under the stock symbol CHPT. We are proud of our role in building the new fueling network and our ability to be 100% focused on EV charging. Since we are not part of a broader company whose interests are diversified in unrelated or even competing fueling solutions, we are able to dedicate all our efforts to our mission: ***to get all people and goods moving on electricity.***

Products & Services

ChargePoint operates as a one-stop shop for customers by providing the complete EV charging ecosystem. Our commitment to EV charging—and only EV charging—enables us to offer the best electric fueling experience across every vertical. We have built a fully integrated portfolio of hardware, cloud services and support with the best technology in the industry. This ensures that everything works seamlessly and with enhanced functionality, which in turn results in great customer satisfaction.



Networked EV charging



Complete solution of cloud-based software and services



Mobile app (Android and iOS)



24/7 Support for EV drivers in North America and Europe

Charger Management Software

Our cloud-based software solution is the heart of our EV charging solution. The intelligent and flexible platform connects all parties in the EV charging ecosystem including the driver, site hosts/station owners, fleet and depot managers, utilities and more. Station owners access the ChargePoint Network via a web portal, as well as APIs, to monitor, report, and set the operating parameters for charging stations on their property. Below are just a few of the features enabled by the ChargePoint Network:



Organization Hierarchy
Define different layers of view at site, city, country scales.



Dashboard & Analytics
Station owners see how stations are being used and when it's time to add capacity.



Energy Management
Efficiently and automatically utilize power available for charging vehicles. Save money on costly upgrades and avoid demand charges.



Fleet Services
Fleet managers can track vehicle charging and pay for electricity if the vehicles need to charge at other stations.

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Charging Infrastructure

ChargePoint is the only global EV charging solution provider that offers a complete portfolio of AC and DC charging solutions for every charging use case – from home to workplace to high power fleet charging. The figure below illustrates the broad coverage of charging levels provided by this portfolio of charging stations unified under the ChargePoint Network. Specific to this solicitation, we are proposing the ChargePoint Express line of Dc fast charging stations.



Fleet Charging Solutions

ChargePoint's global fleet solution portfolio includes everything fleets need to electrify and optimize fueling as they grow. Fleet management software combined with ChargePoint's DC fast charging solutions balance charging costs with operational readiness for transit buses to meet their complex and mission critical requirements. Expert design/build services are also available to ensure a smooth transition to full scale fleet electrification. Ongoing support and maintenance guarantee station uptime to ensure chargers are available to keep buses fully charged. Our optional Fleet Depot optimized charging software is available to help depot managers optimize charging schedules based on vehicle state of charge, assigned route length, departure times, telematic data, power constraints, and other factors.

In Summary

ChargePoint has extensive experience in delivering a complete charging ecosystem for electric fleets including transit bus operators. Only ChargePoint has the necessary experience, scale, service, and quality that will save fleet managers time and money, so you can focus on your core mission of providing public transportation.

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2 ChargePoint Cloud Services for Bus Depots

ChargePoint's charge management system is designed to provide operational visibility and management of the complete charging infrastructure, and to allow operators to reduce capital and operating costs while increasing operational efficiency. Our cloud-based software includes a suite of features to manage an electrified fleet, including the ability to create and manage vehicles and fleets, assign payment methods, see real-time vehicle charging status and vehicle charging session reporting. These features sit alongside the full configuration, control, and reporting of charging stations.

ChargePoint is one of the most experienced suppliers of charge management services in the electric vehicle charging segment. Providing charge management software is our core expertise and we currently support well over 112,000 active places to charge on the ChargePoint Network.

2.1 Charge Management System Overview

All ChargePoint charging stations are offered with our cloud service plans to help efficiently manage station operations. ChargePoint's proposed DC chargers are paired with our Enterprise cloud-based software plan that provides a full feature set to tailor and manage all operating parameters and remotely view status and run utilization reports. Software plans are paid on an annual or pre-paid for multiple years at a discount. Access to the station management software platform is provided through a web-based portal and ChargePoint welcomes the opportunity to review the portal features in detail with your procurement and operations team.

Dashboard

For station operators, a web-based dashboard provides a real-time overview of the charging infrastructure, with easy-to-read tiles. Aggregated monitoring/reporting of all stations, group(s) of stations, and monitoring of individual stations is accomplished using global filters for the Dashboard page.



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- ***Station Status:*** Displays the real-time status of all stations.
- ***Real Time Power:*** Displays the active load of the charging stations.
- ***Energy****:* Indicates how much electricity was discharged by the stations on a monthly basis.
- ***Average Session Length:*** Displays the breakdown between the time that vehicles take to actively charge vs. how long they are physically connected to a charging station.
- ***Environment:*** estimates the emissions avoided based on the energy dispensed.

Organizations and Rights Granting

In the ChargePoint platform, all commercial charging stations are associated with an organization that is utilizing or managing the stations. These organizations determine how their EV charging stations are set up including how they are physically and logically organized, who can use them, how much it costs to use them, energy management, and more. Station operators can assign access rights to multiple individuals within the company with varying rights to align with their needs and responsibilities.

	**Org administration**	Ability to create several layers or organizations at the parking, site, region, country and continental level
	**Charger Group**	Customize the group of stations to administer them by group and generate aggregated reports
	**Role**	Assign roles with various access privileges such as a Network manager, Station Manager, and Fleet Manager

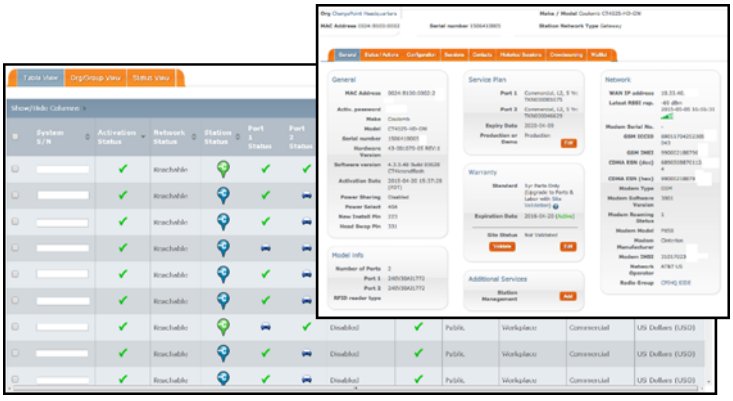
Station Monitoring and Data Reports

ChargePoint provides extensive monitoring and reporting capabilities in a user-friendly and highly flexible web interface. ChargePoint stations are continuously communicating over the ChargePoint network and status updated in real-time and available on the web-based admin interface and via push alerts. The ChargePoint web interface provides the tools necessary to actively monitor and manage all stations, including near real-time status for each port, making it easy to view important information in a clear and concise table format.

Detailed near real-time status for individual stations is available on the Station Properties page, including active charging sessions with current and voltage output levels to vehicle displayed.

Administrators have the ability to:

- Get live status, including network connectivity and port status
- Reboot the station
- View live charging sessions, including instantaneous power output
- View a history of charging sessions



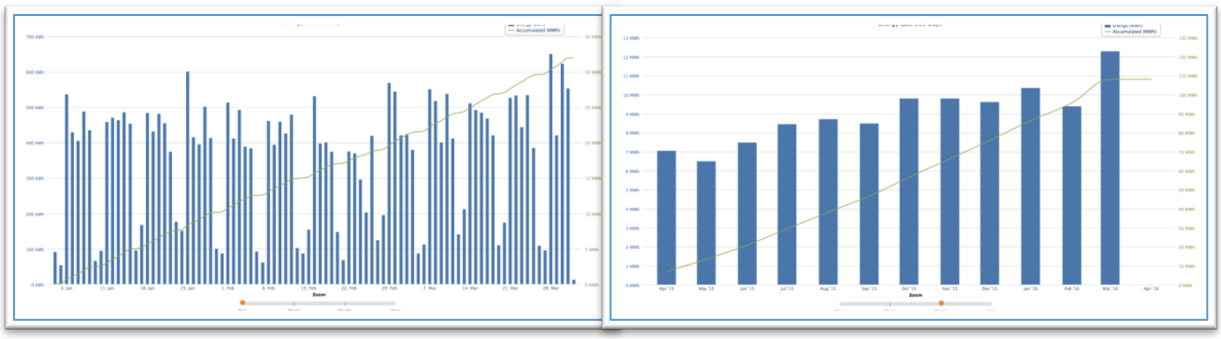
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All reports may be exported to Excel or CSV format from the reports page directly. The categories of reporting available on the ChargePoint web portal include:

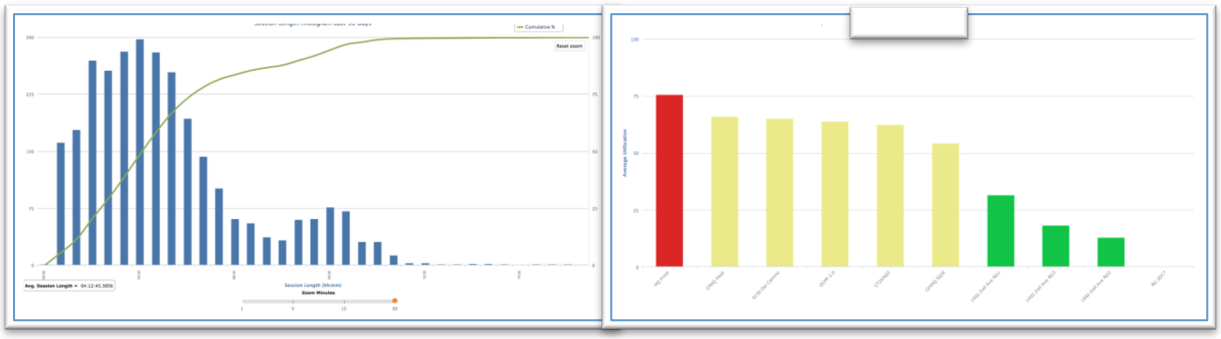
- ***Analytics:*** A large collection of information, including peak occupancy, session information, energy dispensed, and GHG savings. There are several reports under Analytics including the Unique Driver Report, Session Length Histogram Report, and the Average Utilization Report.
- ***Logs:*** A chronology of configuration changes and the success or failure of any attempt by the ChargePoint cloud to download information to the stations.
- ***Audit Trail:*** All configuration and other actions including the user account that performed the action.
- ***Alarms:*** A table of station events, including service-affecting faults.

A sampling of reports is provided below.

Energy by Day & Energy by Month



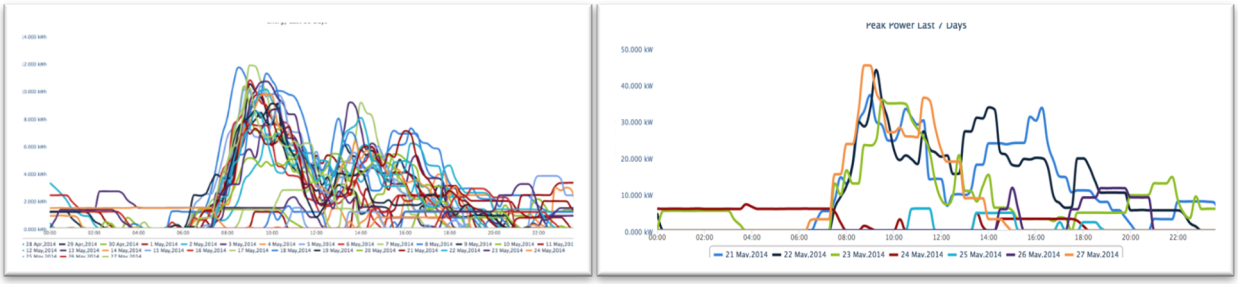
Session Length Histogram & Average Utilization



ChargePoint also provides for more advanced energy reporting that includes more granular 15-minute interval level data reporting down to the port level. An example of advanced analytics reporting is shown below:

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Energy and Peak Power by Time of Day



Station Alarm Reporting

In the ChargePoint web-based portal, depot operators can quickly view overall status of charging stations, including stations in alarm state that need service, categorized by alarm type. Comprehensive alarm log reports may be exported and include listings of station status at time of alarm (in use or available), alarm type, alarm event timestamp, and station details such as location, model number, and software version. Fleet and depot managers also can enable batched email alerts to receive an hourly email containing alerts on all stations or a custom group of stations, for example alerts for stations in a particular geographical territory or customer.

Station Software Updates

ChargePoint leads the industry in innovation and new product development. Our charging stations are designed with intelligent networking capability and automated over-the-air station software upgrades to support new features and enhancements to ensure your investment is future-proofed. As new software features are developed and introduced for general availability, station software upgrades are automatically downloaded over-the-air to our installed base of commercial charging stations. The ChargePoint cloud-based services are also updated on an ongoing basis via sprint releases to support new features and integrated solutions. These ongoing innovations and software upgrades are included with the network services subscription at ***no extra cost***.

Power Management

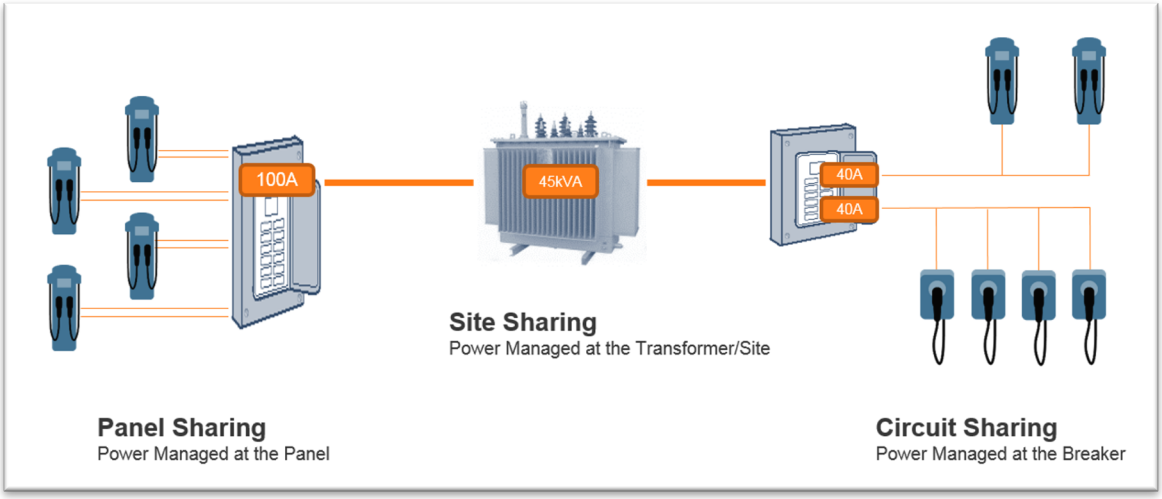
The ChargePoint EVSE charging software platform includes a wide array of options to manage energy and power at stations and groupings of stations. As fleets quickly grow, the ability to manage power among many vehicles can be critical to save on electrical infrastructure costs and ongoing energy costs:

+ ***Demand Response*:** Although not likely to be used in a fleet depot charging environment, ChargePoint software allows for demand response signals through use of a standards based OpenADR interface or APIs. Power can be curtailed completely, by a percentage of the active power, or set to a lower power threshold.
+ ***Power Limit:*** Manage load via building/energy management systems, either through integration via API or installation of a ChargePoint smart meter upstream of the charging stations. This approach optimizes power use by dynamically adjusting power to the charging stations based on real-time monitoring of facility loads.
+ ***Pricing-based Power Management*:** ChargePoint can dynamically set the Power Share ceiling based on pricing information received from the utility. As the price increases, the aggregate

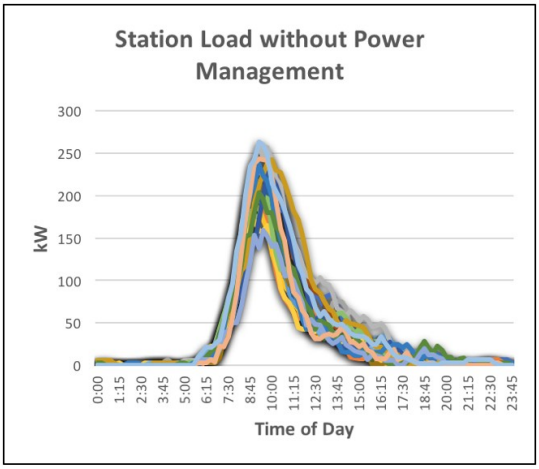
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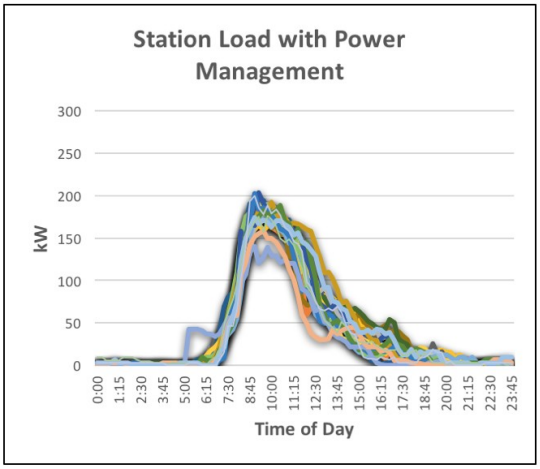
power is decreased, thus reducing consumption. This process is fully automated based on day-ahead pricing information from the utility.

+ ***Power Management*:** Allows an aggregate maximum load to be set for a group of stations at the circuit level, panel level and/or transformer or utility service level. DC power can be managed at a site level, in conjunction with Level 2 circuit and panel level power management applications. This allows for oversubscription of electrical service and optimizes the active charging time of vehicles relative to their overall time the vehicles are parked.



ChargePoint Power Management enables efficient charging of an increased number of vehicles using available power at a site, reduces electrical infrastructure costs, and eliminates higher utility service costs associated with exceeding a peak power threshold. This software feature is extremely useful in fleet applications given the large number of vehicles and charging requirements within a single site/utility service. The following graphs illustrate the impact of using power management to significantly reduce the overall power demand at a single site:



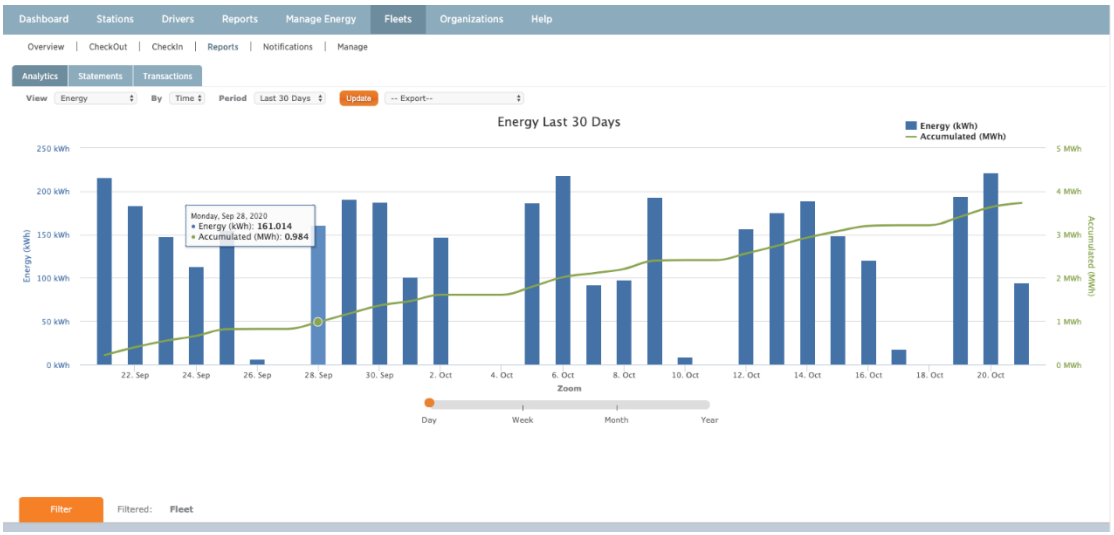


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Customizable Fleet Vehicle Accounts and Reports

With the standard charging management plans, fleet operators will have the ability to create unlimited fleet subgroups to logically separate vehicles by utility or department. Within the fleet groups, fleet operators can add their electric vehicles for usage tracking and data analysis.

Fleet operators can quickly pull usage reports and individual session details from a vehicle or vehicle grouping perspective. The image above shows the energy usage of a specific fleet, filtered by department for overall usage and growth analysis. The detailed reporting table provides over a dozen individual data points collected per vehicle charging session



Fleet Vehicle Dashboard

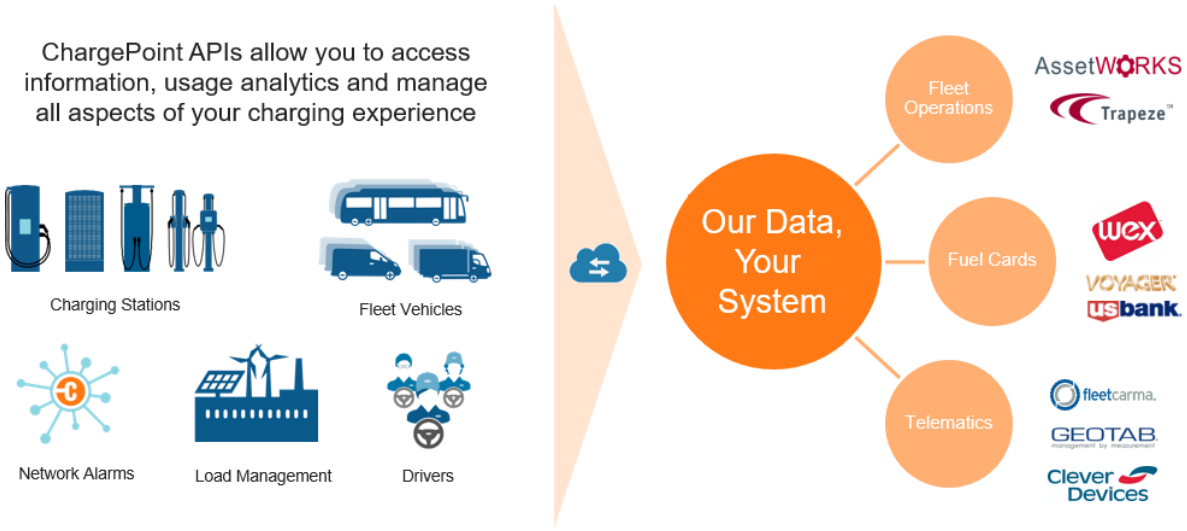
From the fleet dashboard, fleet operators will have visibility into the real time status of all the vehicles within their fleet portfolio. The map provides the location of the charging vehicle within the depot. This dashboard can be filtered to include specific departmental or utility fleets. The display map is interactive, allowing operators to select a vehicle for additional information about the vehicle. The figure to the right is an example of a depot view of chargers and their active status.



Fleet System Integration

Fleets today already operate within a complex ecosystem and it's important that any EV charging solution fit into that existing ecosystem as much as possible. That's why ChargePoint offers a full set of Soap/XML based Application Programing Interfaces (APIs) to ensure a seamless integration with fleet systems relied upon by fleet operators today. Depot and fleet managers can use ChargePoint APIs to retrieve financial transaction data, manage charging stations, view detailed station information, real-time status, and to get a list of active station alarms.

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ChargePoint has completed or initiated integration discussions with the most common platforms as highlighted above, and we continue to grow our partnerships to best serve fleet operators. We welcome the opportunity to discuss additional integrations that can best support your needs.

2.2 Optional Fleet Depot Optimized Charging Software:

In addition to the standard charging station management software, ChargePoint also offers our optional Fleet Depot optimized charging software. The Fleet Depot plan is ideal for larger, mission-critical fleets at a single depot that require complex charge scheduling integration with vehicle workflow to enable operations.

The software prioritizes vehicle charging based on the vehicle state of charge, the assigned route length, and the departure time of the vehicle. The solution can also intake external data such as the vehicle telematics information and route plans from the scheduling system as well as taking into consideration power supply limitations and auxiliary loads at the depot site.



Although not included in the current proposal, we welcome the opportunity to provide additional details on the optional Fleet Depot software upon request.

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3 Charging Hardware

ChargePoint has designed our charging system around the needs of large fleets including electric buses. We also recognize the rapidly changing landscape of bus and truck charging capabilities and different charging standards. The sum of these needs resulted in a scalable modular design that accommodates the wide array of electric vehicle power requirements, different charging standards (CCS Type 1 for North America, CCS Type 2 for Europe), site limitations such as space and electrical capacity constraints, and designed for a 12-year life - long enough to match the average vehicle replacement cycle.

Furthermore, all ChargePoint Express charging stations use DC power which means all power conversion takes place in our wayside equipment and not on the vehicle. The savings result in lower vehicle costs (i.e., no need for larger and more expensive on-board charging systems in the vehicles as power levels increase), and a lower average charging system cost. We describe specific aspects of our charging system below.

Equipment Lifespan and Spare Parts Availability

ChargePoint DC charging stations are designed with long-term needs in mind. All major components of the platform are designed to a last a minimum of 12 years the same as the average bus replacement cycle and spare parts are supported along the same lifespan.

Warranty and Optional Maintenance and Service Plan

ChargePoint standard warranty is one-year parts only, but an optional extended warranty package is available that includes proactive monitoring plus parts and labor coverage that aims to leverage real time station monitoring and a comprehensive labor component to maximize charger availability and minimize downtime when issues occur.

Performance Measuring

ChargePoint's cloud services allow for remote monitoring of the stations, so the project team can quickly diagnose any issues and calibrate charging to match grid and station owner needs.

Safety & Standards Compliance

ChargePoint products are designed, engineered, and built to comply with industry standards and applicable international, national, and local regulations and codes.

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3.1 ChargePoint Express Plus Charging Platform

The proposed Express Plus (EP) charging solution is ChargePoint's latest generation DC fast charging technology that is designed to meet the rigorous, mission-critical requirements of fleet depot charging. The Express Plus distributed DC platform is based on a modular and scalable architecture that can support initial vehicle pilots while easily expanding to accommodate a full electric fleet conversion. In addition, the platform can add power capacity along the way to keep up with vehicle charging capabilities and truly futureproof fleet charging needs.

Key features of the Express Plus Platform:

- **Performance** – the ability to increase power output at a later time to meet increase power demand in the future.
- **Scale** – the ability to add more ports in the future to charge more vehicles.
- **Reliability and Availability** – this is accomplished through system redundancy, design for serviceability and preventative maintenance to maximize uptime.
- **Universal Compatibility***:* The Express Plus supports battery packs from 200V to 1,000V, ensuring both legacy and future electric vehicles can always be charged with any standard connector.
- **Smart & Fully Supported***:* Remote management is easy with ChargePoint Cloud Services and built-in cellular connection. Operates on the new OCPP v2.0.1 protocol and supports 15118.
- **Dynamic Power Sharing***:* Steer available power with up to 8 connected dispensers to make the most efficient use of the investment and to charge vehicles as quickly as possible while managing site level power requirements.

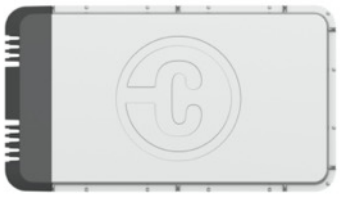
The Express Plus solution is comprised of three core elements: EP Power Blocks, EP Power Modules, and EP Power Links to provide the complete charging solution.

EP Power Modules

EP Power Modules are smart AC to DC power conversion units that convert the supplied 3 phase AC power to the DC power required by many electric fleet vehicles. Power Modules are rated at 40kW each and can provide output voltages between 200 and 1,000 ensuring charging capabilities for the EVs of today and tomorrow.

ChargePoint has designed and engineered the EP Power Modules to provide high-efficiency power conversion (> 95%) which in turn reduces electricity costs and wasted energy for the depot operator. In addition, EP Power Modules are sealed and self-contained which allows for easy replacement in the field with standard tools and minimal training. And with multiple EP Power Modules contained within a system, charging stations can continue to function and provide power even in the rare instance of one module not working properly.

EP Power Module Specifications:



- Maximum Output Power – 40kW
- Maximum Output Current – 100A
- Power Conversion Efficiency –Up to 96%
- Power Factor – 99% at full load
- Automatic blind mate connections
- Failure of a single module does not disable the port
- Harmonics – THD < 5% (complies with IEEE 519 requirements)

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- Integrated liquid cooled cold plate normalizes temperature across all modules
- Power Module Dimensions - 430 mm (H) x 130 mm (W) x 760 mm (L) (1’5” x 5” x 2’6”)
- Power Module Weight - 45 kg (98.5 lbs.)

EP Power Blocks

EP Power Blocks serve as the housing unit for EP Power Modules along with supporting infrastructure such as the liquid cooling system. EP Power Blocks can contain up to five EP Power Modules providing a total output capacity of 200kW. Multiple Power Blocks can be combined via a DC bus to increase power output up to 350 kW for ultra-fast charging applications.

EP Power Blocks provide the allocated power to dispensers using DC cabling and local data connections to enable a fully integrated system with remote diagnostics and management. EP Power Blocks intelligently provide allocated power to one or two dispensers in the base design configuration although have the capability to share power with up to 8 dispensers with the addition of a power distribution cabinet. The unique ability to intelligently charge so many vehicles from just one Power Block allows depot managers to maximize site capacity utilization and reduce the overall charge cost/vehicle.

EP Power Block Specifications:

- AC Input – 480VAC, 3-phase, 260A, 60Hz
- Contains up to 5 Power Modules
- Maximum Output Power – 200kW (5 modules)
- Maximum Output Current – 200, 250, or 350A depending on configuration
- Network Protocol & Communications - 4G/LTE communication between gateway and ChargePoint Cloud Network (Hosted by AWS).
- Ethernet (CAT-VI) connection between Power Block and each DC Dispenser (local not cloud communication).
- Power Block Dimensions – 2200 mm (H) x 1000 mm (W) x 1250 mm (L) (7’3” x 3’3” x 4’1”)
- Power Block Weight - 409 kg (900 lbs.) without Power Modules



EP Power Links

The EP Power Link is the station or dispensing component of the Express Plus platform. EP Power Link stations dispense power to the vehicle via conductive charging and support up to two flexible, lightweight cables with cable management and are compatible with all standard connector types. There are multiple options for managing cables including station installed cable management or external reels for extra-long cables. EP Power Link stations have multiple mounting options to accommodate the various layouts of depots including pedestal, wall, and over-head (gantry).

Each EP Power Link can deliver up to 200kW if connected to a single Power Block, or up to 350kW when connected to two Power Blocks. The optimal Power Block to Power Link configuration is determined based on the operational profile of the fleet depot and is highly dependent on the available time to charge.

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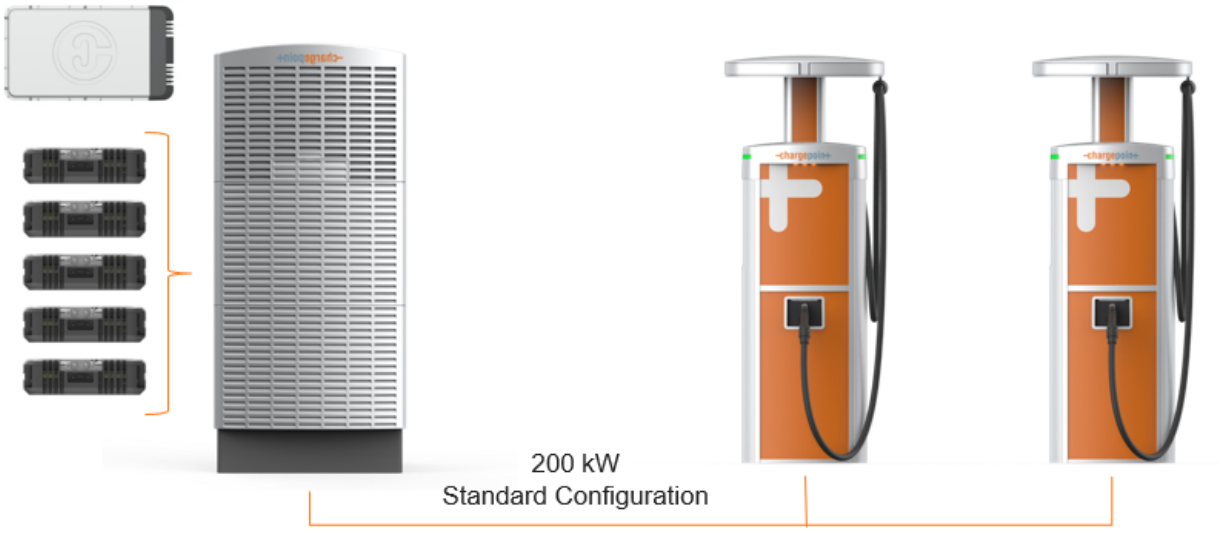
Power Link Specifications:



- Maximum Output Power – 200kW, 250kW, 350kW depending on EP Power Block configuration
- Maximum Output Current – 200A, 250A, or 350A depending on cable version and EP Power Block configuration
- Output Voltage Range - 200 to 1,000 VDC
- Maximum Distance between EP Power Block to EP Power Link – 300’
- Cable length – Up to 4.5 meters (15') with Cable Management Kit
- Supported Connectors: CHAdeMO, CCS-1, and CCS-2
- Dispenser Dimensions – 2400mm (H) x 700mm (W) x 330mm (D) (8’ x 2'4" x 1'1")
- Dispenser Footprint - 970mm (W) 400mm (D) with Cable Management
- Dispenser Weight – 200 kg (440lbs.)

System Configuration

The Express Plus platform is capable of sharing and steering DC power from the central power conversion cabinet to up to 8 dispensers and 16 charging ports in its maximum configuration. Within a bus yard, the more typical architecture is one power conversion cabinet supplying two dispensers each with a single CCS Type 1 connector. This is based on the bus charging capabilities, workflow and parking arrangements within a depot, and the typical bus downtime within which to fully charge before the next trip. The following illustration depicts the Express Plus architecture in a typical depot layout

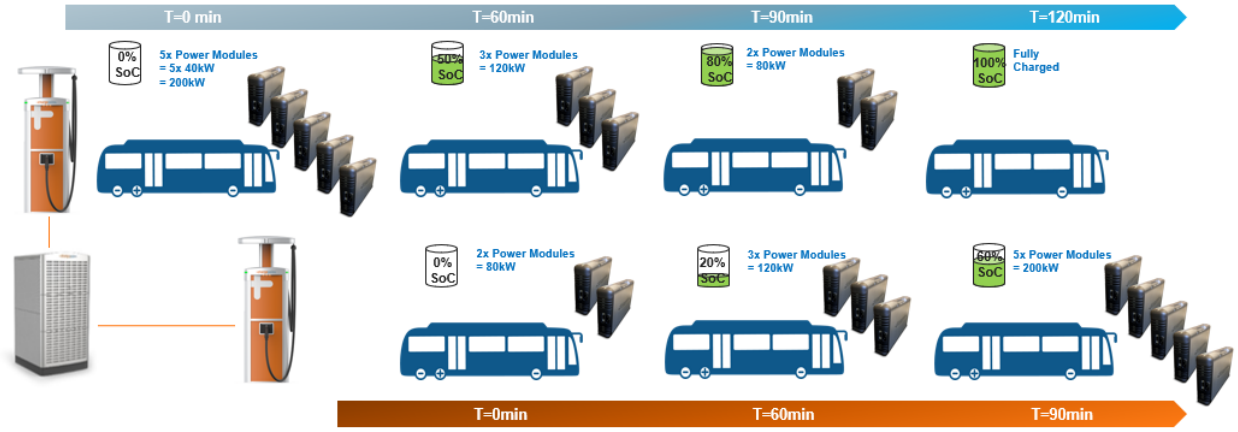


Power Sharing and Steering

The maximum power output for each EP Power Link can be set dynamically based on a combination of the total available input power from the Power Block and the actual power requested by each vehicle. Each EP Power Module can supply power to two isolated outputs. Load is managed on a “per module” (40kW) basis and each EP Power Module can vary its output to achieve intermediary power levels. As charging tapers on one vehicle, more power is available to the other actively charging vehicle.

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The following diagram illustrates the progression and dynamic power allocation charging two electric vehicles arriving at different times using a simple configuration of one EP Power Block with 200kW of capacity shared across two EP Power Links:



- At t = 0 there is a single electric bus charging, and it receives its maximum supported charging rate of the vehicle (200kW) with all 5 EP Power Modules allocated.
- At t = 60 minutes (for illustration only) a second electric bus has arrived and begins charging. Based on a configurable charging algorithm, in this example we reduce the power to the first vehicle to 120kW (3 EP Power Modules) and allocate the remaining EP Power Modules to the second vehicle and it charges at 80kW.
- At t = 60 minutes the first bus reaches 60% state of charge and the charging rate has dropped to 80kW based on the vehicle battery management system, freeing up one of the EP Power Modules which is then switched to the second bus. The second bus now receives 120kW.
- At t > 120 minutes, as the charging rate continues to drop on the first bus, EP Power Modules are automatically switched to the second bus as they free up. Eventually the first bus will be finished charging and the total available power of 200kW may be used by the second vehicle.

The Express Plus system is also designed to transfer power capacity across up to eight EP Power Links connected to the same EP Power Block. At the start of a charging event power is delivered from an EP Power Block to two connected vehicles. However, after both vehicles have been charged to their target, the total available capacity of the EP Power Block can be transferred by dynamic switching to another set of connected vehicles. This process can be completed multiple times up to the limit of time available and physical cabling between the charging cabinet and dispensers.

Intelligent communication between EP Power Blocks at a site, enabled through ChargePoint's cloud services, ensures that the total input power from the grid is never exceeded and the available input power is managed appropriately to accommodate vehicle charging load. Reducing overall site demand results in lower capital costs for supporting electrical infrastructure and allows depot managers to mitigate demand chargers which can be a major operating expense. To maximize the benefit of power sharing and dynamic switching, ChargePoint provides a comprehensive range of modelling and system configuration services.

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3.2 Equipment Uptime and Availability

ChargePoint's DC fast charging equipment is highly modular with minimal Field Replaceable Units (FRU) for ease of installation, service, and operations. Redundancy is built into the system architecture. Each unit is wired via an independent set of power conductors such that a failure of one station or its wiring path does not impact other stations. Low system failure rates significantly reduce the number of FRUs required on site. ChargePoint manages spare parts via its support and operations teams and can discuss our Spares Management Service offering as needed.

Each charging station contains multiple Power Modules, meaning if one were to fail the remaining power module(s) will continue delivering power. Each charging cabinet also has its own cellular modem for independent cellular connection to the ChargePoint Cloud Network. To ensure continued operations, stations will default to their prime directive in the event of a network wide outage.

ChargePoint's cloud connection is enabled through a 4G/LTE communication between the stations and the ChargePoint Cloud Network that is hosted by Amazon Web Services. No connection to the transit operator LAN or data network is required. This reduces the complexity, cost, and security concerns otherwise associated with connecting to local IT infrastructure.

3.3 Transit Bus Interoperability

ChargePoint is an electric vehicle agnostic company and design our solutions to be compatible with all major transit bus manufacturers. ChargePoint's DC charging solutions have been rigorously tested and validated to work with the major bus OEMs in North America including GILLIG, New Flyer, BYD and Proterra.



ChargePoint operates a robust vehicle compatibility program whereby vehicles are brought into the engineering lab for periodic testing. ChargePoint also provides charging stations to select vehicle OEM partners such as GILLIG, New Flyer, and Proterra for ongoing product and engineering testing.

In addition, a future software update will enable support for Plug & Charge on DC stations featuring the IEC/ISO 15118 standard. This element of 15118 prescribes how a charger and network can identify and authenticate a specific vehicle to allow for a charging session to automatically initiate by simply "plugging in".

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4 Warranty and Service Information

ChargePoint EV charging stations are some of the most advanced and reliable in the world, but site conditions can change, wear and tear occurs, and accidents or equipment failures can happen. That is why it is so important that mission-critical applications choose a solution that provides rigorously tested hardware designed for reliability and uptime along with integrated software and services that can quickly identify and proactively resolve issues.

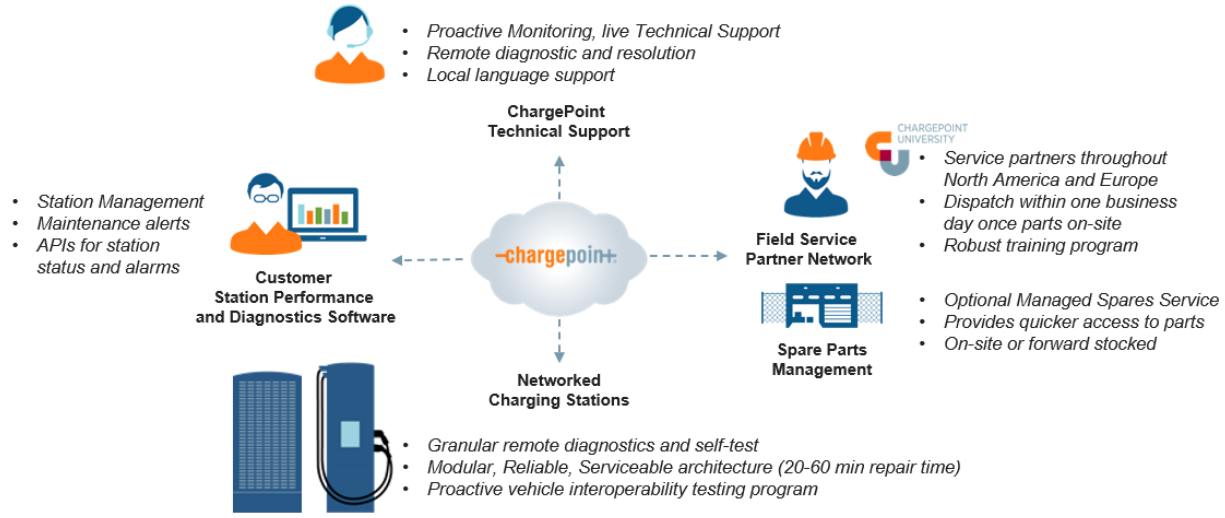
Standard Warranty

Standard warranty for all ChargePoint commercial charging stations is one-year parts only. ChargePoint warrants the charging solution shall be free from defects and related defects under this warranty beginning 90 days post shipment. Given the mission-critical nature of many fleet applications, we recommend ChargePoint Assure for a comprehensive, turnkey, hassle-free station ownership experience.

ChargePoint Assure

ChargePoint's Assure offering is the most comprehensive EV station maintenance and management program in the industry. Assure enhances your standard parts warranty with dispatched labor at committed service levels to perform on-site repairs, as well as a long list of additional features. With Assure, ChargePoint takes responsibility for fixing hardware issues by conducting proactive monitoring, identifying potential issues, and coordination of any necessary repairs by expert support specialists.

ChargePoint's vertically integrated hardware and software offering allows our Customer Support group to proactively monitor stations to detect and remotely diagnose issues or faults at the earliest possible moment. Many issues can be resolved remotely, but when necessary ChargePoint will promptly dispatch on our trained and qualified Operations and Maintenance partners to conduct any repairs along with supplied parts. Since the ChargePoint hardware is designed to be easily field replaceable, technicians can quickly replace the necessary components to return the station back to service.



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Additional Assure features include:

- 24x7 proactive station health monitoring
- Dispatch of repair technicians when required
- Next business-day, on-site response after parts are delivered
- Unlimited software configuration changes
- 98% annual uptime guarantee with financial penalties for non-performance
- Monthly reports and detailed quarterly reports of your station's performance metrics
- Coverage of labor for repairs typically not covered under standard warranty such as vandalism, abuse, and accidents

All ChargePoint Assure offerings include the costs associated for the monitoring, parts, dispatch coordination and the labor to complete all affected warranty repair work. Assure is available for a recurring annual fee or in multiyear packages for a greater discount and ChargePoint welcomes the opportunity to provide additional information and specific costs upon request.

ChargePoint Assure Pro and Spares Management Service

Assure Pro is an enhanced Assure offering specifically designed for mission critical support with general availability expected in late 2021. Assure Pro provides similar monitoring and full-service repairs although on an elevated level compared to Assure. This includes a 1-hour issue acknowledgement time, 24-hour issue resolution time, 24/7 remote technical support, and prioritization of customer support inquiries.

To enable the fastest possible field service and avoid delays due to shipment of spares, ChargePoint offers our Spares Management Service which is required Assure Pro. Through this offering, spare parts will be stored on-site or forward stocked within 1-2 hours of any site with covered charging equipment. ChargePoint will track and manage spare parts inventory as repairs are made over the term of the program.

Although not included in this proposal, we welcome the opportunity to share additional details of both Assure Pro and Spares Management Service upon request.

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5 Network and Security Information

ChargePoint is dedicated to enabling the future of e-mobility by seeking to provide the most open, secure, and robust network anywhere. As such we support and work closely to develop open standards that enable a secure, robust, and easy-to-integrate EV charging ecosystem.

OCPP

The ChargePoint Network supports the OCPP v1.6 and 2.0.1 protocol governing communications between a cloud-based charge point operating network and charging stations in the field. Although the vast majority of charging stations on the ChargePoint Network are also manufactured and designed by ChargePoint, we have over seven years of experience with integrating EVSEs from other manufactures onto our network. This includes vendors such as Schneider Electric, Efacec, Eaton, ABL, ABB, Delta, Tritium, IES, Nissan/Sumitomo, Fuji, and more. Since our charging network is based on OCPP, it is possible to integrate any OCPP 1.6 capable charging station onto our network. ChargePoint has developed a robust "OnRamp" program with a dedicated team of more than 15 engineers to facilitate this process in order to adequately conduct integration and certification to ensure the station works as expected.

Utility System Interface

ChargePoint was one of the first charging networks to be certified as OpenADR 2.0b compliant to help support the broadcasting of price signals and demand response events from utilities to charging station operators. Our advanced set of SOAP/xml-based application programming interfaces are also available to support integration with utility back-office systems.

PCI Compliance

ChargePoint maintains PCI compliance and is audited on an annual basis by Coalfire, an independent 3rd party Qualified Security Assessor (QSA). Coalfire has more than 17 years' experience in IT security and compliance, serving thousands of client organizations across the United States and Europe. Their client list includes 3M, AWS, Azure, Orion Health, Concur, InstaMed, and many more.

Information Security Policy

Our Information Security Policy is based on the PCI-DSS 3.2.1 information security standard. We review our policy at least annually. The PCI DSS standard requires a comprehensive information security policy that is used throughout the organization and is distributed to all system users, including contractors, vendors, and business partners. ChargePoint uses this chapter of its policies, Requirement 12, as a stand-alone security policy for that purpose, in addition to Requirement 12's other functions within the PCI standard.

ChargePoint believes that security measures taken should meet or exceed published standards, but that a public, precise description of measures is actually more likely to lead to a breach of cardholder data. ChargePoint strives to, and believes it does, meet or exceed the PCI-DSS standards, including those standards outside the realm of strict data security.

ChargePoint Services

ChargePoint provides services to thousands of customers through a cloud-based platform that is hosted at Amazon AWS. The IT infrastructure that AWS provides to its customers is designed and managed in alignment with security best practices and a variety of IT security standards, including: SOC 1/SSAE

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16/ISAE 3402 (formerly SAS70), SOC2, SOC3, FISMA, DIACAP, and FedRAMP, DOD CSM Levels1-5, PCI DSS Level1, ISO 9001 / ISO27001, ITAR, FIPS140-2, and MTCS Level3.

The production environment at AWS is isolated from the ChargePoint corporate network. ChargePoint also has no connect to any of our partner networks. The charging stations all communicate over the cellular network, bypassing the need for any local IT connectivity. Access to the cloud-based platform is via standard web browser with no plugins required.

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6 ChargePoint Professional Services

ChargePoint has deep experience working to understand fleet operations and incorporate the depot workflow into a charging plan, as well as training depot managers to use ChargePoint's tools effectively for their depot needs. In support of this project, ChargePoint is able to offer the following professional services as requested.

Preliminary Engineering Support

As part of the preliminary site design services, ChargePoint will provide labor and resources to support preliminary site planning and design. This includes hosting discussions with project partners to ensure architects, engineers, contractors, etc. are up to speed on the technical aspects of the product. ChargePoint will also provide preliminary layouts of the proposed configuration and a sample single line diagram.

For larger projects ChargePoint works closely with transit agencies, consultants, and vehicle manufacturers to perform site workflow analyses to develop a customized site design, including power management configuration. This process includes multi-faceted engagement with the customer and involved parties as directed by the customer. ChargePoint will provide all required technical documentation including design specifications, systems drawings, installation instructions and drawings, and operations and maintenance manuals within the timeframe required.

Project Technical Support

Large scale electric vehicle supply equipment projects require dedicated technical and commercial project management staff. These team members are the backbone of the internal and external teams and provide the driving support required to keep all aspects of the project moving in unison.

ChargePoint allocates senior and experienced project management personnel that have deployed several electric vehicles supply equipment projects including many for transit agencies in North America and Europe. Members from this dedicated team will be tasked to work in parallel with customer consultants and project managers to ensure deliverables are managed according to the budget and timeline of the project.

In addition, ChargePoint can assign a Senior Project Manager who will manage all aspects of ChargePoint deliverables and high-level engagements with the transit operator, the local utility, general and electrical contractors, and any other party involved with this project. Additional fees may apply for such services and will be further refined in a subsequent scope of work.

Onsite Support to Validate and Commission

ChargePoint can provide onsite labor support during installation and commissioning of the charging infrastructure. This person will be responsible for day-to-day site level interface with the transit operator, the local utility, electrical contractors, and other parties that may be involved with this project. This person will shepherd the installers, perform cable checks, and overall ensure charging solution comes online, is functional and operates according to specification. At the time of testing and commissioning, a written report shall be submitted to the customer by ChargePoint listing all incidents and unusual system performance issues.

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Training Program

ChargePoint is also able to provide onsite training based on the operation of the Express DC solution, as applicable, and remote training on the ChargePoint Network. Both trainings can be coordinated during the same timeline as the hardware commissioning. Additional training if requested can be provided. ChargePoint's Training proposal will accommodate 10 personnel per session. The training will include a summary description of the content, suggested attendees and suggested length and timing.

The local fleet operator will need to provide a training room close to installation site for such proposed training, along with internet connection and a screen for presentation.

- Hardware Overview
- Installation Overview
- Network Operations Training
- Safety Requirements
- Equipment Check
- Common Installation Issues
- Operational Best Practices

This typical training confirms the trainee has satisfactory completed ChargePoint training program, which describes in detail how to use the provided hardware and the operator dashboard. The certification is not an attestation of the applicant's professional education or competency. It is not intended to, and does not, replace local and federal license requirements. Additional fees will apply for such services and will be further refined in a subsequent scope of work.

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Momentum®
Wireless Power

CONTINUOUS | HIGH POWER | AUTONOMOUS
HIGH EFFICIENCY | IN-DEPOT & EN-ROUTE

HIGH POWER WIRELESS CHARGING SYSTEMS

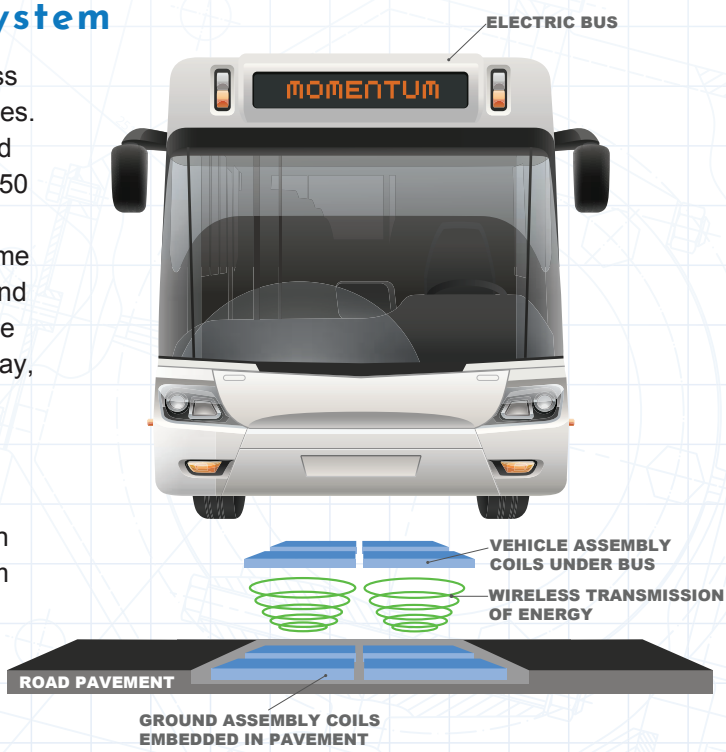
Electric Buses



Modular Wireless Charging System

The Momentum charging system is an inductive wireless charging system designed for all types of electric vehicles. This automatic charging system is ideal for en-route and in-depot charging of electric municipal buses providing 50 to over 300 kW of power while a bus is loading and un-loading passengers. Using our modular system, the same vehicle equipment is interoperable with both en-route and in-depot charging stations. From the moment the vehicle stops over the charger until the vehicle starts to pull away, Momentum's wireless charger is adding energy to the battery—with no driver engagement required.

Wireless charging works in all kinds of weather, is not affected by rain, sleet or snow and is more efficient than most plug-in chargers. The Momentum charging system is simple to use, easy to install, and intrinsically safe with no moving parts. The total cost of ownership of a wireless charging system is lower than overhead chargers.



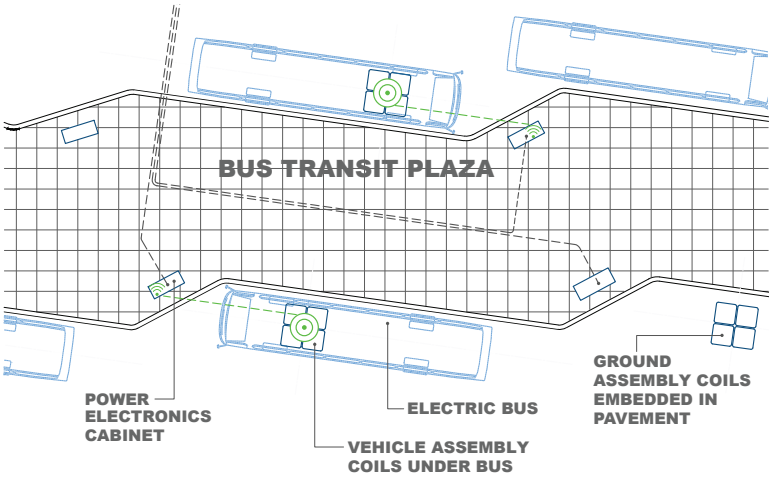
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HIGH POWER WIRELESS CHARGING SYSTEMS

Electric Buses

Momentum® Wireless Power

The plan view to the right shows a bus plaza. Because Momentum's inductive chargers are immune to weather, they can be installed within existing pavement. Each charging pad can service multiple buses with each making 5 to 10 minute scheduled stops. When a bus parks over a charger, charging commences automatically. Operators receive confirmation of the charging and no further action is required to start or stop the process. Extended warranty and service support contracts are available, which include constant monitoring of data, logging, and predictive fault analysis.



SPECIFICATIONS

REQUIREMENT	SPECIFICATION
Input Power	50/60 Hz three phase 400/480 VAC
Power Levels	One to four or more 75 kW modules (300+ kW)
Power Factor	>0.99
Power Transfer Efficiency	>90% peak (measured from power supply to battery)
Operational Frequency	85 kHz nominal
Logging	Remote monitoring
Physical Requirements	No mechanical movement on ground or on vehicle—system is 100% solid state
Alignment Window	20 cm (8")
Air Gap	Up to 18 cm (7")
Ambient Temperature Range	-25 to +50 degrees C (-13 to +140 degrees F)
Compliance	UL, CE, FCC, IEEE C95, ICNIRP
Foreign Object Detection (FOD)	Provided
Living Object Protection (LOP)	Available
Warranty	2 years with option for extended warranty coverage

OPTIONS	
System Management	Admin dashboard for limiting output power and vehicle authorization
Advanced Power Management	Load balancing of chargers based on SOC, time of day, and system usage profiles
Installation	Project management, design, and installation services available
Route Planning	Optimized en-route charging location analysis
System Financing Available	

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Momentum Dynamics is pioneering high power wireless charging solutions to enable the rapid growth of electric vehicles and to promote a cleaner environment. We offer a portfolio of advanced charging solutions across multiple markets. The company's U.S. headquarters is located at 3 Pennsylvania Avenue, Malvern, Pennsylvania 19355. Contact us for more information.

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Driving Security –
Our holistic cybersecurity approach

We are one of the first companies to take a holistic approach on Cybersecurity

SIEMENS
Ingenuity for life

Protection of our
IT and OT infrastructure



Protection of our
products, solutions and services



Enable cyber
solutions for our business



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Our vision

For our society, customers and Siemens,
we are the trusted partner
in the digital world by providing
industry leading cybersecurity

Together we make
cybersecurity real – because it matters

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Derived from our vision and holistic approach, we pursue four strategic objectives

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Ingenuity for life



Business enablement

We enable our business to protect against cyber risk and support them to create market opportunities



Innovation

We develop and adopt leading technologies and leverage our ecosystem



Operational excellence

We continuously improve resilience through clear and holistic accountability and ownership



Culture and talent

We drive a culture of ownership for cybersecurity and attract, develop and retain best talent

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We have four clear distinguishing features that set us apart from the competition

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Global player in digitalization



Domain know-how of verticals and cybersecurity



Holistic approach to cybersecurity



Initiator and driver Charter of Trust



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We offer a holistic concept to secure products, solutions and services as well as our own IT infrastructure

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Internal Cybersecurity

Siemens develops, produces and sells products, solutions and services
Protection of **critical assets, "golden nuggets,"** and **internal IT/OT infrastructures**



Products and Solutions Security

Customer buys products, solutions or (managed) services
Focus on **security for Siemens products and solutions** including **components for critical infrastructure**



Security Customer Services

Siemens service ensures efficient and reliable operations
Focus on **building up security solutions and service business for Siemens customers**

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Our current and long-term innovation topics in Cybersecurity

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Self-Securing Systems Design


Security Validation on Digital Twin


NextGen Patching


Security for Co-operative Autonomous Systems


Post Quantum Crypto


Homomorphic Encryption


Automated Forensics and Malware Analysis


Secure Cloud based Realtime Control


Supply Chain Security

Many more…

Note: “Long term” means “7 years range” of radar

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Evolving threats, technology and regulation due to digitalization create new opportunities and challenges for cybersecurity

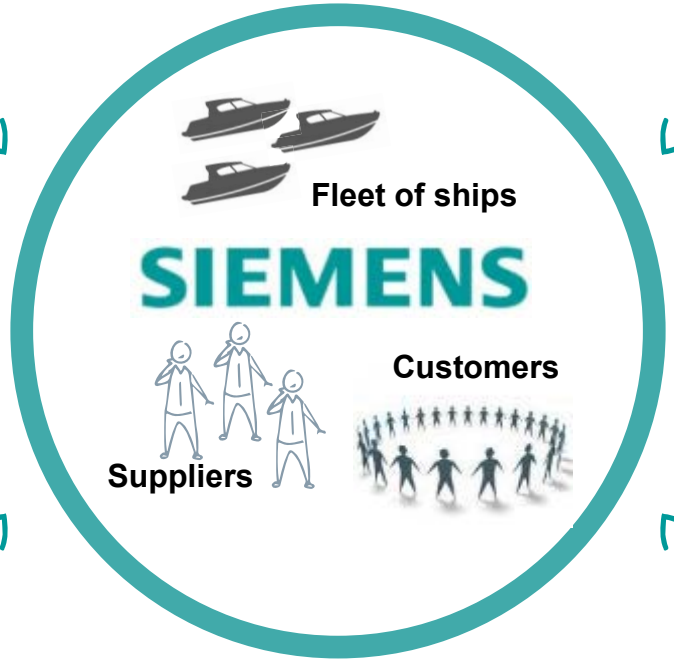
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Increasing market for digitalization

- Market for cybersecurity services
- Interconnection of devices
- Demand new business models

Emerging threat landscape

- Political motivation
- Industrial espionage
- Bringing down critical infrastructure



Technological change

- IT / OT convergence
- Connectivity and cloud
- Big data

Tightened regulations

- Chinese cybersecurity law
- EU regulations: GDPR & NIS
- US regulations

Source: CT CYS, Threat Horizon 2020, NATO CCDCOE, Gartner

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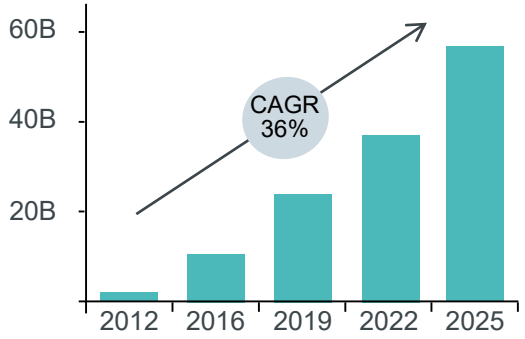
Cybersecurity landscape

Frequency and impact of cyber crime continue to increase – leading to further growing risks and increasing opportunities

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Business Priorities

Internet connected installed base in OT [1]



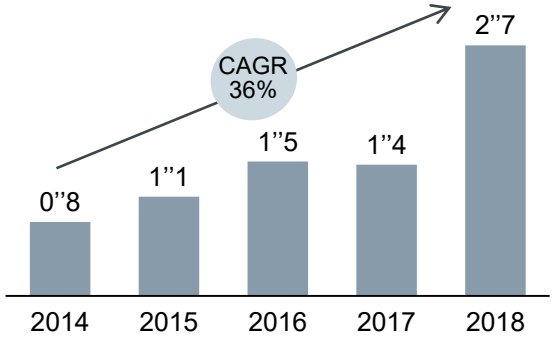
- Advancing **digitization** levels are **blurring the lines between IT and OT**
- **Cyber attack resilience** is becoming **a key issue** for critical infrastructures
- The **OT cybersecurity market is rapidly growing** (18% CAGR) and has **no established front-runner yet** [2]

Technology

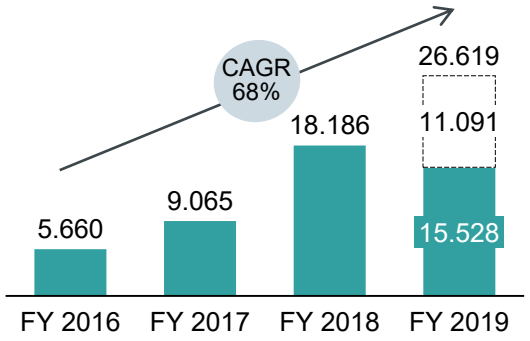
- **No passwords!** - Technology will become widely adopted which does not require passwords as a means of authentication
- **Self authentication for IoT devices** is established technology
- **Quantum computing / AI** provides new means to protect digital environment but compromises e.g. encryption

Threat Landscape

Losses caused by Cyberattacks (USD) [3]



Increasing incidents at Siemens [4]



Laws and Regulations

- **> 70 laws & regulations already affecting Siemens** on Cybersecurity > strong growth in last years > further intensification expected esp. in IoT, digital products/solutions/services and critical infrastructures
- Major governments issue regulations **requiring backdoors** for all OEMs with master keys available for their 3-letter-agencies
- **Increasing high fines** for non-compliance (e.g. up to 4 % of overall revenues according to BSI IT-SiG 2.0) and product liabilities requiring **certification** (e.g. EU Cybersecurity Act, Chinese Cybersecurity Law)
- Requirements reg. Security by Design / Default, e.g. equip software / device with appropriate or specific security features (e.g. California SB327) affecting our product portfolio globally

Source: 1) Gartner 2) Siemens 3) FBI, 4) Siemens Cybersecurity

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EXHIBIT G-4A
40-FT: IT SECURITY VENDOR ASSESSMENT FORM

EXHIBIT G-4A: 40-ft Buses Required Technical Submittal – IT Security Vendor Assessment Form

New Cloud Vendor Assessment Form

This form is intended to be used by internal customer personnel who are intending to onboard a new cloud-based (data, app, service stored or hosted off-premise) vendor.

Part 1.1 Data Backup & Recovery

This section covers standard data backup and recovery concerns.

Question	Vendor Response (respond to questions that are applicable to the application or service provided)	IT Assessment of Acceptability (responses may include acceptable, more information needed, or N/A -- not applicable)
Do you have a documented process for how system, application and data backups are performed? Describe routine for backups (full, incremental, differential; continuous, daily, weekly, etc.).	the backups are done daily and available for 30 days for resotation	
How do you verify that the backup process is functional and that restores work? How often is this done?	Through internal system Diagnostics	
Are all backup media (onsite, offsite, full and/or incremental), rendered unreadable at the end of their useful life? If yes, please describe the method used to render this media unreadable.	NA	
Are procedures in place to fully destroy data contained on back-up media before they are reused? If so, how?	Not enough time to answer but will provide post bid	
Are the backups protected from unauthorized access and tampering? If Yes, describe how they are protected.	Yes Secure Encryption only internal Siemens Enggineers have access	
Is backup media containing confidential information encrypted and stored in a locked container during transport? Please describe encryption method.	YES	
Do you store backups offsite? a. How do you secure access to offsite media? Please specify the name of any 3rd party service providers. b. How do you secure access to media in transit? Please specify the name of any 3rd party service providers.	This is all done in Siemens Secure AES256 Mindsphere platform	
Will any Internet-accessible systems contain data? If so, how is the data on thoses systems protected? Is the data encrypted at rest?	Secure communications TSL 1.2 validated by X.509 certs	
What type of data will you be exchanging with customer? What type of data will you be processing and/or storing FROM customer? How is data transfer secured?	Bus and charging data typical for depot operations	

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What is your SLA? What are the actual results / metrics vs the SLA for the last 12 months?	Service Level Agreement?	
How many outages or failures have you experienced in the past 12 months? What were the shortest and longest durations? What were the fastest and slowest times to recover?	Siemens is Global company that is difficult to answer	
For each outage or failure in the past 12 months, provide the following: -Type of outage or failure -What time of day it occurred -Duration -Time to recover -Number of customers impacted	This information is not readily available. We need a more specific request and can investigate	
Describe the different operating environments for storing and processing customer data. This list of systems names and purposes will help customer with initial evaluation and possible incident response.	We use Tier 3 Datacenters internal and External	
How is your environment architected with respect to fault tolerance and high availability?	Tier 3	
Will any additional third party vendors have access to customer data via our relationship with your organization? Please include backup and recovery vendors, application and service providers, software and hardware support vendors, etc.	no	
Is sensitive data (i.e. PII or cardholder) securely disposed of when no longer needed?	By Customer request and guidance	
Is it prohibited to store the full contents of any track from the magnetic stripe (on the back of the card, in a chip, etc.) in the database, log files, or point-of-sale products?	NA	
Is it prohibited to store the card-validation code (three-digit value printed on the signature panel of a card) in the database, log files, or point-of-sale products?	NA	
If credit card data is used, are all but the last four digits of the account number masked when displaying cardholder data?	NA	
If credit card data is used, are account numbers (in databases, logs, files, backup media, etc.) stored securely— for example, by means of encryption or truncation?	NA	
If credit card data is used, are account numbers sanitized before being logged in the audit log?	NA	

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40-FT: IT SECURITY VENDOR ASSESSMENT FORM

Part 1.2 Security Policy and Administration

This section covers standard information security policy concerns.

Question	Vendor Response (respond to questions that are applicable to the application or service provided)	IT Assessment of Acceptability (responses may include acceptable, more information needed, or N/A -- not applicable)
Is there one person assigned to lead, manage and be accountable for security?	Siemens has a Global security Chief	
Is that person at least at a director level?	C level executive	
Does your company have a dedicated security team? If so, roughly how many people are on it.	1000's	
Does your company have a corporate security policy?		
Are each of the following areas covered in your security policy? -Information Classification -Data privacy -Data-handling (including use, storage and destruction) -Email use and retention -Encryption -Security configuration for network, operating systems, applications and desktops -Change control -Network and User system access -Security incident management -Physical access -External communication -Asset management	Yes we can provide a security Overview with our documentation package	
Are your systems subjected to penetration testing? Is testing performed by internal personnel or outsourced? When was the last penetration test? What were the results?	Yes for this depot Software Using TRA, at teh beginning of each release cycle and we integrate SAST throughout the lifecycle	
Which of the policies above have been substantially modified in the past year?	All are evaluated ongoing	
Are information security policies and other relevant security information disseminated to all system users (including vendors, contractors, and business partners)?	YES	
Are the policies communicated in a way that requires employees to certify their understanding and compliance at least annually?	Internally yes twice each FY	
Do the security policies apply to contract employees (offsite and onsite), dependent Service Providers, etc.?	Yes, but limited access is given to this personnel, very limited	

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Is there a security training and awareness program in place for all employees (new, existing, permanent, temporary or contract staff) ? If yes, describe the program and frequency of re-certification or re-education.	Yes Rigirous	
Is there a formal procedure for reporting a suspected security violation?	YES	
Is the identity and background of all your staff servicing customer known based on security background checks? If yes, describe the screening activities performed on job applicants (e.g., credit, drug screening, references, and criminal background checks) and provide a copy of the policy, procedure or checklist.	Not sure this applies as Siemens will commission this site and then leave, but these are standard proceedures for onboarding employees as Siemens	
Are employees with access to sensitive information prevented from working prior to completion of the background checks?	YES	
Are re-investigations conducted on employees based on job function or length of employment? If yes, describe the re-investigations process performed (e.g., credit, drug screening, references, and criminal background checks).	NA	
Is there a process in place to screen your outside contractors such as security guards, janitorial services, etc.? If yes, describe the process used to screen these individuals (e.g., credit, drug screening, references, and criminal background checks).	NA	

Part 1.3 Secure Software Engineering & Vulnerability Scans

This section covers vulnerabilitiy identification and remediation, vulnerabilitiy scans, and software engineering practices. (The Open Web Application Security Project seeks to make software security

Question	**Vendor Response (respond to questions that are applicable to the application or service provided)**	**IT Assessment of Acceptability (responses may include acceptable, more information needed, or N/A -- not applicable)**
Does your organization scan and/or test for vulnerabilities in your service / application, and if so, how quickly are any identified vulnerabilities remediated? Please provide as much detail in your answer as possible.	Yes	
Does your organization embrace and incorporate the best practices and recommendations provided in the OWASP Developer's Guide and OWASP Cheat Sheet Series to implement or enhance your secure software engineering? Please provide as much detail in your answer as possible.	See attached documentation	
Does your organization utilize the OWASP Testing Guide and/or OWASP Code Review Guide to effectively find vulnerabilities in your service / application (with the intent of remediating identified vulnerabilities)? Please provide as much detail in your answer as possible.	See Attached documentation	
Can you provide a copy of your most recent vulnerability scan results?	this is restricted material	

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Can you provide a scan that identified issue(s), and provide the follow-up scan that shows the issue(s) resolved? Please ensure that dates are clearly listed on each report.	NA	
If you don't scan for vulnerabilities, how do you identify and remediate vulnerabilities? Please provide as much detail in your answer as possible.	See attached documetation	
What concerns or considerations would you have, if any, to customer conducting periodic vulnerability scans of your service / application?	Licensing agreement would have to permit that activity	
Who can we contact with results of vulnerability scans run against your service / application? Please provide their name, title / role, and contact information.	Once awarded we could have session wit Siemens cyber security official I cannot give out company personnal names without a secured procurement	

Part 1.4 Physical Security of Data

This section covers standard physical security concerns where customer data is processed or displayed.

Question	**Vendor Response (respond to questions that are applicable to the application or service provided)**	**IT Assessment of Acceptability (responses may include acceptable, more information needed, or N/A -- not applicable)**
How do you secure access to your data facilities where customer data will be stored?	Tier 3 datacenter	
Are there multiple physical security controls (such as badges, escorts, or mantraps) in place that would prevent unauthorized individuals from gaining access to the facility?	yes	
How are these security controls monitored?	NA	
Are the vendor premises separated into different control areas such as server / computer room, operation areas, loading / delivery areas and others? Please specify how the access controls are in place in each separate area.	these are internal datacenters external are Azure facilities	
Are multiple tenants occupying this facility? If Yes, please specify how tenants are separated	NO	
Is access to areas where work is performed for customer physically separated from that of other clients? If Yes, describe the separation.	It is a datacenter	
Is access to the facility controlled by the use of a token-based card access control system? If Yes, describe the authorization process for requesting access, including changes.	highest security avaialble	
Are visitors required to sign-in, receive ID badge and escorted while on premises?	yes	
Is the facility equipped with surveillance camera(s) 24/7/365?	yes	
Do security cameras cover inside and outside doors and confidential areas?	yes	

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Are precautions taken to prevent the removing of customer information or related assets (checks, credit card information, storage media, hardware) from the premises? Please give details of these precautions.	Secure Datacenter yes	
Are controls or safeguards in place to prevent unauthorized interception or damage to network, power or telecommunications cabling (e.g., wiring and router closets, etc.)?	these are restricted areas in a datacenter	
Please describe whether security guards are required to patrol areas that contain network, power or telecommunications cabling (e.g., wiring and router closets, etc.).	not sure	
How do you secure access to conduits (e.g., wire, fiber, etc.)?	restricted	
How do you secure access to wire closets?	restricted	
Has a clear desk, clear screen policy been implemented where necessary to protect information in shared environments?	no shared environments	
How do you secure access to consoles that may display customer or cardholder information?	restrict access,we do not handle financial transactions	

Part 1.5 Single Sign-On Integration (SAML 2.0 connector)

Question	**Vendor Response (respond to questions that are applicable to the application or service provided)**	**IT Assessment of Acceptability (responses may include acceptable, more information needed, or N/A -- not applicable)**
Do you support SAML 2.0 for user authentication?		
If Yes: 1) Have you previously partnered with an SSO provider to have your SAML connector added to their catalog? 2) Does your SAML implementation support IdP-initiated or SP-initiated? 3) Do you have a link or document you can provide that explains the setup process to SAML-enable your application?	NA	
If you do not support SAML 2.0 currently, is it on your product road map and if so, when do you plan on having it completed by?	NA	
For automated user provisioning, do you support any of the following: 1) Just-in-time SAML Provisioning 2) User REST or SOAP API, and is it SCIM compliant (http://www.simplecloud.info/) 3) Bulk uploading using SFTP+CSV (or similar) 4) Other	NA	

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Please provide a URL or other means by which we can access your automated user provisioning documentation.		
Part 1.6 Application & Data Dependencies & Requirements		
In this section we are interested in understanding the logical and functional dependencies and relationships introduced by the addition of a service organization application to customer's internal		
Question	**Vendor Response (respond to questions that are applicable to the application or service provided)**	**IT Assessment of Acceptability (responses may include acceptable, more information needed, or N/A -- not applicable)**
Approximately, how often do you upgrade your application? Will these upgrades impact my use of the application, and if so what time of day and for how long will I be affected?	Quarterly depends on functionality scope, this is discussed with the customer based on the operations	
How and when will you notify me about any scheduled maintenance? How can I contact you to get more information about unscheduled or extended downtime?	we will have an active Quartly service agreement inplace to handle this with personal visits to the site	
Does application or service's data need to query or update existing customer systems in real-time?	no, these are unique installations	
Does the application or service log logical access and system events, and provide the ability to generate standard reporting on this data?	yes	
What is your permissioning scheme – do all users have access to the entire application or can you customize who has access to what on an individual and by role basis?	no only selected users	
Does the application or service provide appropriate role-based access? (E.g., can date viewing/editing/deleting data, or approving/rejecting changes be restricted or enabled based on a user's role or profile?)	yes, and yes we can restrict and authenticate access	
Does the application or service provide adequate monitoring and escalation via dashboard alerts, email, or other auditable system of communication?	yes	
Does the application or service require additional infrastructure (hardware/software) to be obtained in order to implement the desired functionality?	no	
If the application or service is intended to run on the Force.com platform, has a Salesforce AppExchance Security Review been completed, and what were the results?	no	
Is supported integration, or prebuilt integration, available with any other systems?	API	
Do you offer API access? Are there any extra charges to access API? What form do the APIs take?	API integration is custom and will require separate resources outside this bid	
Can you verify that *all* API unit calls are both 1) authenticated (by managed key or OAuth) and 2) encrypted (by 128-bit or greater encryption)?	yes yes	

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Can I readily export my data in a usable, non-proprietary format? If not, what provisions are in place to quickly gain access to data in a usable, non-proprietary format?	yes	
What are your terms when it comes to ownership of data? How about any metadata I generate while using the application?	it's the customers data they own it	
How easy is it to export data from your service when moving to a new service? Do you offer an option to export the data in one of the open data formats like XML or JSON? Are there any extra charges for exporting the data?	easy and yes	
Is data deleted completely when deleted from the application?	yes, but backups have to be deleted.	
What happens to my data if I discontinue your service – do you delete it immediately? Can I retain access to a read only copy for a fee?	the customer owns the data we can provide it via media	

Part 1.7 Service Organization Controls (SOC) Reports

The SOC1 Report replaces the standard SAS70 report, regarding design and effectiveness of financial reporting controls. The SOC2 Report focuses on a business's non-financial reporting controls

Question	**Vendor Response (respond to questions that are applicable to the application or service provided)**	**IT Assessment of Acceptability (responses may include acceptable, more information needed, or N/A -- not applicable)**
Can your service organization provide its most recent Service Organization Control (SOC) 1 Report, related to design and effectiveness of financial reporting controls? If so, please forward. A SOC 1 Report is a report on controls at a service organization which are relevant to user entities' internal control over financial reporting.	I can check and provide upon award	
Can your organization provide its most recent Service Organization Control (SOC) 2 report, related to design and operating effectiveness of a service organization's controls, performed in accordance with AT 101 and based upon the Trust Services Principles? If so, please forward.	I can check and provide upon award.	

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Part 1.8 Technical and Customer Support

Please provide links, description of available technical and customer support resourcs

Question	Vendor Response (respond to questions that are applicable to the application or service provided)	IT Assessment of Acceptability (responses may include acceptable, more information needed, or N/A -- not applicable)
Is free customer (tier 1) support included in your standard license agreement?	YES	
What is the customer (tier1) support desk's days / hours of operation?	Part of service agreement	
Is technical support (tier 2) included in your standard license agreement?	not sure this customer will have this need	
What is the technical (tier 2) support desk's days / hours of operation?	NA	
Does the application or service include a web-based support site, for answers to technical questions?	Yes	
In the event of an interruption of your service, what is your process for notifying customer operations of the circumstances of the interruption or outage and the expected recovery time	We personally call, notify VIA phone, email text	
Do you have a transparent, public site where you publish any system issues or outages for everyone to see?	No this is a private installation	
Is there a disaster recovery strategy in place? How frequently is it tested?	Yes, need to find out.	

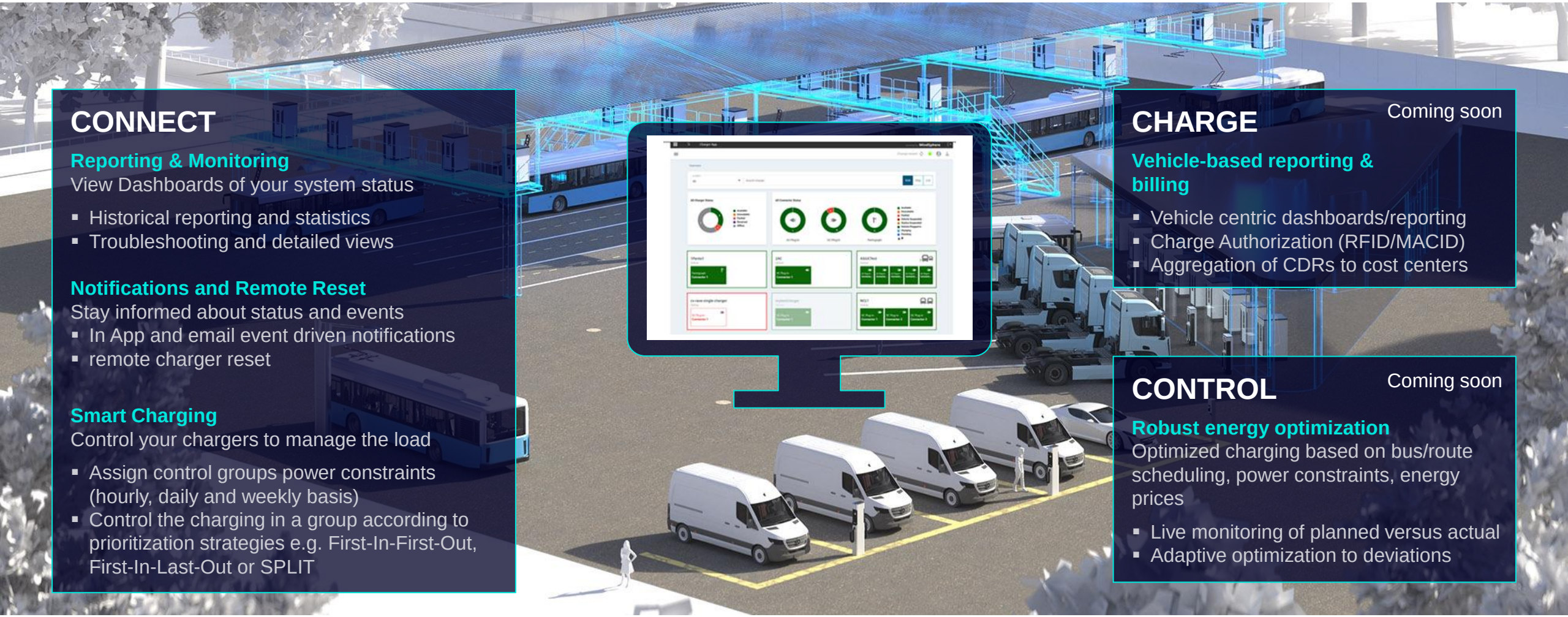
Depot CONTROL



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The general idea



CONNECT

Reporting & Monitoring
View Dashboards of your system status

- Historical reporting and statistics
- Troubleshooting and detailed views

Notifications and Remote Reset
Stay informed about status and events

- In App and email event driven notifications
- remote charger reset

Smart Charging
Control your chargers to manage the load

- Assign control groups power constraints (hourly, daily and weekly basis)
- Control the charging in a group according to prioritization strategies e.g. First-In-First-Out, First-In-Last-Out or SPLIT

CHARGE

Coming soon

Vehicle-based reporting & billing

- Vehicle centric dashboards/reporting
- Charge Authorization (RFID/MACID)
- Aggregation of CDRs to cost centers

CONTROL

Coming soon

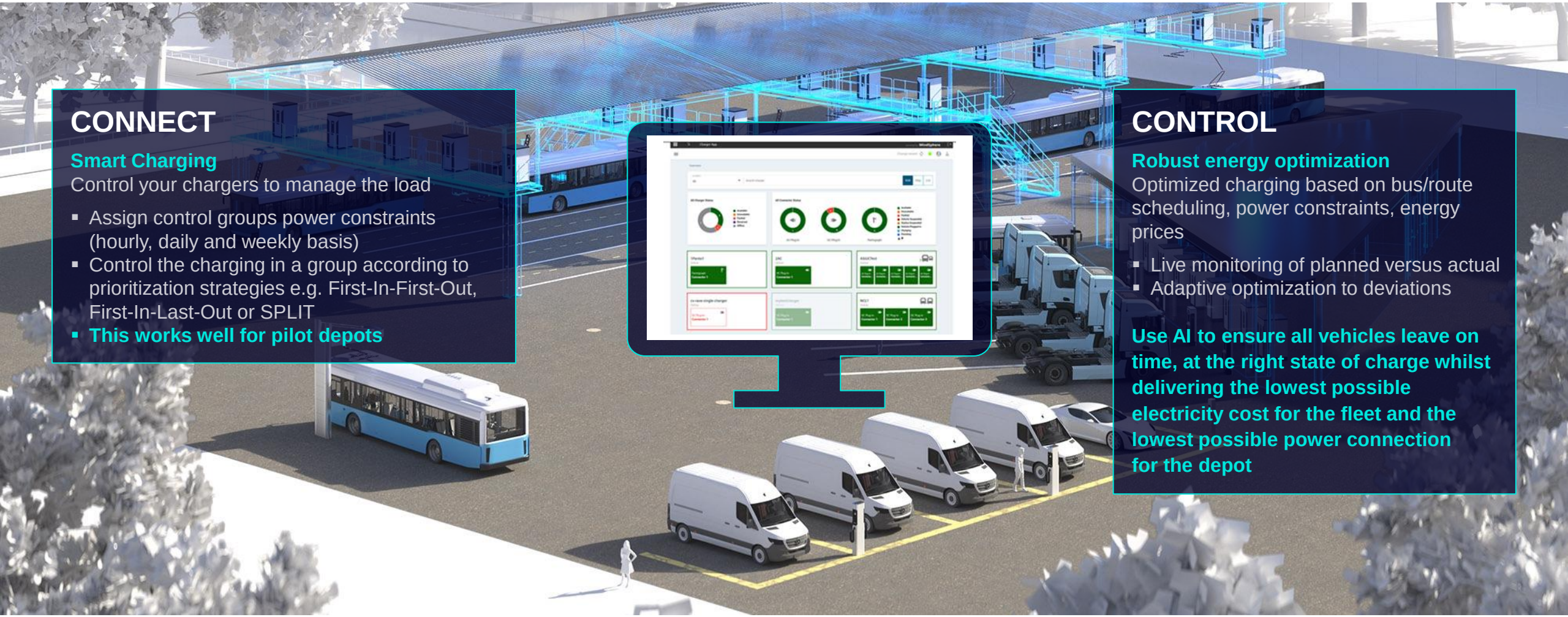
Robust energy optimization
Optimized charging based on bus/route scheduling, power constraints, energy prices

- Live monitoring of planned versus actual
- Adaptive optimization to deviations

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Why Depot Control



CONNECT

Smart Charging

Control your chargers to manage the load

- Assign control groups power constraints (hourly, daily and weekly basis)
- Control the charging in a group according to prioritization strategies e.g. First-In-First-Out, First-In-Last-Out or SPLIT
- **This works well for pilot depots**

CONTROL

Robust energy optimization

Optimized charging based on bus/route scheduling, power constraints, energy prices

- Live monitoring of planned versus actual
- Adaptive optimization to deviations

Use AI to ensure all vehicles leave on time, at the right state of charge whilst delivering the lowest possible electricity cost for the fleet and the lowest possible power connection for the depot

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Typical Benefits for a Depot

Reducing your energy costs

- Charging at the optimal time
- Manage demand charges
- Configurable strategy

Up to 40% reduction of energy costs
Up to 50% reduction in demand charges

Efficient usage of grid connection

- Infrastructure protection
- Reduce power requirements
- Variable constraints

Typically 40 – 60% lower grid capacity
e.g. 1MW → 500 kW = CAPEX

Optimized Charging Operations

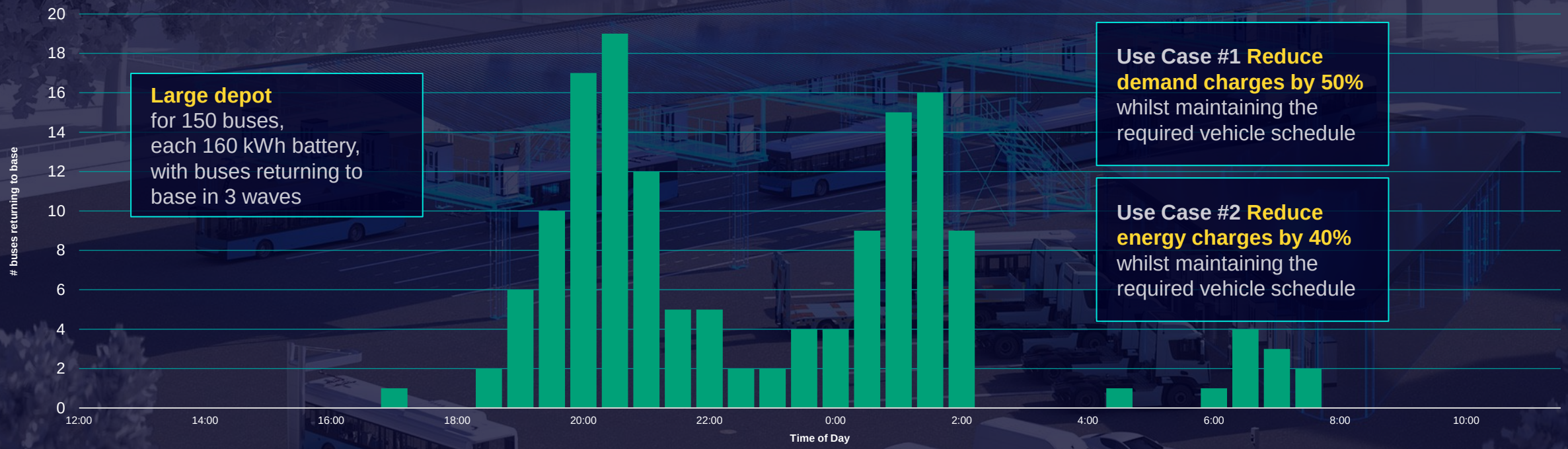
- Automated daily planning
- Operations tracking and reporting
- Integration with existing depot management

Remove human error from operations

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How can we reduce operating costs by 40 – 50% and still maintain the schedule?



Large depot
for 150 buses,
each 160 kWh battery,
with buses returning to base in 3 waves

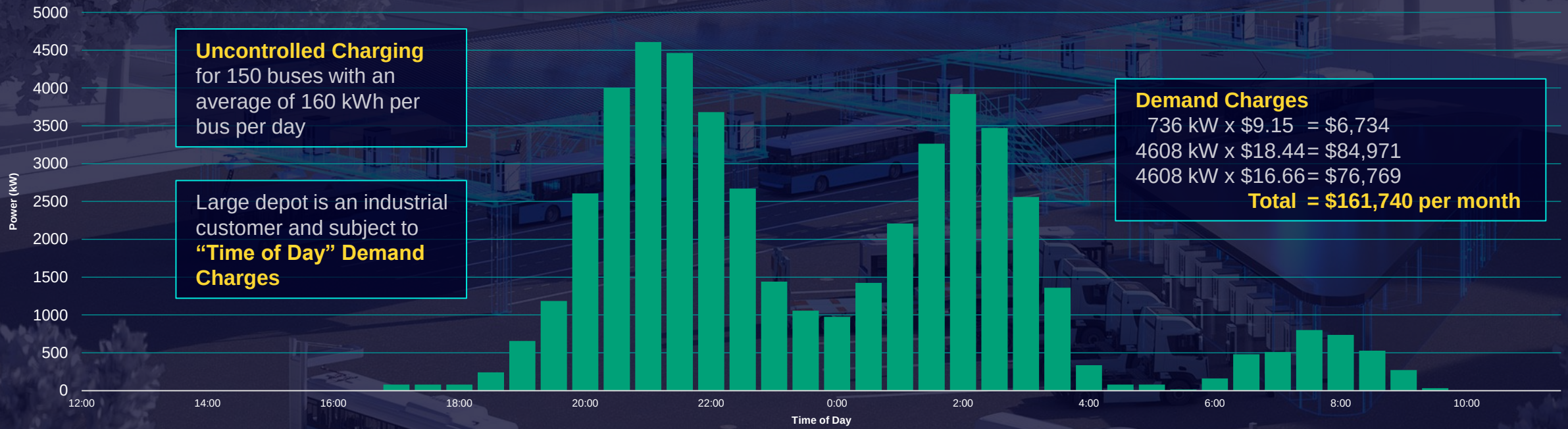
Use Case #1 Reduce demand charges by 50% whilst maintaining the required vehicle schedule

Use Case #2 Reduce energy charges by 40% whilst maintaining the required vehicle schedule

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Use Case #1: Demand Charges Uncontrolled Charging Plan
High demand charges for uncontrolled charging due to power peaks



Uncontrolled Charging for 150 buses with an average of 160 kWh per bus per day

Large depot is an industrial customer and subject to **"Time of Day" Demand Charges**

Demand Charges

736 kW x $9.15 = $6,734
4608 kW x $18.44 = $84,971
4608 kW x $16.66 = $76,769
Total = $161,740 per month

G&T demand 8am – 6pm $9.15/kW[1]

Primary demand 8am – 10pm $18.44/kW[1]

Secondary demand all hours $16.66/kW[1]

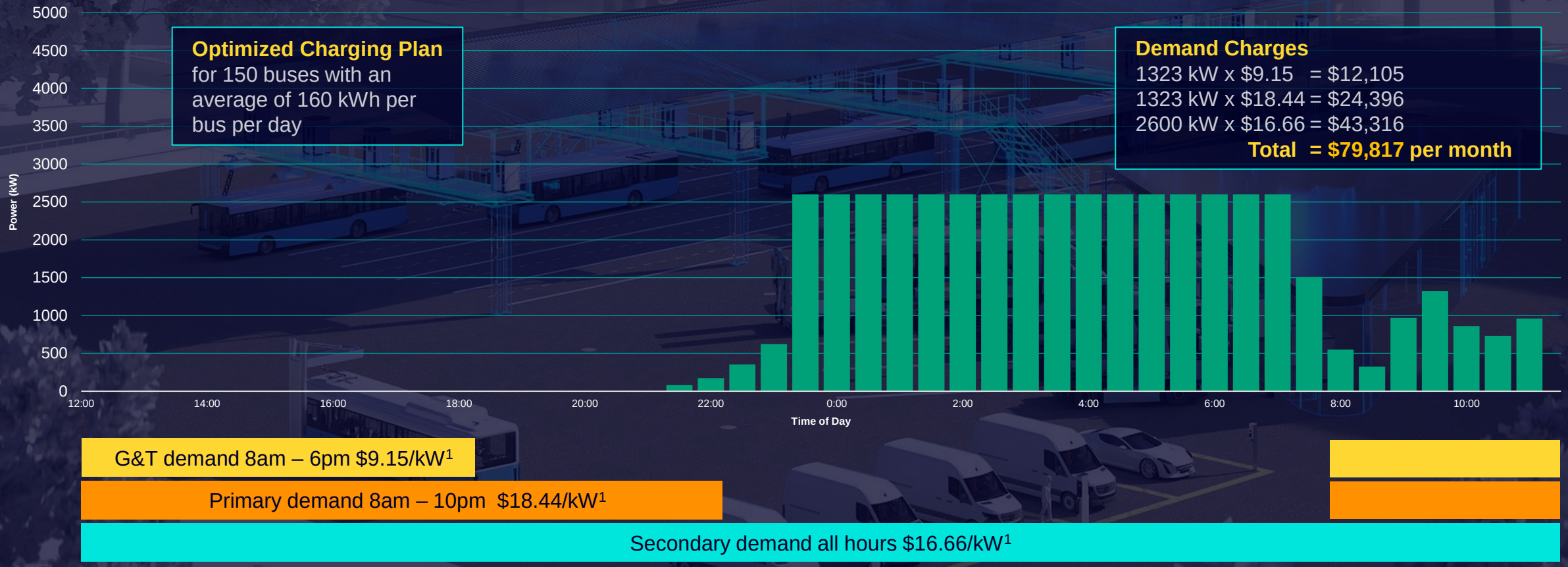
1.) Demand charges based on Con Edison Service Classicifcation No.9 2021 - https://www.coned.com/_external/cerates/historical-PSC10.asp

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Use Case #1: Optimized Charging Plan with Depot CONTROL

Reduce demand charges by 50%



1.) Demand charges based on Con Edison Service Classicifcation No.9 2021 - https://www.coned.com/_external/cerates/historical-PSC10.asp

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Use Case #1: Total Demand Charge savings through the year

Summer (June – September)[1]		Rest of Year[1]	
Mon – Fri, 8am – 6pm	9.15 $/kW	Mon – Fri, 8am – 10pm	13.96 $/kW
Mon – Fri, 8am – 10pm	18.44 $/kW	All hours all days	4.21 $/kW
All hours all days	16.66 $/kW		

Savings (150 buses)	
$81,923 per month	$54,311 per month

Total savings (150 buses) = $762,180 per year

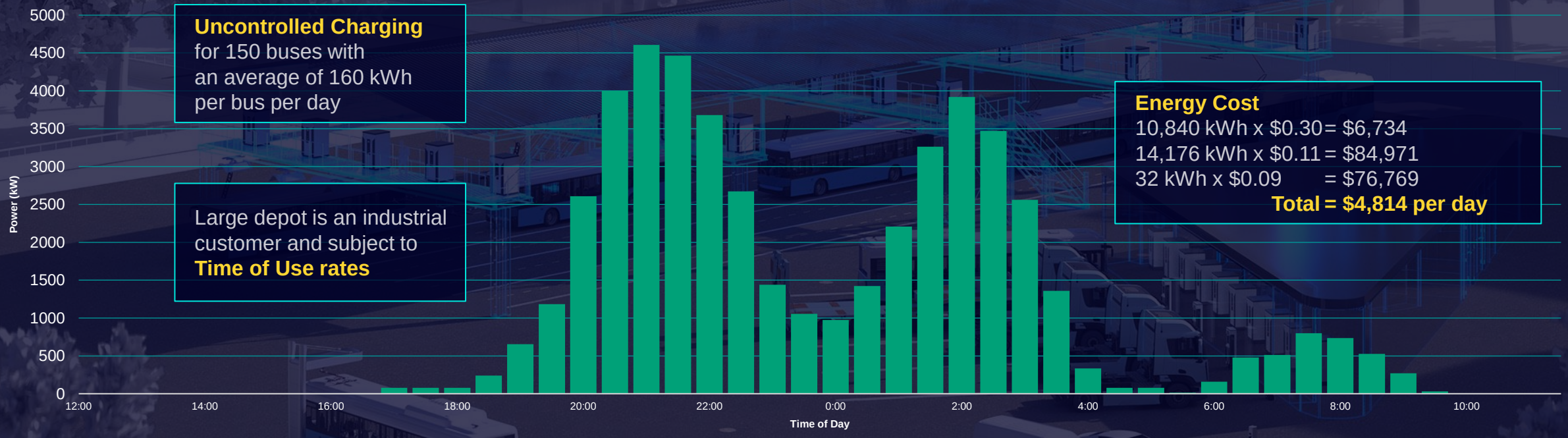
Savings per bus = $5,081 per year

1.) Demand charges based on Con Edison Service Classicifcation No.9 2021 - https://www.coned.com/_external/cerates/historical-PSC10.asp

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Use Case #2: Time of Use Energy price with Uncontrolled Charging
High energy costs for uncontrolled charging



1.) Electricity tariff based on PG&E CEV rate proposals https://caltransit.org/cta/assets/File/Webinar%20Elements/WEBINAR-PGE%20Rate%20Design%2011-20-18.pdf

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Use Case #2: Optimized Charging Plan with Depot CONTROL

Reduce electricity costs by 40%

Optimized Charging Plan
for 150 buses with
an average of 160kWh
per bus per day

Large depot is an industrial customer and subject to **Time of Use rates**

Energy Cost
126 kWh x $0.30 = $38
14,176 kWh x $0.11 = $2,526
1,938 kWh x $0.09 = $174
Total = $2,738 per day



126 kWh consumed in peak

22,966 kWh consumed in off-peak

1,938 kWh consumed in SOP

1.) Electricity tariff based on PG&E CEV rate proposals https://caltransit.org/cta/assets/File/Webinar%20Elements/WEBINAR-PGE%20Rate%20Design%2011-20-18.pdf

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Use Case #2: Total Demand Charge savings through the year

CEV Rates EV-Large S	
Peak, 4-10pm all days	0.30 $/kWh
Off-peak, 10am-9pm, 2-4pm	0.11 $/kWh
SOP, 9am-2pm	0.09 $/kWh

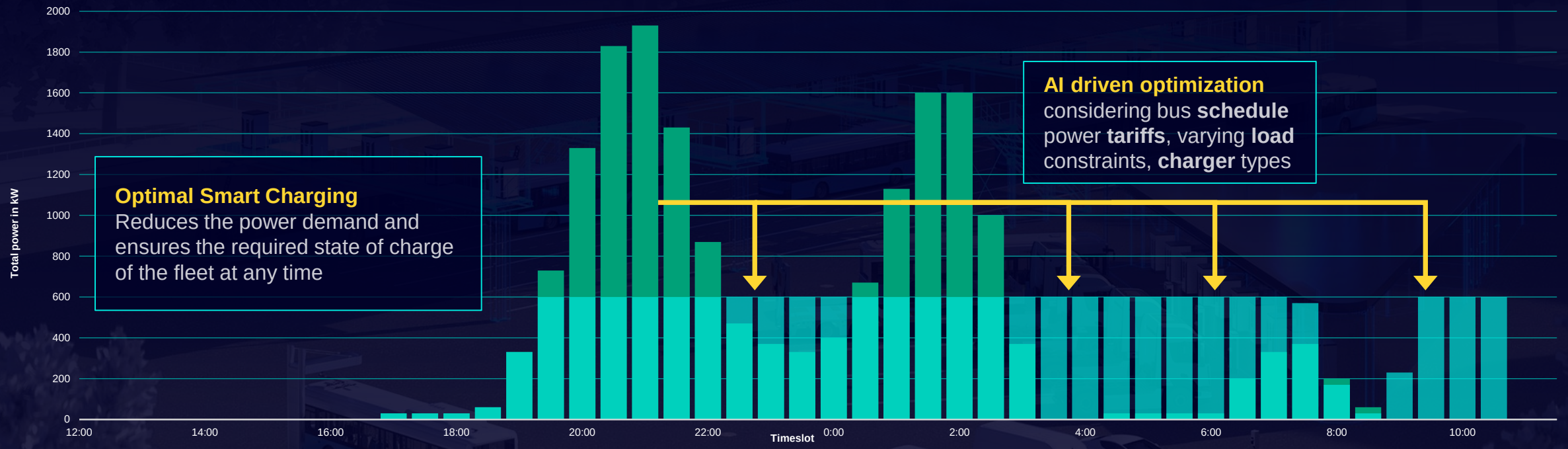
Savings (150 buses)
$2,076 per day
Total savings (150 buses) = $622,800 per year
Savings per bus = $4,152 per year

1.) Demand charges based on Con Edison Service Classicifcation No.9 2021 - https://www.coned.com/_external/cerates/historical-PSC10.asp

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Optimized Charging Plan with Depot CONTROL

Leave on time, at the right SOC, with the lowest power demand



- **Without SMART CHARGING** the charging operations are uncontrolled and start whenever buses are plugged.
- This results in power peaks

- **Depot CONTROL** delivers the required charging energy at the required charging time with reduced power demand

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Use Case #3: Decrease CAPEX required per vehicle



Typical power reduction 40 – 60%

Charge double the number of vehicles with the same power

CAPEX per vehicle is halved.

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Innovative Dynamic Optimization ensures that the charging is not only optimized but is constantly updated according to local conditions

PLAN ahead



Live Monitoring of current situation in the depot

- Which buses are late?
- Are any chargers faulted?
- Are vehicles using more energy?

Static Optimization for Day-AHEAD

Dynamic Optimization to continuously replan to ensure charging is always optimal

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You need help to plan your depot? – Come and talk with our experts!

How many chargers?

Can I charge all my vehicles?

What grid connection do I need?

How many dispensers?

Can I reduce my electricity costs?

What type of charger?

By how much??





With **simulating** and **optimizing** the charging in your depot, our experts ensure the best fit possible.

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Robust Optimized Smart Charging
“Optimized Charging in the real world”

Objective: Leave on time, at the right state of charge with the optimal energy at the lowest cost

Stage 1 – PLAN – DAY AHEAD

E-vehicle schedule/trip
- Arrival time
- Departure time
- Trip energy

Energy Prices
- Time of use tariffs

Charger/connector data
- Charger type (sequential/split)
- Number of connectors
- Max power out
- Charging efficiency

E-vehicle battery data
- Battery cap
- C-rate (Max power in)
- Battery cell balancing requirements

Algorithm inputs

- Vehicle battery model
  - Charging model: Continuous charging
  - Cell balancing model
- Charger/connector model
- Fleet composition model
- Vehicle-connector assignment model
- Grid connection model
- Energy storage model

Optimization engine

- Mixed integer linear programming
- Flexible constraint functions
- Weighted objective functions

INITIAL charging strategy

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Robust Optimized Smart Charging
“Optimized Charging in the real world”

Stage 2 – Live MONITORing of current situation

Are the vehicles running according to schedule?
Are the vehicles returning with expected SOC?
Are all chargers up and running?
Have the energy prices changed?
Have the power constraints changed?
Have the vehicles parked correctly?

Stage 3 – REPLAN based on current situation

Live replanning based on current knowledge of operations
Adaptive self learning approach
Charging plan continuously updated

Changing algorithm inputs

- **Fleet composition model**
- **Vehicle-connector assignment model**

Adjusted charging strategy

Actual charger status

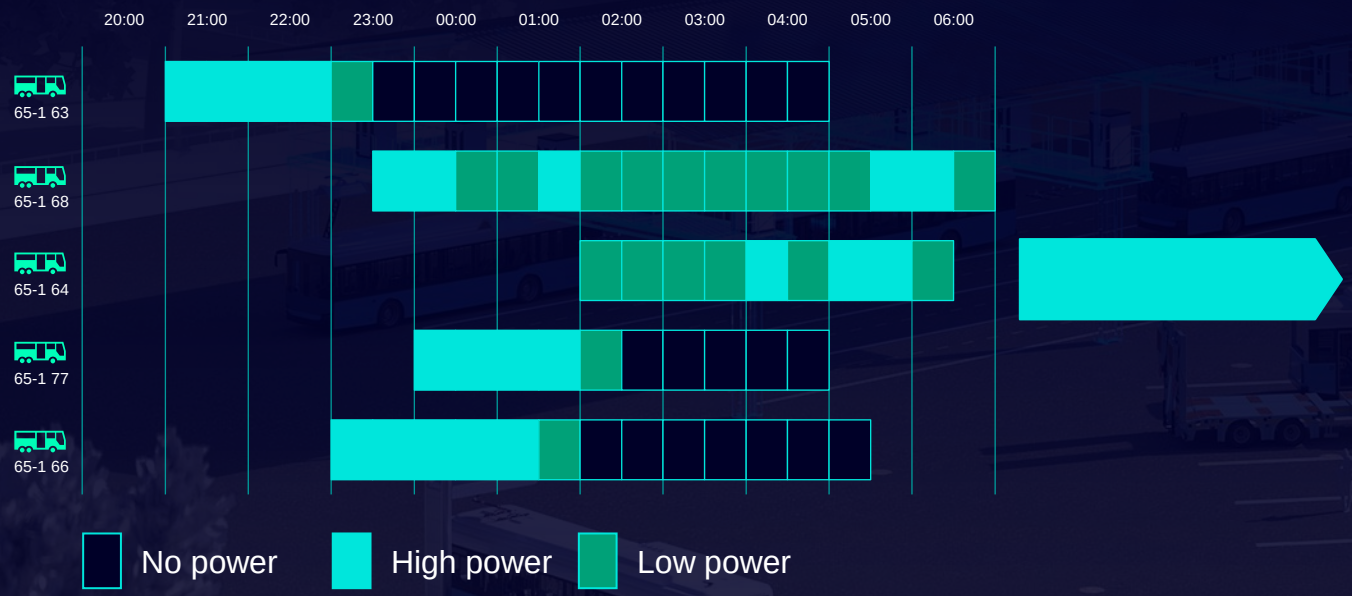
Actual vehicle SoC

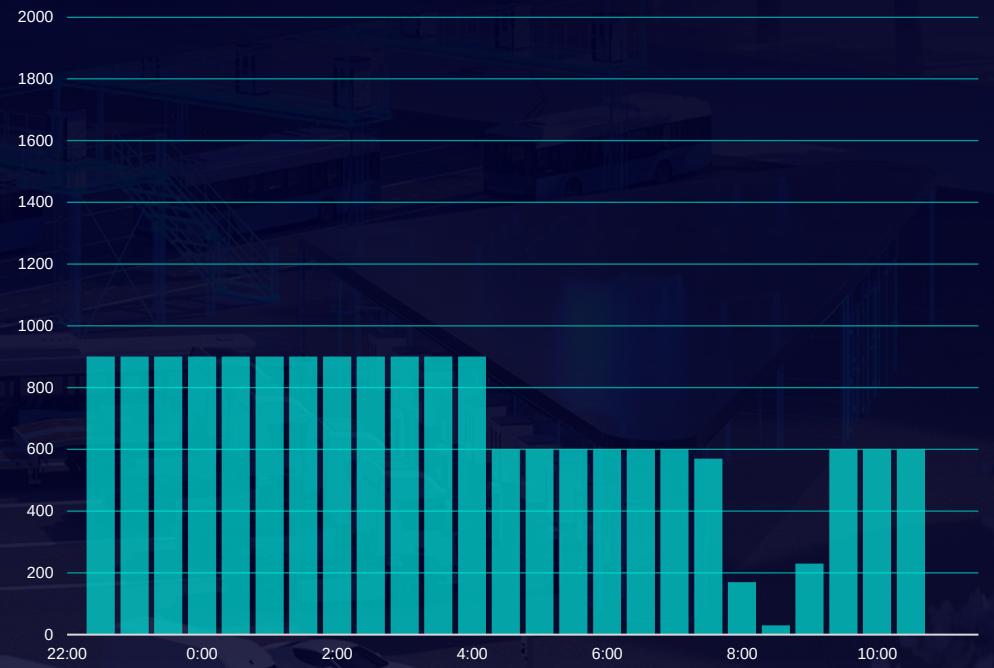
Actual vehicle arrival time

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Deep Dive – PLAN phase
The optimization gives the ideal charging profile for each bus and charger





Individual charging profiles are **optimized**

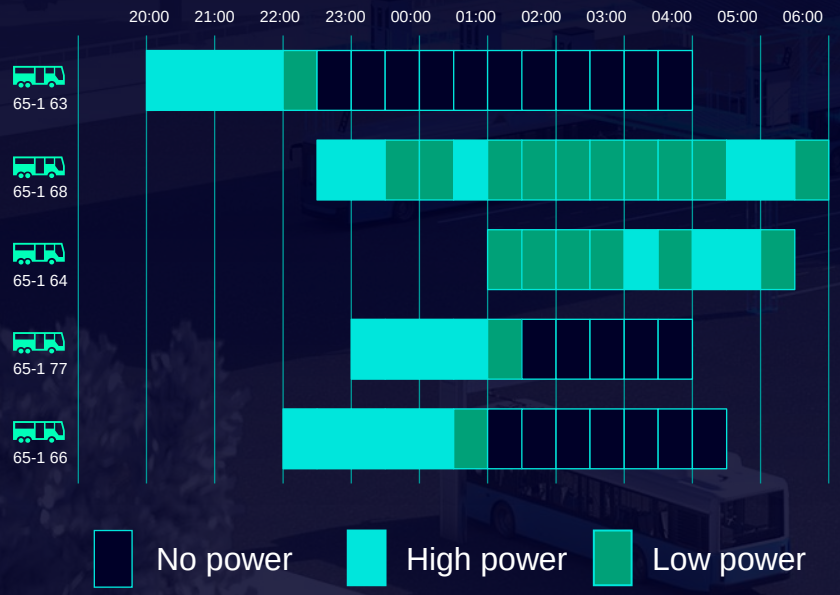
So when combined the profiles deliver the **best possible power point** and/or energy cost

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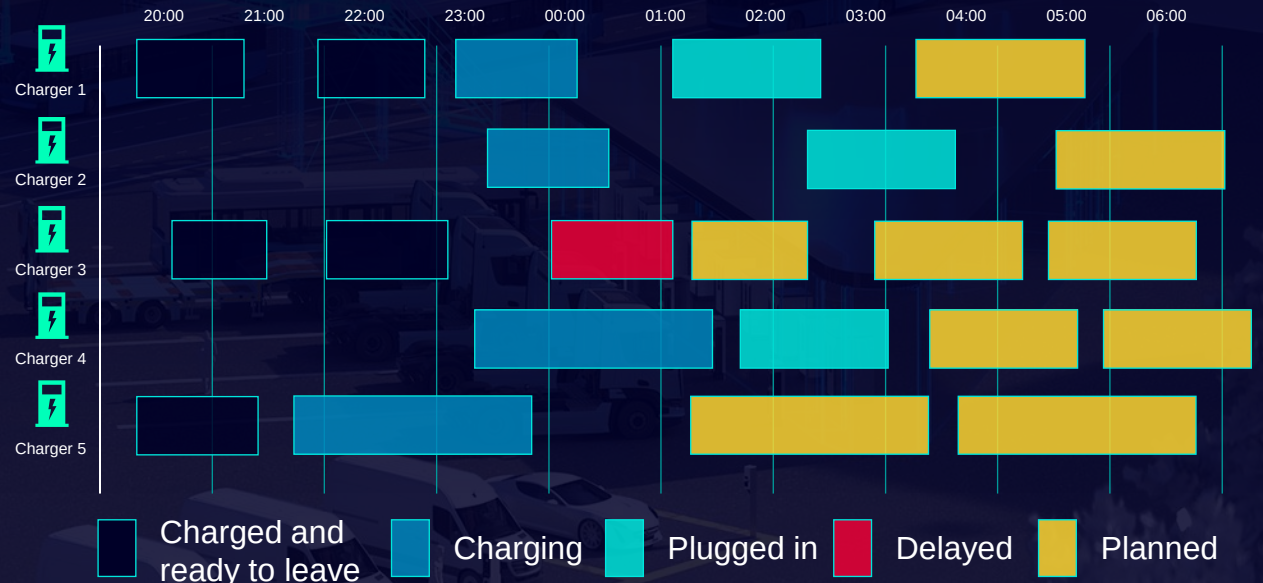
Deep Dive – MONITOR phase
The current local situation at the depot is continuously monitored

PLAN



VS

ACTUAL



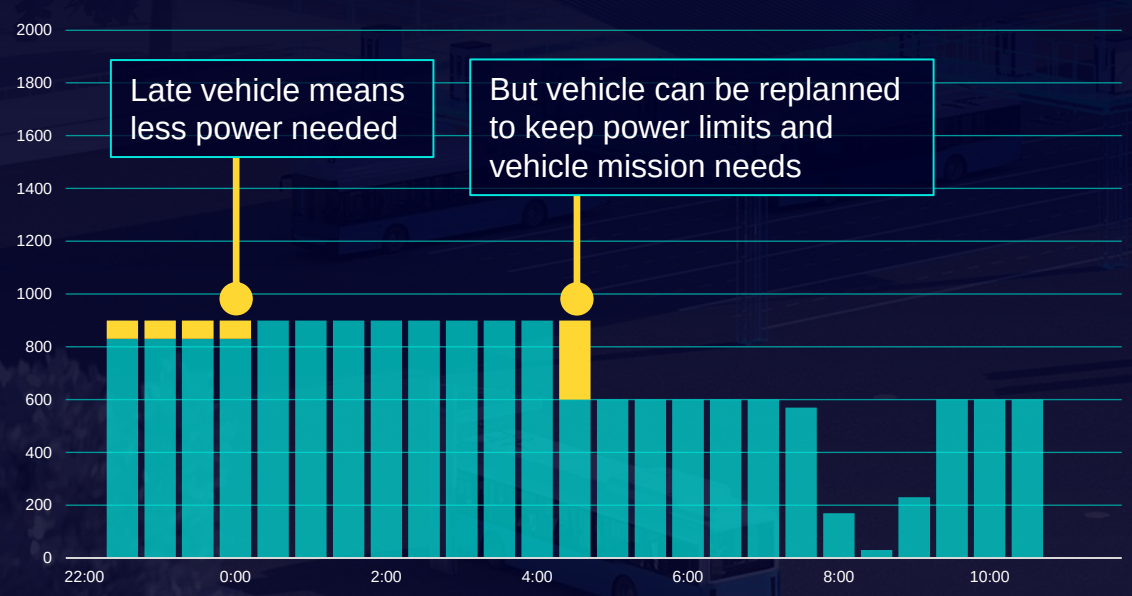
MONITOR the delta between **PLANNED** and **ACTUAL** situation

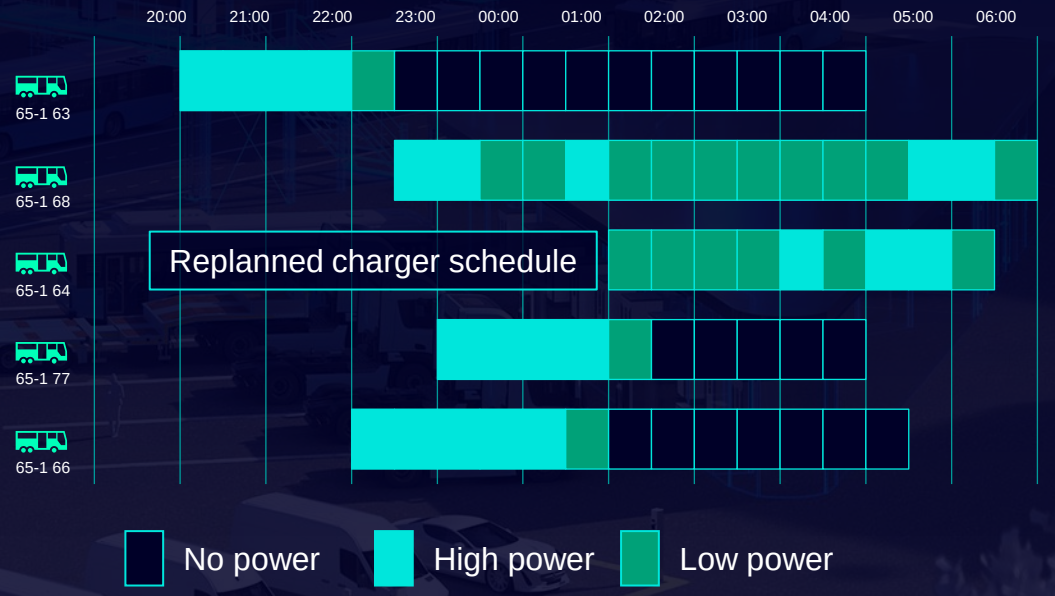
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Deep Dive – REPLAN phase
Live optimization to replan charger schedules to keep lowest energy costs

RE-PLAN





Continuously Optimize based on the current situation so that the depot is always operating at the lowest costs/power no matter what

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Innovative Dynamic Optimization ensures that the charging is not only optimized but is constantly monitored

PLAN ahead



Live Monitoring of current situation in the depot

- Which buses are late?
- Are any chargers faulted?
- Are vehicles using more energy?

Static Optimization for Day-AHEAD

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Customer Support



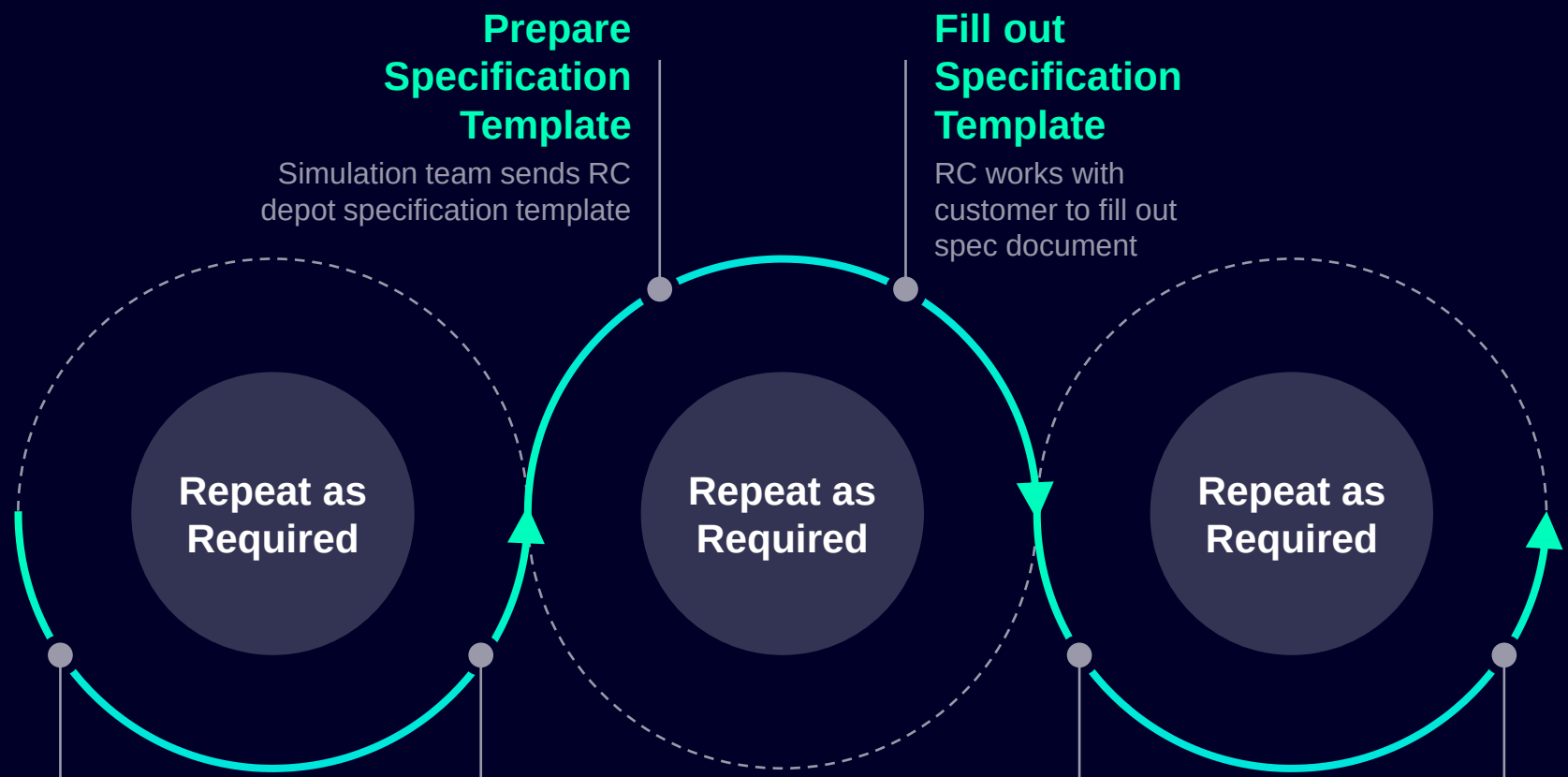
2nd and 3rd level support for the regions

Simulation Support to help the customer plan their depots

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Simulation Support Process



Customer contact
RC gets contacted for planning support

Ordering Simulation
RC orders simulation support in web portal1

Prepare Specification Template
Simulation team sends RC depot specification template

Fill out Specification Template
RC works with customer to fill out spec document

Run Simulation
Simulation team simulates depot and prepares report

Optimize Charging
RC briefs customer on the simulation results

[1] https://emobility.atlassian.net/servicedesk/customer/portal/2

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EVC3 Depot 2.0

Operating Manual

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10/2020
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Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER

indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION

indicates that minor personal injury can result if proper precautions are not taken.

NOTICE

indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

⚠ WARNING

Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Siemens Industry Inc.
100 Technology Drive
Alpharetta, GA 30005
UNITED STATES

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Introduction to EVC3 Depot

1

EVC^3 (Electric Vehicle Connect Charge & Control) Depot is a depot management application that provides the following features:

- Monitor the charging operations in an electric vehicle depot
- Generate and View reports on the charging operations
- Diagnostics and load management

The electric vehicle depot is made up of several hardware elements - power distribution systems, the charging infrastructure, and Distributed Energy Systems. The depot might be connected to several different data streams, some internal to the depot like charger data, energy system data, depot operations, and some external to the system like energy markets and city data.

This complexity needs to be managed and this can be accomplished within the Siemens EVC^3 Depot solution, a cloud offering to manage the charging operations within a depot. Developed on the Siemens secure, open IoT platform – MindSphere, this cloud solution monitors, reports, optimizes, and controls the individual components within the electric vehicle depot to deliver the customer business requirements with reduced CAPEX, reduced energy costs, and increased uptime.

The software is supplied as Software as a Service and differs from licensing-in of software in the following key respects:

- Siemens allows access to its software through the internet, rather than providing the software to the customer electronically or on a CD
- The software runs on servers owned or rented by Siemens rather than on on-premise customer servers
- Siemens is responsible for operating and maintaining the software. As a result, there is no separate maintenance agreement, but a service level agreement governing availability and response and reaction times for technical problems.

The system is charger agnostic and uses open source protocols (OCPP 1.6) to allow integration of Third party chargers.

1.1 Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit (https://www.siemens.com/industrialsecurity).

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customers' exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed visit (https://www.siemens.com/industrialsecurity).

1.2 System Requirements

EVC³ Depot is a cloud-based application that you can access with a web browser.

The following browsers are supported:

- Google Chrome
- Microsoft Edge (based on Chromium)
- Mozilla Firefox

Note

EVC³ Depot does not support Internet Explorer.

1.3 Logging In and Out of EVC3 Depot

EVC³ Depot is fully managed by Siemens. The EVC³ Depot user interface requires a unique user name and password combination for access.

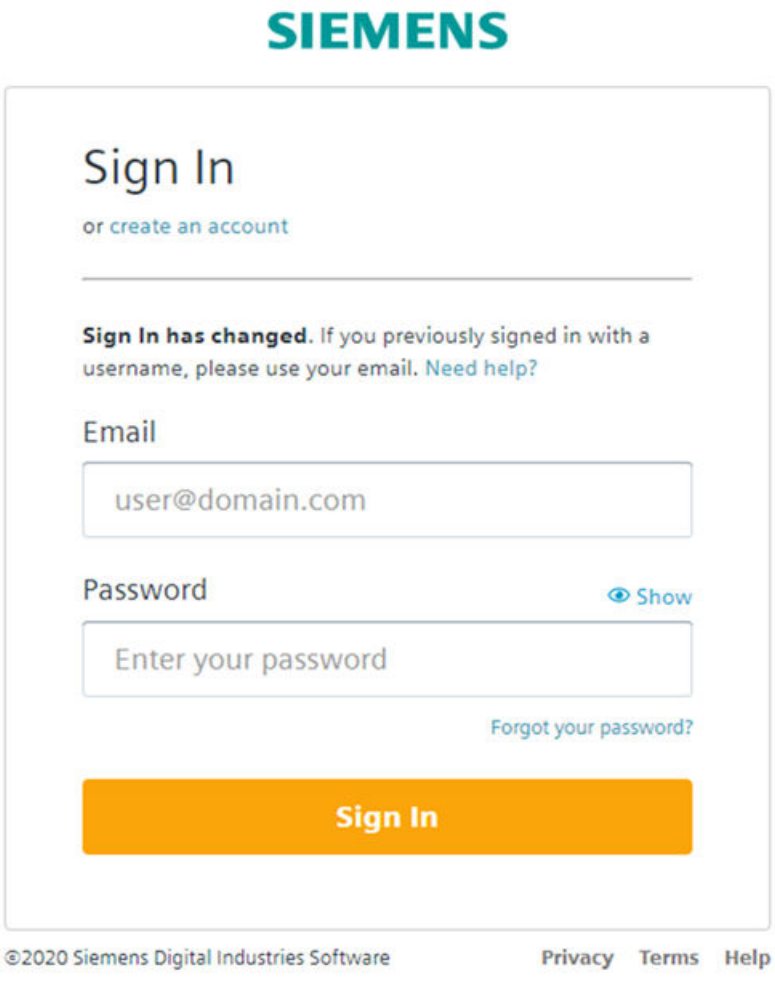
The EVC³ Depot user interface is accessed through a URL, such as:

`https://ebus-chargerapp-ebus.eu1.mindsphere.io/App`

The specific URL information, as well as user names and passwords, are provided to users by your administrator.

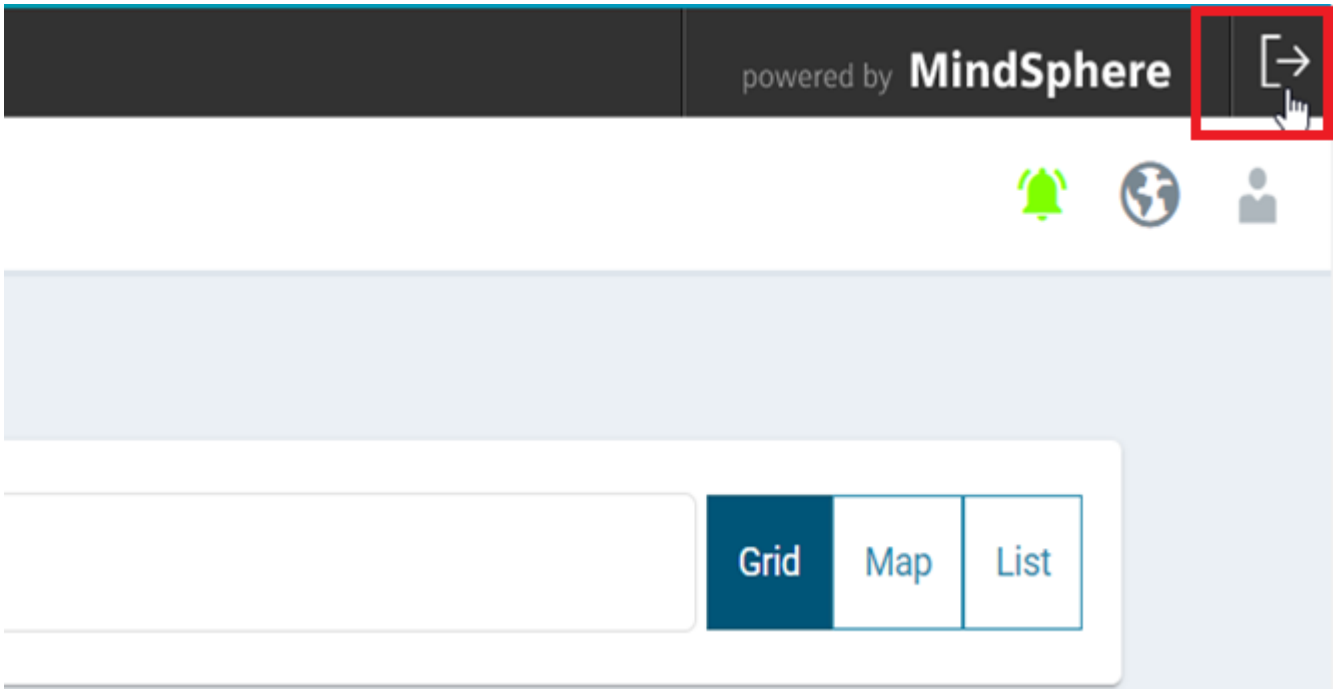
Log in to EVC³ Depot

1. Go to the EVC³ Depot URL and enter your login credentials to log in to the application.

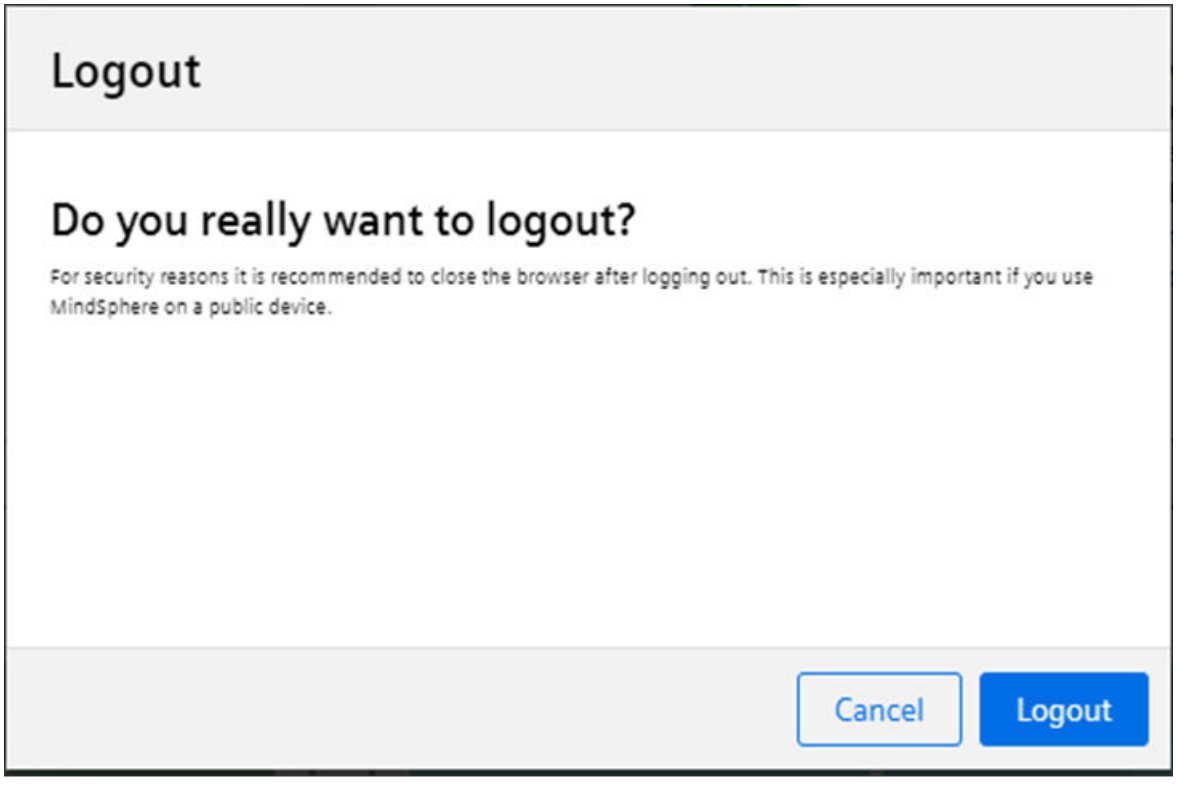


Log out from EVC³ Depot

1. Click the logout button on the EVC³ Depot.



2. Click **Logout**.



For added security, close the browser after you log out.

1.4 EVC3 Depot Architecture

MindSphere is the secure and open integration platform on which EVC[3] Depot is based – with a modular architecture to allow the flexible realization of customer-specific needs.

The application uses open protocols to connect to the assets within the depot and to the wider world outside the depot. Examples of such protocols are the OCPP protocols and ISO 15118 protocols which govern the exchange of data between the EV and the charger, the IEC 63110 protocols which govern the data exchange between the charger and the cloud or IEC 104 which is used for communication with power equipment.

Security

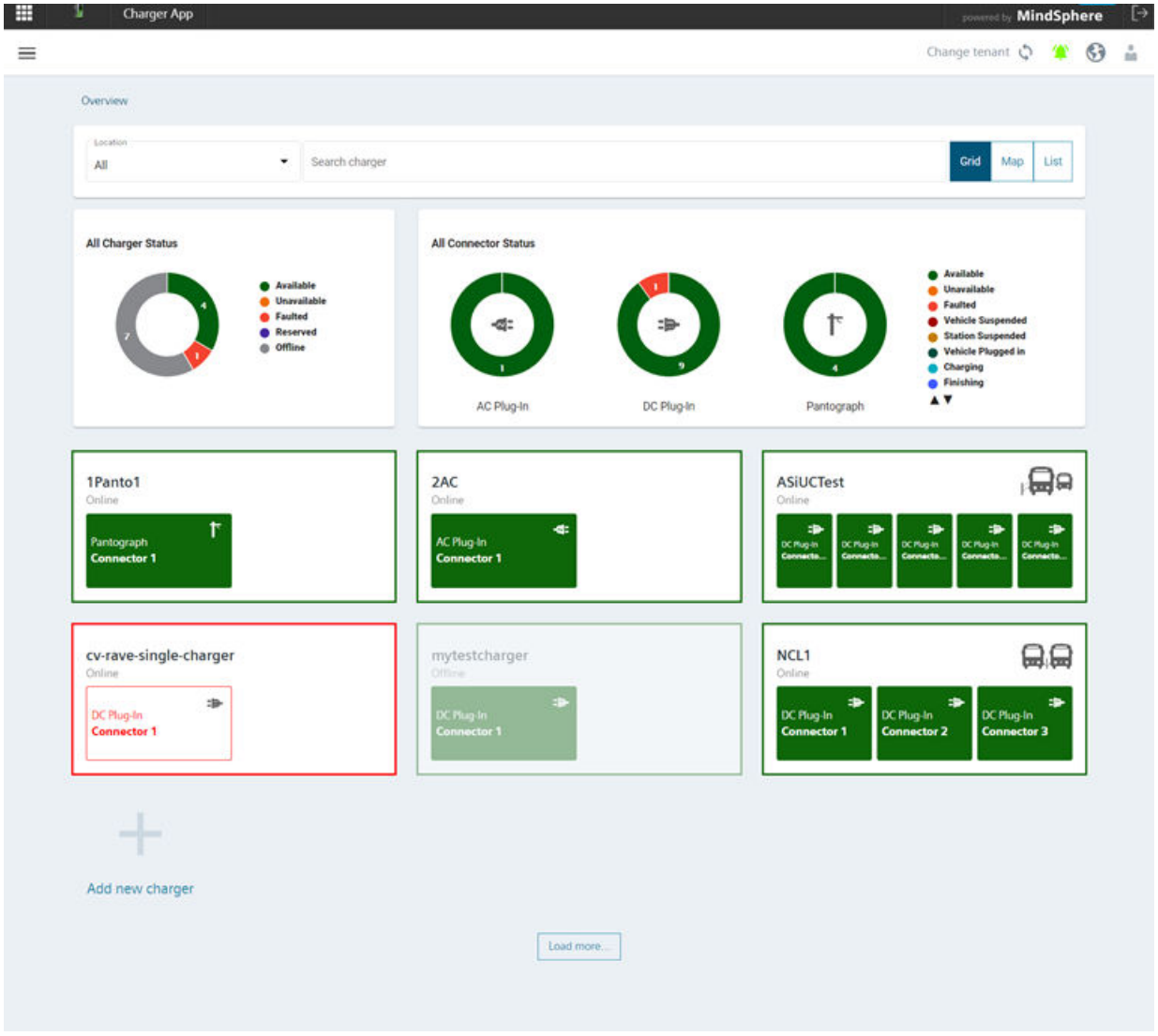
The application has been designed from the ground up to provide the security standards required when connecting critical infrastructure:

- Stringent security features safeguard the successful transfer of sensitive industrial data
- Encrypted communications protect connectivity from devices to MindSphere
- Siemens has dedicated Product and Solutions Security (PSS) and Information
- Security (I-Sec) organizations to advise on security topics Security measures in line with industry standards IEC 62443 and ISO/IEC 27001

Overview

2

The Overview screen of the EVC[3] Depot is the centralized location to analyze the overall health of the system. It provides information on the status and health of the chargers and their connectors. It also shows the status of the electric vehicle charging. Error messages and other notifications are also shown.



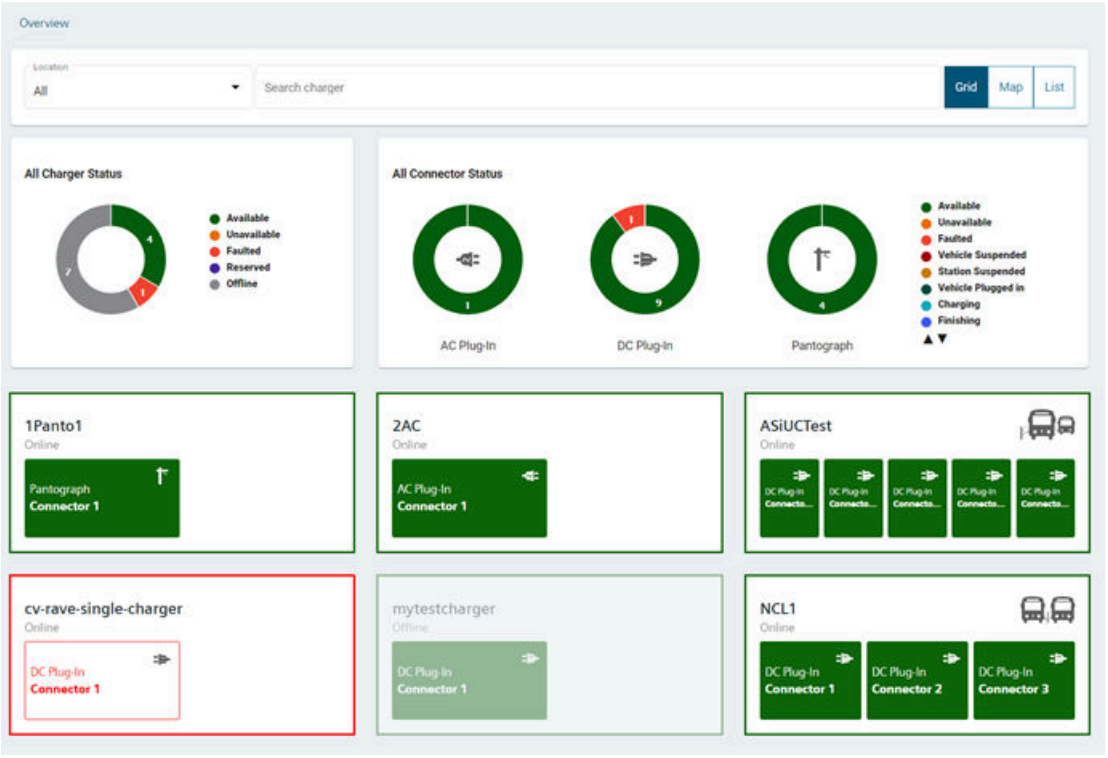
The information on the Overview page is divided in the form of charts and panes and they can be categorized by the following widgets:

- All Charger Status
- All Connector Status

Information on each charger is shown on individual panes. Each pane shows the status of each connector and the status of charging when it is connected. You can filter the chargers by the pre-configured locations. You can also search for a charger. You can click on the charger to see charging information and charge detail records. These chargers can be viewed in a grid, list, or on a map.

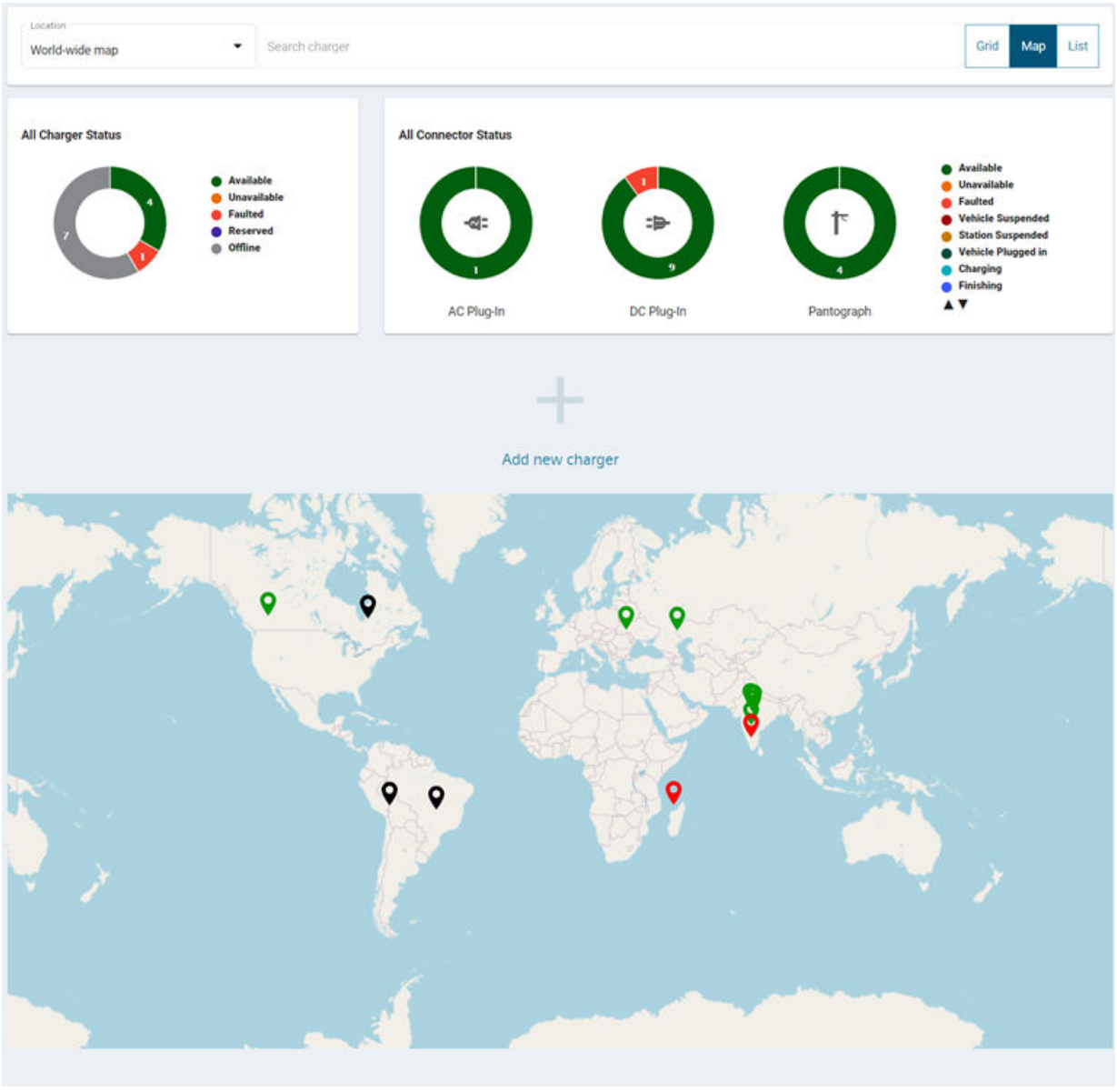
2.1 Grid View

The chargers are arranged in the form of a three-column grid. This is the default view.



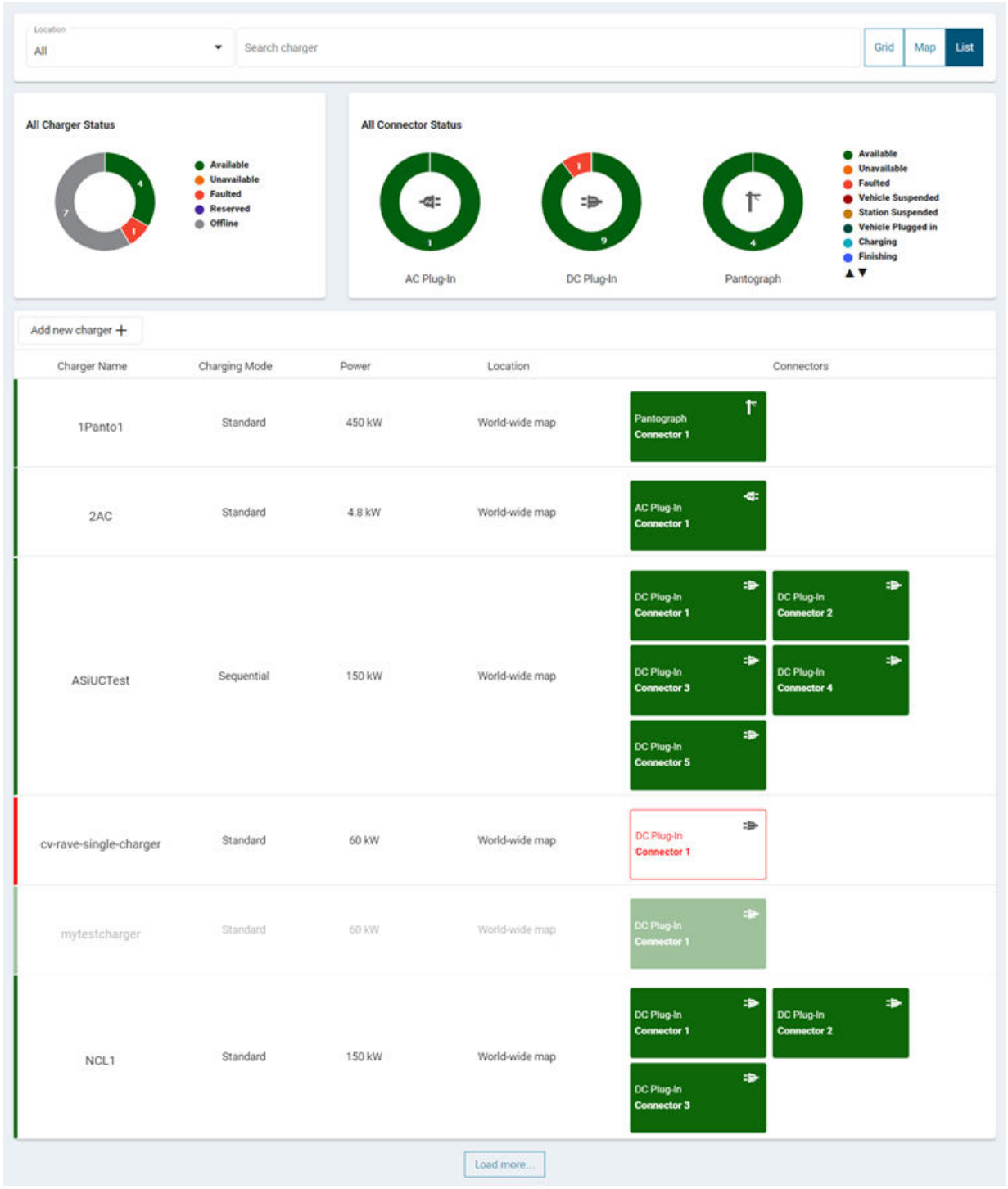
2.2 Map View

The chargers are displayed on a map. This allows you to view chargers in different locations easily.



2.3 List View

The chargers are arranged in the form of a list.



2.4 Charger Information

The Charger Information screen provides information on its statistics, variables, status and lists the connectors and their status. It also allows you to edit the charger details such as its name, location type, coordinates, and charger connection to the cloud. The charging behavior depends on the type of charger.

Monitor Chargers

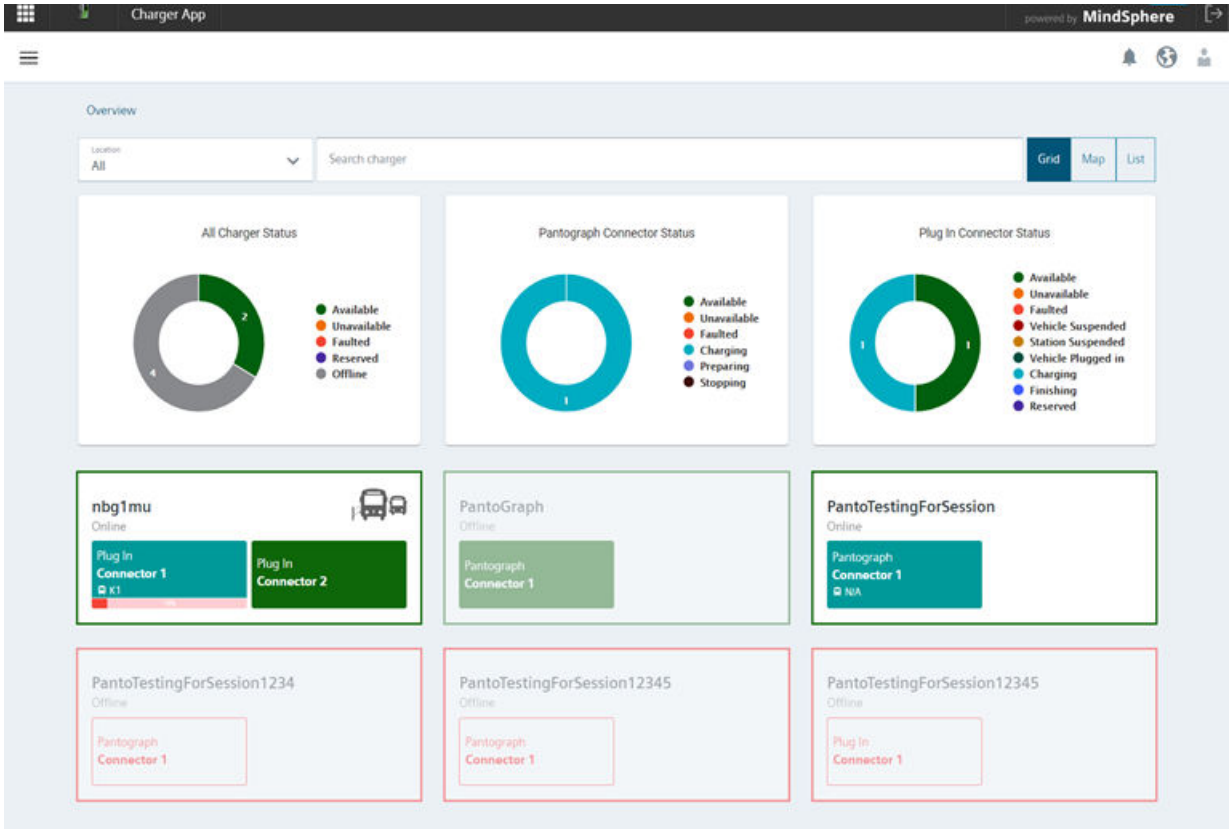
3

The following sections provide information on monitoring chargers, controlling chargers, connectors, and how notifications work.

- Monitor Chargers from Overview (Page 17)
- Notifications (Page 22)
- Remote Control of Chargers (Page 31)

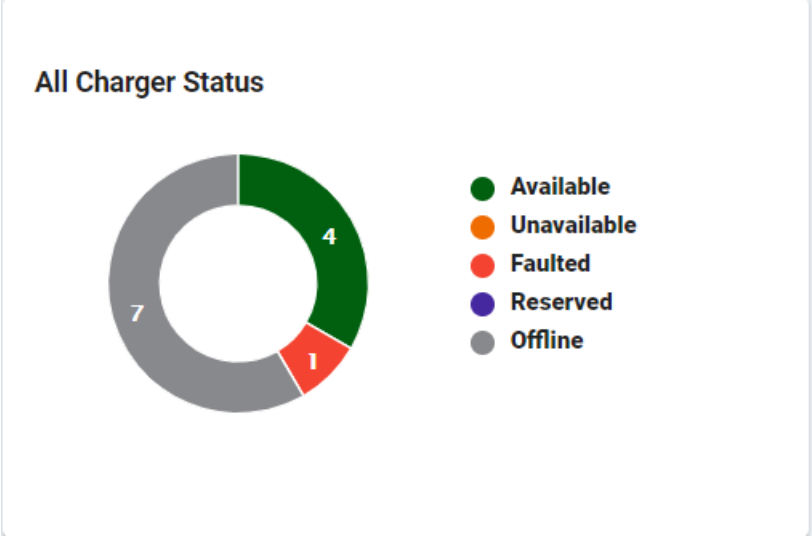
3.1 Monitor Chargers from Overview

The Overview screen allows you to monitor the status of the chargers and connectors. These charts provide a status overview of all the configured chargers and connectors. You can view the details of the individual chargers.



3.1.1 All Charger Status

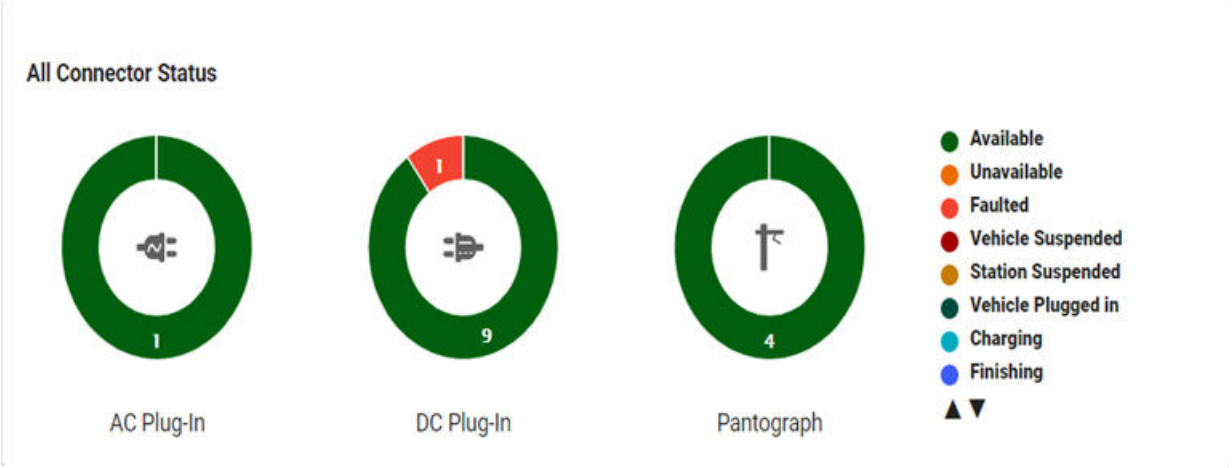
The All Charger Status widget provides information on the status of all the chargers configured on the system.



- **Available:** The charger is online and available for charging.
- **Unavailable:** The charger is online and but not available for charging. This Unavailable state is set by the user using the EVC³ Depot application and once set, will propagate to all the connectors (all connectors of the charger will become unavailable).
- **Faulted:** The charger is online but there is a fault and not available for charging.
- **Reserved:** The charger is online but not available for charging as it is in reserved ·mode for a certain RFID tag or user.
- **Offline:** The charger is offline and not available for charging.

3.1.2 All Connector Status

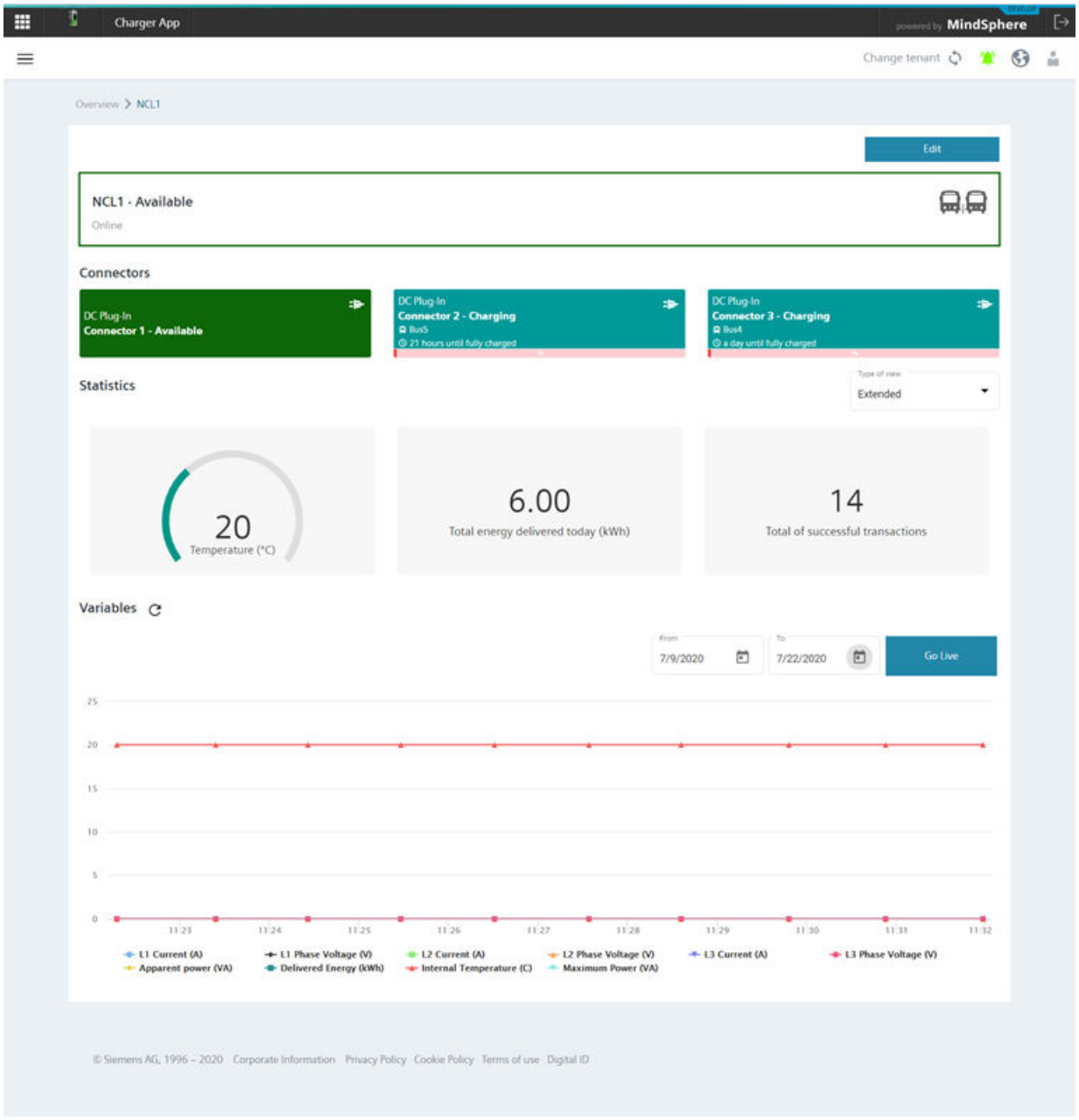
The All Connector Status widget provides information on the status of all the connectors configured on the system.



- **Available:** The connector is online and available for charging.
- **Unavailable:** The connector is online and but not available for charging. This Unavailable state is set by the user using the EVC³ Depot application and once set, will propagate to all the connectors (all connectors of the charger will become unavailable).
- **Faulted:** The connector is online but there is a fault and not available for charging.
- **Vehicle Suspended:** The connector is online and there is a transaction occurring but the vehicle is suspended and not taking any power.
- **Station Suspended:** The connector is online and there is a transaction occurring but the station is suspended and not delivering any power due to Smart Charging.
- **Vehicle Plugged in:** The connector is online and the vehicle is ready for charging but currently not being charged. The plug is inserted in the vehicle but there is no active transaction.
- **Charging:** The connector is online and is charging.
- **Finishing:** The connector is online and the plug inserted but the transaction is already finished.
- **Reserved:** The connector is online but not available for charging as it is in reserved ·mode for a certain RFID tag or user.
- **Preparing:** The connector is online and is being prepared for charging as the plug is inserted in the vehicle but there is no active transaction.
- **Stopping:** The connector is online and charging is being stopped.
- **Offline:** The connector is offline and not available for charging.

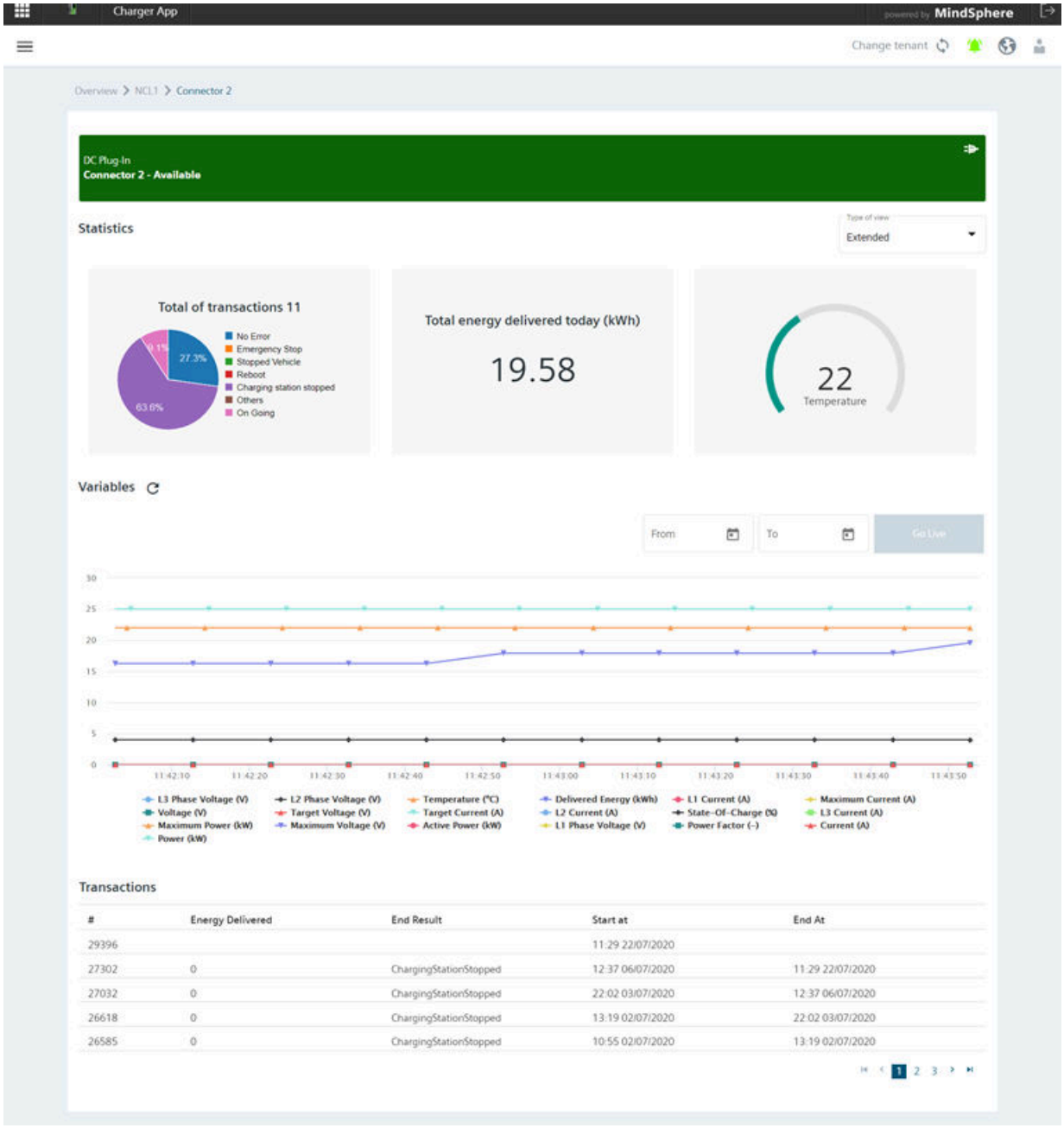
3.1.3 Charger Information

You can click on the charger to view more information on the charger. The charger information screen provides information on the status of the connectors, vital statistics of the charger, and the values of the different variables. You can also edit the charger information.



3.1.3.1 Connectors

This section shows the status of all the connectors of the charger. You can click the individual connectors to see information on the statistics, variables, total transactions, and the transaction details for the connector.



3.1.3.2 Statistics

This section shows the temperature, the total energy delivered on the day, and the total number of successful transactions. You can switch the type of view between extended and light to increase or decrease the statistics visible.

3.1.3.3 Variables

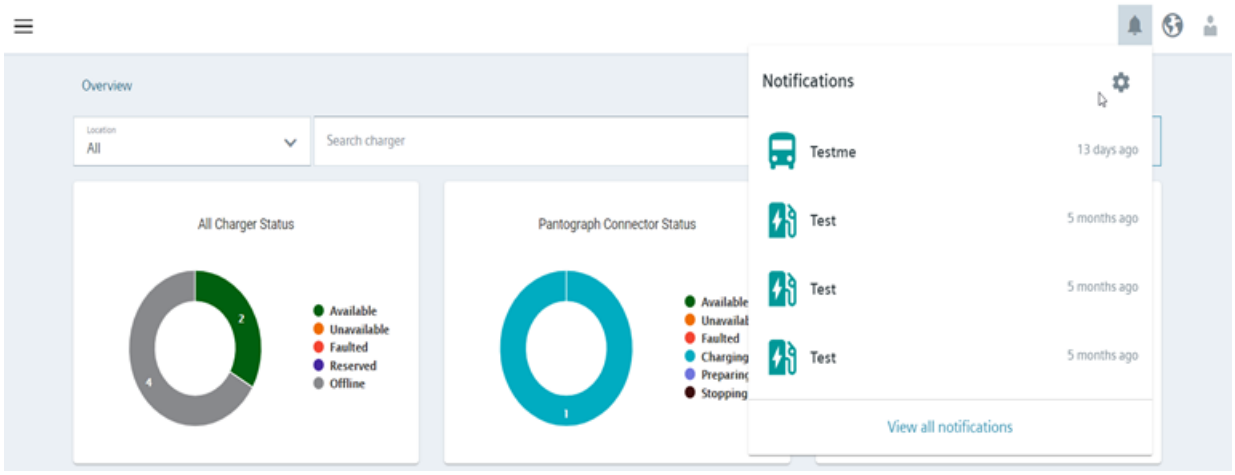
This section displays the status of the different parameters of the charger over a period of time.



3.2 Notifications

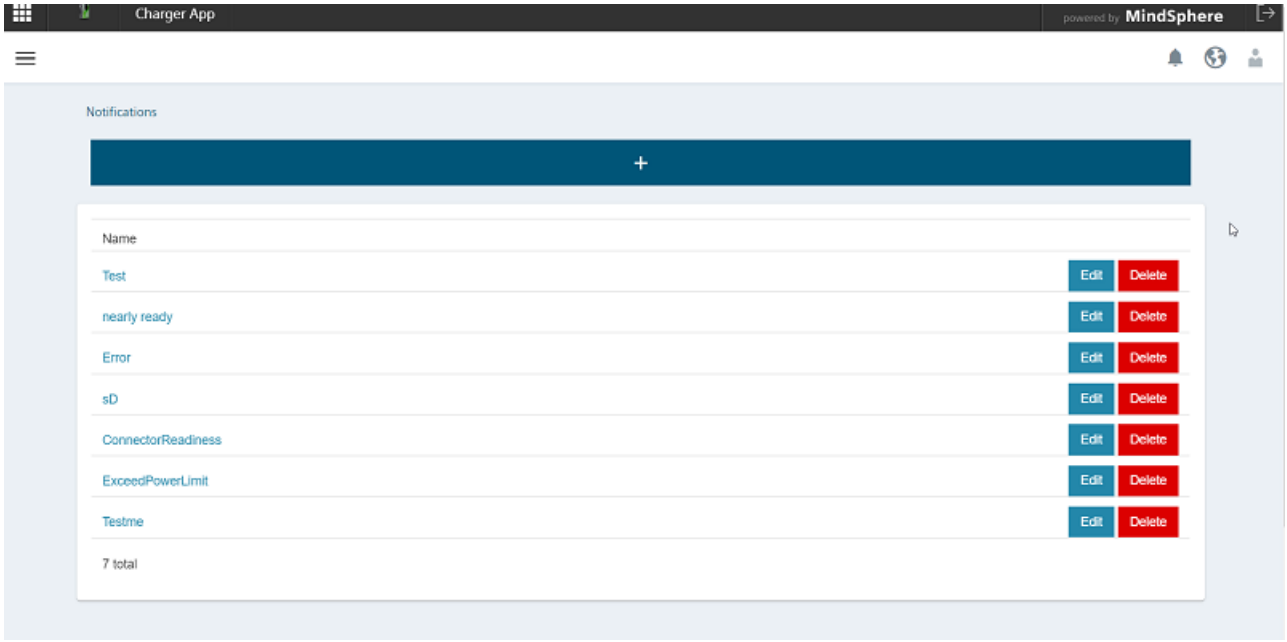
The Notifications screen allows you to configure the type of notifications to send or receive. Notifications can be sent to emails and can also be displayed on the user interface.

You can also enable desktop notifications to appear based on the browser that you use.



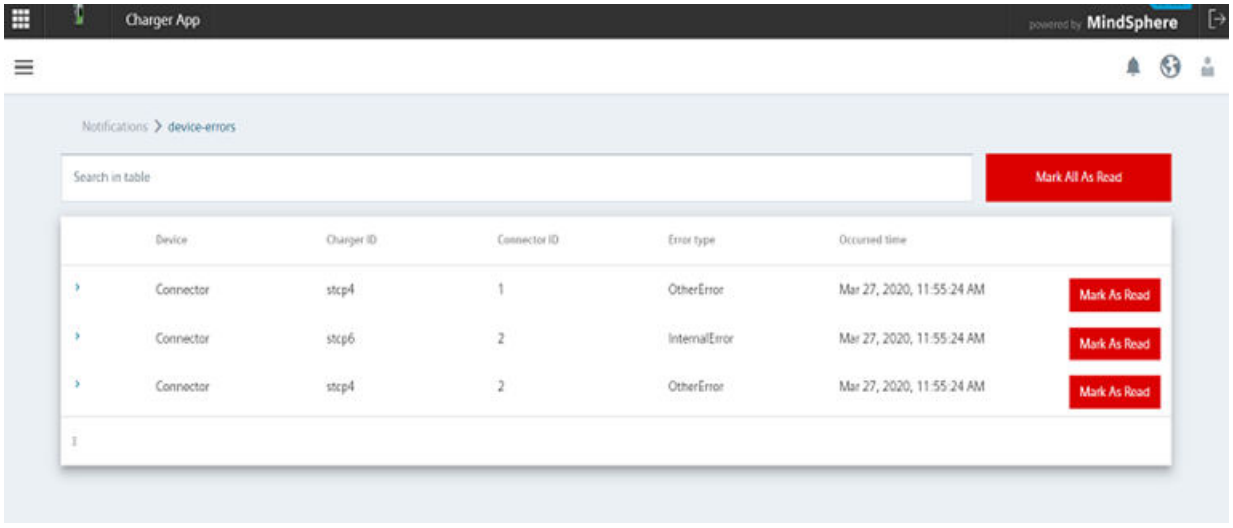
3.2.1 User Notifications

You can configure notifications with various variables that are being monitored and notify a delivery group. You can also edit or delete existing user notifications from the Notifications screen.



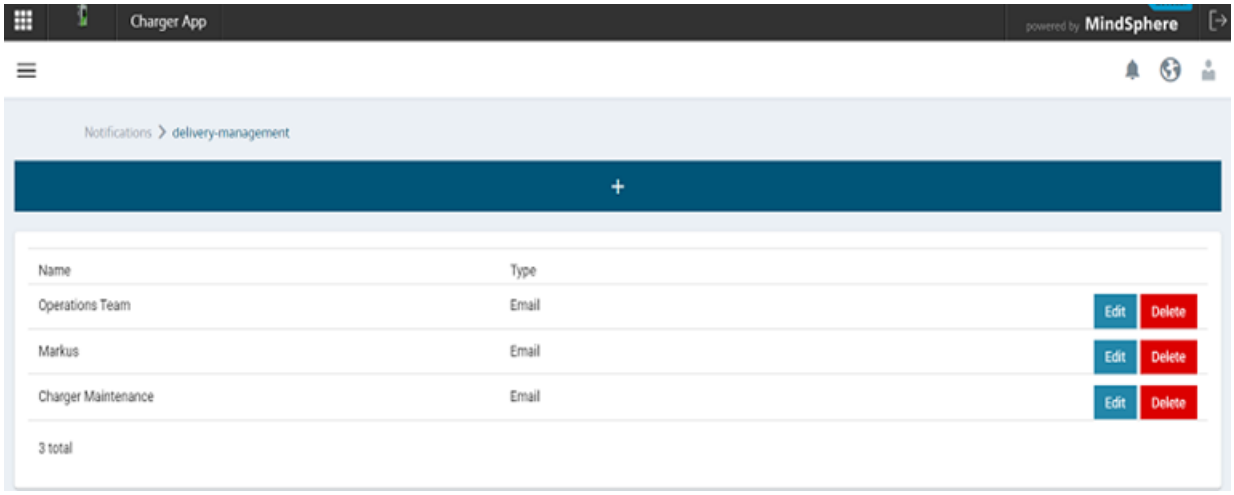
3.2.2 Device Notification

These are displayed on the user interface as a popup when there is a device error. The person notified on the user interface can click the notification to view detailed information such as the charger Id, connector Id, and the error code. For more information on the error codes, see Error Codes (Page 57).



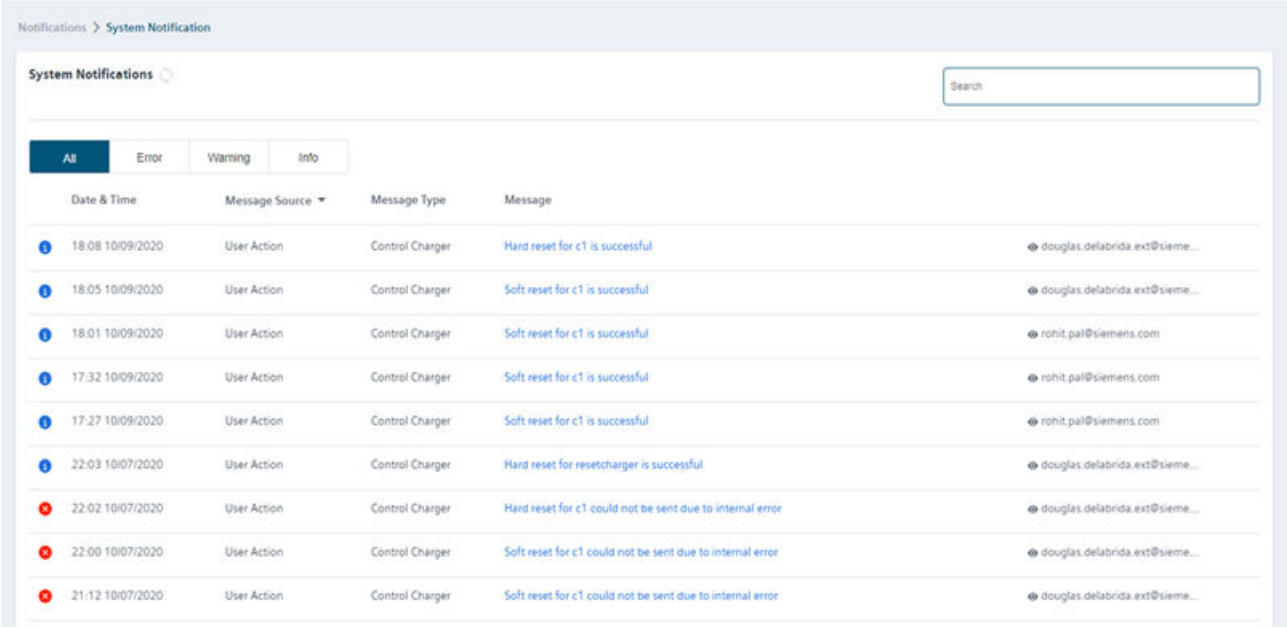
3.2.3 Delivery Groups

Delivery groups are a set of users that are notified for a configured notification. You can set the delivery groups to receive specific notifications when creating or editing a notification. Click "+" to create a new delivery group, add names and the emails of the people to notify in the group.



3.2.4 System Notifications

Important events from the EVC3 Depot system are shown under System Notifications.



The following information is available in system notifications.

- Notification Type: Notifications can be of the type Error, Warning, or Informational. You can filter the notifications based on the type.
- Date & Time: The timestamp of the notification.
- Message Source: The source of the notification like User action, Smart charging, and Optimal charging.
- Message Type: The type of the message.
- Message: The details of the message.
- Action/Action By: If the notification needs an action, options to take the action are available here. After a user takes the action, the details of the user who took the action is available.

You can filter notifications by the notification type (Error, Warning, Info) using the buttons. Notifications can also be filtered by Message source using the drop-down filter.

When new notifications are available while the user is working on the System Notification page, the refresh button will be enabled. User can click on the refresh button to get the latest notifications.

3.2.5 Desktop Notifications

Desktop notifications allow you to be notified of any errors in the chargers even if you are not viewing the application. The error notification on the desktop is accompanied by a sound. When you click on the notification, the Device Errors screen appears.

Desktop notifications are dependent on the web browser being used. When you first open the application, it asks you if you would like to receive browser notifications. Click Allow to receive notifications. You can configure and modify notification permissions from the settings of your browser.

Note

Your operating system (such as Windows 10) must be configured to show notifications from other applications.

3.2.6 Create a Notification

You can configure a notification to deliver a notification for an asset that is being monitored. Notifications can be configured for three different assets: chargers, connectors, and EVs. Perform the following steps to create and configure a new notification.

1. Navigate to left navigation menu > Notifications screen. The Notifications screen appears.
2. Click "+" on the screen to create a new notification. The Create a New Notification screen appears.

3. Select the type of asset for the notification and specify if you want to apply the notification for all assets or specific assets.
   If you select the specific assets option, you must specify the assets for which the notification must be applied.

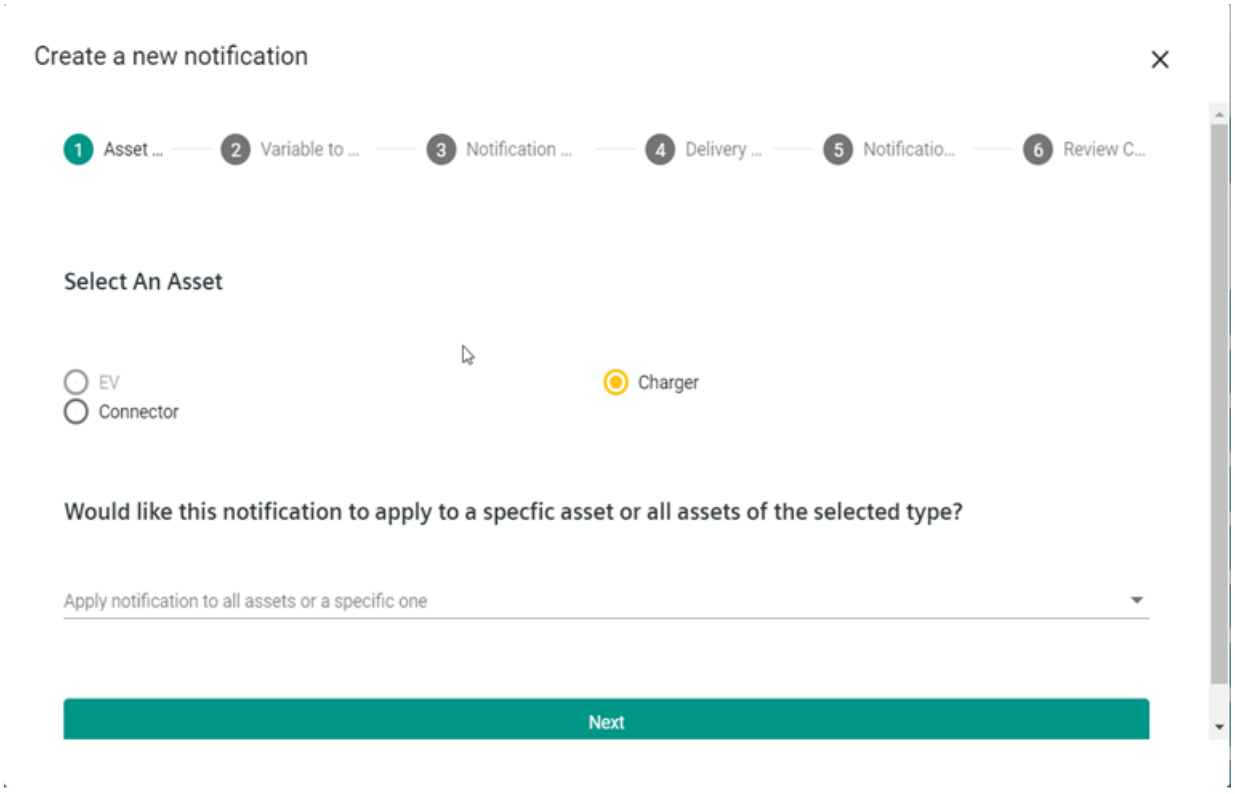
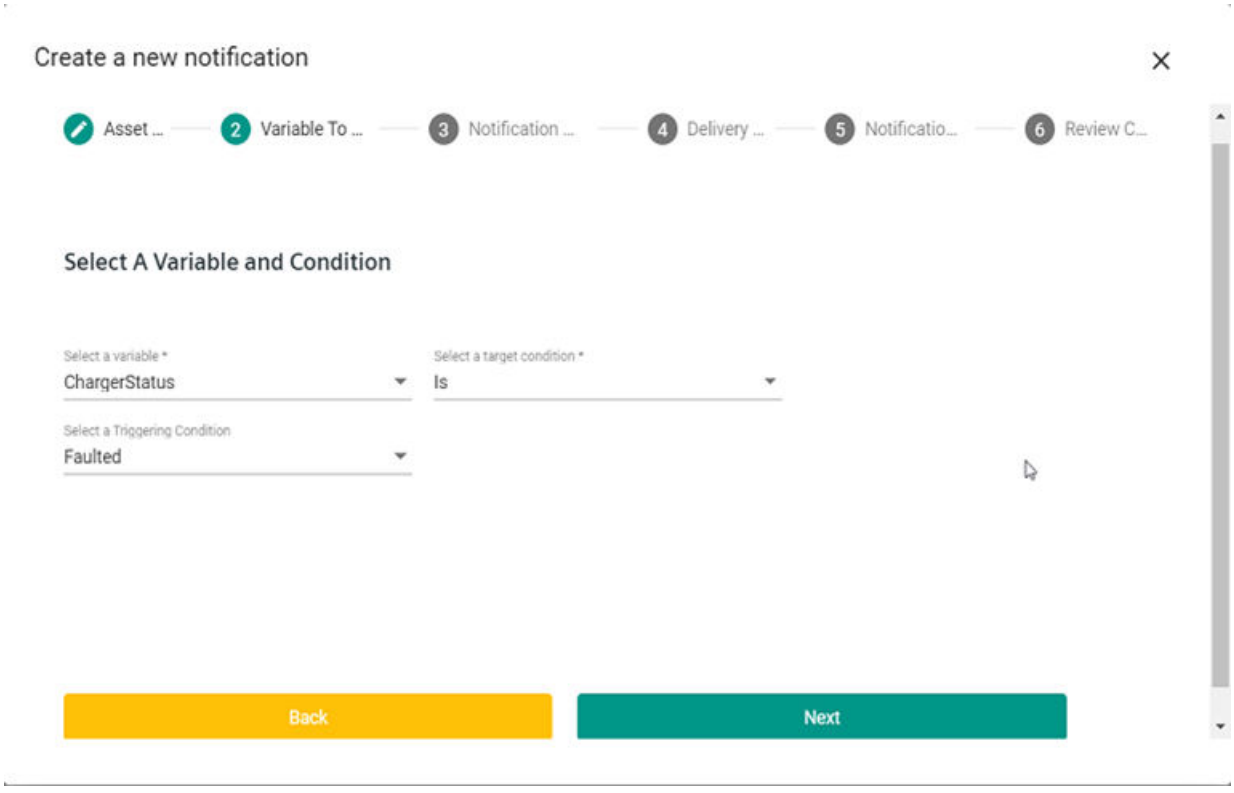
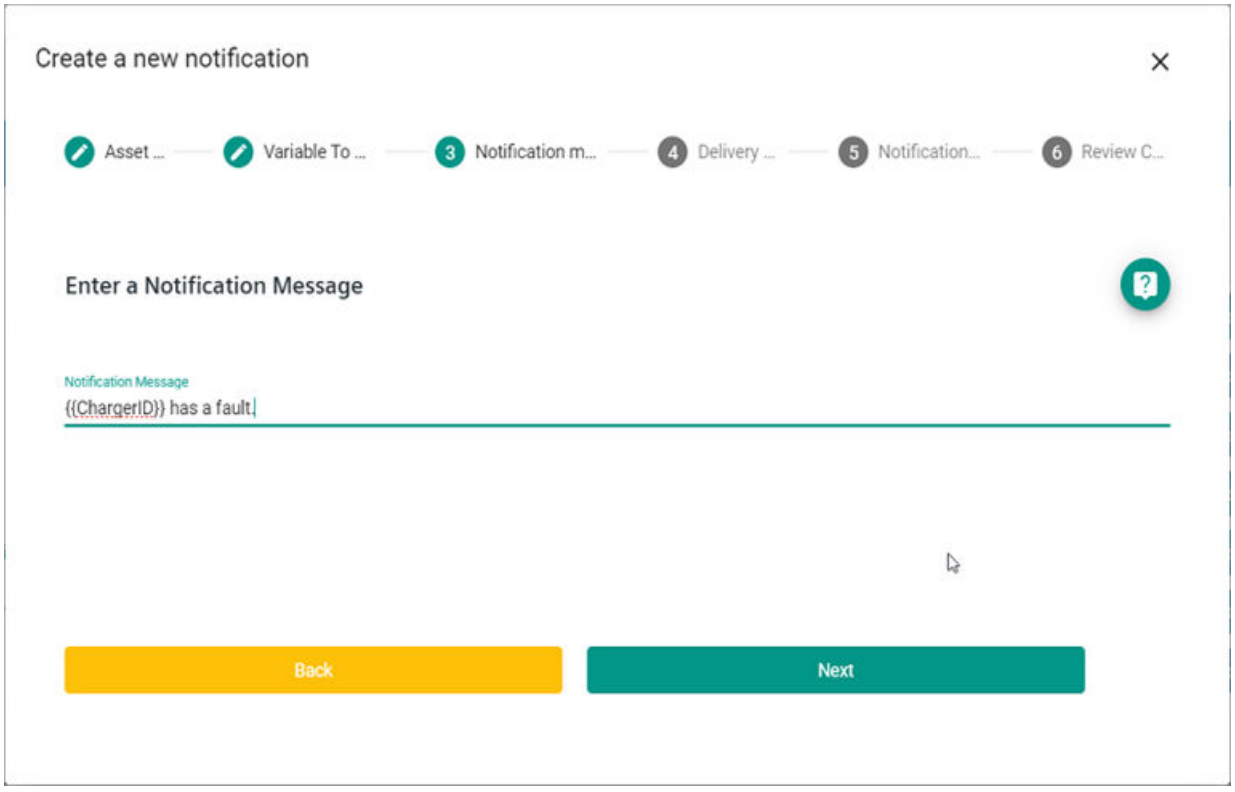


Figure 3-1 Create Notification

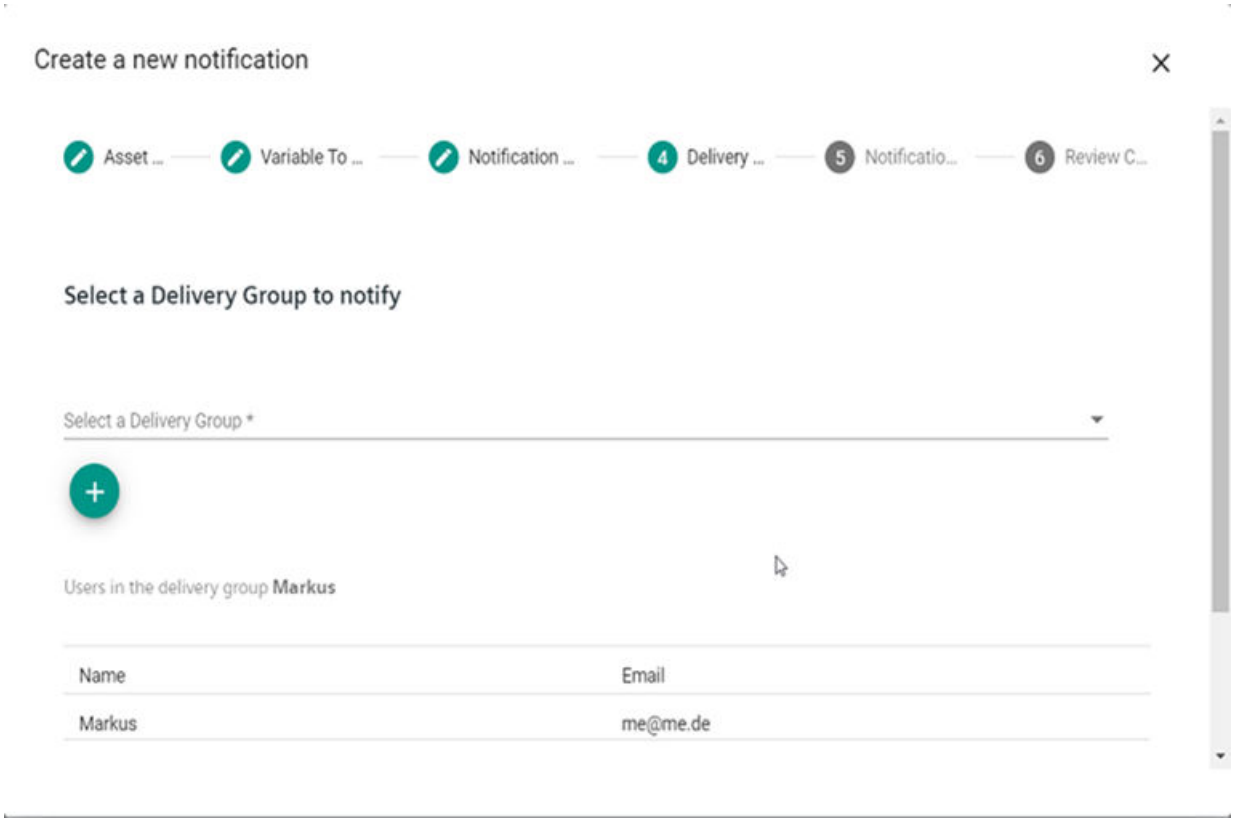
4. Select the variable to monitor, specify the trigger condition, and set the triggering condition.



5. Enter the text to be sent as the notification message.
   You can also add dynamic variables such as {{ChargerID}}, {{ConnectorrID}}, {{Time}}, and so on as part of the message.



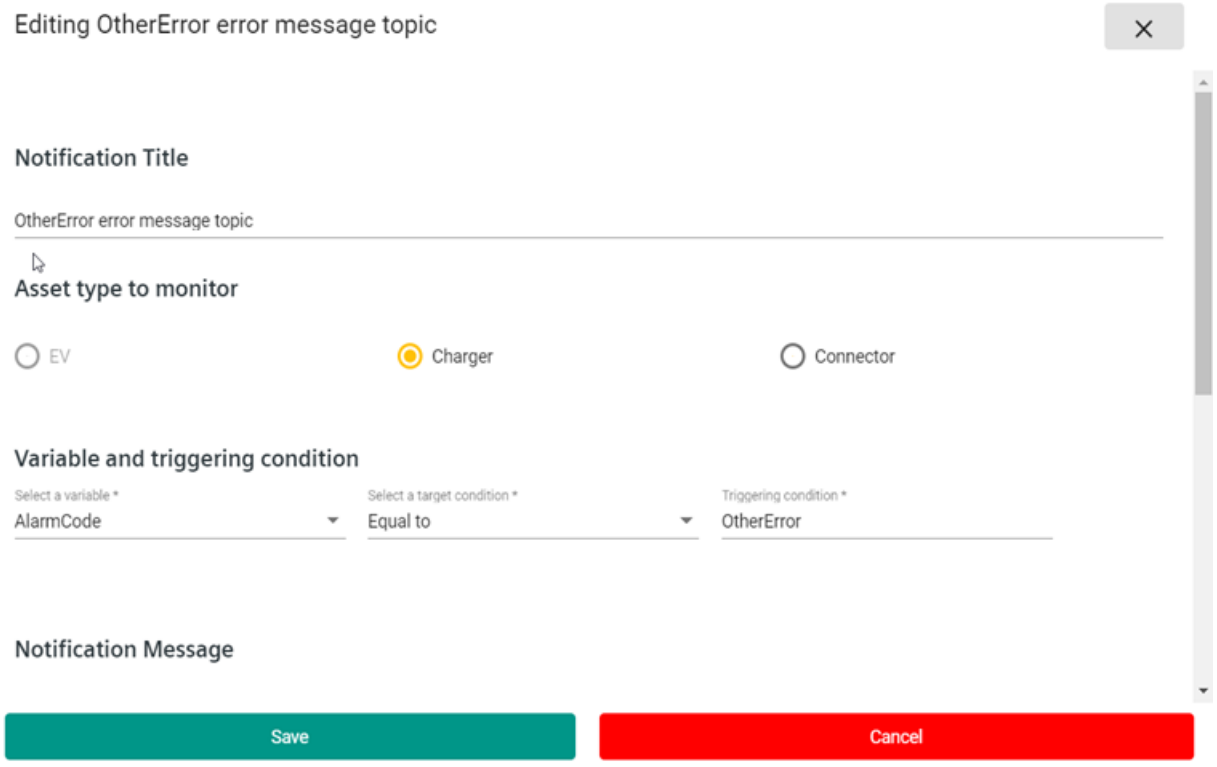
6. Select the delivery group to send the notification. See Delivery Groups for more information.



7. Enter a name for the notification topic, review the notification, and submit to create the notification.

3.2.7 Edit Notifications

You can edit existing notifications by clicking Edit next to the desired notification on the Notifications screen. The Edit Notification screen appears which allows you to change the parameters of the notification.



3.3 Remote Control of Chargers

3.3.1 Remote Control of Chargers

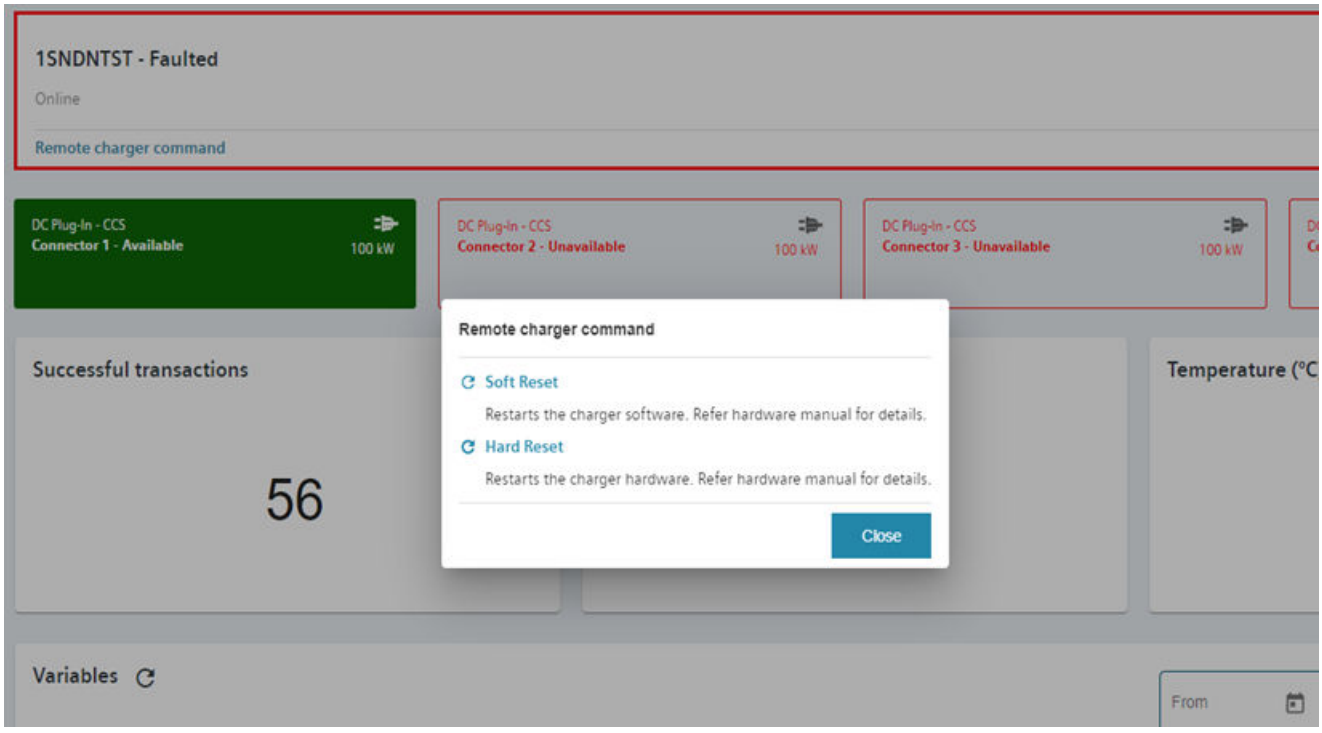
A Service Engineer can send control commands to chargers.

To control a charger remotely, click Remote charger command in the Charger Details page.

You can send the following commands to the charger:

- Soft reset: Sends a "Soft reset" command to the charger
- Hard reset: Sends a "Hard reset" command to the charger.

Soft and Hard reset strategy is specific to the charger type. Refer to the charger documentation for information on how soft and hard reset commands execute for a specific charger.


1SNDNTST - Faulted
Online
Remote charger command
DC Plug-In - CCS
Connector 1 - Available
100 kW
DC Plug-In - CCS
Connector 2 - Unavailable
100 kW
DC Plug-In - CCS
Connector 3 - Unavailable
100 kW
Remote charger command
Soft Reset
Restarts the charger software. Refer hardware manual for details.
Hard Reset
Restarts the charger hardware. Refer hardware manual for details.
Close
Successful transactions
56
Temperature (°C
Variables
From

Onboarding Chargers and EVs

4

You must onboard chargers and EVs in the EVC^3 Depot application before you can configure charging strategies and monitor the activities.

The following sections provide information on onboarding chargers and electric vehicles.

- Onboarding Chargers (Page 33)
- Onboarding EVs (Page 35)

4.1 Onboarding Chargers

You can add new chargers in the EVC^3 Depot application and edit the information of existing chargers.

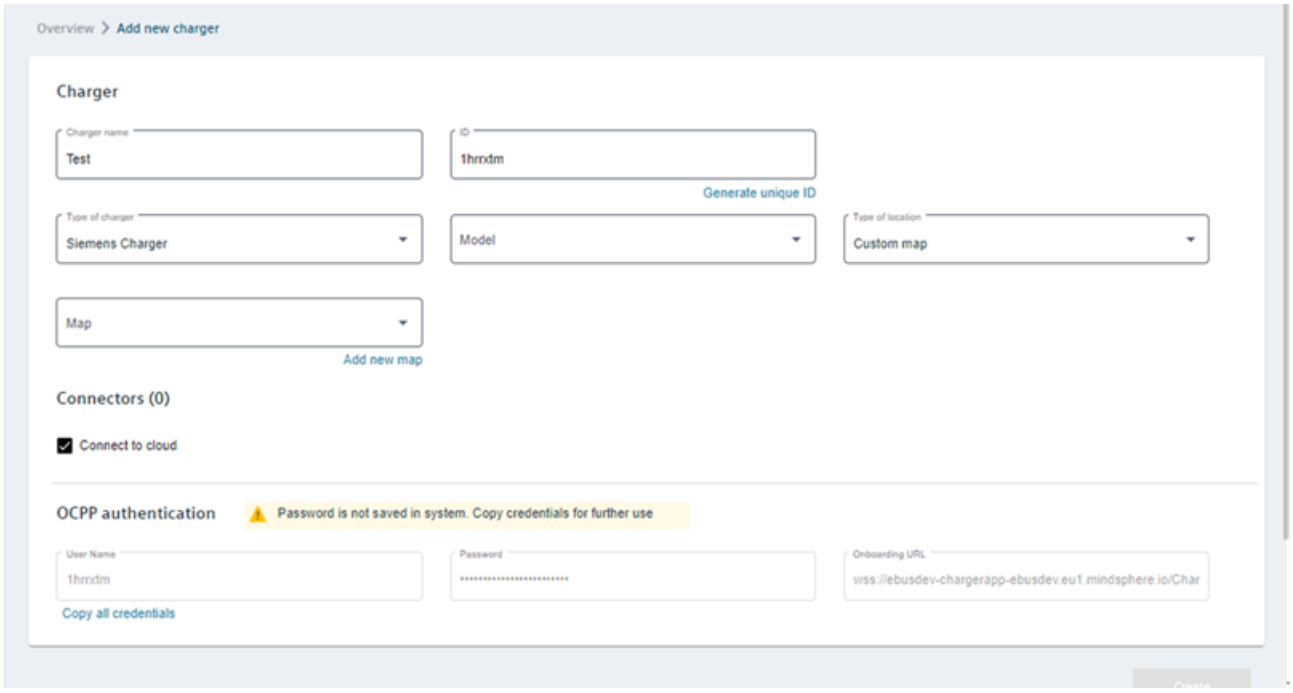
Note

Some features and screens are restricted by permissions assigned for roles. Contact your administrator for more information on your roles and permissions.

4.1.1 Add a Charger

Perform the following steps to add a new charger.

1. Navigate to the Overview screen in EVC[3] Depot.
2. Click Add new charger.
   The Add new charger screen appears.



3. Enter the Charger Name.
4. Enter the unique ID of the charger.
   You can also click Generate an unique ID to generate a unique ID for the charger in the system.
5. Select the type of charger.
   Both Siemens chargers and non-Siemens chargers are supported. Charger power and the connector information are automatically filled in if you select a Siemens charger. For more information on supported models of Siemens chargers, see "Supported Models of SiemensChargers".
   If you select a non-Siemens charger, you must enter the charger power. You must also enter the connector information - number of connectors, efficiency, and power factor.
6. If the charger has more than one connector, you must choose the charging mode for the charger. It can be either seqential or standard.
7. Select the type map from the Type of Location field.
   You can either select custom map or world map.
8. If you select custom map, select the map from the Map dropdown and pin the location on the map. If you select world map, pin the location of the charger on the world map.
   If you want to add a new custom map, click Add new map, select the map file, and click Create.
9. Select whether the charger can connect to the cloud.

10. Click Copy all credentials to copy the authentication credentials.
    The credentials are copied to the clipboard. You should paste it in a note for safe keeping. These credentials has to be send to the team that maintains the charger and has to be updated in the charger. The Chargers should authenticate with the Central System(EVC3) using Basic Authentication scheme according to OCCP V1.6 Standard. The User Name is same as the Charger ID. As soon as the charger ID is generated or entered , the User Name and Onboarding URL field are auto-generated. The password is auto-generated and you cannot customize the password.
11. Click Create.

Supported Models of Siemens Chargers

The following models of Siemens Chargers are supported:

- RAVEGBT (60 kW single, 80 kW single, 30 kW twin, and 60 kW twin)
- RAVECCS (50 kW single, 60 kW single, 80 kW single, 100 kW single, 150 kW single, 150 kW cascade twin, and 150 kW cascade triple)
- MECCCS (20 kW single and 80 kW twin)
- HPC Pantograph (150 kW, 300 kW, 450 kW, and 600 kW)
- VERSI (4.8 kW single, 5.75 kW single, 7.4 kW single, and 22 kW single)
- VERSI Smart Charger (3.84 kW single and 11.5 kW single)
- Sicharge UC (100kW, 150 kW, 225 kW, 300 kW, 450 kW, and 600 kW)

For SiCharge UC, you can add up to 5 connectors. Each connector can have the following plug types: CCS, CHAdeMO, GB/T, and Schunk hood.

4.1.2 Edit and Delete Chargers

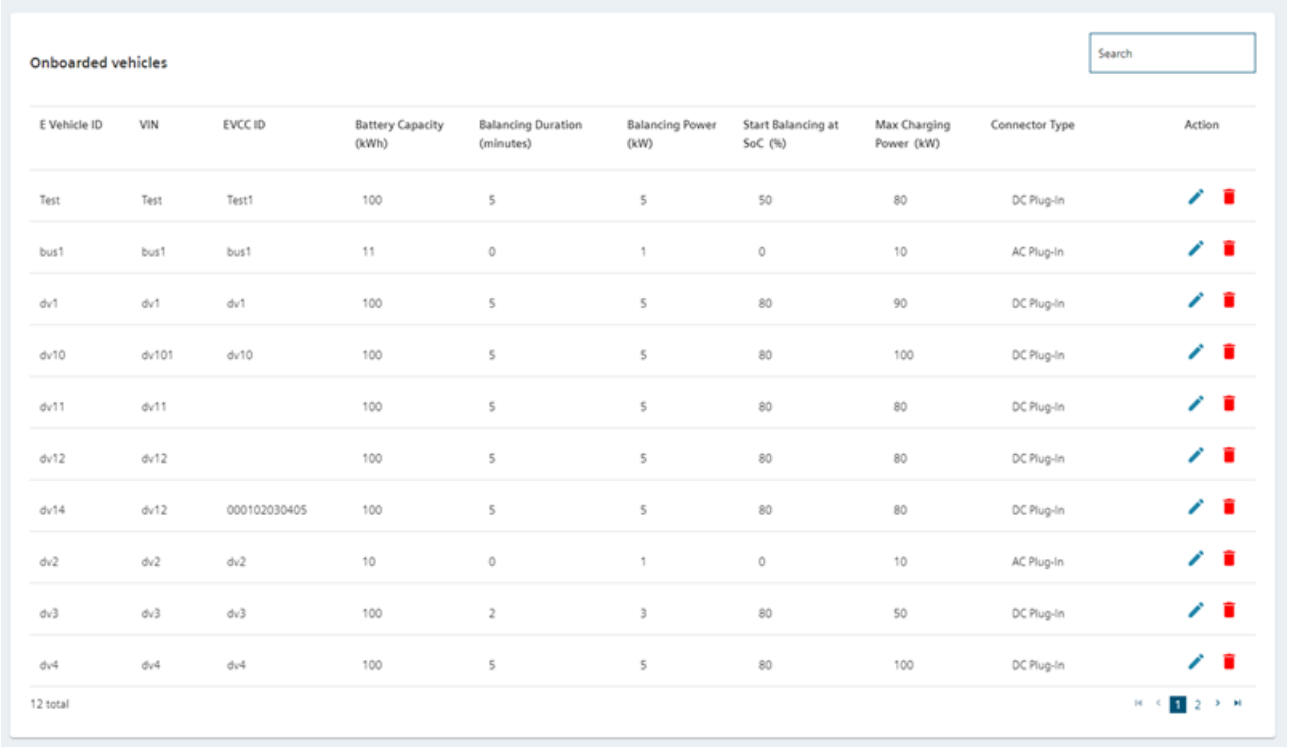
In the Overview screen, select the charger, and click Edit to edit the details of a charger. You can edit the name, location, map, and coordinates of the charger. However, you cannot edit the unique ID. You can also auto-generate and change the password in the edit mode. For those chargers that are already onboarded, you can enable authentication in the edit mode. After you edit the credentials, click Copy all credentials to copy the authentication credentials. The credentials are copied to the clipboard. You should paste it in a note for safe keeping. These credentials has to be send to the team that maintains the charger and has to be updated in the charger.

In the Overview screen, select the charger, click Edit, and then click Delete Charger to remove the charger from the system.

4.2 Onboarding EVs

You must onboard the electric vehicle in the system before you can use EVC^3 Depot to monitor and report charging activities.

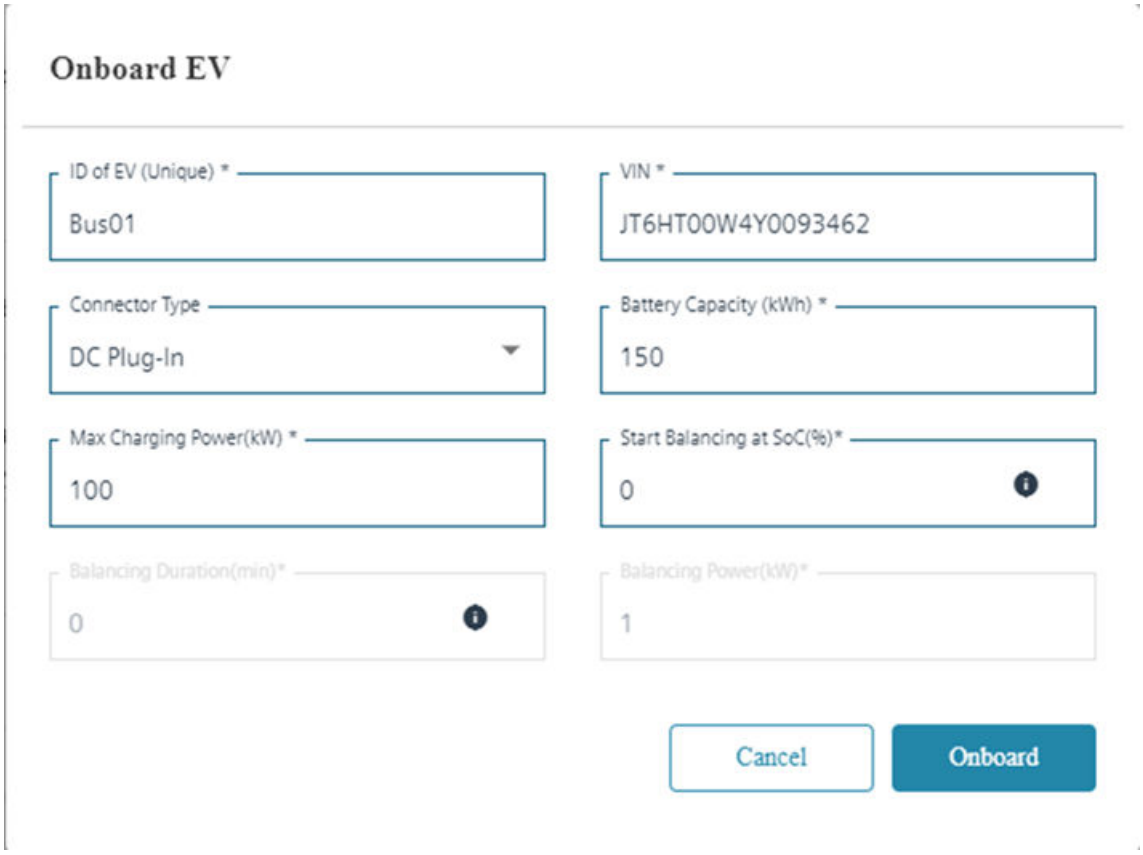
You can manage electric vehicle in the EV Management screen of the EVC^3 Depot.



4.2.1 Onboard an EV

1. Click E Vehicle Management in the left navigation menu.
   The E Vehicle Management screen appears.
2. Click Onboard new EV.
   The Onboard EV screen appears.

3. Enter the unique ID of the electric vehicle, VIN of the electric vehicle, battery capacity (in kWh), the connector type, the maximum charging power (in kW), the percentage of state of charge at which to start the balancing, the time duration for the balancing in minutes, and the power to be supplied for balancing for the electric vehicle.
   The connector type can be Plug In or Pantograph. If the maximum charging power for the electric vehicle is not provided, the connector maximum power is used as an upper limit.



4. Click the Onboard to add the configured electric vehicle into the system.

4.2.2 Add Multiple Electric Vehicles

You can also add multiple electric vehicles with a single operation.

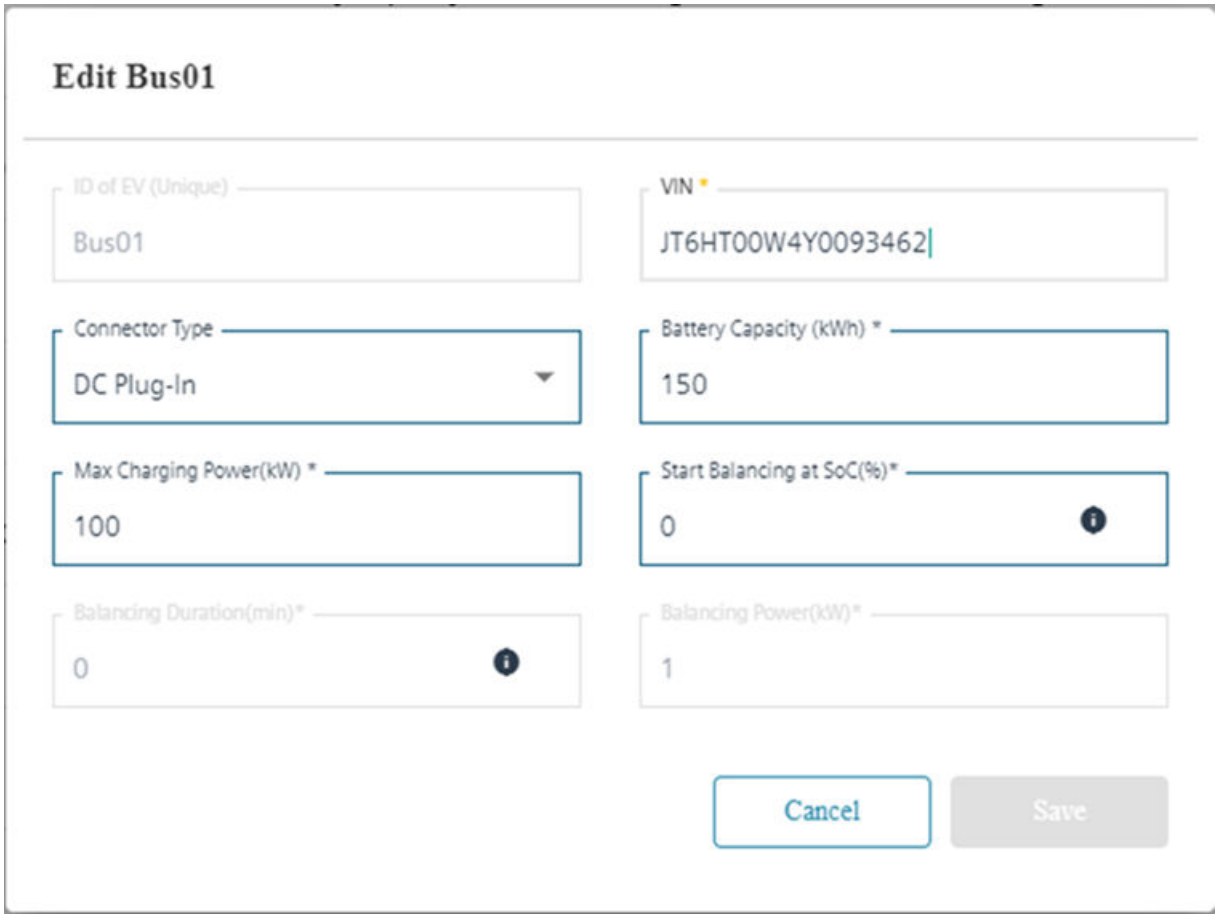
You must create a CSV file with the following details for each electric vehicle in a comma-separated format - unique ID of the electric vehicle, name of the electric vehicle, battery capacity (in Wh), and the connector type, and the maximum charging power (in kW) for the electric vehicle. If the maximum charging power for the electric vehicle is not provided, the connector maximum power is used as an upper limit.

1. Click E Vehicle Management in the left navigation menu.
   The E Vehicle Management screen appears.
2. Click Import.
3. Select the CSV file that contains the electric vehicle information and click Ok.

4.2.3 Edit and Delete Electric Vehicle

In the E Vehicle Management screen, click Edit against an electric vehicle to edit the details of an electric vehicle. You cannot edit the unique ID of an electric vehicle.

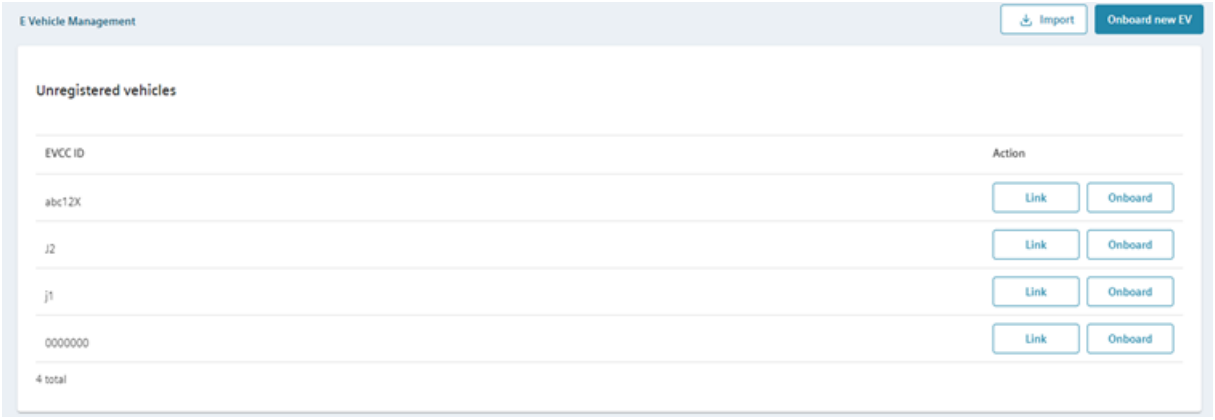
In the E Vehicle Management screen, click Delete to delete an electric vehicle from the system.



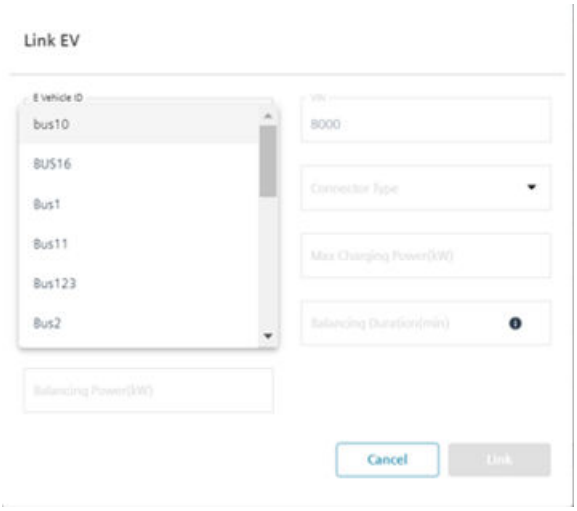
4.2.4 Unregistered EVs

The charger can identify an electric vehicle by the Mac ID of the plugin connector. The E Vehicle Management screen shows the EVCC ID of unregistered vehicles that were connected to the charger.

Click Onboard to onboard the electric vehicle into the system.



If the electric vehicle already exists in the system, click Link to link the EVCC ID to the existing electric vehicle.



After you link or onboard the EVCC ID of the unregistered vehicle, future transactions for the vehicle reflects the E Vehicle ID.

Smart Charging

5

The electrical grid infrastructure of depots is not designed for the load and power demands of charging infrastructure. Therefore, there is a need for smart mechanisms to utilize the charging infrastructure without overloading the grid connection. The EVC^3 Depot application allows you to charge all assets overnight in the depot without exceeding the grid power limits. You can also see a report of the smart charging status of the depot. For more information on the report, see Smart Charge Report (Page 53).

The basic charging algorithms are an easy way to organize the charging of electric vehicles based on simple prioritization rules. Additionally, the algorithms assure that a given maximum power (For example, maximum grid connection power) is never exceeded. The algorithms are invoked live and dynamically distribute the available power to connected electric vehicles. Each time an electric vehicle that requires charging is connected or a connected electric vehicle finishes charging, the algorithms redistribute the allocated power setpoints for each charger or connector in order to provide optimal usage of the available power bandwidth.

Depots have different parking arrangements. In some depots there are separate entrance and exits, thus the electric vehicles are parked with a First In First Out methodology. In some depots there is only a single combined entrance/exit and a First In Last Out methodology is used.

There are three basic algorithms that serve slightly different requirements and objectives.

- First In First Out (FIFO)
- First In Last Out (FILO)
- SPLIT

The basic smart charging algorithms are the simplest method of controlling chargers. Typically used when only a simple objective of limiting the maximum power for a group of chargers is needed or if multiple groups in the depot are needed.

Note

Some features and screens are restricted by permissions assigned for roles. Contact your administrator for more information on your roles and permissions.

The basic smart charging algorithms also implement a basic balancing model which allows,

- enabling of active electric vehicle battery balancing to ensure error-free operations
- constraining effectively the overall charging duration and reduced power allocation during balancing, which in turn allows for a more efficient use of the overall available power

Balancing allows the user to define a balancing duration, balancing power, and state of charge at which bulk charging concludes and balancing is started. The basic smart charging algorithms implement the balancing parameters and control the transition from bulk charging to balancing, prioritize vehicles during balancing, and finish the charging session after the balancing duration expires.

5.1 First In First Out Chargers

The First In First Out (FIFO) strategy organizes charging of electric vehicles with the strategy to first fully charge the electric vehicles that entered the depot first. The motivation behind this strategy often is the depot layout being a one-way lane so it is a requirement that the first electric vehicle coming into the depot is also the first one leaving the depot.

FIFO strategy is a "live" strategy that sets the PowerSetPoint of each charger depending on the following conditions.

- Is the charger connected to an electric vehicle that is not yet finished charging?
- When was the charger connected to the electric vehicle?
- What is the available maximum power for the electric vehicle / charger / charging_group / depot?

5.2 First In Last Out Chargers

The First In Last Out (FILO) strategy that organizes charging of electric vehicles with the strategy to first fully charge the electric vehicle that entered the depot most recently. The motivation behind this strategy often is the depot layout being a dead-end one-way lane so it is a requirement that the last electric vehicle coming into the depot is also the first one leaving the depot.

FILO strategy is a "live" strategy that sets the PowerSetPoint of each charger depending on the following conditions.

- Is the charger connected to an electric vehicle that is not yet finished charging?
- When was the charger connected to the electric vehicle?
- What is the available maximum power for the electric vehicle / charger / charging group / depot?

Note

For sequential chargers, a First In First Out (FIFO) strategy is used at the connector level. Hence, the electric vehicle which was connected first to the charger will finish charging before the next electric vehicle is charged even if a FILO strategy is used for the chargers.

5.3 SPLIT Chargers

SPLIT is a basic strategy that organizes the charging of electric vehicles to equally distribute the available charging power of the charging_group or depot to all connected (and not yet fully charged electric vehicles). This is useful if there are no constraints to the inbound and outbound movement of the electric vehicles. SPLIT also reduces stress on the equipment / electric vehicles due to lower PowerSetPoints. SPLIT strategy can be used if there are no significant time constraints on charging individual electric vehicles.

SPLIT strategy is a "live" strategy that sets the PowerSetPoint of each charger depending on the following conditions.

- Is the charger connected to an electric vehicle that is not yet finished charging?
- What is the available maximum power for the charger or charging group?
- What is the available maximum power for the electric vehicle / charger / charging group / depot?

If there are two chargers that have different charging rates, the EVC^3 Depot application calculates how much power needs to be sent for each charger based on the maximum power limit configured.

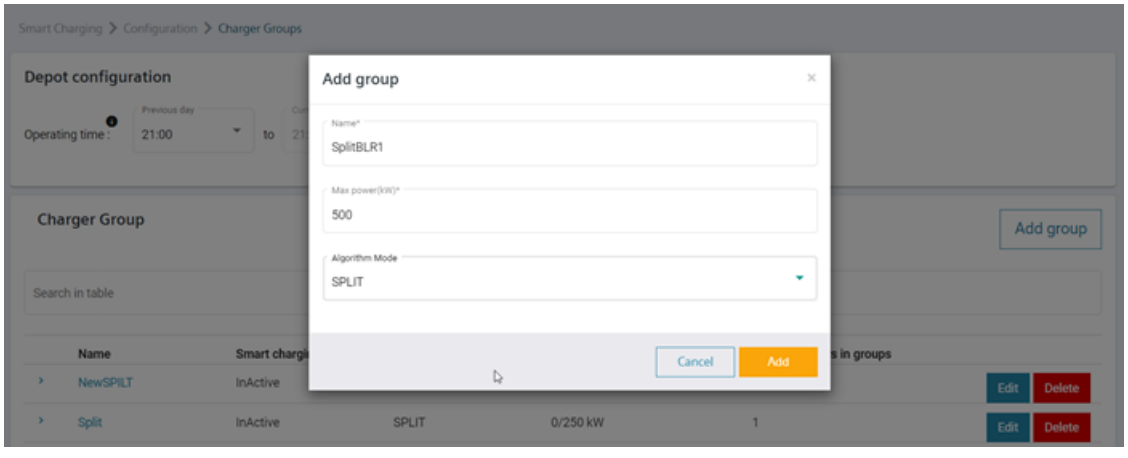
The SPLIT strategy works based on the following parameters.

- The power distribution is weighed on the charger, connector, and vehicle maximum power parameters
- Balancing is always prioritized when bulk charging is ongoing
- For sequential chargers, a First In First Out (FIFO) strategy is used at the connector level. Hence, the electric vehicle which was connected first to the charger will finish charging before the next electric vehicle is charged even if a FILO strategy is used for the chargers.

5.4 Add Charger Group

You must create charger groups to allow EVC^{3}Depot to monitor smart charging.

1. Click Smart Charging Config in the left navigation menu.
   The Configuration screen appears.
2. Click Smart Charging Configuration to open the Charger Groups screen.
   The Charger Groups screen allows you to add, edit, or delete charger groups and also set te depot operating time.
3. Click the Add Group button.
   The Add group popup appears.



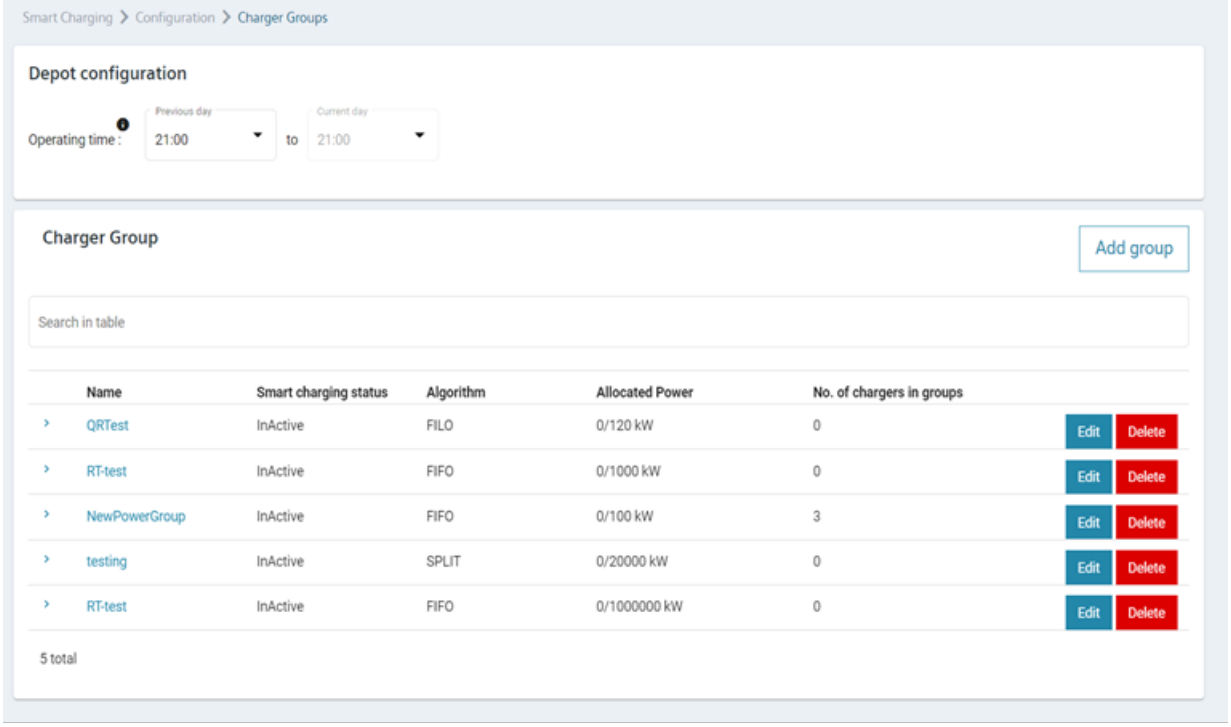
4. Enter the name for the group in the Name field.

5. Enter the maximum power in kW for the charging group in the Max Power field.
6. Select the smart charging algorithm mode to be used for the charger group and click Add. For more information on the smart charging algorithms, see Smart Charging.

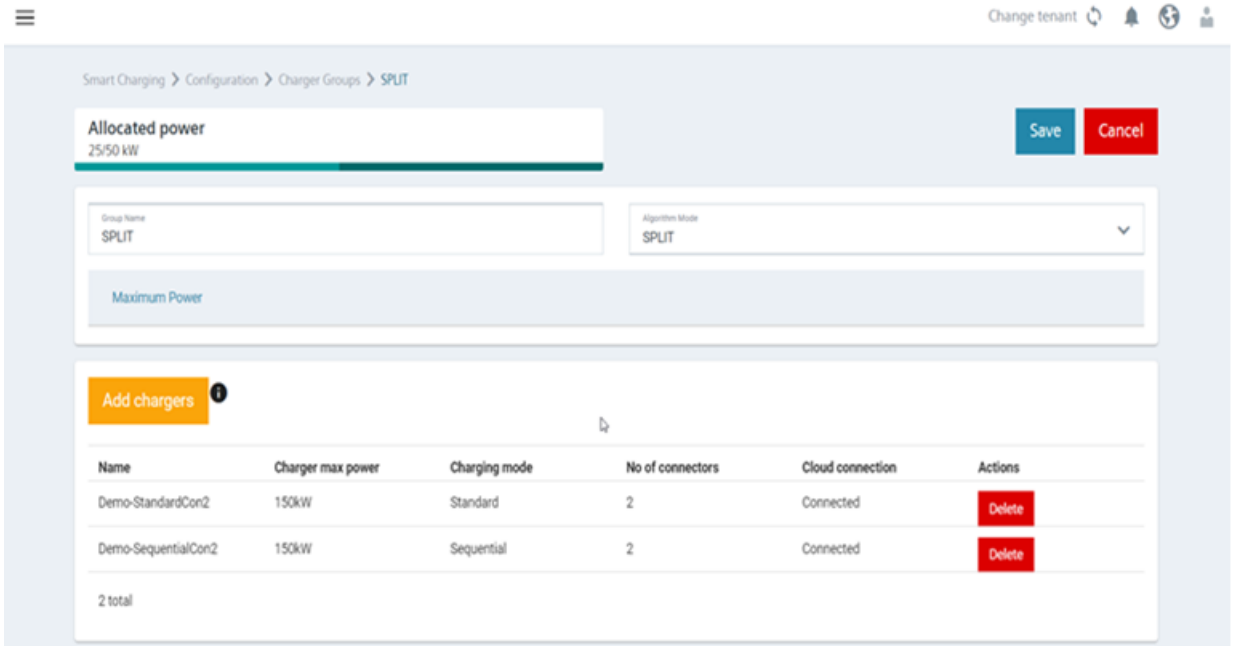
5.5 Add Charger to Group

You must add chargers to a charger group. Only chargers that are connected to the cloud and have a Plug-in connector can be added to the group.

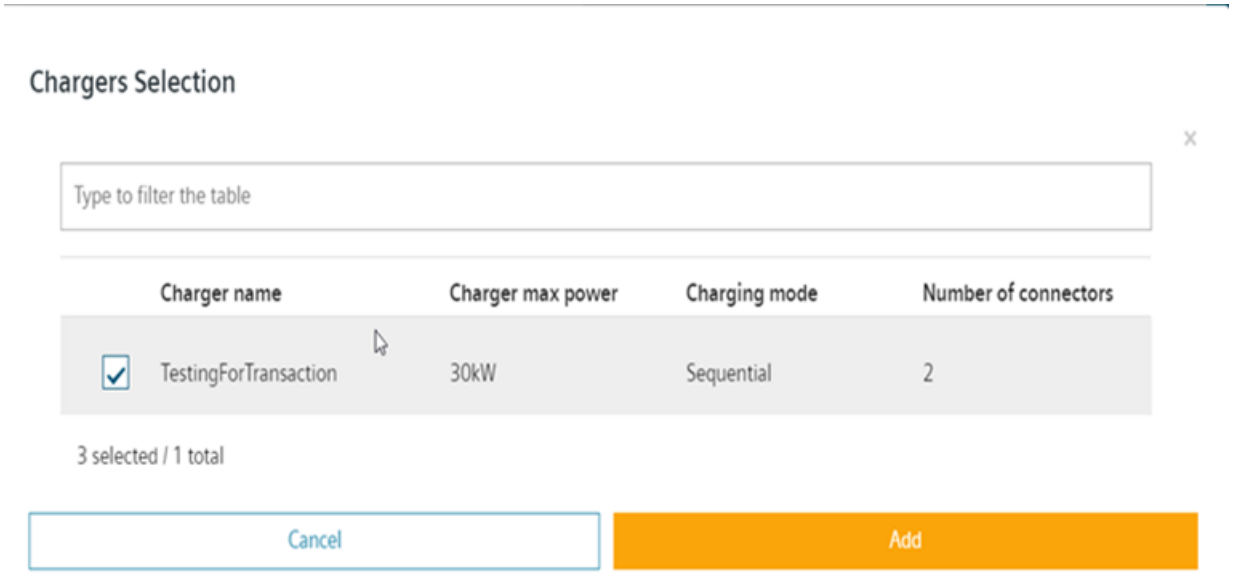
1. Click Smart Charging Config in the left navigation menu.
   The Configuration screen appears.
2. Click Smart Charging Configuration to open the Charger Groups screen.
   The Charger Groups screen allows you to add, edit, or delete charger groups.



3. Click Edit on the charger group you want to edit.
   The Charger Group information screen appears.



4. Click Add chargers to select the chargers to add to the group.
   The Charger Selection popup screen appears.

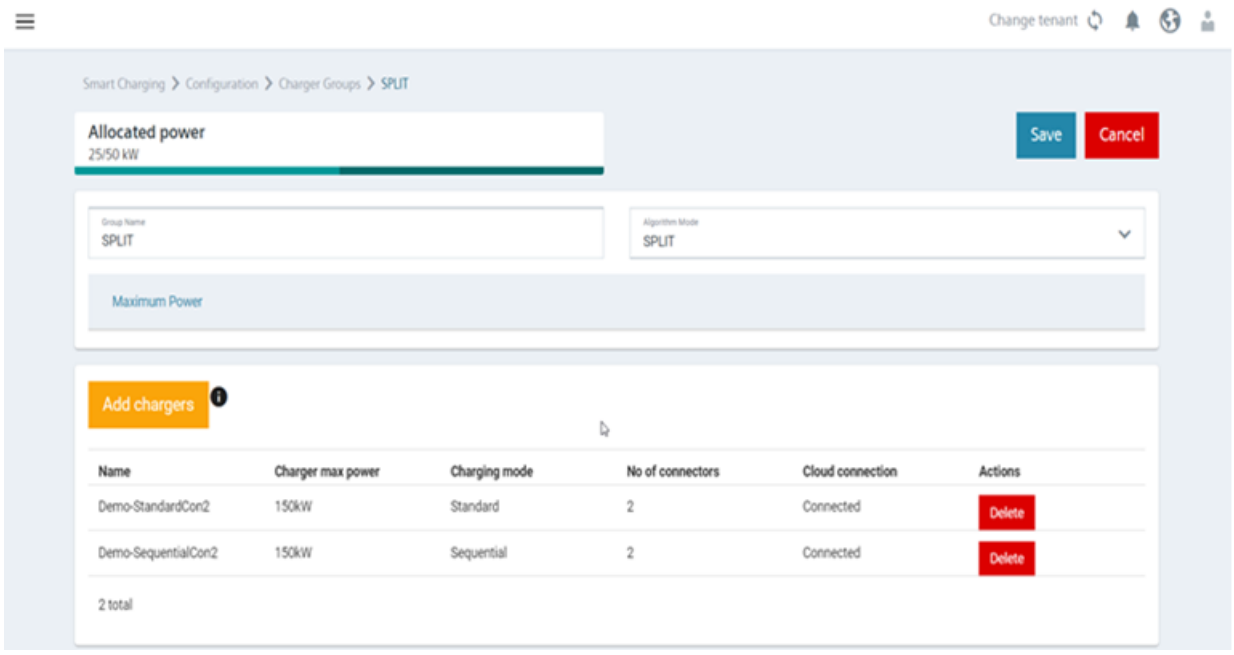


5. Select the chargers to add and click Add.

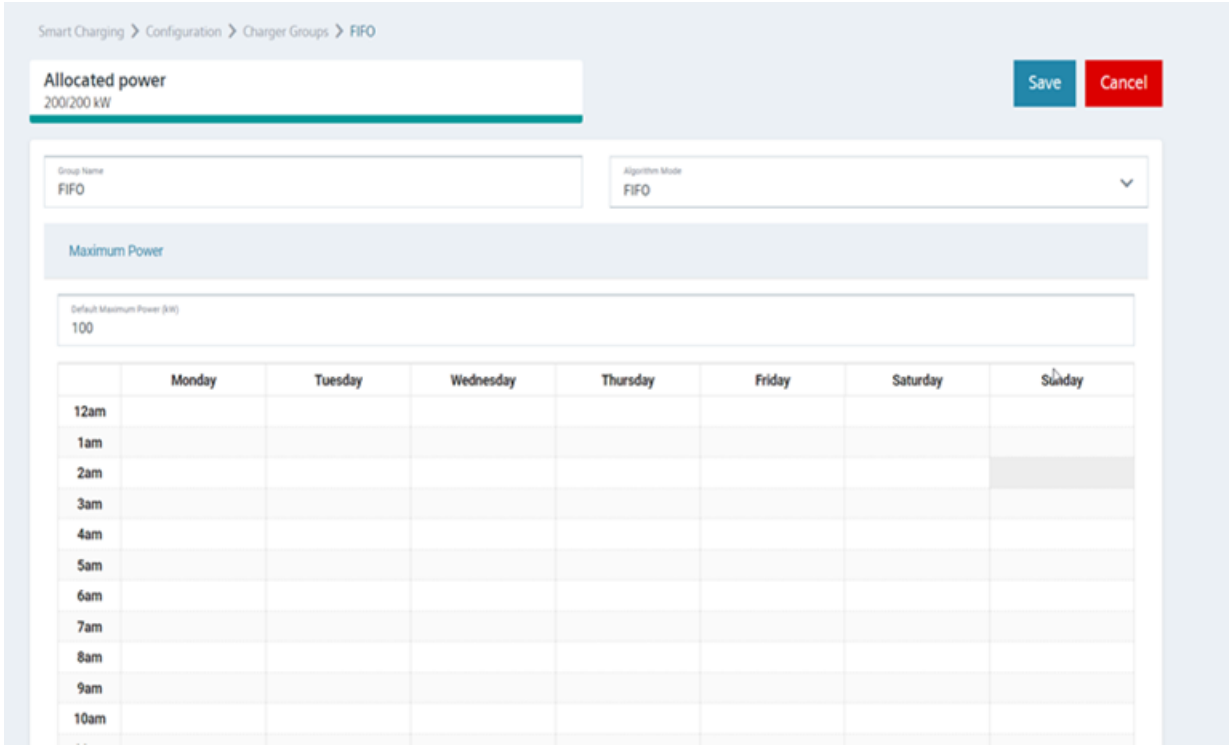
5.6 Add Charger Group Events

Smart charging allows you to specify the maximum power that can be delivered for a charger group. In addition to the default maximum power, EVC[3]Depot allows you to specify a different maximum value for a specific time period. This allows you to manage your charging in for different times of the day and take advantage of different energy pricing at different times of the day.

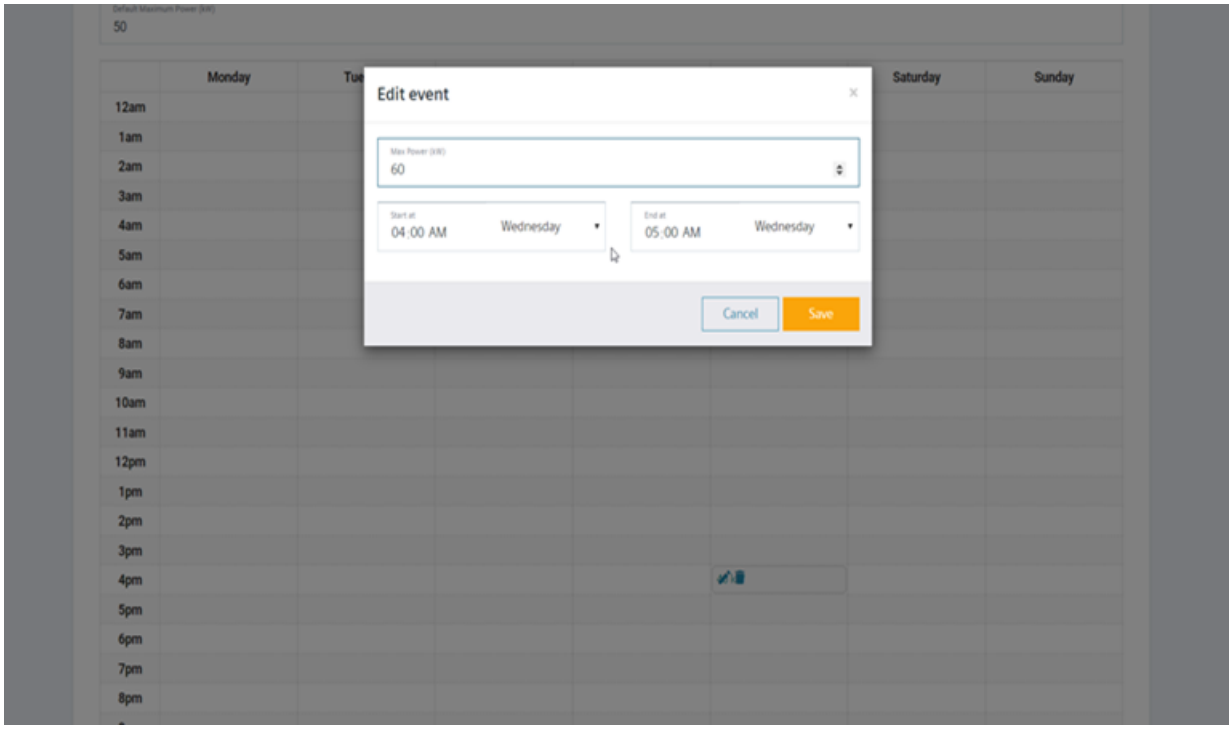
1. Click Smart Charging Config in the left navigation menu.
   The Configuration screen appears
2. Click Smart Charging Configuration to open the Charger Groups screen.
   The Charger Groups screen allows you to add, edit, or delete charger groups.
3. Click Edit on the charger group you want to edit.
   The Charger Group information screen appears.



4. Click Maximum Power on the information screen.
   A grid corresponding to 24 hours and seven days appears.



5. Click the cell which corresponds to the day and time at which you want to specify a maximum power which is different from the default.
   The Edit event popup appears.



6. Enter the maximum power in kW, the start time and day, and the end time and day for the event and click Save. The event time duration can be as short as 15 minutes.
7. Click Save on the Charger Group information screen to apply the changes to the charger group.

Reports

6

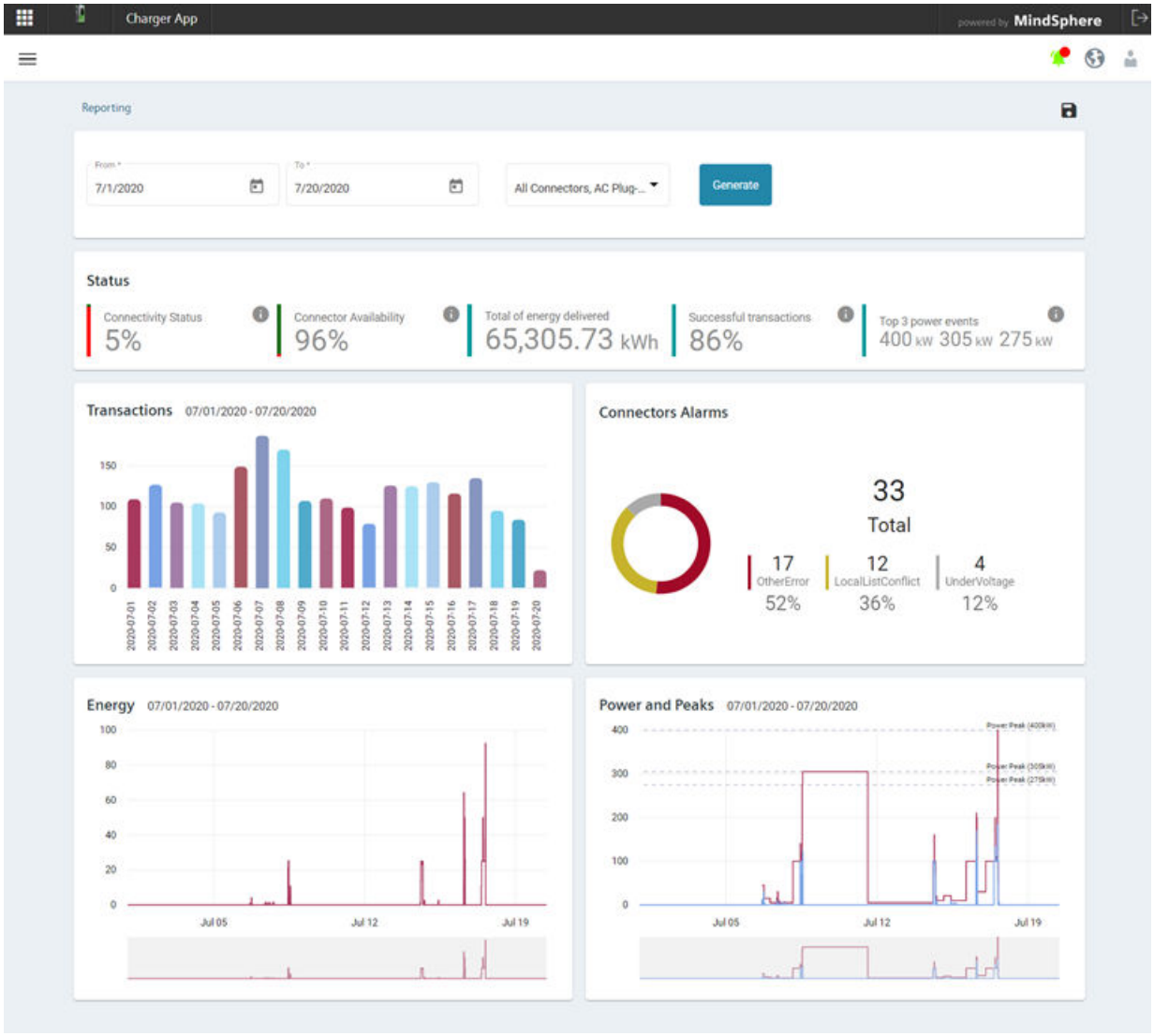
The EVC[3] Depot application allows you to generate reports to view information on the energy consumption, billing, availability status of connectors and chargers, comparison of daily and monthly usage. The following topics provide more information on the transactions and reports.

- Reporting (Page 49)
- Transactions (Page 51)
- Smart Charge Report (Page 53)

6.1 Reporting

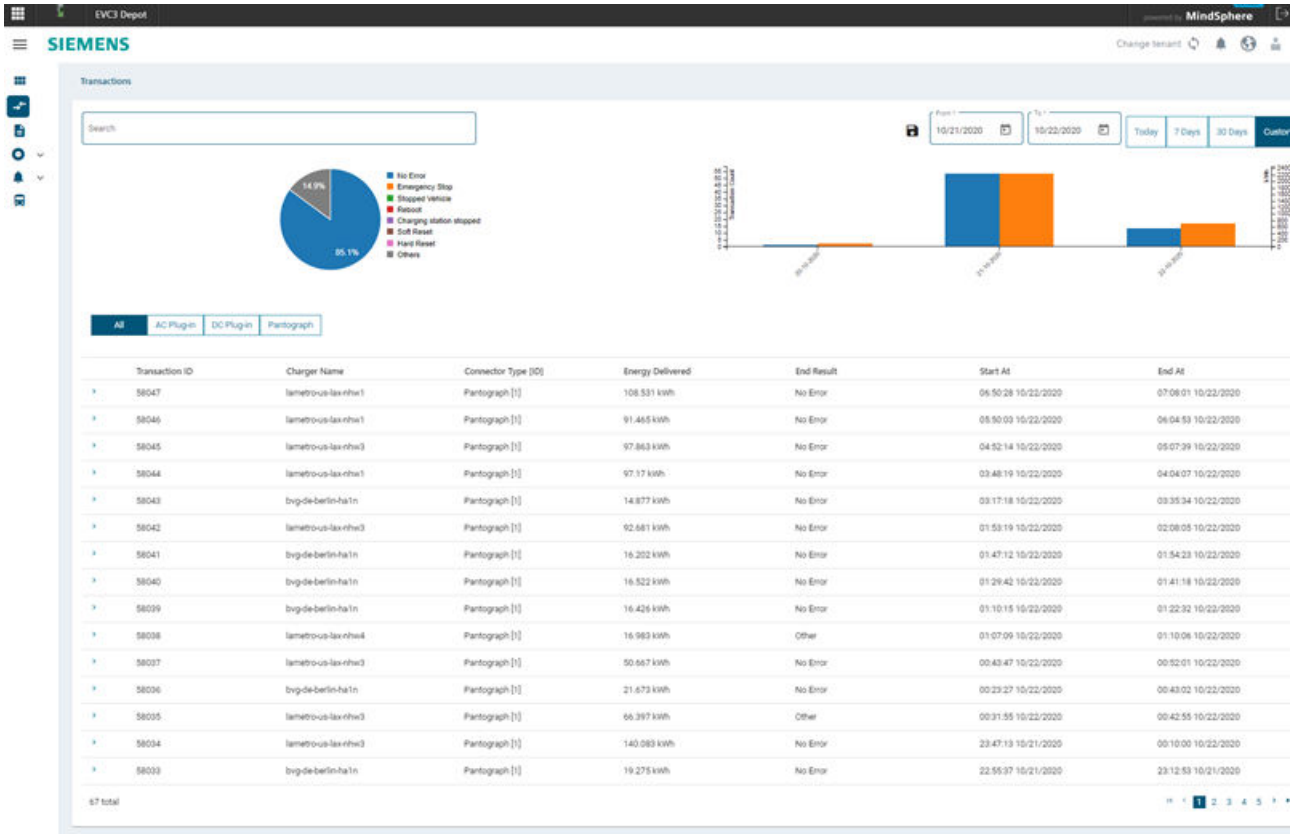
The Reporting screen provides visualization and download capability for depot KPI's such as connectivity status, connector availability, transactions, alarms, energy consumed and so on. The main reporting screen displays a few KPI's as in widgets to provide a quick understanding of the status of depot operation. It also provides information on the top three power events. This information allows you to the highest power consumption (peak power) from which you can determine your power profile. Select Reporting on the left navigation menu to view the Reportings screen. You must specify the time period, the type of report and the types of chargers for which to generate the report. Also, you can download the generated reports in a CSV format by clicking the save icon.

The report provides information on the connectivity status, availability of chargers and connectors, and the transaction made during the specified time period. You can also view the different types of errors, such as caused by chargers, caused by the electric vehicle, or caused by a person in this report.


Charger App
powered by MindSphere
Reporting
From *
7/1/2020
To *
7/20/2020
All Connectors, AC Plug-...
Generate
Status
Connectivity Status
5%
Connector Availability
96%
Total of energy delivered
65,305.73 kWh
Successful transactions
86%
Top 3 power events
400 kW 305 kW 275 kW
Transactions 07/01/2020 - 07/20/2020
150
100
50
0
2020-07-01
2020-07-02
2020-07-03
2020-07-04
2020-07-05
2020-07-06
2020-07-07
2020-07-08
2020-07-09
2020-07-10
2020-07-11
2020-07-12
2020-07-13
2020-07-14
2020-07-15
2020-07-16
2020-07-17
2020-07-18
2020-07-19
2020-07-20
Connectors Alarms
33
Total
17
OtherError
52%
12
LocalListConflict
36%
4
UnderVoltage
12%
Energy 07/01/2020 - 07/20/2020
100
80
60
40
20
0
Jul 05
Jul 12
Jul 19
Power and Peaks 07/01/2020 - 07/20/2020
400
300
200
100
0
Jul 05
Jul 12
Jul 19

6.2 Transactions

The Transaction screen shows all the billing-related information. It also shows some statistics on usage. You can set the period for which to view the transactions and also search for individual transactions. You can view the transactions are also represented in the form of charts. The charts allow you to understand the usage characteristics at a glance. You can select Transactions on the left navigation menu to view this screen. The grid provides information on the connector type, the energy transferred, the end result and the transaction start and end times.

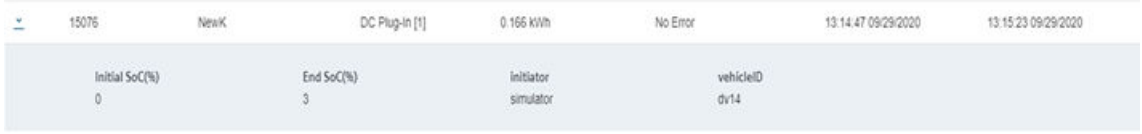


Click on the arrow to view more details about a transaction.

The following figure shows a transaction from the AC Plugin charger.



The following figure shows a transaction from the DC Plugin charger.



For transactions from Pantograph charger, following additional details are available – Initial SoC %, End SoC %, Vehicle ID, Maximum Current, Average Current, Communication Start time, Communication End time, Charge Duration, Docking duration, and Undocking duration.

- **Communication Start time:** The time at which the vehicle connected to the depot Wi-Fi.
- **Communication End time:** The time at which the vehicle disconnected from the depot Wi-Fi.
- **Docking duration:** The time taken for vehicle to connect to Pantograph and start charging. It is calculated as the difference between the transaction start time and the communication start time.
- **Undocking duration:** The time taken for the vehicle to disconnect the vehicle after charging. It is calculated as the difference between the communication end time and the transaction end time.
- **Charge duration:** The time taken for the charging activity. It is calculated as the difference between the transaction end time and the transaction start time.

The following figure shows a transaction from the Pantograph charger.



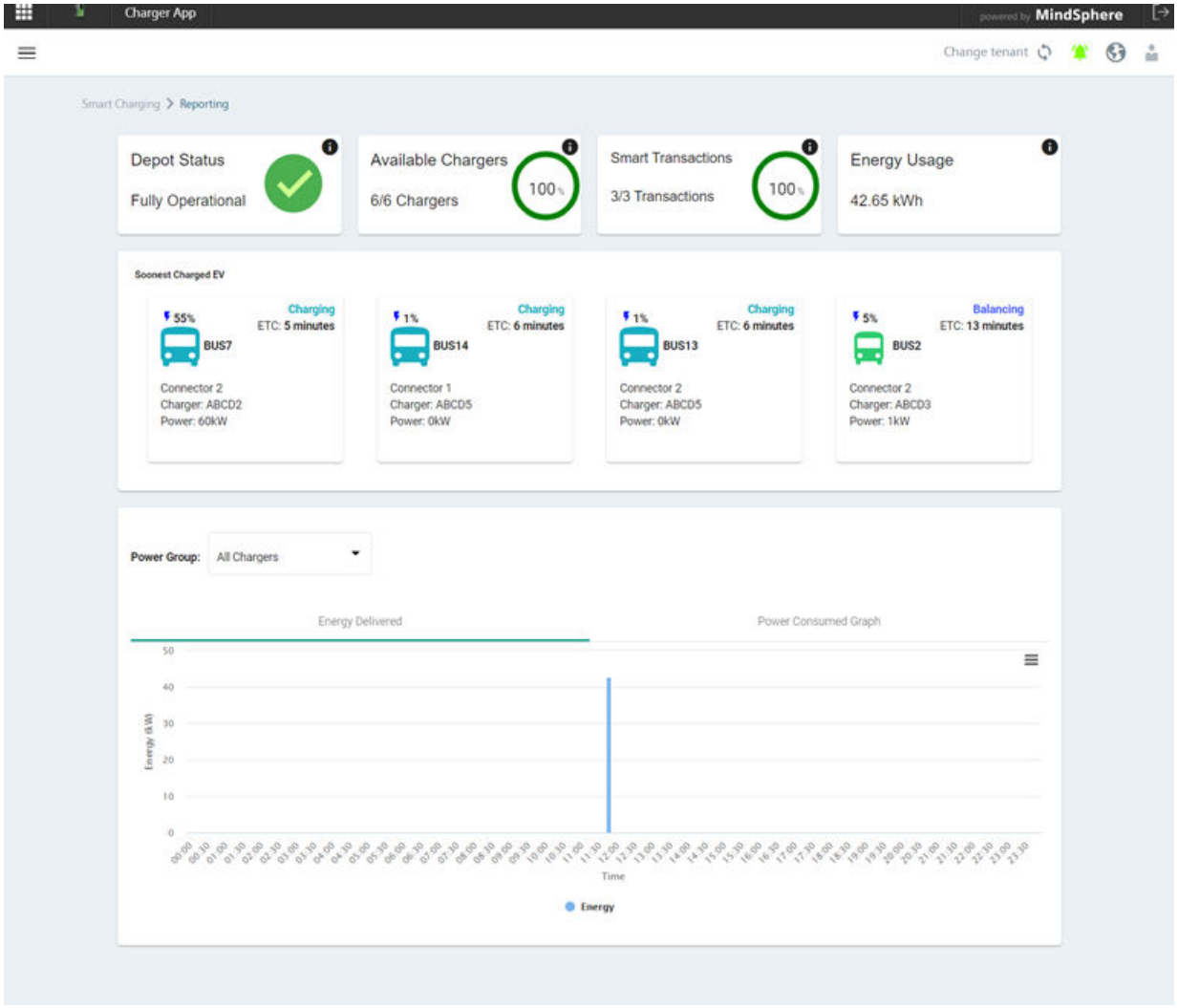
Transactions End Results

The following transaction end results can be seen on the UI.

- **NoError:** The transaction ended with a normal procedure. The vehicle requested to end the transaction (100% SoC), the user clicked on charger HMI to stop, or the user requested at the vehicle side to end transaction
- **EmergencyStop:** Emergency stop on the charging station was hit by the user which resulted at the end of the transaction.
- **VehicleStopped:** The vehicle stopped the transaction due to a non-critical error.
- **ChargingStationStopped:** Transaction ended because of the charging station request. Triggers for this request are user not authorized to charge and non-critical error on the charging station.
- **Reboot:** The transaction ended because of the reboot of the station.
- **Soft reset:** Transaction was stopped due to soft reset of charger
- **Hard reset:** Transaction was stopped due to hard reset of charger
- **Other:** If the backend system (MindSphere Application) can not determine exactly the reason for stop (multiple reasons or very specific vehicle errors) then this is used.

6.3 Smart Charge Report

The Smart Charge Report captures events all relating to smart charging of electric vehicles. It allows you to see the overall status of the depot, available chargers, which chargers are smart charging, smart chargers which will finish charging soon, and power and energy consumption graphs. The graphs also allow you to print or download the information in multiple formats.



6.3.1 Depot Status

This widget shows the overall status of all the chargers in the depot. The following depot statuses are shown.

- **Fully Operational:** When 100% of the assets in the depot are working and connected to the cloud.
- **Warning:** When 35% to 99% of the assets have faulted or not connected to the cloud.
- **Error:** When less than 35% of the assets in the depot are connected to the cloud.

6.3.2 Available Chargers

The report shows the chargers that are connected to the cloud and available for charging. This includes the chargers that have been created on the system but do not have an active connection.

6.3.3 Smart Transactions

The report shows how many of the charging transactions have been completed using smart charging in the time period set as the depot operating time. The total number of charging transactions done in the depot is also shown.

6.3.4 Energy Usage

The report shows the energy used in the time period set as the depot operating time.

6.3.5 Soonest Charged EV

This widget shows the EVs that are part of a smart charger group that are currently being charged and are expected to finish charging soon. The following information is also shown on the widget.

- **Status of Charge:** Charging or Balancing
- **ETC:** Expected time for completion of the charging
- **Current charge:** The current charge of the electric vehicle (in percentage)
- Electric vehicle name
- Charger name
- Connector ID
- Power

6.3.6 Energy Delivered Graph

This widget shows the energy delivered in a depot configured operation time period. By default, it shows the energy delivered for all chargers in the depot. You, can select your configured charger groups from the drop down to see the energy delivered for each charger group.

6.3.7 Power Consumed Graph

This widget shows the power delivered in a depot configured operation time period.

Frequently Asked Questions (FAQs)

7

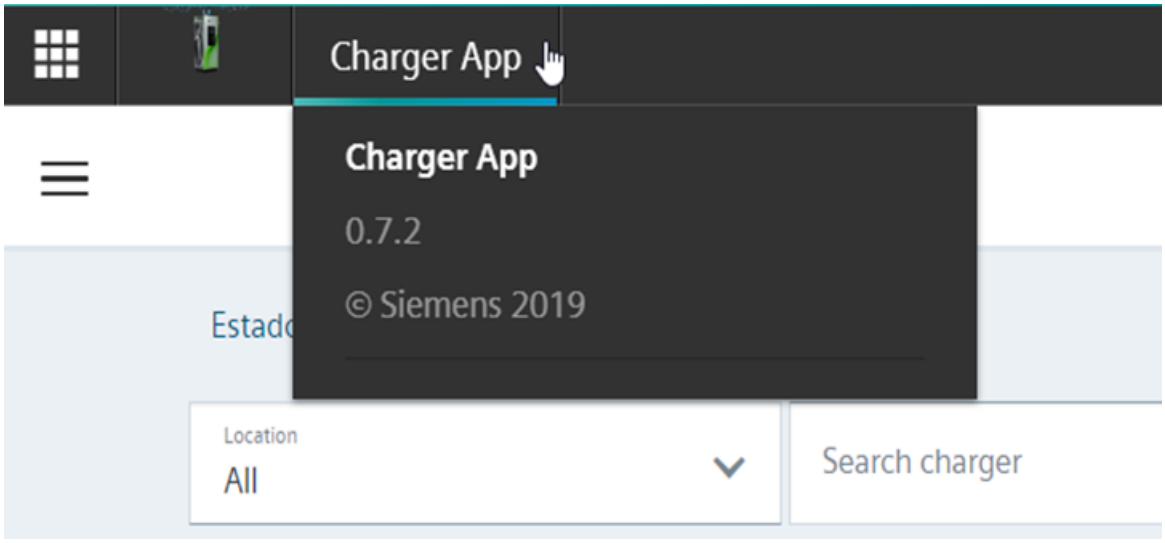
7.1 How do I Change the Language of the EVC3 Depot Application?

On the top banner, click the globe icon. This opens the language menu. Select the required language from the menu.



7.2 How do I Check the Version of the EVC3 Depot Application?

On the MindSphere banner, click the ChargerApp to view the version of the EVC³ Depot.



Error Codes

A

Error codes can be seen on the Error Notifications screen. An error has the following information tags.

- **Error Code:** This is split into Charger Errors codes and Connector error codes. OCPP only supports a few standard error codes but uses the "Other" classification for vendor-specific codes
- **Vendor-specific Code:** This is usually denoted by a digit.

The error codes and vendor-specific codes vary based on the platform and hardware used.

A.1 Error Codes

A.1.1 DC Plug-in Charger Error Codes

- **GroundFailure:** Ground fault circuit interrupter has been activated.
- **HighTemperature:** Temperature inside charge is too high.
- **InternalError:** Error in internal hard- or software component.
- **NoError:** No error to report.
- **OtherError:** Not defined error. Check VendorAlarm and ExtendedAlarmDescription
- **OverCurrentFailure:** Over current protection device has tripped.
- **OverVoltage:** Voltage has risen above an acceptable level.
- **PowerMeterFailure:** Failure to read electrical/energy/power meter.
- **PowerSwitchFailure:** Failure to control the power switch.
- **ResetFailure:** Unable to perform a reset.
- **UnderVoltage:** Voltage has dropped below an acceptable level.
- **WeakSignal:** Wireless communication device reports a weak signal.

A.1.2 AC Plug-in Charger Error Codes

- **ConnectorLockFailure:** Failure to lock or unlock connector.
- **EVCommunicationError:** Communication failure with the vehicle might be Mode 3 or other communication protocol problem. This is not a real error in the sense that the Charge Point does not need to go to the faulted state. Instead, it should go to the SuspendedEVSE state.
- **GroundFailure:** Ground fault circuit interrupter has been activated.

- **HighTemperature:** Temperature inside Charge Point is too high.
- **InternalError:** Error in internal hard or software component.
- **LocalListConflict:** The authorization information received from the Central System is in conflict with the LocalAuthorizationList.
- **NoError:** No error to report.
- **OtherError:** Other type of error.
- **OverCurrentFailure:** Over current protection device has tripped.
- **OverVoltage:** Voltage has risen above an acceptable level.
- **PowerMeterFailure:** Failure to read electrical/energy/power meter.
- **PowerSwitchFailure:** Failure to control power switch**.**
- **ReaderFailure:** Failure with idTag reader.
- **ResetFailure:** Unable to perform a reset.
- **UnderVoltage:** Voltage has dropped below an acceptable level.
- **WeakSignal:** Wireless communication device reports a weak signal.

A.1.3 Pantograph Charger Error Codes

- **EVCommunicationError:** Communication failure with the vehicle, might be Mode 3 or other communication protocol problem. This is not a real error in the sense that the Charge Point doesn't need to go to the faulted state. Instead, it should go to the SuspendedEVSE state.
- **GroundFailure:** Ground fault circuit interrupter has been activated.
- **HighTemperature:** Temperature inside Charge Point is too high.
- **InternalError:** Error in internal hard or software component.
- **NoError:** No error to report.
- **OtherError:** Other type of error. See Siemens HPC Pantograph Connector Error Codes for more information.
- **WeakSignalWifi**: Wifi connection between the electric vehicle and charge point is weak.
- **WeakSignalGsm:** GSM connection of the charge point is weak
- **OverCurrentFailure:** Over current protection device has tripped.
- **OverVoltage:** Voltage has risen above an acceptable level.
- **PowerMeterFailure:** Failure to read power meter.
- **PowerSwitchFailure:** Failure to control power switch. Inverter DC Breaker Error. This is a fatal error, that causes charge process termination and requires service.
- **ReaderFailure:** Failure with idTag reader. Might signal an association sensor error in the future
- **ResetFailure:** Unable to perform a reset.

- **UnderVoltage:** Voltage has dropped below an acceptable level.
- **WeakSignal:** Wireless communication device reports a weak signal.

A.1.4 Charger Connector Error Codes

- **ConnectorLockFailure:** Failure to lock or unlock the connector.
- **EVCommunicationError:** Communication failure with the vehicle.
- **GroundFailure:** Ground fault circuit interrupter has been activated.
- **HighTemperature:** Temperature of Plug is too high.
- **InternalError:** Error in internal hard- or software component.
- **NoError:** No error to report.
- **OtherError:** Not defined error. Check VendorAlarm and ExtendedAlarmDescription
- **OverCurrentFailure:** Over current protection device has tripped.
- **OverVoltage:** Voltage has risen above an acceptable level.
- **PowerMeterFailure:** Failure to read electrical/energy/power meter.
- **PowerSwitchFailure:** Failure to control the power switch.
- **ResetFailure:** Unable to perform a reset.
- **UnderVoltage:** Voltage has dropped below an acceptable level.

A.2 Vendor-specific Code

The following topics describe the vendor codes.

- RAVE Plug-In Charger Error Codes (Page 59)
- SICHARGE UC Plug-In Charger Error Codes (Page 61)
- Siemens HPC Pantograph Connector Error Codes (Page 64)
- VersiCharge SG Connector Fault Error Codes (Page 65)

A.2.1 RAVE Plug-In Charger Error Codes

The following error codes are published for Siemens RAVE Plug-in Heavy Duty charging stations.

Vendor Code	Description	Recommended Action
1	Emergency button pressed	Un-press the emergency button and reconnect.
2	Cabinet Power open	Confirm that door is closed properly.
3	Output Fuse blown	Check if the output fuse (FO1, FO2) is blown.
4	Filter fuse blown	Check if the filter fuse is blown.

5	Isolation values between DC and Ground are below recommended values.	Check whether the plug is damp or wet. Check whether the vehicle also has an isolation fault when in Drive Mode. If neither of these contacts qualified personnel.
6	Surge Arrester on	Check if the surge arrester is red. If yes then replace. The surge arrester is can be found to the left of the main switch.
7	Power reduction active	Charing will continue. The transformer temperature is too high and therefore the power reduction is active.
8	AC input voltage is too high	Guarantee that AC input values are according to specification on the product manual.
9	DC output voltage is too high	Reconnect. If failure remains, contact assistance.
10	DC output current is too high	Reconnect. If failure remains, contact assistance
11	High temperature	Check if the cooling air filter needs to be changed. Check whether the cooling is active during charging.
12	Low input voltage	Guarantee that AC input values are according to specification on the product manual.
13	Low temperature	Measure ambient temperature. The charging station is designed for -25C, if the ambient temperature is less than this warning is normal. If not then contact qualified personnel.
14	CAN Comms lost	Check whether the CCS communications equipment is active.
15	No Preload target value	This message only comes when no target value for Preload is available. Check whether the CCS communication equipment of the vehicle is active.
16	Battery Temperature	Check the battery status.
17	Vehicle moved	Check the vehicle has not moved during charging.
18	Plug faulty	Check the status of the CCS socket on the vehicle.
19	Battery fault	Check battery status.
20	Current deviation	The charging station cant obeys the current target value set by the Vehicle. Contact qualifies personnel.
21	Voltage out of range	The charging station cant obeys the voltage target value set by the vehicle. Contact qualified personnel.
22	System incompatibility	The communication protocol of the vehicle is not compatible with the charging station protocol.
23	Charging finished	No action required.
24	Session adjustment timeout	Restart charging procedure. If the problem persists contact qualifies personnel
25	Main protection timeout	Set a charger in manual mode and click the mains protection switch. If the main protection switch does not close the relay RL1 must be manually triggered. If the main protection still does not close then please contact qualified personnel.
27	Discharge circuit protection time out	Check the status of the Discharge circuit protection.
28	High DC+ temperature	Plug temperature in DC+ contactor is over 90C. Contact qualified personnel.

29	High DC- temperature	Plug temperature in DC- contactor is over 90C. Contact qualified personnel.
30	Auxiliary switch fault	Check whether the axillary switch has been triggered.
31	Rectifier fuse is blown	Check whether the rectifier fuse has blown.

A.2.2 SICHARGE UC Plug-In Charger Error Codes

The following error codes are published for Siemens charging stations.

Code	Alarm	Alarm Mapping	Details	Suggested Actions
0	NO_ERROR			
1	EMERGENCY	Other Error	Emergency button pressed	Un-press the emergency button and reconnect.
2	DOOR	Other Error	Cabinet door open	Confirm that door is closed properly.
3	ISOLATION_FAULT	Ground Failure	Isolation values between DC and Ground are below recommended values	Guarantee if the fault is coming from the vehicle or the charger. Reconnect
4	TEMPERATURE_OUT_OF_RANGE	Internal Error	Internal temperature is outside of the permitted range	Wait for the temperature to go back to the permissible range.
5	DC_PLUS_TEMPERATURE	High Temperature	The temperature at DC + contact of the plug is too high	Overheating can be caused by bad contact or degradation/damages to the plug.
6	DC_MINUS_TEMPERATURE	High Temperature	The temperature at DC - contact of the plug is too high	Overheating can be caused by bad contact or degradation/damages to the plug.
7	INPUT_VOLTAGE_OUT_OF_RANGE	Internal Error	AC input voltage is outside the permissible range	Guarantee that AC input values are according to specification on the product manual
8	INPUT_CURRENT_OUT_OF_RANGE	Internal Error	AC input current is outside the permissible range	Guarantee that AC input values are according to specification on the product manual.
9	HIGH_OUTPUT_VOLTAGE	Over Voltage	DC output voltage is too high	Reconnect. If failure remains, contact assistance.
10	HIGH_OUTPUT_CURRENT	Over Current Failure	DC output current is too high	Reconnect. If failure remains, contact assistance.
11	CAN_COMMUNICATION_LOST(AURONIK)	EV Communication Error	Internal communication error	Reconnect. If failure remains, contact assistance.

12	CAN_COMMUNICATION_LOST(GI)	Internal Error	Internal communication error	Reconnect. If failure remains, contact assistance.
13	AC_CONTACTOR_TIMEOUT	Power Switch Failure	AC contactor is not closing/ opening	Check AC contactors for damages or possible welding.
14	DC_CONTACTOR_TIMEOUT	Power Switch Failure	DC contactor is not closing/ opening	Check DC contactors for damages or possible welding.
15	CP_STATE_FAULT	EV Communication Error	Control pilot state is not according to IEC61851	Check plug integrity. Reconnect. If failure remains, contact assistance.
16	FREQUENCY_OUT_OF_RANGE	Internal Error	AC input frequency is outside the permissible range	Guarantee that AC input values are according to specification on the product manual.
18	RESS_TEMPERATURE_INHIBIT	Other Error		Vehicle generated error
19	EV_SHIFT_POSITION	Other Error		Vehicle generated error
20	CHARGER_CONNECTOR_LOCK_FAULT	Connector Lock Failure		Vehicle generated error
21	EVRESS_MALFUNCTION	Other Error		Vehicle generated error
22	CHARGING_CURRENT_DIFF	Other Error		Vehicle generated error
23	CHARGING_VOLTAGE_OUT_OF_RANGE	Other Error		Vehicle generated error
24	CHARGING_SYSTEM_INCOMPATIBILITY	Other Error		Vehicle generated error
25	DC_LINK_UNDER_BALANCE	Internal Error	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
26	DC_LINK_OVER_VOLTAGE	Over Voltage	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
27	DC_LINK_UNDER_VOLTAGE	Under Voltage	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
28	FREQUENCY_DEVIATION	Internal Error	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
29	INVERTER_IGBT_DESATURATION	Internal Error	Internal Power Converter error	Reconnect. If failure remains, contact assistance
30	INPUT_MAINS_HIGH	Over Voltage	Internal Power Converter error	Reconnect. If failure remains, contact assistance.

31	INPUT_MAINS_LOW	Under Voltage	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
32	INPUT_MAINS_CURRENT	Over Current Failure	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
33	RECTIFIER_IGBT_DESATURATION	Internal Error	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
34	START_TIMEOUT	Power Switch Failure	Internal Power Converter error	Reconnect. If failure remains, contact assistance
35	SHUTDOWN_RETIFIER	Internal Error	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
36	OUTPUT_SHORT_CIRCUIT	Other Error	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
37	OUTPUT_OVERLOAD	Power Converter	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
38	OUTPUT_OVER_VOLTAGE	Over Voltage	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
39	OUTPUT_UNDER_VOLTAGE	Under Voltage	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
40	CAN_COMMUNICATION_TIMEOUT	Internal Error	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
41	INPUT_CONTACTOR_OFF	Power Switch Failure	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
42	DC_BUS_PRECHARGE_TIMEOUT	Internal Error	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
43	OVER_TEMPERATURE	High Temperature	Internal Power Converter error	Reconnect. If failure remains, contact assistance.
44	FRONTEND_DOOR	Other Error	Front End door is open	Confirm that door is closed properly.
45	OUTPUT_FUSE_PLUS_BLOWN	Power Switch Failure	Front End fuse is blown	Replace fuse
46	OUTPUT_FUSE_MINUS_BLOWN	Power Switch Failure	Front End fuse is blown	Replace fuse
47	OUTPUT_CONTACTOR_PLUS_TIMEOUT	Power Switch Failure	Contactor is not closing/opening	Check contactors for damages or possible welding.

48	OUTPUT_CONTACTOR_MINUS_TIMEOUT	Power Switch Failure	Contactor is not closing/opening	Check contactors for damages or possible welding.
49	MODBUS_COMMUNICATION_LOST(CLIENT)	Internal Error	Communication between Charger and Front End lost	Check connection
50	MODBUS_COMMUNICATION_LOST(SERVER)	Internal Error	Communication between Charger and Front End lost	Check connection
51	AC_CONTACTOR_ERROR	Power Switch Failure	Contactor changed state unexpectedly	Check contactors for damages or possible welding.
52	DC_CONTACTOR_ERROR	Power Switch Failure	Contactor changed state unexpectedly	Check contactors for damages or possible welding.
53	RESERVED	Other Error	Error reserved for local emergency button (project specific)	Un-press the emergency button and reconnect.
54	FRONTEND_TEMPERATURE	Internal Error	Internal Front End temperature is outside of permitted range	Wait for the temperature to go back to the permissible range.
55	IOTDISCONNECTED	Internal Error		
56	OCPPDISABLED	Other Error		
57	SESSIONSETUPFAILURE	EV Communication Error		

A.2.3 Siemens HPC Pantograph Connector Error Codes

The following error codes are published for Siemens HPC Pantograph Connector.

Vendor Code	**Alarm mapping**	**Description**
IOSystem	Internal Error	The IO system is not operational or causes the system not to be operational.
ChargerStopStation	Other Error	The Charge Stop button has been pressed.
SafetyRelay	Power Switch Failure	The Power Switch is not operational or causes the system not to be operational.
IsolationMonitor	Ground Failure	The Isolation Monitor is not operational or causes the system not to be operational.
DCBreaker	Internal Error	The DC Breaker is not operational or causes the system not to be operational.
Pantograpth	Internal Error	The Pantograph is not operational or causes the system not to be operational.
ControlPilot	EV Communication Error	The Control Pilot is not operational or causes the system not to be operational.
TrafoTemperature	High Temperature	The Trafo Temperature is not operational or causes the system not to be operational.
KeyswitchMaintenance	Other Error	Indicates that the keyswitch in the charge station is in position "maintenance".

KeyswitchPantoma-nual	Other Error	Indicates whether the keyswitch in the charge station is in position "panto manual down".
SmokeAlarm	Internal Error	The Smoke Alarm is not operational or causes the system not to be operational.
HPCCTemperature-Fault	High temperature	Indicates that the HPCC (Converter) has a temperature fault.
ChargeStopPole	Other Error	Indicates whether the charge stop button at the pole is pressed.
ElectricalFault	Internal Error	Indicates whether one of the fuses indicates an electric fault. Contact qualified personnel.
StationTemperature	High Temperature	Indicates whether the temperature inside the station is too high.
UPSPowerFailure	Internal Error	Indicates whether the UPS module has a power failure.

A.2.4 VersiCharge SG Connector Fault Error Codes

The following fault error codes are published for Siemens VersiCharge SG Connector.

Fault Type	Equivalent OCPP Error code
FAULT_TYPE.ANY_LINE_PHASE_UNDER_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LINE_PHASE_A_UNDER_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LINE_PHASE_B_UNDER_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LINE_PHASE_C_UNDER_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LINE_ANY_PHASE_OVER_V	ChargePointErrorCode.OverVoltage
FAULT_TYPE.LINE_PHASE_A_OVER_V	ChargePointErrorCode.OverVoltage
FAULT_TYPE.LINE_PHASE_B_OVER_V	ChargePointErrorCode.OverVoltage
FAULT_TYPE.LINE_PHASE_C_OVER_V	ChargePointErrorCode.OverVoltage
FAULT_TYPE.LINE_ANY_PHASE_ZERO_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LINE_PHASE_A_ZERO_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LINE_PHASE_B_ZERO_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LINE_PHASE_C_ZERO_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.ANY_LOAD_PHASE_UNDER_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LOAD_PHASE_A_UNDER_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LOAD_PHASE_B_UNDER_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LOAD_PHASE_C_UNDER_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LOAD_ANY_PHASE_OVER_V	ChargePointErrorCode.OverVoltage
FAULT_TYPE.LOAD_PHASE_A_OVER_V	ChargePointErrorCode.OverVoltage
FAULT_TYPE.LOAD_PHASE_B_OVER_V	ChargePointErrorCode.OverVoltage
FAULT_TYPE.LOAD_PHASE_C_OVER_V	ChargePointErrorCode.OverVoltage
FAULT_TYPE.LOAD_ANY_PHASE_ZERO_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LOAD_PHASE_A_ZERO_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LOAD_PHASE_B_ZERO_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.LOAD_PHASE_C_ZERO_V	ChargePointErrorCode.UnderVoltage
FAULT_TYPE.BAD_PILOT_VOLTAGE	ChargePointErrorCode.OtherError
FAULT_TYPE.BAD_AMP_SWITCH_POSITION	ChargePointErrorCode.OtherError
FAULT_TYPE.ADC_FAULT	ChargePointErrorCode.OtherError
FAULT_TYPE.STATIC_MEMORY_FAULT	ChargePointErrorCode.OtherError

Fault Type	Equivalent OCPP Error code
FAULT_TYPE.CCID_FAULT	ChargePointErrorCode.GroundFailure
FAULT_TYPE.CCID_SELFTEST_FAULT	ChargePointErrorCode.GroundFailure
FAULT_TYPE.CONTACTOR_OPEN_FAULT	ChargePointErrorCode.PowerSwitchFailure
FAULT_TYPE.OVER_TEMPERATURE	ChargePointErrorCode.HighTemperature
FAULT_TYPE.J1772_COMM_FAULT	ChargePointErrorCode.OtherError
FAULT_TYPE.SGD_COMM_FAULT	ChargePointErrorCode.OtherError

Glossary

Available

The charger or connector is available to charge.

Offline

The charger or connector is not connected to the cloud.

Online

The charger or connector is connected to the cloud.

SoC

State of charge

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Security and Privacy in EVC³ Depot

Version 2.0.0

Enabling customers to confidently operate in a secure cloud environment.

Executive Summary

As a world-leader in automation and connected devices, Siemens understands the importance of in-depth, proactive cybersecurity policies. Therefore, Siemens EVC³ Depot Software-as-a-Service (SaaS) operates over the Siemens MindSphere platform, which is designed for secure Industrial Internet of Things (IIoT) applications. Security is a practice of continuous improvement and EVC³ Depot has commenced the practice on sound footing.

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4 Privacy of Customer Data

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6 Frequently Asked Questions (FAQs)

6 Summary

7 Terms and Abbreviations

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Abstract

Electrification is an industrial megatrend that is in its nascent stages. The megatrend holds great promise for reducing noise and air pollution while improving customer comfort and operator profitability. EVC³ Depot aims to be at the forefront of fulfilling the promise by providing a secure, robust and standards-compliant cloud software for monitoring and controlling geographically distributed charging stations located in electric-bus depots. Siemens realizes that data and computing security are a lynchpin for the success of its EVC³ Depot software. This document describes the security measures that protect customers' interests and information in the EVC³ Depot software.



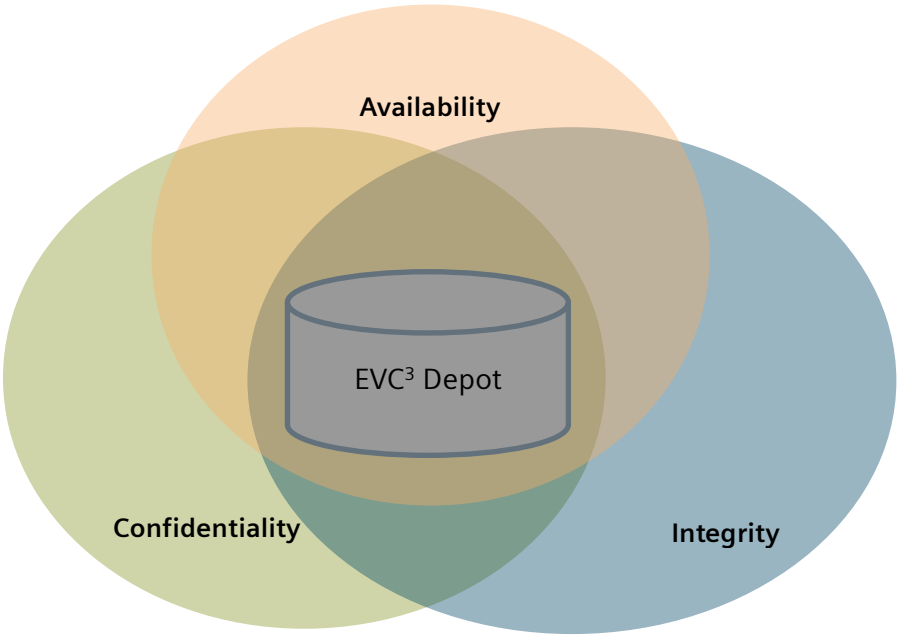
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Governance, Principles, and Guidelines

We aim to protect the confidentiality, integrity, and availability of the operational data of electrified bus depots. We understand that our customers' success and competitive advantage is decided by their operational data, which includes charging strategies & plans, charging station usage patterns, bus itinerary, and resource allocation information. Therefore, confidentiality, integrity, and availability of customer operational data needs to be protected.

The availability of the operational data ensures that all charge points at the customer premises are fully monitored and utilized on demand. Confidentiality of the data ensures that the customers' intellectual property is available only to the customer – customers' intellectual property may be their strategies and plans for charging and operating their buses. Integrity ensures that the customer can fully depend on the veracity of their data, which are collected and reported by EVC³ Depot.

Security is an on-going process of improvement. The value of information security is proportional to the value of the operational data. Siemens's information security principles are well tempered and evolved. Siemens EVC³ Depot software inherits the same Siemens principles. Data is the oil in the new megatrend of electrification and data security literally protects wealth.
Thus, Siemens EVC³ Depot software accurately implements the Siemens Information Security guidelines so that the value of the Siemens brand can be fully utilized by our customers.
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Privacy of Customer Data

Siemens takes its responsibility for protecting and using customer information very seriously. The strict access control mechanisms implemented in the service ensures that customers can only view data belonging to their organization.

Also, the only customer data that is collected by the EVC³ Depot service is the official email addresses of designated employees in customer organizations. The collected email addresses are only used to send information about charging operations in that employee's organization. The email address is not shared with any other business of Siemens nor is it used to send any marketing information

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Secure Cloud Environment

The information security measures adopted by EVC³ Depot to protect customer data are listed in this section. The information is intended to help our customers be fully informed about the safety and security of their data in Siemens' custody.



Identity & Access Management

To control end-user access, EVC³ Depot reuses the MindSphere IAM. MindSphere IAM is an aggregation of state-of-the-art, rule-based and role-based rights models. To control access to the depot IT systems, Siemens ID and industry standard OAuth protocol are used for IAM.

Every charge point has a unique identity and an associated secret credential, which is known only to Siemens engineers. EVC³ Depot securely authenticates the charge point and its associated tenant depot before interacting with the device.

The EVC³ Depot MindSphere IAM conforms to the recommendations from the National Institute for Standards and Technology (NIST). Consistent authentication and unambiguous access control mechanisms protect sensitive customer operational data and prevent unauthorized disclosure. EVC³ Depot customizes the fine-grained access control model of MindSphere IAM to suit the needs of electrified Bus Depot operations.

Secure Communications

The TLS v1.2 secure communication protocol protects all communications between devices (charge points and employees' computers) in the customers' premises and the cloud service. The protocol is configured to use perfect forward secrecy and globally valid X.509 certificates. The charge points are bootstrapped to the EVC³ Depot software on the cloud by trained Siemens field engineers. This mechanism and operation ensure secure communication between Siemens EVC³ Depot and the geographically distributed charging points.

Secure Cloud Storage

All customer operational data are stored in encrypted databases provisioned by Siemens MindSphere platform. AES256, which provides industry-grade, future-proof encryption, is used to encrypt the databases. This ensures that only EVC³ Depot software can access sensitive customer data.

Secure Software Development Process

Systematic Threat and Risk Analysis (TRA) is performed at the beginning of each release cycle to prevent design flaws that may result in security issues. Automated Static Application Security Testing (SAST) is integrated into the continuous development process of the software development lifecycle. This prevents the introduction of any security vulnerability in the software system. Additionally, penetration testing is performed by an independent security team. The findings of the penetration testing activity are used by the development team to improve the security of the software system.

Secure Backup

Data is backed up securely daily and the backed-up data is available for 30 days for restoration.

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Frequently Asked Questions (FAQs)

- **Is education/training given to provide staff with an awareness of information security?**
  Yes, all Siemens employees undergo periodic information security awareness training.

- **How is the privacy of customer data protected?**
  The privacy contract for the service is available in the EVC³ Depot - Fact Sheet document. Only the official email address of designated employees in customer organization is collected and stored by the service. The email addresses are used only to communicate customer organization specific charging information. The customer organization can modify the email address of the designated employee.

- **How is the customer information protected by the service?**
  Operational information which belongs to a customer organization in accessible only to authenticated and authorized employees in the customer organization. All information collected from the customer premises and shared with the customer organization is protected using the industry standard TLS 2.0 protocol. Customer operational information is stored in encrypted databases in the cloud.

- **Are all communications between the customers' devices and cloud service encrypted?**
  Yes, all communications with the cloud service are protected using TLS v1.2 protocol with globally valid public key certificate for the service.

- **Is customer data stored in the cloud encrypted?**
  Yes, all customer data, including backed-up data, stored in the cloud is encrypted.

Summary

The EVC³ Depot service provides robust mechanisms for Identity & Access Management (IAM), Secure Communications, Secure Cloud Storage, and Secure Backup to ensure Confidentiality, Integrity, and Availability to secure and safeguard customers operational data. Siemens fully understands that security is an ongoing process of improvement and has put in place organizational structures to ensure that security evolves with the subsequent versions of the service.

The EVC³ Depot Service ensures the privacy of customer data in two ways.

- The service enforces strict access control such that a customer's employee can only access information belong to that customer's organization.
- The service only collects the official email address belong to the customer's organization. This email address is only used to send relevant charging operation information.

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Terms and Abbreviations

IAM	Identity and access management (IAM) is a central console to control access to assets as a unique solution
IIoT	Industrial Internet of Things
SaaS	Software-as-a-Service
EVC³	Electric Vehicle Connect Charge & Control
MindSphere	Cloud-based open operating system from Siemens

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Smart Charging with Depot Connect

Version 1.0

Executive Summary

The Depot Connect package delivers the ability to control chargers and to conduct Smart Charging. The basic charging algorithms provided as part of Depot Connect are an easy way to organize charging of electric vehicles based on simple prioritization rules. These control algorithms can be configured for either “load shaving” or “load shifting” use cases.

Contents

3 Abstract

4 FIFO (= First In First Out)

4 FIFO with Sequential Charging

5 FILO

5 FILO with Cell Balancing

6 FILO with Sequential Charging

6 SPLIT

Abstract

The basic charging algorithms are an easy way to organize charging of electric vehicles based on simple prioritization rules. Additionally, the algorithms assure that a given maximum power (e.g. maximum grid connection power) is never exceeded. The algorithms are invoked live and dynamically distribute the available power to connected buses. Each time a bus that requires charging is connected or a connected bus is finished charging the algorithms redistribute the allocated power set points for each charger / connector in order to provide optimal usage of the available power bandwidth.

There are four algorithms that serve slightly different requirements and objectives.

FIFO (= First In First Out)

FIFO is a basic strategy that organises charging of buses with the strategy to first fully charge the buses that entered the depot first. The motivation behind this strategy often is the depot layout being a one-way lane so it is a requirement that the first bus coming into the depot is also the first one leaving the depot. FIFO strategy is a "live" strategy that sets the power set point of each charger depending on

- Is the charger connected to a bus that is not yet finished charging?
- When was the charger connected to the bus?
- What is the available maximum power for the charger / charging group / depot?

The algorithm sets the power set point of all active connectors to the maximum power however constraint by charger maximum power and maximum available power. It prioritizes the buses that were connected first. This can be seen in the detailed workflow in the following figure.

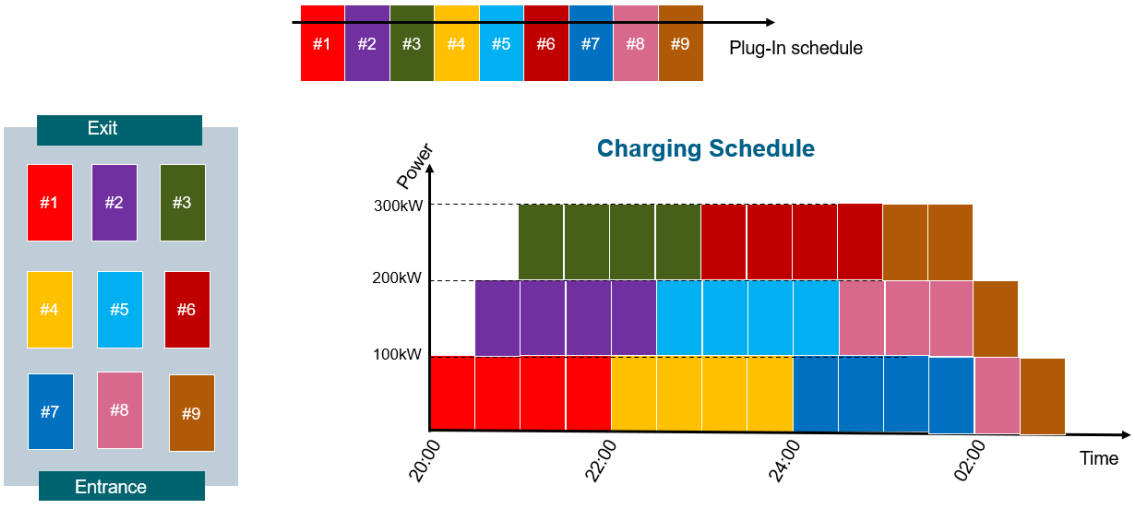


Figure 1. Charging schedule and parking layout for FIFO

1. Consider a depot that has a separate entrance and exit.
2. There are 9 buses and these buses return to the depot, in the order 1→9 every 30 mins
3. Each bus requires 200kWh of energy during charging
4. There are 9 chargers and each charger can deliver 100kW – therefore each bus needs 4 x 1/2hour slots to fully charge
5. As the buses return to base they are plugged into a charger.
6. The chargers are grouped together and assigned a maximum power for the whole group of 300kW.
7. As the buses are plugged in they start to charge until the maximum group power is reached (at around 21:00).
8. At this point buses #1 - #3 are charging
9. When new buses are plugged in they are not charged and are waiting.
10. When the first bus (#1) is fully charged at 22:00, Bus #4 can start charging.
11. The same logic applies for all the subsequent buses
12. This ensures that the early buses are charged before the later buses e.g. the first bus in (FI) is the first bus out (FO) = FIFO

Now when EVC³ Depot CONNECT controls the chargers according to FIFO the following sequence happens

FIFO with Sequential Charging

Sequential charging will follow the following structure

(1) The chargers will be prioritised according to FIFO

(2) The connectors on the chargers will also be prioritised according to FIFO.

FILO (= First In Last Out)

FILO is a basic strategy that organises charging of buses with the strategy to first fully charge the buses that entered the depot most recently. The motivation behind this strategy often isthe depot layout being a dead-end one-way lane so it is a requirement that the last bus coming into the depot is also the first one leaving the depot. FILO strategy is a "live" strategy that sets the power set point of each charger depending on

- Is the charger connected to a bus that is not yet finished charging?
- When was the charger connected to the bus?

The algorithm sets the power set point of all active connectors to the maximum power as defined by the charger maximum power and the maximum available power. It prioritises the buses that were connected last. This can be seen in the detailed workflow in the following figure.

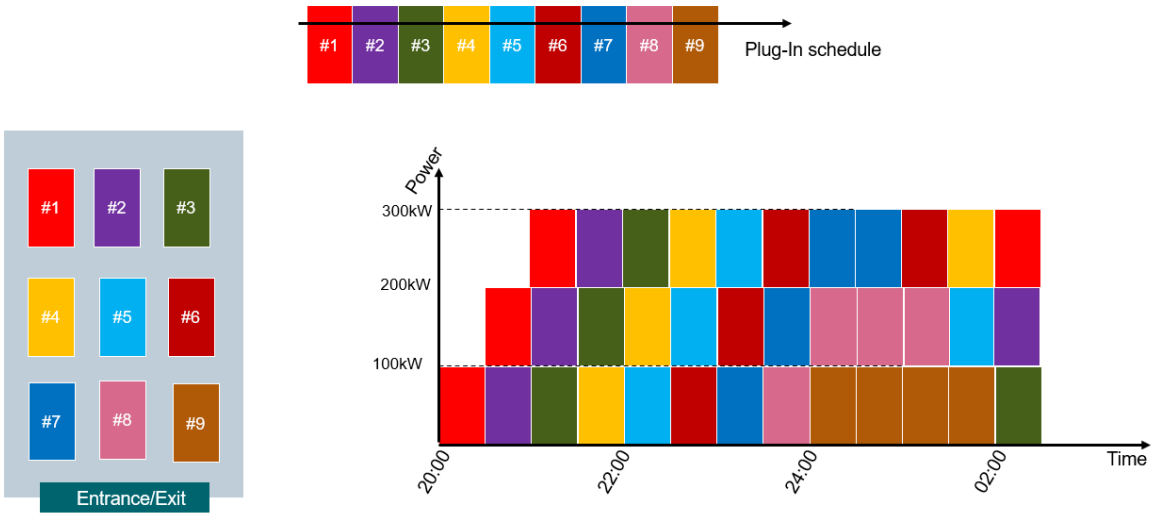


Figure 2. Charging schedule and parking layout for FILO

(1) Consider a depot that has a separate entrance and exit.
(2) There are 9 buses and these buses return to the depot, in the order 1→9 every 30 mins
(3) Each bus requires 200kWh of energy during charging
(4) There are 9 chargers and each charger can deliver 100kW – therefore each bus needs 4 x 1/2hour slots to fully charge
(5) As the buses return to base they are plugged into a charger.
(6) The chargers are grouped together and assigned a maximum power for the whole group of 300kW.
(7) As the buses are plugged in they start to charge until the maximum group power is reached (at around 21:00).
(8) At this point buses #1 - #3 are charging
(9) When bus #4 is plugged in (at around 21:30), bus #1 stops charging so that #4 can start charging. Bus #1 is now waiting.
(10) Similarly when bus #5 is plugged in, bus #2 stops and waits. And so on.
(11) When the later buses have been charged the earlier buses can finish their charging
(12) This ensures that the early buses are charged after the later buses e.g. the first bus in (FI) is the last bus out (LO)=FILO

Now when EVC³ Depot CONNECT controls the chargers according to FILO the following sequence happens

FILO with Cell Balancing

On a charger level balancing is prioritized (first all chargers in balancing will receive balancing power, then follows bulk charging), but on a connector level again strictly FIFO is applied no matter if the connected vehicles are in charging or balancing mode.

FILO with Sequential Charging

Sequential charging will enact in the following manner:
(a) The chargers will be prioritised according to FILO and (b) the connectors on the chargers will be prioritised according to FIFO.
Sequential charging will follow the following structure:

(1) The chargers will be prioritised according to FIFO
(2) The connectors on the chargers will also be prioritised according to FIFO.

SPLIT

SPLIT is a basic strategy that organises charging of buses with the strategy to equally distribute the available charging power of the charging group to all connected (and not yet fully charged) buses. This strategy is useful if there are no constraints to the in- and out-bound movement of the buses and there is no timetable available.

SPLIT strategy is a "live" strategy that sets the power set point of each charger depending on

- Is the charger connected to a bus that is not yet finished charging?
- What is the available maximum power for the charger / charging group?

The algorithm sets the power set point of each active connector to the same fraction of its maximum power (constraint by charger maximum power and maximum available power)

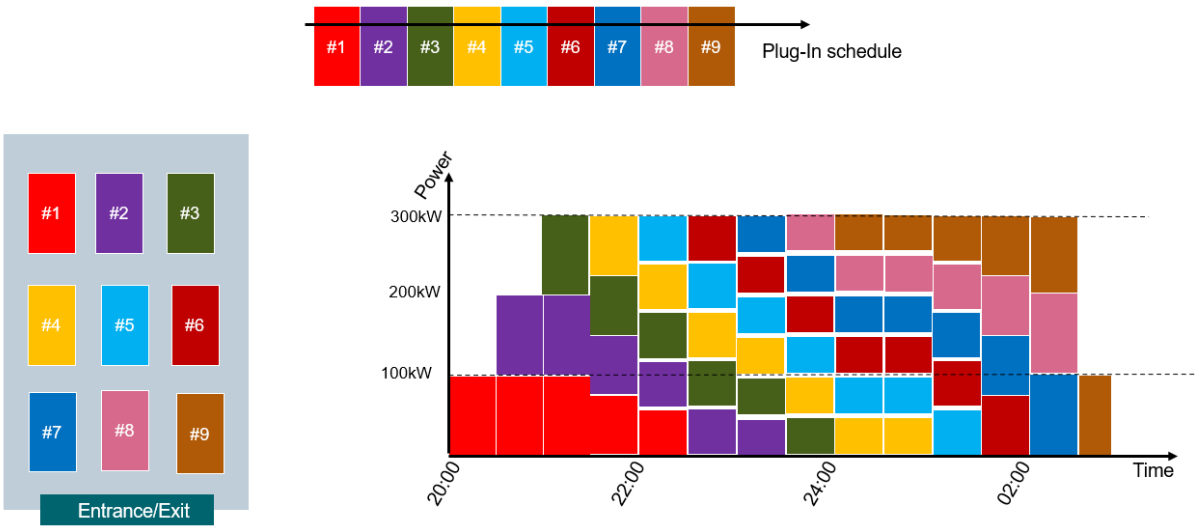


Figure 3. Charging schedule and parking layout for SPLIT

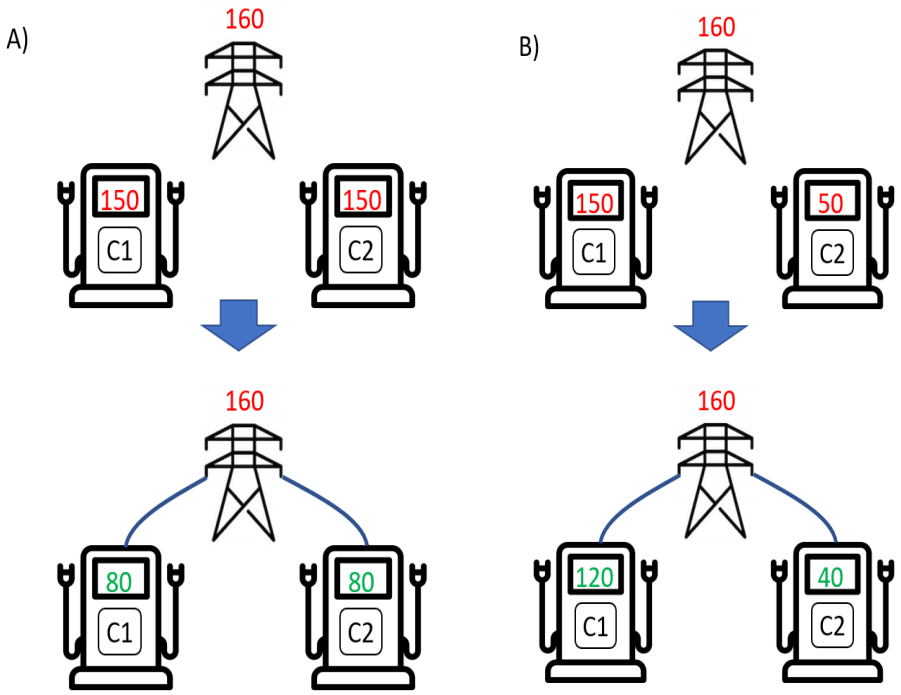
(1) Consider a depot that has a separate entrance and exit.
(2) There are 9 buses and these buses return to the depot, in the order 1→9 every 30 mins
(3) Each bus requires 200kWh of energy during charging
(4) There are 9 chargers and each charger can deliver 100kW – therefore each bus needs 4 x 1/2hour slots to fully charge
(5) As the buses return to base they are plugged into a charger.
(6) The chargers are grouped together and assigned a maximum power for the whole group of 300kW.

Now when EVC³ Depot CONNECT controls the chargers according to SPLIT the following sequence happens

(7) As the buses are plugged in they start to charge until the maximum group power is reached (at around 21:00).
(8) At this point buses #1 - #3 are charging
(9) When bus #4 is plugged in (at around 21:30), The power is now shared between the 4 chargers
(10) Similarly when bus #5 is plugged in, the power is now shared amongst 5 chargers

For EVC³ Depot CONNECT the SPLIT strategy has been modified to ensure that the charging is as efficient as possible and takes into account variations in Charger, Connector and Vehicle power.

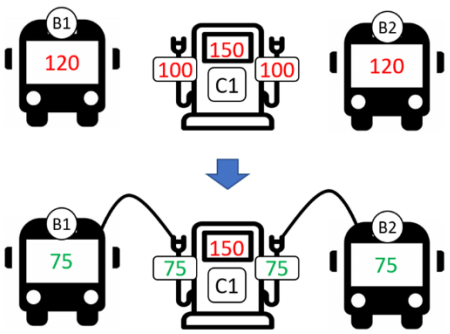
How is Power Split Amongst Chargers?



The power is distributed such that the distribution is weighted by the maximum power of the charger.

How is Power Split Amongst Connectors?

A)



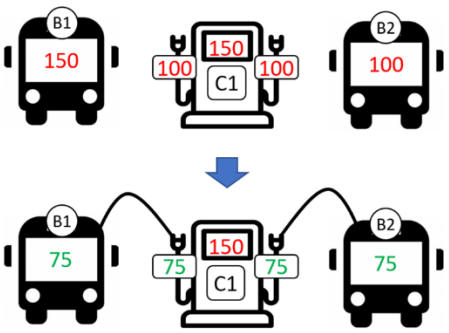
The MaxPower of the bus + connector system is the smaller of both.

A) Ratio = 150/(100+100) = 0.75
B1 = B2 = 100 * 0.75 = 75

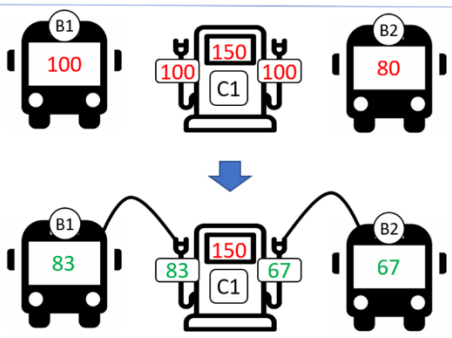
B) Same as A, because B1 and its connector have 100 as the smaller MaxPower value

C) Ratio = 150/(100+80) = 0.83
B1 = 100*0.83 = 83
B2 = 80*0.83 ≈ 67

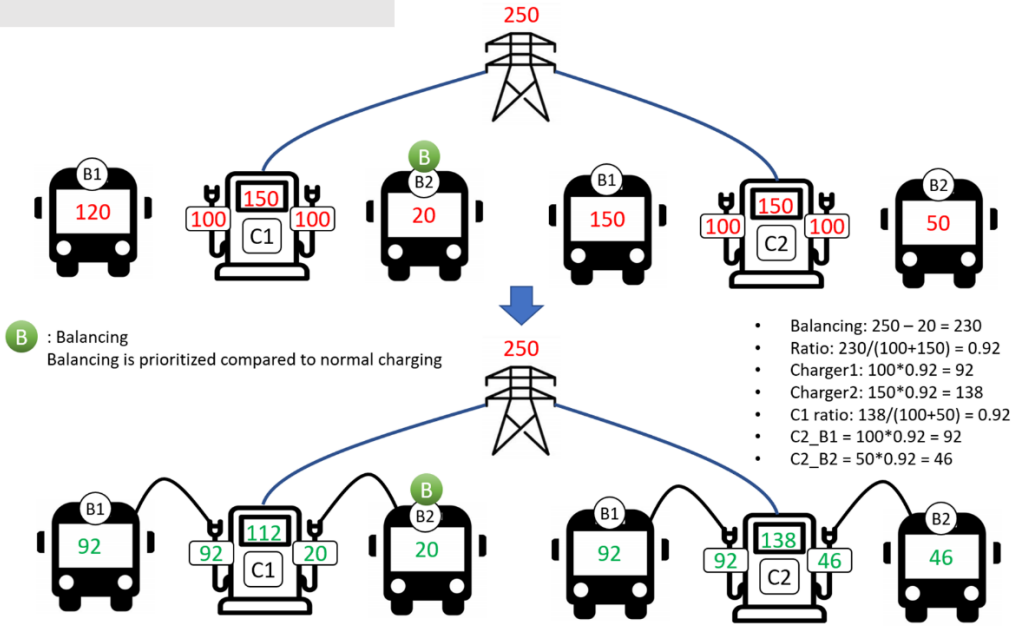
B)



C)



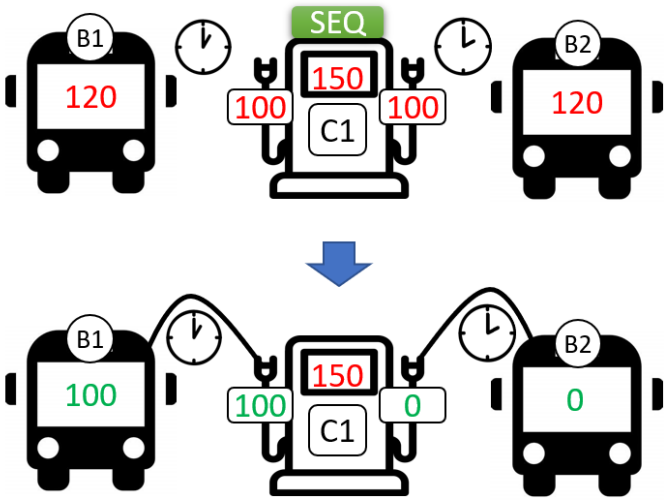
How is Power Split Amongst Connectors?



How is Power Split for Sequential Chargers?

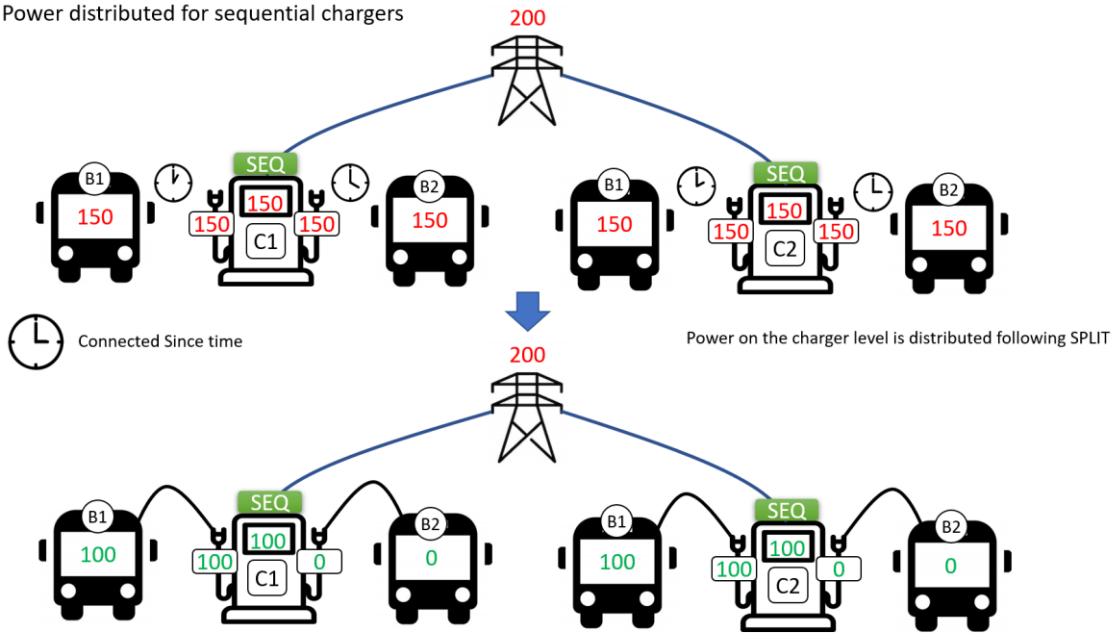
Connected Since time

A)

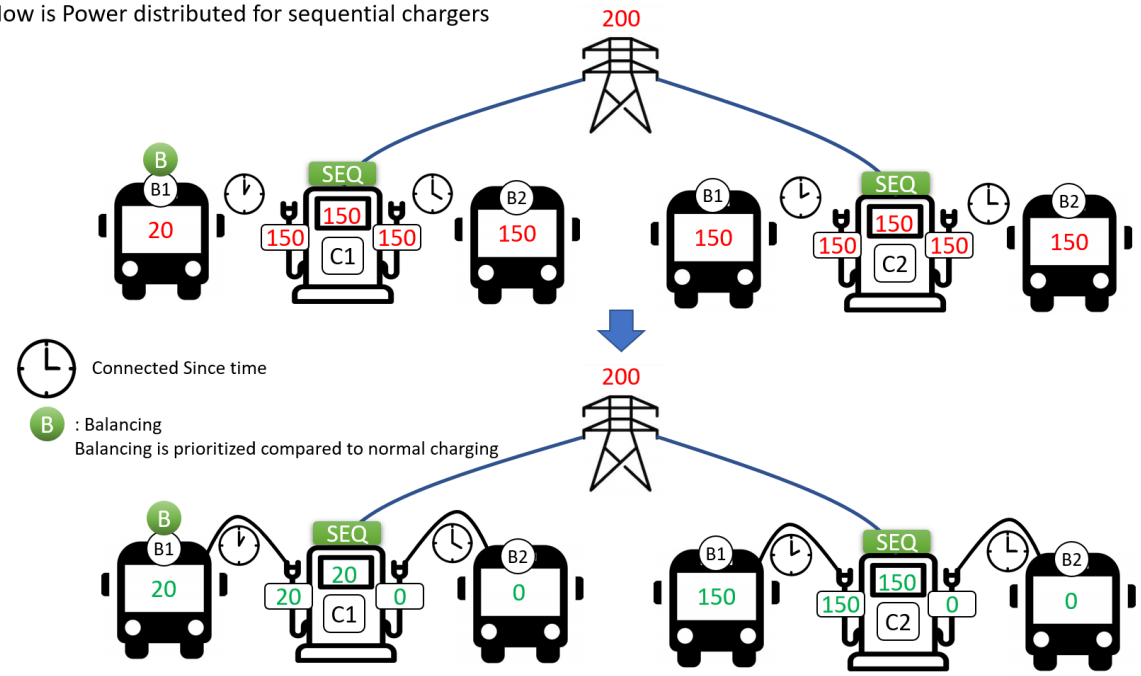


Power on the connector level is distributed following FIFO

How is Power distributed for sequential chargers



How is Power distributed for sequential chargers



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E-mail	ross.mueller@siemens.com
Our reference	Spokane Transit Authority
Date	8/19/2020

5 year Warranty and Preventative Maintenance For SiCharge UC200 150Kw and SiCharge UC 600 450Kw W Pantographs All Facilities total 5 Years

Siemens Industry Inc. is pleased to provide the following Spokane Transit Authority 2020-10495 project.

1.0 Depot Charger description

Each 150kW depot charger included in this offer has the following specifications:

Rated output power	Max **160kW** (for batteries in voltage range 200…850V DC*)
Rated output current	200A continuous through voltage range
Supply voltage (phase to phase)	3 phase, 480V AC Supply, 3 wires + PE Ground
Frequency	57-63 Hz
Input current	220 A
Harmonics	<5% at full power, according to IEEE519
Type of installation (indoor/outdoor)	Outdoor, IP54/NEMA3R compatible enclosure, -25degC … 50degC, 5%-95% humidity
Applicable Standards (UL, IEC, CSA)	UL Certified, SAE J-1772/CCS Type 1
Dimensions main charging unit	55 in x 47 in x 75 in
Grounding system	PE Grounded AC input / Isolated DC output
Weight	Approx. 4800lbs.
Frontend / dispensers	QTY 2 dispensers per charger. Can accommodate up to 4 remote dispensers.
Connector Type / length	QTY. 1 per dispenser / CCS Type 1 / max. 25ft. / UL certified
Remote access (by Siemens)	VPN access via Router with SIM Card
Backend capability	Fully compatible with OCPP v1.6 (JSON)

The DC Charging Station is composed by two parts: a **Power Module** and a **Pole Mount Satellite / Dispenser**. Up to four Dispensers can be coupled to the Power Module in a radial configuration – each dispenser having its own set of power and communication cables. The distance between the Power Module and each Dispenser is limited by the communication method outlined below.

Chargers with multiple dispenser's support a sequential charging concept.

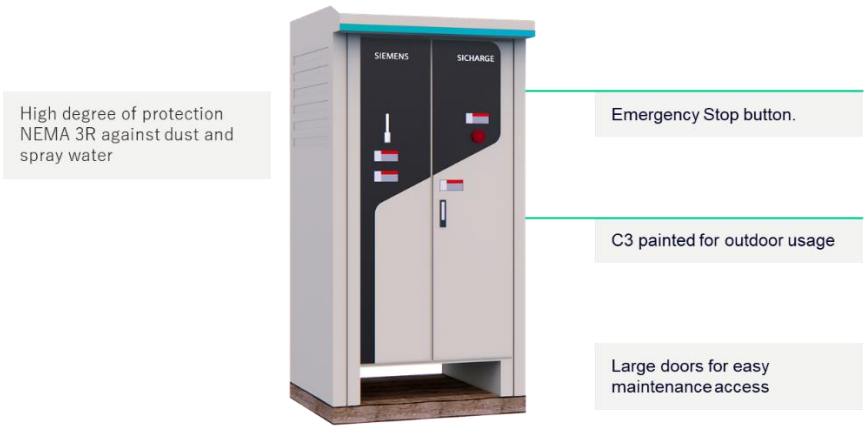
Communication to be considered	
Distance	**Communication Method**
1m – 100m	Ethernet*
100m – 200m	Fiber Optic*

**Solutions under review and still require additional testing.*

The maximum cable distance between main cabinet and each satellite is 200m. The distance should always be measured radially.

The Dispenser is equipped with a Siemens HMI Display Panel which is found on the cabinet's door. A Siemens PLC manages the charging procedure and all the station's actions. The Siemens HMI Display Panel on the door has a user-friendly functions and graphics to support the charging process.

The charging station is designed considering the standard IEC 61851, namely charging mode 4. Charging mode 4 is a fast charging method for battery electric vehicles of high-voltage direct current via a special electrical connector.





Charging Center
The Charging Center is the core of your system. Several other vehicle connections like the cable-based dispenser, or inverted Pantograph can be powered by this unit. Combine power cabinets to achieve up to 600 kW of DC power. AC Incoming and DC outgoing cabinets dramatically reduces the installation cost. This feature reduces infrastructure costs by limiting the number of AC input feeds required for multiple cabinets.

2.0 Preventative Maintenance Services

Preventative Maintenance Schedule (Per Year):

- Qty. (4) Preventative Maintenance (PMs) per year. Once every 3 months.
- Work will be performed Monday through Friday (non-holidays) during normal working hours (8a – 5p).
- Four mobilizations per year.
- Each mobilization per year will provide preventative maintenance on four (4) VersiCharge MaxxHP chargers / associated (10) dispensers.
- A vehicle for charging purposes will be needed for a preventative maintenance functional testing. If a vehicle is not provided delays and possible additional service charges may apply.

Preventative Maintenance Scope of Services:

External Visual Inspection

- Check visible damages (holes or corrosion) in the cabinet
- Check if plug support and cable holding are in the correct position
- Clean and check if the ventilation system is not obstructed
- Check if the charging plug shows and signs of humidity, dust or corrosion
- Cleaning the HMI with microfiber cloth and check if is correctly responding to the touch and cleaning.
- Clean all dust and/or dirt accumulations from the charger cabinets.

Internal Visual Inspection

- Check charging plug and any signs of humidity, dust or corrosion.
- Check if the capacitors are leaking out liquid or are damaged.
- Check all relays, lights, and other indicating devices for proper operation

Mechanical Inspection

- Check if the side panels are correctly tightened.
- Check if the cabinet's fixing points to the ground are correctly tightened.
- Check if the input connections are correctly tightened (L1, L2, L3, PE)
- Check if the main output connections are correctly tightened (DC+, DC-, PE, CP)
- Check if the main transformer fixing points are correctly tightened.
- Check if the main base plate (behind the main transformer) is correctly tightened.

Other Inspections

- Check for abnormal sounds from the running fans and power units.
- Check for abnormal smells, changes of inner materials, corrosion

Functional Tests

- Measure the line voltages (L1-PE, L2-PE, L3-PE) and compare with the values on the HMI.
- Measure the output voltage (DC+, DC-) and compare with the values on the HMI
- Measure the output current and compare with the values on the HMI
- Opening doors while charging (Safety Check)
- Press E-Stop button while charging (Safety Check)
- Check Functionality of Manual Mode. (HMI Check)
- Charging Procedure**: Functional check of the charging procedure of the charger. Confirm charging procedure goes through the phases: Vehicle Connected/ Cable Check/ Pre-Charge/ Charging.

**Will need the use of a vehicle for charging purposes for this procedure. If a vehicle is not provided delays and possible additional service charges may apply.

Maintenance / Service Clarifications:

Siemens is providing a preventative maintenance plan, each year each charger will be provided with two preventative maintenance visits. Siemens cannot guarantee any performance up-time due to preventative maintenance at this time. Siemens will strive to respond to service requests at our best possible response time but cannot at this time guarantee or stipulate any given response time.

Siemens will not provide services on vehicle battery systems or other third-party equipment that is not discussed in this proposal. All vehicle related maintenance and battery system maintenance or services are the responsibility of others. Siemens also does not guarantee any performance up-time due to regular preventative maintenance.

3.0 Documentation

The following documents may be provided. The documents will be provided at the time of acknowledging the PO. Drawings and documentation are as follows (when applicable):

- Product Manual
- Standard product drawings
- Certified test reports (upon completion)
- Any requirements for project specific drawing set is an additional cost.
- Any requirement for PE stamped drawings is an additional cost.

Quality Assurance

Siemens' quality management program is the basis of our outstanding reputation on the world market. Relentless efforts and unwavering commitment enable us to satisfy our customers, employees, and stakeholders.

Project Execution Schedule

The final schedule will be based upon available manufacturing slots at the time of order receipt.

Manufacturing completion is expected to be 16 weeks after receipt of order for depot chargers.

4.0 Clarifications

The following are clarifications to our proposal:

- Siemens is quoting our standard VersiCharge MaxxHP 150kW depot charger with two dispensers each on two Power Cabinets and (3) Dispensers each on two more Power Cabinets for (10) total dispensers Boone Garage.
- Siemens has successfully charged Proterra, New Flyer and Gillig electric buses with MaxxHP technology. Anticipate compatibility with BYD and Novabus CCS1 DC charged buses.
- Sequential charging is possible and has been proven but must be coordinated with bus supplier. Bus side charge control unit must be capable of supporting a sequential charge.
- The VersiCharge MaxxHP is OCPP V1.6
- Siemens requires either an internet connection with VPN tunnel (firewall arrangement to allow for outside traffic to access chargers) or customer supplied LTE SIM card and data plan to enable any remote connectivity.
- All MaxxHP chargers use identical IP addresses on components from charger to charger. Customer will require additional components with VLAN capabilities to accommodate LAN connection.
- In the event shipment is delayed for any reason that is beyond the control of Siemens a storage fee in the amount of 1.5% of the equipment value shall be charged per month on the first day of the month.
- Dimensions of equipment and enclosures included in this proposal are approximate.
- All site works including installation field wiring and interconnection are done by others
- Commissioning will require that a bus is available during the entire commissioning period.
- Documentation, labels, nameplates, user interfaces, displays, training, signage, etc. for the equipment and subsystems will be provided in English only.
- Siemens excludes any onsite installation activities including but not limited to cabling outside the enclosures and external switchgear, concrete pads and equipment installation.
- Any requirements for project specific drawing set is an additional cost.
- Any requirement for PE stamped drawings is an additional cost.

SIecharge UC 600 450Kw Charge Center & Pantograph

Technical data



SICHARGE UC
Charging Center

The Charging Center is delivered 100-percent factory-tested, including controllers, the device as a whole and, optionally, communication with the Frontend

	Technical data Siemens eBus / eUtility Charging Center						
SICHARGE UC	**50**	**100**	**200**	**300**	**400**	**600**	**800**
Vehicle interface							
CCS cable on Charging Center	×	×	×	-	-	-	-
Frontend or Charging Center with GB/T cable	×	×	-	-	-	-	-
Frontend with CCS cable	×	×	×	-	-	-	-
Frontend with cooled CCS cable with max 500 A	×	×	×	×	×	up to 15 min	-
Mast mounted Hood	×	×	×	×	×	×	×
Mast mounted (inverted) Pantograph	×	×	×	×	×	×	×
Nominal input							
Voltage	400 Vac (3ph + PE) ± 10 %						
Current at nominal voltage per phase, A	76	152	228	342	456	683	911
Frequency, Hz	50/60						
Power factor (cos phi)	> 0.98						
DC output*							
Peak power, kW	63	125	200	300	400	600	800
Rated power, kW	50	100	150	225	300	450	600
Current (max.), A	63	125	200	300	400	600	800
Voltage (range), V_{dc}	10 ... 1000						
Efficiency factor η (at load 100%)	96% ... 97%						
Environmental conditions							
Operating Temperature	-25 °C ... +45 °C (extended upon request)						
Mechanical specifications							
Operational environment	Indoor and outdoor						
Protection enclosure	IP54, IK10						
Casing material	Galvanized steel, painted, C3						
Color	Main housing: RAL 9006 – White aluminium; roof and base: RAL 9017 – Traffic black matt						
Overall dimensions W x D x H (mm)	700 × 800 × 1800		915 × 1000 × 2000	1400 × 1000 × 2000		2400 × 1000 × 2000	2800 × 1000 × 2000
Approx. weight, kg	700	1000	1400	2000	2600	4000	5200
General specifications							
Charge control unit	Siemens SIMATIC S7						
Local user interface	Siemens SIPLUS HMI TP700						
Network connection	Ethernet interface / 3G and 4G / WLAN						
Communications protocol	OCPP 1.6 (J-SON)						
Charging standards	EN 61851-1/23/24, ISO 15118 (DIN 70121)**						
EMC standards	EN 55016-2-1 & -3; EN 61000-4-2 & -3 & -4 & -5 & -6						
Compliance	CE declaration						

* Details available in the technical manual
** Complies with ISO15118-1 standard use-cases, further use-cases being implemented



SICHARGE UC
Frontend

Cooled cables as an option can be installed in the same Frontend housing, increasing charging power up to 400 A continuous (500 A for 15 min)



SICHARGE UC
Inverted Pantograph

Inverted Pantograph is a plug-and-play solution for top-down Pantograph charging – each mast arrives fully preinstalled, electrically checked and equipped with the Pantograph.



SICHARGE UC
Mast mounted Hood

The mast mounted Hood is designed for the efficient connection of any ISO 15118 bottom-up Pantograph system. Each mast arrives fully preinstalled, electrically checked and equipped with the contact Hood.

	Technical data Siemens eBus / eUtility Charging					
Frontend & masts	**SICHARGE UC Frontend**	**SICHARGE UC Inverted Pantograph**			**SICHARGE UC Mast mounted Hood**	
Design variants		UD Urban design	ID Industrial design	ID-E Industrial design-extended	ID Industrial design	ID-T Industrial design, T-shape
Connector						
Frontend with CCS or GB/T cable	×	-	-	-	-	-
Mast mounted Hood	-	-	-	-	×	×
Mast mounted (inverted) Pantograph	-	×	×	×	-	-
DC output*						
Peak power, standard, kW	200	800			800	
Peak power, liquid-cooled cable (option), kW	500	n/a			n/a	
Rated power, standard, kW	150	600			600	
Current (max.) standard, A	200	800			800	
Current (max.) liquid-cooled cable (option), A	500	n/a			n/a	
Voltage (range), V_{dc}	10...1000					
Mechanical specifications						
Protection	IP54, IK10					
Height, installed (mm)	1765	5805	6573	6573	5000	5000
Road clearance (mm)	n/a	4550 to 4650			4635	4635
Cantilever length (mm)	n/a	3955	4200	5200	3500	7000
Approx. distance mast to curb (mm)	n/a	1400	1400	2400	1900	1900
Footprint on sidewalk (mm)	600 × 300	940 × 315	1300 × 330	1300 × 330	350 × 300	350 × 300
Operating range Pantograph (mm)	n/a	900			n/a	
Approx. weight, kg	100 / 150**	1975	1870	2300	900	1100
Color	Main housing: RAL 9006 – White aluminium; roof and base: RAL 9017 – Traffic black matt	RAL 9006 – White aluminium				
Material	Galvanized powder coated steel	Galvanized steel with fiber glass panel	Galvanized steel, painted, min. C3			
General specifications						
Communication standard	PLC	WiFi IEEE 802.11a			PLC	
Number of possible connectors (sequential charging)	up to 5	1			1	2

Preventative Maintenance Services

Preventative Maintenance Schedule - Five Year: Siecharge UC 600 Inverted and Gantry mounted

- Four (4) Preventative Maintenance (PMs) per year, once every three months, for (4) chargers with gantry mounted pantographs at one facility.
- Four (4) Preventative Maintenance (PMs) per year, once every three months, for four (2) chargers with mast / pantographs at two remote facilities.
- Work schedule: Monday through Friday (non-holidays)
- A vehicle for charging purposes will be needed for a preventative maintenance functional testing. If a vehicle is not provided delays and possible additional service charges may apply.

Preventative Maintenance Sample Scope of Services:

Every 3 months:

Area	Maintenance Task
Main Power Cabinet	● Check function of all access doors ● Check door locks and hinges ● Check indoor lighting system ● Inspect main disconnect switch ● Energy meter (if installed): Check MID approval/calibration validity, replace before the expiry date, or after 8 - 10 years, record the meter reading! ● Check E-Stop button ● Check all filter mats and replace if dirty ● Visual inspection of the cabinet ● Operation lamp test
Charger mast (if supplied)	● Check Stop charge button ● Visual inspection of the panel for external damage ● Inspect locks ● Inspect hinges
Y-Sensor	● Proceed with functional check of correct positioning ● Check the set distance according to the Y-sensor setting instruction [R12]
WLAN antenna	● Check level using app "WLAN Analyzer" (min. < -80 dBm)
Wind sensor	● Visual inspection for external damage of the rotor ● Remove leaves and any other coarse dirt
Pantograph	● Visual inspection of the pantograph ● Visual inspection of the collector head ● Visual inspection of the jumper leads ● Visual inspection of the connector cables ● Visual inspection of the contact bars ● Use emery paper to sand contact bars ● Function test

Main Power Cabinet	● Check the Operating Status and Charging Active functions ● Inspect and clean indoor fans [-M72] and [-M73] ● Check insulation monitor [-T35]

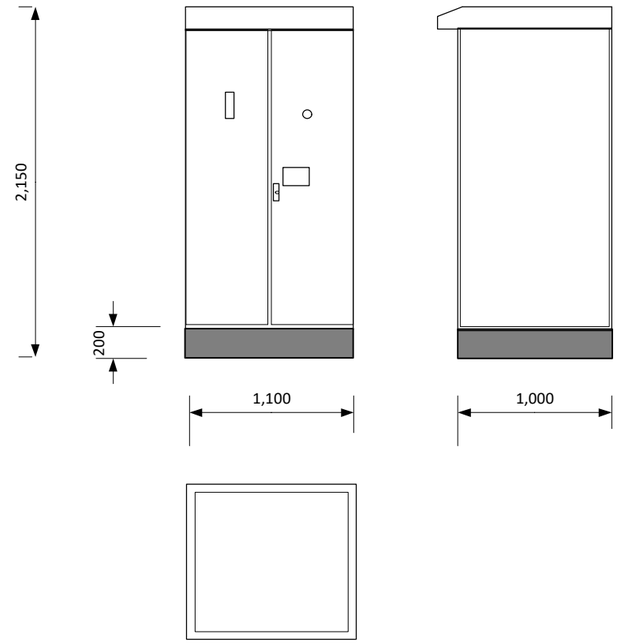
Main Power Cabinet	● Inspect charger housing, check ceiling, doors, grating, and cable bushings ● Clean grilles of fans and air intakes ● Check and clean the rainwater drains ● Ensure the earthing straps are complete and check for damage and tightness ● Measure the earth resistance at the earthing stations in accordance with the floor plan ● Check output contactors [-Q31] and [-Q32] ● Clean air intake grill, magnetic components, and main fan ● Press the "Reset Charging station" button [-S4]
Isolation transformer	● Inspection of fans ● Cleaning the transformer ● Cleaning the main fans
Charger mast	● Check earthing connection of the mast
Pantograph	● Check proper function of the heating circuit ● Check contact force ● Measuring the lowering and lifting times ● Cleaning and lubricating the set screw on the spring balancer and the chain strand ● Check the spring force of the spring balancer

Isolating transformer	● Checking the tightening torques ● Periodic inspection according to IEEE C57.94
Pantograph	● Replace plug-in relays in the pantograph control box

Main Power Cabinet	● Replace UPS battery module
Pantograph	● Replace the jumper leads and connector cables

Maintenance Service Clarifications:

1. Siemens will strive to respond to service requests at our best possible response time but cannot guarantee or stipulate any given response time.
2. Siemens is providing a preventative maintenance plan, each year each charger will be provided with two preventative maintenance visits. Siemens cannot guarantee any performance up-time due to preventative maintenance.
3. Siemens will not provide services on vehicle battery systems or other third-party equipment that is not discussed in this proposal. All vehicle related maintenance and battery system maintenance or services are the responsibility of others.



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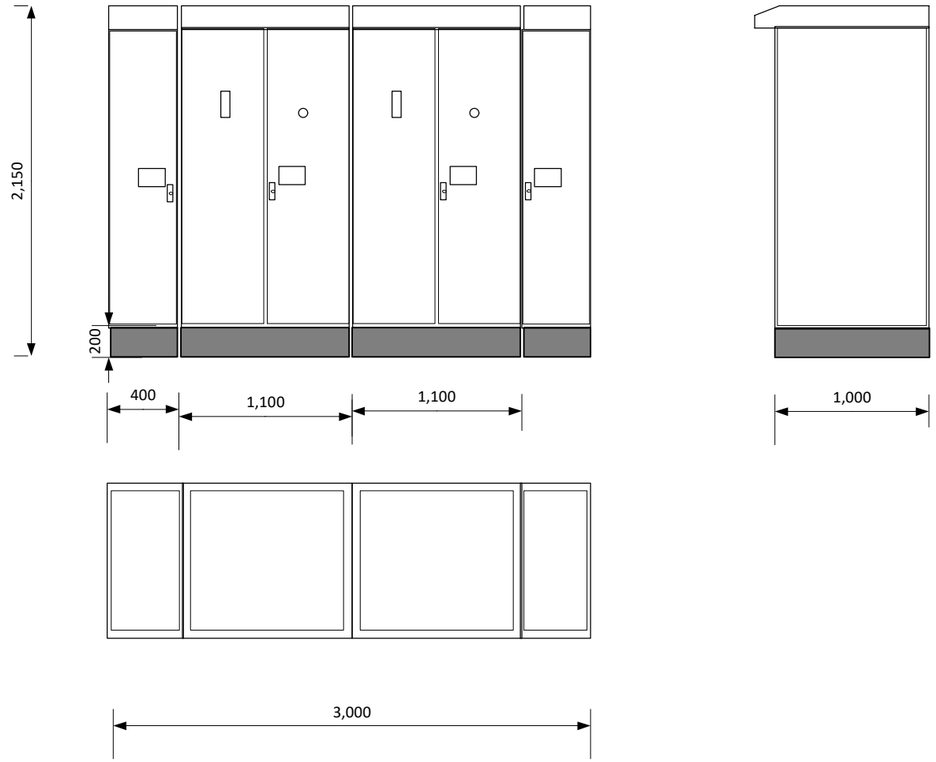
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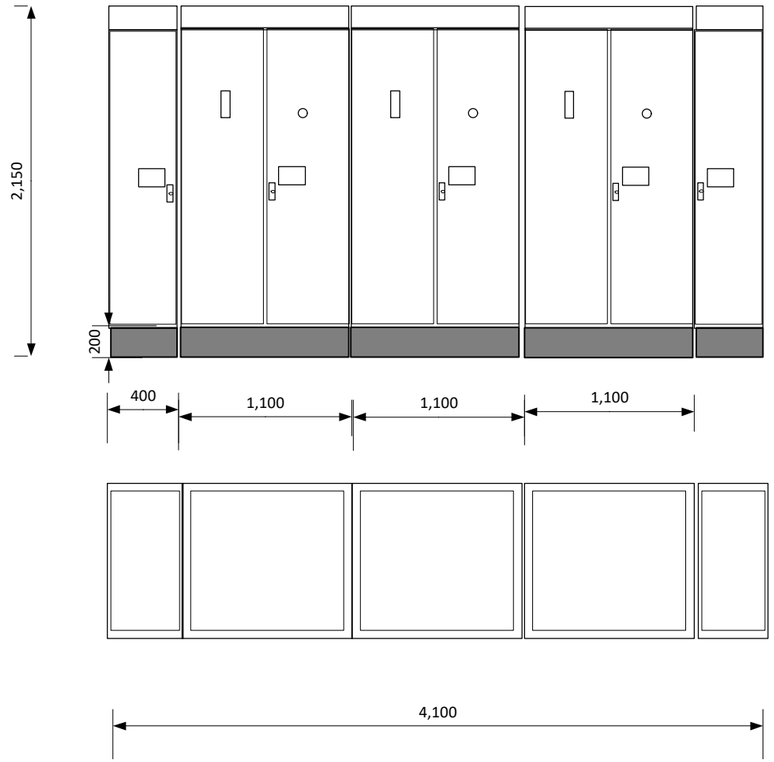
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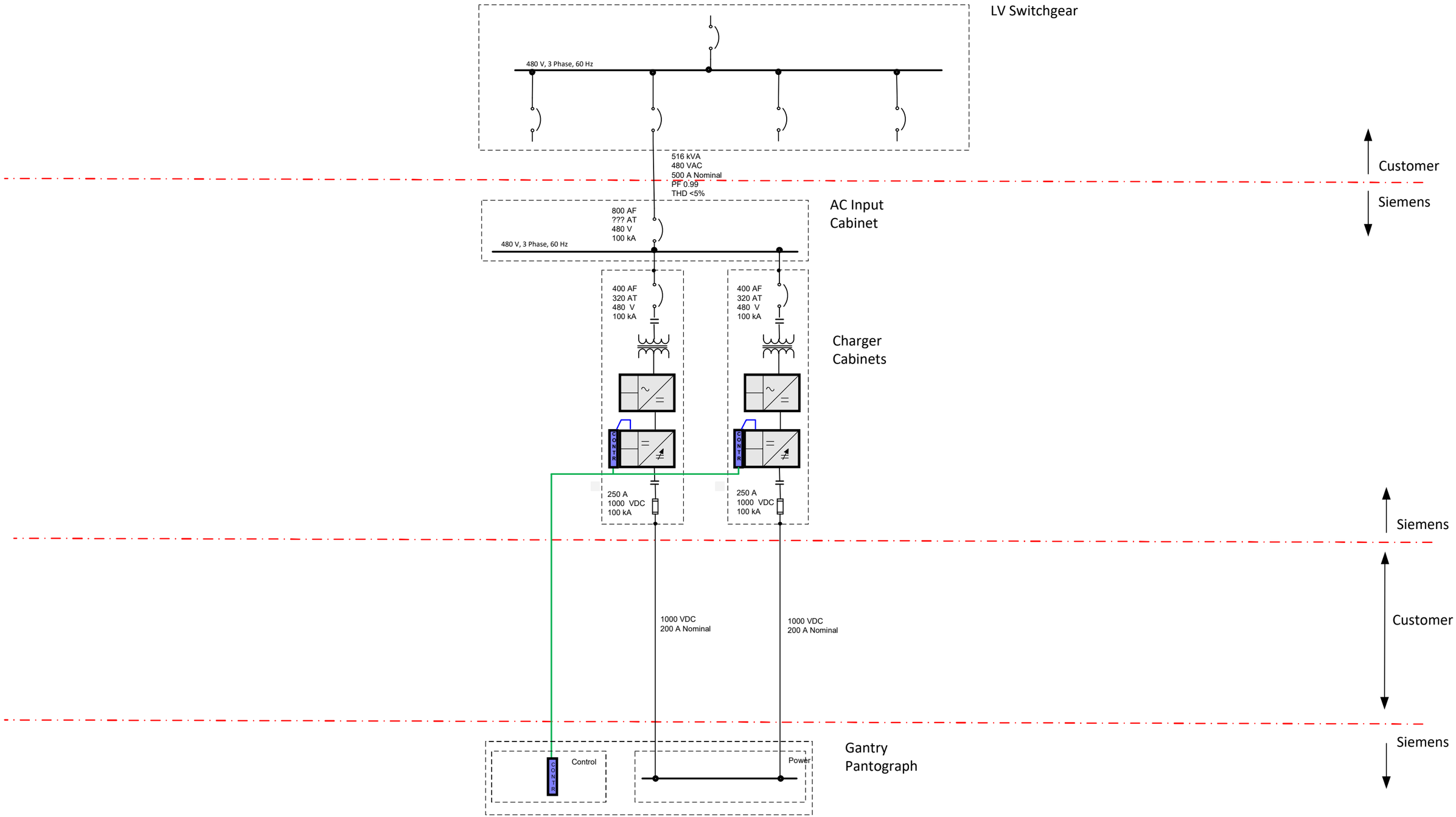
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400 kW_Power Distribution

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Gantry Charging Unit 400 kW

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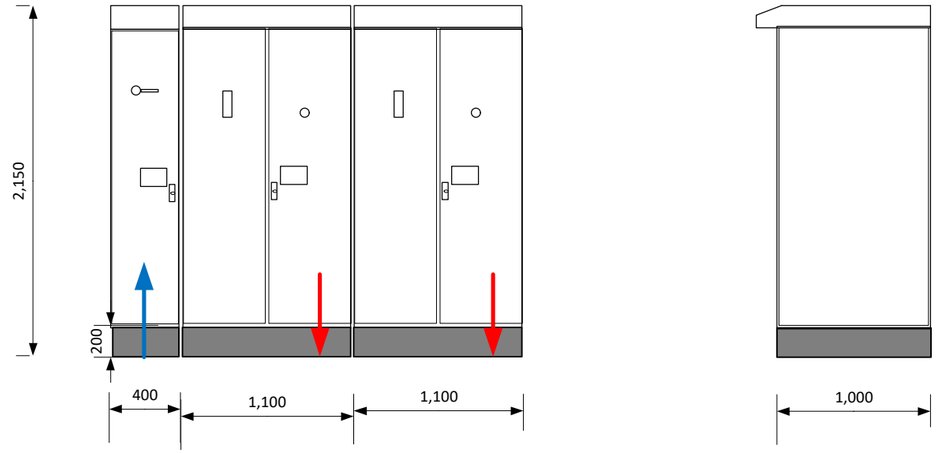
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LEGEND:

480 VAC Feeder

1000 VDC Feeder

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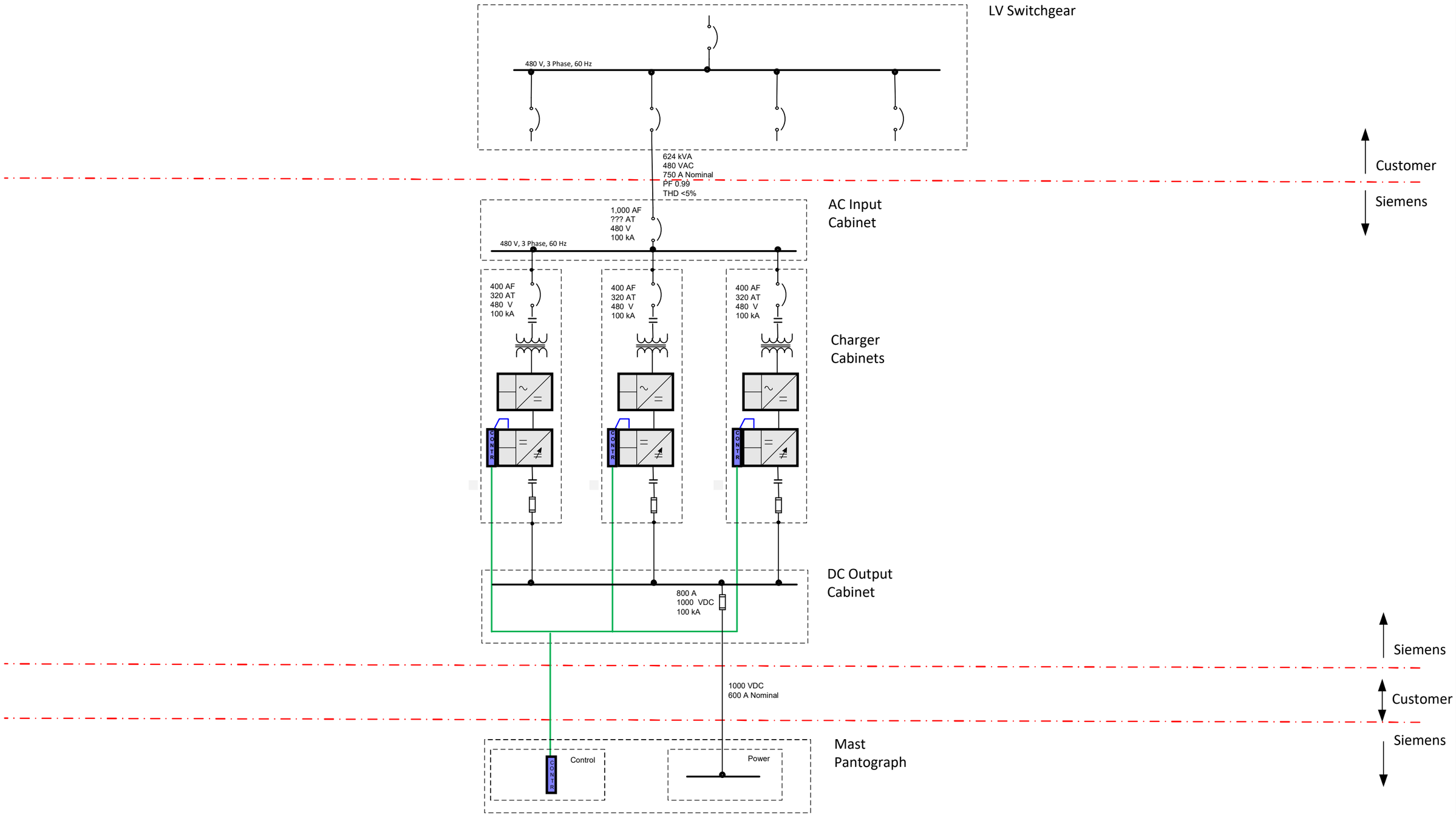
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600 kW_Power Distribution

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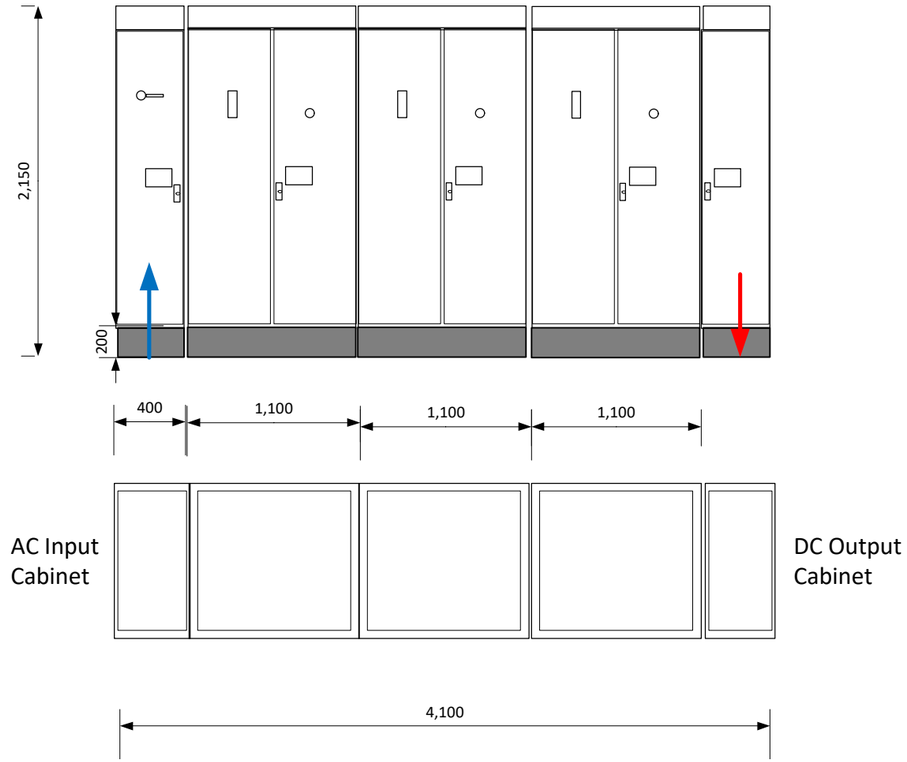
Mast Charging Unit 600 kW

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CONT 2



LEGEND:

480 VAC Feeder

1000 VDC Feeder

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600 kW_Layout

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Mast Charging Unit 600 kW

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SHT 2

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Transport and Installation

Urban Design Mast

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Date: 20.04.2018 File name: R32-SCC2-0-DesMast_enTM_V0-1.docx
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1 Introduction

1.1 Content of the Document

This document is an annex of the “Transport and Installation Instruction” [R30] for the transport and installation of the Urban Design Mast [R11]. All information within this document are design specific deviations of the Urban Design Mast compared to the Standard Mast variants described in [R30]. Please mind and observe all important information such as proper use, safety notices, regulations and guidelines as described in the main document [R30].

1.2 Additionally Applicable Documents

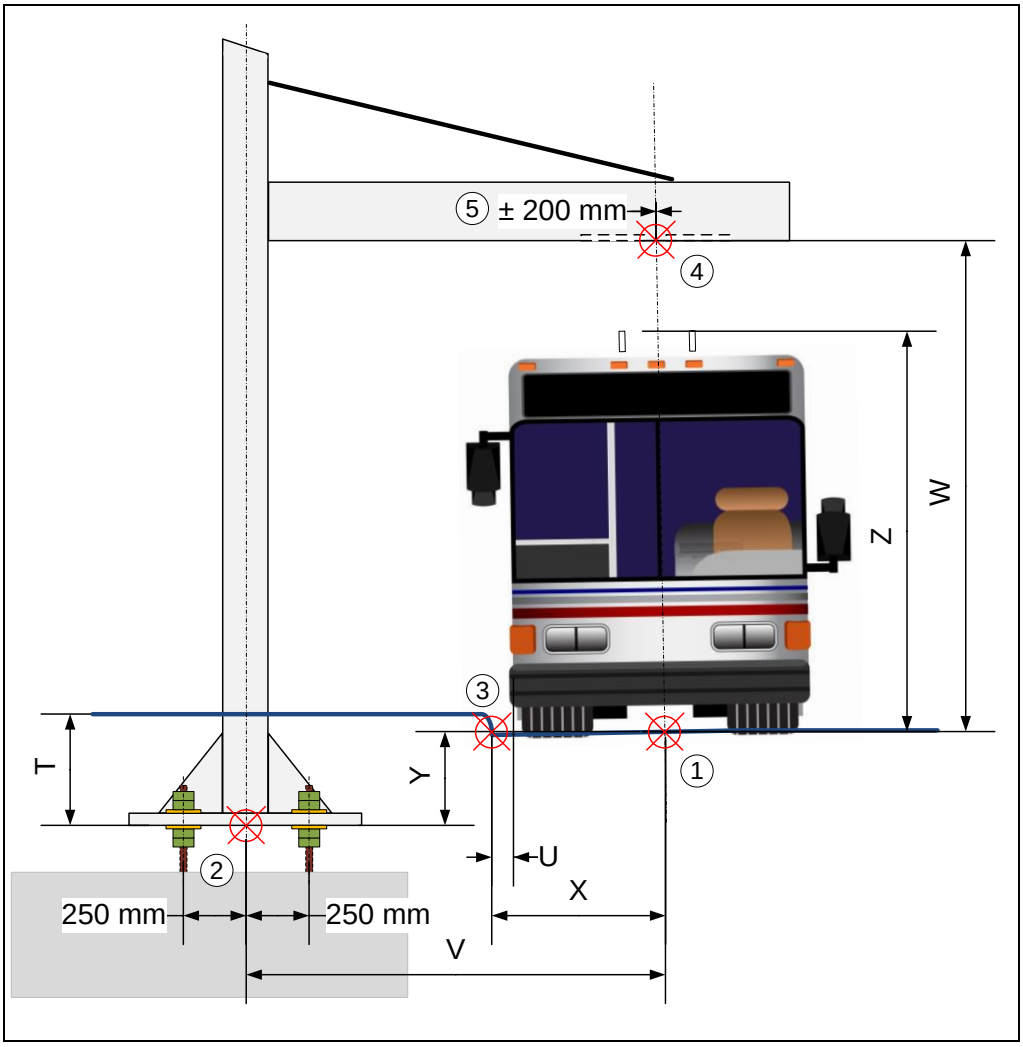
Table 1 Additionally applicable documents

Reference	Assembly	Siemens part number
[R01]	Description of construction, civil works	A2V00002719973
[R11]	Design charger mast	A2V00002727735
[R30]	Transport and Installation Instruction	A6Z00042601002

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1.2.1 Definition of the Charger Mast Position

Fig. 1 Sample image: Definition of the charger mast position



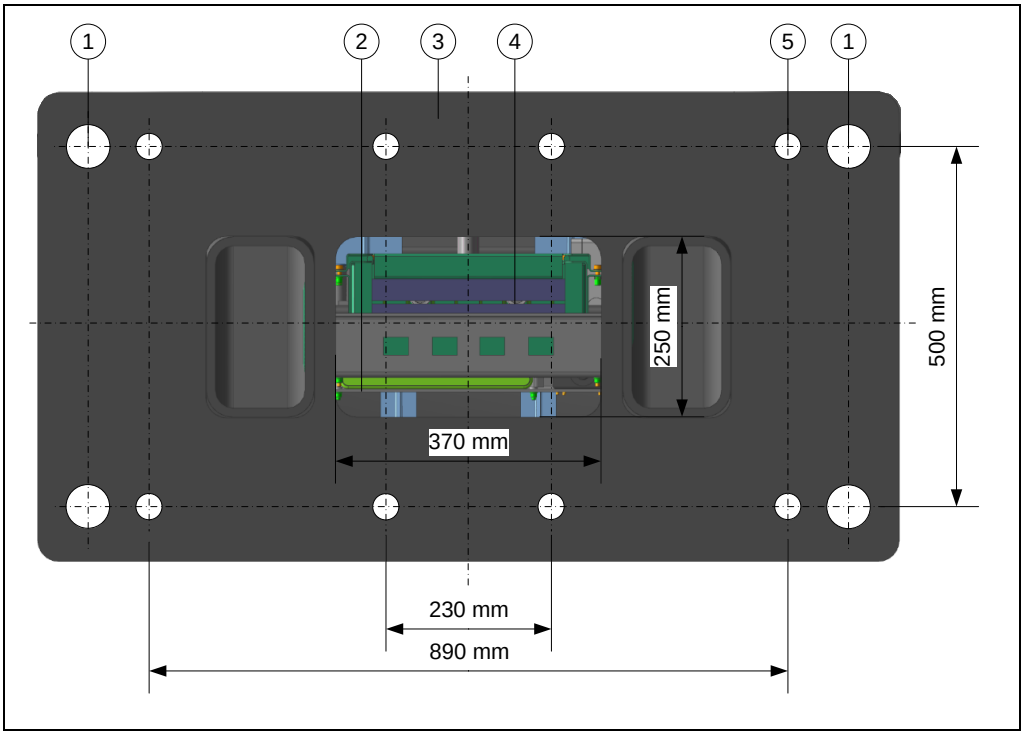
1 Measuring point **X** = 1250 ± 10 mm + **U**
2 Reference point mast bottom
3 Reference point curb
4 Reference point pantograph/e-bus center line
5 Vertical adjustment range of the pantograph
T Urban Design Mast **T** ≤ 900 mm
U Distance e-bus to curb **U** = 0 … ≤100 mm
V Urban Design Mast **V** = 2650 mm
W Required mast clearance
Y Level difference
Z Height of the e-bus

Table 2 Dimension dependencies

Y	W (clearance)	Z min	Z max
480 mm	4850 mm (max.)	3350 mm	4450 mm
530 mm	4800 mm	3300 mm	4400 mm
580 mm	4750 mm	3250 mm	4350 mm
630 mm	4700 mm	3200 mm	4300 mm
680 mm	4650 mm	3150 mm	4250 mm
730 mm	4600 mm	3100 mm	4200 mm
--	4550 mm (min.)	3050 mm	4150 mm

1.2.2 Fastening Points on Charger Mast

Fig. 2 Sample image: Charger mast from below (dimensioned fastening holes)



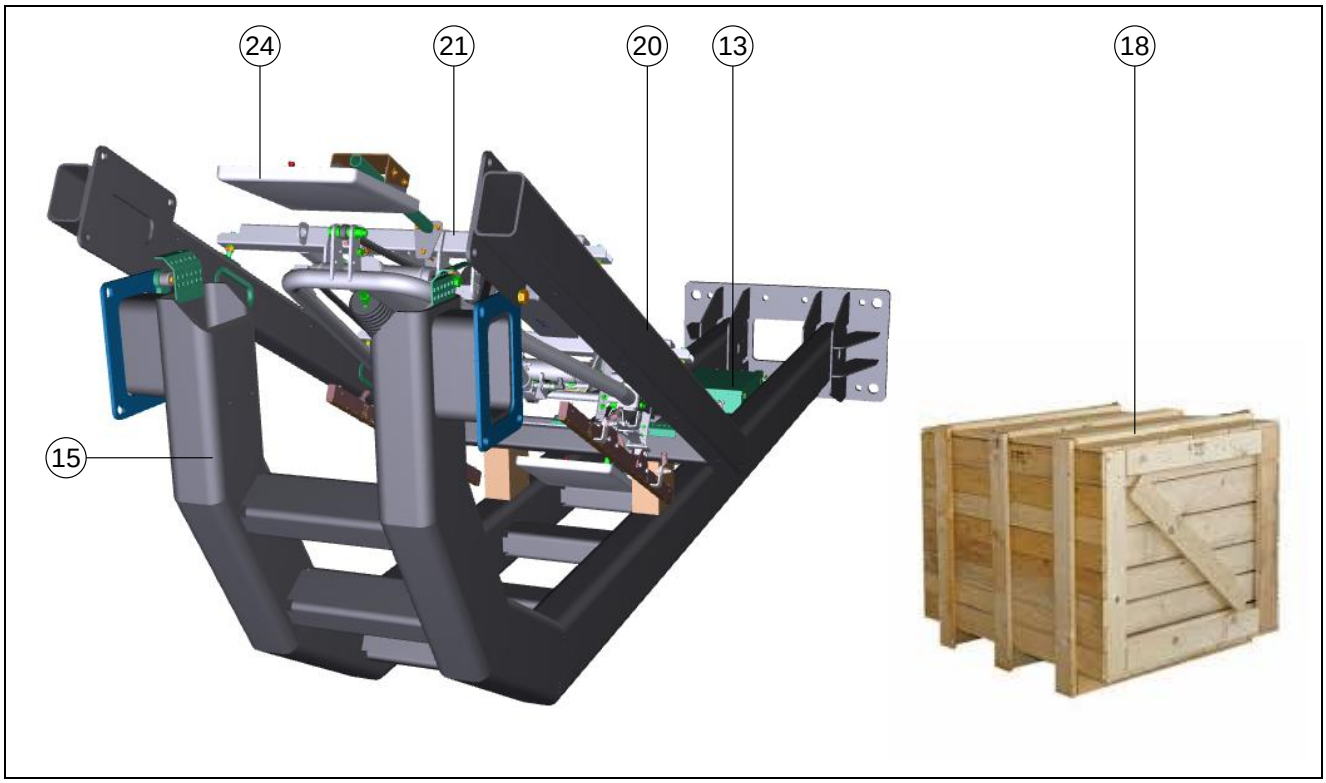
1 Attachment points for lifting straps
2 Connection point of the signal and control cables
3 Baseplate
4 Connection point of the power supply
5 Fastening holes

© Siemens

2 Transport

2.1 Transport Units

Fig. 3 Sample image: Transport units



13 Terminal box
15 Charger mast
18 Panels
20 Cantilever arm
21 Pantograph
24 WLAN antenna

The Urban Design Mast is transported in a pre-assembled condition and consists of the following transport units:

1. Charger mast (15)
   - Cantilever arm (20)
   - Cable harness for the cantilever arm (20) retracted
   - All built-in equipment cabled and connected
   - Pantograph (21) mounted in cantilever arm (20) and connected
   - WLAN antenna (24) mounted in the cantilever arm (20) and connected
   - Accessory pack:
     Fixing elements on the cantilever arm, corrosion prevention colour and spray and
     fixing material on the terminal box (13)

INFO Load carrying capacity approx. 1,800 kg
Unit dimensions approx. 6,000 mm x 1,500 mm x 1,700 mm
(length x width x height)

2. Cable harnesses for connecting the charger housing to the charger mast and fixing material.

   INFO The cables are supplied by the respective Siemens local company and are laid in the cable ducts in the course of civil work.

3. Panels (18, sample image can vary in different packing units), delivered separately consisting of

   - demounted panels of the charger mast (15)
   - panels of the cantilever arm (20)
   - fixing materials for these assemblies

   INFO Load carrying capacity approx. 200 kg

2.2 Transport

The Urban Design Mast can be transported by ship, rail or road. To prevent damage during transportation, all components must be secured with shipping stops in accordance with the CTU Code and designed for the incurring forces (shock resistance: 3 g).

Ideally, the Urban Design Mast shall be transported to the construction site on a 20 ton truck that has its own loading crane (e.g. Palfinger). See main document [R30].

NOTICE **Damage to the charger mast during transport**

☞ Store and secure the charger mast in such a way that it is not damaged during transport. If possible, use a transport frame.

☞ Do not use a forklift w/o additional supporting structure in order to prevent damages on coating and covers mounted!

© Siemens

3 Requirements for the Place of Installation

3.1 Documents

The following documents must be present before assembly start:

- Soil survey, structural analysis, including that of the contracting company, see e.g. [R01]

3.2 Foundation

The foundation must fulfill the following requirements:

- Load carrying capacity approx. 2,000 kg
- Maximum distance from charger housing foundation (maximum length of signal cables): 100 m
- Foundation ground compliant local requirements. Grounding wire D10.
- 8 x M30 fixing bolts, for position see section 1.2.2
- 32 x M30 nuts and 16 washers for fastening the mast
- 2 bushings Ø = 120 mm for the cable ducts from charger housing, see section 1.2.2

3.3 Cable Laying

Output from charger housing to charger mast

Over their entire length the power cables must maintain a distance of **≥20 cm** to the signal and control cables to avoid interference.

- Foundation interface according to [R01]
- The outgoing supply cables must protrude at least 1.5 m from the foundation.
- The outgoing signal and control cables must protrude at least 2 m from the foundation.
- For the position of the cable entries to the charger mast foundation, see section 1.2.2

4 Installation

4.1 Preparation

Tools and working equipment see main document [R30]	Barrier material, padlock, cleaning material

DANGER

Danger of death or serious injury!

Possible electric shock from applied mains voltage.

☞ Ensure that the external voltage supply is switched off and secured against reconnection.

☞ Lock the circuit breaker with a personal padlock.

☞ Secure the working area.

☞ Clean all impurities from the foundations for charger housing and charger mast.

☞ Ensure that all fixing bolts in the foundations are undamaged.

☞ Ensure that all cables in the flexible tubes of the charger housing and charger mast foundations are undamaged.

☞ Ensure that the flexible tubes protrude 200 mm from the foundation for the charger housing and shorten them if necessary.

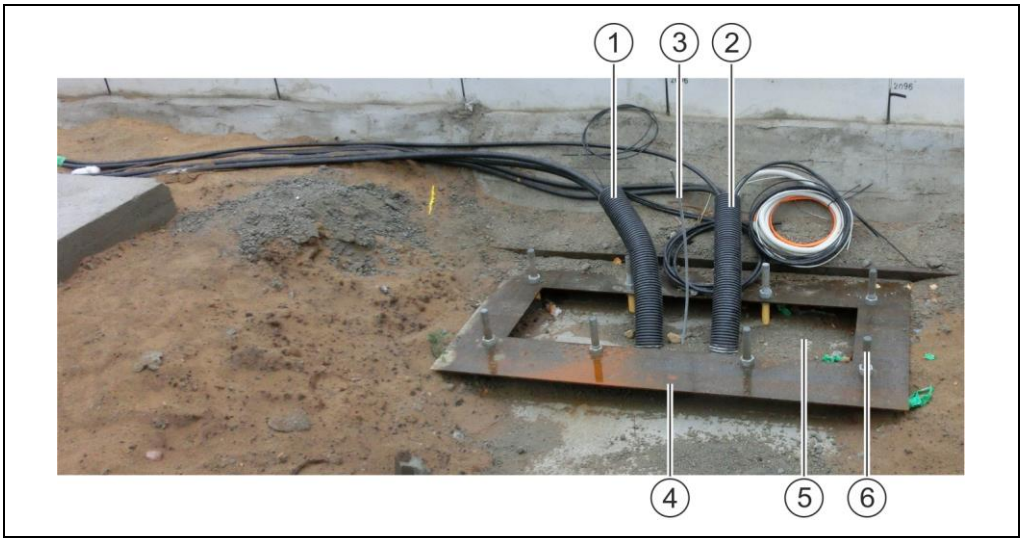
☞ Ensure that the flexible tubes protrude 850 mm from the foundation for the charger mast and shorten them if necessary.

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4.2 Setting Up Charger Mast, Extending and Attaching Cantilever Arm

Tools and working equipment see main document [R30]	Crane, mobile telescopic working platform, 4 lifting straps, safety rope, 32 x M30 nuts and 16 Washers, torque wrench, spirit level, folding rule, laser leveler

Fig. 4 Sample image: Foundation, template and cable ducts



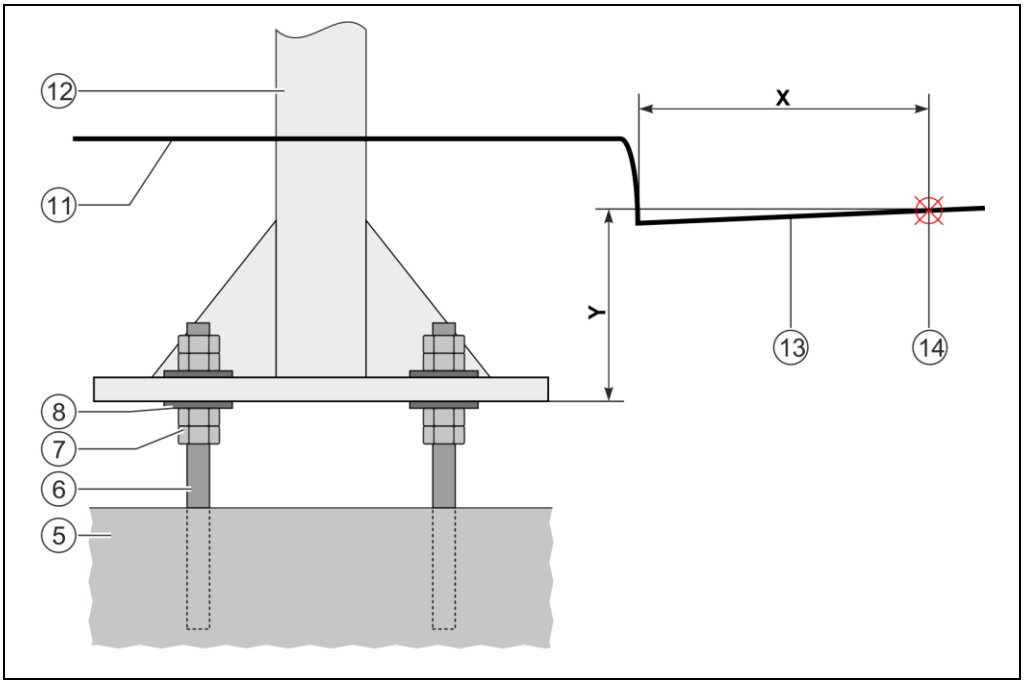
1 Cable duct power cable
2 Cable duct for signal/control lines
3 Foundation ground electrode
4 Template
5 Foundation
6 Anchor bolts

☞ Lay out the cable harnesses.

☞ Remove the locknuts from the template (4) and remove the template (4).

☞ Clean the foundation (5) and all 8 anchor bolts (6).

Fig. 5 Sample image: Leveling the charger mast



5 Foundation
6 Anchor bolts
7 Lower nut with locknut
8 Washer
11 Footpath, for example
12 Charger mast
13 Upper edge of street level
14 Measuring point, **X** = 1.250 ± 10 mm + **U** (see Fig. 1 in section 1.2.1)

☞ Define the zero point of the floor level with a laser leveler at the measuring point (14).

☞ Use the nuts (7) to align the upper edge of the washer (8) to the measuring point (14) considering the level difference **Y** (which depends on the required mast clearance, see Fig. 1 in section 1.2.1).

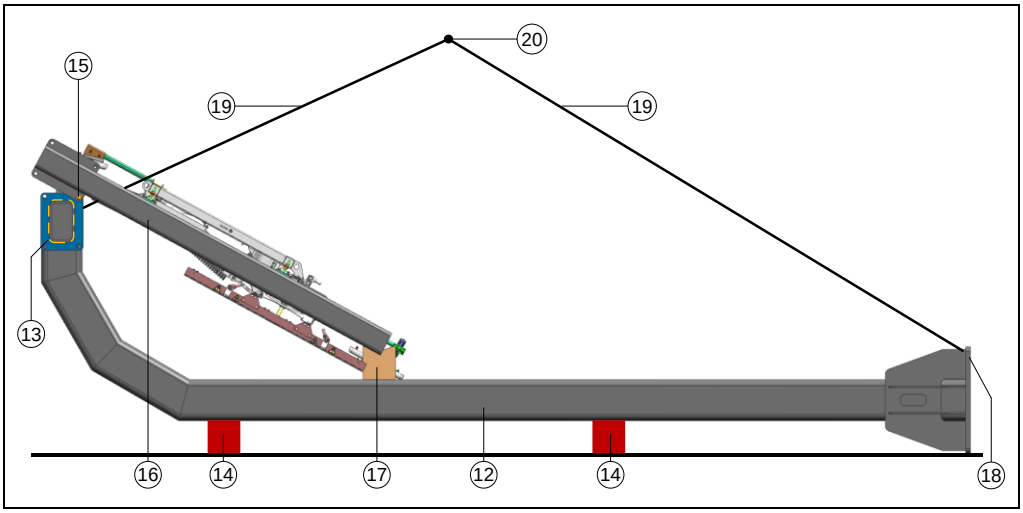
☞ Align the remaining 7 washers (8) to the same value.

☞ Tighten all 8 locknuts (7) to a torque of 220 Nm.

☞ Check the alignment of the 8 washers (8) against each other with a spirit level. Adjust them if necessary.

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Fig. 6 Schematic diagram: Attaching the charger mast to a crane



12 Charger mast
13 2 attachment points of tensioning rods
14 Support
15 Fastening screw (pivot point)
16 Retracted cantilever arm with pantograph
17 Transport stop
18 2 attachment points for lifting straps
19 4 lifting straps
20 Attachment point on the crane

☞ Attach 2 lifting straps to the attachment points (18).

☞ Attach 2 lifting straps to the attachment points (13).

☞ Attach all 4 lifting straps (19) securely to the crane (20).

☞ Attach safety rope to the charger mast.

☞ Ensure that all 4 lifting straps (19) are correctly attached. If necessary, re-attach them.

☞ Position the supports ready for the charger mast.

⚠ DANGER

Danger of death or serious injury!

Danger of death or serious injury from falling suspended loads.

☞ Observe all safety regulations for suspended loads.

☞ Only use lifting straps in perfect condition for lifting.

☞ Do not enter the hazardous area beneath a suspended load.

☞ Secure the suspended load with a rope to prevent it from swinging to and fro.

NOTICE

Before lifting the charger mast for installation

☞ Remove all packing material and supporting frames before lifting the charger mast!

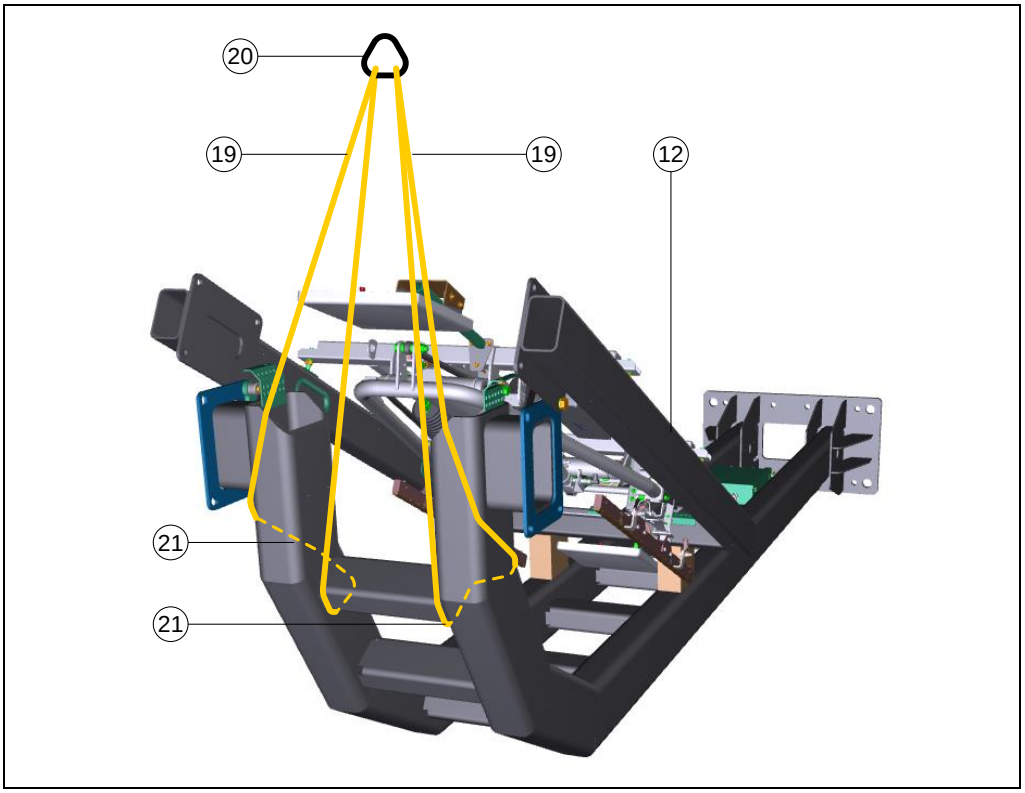
☞ Remove all loose cover parts and accessory packs before lifting the charger mast!

☞ Raise the charger mast slowly and unload it from the truck.

☞ Carefully lower the charger mast onto the supports.

☞ Remove all 4 lifting straps.

Fig. 7 Sample image: Attachment point on the crossbeam (pantograph not mounted)



12 Charger mast 21 Attachment point on the crossbeam (mind note below)

☞ Attach the lifting strap to the attachment point (21) of the upper cross beam. Mind note below!

DANGER

Danger of death or serious injury!

Danger of death or serious injury from falling suspended loads.

☞ Attach the lifting straps securely to the steel frame of the charger mast!

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☞ Ensure that the lifting strap is correctly attached. If necessary, re-attach it.

☞ Raise the charger mast slowly and swing it over the foundation.

☞ Align the charger mast with the cable harnesses and lower it slowly.

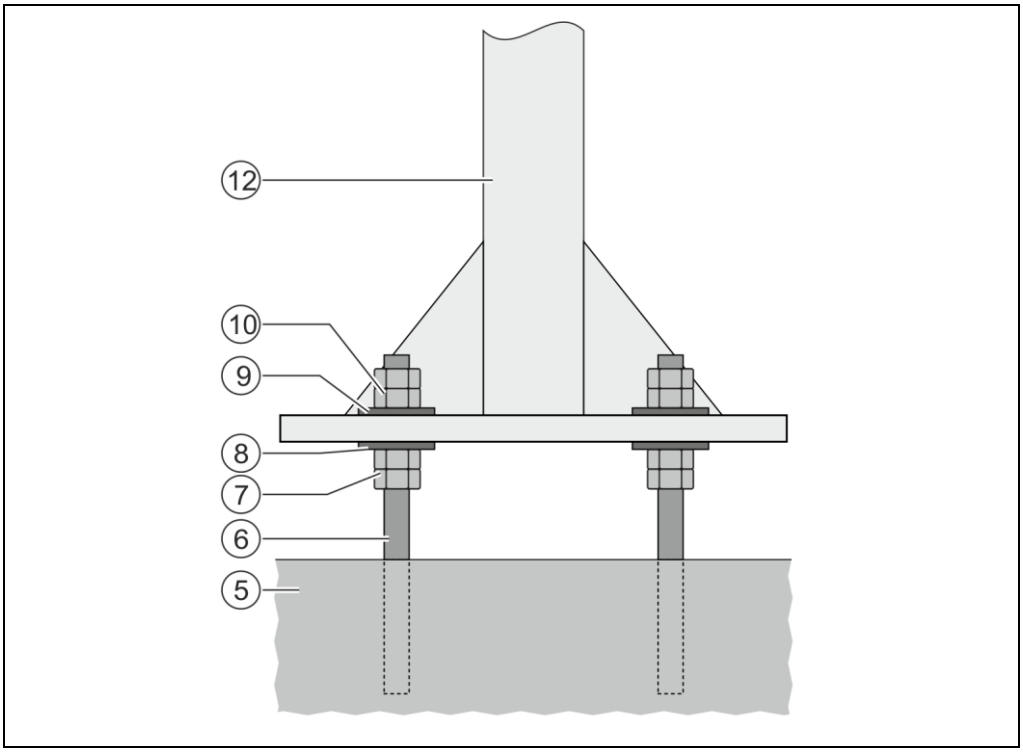
☞ As soon as the cable harnesses can be fed through, stop the lowering and thread the cables through.

☞ Ensure not to damage the fixing bolts (6) and cable harnesses while lowering the mast.

☞ Continue lowering the charger mast (12), align it with the fixing bolts (6), and set it down.

☞ Ensure that the charger mast (12) is positioned correctly. If necessary, raise it slightly and align it again.

Fig. 8 Sample image: Securing the charger mast



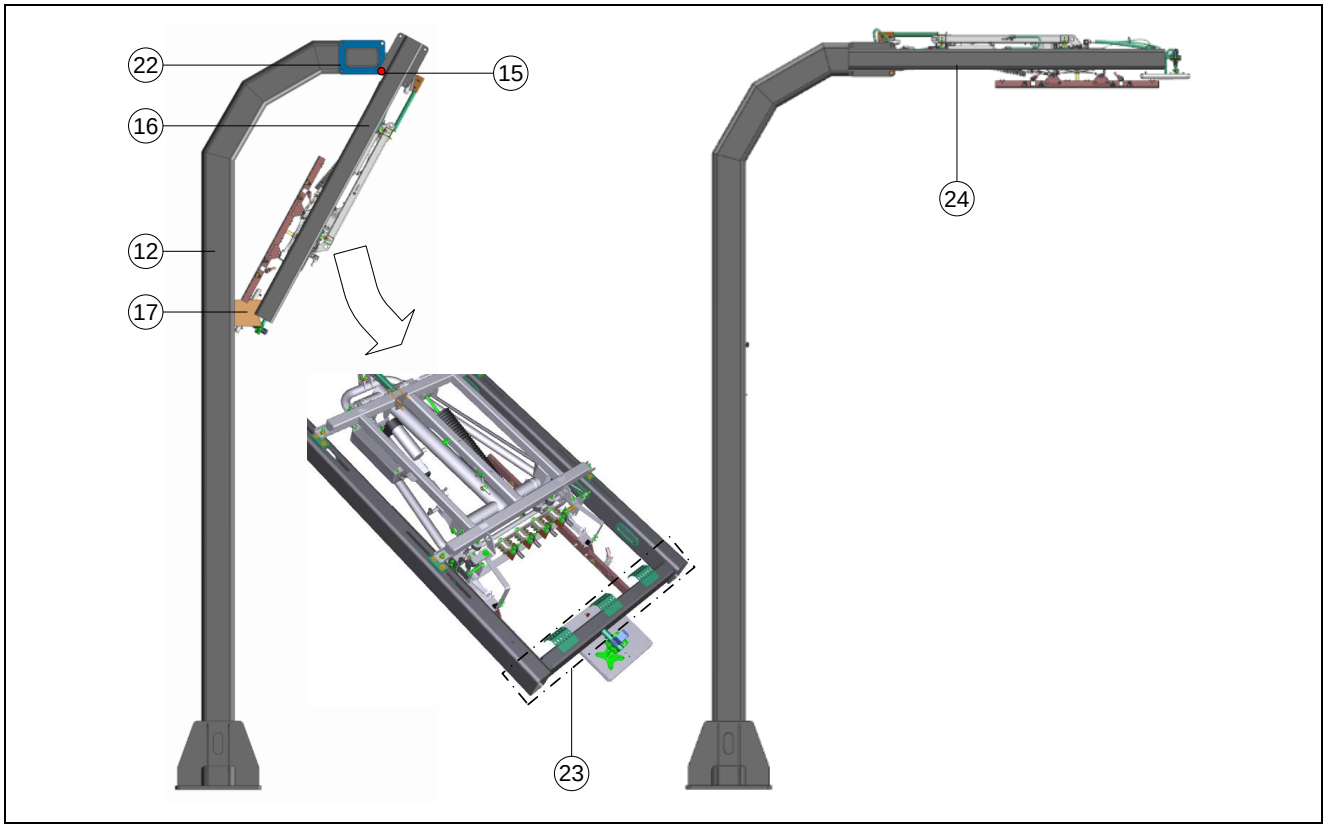
5 Foundation
6 Anchor bolts
7 Lower fixing nut with locknut
8 Washer
9 Washer
10 Upper fixing nut with locknut
12 Charger mast

☞ Place the washers (9) on the fixing bolts (6) and secure the charger mast (12) with 8x M30 fixing nuts (10).

☞ Tighten all 8 M30 fixing nuts (10) to a torque of 220 Nm.

☞ Secure the 8 fixing nuts with M30 locknuts (10) and tighten them to a torque of 220 Nm.

Fig. 9 Sample image: Extending and securing cantilever arm



12 Mast
15 Fixing screw with lock washer (pivot point)
16 Retracted cantilever arm
17 Shipping stop
22 Fixing bracket on the mast
23 Attachment points for lifting straps
24 Cantilever arm

☞ Coat all threads of fixing material with the corrosion prevention spray out of the accessory kit.

☞ Attach 2 lifting straps to the attachment points (23) and to the crane.

☞ Move mobile telescopic working platform into position.

INFO On the telescopic working platform you will need all materials required for 2 persons to securely attach the cantilever arm to the mast.

⚠ WARNING **Danger of serious injury!**

Risk of falling when working at great heights.

☞ Observe all safety regulations about working at great heights.

☞ Secure the fall arrester to one of the specially marked points on the telescopic working platform.

☞ If necessary, loosen the fixing bolts (15, pivot point) until the retracted cantilever arm (16) can be extended (24).

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⚠ WARNING **Risk of injury from sudden movement of the cantilever arm**

Severing, pinching or crushing of extremities.

☞ Only use lifting straps in perfect condition for lifting.

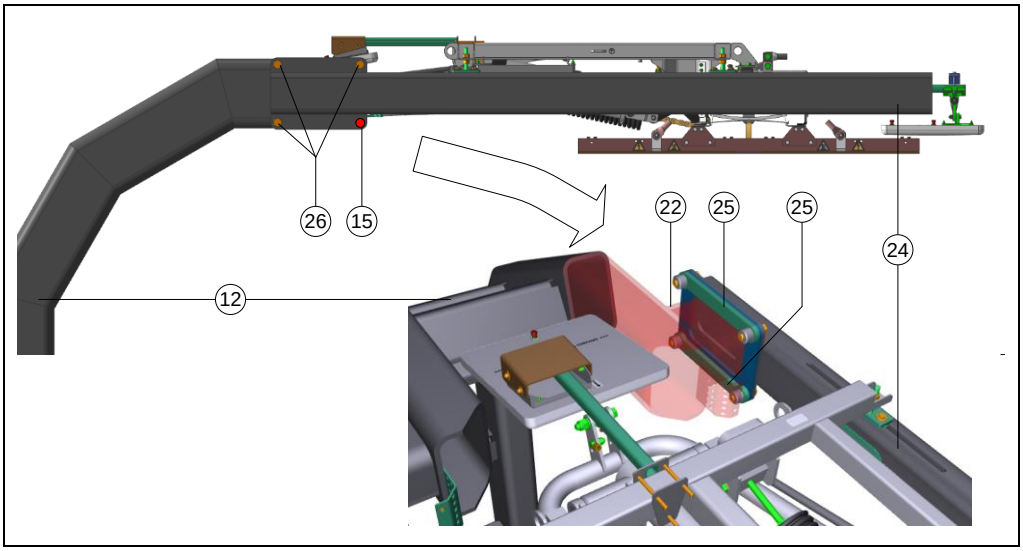
☞ Do not reach into the hazardous area when extending the cantilever arm.

☞ Carry out the work in a coordinated manner.

☞ Slowly raise the cantilever arm (16) to its extended position with the crane. Note the following points:

- While extending the cantilever arm (16), pay attention to the cables running from the cantilever arm (16) into the tube of the charger mast (12).
- If necessary, stop the raising and feed the cables by hand before continuing.

Fig. 10 Sample image: Securing the cantilever arm



12 Charger mast
22 Mounting bracket
15 Fixing screws (pivot point)
26 Fixing screws with lock washers
25 Fixing elements
24 Cantilever arm, correct position

☞ As soon as the cantilever arm is positioned correctly (24), proceed as follows:

- Fix the cantilever arm (24) with the fixing screws (15) and (26) including the lock washers and the fixing elements (25) to the mounting brackets (22) on both sides.
- Slightly tighten the fixing screws (15) and (26).
- Remove the shipping stop (17, Fig. 9) from the charger mast (12).

4.3 Check polarity of the Pantographs contact rails

Tools and working equipment see main document [R30]	Mobile telescopic working platform Heat shrink tube "POSITIVE POLE", 4FB206.03.93.1.92, 35 mm, Manufacturer part No. 1219558 Heat shrink tube "NEGATIVE POLE", 4FB206.03.93.2.93, 35 mm, Manufacturer part No. 1219560 Heat shrink tube "CONTROL PILOT", 4FB206.03.93.3.94, 35 mm, Manufacturer part No. 1219561 Heat shrink tube "PE", 4FB206.03.93.4.95, 35 mm, Manufacturer part No. 1219562

⚠ WARNING **Danger of serious injury!**

Risk of falling when working at great heights.

☞ Observe all safety regulations regarding working at great heights.

☞ Secure the fall arrester (PPE) to one of the specially marked points on the telescopic working platform.

☞ Check that all labels of the Pantographs contact rail cables are correct according driving direction (see main document [R30]).

☞ In case of wrong marked polarity labels exchange attached labels against the right ones.

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4.4 Aligning the WLAN Antenna

Tools and working equipment see main document [R30]	Mobile telescopic working platform, protractor

⚠ WARNING

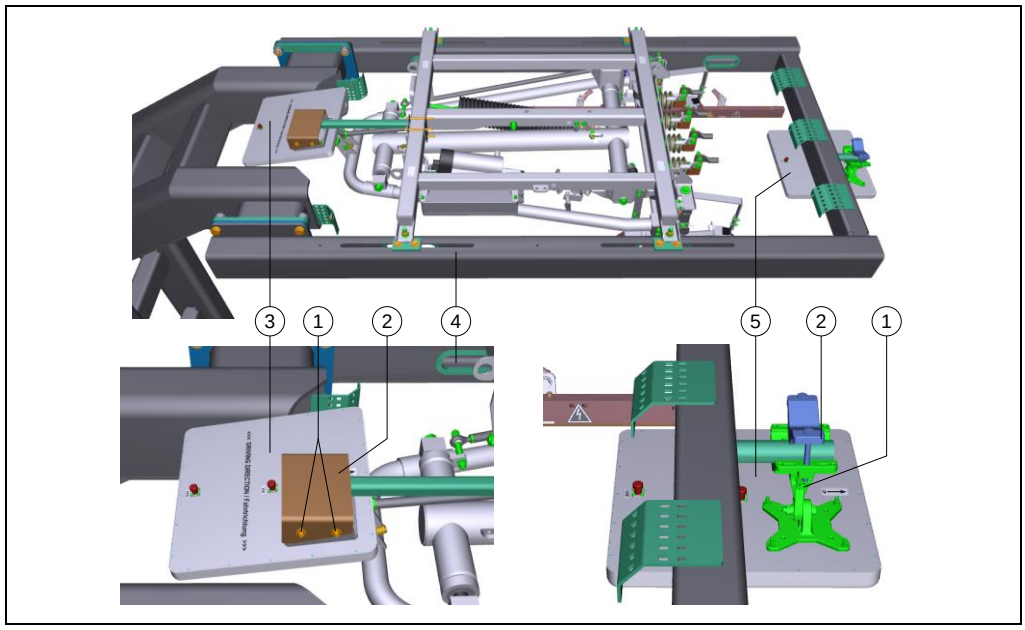
Danger of serious injury!

Risk of falling when working at great heights.

☞ Observe all safety regulations regarding working at great heights.

☞ Secure the fall arrester to one of the specially marked points on the telescopic working platform.

Fig. 11 Sample image: Aligning the WLAN antenna



1 Adjusting screws
2 Holding bracket
3 WLAN antenna (standard position)
4 Cantilever arm
5 WLAN antenna (alternative position)

☞ Adjust the WLAN antenna (3):

- Loosen all 4 adjusting screws (1).
- Adjust the WLAN antenna (3) to an angle of 20° ±1°.
- Tighten all 4 adjusting screws (1).

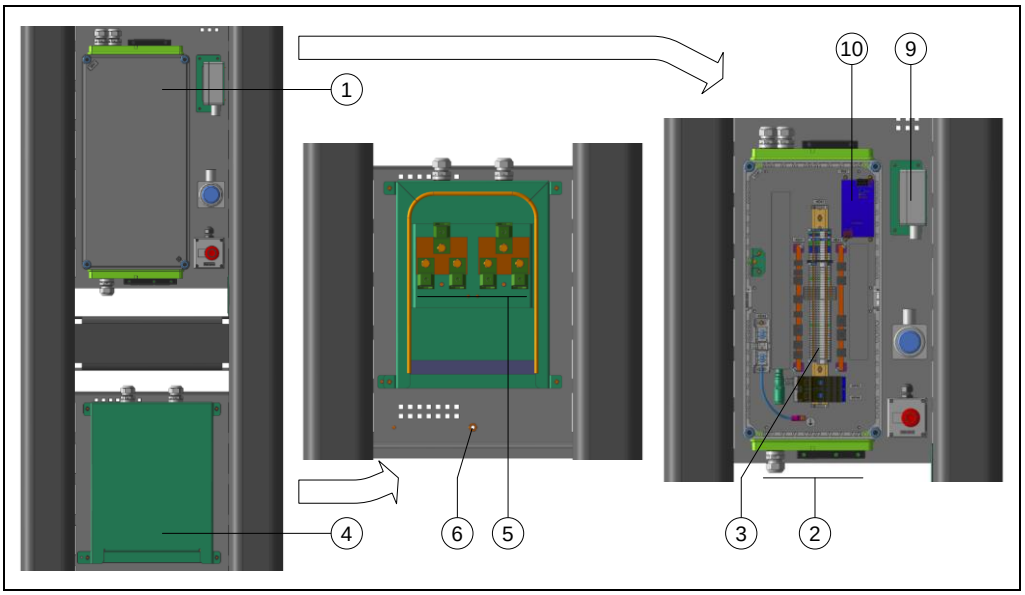
☞ Adjust the WLAN antenna (5):

- Loosen all 4 adjusting screws (1).
- Adjust WLAN antenna (5) to an angle of 2° ±2°.
- Tighten all 4 adjusting screws (1).

4.5 Connecting the Charger Mast

Tools and working equipment see main document [R30]	Torque wrench

Fig. 12 Sample image: Connecting the cable to the terminal boxes



1 Terminal box cover
2 Control and signal cables
3 Shield rail
4 Power supply cover
5 Power supply
6 Potential terminal for foundation ground
9 Temperature controller -KF01
10 24V power supply -TA01

☞ Remove terminal box cover (1).

☞ Remove power supply cover (4).

☞ Before connecting the foundation ground cable, trim it to the required length.

☞ Attach the foundation ground to the specially marked potential terminal (6).

☞ Connect the cable harness, comprising power cables (5), signal and control lines (2), to the power and PE cable terminals (see the following table). Observe the circuit diagram A6Z00042647933 [R11] and the torque settings.

☞ Install and connect the wifi cable according to the ECOFLEX® 15 mounting instruction.

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Type	Cables	Connecting terminals	Description
Power cables	=CDT1-WD30 (50 Nm)	=PCN1+40-UC42-XD43	+600kW pantograph – e.g. 600kcmil 2kV rated
	=CDT1-WD31 (50 Nm)		-600kW pantograph – e.g. 600kcmil 2kV rated
	=CDT1-WD34	=PCN1+40-UC41-XD42	230 V e.g. 2 #10 AWG, 1 – #10 AWG GND
	=CDT1-WD35		230 V e.g. 2 #10 AWG, 1 – #10 AWG GND
Signal and control cables	=CDT2-WG32	=PCN1+40-UC41-XD41	Control
	=CDT2-WG33		Control
	=CDT2-WE30 (20 Nm)	=PCN1+40-UC41-XE42	PE e.g. #3/0 AWG GND
	=CDT2-WE31	=PCN1+40-UC41-XD41	CP cable e.g. 2/C #20 AWG Twisted Pair
	=CDT2-WG31 from =CDB1+12-UC12-XD22:SH31	=PCN1+40-UC41-XE41	Shield terminals from -WG31
	=CDT2-WG36	=PCN1+40-UC41-XG46	WLAN cable direct from the HPCC (N-male/female connector)
	=CDT2-WG37	=PCN1+40-UC41-XD41	Charging indicator (red/green/blue)

☞ Check that all cables are laid correctly according to the cable laying plan [R11]. If necessary, secure them accordingly.

Charging Indicator (red/green/blue)

NOTICE

Wiring of charging indicator

Risk of damages.

☞ Incorrect wiring could damage the LED lights or other parts.

☞ Only electrical skilled personnel may perform the wiring.

☞ Observe the circuit diagram A6Z00042647933 [R11].

☞ The colour of the operating status lamp (7, Fig. 13) and the charging status lamp (8, Fig. 13) can be aligned and combined between red, green and blue (two colours each).

☞ The alignment and combination of the colours can be done by electrical wiring at the terminals -WG43 for operating status lamp and -WG44 for the charging status lamp.

☞ To switch over between two colours can be done by electrical wiring at the terminals -KF43 for operating status lamp and -KF44 for the charging status lamp.

Final steps

☞ Secure the power supply cover (4) with 4 screws.

☞ Secure terminal box cover (1) with 4 screws.

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4.6 Fitting the Mast Panels

Tools and working equipment see main document [R30]	Mobile telescopic working platform
OEM equipment	panel kit A2V00002722109 and Mounting Instructions [R11]

⚠ WARNING

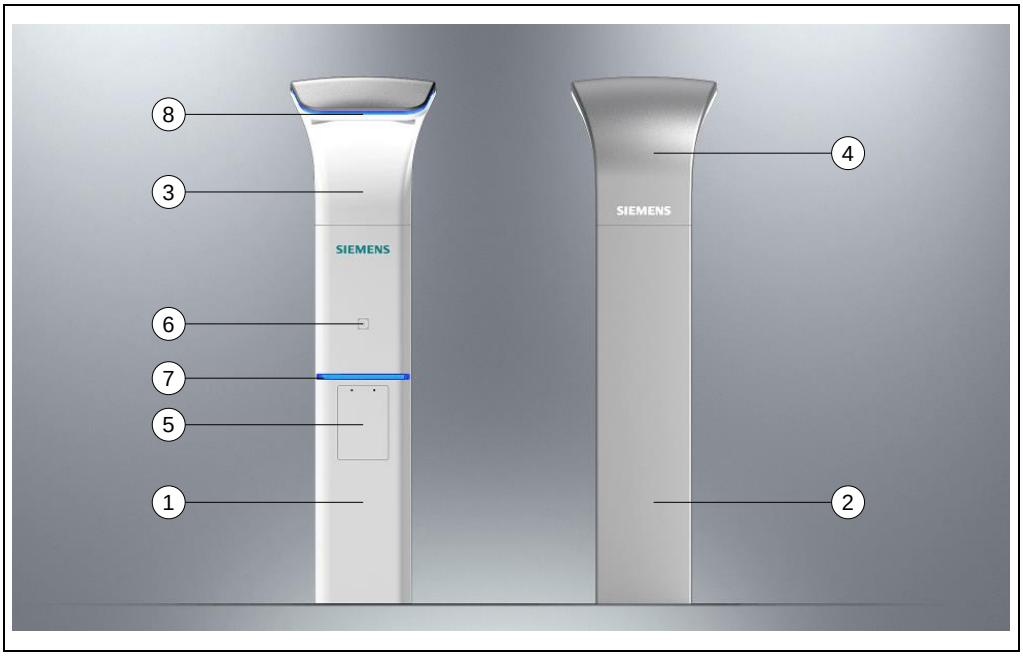
Danger of serious injury!

Risk of falling when working at great heights.

☞ Observe all safety regulations regarding working at great heights.

☞ Secure the fall arrester to one of the specially marked points on the telescopic working platform.

Fig. 13 Sample image: Mast panel and functional elements



1 Lower panel front side
2 Lower panel back side
3 Upper panel front side (2 parts)
4 Upper panel back side (2 parts)
5 Hatch to terminal box
6 Y-sensor
7 Operating status lamp (red/green/blue)
8 Charging status lamp (red/green/blue)

☞ Secure all panels according to the panel kit A2V00002722109 and Mounting Instructions [R11].

☞ Make sure that no pantograph cable rubs against the panels.

5 Initial Tests and First Commissioning

5.1 Insulation Test

☞ Prior to commissioning, perform an insulation test for the following cable connections from the charger housing to the charger mast:

Type	Cables	Connecting terminals	Description
Power cables	=CDT1-WD30	=PCN1+40-UC42-XD43	+600 V pantograph
	=CDT1-WD31		-600 V pantograph
	=CDT1-WD34	=PCN1+40-UC41-XD42	230 V
	=CDT1-WD35		230 V

5.2 Signal Check

☞ Prior to commissioning, perform a signal check in accordance with the circuit diagram A6Z00042647933 [R11]. Do the following cable connections from the charger housing to the charger mast function correctly:

Type	Cables	Connecting terminals	Description
Signal and control cables	=CDT2-WG32	=PCN1+40-UC41-XD41	Control
	=CDT2-WG33		Control
	=CDT2-WE31	=PCN1+40-UC41-XD41	CP cable
	=CDT2-WG37	=PCN1+40-UC41-XD41	Charging indicator (red/green/blue)

5.3 First Commissioning

☞ Proceed with first commissioning according to the main document [R30].

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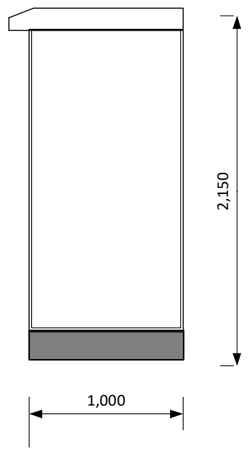
Siemens AG
Rudower Chaussee 29
12489 Berlin, Germany

E-mail: EB-EN.support.mobility@siemens.com

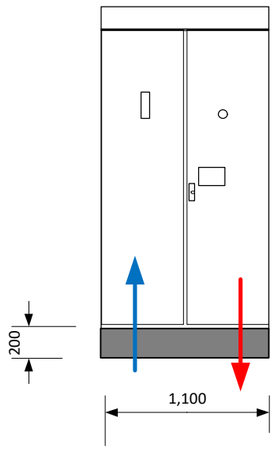
Sicharge UC 00

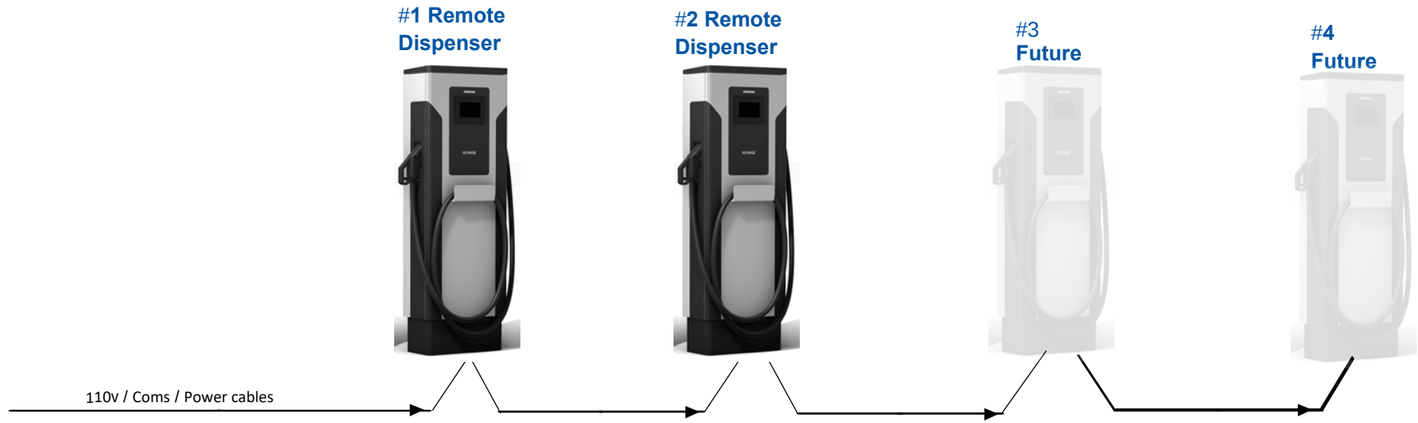
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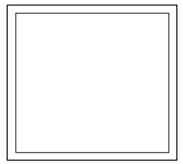
Side



Front







Top

200 meters maximum distance



LEGEND:

480 VAC Feeder

1000 VDC Feeder

Preliminary

ISSUE	DESCRIPTION	DATE	DRAWN	CHECKED	APPR'D
	Initial draft				
1					
2					

200 kW_Layout

INITIAL RELEASE: xxxxxxxx PLOT DATE: xxxxxxx

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Sicharge UC Charging Unit 200 kW

CUSTOMER DRAWING NUMBER

INITIAL RELEASE DATE

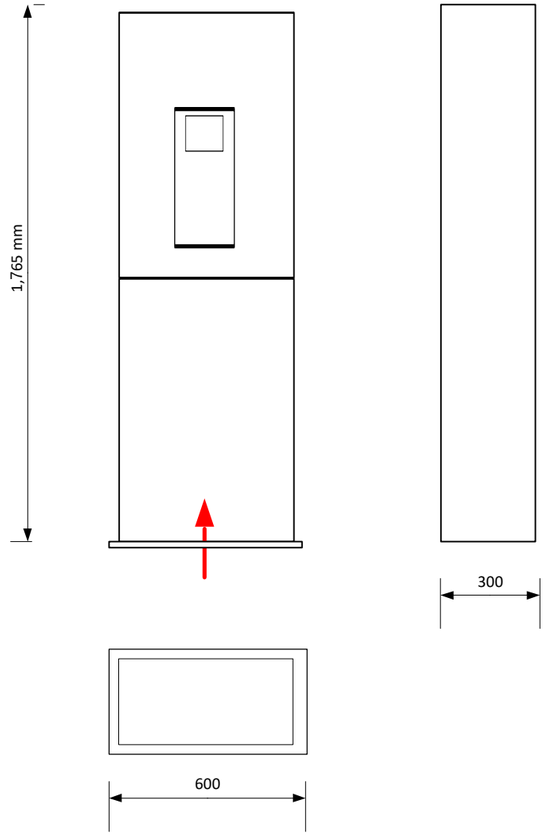
DRAWING NUMBER

SHT 3

CONT 4

Sicharge UC 00
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e era S eci ica i

Protection:	IP54 / IK10
Weight:	100kg / 220 Lbs
Height:	1,765mm / 69.5 in
Width:	600mm / 23.6 in
Depth:	300mm / 11.8 in
Peak Power:	200kW
Rated Power:	150kW
Current (max):	200A
Voltage Range:	10-1,000Vdc
Cable:	CCS

LEGEND:

- 110V control
- Communications cable
- Power Cables

Preliminary

ISSUE	DESCRIPTION	DATE	DRAWN	CHECKED	APPR'D
0	Initial draft				
1					
2					

200 kW Dispenser General Design

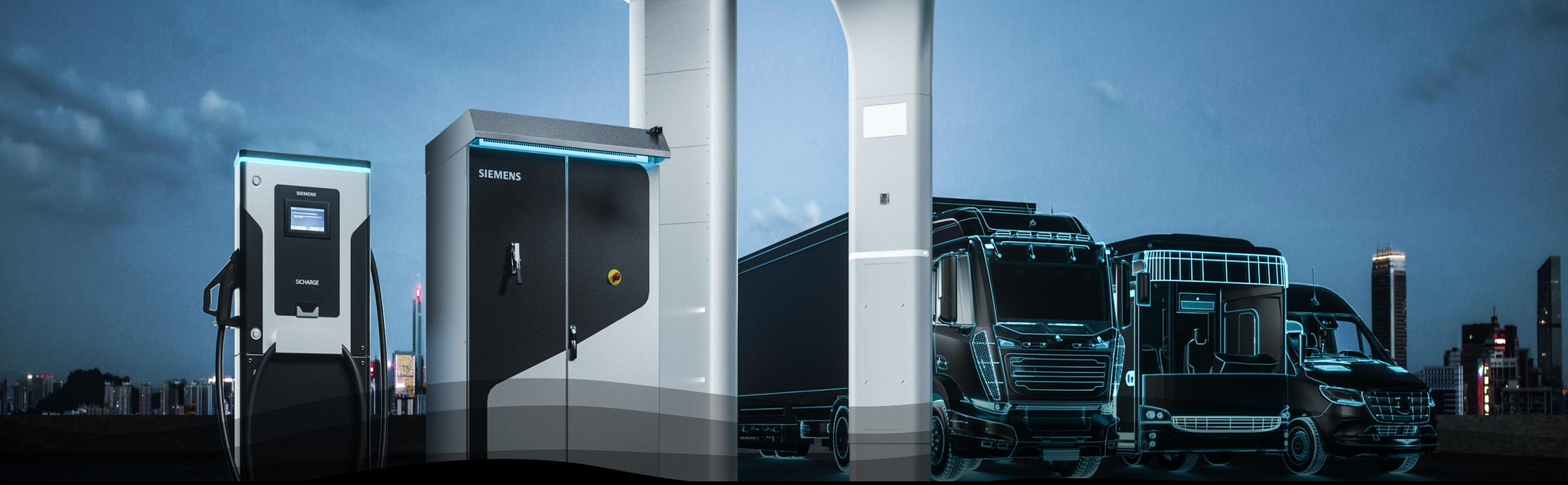
INITIAL RELEASE: xxxxxxxxx PLOT DATE: xxxxxxxx

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Dispenser Unit 200 kW

CUSTOMER DRAWING NUMBER: XXXXXXXXXXX

INITIAL RELEASE DATE | DRAWING NUMBER | SHT 4 | CONT



Modular charging solution for your electric fleet

SICHARGE UC™

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Electrical public charging concepts –
High power for your electric fleet



The future-oriented charging setup

- **Best fitting hardware and software** for your specific needs
- Freely choose from components of the SICHARGE UC family in **various power classes**
- **Core of the system**: One or multiple Charging Centers
- Charging Center contains AC grid connection and DC power electronics for your charging purposes
- The whole system provides various connection options for your **highest flexibility**

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SICHARGE UC™
High power for your electric fleet

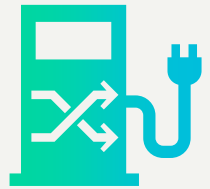


Interoperability and future proof up to 950 V

Ensure flexibility while electrifying your fleet – today & tomorrow

Flexible and space-saving

Easily integrate into the existing depot with constraints in HW, SW or layout



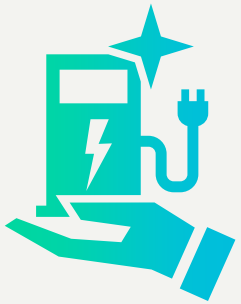


Robust, durable, and outdoor designed

Ensure longevity of equipment and the highest fleet availability

Optimized CAPEX and OPEX

Possess the most competitive solution and efficiently manage your daily operation



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SICHARGE UC™ - Tailored to your needs
Flexible configuration options

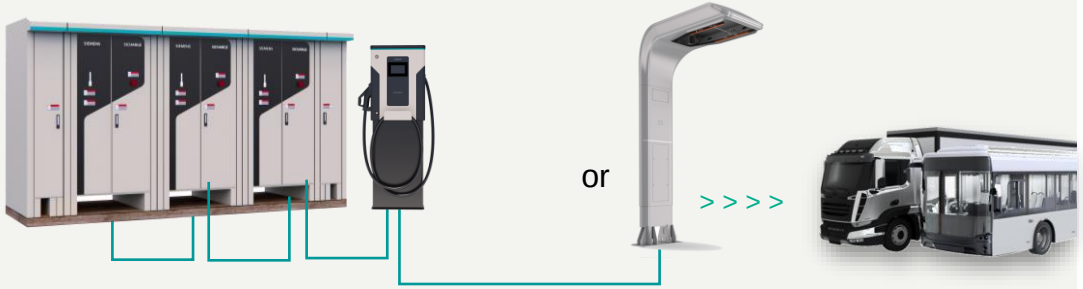
Sequential charging
SICHARGE UC™ connects to four J3105 pantographs, or CCS1 dispensers and allows for dynamic sequential charging.



Ultra high-power charging
Connect to liquid-cooled dispensers with up to 500A or J3105 compatible pantograph connections with up to 800A .



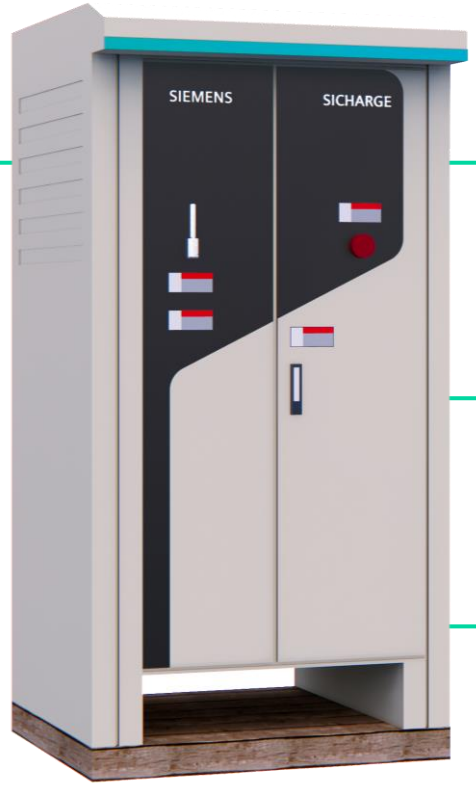
Charging flexibility – project specific
The SICHARGE UC™ family can adapt to your individual needs through a flexible combination of hardware in a switching matrix.



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SICHARGE UC™
Compact charging center

SICHARGE UC™



High degree of protection NEMA 3R against dust and spray water

Emergency Stop button.

C3 painted for outdoor usage

Large doors for easy maintenance access



Charging Center

The Charging Center is the core of your system. Several other vehicle connections like the cable-based dispenser, or inverted Pantograph can be powered by this unit. Combine power cabinets to achieve up to 600 kW of DC power. AC Incoming and DC outgoing cabinets dramatically reduces the installation cost. This feature reduces infrastructure costs by limiting the number of AC input feeds required for multiple cabinets.

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SICHARGE UC™
Vehicle interface front view – Dispenser

- Inclined rain protection Hood directs water to the rear
- Covered plug holder
- High degree of protection NEMA 3R against dust and moisture
- Multiple options for floor, wall or roof mounting
- Cable optionally cooled for up to 500 A



- Charging status indication by 360° LED light
- Multilingual 7“ outdoor touch-screen display at an ergonomic height, accessible and easy to read – also in bright sunlight (optional)
- Cable holder for convenient and clean operation
- Power cable for application in congested environments with comfortable length
- Air ventilation slots for the liquid cooled cable





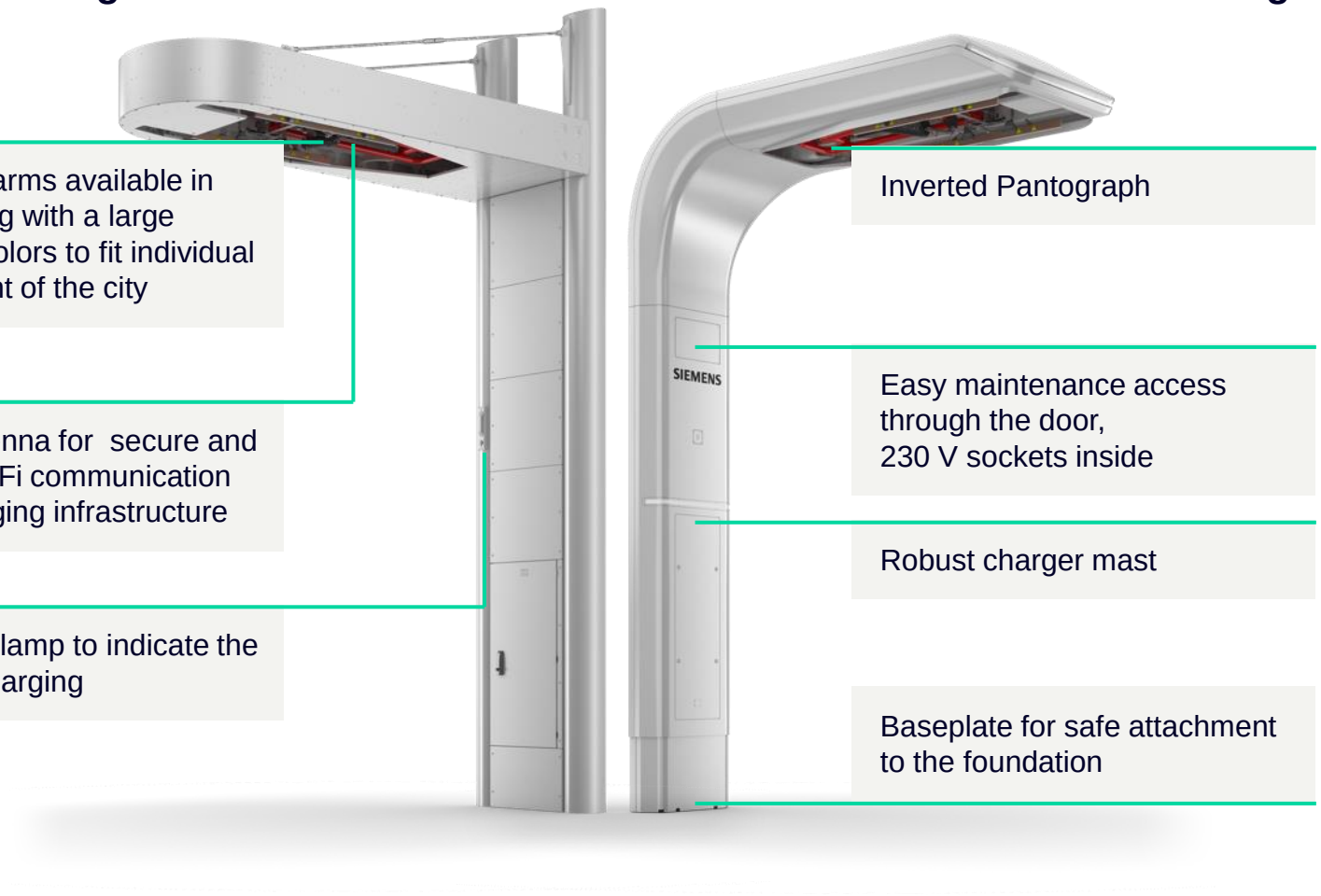
Dispenser

The cable connected dispenser of the UC family is installed close to the vehicle’s connection with a small footprint and elegant design. For investment and space optimization, several dispensers can be powered in sequence by a single Charging Center.

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SICHARGE UC™
Vehicle interface front view – **Inverted Pantograph**

Industrial Design **Urban Design**



Cantilever arms available in short or long with a large variety of colors to fit individual environment of the city

WLAN antenna for secure and reliable Wi-Fi communication to the charging infrastructure

LED signal lamp to indicate the status of charging

Inverted Pantograph

Easy maintenance access through the door, 230 V sockets inside

Robust charger mast

Baseplate for safe attachment to the foundation

Inverted Pantograph
The inverted Pantograph is a fully automated option to connect to the fleet, e.g., on feeding opportunities along the route.

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SICHARGE UC™
Plug-in connection

Siemens products



Dispenser 200A
Standard for up to 200 A no cooled cable application available

Dispenser 500A
Ventilation Slots for up to 500 A liquid cooled cable application





Charging Center
150 kW (or up to 600 kW)

Partner solutions



Cable Reel

Technical Data

- 4,7 m possible cable length
- Diameter approx. 900mm
- Weight approx. 100 kg
- CCS type 2 possible
- Up to 200 A DC
- Remote control possible

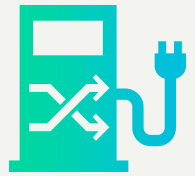
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SICHARGE UC™
Benefits at-a-glance



Future proof
- Upgradable to latest standards
- Highest voltage up to 950 V
- Proven interoperability

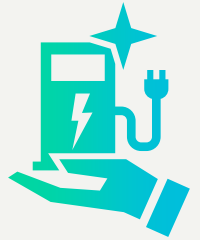
Flexibility
- A variety of charging opportunities for depot charging
- Power range from 100 to 800 kW
- Various connectivity options

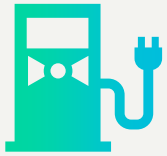




Robust and reliable
- Indoor and outdoor use
- Superior product quality
- Long-life components

Efficiency
- Best-in-class efficiency
- Smart charging option
- Smooth operation





Lean architecture
- Seamless design
- High reliability
- Small footprint

Smart charging
- High availability
- Fast and easy installation
- Excellent serviceability



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Cloud-based services
Taking care of your investment

Freely choose any element of our comprehensive services in your individual service contract





Our basic **Care package** includes:

- Connectivity independent of the OCPP channel
- On-demand remote analysis and diagnostics
- Firmware updates
- Included in the warranty period

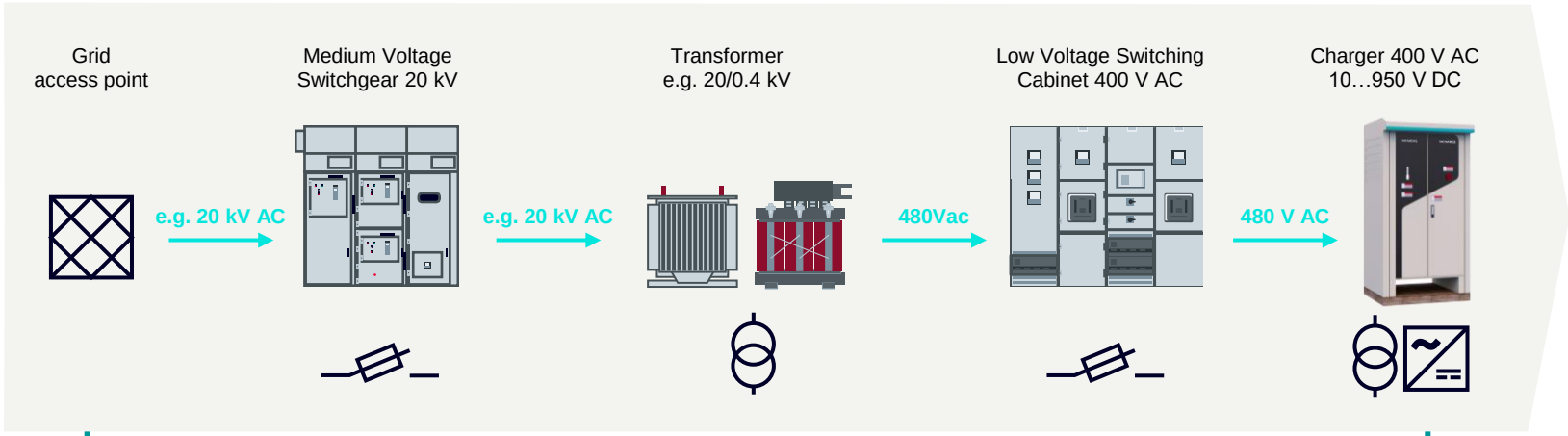
Easily manage your charging infrastructure from remote diagnostics to detailed reporting and operational planning and scheduling with one, simple user interface.

Choose your level of advanced management with our **Connect, Charge, and Control packages** - from device connectivity management, reporting functions, smart charging, route and power optimization and data analytics.

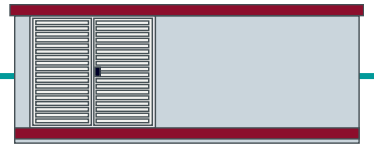
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End-to-end solution for your eFleet
Grid connection

Siemens offering:	Switchgear	Transformers	Switching cabinet	SICHARGE UC™	Vehicle interface





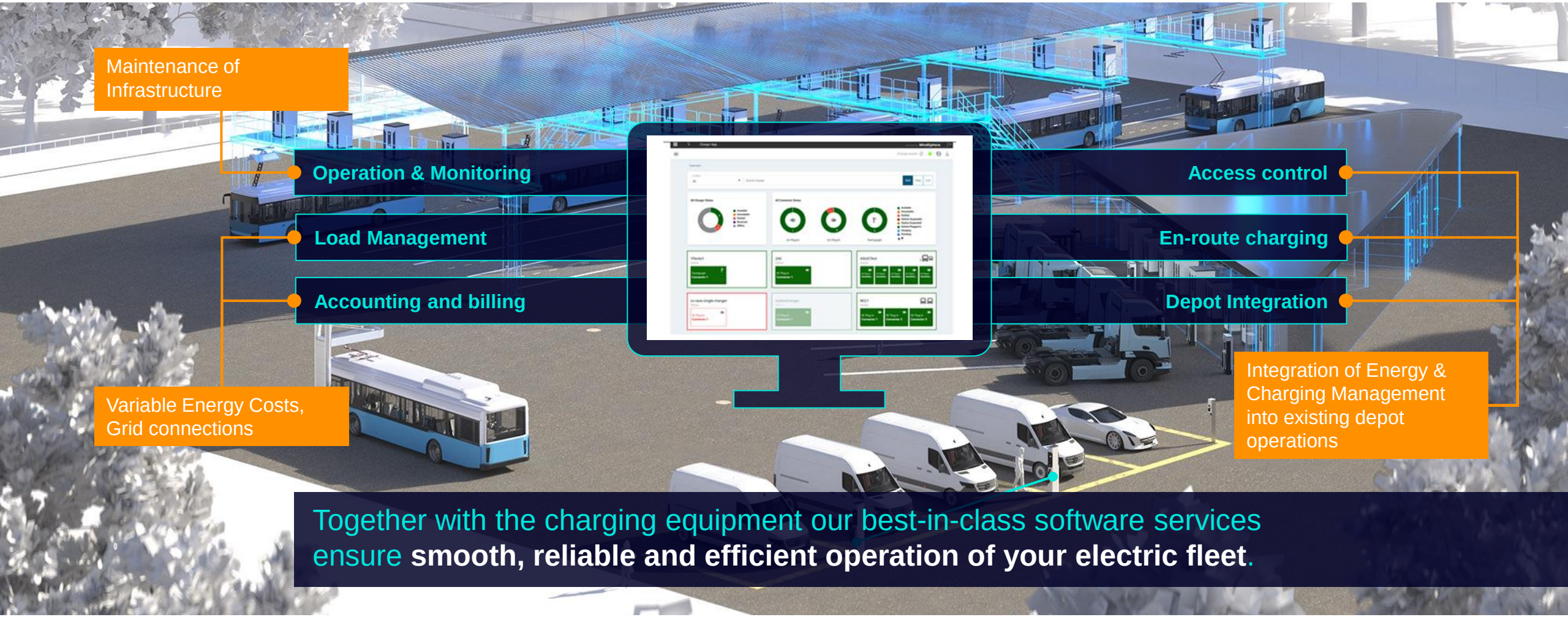


e.g. compact concrete station

Siemens offering: **Digital solutions to manage the operations of your eFleet**

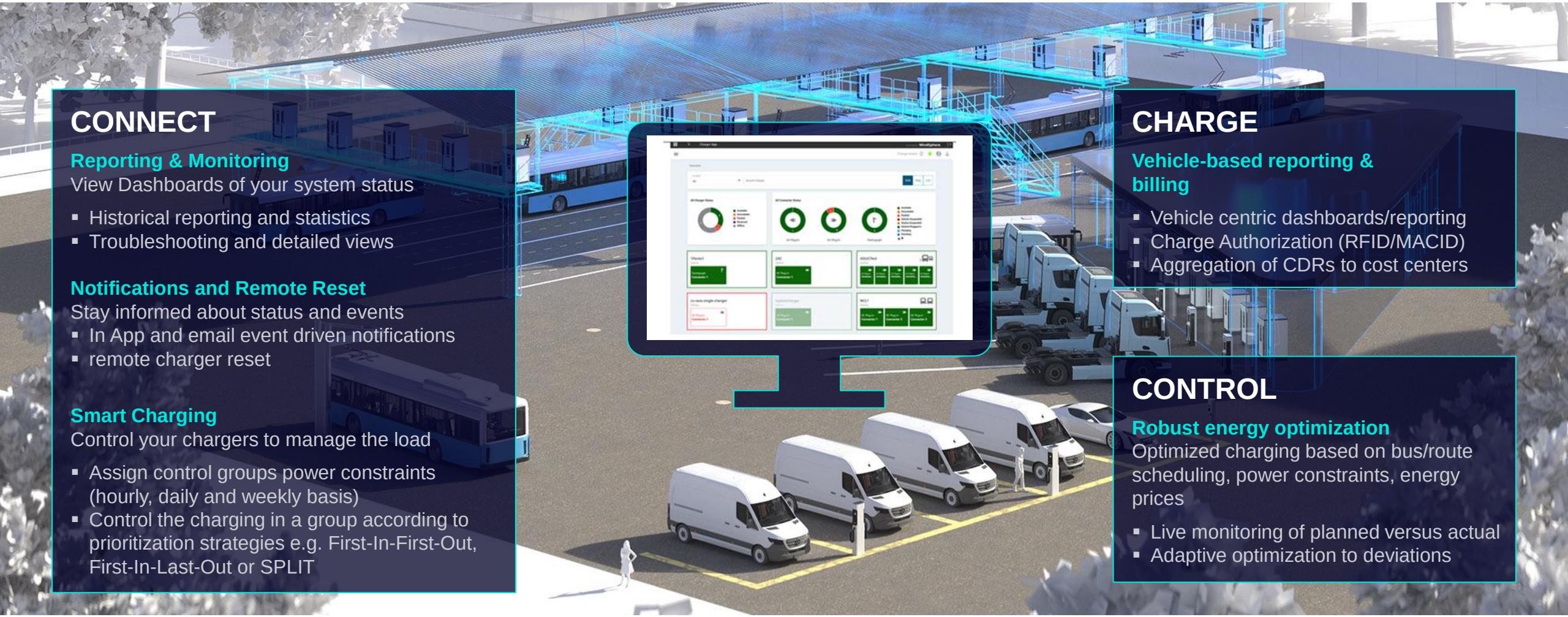
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Managing charging of your fleet
Benefit from Siemens software services



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The general idea



CONNECT

Reporting & Monitoring

View Dashboards of your system status

- Historical reporting and statistics
- Troubleshooting and detailed views

Notifications and Remote Reset

Stay informed about status and events

- In App and email event driven notifications
- remote charger reset

Smart Charging

Control your chargers to manage the load

- Assign control groups power constraints (hourly, daily and weekly basis)
- Control the charging in a group according to prioritization strategies e.g. First-In-First-Out, First-In-Last-Out or SPLIT

CHARGE

Vehicle-based reporting & billing

- Vehicle centric dashboards/reporting
- Charge Authorization (RFID/MACID)
- Aggregation of CDRs to cost centers

CONTROL

Robust energy optimization

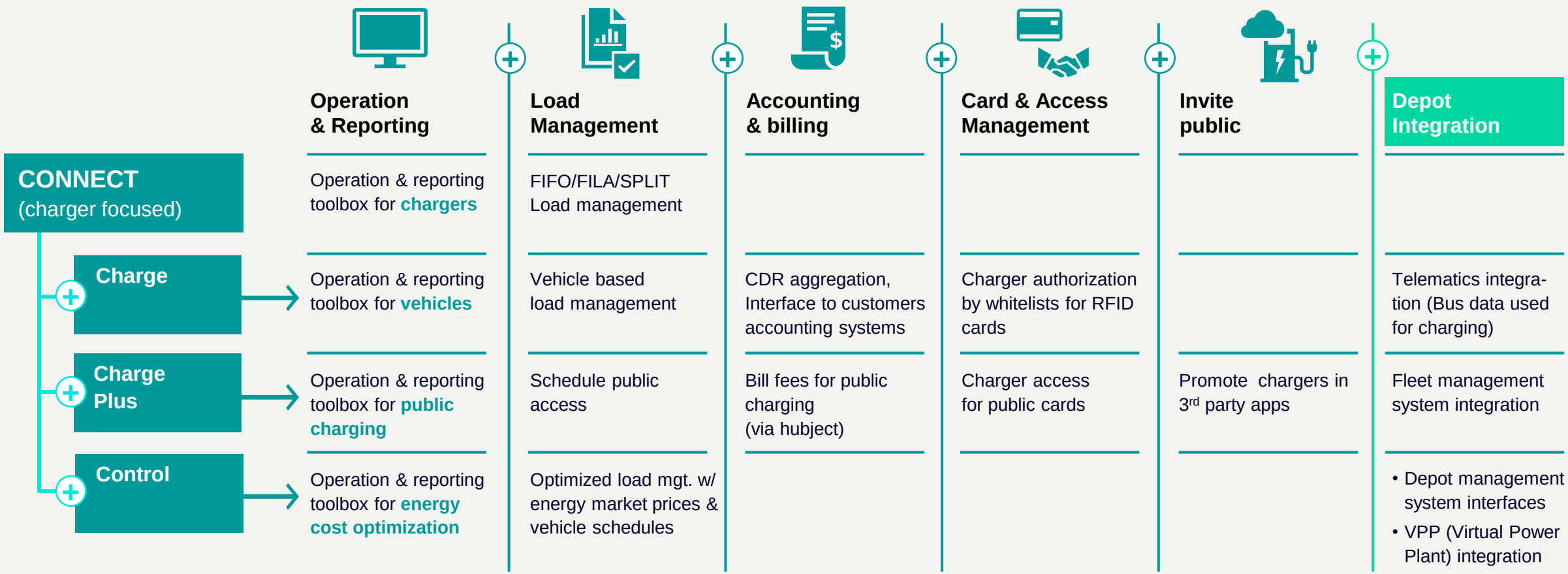
Optimized charging based on bus/route scheduling, power constraints, energy prices

- Live monitoring of planned versus actual
- Adaptive optimization to deviations

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Depot Charging Management



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SICHARGE UC
Core of the system



SICHCHARGE UC	200	400	600	800
Vehicle interface				
Air-cooled CCS Dispenser	X	-	-	-
Liquid-cooled CCS Dispenser	-	X	X	-
Mast-mounted inverted Pantograph	X	X	X	X
Nominal input				
Voltage	480 and 600 V AC (3ph + PE) ± 10 %			
Frequency, Hz	60			
Power factor COS phi	>0.98			
DC output*				
Rated power, kW	150	300	450	600
Current max., A	200	400	600	800
Voltage (range), V DC	10 ... 950			
Efficiency factor (at load 100%)	96% ... 97%			
Environmental Conditions				
Operating temperature	-13°F ... +113°F (Upon request)			

* Details available in the technical manual.

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SICHARGE UC
Core of the system





SICHARGE UC	200	400	600	800
Mechanical specifications				
Operational environment	Indoor and outdoor			
Protection enclosure	IP54, IK10 for housing			
Casing material	Galvanized steel, painted, C3			
Color	Main housing: RAL 9006 – White aluminium; roof and base: RAL 9017 – Traffic black matt			
Overall dimensions W x D x H, mm	43x39x87	87x39x87	130x39x87	173x39x87
Approx. weight, lbs. (without combiner cabinets)	3,307	6,614	9,921	13,228
General specifications				
Charge control unit	Siemens SIMATIC S7			
User authentication	RFID (optional)			
Network connection	Ethernet interface / 3G and 4G / WLAN			
Electric safety device	RCD B-type (optional)			
Communications protocol	OCPP 1.6 (J-SON)			
Charging standards	EN 61851-1/23/24, ISO 15118 (DIN 70121)*			
EMC standards	EN 55016-2-1 & -3; EN 61000-4-2 & -3 & -4 & -5 & -6			
Compliance	UL2202; UL2231			

* Complies with ISO15118-1 standard use-cases, further use-cases being implemented

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SICHARGE UC
Core of the system





DC Output*					
Connection standard	CCS type 1		OPPCharge		
Rated power, kW	150	300	600		
Current, A	200	500	800		
Voltage (range), V DC	10...950				
Environmental Conditions					
Operating Temperature	-13 ° F...+113 ° F				
Mechanical Specifications					
Protection	IP54, IK10 for housing, IK 09 for HMI				
Height, installed (in)	79 (36 for wall mounting)		223	259	259
Road clearance (in)	n/a		179 to 183		
Cantilever length (in)			156	165	205
Approx. distance mast to curb (in)			55	55	95
Footprint on sidewalk (in)	24 x 12		37 × 12	51 × 13	51 × 13
Operating range Pantograph (in)	n/a		35		
Approx. weight, (lb)	209 (132 for wall mounting)	397	4,354	4,123	5,071
Color	Main housing: RAL 9006 – White aluminum; roof and base: RAL 9017 – Traffic black matt				
Material	Galvanized powder coated steel		Galvanized steel with fiber glass panel	Galvanized steel, painted, min. C3	

* eVehicle under the Mast Hood will be given priority in charging sequence

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SICHARGE UC
Core of the system





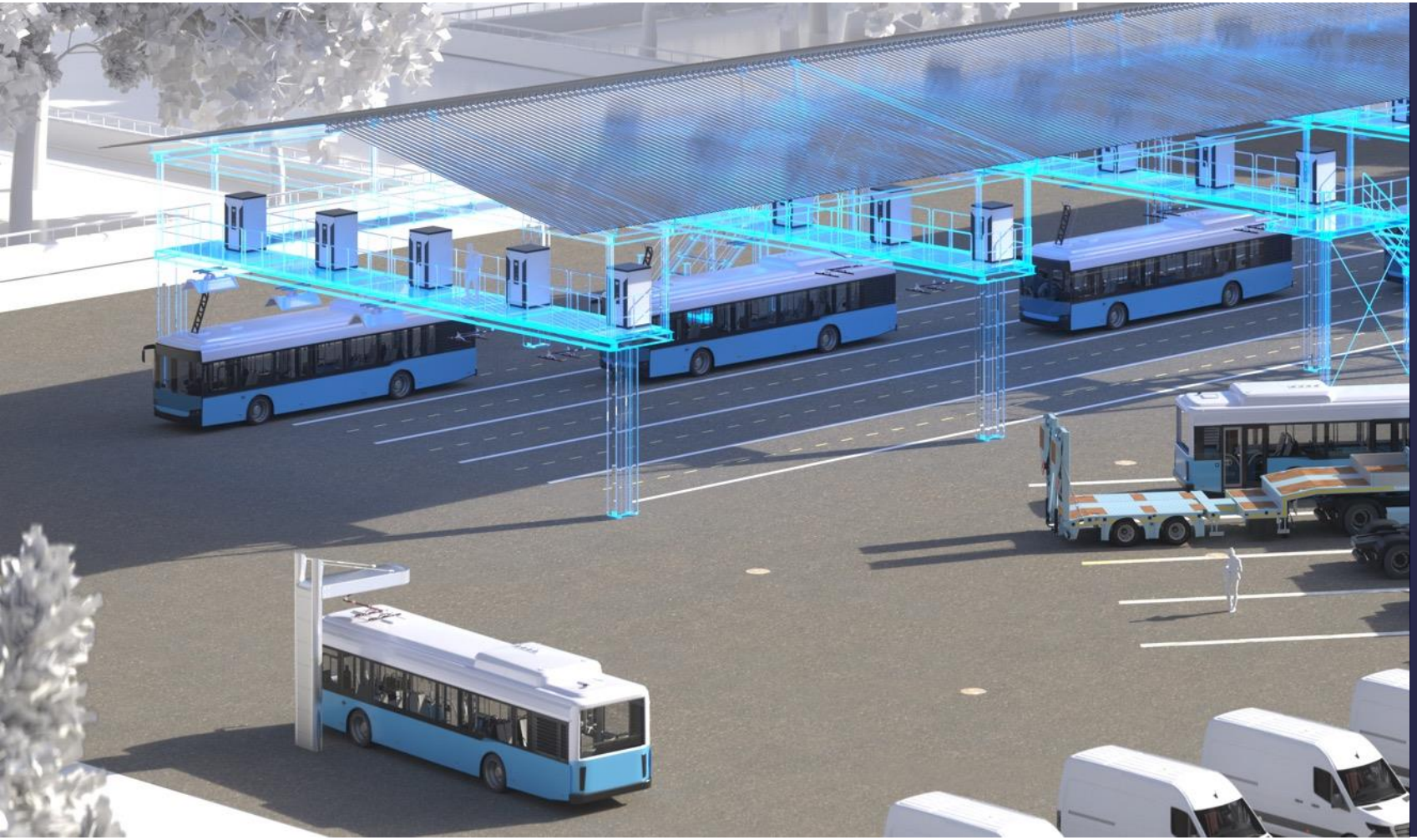
Connection Options	Dispenser		Inverted Pantograph		
Design Variants	Air-Cooled Cabinets	Liquid-Cooled Cabinets	UD Urban Design	ID Industrial Design	ID-E Industrial Design- Extended
General Specifications					
Communication standard	PLC		Wi-Fi IEEE 802.11a		
Number of possible connectors (sequential charging)	up to 4		4		
User authentication	RFID (optional)		RFID (optional)		
Cable lengths (ft)	11.5 / 20 / 33	11.5 / 16	n/a		
Compliance	UL				
Network connection	Ethernet interface / 3G / 4G / WLAN				
Local user interface	7" touchscreen HMI		n/a		
Charging status indication	LED		LED		

* eVehicle under the Mast Hood will be given priority in charging sequence

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SICHARGE UC

Best fitting charging setup for **public transport operators & municipalities**

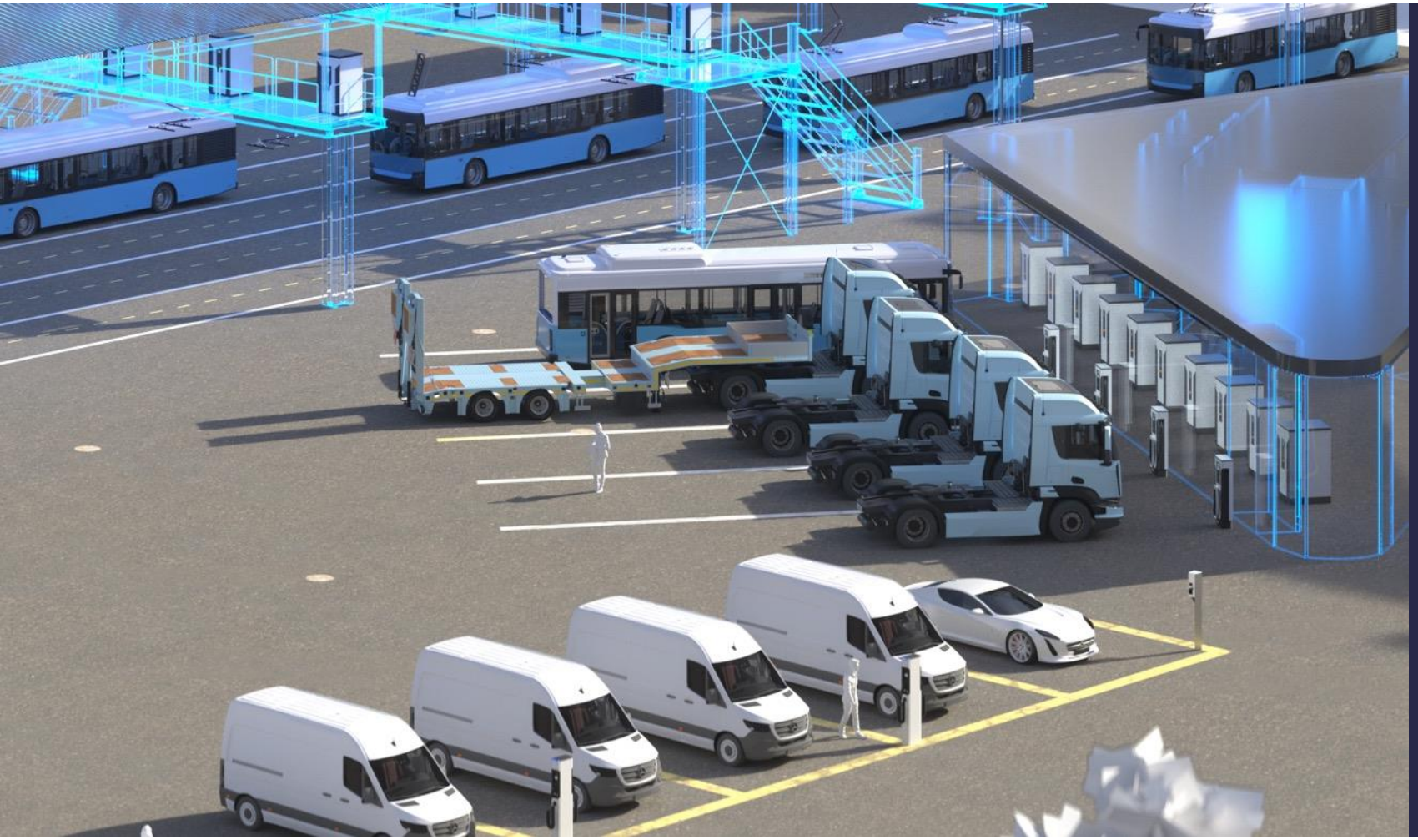


- eBus & duty vehicle depots charge at **low-power levels overnight** and at **high-power levels in terminals or during on-route** opportunity charging
- This requires technical solutions fitting your **specific needs** and ensuring the **highest fleet availability**
- Our solution includes **sequentially connected Dispensers** and **high-power, automated charging** with Pantographs (which even fit into depots with space limitations)

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SICHARGE UC
A comprehensive solution for **commercial applications**



- Keeping **tight delivery schedules** is one of the biggest challenges for commercial fleet operators
- **Parking, loading and unloading scenarios** need to be considered when planning charging infrastructure
- Direct charging from a **compact charger overnight** may be the best depot solution.
- **A liquid-cooled CCS plug** can deliver a **quick charge during the day.**

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SICHARGE Product Family overview – the Siemens 4x4

4x 200A Power Cabinet



X

4x Outlets, sequential operation and interchangeable



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SICHARGE Product Family – Designed for You



Adaptable System

Modular concept adapts to Your needs. Start with 200A and upgrade later. Start with single dispenser and add more later

Dynamic LED Light

Safety in public places and status indicator

DC output cabinet

Up to 4 outlets, J3105 pantograph, 200A or 500A CCS1 dispenser

AC Input Cabinet

Reduces construction while maintaining flexibility

Modular 200A Power Block

100-1000V DC with 200A continuous Power

Easy to service, easy to upgrade

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SICHARGE UC Features



4G/ Ethernet connected

Constant monitoring and OTA updates

Integration with Backend Systems

Out of the box EVC3 integration, fully OCPP 1.6 compliance for 3rd party integration

Design for Serviceability

Front access only allows for integration in small spaces while ensuring easy service

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SICHARGE UC™

Modular charging system

usa.siemens.com/sichargeuc

SICHARGE UC offers 150 kW (or up to 600 kW) of flexible charging solutions for buses, trucks, and heavy-duty vehicles, whether charging at a depot or en route.

- Fast, secure charging
- Design flexibility
- Sleek, compact dispenser size
- Easily upgradeable
- Low installation costs with one power cable needed
- Customizable: Connect up to four cabinets together to achieve 600kW of power
- Compatible with the Combined Charging System (CCS) charging standard and OCPP compliant.
- Interoperability

Designed with flexibility in mind

SICHARGE's sleek, compact design fits into a variety of configurations making the best use of limited space. Each SiCharge UC cabinet can power up to four charging dispensers with easy installation. With SICHARGE UC you can combine power cabinets to achieve up to 600 kW of DC power. AC incoming and DC outgoing cabinets dramatically reduces the installation cost. This feature reduces infrastructure costs by limiting the number of AC input feeds required for multiple cabinets.

Optimize your SICHARGE UC charging with sequential charging and easily manage your sequential charging with Siemens cloud-based services.

Choosing the right set up for you

Whether needing plug-in charging, en route charging, or overhead charging, SICHARGE UC offers a variety of charging configuration options to choose from.

Charging setup tailored to your needs

Flexible configuration options

Sequential charging

SICHARGE UC connects up to four J3105 pantographs, or CCS1 dispensers and allows for dynamic sequential charging.



Ultra-high-power charging

SICHARGE UC can be connected to liquid cooled dispensers with up to 500A or J3105 compatible pantograph connections with up to 800A.



Implementation of charging flexibility – project specific

The SICHARGE UC family can adapt to your individual needs using a flexible combination of switching matrix power.



Beyond the chargers

A variety of cloud service packages designed to effectively manage your depot and eFleet are available to help you best manage your charging infrastructure. Our solutions combined with our ecosystem of partners offers remote diagnostics to detailed reporting and operational planning and scheduling with one, simple user interface.

Siemens offers PlugtoGrid™, an end-to-end set of solutions for EV charging infrastructure. Easily connect your chargers to the grid with Siemens' eMobility open protocol technology and electrical power distribution solutions, as well as flexible options like energy storage, renewable power integration, and managed cloud services.

Technical data

	SICHARGE UC Charging center	SICHARGE UC Charging center and combiner cabinet		SICHARGE UC High-power charger
				
SICHARGE UC	**200**	**400**	**600**	**800**
Vehicle interface				
Air-cooled CCS cable Dispenser	×	-	-	-
Liquid-cooled CCS cable Dispenser	-	×	×	-
Mast mounted (inverted) Pantograph	×	×	×	×
Nominal input				
Voltage	480 and 600 V AC (3ph + PE) ± 10 %			
Frequency, Hz	60			
Power factor (cos phi)	> 0.98			
DC output*				
Rated power, kW	150	300	450	600
Current (cont.), A	200	400	600	800
Voltage (range), V DC	10 ... 950			
Efficiency factor η (at load 100%)	96% ... 97%			
Environmental conditions				
Operating temperature	-13 °F...+113 °F			
Mechanical specifications				
Operational environment	Indoor and outdoor			
Protection enclosure	IP54, IK10 for housing			
Casing material	Galvanized steel, painted, C3			
Color	Main housing: RAL 9006 – White aluminium; roof and base: RAL 9017 – Traffic black matt			
Overall dimensions W x D x H (in) without combiner cabinets (in side-by-side arrangement)	43x39x87	87x39x87	130x39x87	173x39x87
Approx. weight (lbs) without combiner cabinets	3,307	6,614	9,921	13,228
General specifications				
Charge control unit	Siemens SIMATIC S7			
User authentication	RFID (optional)			
Network connection	Ethernet interface / 3G / 4G / WLAN			
Electric safety device	RCD B-type (optional)			
Communications protocol	OCPP 1.6 (J-SON)			
Charging standards	EN 61851-1/23/24, ISO 15118 (DIN 70121)**			
EMC standards	EN 55016-2-1 & -3; EN 61000-4-2 & -3 & -4 & -5 & -6			
Compliance	UL2202; UL2231			

* Details available in the technical manual

** Complies with ISO15118-1 standard use-cases, further use-cases being implemented

SICHARGE UC
Dispenser

Air-cooled Liquid-cooled



SICHARGE UC
Inverted Pantograph



Connection options	Dispenser		Inverted Pantograph		
Design variants	**Air-cooled cables**	**Liquid-cooled cables**	**UD Urban design**	**ID Industrial design**	**ID-E Industrial design-extended**
DC output*					
Connection standard	CCS type 1		OPPCharge		
Rated power, kW	150	300	600		
Current, A	200	500	800		
Voltage (range), V DC	10...950				
Environmental conditions					
Operating temperature	-13 °F...+113 °F				
Mechanical specifications					
Protection	IP54, IK10 for housing, IK 09 for HMI				
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Road clearance (in)	n/a		179 to 183		
Cantilever length (in)			156	165	205
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Material	Galvanized powder coated steel		Galvanized steel with fiber glass panel	Galvanized steel, painted, min. C3	
General specifications					
Communication standard	PLC		WiFi IEEE 802.11a		
Number of possible connectors (sequential charging)	up to 4		4		
User authentication	RFID (optional)		RFID (optional)		
Cable lengths (ft)	11.5 / 20 / 33	11.5 / 16	n/a		
Compliance	UL				
Network connection	Ethernet interface / 3G / 4G / WLAN				
Local user interface	7" touchscreen HMI		n/a		
Charging status indication	LED		LED		

* eVehicle under the Mast Hood will be given priority in charging sequence.

Published by Siemens Industry, Inc. 2021

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Article No. SIDS-T40104-004AUS
Printed in USA
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SiCharge UC Spare Parts List

Component number	Object description	Assembly	Price
P3R77992000662	DC Axial Fan,119mm Square,24V, 30W	Cabinet	$ 213.06
P3R77992000663	16A, 1000VDC, 10x38 gPV Fuse	Cabinet	$ 6.14
P3R77992000702	Solid-state relay module , PLC-OPT- 24DC	Cabinet	$ 13.37
6GK58964ME000AA0	IRC ANTENNA ANT896-4ME	Cabinet	$ 71.40
P3R77879000018	FAN HEATER,028,250W,230V, dinrail mount	Cabinet	$ 164.73
3VA99780BL30	BREAKER 3VA SHUNT TRIP LEFT 24-30VDC	Cabinet	$ 32.76
3VA99780AA12	BREAKER 3VA4,5,6 AUX SWITCH STANDARD	Cabinet	$ 9.00
P3R77992000633	DIN-RAIL PLUGGABLE SPD, 480V, 20KA	Cabinet	$ 108.81
P3R77992000631	Input EMI Filter, 3 Ph, 250A, 760VAC	Cabinet	$1,019.63
3RT10666NP36	CONTACTOR S10 300A 200-277VUC 3P BAR	Cabinet	$ 729.50
3RT19664EA1	CONTACTOR COVERS 3RT1_6/3RT1_7 LONG	Cabinet	$ 14.29
3RT20231FB40	CONTACTOR S0 9A 24VDC 1NO/1NC SCRW	Cabinet	$ 51.09
P3R77992000663	16A, 1000VDC, 10x38 gPV Fuse	Cabinet	$ 6.14
3RV29011E	TRANSVERSE AUX. SWITCH 1NO+1NC SCREW	Cabinet	$ 6.24
5ST30100HG	AUXILIARY SWITCH , 1NO + 1NC , UL489	Cabinet	$ 8.76
3SK11111AB30	SAFETY RELAY,3NO,1NC,24V AC/DC,SCREW	Cabinet	$ 181.44
3RH21401FB40	CONTACTOR RELAY 4NO DC 24V SCREW	Cabinet	$ 27.50
3RH29111GA22	AUX. SWITCH 2NO+2NC FOR S00 SCREW	Cabinet	$ 9.67
P3R77992000013	Relay Module PLC-RPT- 24DC/21	Cabinet	$ 5.60
P3R77992000748	Relay Module - PLC-RPT- 24DC/21-21	Cabinet	$ 7.87
P3R77992000658	950uF,900VDC,CAPACITOR	Cabinet	$ 189.83
A6X30118410	Fuse,1000VDC,250A	Cabinet	$ 210.21
A6X30118461	SWITCH,MICRO,NH FUSE BVL50	Cabinet	$ 52.31
A6X30118462	ACC_FUSE_NH_SD2-D-PV_BASE_1kV	Cabinet	$ 70.11
A6X30118463	ACC_FUSE_SD12_SHROUD-KIT TO NH-PH	Cabinet	$ 8.17
P3R77992000017	1500V, 300A Sealed DC Contactor	Cabinet	$ 233.76
3NW70144	FUSE HOLDER PV 1P 25A 1000V 10X38MM LED	Cabinet	$ 14.93
P3R77992000156	20A, 1000VDC 10x38 gPV Fuse 50-215-06.20	Cabinet	$ 6.17
P3R77992000664	1500V,200A,NC,Sealed DC Contactor	Cabinet	$ 178.57
P3R77992000087	Output EMI Filter, 250A, 1000VDC	Cabinet	$ 412.20
P3R77992000660	RadiCal Centrif Fan 975m3/h 169W	Cabinet	$ 543.19
P3R77992000640	6P DIODE BRIDGE,232A,SEMiX291D16s	Cabinet	$ 61.89
P3R77992000643	IGBT MODULE HALF BRIDGE,1200V,300A	Cabinet	$ 140.29
P3R77992000643	IGBT MODULE HALF BRIDGE,1200V,300A	Cabinet	$ 140.29
P3R77992000658	950uF,900VDC,CAPACITOR	Cabinet	$ 189.83
P3R77992000644	25uF,1000VDC,METALIZED POLY CAP	Cabinet	$ 26.43
A6X30021340	DIODE RECTIFIER MODULE 380AMP, 1600V	Cabinet	$ 179.81
P3R77992000757	DC Axial Fan,Square, 24V, 90W, 294 CFM	Cabinet	$ 217.60
P3R77992000011	Cord / Plug set (25 ft)	Dispenser	$1,571.43
6GK50041BD001AB2	Ethernet-Switch	Dispenser	$ 142.20
P3R77992000234	Ventilation Filter Hood	Dispenser	$ 135.71
P3R77992000228	Ventilation Filter	Dispenser	$ 85.71
P3R77992000012	Cable Plug Holster	Dispenser	$ 50.00
P3REC100000509	Cable Reel	Dispenser	$ 72.19
P3REC100000503	Cable Reel	Dispenser	$ 165.87
P3R77992000013	Relay 24VDC	Dispenser	$ 5.60

*List as of Dec ‘20

SiCharge UC Spare Parts List

P3R77992000200	Relay 120VAC	Dispenser	$ 9.86
P3R77992000014	Relay 120VAC	Dispenser	$ 9.94
P3R77969000101	Vent filter replacement pad	Dispenser	$ 5.23
P3R77992000015	Dual Thermostat, ZR 011, 1NC+1NO	Dispenser	$ 45.06
P3R77992000014	Relay Module - PLC-RPT-230UC/21-21	Dispenser	$ 9.94
P3R77992000666	Power supply unit - UNO-PS/1AC/24DC/100W	Dispenser	$ 51.57
P3R68879000014	Cabinet Heater, 230V, 30W	Dispenser	$ 156.43
P3R77992000634	Power supply unit PS/1AC/24DC/240W	Dispenser	$ 86.29
6ES72315PD320XB0	SIMATIC S7-1200 SM1231 RTD 4 X AI	Dispenser	$ 210.56
6GK50042BD001AB2	SCALANCE XB004-2	Dispenser	$ 204.14
3RH21401FB40	CONTACTOR RELAY 4NO DC 24V SCREW	Dispenser	$ 27.50
P3R77992000013	Relay Module PLC-RPT- 24DC/21	Dispenser	$ 5.60
P3R77992000748	Relay Module - PLC-RPT- 24DC/21-21	Dispenser	$ 7.87
P3R77992000178	PT100, M4 thread, -50 to 230 degC	Dispenser	$ 80.67
A6X30118461	SWITCH,MICRO,NH FUSE BVL50	Dispenser	$ 52.31
P3R77992000017	1500V, 300A Sealed DC Contactor	Dispenser	$ 233.76
6ES72141HG400XB0	CPU 1214C, DC/DC/RELAY, 14DI/10DO/2AI	Dispenser	$ 244.03
6AV21240GC130AX0	SIMATIC HMI TP700 COMFORT OUTDOOR	Dispenser	$1,305.27
P3R77992000764	MICROSWITCH for DC Output Fuse	Mast	$ 65.49
P3R77992000762	Specialty Fuses 1kA 1250V 3BKN/90 AR	Mast	$1,002.86
6GK57938DK000AA0	WLAN Antenna	Mast	$ 325.07
P3R77992000325	Y-Sensor	Mast	$ 285.71
P3R77992000404	Mast Heater Unit	Mast	$ 85.79
P3R77992000324	Media Converter	Mast	$ 265.47
6GK57741FX000AA0	Wifi Router	Mast	$ 671.29
P3R77992000398	Mast power supply	Mast	$ 121.14
5SJ41107HG41	MCB 5SJ4 1P 240V 10A 14K C-TRIP	Mast	$ 14.24
5SJ41067HG41	MCB 5SJ4 1P 240V 6A 14K C-TRIP	Mast	$ 18.23
5SJ41027HG41	MCB 5SJ4 1P 240V 2A 14K C-TRIP	Mast	$ 18.27
6GK50042BD001AB2	SCALANCE XB004-2	Mast	$ 204.14
6ES72141AG400XB0	SIMATIC S7-1200 CPU 1214C DCDCDC	Mast	$ 253.23
6ES76470AA001YA2	SIMATIC IOT2040	Mast	$ 173.29
6GK57741FX000AB0	SCALANCE W774-1 RJ45	Mast	$ 665.61
P3R77992000666	Power supply unit - UNO-PS/1AC/24DC/100W	Mast	$ 51.57
P3R77992000398	Power supply unit - UNO2-PS/1AC/24DC/480	Mast	$ 121.14
P3R77992000404	PTC Heater, 50W, with fixed point thermo	Mast	$ 85.79
P3R77992000014	Relay Module - PLC-RPT-230UC/21-21	Mast	$ 9.94
A2V00002693010	CONTROL PILOT DEVICE	Mast	$ 726.60
P3R77992000013	Relay Module PLC-RPT- 24DC/21	Mast	$ 5.60
6GT28116CA101AA0	RF685R UHF Reader, FCC Version	Mast	$1,947.94
P3R77992000785	16GB microSDHC Flash Memory Card	Mast	$ 14.40

*List as of Dec ‘20

SiCharge UC Spare Parts List

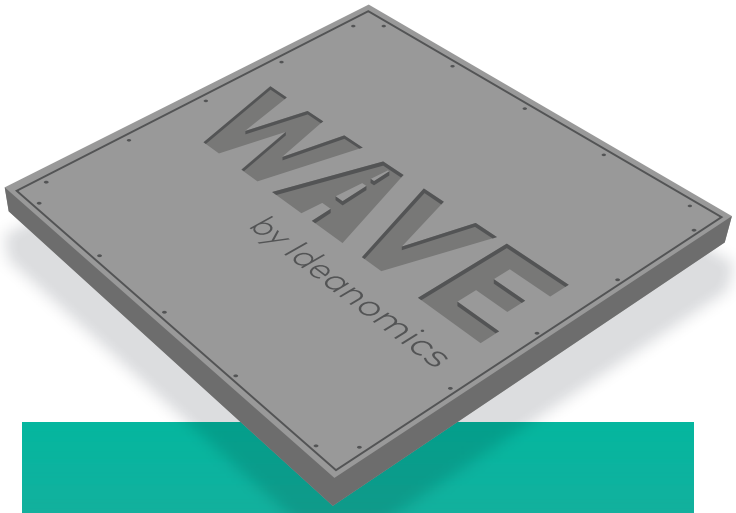
Component number	Object description	Assembly
P3R77992000662	DC Axial Fan,119mm Square,24V, 30W	Cabinet
P3R77992000663	16A, 1000VDC, 10x38 gPV Fuse	Cabinet
P3R77992000702	Solid-state relay module , PLC-OPT- 24DC	Cabinet
6GK58964ME000AA0	IRC ANTENNA ANT896-4ME	Cabinet
P3R77879000018	FAN HEATER,028,250W,230V, dinrail mount	Cabinet
3VA99780BL30	BREAKER 3VA SHUNT TRIP LEFT 24-30VDC	Cabinet
3VA99780AA12	BREAKER 3VA4,5,6 AUX SWITCH STANDARD	Cabinet
P3R77992000633	DIN-RAIL PLUGGABLE SPD, 480V, 20KA	Cabinet
P3R77992000631	Input EMI Filter, 3 Ph, 250A, 760VAC	Cabinet
3RT10666NP36	CONTACTOR S10 300A 200-277VUC 3P BAR	Cabinet
3RT19664EA1	CONTACTOR COVERS 3RT1_6/3RT1_7 LONG	Cabinet
3RT20231FB40	CONTACTOR S0 9A 24VDC 1NO/1NC SCRW	Cabinet
P3R77992000663	16A, 1000VDC, 10x38 gPV Fuse	Cabinet
3RV29011E	TRANSVERSE AUX. SWITCH 1NO+1NC SCREW	Cabinet
5ST30100HG	AUXILIARY SWITCH , 1NO + 1NC , UL489	Cabinet
3SK11111AB30	SAFETY RELAY,3NO,1NC,24V AC/DC,SCREW	Cabinet
3RH21401FB40	CONTACTOR RELAY 4NO DC 24V SCREW	Cabinet
3RH29111GA22	AUX. SWITCH 2NO+2NC FOR S00 SCREW	Cabinet
P3R77992000013	Relay Module PLC-RPT- 24DC/21	Cabinet
P3R77992000748	Relay Module - PLC-RPT- 24DC/21-21	Cabinet
P3R77992000658	950uF,900VDC,CAPACITOR	Cabinet
A6X30118410	Fuse,1000VDC,250A	Cabinet
A6X30118461	SWITCH,MICRO,NH FUSE BVL50	Cabinet
A6X30118462	ACC_FUSE_NH_SD2-D-PV_BASE_1kV	Cabinet
A6X30118463	ACC_FUSE_SD12_SHROUD-KIT TO NH-PH	Cabinet
P3R77992000017	1500V, 300A Sealed DC Contactor	Cabinet
3NW70144	FUSE HOLDER PV 1P 25A 1000V 10X38MM LED	Cabinet
P3R77992000156	20A, 1000VDC 10x38 gPV Fuse 50-215-06.20	Cabinet
P3R77992000664	1500V,200A,NC,Sealed DC Contactor	Cabinet
P3R77992000087	Output EMI Filter, 250A, 1000VDC	Cabinet
P3R77992000660	RadiCal Centrif Fan 975m3/h 169W	Cabinet
P3R77992000640	6P DIODE BRIDGE,232A,SEMiX291D16s	Cabinet
P3R77992000643	IGBT MODULE HALF BRIDGE,1200V,300A	Cabinet
P3R77992000643	IGBT MODULE HALF BRIDGE,1200V,300A	Cabinet
P3R77992000658	950uF,900VDC,CAPACITOR	Cabinet
P3R77992000644	25uF,1000VDC,METALIZED POLY CAP	Cabinet
A6X30021340	DIODE RECTIFIER MODULE 380AMP, 1600V	Cabinet
P3R77992000757	DC Axial Fan,Square, 24V, 90W, 294 CFM	Cabinet
P3R77992000011	Cord / Plug set (25 ft)	Dispenser
6GK50041BD001AB2	Ethernet-Switch	Dispenser
P3R77992000234	Ventilation Filter Hood	Dispenser
P3R77992000228	Ventilation Filter	Dispenser
P3R77992000012	Cable Plug Holster	Dispenser
P3REC100000509	Cable Reel	Dispenser
P3REC100000503	Cable Reel	Dispenser
P3R77992000013	Relay 24VDC	Dispenser

SiCharge UC Spare Parts List

P3R77992000200	Relay 120VAC	Dispenser
P3R77992000014	Relay 120VAC	Dispenser
P3R77969000101	Vent filter replacement pad	Dispenser
P3R77992000015	Dual Thermostat, ZR 011, 1NC+1NO	Dispenser
P3R77992000014	Relay Module - PLC-RPT-230UC/21-21	Dispenser
P3R77992000666	Power supply unit - UNO-PS/1AC/24DC/100W	Dispenser
P3R68879000014	Cabinet Heater, 230V, 30W	Dispenser
P3R77992000634	Power supply unit PS/1AC/24DC/240W	Dispenser
6ES72315PD320XB0	SIMATIC S7-1200 SM1231 RTD 4 X AI	Dispenser
6GK50042BD001AB2	SCALANCE XB004-2	Dispenser
3RH21401FB40	CONTACTOR RELAY 4NO DC 24V SCREW	Dispenser
P3R77992000013	Relay Module PLC-RPT- 24DC/21	Dispenser
P3R77992000748	Relay Module - PLC-RPT- 24DC/21-21	Dispenser
P3R77992000178	PT100, M4 thread, -50 to 230 degC	Dispenser
A6X30118461	SWITCH,MICRO,NH FUSE BVL50	Dispenser
P3R77992000017	1500V, 300A Sealed DC Contactor	Dispenser
6ES72141HG400XB0	CPU 1214C, DC/DC/RELAY, 14DI/10DO/2AI	Dispenser
6AV21240GC130AX0	SIMATIC HMI TP700 COMFORT OUTDOOR	Dispenser
P3R77992000764	MICROSWITCH for DC Output Fuse	Mast
P3R77992000762	Specialty Fuses 1kA 1250V 3BKN/90 AR	Mast
6GK57938DK000AA0	WLAN Antenna	Mast
P3R77992000325	Y-Sensor	Mast
P3R77992000404	Mast Heater Unit	Mast
P3R77992000324	Media Converter	Mast
6GK57741FX000AA0	Wifi Router	Mast
P3R77992000398	Mast power supply	Mast
5SJ41107HG41	MCB 5SJ4 1P 240V 10A 14K C-TRIP	Mast
5SJ41067HG41	MCB 5SJ4 1P 240V 6A 14K C-TRIP	Mast
5SJ41027HG41	MCB 5SJ4 1P 240V 2A 14K C-TRIP	Mast
6GK50042BD001AB2	SCALANCE XB004-2	Mast
6ES72141AG400XB0	SIMATIC S7-1200 CPU 1214C DCDCDC	Mast
6ES76470AA001YA2	SIMATIC IOT2040	Mast
6GK57741FX000AB0	SCALANCE W774-1 RJ45	Mast
P3R77992000666	Power supply unit - UNO-PS/1AC/24DC/100W	Mast
P3R77992000398	Power supply unit - UNO2-PS/1AC/24DC/480	Mast
P3R77992000404	PTC Heater, 50W, with fixed point thermo	Mast
P3R77992000014	Relay Module - PLC-RPT-230UC/21-21	Mast
A2V00002693010	CONTROL PILOT DEVICE	Mast
P3R77992000013	Relay Module PLC-RPT- 24DC/21	Mast
6GT28116CA101AA0	RF685R UHF Reader, FCC Version	Mast
P3R77992000785	16GB microSDHC Flash Memory Card	Mast

WAVE
by Ideanomics

250kW Wireless Charging System



Heavy-duty, high-power EV charging made easy

WAVE's 250-kilowatt wireless electric vehicle charging system enables the battery-electric vehicles used in mass transit, seaports, and warehouse and distribution operations to achieve the same operational range and duty cycles as their diesel counterparts.

- Hands-free and safe; just park and charge
- High-efficiency performance (92%+)
- Nearly invisible; minimal space required
- Interoperable with leading vehicle OEMs
- Industry-leading commercial deployments

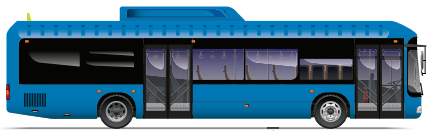
Extending the operational range of electric vehicles

For medium and heavy-duty transit and commercial vehicles to match the operational range of their diesel counterparts, high-power charging must be readily accessible and initiate quickly.

WAVE'S 250KW WIRELESS CHARGING SYSTEM:

- Initiates in seconds during scheduled stops or natural dwell times
- Eliminates the need to handle high-voltage cables and connectors for improved safety
- No moving parts, connectors, or cables
- Minimal impact on existing operations
- Removes the collision risks and unsightly presence of legacy chargers

TRANSIT



SEAPORTS



WAREHOUSE + DISTRIBUTION OPERATIONS



Unlike unsightly and cumbersome plug-in and overhead systems, WAVE delivers near-instantaneous high power from charging pads embedded in the roadway. Automated and hands-free, the "park and charge" simplicity makes EV adoption easier for fleet operators of all types.

WAVE
by Ideanomics

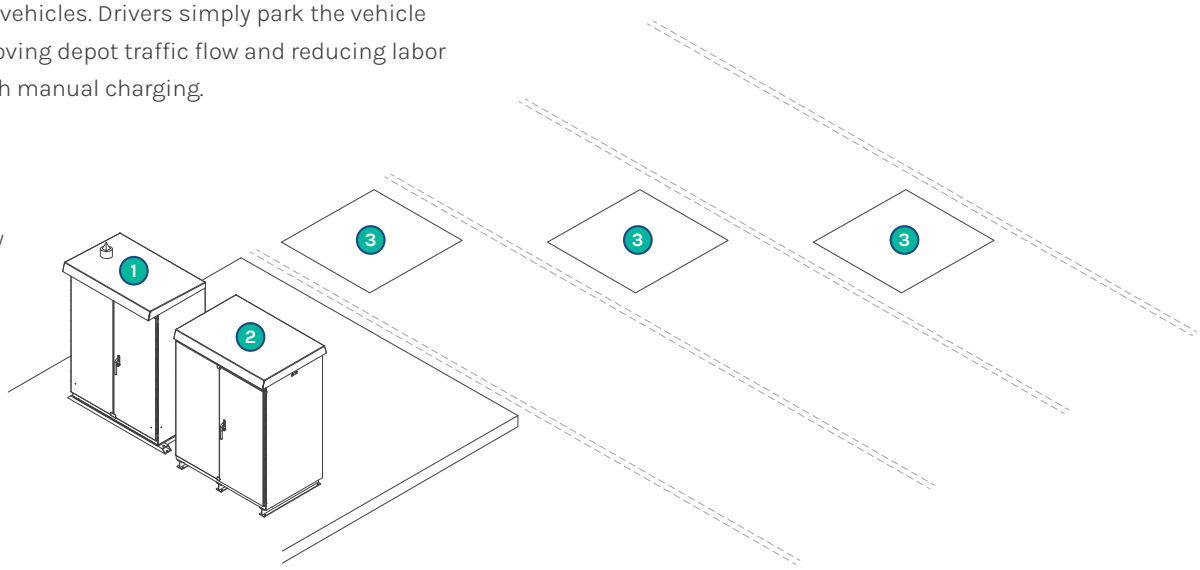
Lower ownership costs, more peace of mind

Hands-free, wireless charging eliminates the labor costs, maintenance issues and safety risks associated with legacy plug-in and overhead charging solutions. The result? Lower total cost of ownership and efficient, safe operation every day.

WAVE depot charging

In a depot configuration, WAVE's 250kW system can be equipped with multiple pads for the simultaneous, automated charging of multiple vehicles. Drivers simply park the vehicle and walk away, improving depot traffic flow and reducing labor costs associated with manual charging.

1) Primary power electronics
2) Primary power supply with cooling unit
3) Charging pad



Specifications

Certification: UL Field Evaluation

System Input to Power Supply

- Connections: Single grid connection
- Voltage: 480V Three Phase
- Protection: Requires UL listed 500A overcurrent protection in upstream switchgear

System Output to Vehicle

- Up to 250kW to vehicle battery

Range Extension

Bus Size	Battery Consump. (kWhr/mi)	Miles added in five-minute charge	Miles added in ten-minute charge
40-foot*	**1.5-2.0**	**10-14**	**20-25**
60-foot	**2.4-2.6**	**8-10**	**16-18**

* Power delivered can be less than 250kW and is subject to control by the bus battery management system.

Learn more by contacting us at gowireless@waveipt.com.

WAVE | 4752 WEST CALIFORNIA AVENUE | SUITE B-400 | SALT LAKE CITY, UT 84104 | 801.935.8650

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Paint Appearance Standard

1. Purpose

1.1 The purpose of this document is to identify the steps required to inspect the exterior surface of a painted bus.

2. Scope

2.1 This standard describes the painted surface appearance requirements of exterior body panels. These requirements, with regard to appearance attributes and surface blemishes, are outlined in the following standards to ensure the paint finish of GILLIG buses will meet or exceed customer expectations.

3. Responsibilities

3.1 All exterior finished surfaces shall adhere to the appropriate ASTM standard for resistance to diesel fuel, gasoline and common cleaning agents. Use of any chemicals on painted surfaces shall be verified for acceptance with the paint manufacturer before use, approval of which shall be maintained by the paint department supervisor.

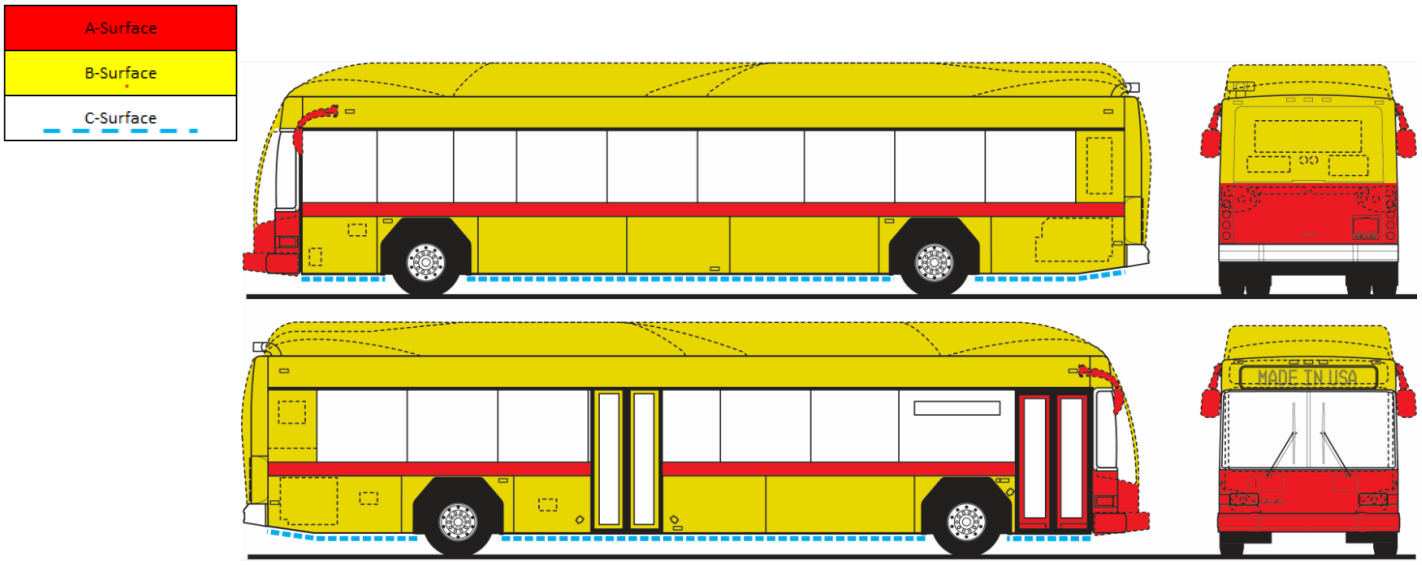
3.2 Proper adhesion between the basic surface and successive coats of the original paint shall be measured using ASTM D3359, Method B.

4. Procedure

4.1 Appearance Zones - Exterior Body

The body of a bus is divided into different appearance zones (A through C) to set the Appearance Quality Requirements of each zone separately. The Appearance Quality Requirements are detailed in Section 4.2.

Zone	Description
A	Sides - Horizontal mid-rail extrusion along length of bus. Front - From bottom edge of windshield down. Rear - From the bottom edge of AC access door down.
B	Sides - From the bottom edge of the horizontal mid-rail extrusion down and from the top edge the horizontal mid-rail upward. Front - From the top of the windshield upward (including all roof cowlings). Rear - From the bottom of the AC access door upward (including all roof cowlings).
C	All surfaces of the lower bottom edge of skirt panels, interior side of all panels, and access doors.



		Surface Area (sqft)			Inspection Duration (min)		
Location	**Rate (sqft/min)**	**29'**	**35'**	**40'**	**29'**	**35'**	**40'**
Front	24	40	40	40	2	2	2
Curb Side	24	165	198	210	7	8	9
Rear	24	80	80	80	3	3	3
Street Side	24	180	213	220	8	9	9
				Total Inspection Time	19	22	23

Note: The vehicle must be viewed in a normal run operation condition and from ground level or equivalent. The use of flashlights is prohibited. Visual inspection is performed at a distance of 36" from painted surface.

4.2 Paint Audit Procedure

4.2.1 Quality Requirements for Appearance Attributes

4.2.1.1 Method of Taking readings

Visual inspection shall be completed in compliance with the above stated criteria. As defects are identified they will be marked/highlighted using a contrasting grease pen. After the inspection is completed, the results shall be tallied on either the Hard Card, or the In Process Inspection sheet (depending on where the inspection is completed).

All identified issues shall be reworked/reprocessed to achieve an acceptable level. Panel repair is an approved option if GILLIG determines a good repair can be achieved.

4.2.1.2 Orange Peel

Wavy appearance of the painted surfaces, poor flow, poor leveling, and pebbling.

Description: Uneven surface formation - much like that of the skin of an orange - which results from poor coalescence of atomized paint droplets. Paint droplets dry out before they can flow out and level smoothly together.

Method of Inspection: Optical evaluation utilizing a BYK Gardner Micro-Wave-Scan and associated software.

The scale used in the software is “Rating” from ACT Laboratories Inc. This scale rates orange peel from 1 to 10. 1 being a rough textured finish and 10 being a glass finish.

The micro-wave-scan evaluates structure size as well as the brilliance of the surface. Orange peel is rated from 1 to 10. 1 being the lowest and equivalent to the surface of an orange and 10 is the highest and equivalent to a glass surface. The industry average for this reading is a finish of 3.5 to 4. Use of the Micro-Wave-Scan is performed on a random sample basis or upon request. Measurements are taken on the bus mid-rail: front, middle, rear, and center of engine door.

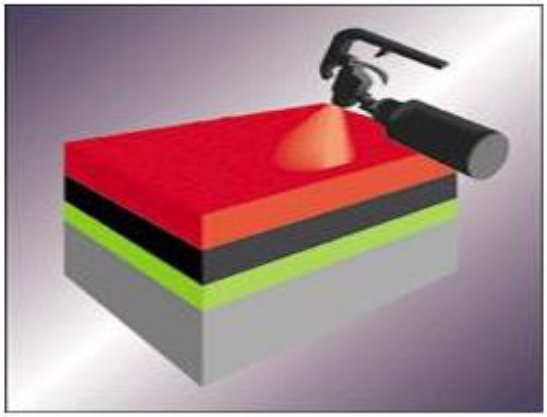
Appearance Zone Requirements:

Table 2 - Orange Peel

Zone	Requirements
A	≥ 4.5
B	≥ 4.0
C	≥ 3.5

Note: Wet sand and polish is an acceptable repair method.





4.2.1.3 Gloss

Shininess of the painted surfaces.

Method of Inspection: Gloss meter (60°) as referenced in ASTM D523.

Optical evaluations utilizing a BYK Gardner Micro-Gloss 60° meter and associated software.

Note: Gloss measurements should not be taken on non-metallic or contoured surfaces due to resultant false or inaccurate readings. Readings will only be taken as the bus exits the paint booth.

Appearance Zone Requirements:

Table 3 - Solids Gloss - Using BTK Gardener Micro-Gloss Meter

Zone	Requirements
A	80 units +
B	80 units +
C	80 units +

Note: Wet sand and polish is an acceptable repair method.

4.2.1.4 Uniformity

Appearance is consistent over entire bus, both within individual panels and between adjacent panels within a zone.

Axalta Coating Systems Approved Film Build Specification:

Single Stage - EX:

Axalta Coating System "Dry Film Thickness" specifications for the total primer/topcoat system for GILLIG is 3.0 mils minimum. The 3.0 mils for GILLIG has been approved by Axalta Coating System technical group.

* 920S primer "Dry Film Thickness" specification is 1.2 – 1.5 mils minimum.
* Imron Elite EX topcoat "Dry Film Thickness" specification is 1.8 – 2.2 mils minimum.

Axalta Coating System will continue to warranty units produced at GILLIG provided they meet minimum dry film thickness of 3.0 mils for single stage EX.

Basecoat/Clearcoat - EW/EB:

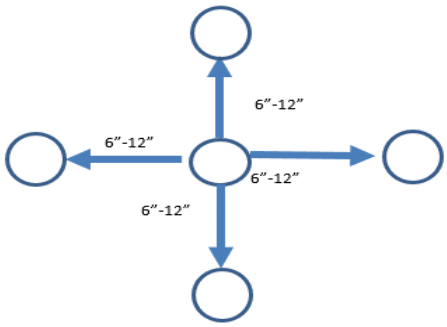
Axalta Coating System "Dry Film Thickness" specifications for the total primer/topcoat system for GILLIG is 4.0 mils minimum. The 4.0 mils for GILLIG has been approved by Axalta Coating System technical group.

* 920S primer "Dry Film Thickness" specification is 1.2 – 1.5 mils minimum.
* Imron Elite EW/EB topcoat "Dry Film Thickness" specification is 1.0 mils minimum.
* 8831S clearcoat "Dry Film Thickness" specification is 1.8 – 2.2 mils minimum.

Axalta Coating System will continue to warranty units produced at GILLIG provided they meet minimum dry film thickness of 4.0 mils for basecoat/clearcoat EW/EB.

GILLIG Film Build Measurement Process:

* If at any given point on the vehicle, total dry film thickness (DFT) is less than 3.0 mils for single stage or 4.0 mils for basecoat/clearcoat the following steps should be followed:
    * Measurement should be taken 6" – 12" inches above, below, and on each side of that low reading (see below diagram for reference).
    * If three (3) of the four (4) readings are within acceptable range for DFT, the area does not require paint repair for low film build and the current warranty will be honored.



4.2.1.5 Bubbles/Craters - Fish Eyes

Small round depressions in the paint film which may or may not expose the underlying surface.

Method of Inspection:

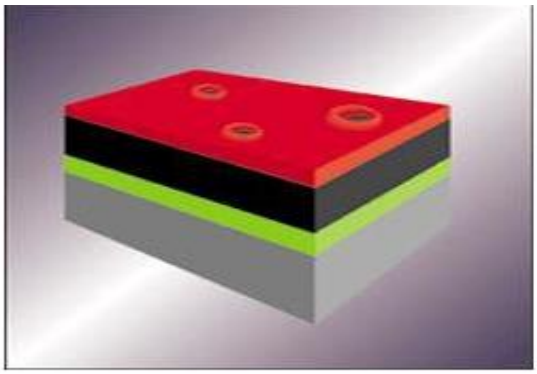
Visual evaluation and comparison to zone table 4.

Table 4 - Bubbles/Craters

Zone	OK	Qty Per Panel Per	Max Size / Diameter	Description
A	No			
B	Yes	2 within 2 ft square (No Cluster)	0.059 in (1.5mm)	Primer Not Exposed
C	Yes	No More than 3 per panel	0.059 in (1.5mm)	Primer Not Exposed

Note: Wet sand and polish is an acceptable repair as long as the mil thickness is not compromised or repaint.





4.2.1.6 **Dirt Inclusion**

Foreign matter in, on, or under the paint film surface (i.e.: lint, fibers, sanding dust, etc...).

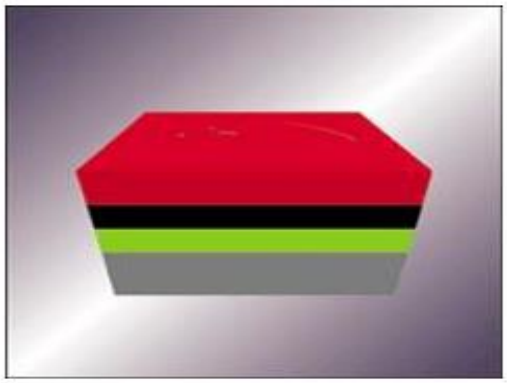
Method of Inspection:

Standard/Metric scale with visual evaluation and comparison to zone table 5.

Table 5 - Dirt in Paint

Zone	OK	Qty Per Panel Per Zone	Max Size / Diameter
A	Yes	No more than 2 spec. in 2 ft section but not in a cluster	0.059 in (1.5mm)
B	Yes	No more than 3 spec. in 2 ft section but not in a cluster	0.059 in (1.5mm)
C	Yes	No more than 5 spec. on any panel, should not be in a cluster	0.059 in (1.5mm)





Note: Wet sand and polish is an acceptable repair as long as the mil thickness is not compromised.

4.2.1.7 **Ding**

A localized depression or protrusion in the metal surface or substrate, which is visible after paint.

Method of Inspection:

Visual evaluation and comparison to zone table 6.

Table 6 - Ding in Paint Coating

Zone	OK	Description
A	No	
B	No	
C	Yes	Slight (less than 2 mm)

Note: Wet sand and polish is an acceptable repair as long as the mil thickness is not compromised or repaint.

4.2.1.8 **Overspray/Dry Spray**

Rough or gritty texture on paint film surface.

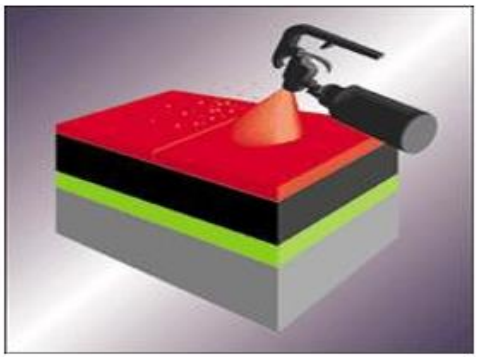
Method of Inspection:

Visual evaluation and comparison to zone table 7.

Table 7 - Overspray/Dry Spray

Zone	OK	Description
A	No	
B	No	
C	Yes	Only on inside of flange





Note 1: Wet sand and polish is an acceptable repair.

Note 2: Acceptable on underside of chassis, engine compartment, and inside of wheel wells.

4.2.1.9 Solvent Pop

Small holes in a paint film usually caused by trapped solvent or porosity. Solvent boils are small, clustered, raised but unbroken bubbles in a paint film surface.

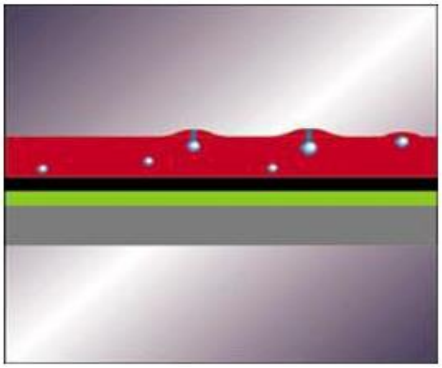
Method of Inspection:

Visual evaluation and comparison to zone table 8.

Table 8 - Solvent Pop

Zone	OK	Description
A	Yes	Pinhole type solvent pops, which are visible only when viewed at an angle or small random pops not visible from 3 ft away.
B	Yes	
C	Yes	





Note: Wet sand and polish is an acceptable repair as long as the mil thickness is not compromised or repaint.

4.2.1.10 Polish Marks

Visible swirl marks or hazy marks, which are caused by polishing techniques viewed in reflected or non-reflected lighting.

Method of Inspection:

Table 9 - Polish Marks

Zone	OK	Description
A	Yes	Provided the gloss meets the Paint Appearance Standards.
B	Yes	Provided the gloss meets the Paint Appearance Standards.
C	Yes	Provided the gloss meets the Paint Appearance Standards.

4.2.1.11 Sags and Runs

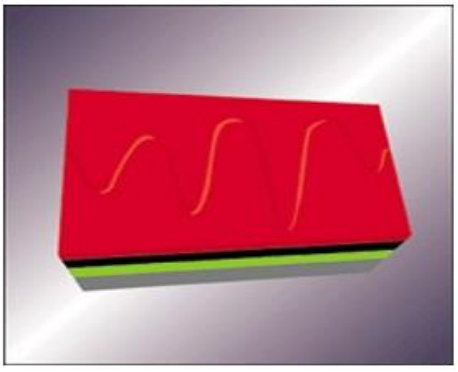
Method of Inspection:

Visual evaluation and comparison to zone table 10.

Table 10 - Sags and Runs

Zone	OK	Description
A	Yes	Slightly below punched/hole, rivets, and screws in panels.
B	Yes	Slightly below punched/hole, rivets, and screws in panels.
C	Yes	Slightly below punched/hole, rivets, and screws in panels.





Note: Wet sand and polish is an acceptable repair.

4.2.1.12 Scratches

Scratches on surface of paint film.

Method of Inspection:

Visual evaluation and comparison to zone table 11.

Table 11 - Scratches

Zone	OK	Length	Description
A	No		
B	Yes	Not >5 mm	On Non-Metallic
C	Yes	Not >5 mm	On Non-Metallic

Note: Touch-ups with a brush with primer and paint acceptable repairs.

4.2.1.13 Sand Marks

Cuts in the surface metal caused by poor sand technique or improper repair, only visible after paint.

Method of Inspection:

Visual evaluation and comparison to zone table 12.

Table 12 - Sand Marks after Paint

Zone	OK	Description
A	No	
B	No	
C	Yes	Minor

Note: Touch-ups with a brush with primer and paint acceptable repairs.

4.2.1.14 Pinholes

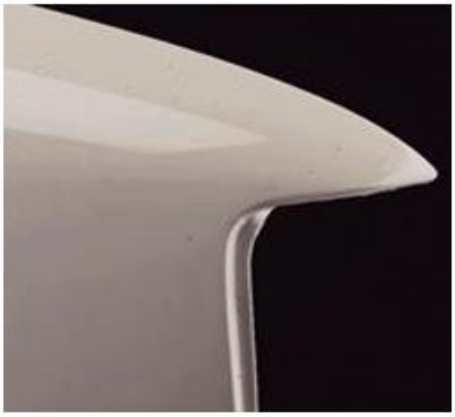
Small holes in a paint film, usually in the area of fiberglass gelcoat parts (i.e. porosity).

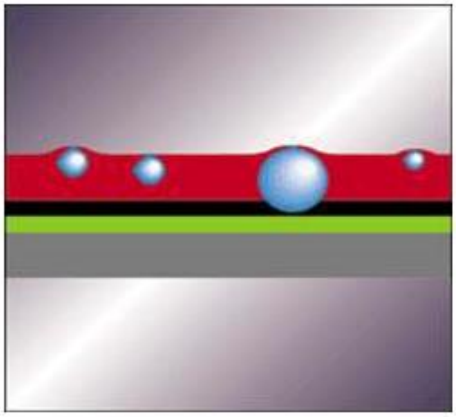
Method of Inspection:

Visual evaluation and comparison to zone table 13.

Table 13 - Pinholes

Zone	OK	Qty per	Description
A	No		
B	Yes	2	Not in a cluster 2 sqft area
C	Yes	2	Not in a cluster 2 sqft area





Note: Wet sand and polish is an acceptable repair as long as the mil thickness is not compromised or repaint.

4.2.1.15 Paint Chips

The absence of a small portion of the paint film.

Method of Inspection:

Visual evaluation and comparison to zone table 14.

Table 14 - Paint Chips

Zone	OK	Qty per	Description
A	No	0	Not Allowed
B			
C			

Note: Touch-ups with a brush on panel-edge is acceptable if no color change.

CER 3. Acknowledgement of Addenda

Failure to acknowledge receipt of all addenda may cause the Proposal to be considered nonresponsive to the Solicitation. Acknowledged receipt of each addendum must be clearly established and included with the Proposal.

The undersigned acknowledges receipt of the following addenda to the documents:

Addendum No.:	1	Dated:	JULY 29, 2021
Addendum No.:	2	Dated:	AUGUST 5, 2021
Addendum No.:	3	Dated:	AUGUST 17, 2021
Addendum No.:	4	Dated:	AUGUST 30, 2021
Addendum No:	5	Dated:	SEPTEMBER 1, 2021
Addendum No:	6	Dated:	SEPTEMBER 10, 2021
Addendum No:	7	Dated:	SEPTEMBER 15, 2021
Addendum No:	8	Dated:	SEPTEMBER 20, 2021

Proposer:	GILLIG LLC
Name:	WILLIAM F. FAY, JR.
Title:	VICE PRESIDENT, SALES
Phone:	800-735-1500
Street address:	451 DISCOVERY DRIVE
City, state, ZIP:	LIVERMORE, CA 94551

William F. Fay Jr

Authorized signature

SEPTEMBER 17, 2021

Date

CER 4. Contractor Service and Parts Support Data

Location of nearest Technical Service Representative to Agency

Name: VICTOR DORAN, EXECUTIVE DIRECTOR, CUSTOMER CARE
Address: 451 DISCOVERY DRIVE, LIVERMORE, CA 94551
Telephone: 800-735-1500
Describe technical services readily available from said representative:

REFERENCE OUR ATTACHED INFORMATION.

Location of nearest Parts Distribution Center to Agency:

Name: GILLIG PARTS DEPARTMENT
Address: 25972 EDEN LANDING ROAD, HAYWARD, CA 94545
Telephone: 800-735-1500
Describe the extent of parts available at said center:

REFERENCE OUR ATTACHED INFORMATION.

Policy for delivery of parts and components to be purchased for service and maintenance:

Regular method of shipment: UPS
Cost to Agency: PREPAID INCLUDED

4. GILLIG SERVICE AND PARTS SUPPORT DATA

GILLIG has included the following documents confirming our ongoing support to transit agencies in the State of Florida, as follows:

- GILLIG CUMMINS SERVICE & SUPPORT NETWORK MAP
- CUMMINS SUPPORT REFERENCE LETTER
- SERVICE, WARRANTY & ENGINEERING SUPPORT
  - SUPPORT STAFF
- GILLIG STANDARD LIMITED WARRANTY & EXTENDED COVERAGE
- WARRANTY DEPARTMENT SUPPORT
- TRAINING OUTLINE
  - AVAILABLE OPTIONAL TRAINING PROGRAMS
- GILLIG AFTERMARKET PARTS WAREHOUSE
  - SUPPORT STAFF

Unmatched service and support network across the US

GILLIG | Cummins

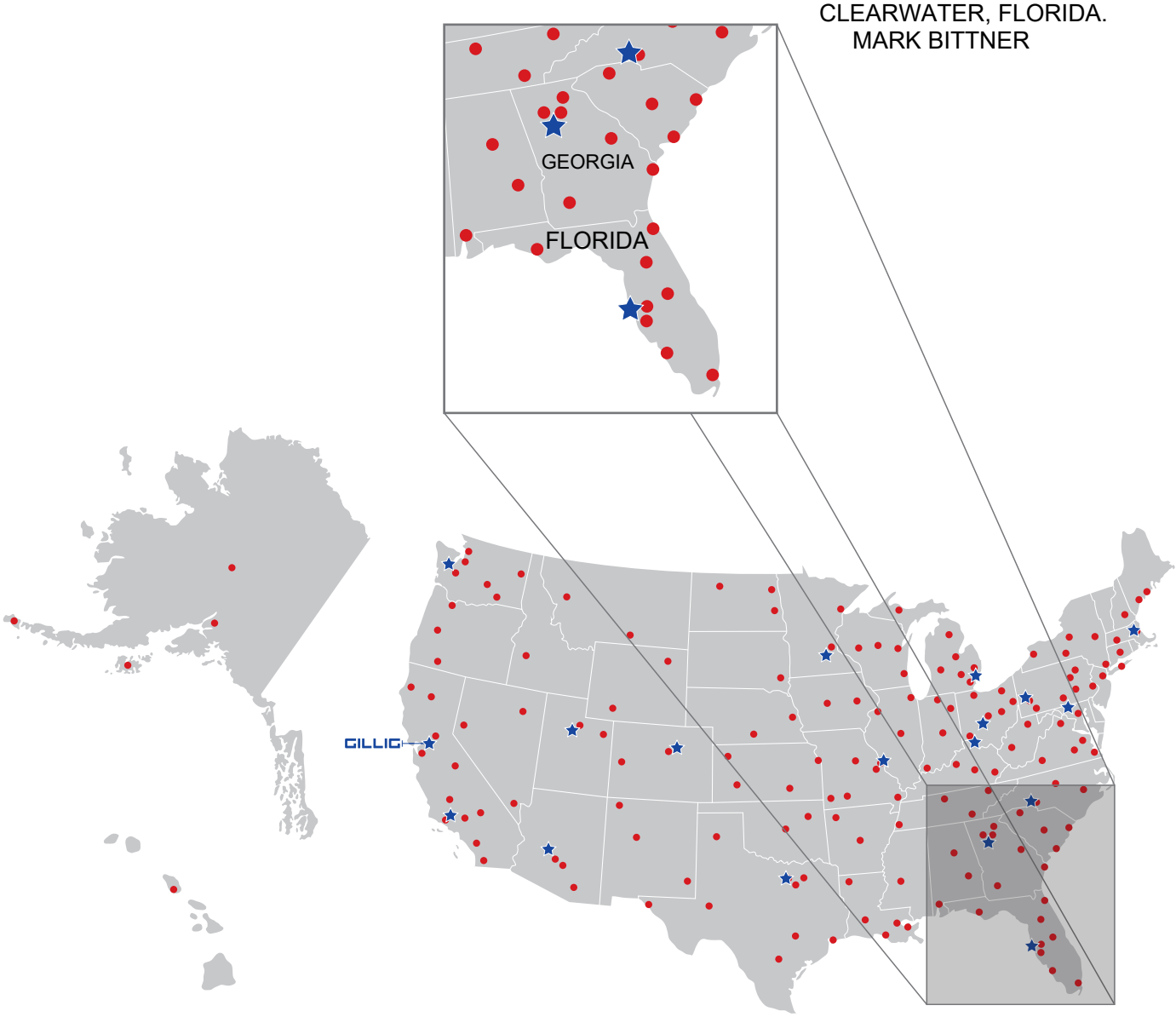
Partners you can trust.

GILLIG Field Service Technicians

Cummins Service Locations

GILLIG RETAINS FIELD SERVICE REPRESENTATIVES WHO RESIDE IN THE SOUTHEASTERN U.S. FOR EASY ACCESS TO OUR TRANSIT AGENCIES.

OUR FLORIDA FIELD SERVICE REPRESENTATIVE RESIDES IN CLEARWATER, FLORIDA.
MARK BITTNER



September 21, 2021

Gillig
451 Discovery Drive
Livermore, CA 94551

Subject: Cummins Sales and Service support for Gillig Electric Buses throughout the state of Florida

Cummins Sales and Service Branches are fully prepared to support Transit Authority Customers throughout the state of Florida. Cummins Sales and Service has 7 branch service locations in Florida. The service centers are in Jacksonville, Ocala, Tampa, Orlando, Ft. Myers, West Palm Beach and Miami. All branches will have both field and in-shop trained technicians to service Gillig Battery Electric Buses. The standard branch hours are 7:30 a.m. to 4:30 p.m. Monday through Friday with 24/7 on call technician support. We provide full Cummins warranty and after warranty support.

For additional technical support, we have Customer Field Service Engineers that support all our Florida facilities. We also have dedicated Bus Account Executives and a Florida based Technical Support Manager to support PDI and familiarization activities upon bus arrival at each Transit Authority.

Parts for repairs will be available either at the branch or at the regional distribution center located in Atlanta, Georgia or at the main distribution center located in Memphis, Tennessee. We will also be able to obtain parts from Gillig if needed.

We are excited to support this endeavor and look forward to working with Gillig to ensure their electric buses are available to support the tens of thousands of travelers that will move through the State of Florida.

Please contact me directly if you have any questions.

Sincerely,

Jim Cress
Area Vice President | Southern US
Cummins Inc. dba Cummins Sales and Service
Tel: (470) 484 1074
Email: james.cress@cummins.com

SERVICE, WARRANTY & ENGINEERING SUPPORT

SERVICE DEPARTMENT

GILLIG maintains a fully qualified, trained Service Department to respond to the procuring Agency's request for assistance after delivery of equipment.

The Field Service Trainers and Field Service Representatives have extensive "hands-on" experience on our coaches. The Field Service Trainers are available to provide training to your staff on the proper operation and maintenance of the equipment. The Field Service Representatives are fully qualified to assist the procuring Agency in the maintenance of equipment, including, but not limited to major component replacement and repair, electrical troubleshooting, suspension and frame repair, as well as repair of all ancillary components and systems.

In-house qualified Field Service Representatives are available to troubleshoot questions by phone, Monday through Friday, 5:00 a.m. to 2:00 p.m. (PST).

WARRANTY DEPARTMENT

The Warranty Department is available to assist the procuring Agency processing warranty claims as required. The Warranty Processing Specialist will assist the procuring agency in the proper procedure for obtaining warranty parts, completion of the warranty forms, and the handling of parts for warranty claims processing.

ENGINEERING DEPARTMENT

We also maintain a fully experienced, qualified Engineering Department, directed by the Vice President of Engineering, Quality Control and Customer Service. The Engineering staff are available on request to assist in the resolution of engineering or design problems that may arise within the scope of the specifications during the warranty period.

The GILLIG Engineering Department is located at the manufacturing plant in Livermore, CA, and is continually available to assist the manufacturing process. The integrated staff performs all vehicle engineering, including the research and development of all systems integrated on our vehicles.

All current products were designed and developed by GILLIG Engineering. The entire GILLIG Low Floor transit bus is manufactured in the United States at this one location in Livermore, CA.

CUSTOMER CARE SUPPORT NETWORK

EXECUTIVE DIRECTOR, CUSTOMER CARE
Victor Doran

SERVICE MANAGER
Eric Ocampo

WARRANTY MANAGER
Micah Denecour

TECHNICAL ADVISOR
Bo Vongamath

TECHNICAL TRAINERS		Based:
Russ Ando	-	Seattle, WA
Lyle Archambeau**	-	St. Paul, MN
Ben Braun	-	Baltimore, MD
Blaine Fagel	-	Charlotte, NC
Kevin Hardesty	-	Columbus, OH

FIELD SERVICE REPRESENTATIVES *		BASED:
Mark Bittner	-	Clearwater, FL
Rob Bolog	-	Detroit, MI
Cody Campeau	-	St. Paul, MN
Jason Fairclough*	-	Salt Lake City, UT
Jose Garcia	-	San Francisco, CA
Dave Hagopian*	-	St. Louis, MO
Scott Kovaly	-	Pittsburgh, PA
Tim Lopez	-	San Francisco, CA
Sam Nicoara	-	Atlanta, GA
Paul Oden, Jr.		Cincinnati, OH
Joe Rhea*	-	Dallas, TX
Richard Salas*	-	San Francisco, CA
Steven Sayne*	-	Seattle, WA
Jason Schwalbert	-	Phoenix, AZ
Thomas Seymour	-	Denver, CO
Joy Sisouvanthong	-	Boston, MA
Sang Tran*	-	Los Angeles, CA

FIELD SERVICE & WARRANTY **Phone - 800-735-1500 Fax- 510-785-1348**

Victor Doran	Exec.Director, CustomerCare	victor.doran@gillig.com
Eric Ocampo	Service Manager	eocampo@GILLIG.com (call to schedule training)
Micah Denecour	Warranty Operations Manager	micah.denecour@GILLIG.com
Johnny Phothipanya	Warranty Processing Specialist	jphothipanya@GILLIG.com
Bo Vongamath	Technical Advisor	bvongamath@GILLIG.com
Dominic Nava	Warranty Parts Specialist	dnava@GILLIG.com (call to order warranty parts)
Vy Vu	Field Service Coordinator	vvu@GILLIG.com
Kristina Aldana	Administrative Assistant	kaldana@GILLIG.com

Training instructors employed by GILLIG are fully qualified service personnel with extensive “hands on” experience on our coaches. They have been trained in all phases of coach repair including, but not limited to major component replacement and repair, electrical troubleshooting, suspension and frame repair as well as repair of all ancillary components and systems.

* Performs pre-delivery service at the customer site, as well as ongoing field product support services.
** ASE Certified Mechanic

FIELD SERVICE QUALIFICATIONS

VICTOR DORAN - Executive Director, Customer Care
Executive Director of Customer Care is responsible for supporting customers post delivery service needs including warranty, field service and training. Victor's 30+ years' experience includes Diesel Technician, Service Department Management, Custom Engineering and broad OEM Customer Service Support functions primarily in the Commercial Truck and School Bus market. In addition, Victor earned a Diesel Technician Certification from Ohio Diesel Tech. and a BSMET from Kent State University and joined GILLIG in 2020.

ERIC OCAMPO – Service Manager
Eric has been with GILLIG since January 1987. He came to GILLIG from A.C. Transit where he worked for 2 ½ years involved in special projects. He has 1 year in R.O.C. diesel technology and electrical and 5 years as an automotive technician. He also received training on DDEC, Allison, Lift-U wheelchair lifts and Luminator destination signs for troubleshooting and repair. Eric spent 10 years as a Field Service Representative and was a Field Service Trainer from 1996-2013. In April 2002, he completed training with Cummins I.S.L. troubleshooting and familiarization, and in November 2004, he completed training with Allison Hybrid electric drives. Since 1999, he has received numerous extensive training classes from I.O. Controls Multiplex Systems covering the T-1, T-2, G-3 and the latest G-4 systems.

MICAH DENECOUR – Warranty Manager
Micah has been with GILLIG since October 2016. He has worked in the Industrial Engineering, Supply Chain, and Warehousing teams at GILLIG. Micah holds a BS and MS in Industrial Engineering from Cal Poly. Prior to GILLIG he worked in the medical device industry.

RUSS ANDO - Trainer
Russ resides in Washington State and covers the Pacific Northwest Region. Russ Joined GILLIG in March 2001 and worked in several areas on the production line, including line foreman. In July 2002, Russ joined the Field Service Department. He has done classic auto restoration since 1979 and has completed several body-off, frame-up restorations. Along with his knowledge of mechanics and hands on approach to his job, he earned a BFA with honors in illustration from California College of Arts and Crafts.

LYLE ARCHAMBEAU – Trainer
Lyle lives in St. Paul, MN and covers the Midwest region. He has been employed at GILLIG since 1989. He has three years' experience in Heavy vehicle Maintenance while stationed in the U.S. Army. Also, Lyle has five years' experience in the Automotive Maintenance Industry. He is ASE Certified in Auto Electric, Brakes, Suspension, Engine Performance and Engine Rebuilding. He has attended classes at Auto tech for Air Conditioning, and Engine Electronics Controls and Diagnosing.

MARK BITTNER – Senior Field Service Representative
Mark joined our GILLIG family in 2019. He brings extensive knowledge and experience in transit bus maintenance and troubleshooting. He grew up in Pittsburgh, PA and is a graduate of Steel Center Technical School and Ohio Diesel Technical Institute. He began his career in 1986 with a Pittsburgh based Detroit Diesel Allison distributor. There he served in troubleshooting, repair and overhaul of all Detroit Diesel Allison Propulsion systems. From 1993 through 2018 Mark worked for the Port Authority of Allegheny County in Pittsburgh, PA. There he performed all aspects of transit bus maintenance, troubleshooting and repairs. While there he became a bus maintenance technical trainer and developed many vehicle maintenance, overhaul programs and provided technical support. Since 2005 Mark has been working with GILLIG busses at the Pittsburgh Port Authority of Allegheny county. Mark also enjoyed owning a business in Pittsburgh, PA with his two sons where they design and build racing engines and offer field service repairs for a diesel propulsion systems. Mark and his family now reside in the Florida.

ROB BOLOG – Senior Field Service Representative
Rob graduated from Michigan State University where he completed a Power Equip. Technology program. Rob started in the heavy equipment and consumer products business (chainsaws to excavators) in 1978 before moving to the Ann Arbor Transit as a technician in 1984. He was a maintenance supervisor and warranty administrator at the time he retired in 2018 to join the GILLIG Field Service Team.

CODY CAMPEAU – Field Service Representative
Cody lives in New Richmond, WI and covers the Midwest region, he joined the GILLIG family in 2019 after working as a contractor for GILLIG since 2010. During that time he gained experience from many hands on repairs and projects he was involved with.

BEN BRAUN – Trainer
Ben lives in Street, MD and covers the Eastern Region. He has been employed with GILLIG since 1995 and has been in the motorcycle, automotive, truck and bus industry full time since 1971. He has experience in all areas of fabrication, welding, manual machining, repair, welding and diagnostic work. He previously was a GM Buick Master certified technician and held ASE Master Technician certification from 1985 to 2000.

BLAINE FAGEL – Trainer
Blaine joined GILLIG as an FSR in 2006 and moved to Trainer in 2010. He began in the trucking industry in 1990. He has been in the transit industry since 1995. He has fueled trucks/buses and performed preventative maintenance. He has also been a technician, union officer, shop supervisor, technical spec writer and QA officer. He worked for Lynx Orlando from 1995-2003 and Charlotte CATS from 2003-2006. He has been ASE Certified for heavy truck steering and suspension, A/C refrigerant recovery and recycle, as well as for bus/truck air brakes. Blaine is also a Type I & II Certified A/C Technician. He has taken many classes for electrical, preventative maintenance, suspension, hydraulics, brakes, A/C, wheelchair lift (Lift-U), Cummins, Detroit Diesel, Allison, Amerex as well as many managerial courses in people skills, time management, computer software for transit specific products, Excel, Word, Outlook, Adobe Professional, and PowerPoint.

JASON FAIRCLOUGH – Senior Field Service Representative
Jason has been employed with GILLIG since March 2001. He has 3 years' experience as a Quality Engineering Technician for Nova Bus Inc. Where he had taken several classes: Kizan, Metrology, Paint and Body. Jason also has a certificate from the National Fire Academy, for Hazardous Materials Incident Analysis, Hydraulics and Fluidics. While at GILLIG, Jason has taken classes in I/O, Air Systems, Allison Electric Drive, and Service Training. In addition, Jason has been building and racing vehicles since 1989.

JOSE GARCIA - Field Service Representative
Jose joined GILLIG in the Production Department in 2015. He started in second shift and became a lead after four months. After one year, he moved to first shift labor pool and worked various departments before joining Field Service. Before GILLIG, Jose worked for 15 years as an auto mechanic. He started as a lube mechanic as a tech 1, then became a tech 4 master mechanic. He attended De Anza College and completed the automotive program. He also completed 3 ASE certified tests.

DAVID HAGOPIAN – Senior Field Service Representative
Dave lives in southern Illinois and covers the Midwest region. He has been employed with GILLIG since November 2000. Dave came to GILLIG with 19 years of experience as manager, service writer and mechanic in the automotive industry. He has been ASE certified in heating, air conditioning, and electrical/electronic systems. He is trained in industrial electronics at Southwestern Illinois College.

SCOTT KOVALY – Field Service Representative
Scott was born and raised in Pittsburgh PA where he currently live with his wife, son and daughter. He graduated from Rosedale Technical College in 1988. After Rosedale he worked for GM, VW and Ford as the transmission and drive-ability specialist until 1994. He began his transit career with the Port Authority of Allegheny County in 1993 where he held various positions to include, hourly technician, materials control specialist, maintenance technical trainer, assistant manager of maintenance, manager of maintenance and bus procurement specialist. Scott holds ASE Master Technician status in Transit, Automotive and Heavy disciplines. He joined the GILLIG family in October of 2019 with the Field Service Department.

KEVIN HARDESTY – Trainer
Kevin has been a technical coach trainer since 1987. He has been a field service trainer for GILLIG since 2005. Prior to being employed as a field service trainer for GILLIG, Kevin operated his own technical training company for 9 years. Kevin started as a technical trainer for the FIxible Corporation in 1987. He also spent 2 years at the Central Ohio Transit Authority as the Training Supervisor. During his time at these positions, he has performed technical writing and created numerous training classes using PowerPoint software. His other duties have included various field service tasks as required.

TIMOTHY LOPEZ – Field Service Representative
Tim has been employed with GILLIG since January 2007. He worked in Labor Pool for five years and three years in Ready Row. Two of the three years in Ready Row he obtained his Commercial Driving License. While working in Ready Row he took customers on test drives on their new buses and explained the functionality of the bus. He studied Automotive Maintenance and Repair along with Machine Shop in High School Regional Occupation Center (R.O.C.). He received an Associate of Occupational Studies degree from Universal Technical Institute.

SAMUEL MAC NICOARA - Field Service Representative
Sam was born in Romania and immigrated to the US in 1980. In 1994, he graduated Sierra Academy of Aeronautics in Oakland, CA and received an aeronautical degree in Airframe & Powerplant as well as flight engineering. He applied his training in the aviation field and helped expand a superconducting magnet fabricating plant that he managed for over 10 years. In 2014, he joined GILLIG and worked as a troubleshooter in the Electrical Department. In 2016, he joined Field Service as a field service representative, servicing customers nationwide.

PAUL ODEN, JR. – Field Service Representative
Paul has in-depth experience working on GILLIG buses. For 19 years, he has served as a mechanic for the South Western Ohio Regional Transit Authority in Cincinnati, maintaining GILLIG buses and Cummins powertrains. He particularly enjoyed working on schematics and using his problem-solving skills. Paul joined GILLIG in October of 2019.

JOE RHEA - Senior Field Service Representative
Joe has been employed with GILLIG since 1988 and has had training in Voith, Transmission troubleshooting, & Lift-U Wheelchair lifts and Luminator Electric Destination Signs. He has also attended training classes by the GILLIG trainer in the Electrical System, Air System and Hydraulic systems on the GILLIG buses. Joe lives in Central Texas and covers the Southern Region.

RICHARD SALAS – Senior Field Service Representative
Richard has been employed with GILLIG since 1998. He worked in Labor Pool for one year and worked 4 years as a Working Foreman in in the Trim department. He was also the Working Foreman for the Maintenance Department on 3rd shift. He has attended training courses for the Dinex and Air systems. He is based out of the San Francisco area.

STEVEN SAYNE – Field Service Representative
Steven has been employed with GILLIG since June 2003. He worked with 1st shift Maintenance Department for 3 years. He was also the Working Foreman for the Maintenance Department on 2nd shift for 5 years. He has 10+ years of automotive and machine service and repair experience. He also has 10+ years of electrical and electronics service and repair experience. He has attended training courses for the Dinex and Air systems. He resides in Washington State and covers the Pacific Northwest Region.

JASON SCHWALBERT – Field Service Representative
Jason has been employed with GILLIG since December of 2017. Prior to that, he worked in the Phoenix Transit System for over 17 years as a Project Lead performing duties ranging from Transit Bus Maintenance to Shop Management. Jason has accumulated many Certifications and Licensing over the years including 3 ASE Master Certifications, Both A/C Section 608 Universal, & Section 609 certifications, and a Class B CDL w/Passenger Endorsement. He has earned an Associate Degree in Automotive, Diesel, and Industrial Technologies from Universal Technical Institute. Jason lives just outside Phoenix in Goodyear AZ.

THOMAS SEYMOUR – Field Service Representative
Tom has been with GILLIG since November of 2018. Prior to joining GILLIG, he worked at the Kansas City Area Transportation Authority. He spent 13 years as a Class A Mechanic, and 1 year as the Maintenance trainer. He has multiple ASE certifications, HVAC Type II certification, and is a Certified CNG fuel Cylinder and Systems inspector. He holds a Class A CDL w/passenger endorsement. He has been trained on Voith transmissions, Allison transmissions, Cummins engines, Agility fuel systems, Lift-U, Thermo King Intelligaire I & II, Dinex T2/G3/&G4, J1939, and Amerex fire suppression. He has competed and won multiple awards at the APTA International Bus Roadeo.

JOY SISOUVANTHONG – Field Service Representative
Joy started working at GILLIG in 2015. He worked in the Labor Pool Department then transferred to 03 Electrical Department until 2016 when he became a Field Service Rep. He worked various jobs on the line and did pick up work for all departments. His main focus became programming buses on Engine Transmission and downloading the I/O program along with troubleshooting.

SANG TRAN – Senior Field Service Representative
Sang joined GILLIG in March 1997. He first started out in Dept. 04 for a few months then transferred to the Labor Pool in late 1998. For the following years, he worked throughout most departments, and spent most of his time in Dept. 03 (Electrical), performing work duties such as front dash harnesses/main electrical panel installations, engine power trouble shooting for buses to start before they get into Rack area (Dept.09). In mid-2001, Sang became a Field Service Representative and relocated to Fairfax County in State of Virginia. During his service years, he had attended training courses for Dinex and Air Systems. Before joining GILLIG, Sang worked for Morehouse Foods Co. in Emeryville, CA as a lead machinist and oversaw the high volume of bottling, labeling, capping machines, and performed electrical trouble shooting problems as required. Upon CNG market demand in Southern California, Sang lives in Orange County, CA in and covers the Pacific Southwest region.

BO VONGAMATH – Technical Service Advisor
Bo has been with GILLIG since January of 1999. He worked 2 years in the Labor Pool, 3 years in the Electrical Department and 4 years as a Quality Inspector in the Field Service Department. He also received training on Allison Electric Drive, Certified ASE Refrigerant Recovery and Recycling. Before GILLIG, Bo worked at Chuck E. Cheese as their Electronic Technician for 10 years.

ENGINEERING SUPPORT

GILLIG maintains a fully experienced and qualified Engineering Department directed by the Vice President of Engineering. The Engineering staff is involved in all design requests and is also made available to the customer on request to assist in the resolution of engineering or design problems that may arise within the scope of the specifications during the production and/or warranty period.

The GILLIG Engineering Department is located in the manufacturing plant in Livermore, CA and is available to assist the manufacturing process. The integrated staff performs all vehicle engineering including the research and development of all systems integrated on our vehicles.

All current products were designed and developed by GILLIG Engineering. Attached is our staff description and organization.

GILLIG ENGINEERING ORGANIZATION

Name	Function	Education	Background
G. Vismara	Vice President, Engineering	BSME	32 yrs. industry experience at Peterbilt, Loral Space Systems & GILLIG
T. Meagher	Director, Design Engineering	BSME, BSEE	33 yrs. industry experience at Ford, Caterpillar, Case New Holland & GILLIG
D. Jayasinghe	Program Mgmt.	BSAE & MSME	16 yrs. industry experience at CAT, Cummins & GILLIG
R. Quebbeman	Manager, Specifications & Bill of Material	AS Mech. Engr.	51 yrs. industry experience bus and truck design - Mack, International & GILLIG
S. Vanderlip	Manager, Mechanical Engineering Systems	BSETME,PE	34 yrs. industry experience at Peterbilt & GILLIG
C. Ababseh	Manager, Mechanical Engr Body & Interior	BSME	14 yrs. industry experience at GILLIG
K. Vorsatz	Manager, Mechanical Engineering Powertrain	BSME	14 yrs. industry experience at BAE & GILLIG
J. Abrew	Bill of Material Order Technician	H.S.	31 yrs. industry experience at GILLIG
T. Agawa	Bill of Material Order Technician	BSIT	29 yrs. industry experience at GILLIG & Peerless Lighting
F. Andrade	Supervisor, Controls	BSEE	7 yrs. industry experience at E-N-G Mobile & GILLIG
D. Aranovich	Mechanical Designer	BS Engr Tech	19 yrs. industry experience at Metaldyne, Ford, LightSail Energy & GILLIG
M. Banwait	Mechanical Design Engineer	BS	2 yrs. industry experience at GILLIG
R. Brar	Mechanical Design Engineer	MS Aerospace Engineering	9 yrs. industry experience at Int'l Cars & Motors, Heil Trailer & GILLIG
B. Burdick	CAD Designer	HS	44 yrs. industry experience at Altamont Mfgr, Lawrence Livermore Lab & GILLIG

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ENGINEERING SUPPORT

L. Bush	Electrical Engineer	BSIT	20 yrs. industry experience at Compass, Autocam, TPI, Dow Jones & GILLIG
N. Clopton	Supervisor, Body	BSME	14 yrs. industry experience Parker Hannifin, Racor Division
F. Cruz	Bill of Material Technician	BSC-Mgmt.	20 yrs. industry experience at GILLIG
J. Dalmeida	Sr. Mechanical Engineer	BSME	8 yrs. industry experience at New Flyer & GILLIG
B. Den Hollandar	Electrical Engineer	BSEE	8 yrs. industry experience at Proficient Machining, Optimal & GILLIG
S. Dunbar	Electrical Engineer	BSEE	4 yrs. industry experience at GILLIG
J. Edmondson	Bill of Material Order Technician	H.S.	41 yrs. industry experience Peterbilt & GILLIG
C. Espinosa	Supervisor, Passenger Compartment	MSME	9 yrs. industry experience at Lawrence Livermore Lab, SFMTA & GILLIG
G. Estantino	Mechanical Engineer I	BSME	4 yrs. industry experience at ICON Aircraft & GILLIG
S. Faria	Bill of Material Technician	BSBA	27 yrs. industry experience Mack, Xerox & GILLIG
K. Fernandez	Bill of Material Technician	H.S.	9 yrs. industry experience at GILLIG
S. Finley	Supervisor, Power Distribution	BSEE	28 yrs. industry experience at Georgia-Pacific, Walk-Haydel & GILLIG
J. Fisher	Mechanical Designer	HS	23 yrs. industry experience at Burke Porter Machinery, Stewart & Stevenson & GILLIG
F. Fotos	Electrical Engineer I	BSEE, MEM	6 yrs. industry experience at Northrop Grumman & GILLIG
A. Frey	Engineer 2, Powertrain	BSME	12 yrs. industry experience at Cummins & GILLIG

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ENGINEERING SUPPORT

D. Garcia	Bill of Material Technician	H.S.	7 yrs. industry experience at GILLIG
M. Genova	Mngr. Product Safety & Compliance	MSAE	19 yrs. industry experience at AVL, Fiat, Landirenzo-Baytech USA, & GILLIG
J. Graves	Bill of Material Order Technician	BSCJ/S	11 yrs. industry experience at GILLIG
J. Hackney	Electrical Engineer II	BSEE	13 yrs. industry experience at IoT, Davis Instruments & GILLIG
D. Haiduk	CAD Designer	BS	16 yrs. industry experience at AGAT, Yo-Engineering, RenyMed & GILLIG
B. Haley	Mechanical Engineer	BSME	6 yrs. industry experience Product development
N. Henderson	Mechanical Design Engineer	BSME	7 yrs. industry experience at Zodiac Aerospace & GILLIG
E. Hughes	Assoc. Mechanical Engineer	BS	2 yrs. industry experience at GILLIG
M. Itanna	Sr. Electrical Engineer	MSc. EE	7 yrs. industry experience at Vertiv & GILLIG
T. Jones	Mechanical Drafter Design	AA Mechanical	18 yrs. industry experience NABI & GILLIG
T. Junge	Mechanical Engineer	BSME	5 yrs. industry experience at Durst-field, Cessna Aircraft-Interior & GILLIG
S. Loyd	Supervisor, ITS & Surveillance	B.S. Physics	10 yrs. industry experience at Areias Systems
EJ Mariscal	Bill of Material Technician	HS	21 yrs. industry experience at GILLIG
M. Mohammedkair	Power Distribution Engineer	BSEE	10 yrs. industry experience at GILLIG
A. Monserret	Associate Mech Engineer	BSME	2 yrs. industry experience at GILLIG

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ENGINEERING SUPPORT

G. Mortazavi	Electrical Engineer	MSEE	3 yrs. industry experience at Chicago Transit Authority & GILLIG
W. Nairn	Liaison Engineer	College	20 yrs. industry experience at GILLIG
B. Nguyen	Design Engineer, Electrical	BSEE	13 yrs. industry at HP, Kla-Tencor & GILLIG
L. Nguyen	Supervisor, Drivers Area	BSEE	14 yrs. industry experience Panasonic Automotive & GILLIG
J. Ocampo	Bill of Materials Technician	College	31 yrs. industry experience at GILLIG
M. Ortega	Associate Electrical Engineer	BSEE	2 yrs. industry experience at GILLIG
H. Perez	Production Support Tech	H.S	5 yrs. industry experience at GILLIG
M Pinto	Program Manager CPI	BSME, MSME, MSPM and PMP	17 yrs. industry experience at Ford, Volkswagen & GILLIG
P. Pruscha	Industrial Designer	BS Industrial Design	35 yrs. industry experience at Peterbilt, Jacuzzi & GILLIG
M. Rands	Bill of Material Technician	H.S.	8 yrs. industry experience at GILLIG
J. Reekie	Sr. Mechanical Engineer	MSME	9 yrs. industry experience at Caterpillar & Castrol
M. Roberts	Mechanical Design Engineer	MSME	7 yrs. industry experience at BHJ Dynamics & GILLIG
G. Roderick	Supervisor, Order Processing	AA	36 yrs. industry experience at GILLIG
M. Ruth	Powertrain Systems Engineer	BS EMET	19 yrs. industry experience at Harley Davidson, Voith & GILLIG.
H. Sanchez	Mechanical Engineer	BSME	7 yrs. industry experience GCM & GILLIG

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ENGINEERING SUPPORT

T. Scheumann	Sr. Mechanical Design Engr	MSME	8 yrs. industry experience at Hyster-Yale, Mizuho OSI & GILLIG
J. Seei	Bill of Material Technician	HS	23 yrs. experience at GILLIG
M. Shaieb	Project Engineer Technician	BSME	38 yrs. industry experience at BAE Systems & GILLIG
C. Silva	Bill of Material Technician	HS	34 yrs. industry experience at GILLIG
H. Tuft	Supervisor, Powertrain	BSME	14 yrs. experience at Electroglas Inc & AutoCat USA Inc.
J. Turner	Electrical Design Engineer	BSEE	5 yrs. industry exp at GILLIG
A.vanHaeften	Supervisor, Chassis	BSME, PE	14 yrs. industry experience at Westinghouse, Park Hannifin & GILLIG
D. Williamson	Proj. Mngr./Mechanical Engineer I	BSME	4 yrs. industry experience at Kratos Unmanned Aerial Sys. & GILLIG
R. Williamson	Sr. Design Engineer	MS, MEng ME	11 yrs. industry experience GE, Tesla & GILLIG
B. Wu	Design Engineer Electrical Systems	BSEE EIT	21 yrs. industry experience at Pulver Genau & GILLIG
C. Xue	Program Manager NPI	BSME	7 yrs. industry experience at BYD & GILLIG
J. Yang	Electrical Engineer	MSEE	12 yrs. industry experience at Auto, Commercial Avionics, BAE & GILLIG

TRAINING OVERVIEW

GILLIG wishes to advise the AGENCY that all training programs presented by GILLIG instructors are individually tailored to be representative of the vehicle specifications and equipment supplied on the buses at the time of delivery. These programs may also be modified further to meet the needs and/or time constraints of the customer at the preproduction meeting, if GILLIG is the successful bidder.

GILLIG's field service technicians and trainers are GILLIG employees with the experience and knowledge to provide the AGENCY with training customized to your bus. Operator and Maintenance orientation and familiarization training will be provided during the post-delivery inspection, which generally takes place within the week following delivery of the units to your location. This training will be customized to your buses, is provided in addition to the training requirements specified in the RFP and is provided at no additional cost. As well, the field service technicians who perform the post-delivery inspection typically will work with the maintenance staff as they perform any necessary repairs in order to provide further training contemporaneously with the repair.

More in-depth training will be scheduled and provided by GILLIG trainers on a mutually agreed upon schedule based upon the AGENCY's needs. These training classes are specified in the GILLIG bid and class descriptions are provided therein. However, as it is GILLIG's desire to provide the best and most effective training for our customers, we encourage the AGENCY's training coordinators to contact the GILLIG Training Department prior to the class start dates, to pass along any items or issues that you wish to be elaborated on, or items that need not be covered. This allows the trainer to further tailor the class to best meet the needs of the AGENCY personnel.

GILLIG strives to go above and beyond all minimum requirements to ensure that we provide the best customer service in the industry. Providing the tailored training that our customers need to make them as efficient as possible is just another example of our commitment to this philosophy.

The GILLIG proposal includes the training modules as outlined below.

1. GILLIG Basic Bus Training – provided at Post Delivery Inspection
2. Operator Orientation – provided at PDI
3. GILLIG will provide a complete set of Low Floor training video's on USB

Additional Training may be purchased separately and can be quoted upon request.

Attached is our **AVAILABLE OPTIONAL – TRAINING PROGRAM** with additional information on training that is available.

CUSTOMER CARE SUPPORT NETWORK

EXECUTIVE DIRECTOR, CUSTOMER CARE
Victor Doran

SERVICE MANAGER
Eric Ocampo

WARRANTY MANAGER
Micah Denecour

TECHNICAL ADVISOR
Bo Vongamath

TECHNICAL TRAINERS		**Based:**
Russ Ando	-	Seattle, WA
Lyle Archambeau**	-	St. Paul, MN
Ben Braun	-	Baltimore, MD
Blaine Fagel	-	Charlotte, NC
Kevin Hardesty	-	Columbus, OH

FIELD SERVICE REPRESENTATIVES *		**BASED:**
Mark Bittner	-	Clearwater, FL
Rob Bolog	-	Detroit, MI
Cody Campeau	-	St. Paul, MN
Jason Fairclough*	-	Salt Lake City, UT
Jose Garcia	-	San Francisco, CA
Dave Hagopian*	-	St. Louis, MO
Scott Kovaly	-	Pittsburgh, PA
Tim Lopez	-	San Francisco, CA
Sam Nicoara	-	Atlanta, GA
Paul Oden, Jr.		Cincinnati, OH
Joe Rhea*	-	Dallas, TX
Richard Salas*	-	San Francisco, CA
Steven Sayne*	-	Seattle, WA
Jason Schwalbert	-	Phoenix, AZ
Thomas Seymour	-	Denver, CO
Joy Sisouvanthong	-	Boston, MA
Sang Tran*	-	Los Angeles, CA

FIELD SERVICE & WARRANTY **Phone - 800-735-1500 Fax- 510-785-1348**

Victor Doran	Exec.Director, Customer Care	victor.doran@gillig.com
Eric Ocampo	Service Manager	eocampo@GILLIG.com (call to schedule training)
Micah Denecour	Warranty Operations Manager	micah.denecour@GILLIG.com
Johnny Phothipanya	Warranty Processing Specialist	jphothipanya@GILLIG.com
Bo Vongamath	Technical Advisor	bvongamath@GILLIG.com
Dominic Nava	Warranty Parts Specialist	dnava@GILLIG.com (call to order warranty parts)
Vy Vu	Field Service Coordinator	vvu@GILLIG.com
Kristina Aldana	Administrative Assistant	kaldana@GILLIG.com

Training instructors employed by GILLIG are fully qualified service personnel with extensive “hands on” experience on our coaches. They have been trained in all phases of coach repair including, but not limited to major component replacement and repair, electrical troubleshooting, suspension and frame repair as well as repair of all ancillary components and systems.

* Performs pre-delivery service at the customer site, as well as ongoing field product support services.
** ASE Certified Mechanic

FIELD SERVICE QUALIFICATIONS

VICTOR DORAN - Executive Director, Customer Care
Victor is responsible for all areas of Field Service, Warranty, Customer Acceptance, and coordinates the efforts of the entire department. Victor utilizes his many years of experience with heavy-duty motor vehicle production to lead a team of more than 30 on site and field-based representatives ensuring 100% customer satisfaction. Victor earned a Bachelor of Science in Mechanical Engineering Technology from Kent State University in Ohio.

ERIC OCAMPO – Service Manager
Eric has been with GILLIG since January 1987. He came to GILLIG from A.C. Transit where he worked for 2 ½ years involved in special projects. He has 1 year in R.O.C. diesel technology and electrical and 5 years as an automotive technician. He also received training on DDEC, Allison, Lift-U wheelchair lifts and Luminator destination signs for troubleshooting and repair. Eric spent 10 years as a Field Service Representative and was a Field Service Trainer from 1996-2013. In April 2002, he completed training with Cummins I.S.L. troubleshooting and familiarization, and in November 2004, he completed training with Allison Hybrid electric drives. Since 1999, he has received numerous extensive training classes from I.O. Controls Multiplex Systems covering the T-1, T-2, G-3 and the latest G-4 systems. In 2013, he became the Warranty Administrator.

MICAH DENECOUR – Warranty Manager
Micah has been with GILLIG since October 2016. He has worked in the Industrial Engineering, Supply Chain, and Warehousing teams at GILLIG. Micah holds a BS and MS in Industrial Engineering from Cal Poly. Prior to GILLIG he worked in the medical device industry.

RUSS ANDO - Trainer
Russ resides in Washington State and covers the Pacific Northwest Region. Russ Joined GILLIG in March 2001 and worked in several areas on the production line, including line foreman. In July 2002, Russ joined the Field Service Department. He has done classic auto restoration since 1979 and has completed several body-off, frame-up restorations. Along with his knowledge of mechanics and hands on approach to his job, he earned a BFA with honors in illustration from California College of Arts and Crafts.

LYLE ARCHAMBEAU – Trainer
Lyle lives in St. Paul, MN and covers the Midwest region. He has been employed at GILLIG since 1989. He has three years' experience in Heavy vehicle Maintenance while stationed in the U.S. Army. Also, Lyle has five years' experience in the Automotive Maintenance Industry. He is ASE Certified in Auto Electric, Brakes, Suspension, Engine Performance and Engine Rebuilding. He has attended classes at Auto tech for Air Conditioning, and Engine Electronics Controls and Diagnosing.

MARK BITTNER – Senior Field Service Representative
Mark joined our GILLIG family in 2019. He brings extensive knowledge and experience in transit bus maintenance and troubleshooting. He grew up in Pittsburgh, PA and is a graduate of Steel Center Technical School and Ohio Diesel Technical Institute. He began his career in 1986 with a Pittsburgh based Detroit Diesel Allison distributor. There he served in troubleshooting, repair and overhaul of all Detroit Diesel Allison Propulsion systems. From 1993 through 2018 Mark worked for the Port Authority of Allegheny County in Pittsburgh, PA. There he performed all aspects of transit bus maintenance, troubleshooting and repairs. While there he became a bus maintenance technical trainer and developed many vehicle maintenance, overhaul programs and provided technical support. Since 2005 Mark has been working with GILLIG busses at the Pittsburgh Port Authority of Allegheny county. Mark also enjoyed owning a business in Pittsburgh, PA with his two sons where they design and build racing engines and offer field service repairs for a diesel propulsion systems. Mark and his family now reside in the Florida.

ROB BOLOG – Senior Field Service Representative
Rob graduated from Michigan State University where he completed a Power Equip. Technology program. Rob started in the heavy equipment and consumer products business (chainsaws to excavators) in 1978 before moving to the Ann Arbor Transit as a technician in 1984. He was a maintenance supervisor and warranty administrator at the time he retired in 2018 to join the GILLIG Field Service Team.

CODY CAMPEAU – Field Service Representative
Cody lives in New Richmond, WI and covers the Midwest region, he joined the GILLIG family in 2019 after working as a contractor for GILLIG since 2010. During that time he gained experience from many hands on repairs and projects he was involved with.

BEN BRAUN – Trainer
Ben lives in Street, MD and covers the Eastern Region. He has been employed with GILLIG since 1995 and has been in the motorcycle, automotive, truck and bus industry full time since 1971. He has experience in all areas of fabrication, welding, manual machining, repair, welding and diagnostic work. He previously was a GM Buick Master certified technician and held ASE Master Technician certification from 1985 to 2000.

BLAINE FAGEL – Trainer
Blaine joined GILLIG as an FSR in 2006 and moved to Trainer in 2010. He began in the trucking industry in 1990. He has been in the transit industry since 1995. He has fueled trucks/buses and performed preventative maintenance. He has also been a technician, union officer, shop supervisor, technical spec writer and QA officer. He worked for Lynx Orlando from 1995-2003 and Charlotte CATS from 2003-2006. He has been ASE Certified for heavy truck steering and suspension, A/C refrigerant recovery and recycle, as well as for bus/truck air brakes. Blaine is also a Type I & II Certified A/C Technician. He has taken many classes for electrical, preventative maintenance, suspension, hydraulics, brakes, A/C, wheelchair lift (Lift-U), Cummins, Detroit Diesel, Allison, Amerex as well as many managerial courses in people skills, time management, computer software for transit specific products, Excel, Word, Outlook, Adobe Professional, and PowerPoint.

JASON FAIRCLOUGH – Senior Field Service Representative
Jason has been employed with GILLIG since March 2001. He has 3 years' experience as a Quality Engineering Technician for Nova Bus Inc. Where he had taken several classes: Kizan, Metrology, Paint and Body. Jason also has a certificate from the National Fire Academy, for Hazardous Materials Incident Analysis, Hydraulics and Fluidics. While at GILLIG, Jason has taken classes in I/O, Air Systems, Allison Electric Drive, and Service Training. In addition, Jason has been building and racing vehicles since 1989.

JOSE GARCIA - Field Service Representative
Jose joined GILLIG in the Production Department in 2015. He started in second shift and became a lead after four months. After one year, he moved to first shift labor pool and worked various departments before joining Field Service. Before GILLIG, Jose worked for 15 years as an auto mechanic. He started as a lube mechanic as a tech 1, then became a tech 4 master mechanic. He attended De Anza College and completed the automotive program. He also completed 3 ASE certified tests.

DAVID HAGOPIAN – Senior Field Service Representative
Dave lives in southern Illinois and covers the Midwest region. He has been employed with GILLIG since November 2000. Dave came to GILLIG with 19 years of experience as manager, service writer and mechanic in the automotive industry. He has been ASE certified in heating, air conditioning, and electrical/electronic systems. He is trained in industrial electronics at Southwestern Illinois College.

SCOTT KOVALY – Field Service Representative
Scott was born and raised in Pittsburgh PA where he currently live with his wife, son and daughter. He graduated from Rosedale Technical College in 1988. After Rosedale he worked for GM, VW and Ford as the transmission and drive-ability specialist until 1994. He began his transit career with the Port Authority of Allegheny County in 1993 where he held various positions to include, hourly technician, materials control specialist, maintenance technical trainer, assistant manager of maintenance, manager of maintenance and bus procurement specialist. Scott holds ASE Master Technician status in Transit, Automotive and Heavy disciplines. He joined the GILLIG family in October of 2019 with the Field Service Department.

KEVIN HARDESTY – Trainer
Kevin has been a technical coach trainer since 1987. He has been a field service trainer for GILLIG since 2005. Prior to being employed as a field service trainer for GILLIG, Kevin operated his own technical training company for 9 years. Kevin started as a technical trainer for the FIxible Corporation in 1987. He also spent 2 years at the Central Ohio Transit Authority as the Training Supervisor. During his time at these positions, he has performed technical writing and created numerous training classes using PowerPoint software. His other duties have included various field service tasks as required.

TIMOTHY LOPEZ – Field Service Representative
Tim has been employed with GILLIG since January 2007. He worked in Labor Pool for five years and three years in Ready Row. Two of the three years in Ready Row he obtained his Commercial Driving License. While working in Ready Row he took customers on test drives on their new buses and explained the functionality of the bus. He studied Automotive Maintenance and Repair along with Machine Shop in High School Regional Occupation Center (R.O.C.). He received an Associate of Occupational Studies degree from Universal Technical Institute.

SAMUEL MAC NICOARA - Field Service Representative
Sam was born in Romania and immigrated to the US in 1980. In 1994, he graduated Sierra Academy of Aeronautics in Oakland, CA and received an aeronautical degree in Airframe & Powerplant as well as flight engineering. He applied his training in the aviation field and helped expand a superconducting magnet fabricating plant that he managed for over 10 years. In 2014, he joined GILLIG and worked as a troubleshooter in the Electrical Department. In 2016, he joined Field Service as a field service representative, servicing customers nationwide.

PAUL ODEN, JR. – Field Service Representative
Paul has in-depth experience working on GILLIG buses. For 19 years, he has served as a mechanic for the South Western Ohio Regional Transit Authority in Cincinnati, maintaining GILLIG buses and Cummins powertrains. He particularly enjoyed working on schematics and using his problem-solving skills. Paul joined GILLIG in October of 2019.

JOE RHEA - Senior Field Service Representative
Joe has been employed with GILLIG since 1988 and has had training in Voith, Transmission troubleshooting, & Lift-U Wheelchair lifts and Luminator Electric Destination Signs. He has also attended training classes by the GILLIG trainer in the Electrical System, Air System and Hydraulic systems on the GILLIG buses. Joe lives in Central Texas and covers the Southern Region.

RICHARD SALAS – Senior Field Service Representative
Richard has been employed with GILLIG since 1998. He worked in Labor Pool for one year and worked 4 years as a Working Foreman in in the Trim department. He was also the Working Foreman for the Maintenance Department on 3rd shift. He has attended training courses for the Dinex and Air systems. He is based out of the San Francisco area.

STEVEN SAYNE – Field Service Representative
Steven has been employed with GILLIG since June 2003. He worked with 1st shift Maintenance Department for 3 years. He was also the Working Foreman for the Maintenance Department on 2nd shift for 5 years. He has 10+ years of automotive and machine service and repair experience. He also has 10+ years of electrical and electronics service and repair experience. He has attended training courses for the Dinex and Air systems. He resides in Washington State and covers the Pacific Northwest Region.

JASON SCHWALBERT – Field Service Representative
Jason has been employed with GILLIG since December of 2017. Prior to that, he worked in the Phoenix Transit System for over 17 years as a Project Lead performing duties ranging from Transit Bus Maintenance to Shop Management. Jason has accumulated many Certifications and Licensing over the years including 3 ASE Master Certifications, Both A/C Section 608 Universal, & Section 609 certifications, and a Class B CDL w/Passenger Endorsement. He has earned an Associate Degree in Automotive, Diesel, and Industrial Technologies from Universal Technical Institute. Jason lives just outside Phoenix in Goodyear AZ.

THOMAS SEYMOUR – Field Service Representative
Tom has been with GILLIG since November of 2018. Prior to joining GILLIG, he worked at the Kansas City Area Transportation Authority. He spent 13 years as a Class A Mechanic, and 1 year as the Maintenance trainer. He has multiple ASE certifications, HVAC Type II certification, and is a Certified CNG fuel Cylinder and Systems inspector. He holds a Class A CDL w/passenger endorsement. He has been trained on Voith transmissions, Allison transmissions, Cummins engines, Agility fuel systems, Lift-U, Thermo King Intelligaire I & II, Dinex T2/G3/&G4, J1939, and Amerex fire suppression. He has competed and won multiple awards at the APTA International Bus Roadeo.

JOY SISOUVANTHONG – Field Service Representative
Joy started working at GILLIG in 2015. He worked in the Labor Pool Department then transferred to 03 Electrical Department until 2016 when he became a Field Service Rep. He worked various jobs on the line and did pick up work for all departments. His main focus became programming buses on Engine Transmission and downloading the I/O program along with troubleshooting.

SANG TRAN – Senior Field Service Representative
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AVAILABLE OPTIONAL - TRAINING PROGRAMS

All training programs presented by GILLIG are individually tailored to be representative of the vehicle specifications and equipment supplied on the buses at the time of delivery. These programs may also be modified further to meet the needs and/or time constraints of the customer at the pre-production meeting. GILLIG's training program is designed to instruct your transportation and maintenance personnel in the proper methods of operating, maintaining, and servicing the buses. Your training program has been specifically addressed in the appropriate section of this proposal and we are certain it will exceed your expectations.

Our training programs have been well accepted by other transit agencies as described in the attached customer testimonials.

You will also note that our technical trainers have extensive Mechanical Maintenance experience and hold numerous training certifications.

To further aid in the training of your maintenance group, GILLIG will supply a set of bus training DVD's.

GILLIG FIELD SERVICE TRAINING PROGRAMS

OBJECTIVE:

Our training programs are specifically designed to acquaint our customers with their new GILLIG transit bus and to ensure their understanding for proper operation, maintenance, diagnosis and repair of their coach, which employs the latest in "state of the art" bus technology.

These programs will help our customers maximize the potential of the GILLIG transit bus throughout its life.

All training programs presented by GILLIG instructors are individually tailored to be representative of the vehicle specifications and equipment supplied on the buses at the time of delivery. These programs may also be modified further to meet the needs and/or time constraints of the customer.

PROGRAM PLAN(S):

The basic programs shall be presented as follows:

- Operator Instruction
- Maintenance Department General Vehicle Orientation
- Air Systems and Brake
- Basic Bus Electrical System
- Multiplex Electrical System
- Hydraulic System
- E-FAN System
- Gillig Battery Electric Bus Safety & Familiarization
- Entrance/Exit Door Systems

OPERATOR INSTRUCTION

OBJECTIVE:

This class will take approximately four hours and class size should not exceed six drivers. This is a "hands-on" program to familiarize the driver in the proper operation of the GILLIG transit bus and requires that a coach be made available by the customer for this instruction. Topics included in this program are:

A. Seat and Seat Belt Operation and Adjustments

B. Steering Column Adjustments

C. Switches and Controls
   1. Location
   2. Proper Operation
   3. Function

D. Instrumentation and Warning Lights

E. Entrance and Exit Door Operation

F. Wheelchair Ramp Operations
   1. Safety Precautions

G. Brake Interlock
   1. Safety Precautions

H. Speed Switch Circuit
   1. Verbal Explanation
   2. Demonstration
   3. Safety Precautions

I. Engine Protection System
   1. Controlling Functions
   2. Shut Down Sequence
   3. E.P.M. Override
      a. Purpose
      b. Proper Usage

J. Gillig Battery Electric Bus Operation

MAINTENANCE DEPARTMENT GENERAL VEHICLE ORIENTATION

OBJECTIVE:

This is an on-vehicle instruction program to acquaint the mechanic with the operational aspects of the GILLIG transit bus, as well as the components employed in its operation and their locations. It also provides brief explanations and demonstrations of how and when various systems interface with each other. These explanations and demonstrations are designed to provide the mechanic with a better understanding of the system logic employed and ultimately result in more rapid and accurate diagnosis and repair. Other areas covered in this orientation program are maintenance items and can be tailored for in-depth instruction on the door system, hydraulic system, steering system, suspension systems, and propulsion systems.

This class will take approximately eight hours to complete with a maximum class size of twelve mechanics. A coach must be made available for this instruction by the customer. Please be aware that any identified system can be expanded on and discussed more in-depth in subsequent classes. Topics included in this program are:

A. Seat and Seat Belt Operation and Adjustments

B. Steering Column
   1. Adjustments
   2. Maintenance

C. Switches and Controls
   1. Location
   2. Proper Operation
   3. Function
   4. System Interfacing
   5. Diagnostic Tips on the More Complex Systems

D. Instrumentation and Warning Lights

E. Engine Protection System
   1. Controlling Functions
   2. Shut Down Sequence
   3. E.P.M. Override
      a. Purpose
      b. Proper Usage

F. Brake Interlock
   1. Components
   2. Operational Description
   3. Explanation of Circuits that Apply Interlock
   4. Interlock Air Pressure Adjustment

5. Override
6. Safety Precautions

G. Under 3 MPH Speed Switch Circuit
1. Operational Description
2. Diagnosis of Circuit
3. Safety Precautions

H. Wheelchair Ramp
1. Components and Component Location
2. Operation
3. Safety Device
4. Safety Precautions

I. Entrance Door
1. Components and Component Location
2. Operation
3. Door Panel Adjustment
4. Door Motor Adjustments
5. Proximity Switch Adjustments

J. Exit Door
1. Components and Component Location
2. Operation
3. Door Panel Adjustments
4. Door Motor Adjustments
5. Micro/Proximity Switch Adjustments

K. Compartment by Compartment Tour of Bus
1. Components and Component Location
2. Operational Descriptions of Systems Viewed
3. Maintenance Information
4. Diagnostic Tips and Test Procedures
5. Safety Precautions

L. Vanner Equalizers
1. Component Location
2. Operational Description
3. Test Procedures

M. Hydraulic System
1. Component and Component Location
2. Description of Components and Maintenance Required
3. Explanation of Fan Drive Circuit and Its Function
4. Explanation of Steering Circuit and Its Function
5. Presentation of Flow and Pressure Specifications for Fan Drive and Steering Circuits

6. Description and Explanation of Test Equipment Needed to Properly Diagnose Hydraulic System Problems
7. Safety Precautions

N. E-FAN System
1. Individual Fan Location and Function
2. Location and Function of the EFAN Controller
3. Use of EFAN Controller LED's for Diagnostics
4. Location and Function of EFAN Fuses Panel
5. Reverse Fan Operation
6. Safety Precautions

O. Fire Alarm System
1. Components and Component Location
2. Operational Description
3. Test Procedures

P. Steering and Front Suspension
1. Explanation of Front Ride Height Adjustment and Specifications
2. Explanation of Adjustment Points for Front End Alignment
3. Explanation of Front Shock Absorber
4. Explanation of Steering and Suspension Maintenance Requirements

Q. Rear Suspension
1. Components and Component Location
2. Discuss Inspection of Welds
3. Discuss Inspection of Suspension Components
4. Discuss Bushing Wear and Bushing Replacement
5. Explanation of Rear Ride Height Adjustment and Specifications
6. Explanation of Adjustment Points for Rear End Alignment

R. Engine Cooling System
1. Components and Component Location
2. Explanation of Cooling System Maintenance Requirements
3. Safety Precautions

S. Gillig Battery Electric Bus
1. System Components and Component Location
2. Drive System Theory of Operation
3. High Voltage Safety
4. LOTO Discussion

AIR SYSTEM AND BRAKES

SCOPE:

This is a sixteen hour program of which approximately the first thirteen hours of instruction will take place in a classroom setting utilizing a color coded air system drawing projected from a laptop with a projector. Each student will have a copy of the drawing and a detailed power point handout to follow along through the air system circuits. The remaining time will be spent applying the classroom information to the vehicle in "hands-on" tests and adjustments.

The customer shall make available a suitable room for training that is appropriately equipped, keeping in mind the class size shall not exceed twelve mechanics, and a bus for the last segment of the training program.

OBJECTIVE:

This program will focus primarily on providing the mechanic with a better understanding of the air system, its components, and their operation under various operating conditions. The class participants accomplish this by viewing and following along with the colored air flow charts for normal brake operation, brake operation with loss of primary air, brake operation with loss of secondary air, brake interlock, and anti- compounding circuits to facilitate diagnosis of air leaks. Presentation of a comprehensive systematic air system test procedure will also be included in this program. The air flow charts, when used in conjunction with these air system tests, will aid the mechanic in determining if the components in the air and braking systems are operating properly and may also be used as a tool in the diagnosis and isolation of a problem or air leak in the system.
The secondary focus of this program is on the mechanical aspects of the braking system such as but not limited to the operational principles of the Haldex slack adjuster, initial set up and adjustments of the Haldex slack adjuster, maximum push rod travel, and push rod angles, air dryer operation and compressor troubleshooting. Additional topics will be covered upon request by the customer based on their particular need or desire. ABS and Traction control systems will also be discussed.

Brief overview of disc brake system including wheel end overview and differences to air system.

BASIC BUS ELECTRICAL SYSTEM

SCOPE:

This is a twenty-four hour program for a maximum of twelve mechanics. The program will take place in both the classroom setting utilizing the supplied power point handout and on the coach for practical application of the classroom material. The customer shall make available a suitable room for training that is appropriately equipped. The customer will also make available for training the schematics for the bus that the class is training on.

OBJECTIVE:

This program is designed to help the mechanic utilize the GILLIG electrical diagrams and schematics to the fullest extent possible. This will promote a better understanding of the system logic, resulting in less time consuming and more accurate diagnosis. Topics included in this program are:

A. Review of Basic Electrical Principles
   1. Use of Digital VOM
   2. Open Circuits
   3. Completed Circuits
   4. Shorted Circuits
      a. Dead Short
      b. Cross Short
   5. Series Battery Connections
      a. Results
      b. Benefits
   6. Parallel Battery Connections
      a. Results
      b. Benefits
   7. Series Circuits
      a. Benefits
   8. Parallel Circuits
      a. Benefits
   9. Voltage Drop
      a. Demonstration of How to Use Voltage Drop for Diagnostic Purposes

B. Relays Used in GILLIG busses
   1. Description of Internal Operation
   2. Symbols as Represented on Drawings
   3. Functional Diagrams

C. Diodes
   1. Explanation of Operational Principles
   2. Uses
   3. Symbols and How to Determine Directional Flow
   4. Test Procedures

D. Transistors
   1. PNP's
   2. NPN's
   3. Test Procedures

E. General Electrical Symbols
   1. Fuses
   2. Circuit Breakers

3. Resistors
    a. Fixed Resistors
    b. Variable Resistors
4. Coils
5. Normally Open Contacts
6. Normally Closed Contacts
7. Pressure Switches

F. Information Supplied on GILLIG Electrical Diagrams
1. Print Number
2. Revision
3. Part Numbers
4. Torque Specifications
5. Drawing Size
6. Component Location
7. Wiring Connector Locations
8. Wiring Numbering System
9. Wiring Color Coding

G. Typical Electrical Diagrams or Schematics Used to Determine System Logic
1. Battery Cables with Cut Off Switch
    a. For Charging System Diagnosis
    b. For Vanner Equalizer System Diagnostic
2. Ignition, Start, Fast Idle
    a. For Front Run Diagnosis
    b. For Rear Run Diagnosis
    c. For Fast Idle Diagnosis
3. Wheelchair Ramp
    a. For Wheelchair Ramp Interface Diagnosis
4. Kneeling
    a. For Kneeling Diagnosis
    b. For Raise Diagnosis
5. Stop Request
6. Fire Alarm
    a. For Engine Fan Circuit Diagnosis
    b. For Fire Alarm Diagnosis
7. Rear Door
    a. For rear Door Operation Diagnosis
    b. For sensitive Edge Diagnosis
    c. For Door Alarm Diagnosis
8. Interlock
    a. For Under 3 MPH Circuit Diagnosis
    b. For Interlock Diagnosis

H. Different or additional circuits will be covered upon the customer's request.

MULTIPLEX ELECTRICAL SYSTEM G5 I/O

SCOPE:

This is a twenty-four hour program for a maximum of twelve technicians. The program will be split between a classroom setting and on the bus. The classroom portion will use the supplied handout and the specific vehicle schematics. Using a digital projector the instructor will cover the supplied handout. The customer shall make available a suitable room for training that is appropriately equipped.

OBJECTIVE:

This program is designed to help the technician utilize the GILLIG electrical schematics and ladder diagrams to the fullest extent possible. This will promote a better understanding of the system logic, resulting in less time consuming and more accurate diagnosis. Topics included in this program are:

A. General Information Supplied in the Gillig Electrical Schematics
1. Vehicle Identification Numbers and Bus (Fleet) Numbers
2. Safety Precautions
3. Print Numbers
4. Part Numbers
5. Torque Specifications
6. Welding Precautions
7. Component Locations
8. Wire Circuit Identification
9. Power Cables and Wire Color Coding
10. Different Types of Wire Connectors that Gillig uses
11. Wire Connector Location Guide

B. General Electrical Symbols Used in the Gillig Electrical Schematics
1. Ground Symbols and How to Identify and their Locations on the bus
2. Fuses and Locations of the Main Power Fuses
3. Circuit Breakers, Circuit Breaker Numbers, and Locations
4. Resistors
5. Different Types of Switches (Toggle, Push Button, Rotary, Proximity, Pressure Type)
6. Wire Connector Symbol and How to use the Information Provided Inside the Symbol
7. Normally Open Contacts
8. Normally Closes Contacts
9. L.E.D. (Light Emitting Diode) Benefits and where we use them
10. Diodes and Diode Pack – Test Procedures, Locations, Where Used

C. Review of Basic Electrical Principles
1. Open Circuits and How to Troubleshoot
2. Shorted Circuits (Direct Short and Cross Short) and how to Troubleshoot

3. Completed Circuits
4. Series Battery Connections
5. Results
6. Benefits
7. Parallel Battery Connections
8. Results
9. Benefits
10. Series Circuits and their Benefits
11. Parallel Circuits and their Benefits
12. Voltage Drop Demonstrations to use for Diagnostic Purposes.

D. Introduction to Multiplex
1. What is and Why Multiplex
2. Why Gillig uses Multiplexing Systems
3. How Multiplex Works in a bus
4. Benefits of having a Multiplex system

E. Coach Zone Concept
1. Zone Layout
2. Zone Function
3. View of Each Zone
4. Communication Process of each Zone
5. Communication Harness and Location
6. Diagnostic Fault Codes for Communication

F. I/O Controls Corporation "Dinex" Components
1. Power Management Module(PMS)
2. High Speed Cell Network Control Module (D2)
3. Main Bus Controller (MBC)
4. Digital Input/Output Module (A1,B2,B3,B4,C1,D3,D4)
5. 816 Modules
6. 16/16 Modules
7. Digital 32 Input Module (A2)

G. I/O Controls Corporation "Dinex" Components (cont.)
1. The "Smart" Indicator Light Bar (B1)
2. Digital 24 Output Module (B5) if Applicable
3. Multi-Function Display (MFD)
4. Explanation of the module I.D.'s
5. Explanation of each Different Colored L.E.D.'s on each Module
6. Component Function and Location
7. System Interface Using the Multiplex Inputs and Outputs Chart

H. Ladder Logic Diagrams
1. Why we use Ladder Logic Diagrams
2. How to read a Ladder Logic Diagram
3. How to use a Ladder Logic Diagram for Troubleshooting the System

I. Electrical System Interface
   1. Multiplex System Power
   2. Starting System
   3. Charging System with Vanner Equalizer
   4. Tail and Marker Lights
   5. Turn Signals
   6. Kneeling System
   7. Wheelchair Ramp Power
   8. Fast Idle
   9. Brake and Throttle Interlock System
   10. Senders and Switches and Engine Shutdown System

J. J1939 Controller Area Network
   1. J1939 Theory
   2. Gateway Function
   3. Backbone Construction and Troubleshooting
   4. Stub and Extension Cable Troubleshooting
   5. Complete Network Troubleshooting

K. Diagnostics and Troubleshooting
   1. Using the L.E.D.'s for Circuit Integrity
   2. Using the Ladder Logic Diagrams
   3. Using the Gillig Electrical Schematics
   4. Using the "Dinex" Diagnostic Tools
      a. G3-MK-TEST KIT
      b. G3-MK-ID-WRITER
      c. G3-MK-PROGRAM KIT
      d. Real Time Logic (RTML)
   5. Create Defects in the bus Multiplex Electrical Systems for the Technicians to Locate and Repair.

L. Different or Additional Circuits will be covered upon Customers Request.

HYDRAULIC SYSTEM

SCOPE:

This is an eight hour program of which approximately the first four hours of instruction will take place in a classroom setting utilizing a hydraulic system drawing projected from a laptop with a projector. Each student will have a copy of the drawing and a detailed power point handout to follow along through the hydraulic system. The remaining time will be spent applying the classroom information to the vehicle in "hands-on" tests and adjustments.

The customer shall make available a suitable room for training that is appropriately equipped, keeping in mind the class size shall not exceed twelve mechanics, and a bus for the last segment of the training program.

OBJECTIVE:

This program will focus primarily on providing the mechanic with a better understanding of the hydraulic system, its components, and their operation under various operating conditions. The class participants accomplish this by viewing and following along with the hydraulic system

drawing. The hydraulic flow charts will aid the mechanic in determining if the components in the hydraulic system are operating properly and may also be used as a tool in the diagnosis and isolation of a problem in the system. Safety precautions, maintenance, and troubleshooting will also be discussed.

A. Hydraulic Safety

B. Hydraulic Reservoir
   1. System/Reservoir Capacity
   2. Fluid type
   3. Filter/Fluid Change Intervals

C. Hydraulic Pump
   1. Type
   2. Flow Rates
   3. Inspection

D. Hydraulic Manifold
   1. Valve Identification/Ratings
   2. Flow through The Valves
   3. Inspection

E. Steering Gear Box
   1. Flow Through the Box
   2. Inspection
   3. Flow Rates Needed
   4. Gear Box Bleeding Procedures

F. Fan Drive Motor
   1. Motor Operation
   2. Motor Inspection
   3. Required Motor Speeds

G. Fan Drive Controller
   1. Required Wiring
   2. J1939 Interface
   3. Controller Logic
   4. Verification of Operation

H. Hydraulic Cooler
   1. Location

2. Maintenance
3. Cooler Pressure Relief Valve

E-FAN SYSTEM

SCOPE:

This is a four to six hour program of which approximately the first four hours of instruction will take place in a classroom setting utilizing a detailed system handout. The handout material will be projected from a laptop and projector while each student follows along. The remaining time will be spent applying the classroom information to the vehicle in "hands-on" tests and adjustments.

The customer shall make available a suitable room for training that is appropriately equipped, keeping in mind the class size shall not exceed twelve mechanics, and a bus for the last segment of the training program.

OBJECTIVE:

This program will focus primarily on providing the mechanic with a better understanding of the EFAN systems, their components, and operation under various operating conditions. While Gillig utilizes two different EFAN systems, the scope and objective for each system is the same. The class participants accomplish system understanding by viewing and following along with the system handouts. Presentation of a comprehensive EFAN system test procedure will also be included in this program. The handout, when used in conjunction with the system tests, will aid the mechanic in determining if the components in the EFAN system are operating properly and may also be used as a tool in the diagnosis and isolation of a problem in the system. Safety precautions, maintenance, and troubleshooting will also be discussed.

A. E-FAN Safety
   1. System Do's and Don'ts

B. Cooling Module
   1. Engine Radiator
      a. Radiator Construction and Airflow
      b. Inspection and Maintenance
   2. Charge Air Cooler
      a. Construction and Airflow
      b. Inspection and Maintenance
   3. Hybrid Cooler (If Equipped)
      c. Construction and Airflow
      d. Inspection and Maintenance

C. Physical Description Cooling Module
   1. Electric Motor Fan Banks

a. Fan Make and Model
b. Fan Wiring
c. Fan Operation and Speeds
d. Fan Inspection/Maintenance/Reverse
e. Fan Troubleshooting

D. EFAN Controllers
1. Controller Overview
2. Controller Logic
3. Controller Wiring
4. Controller Protection Features

E. Overall System Maintenance and Troubleshooting

F. Diagnostic Software (If Applicable)

GILLIG BATTERY ELECTRIC BUS SAFETY AND FAMILIARIZATION

SCOPE:

This is a twelve hour program for a maximum of twelve technicians. The program will be split between a classroom setting and on the bus. The classroom portion will include using a digital projector to cover a PowerPoint handout that will be supplied to the technicians. The projector will also be used to cover all applicable schematics for the Battery Electric Bus system. The on hands portion will cover component location, function and operation. The customer shall make available a suitable room for training that is appropriately equipped.

OBJECTIVE:

After completion of the GILLIG Battery Electric Bus Safety and Familiarization program, each mechanic will be familiar with BEB system component identification, location and operation. We will also cover electrical accessory systems and their operation. Safety precautions and troubleshooting will also be discussed with focus on High Voltage Safety. This will promote a better understanding of the BEB system components and their operation resulting in less time consuming and more accurate diagnosis. High voltage safety will also be discussed.

A. History of High Voltage Vehicles Used in Transportation
B. System Operating Voltages and Safety
C. Importance of Arc Flash, Lock Out Tag Out, and Fall Protection Training
D. First Responders Card and Emergency Shutdown Procedures
E. Gillig/Cummins Parts
F. Discuss PPE in Detail

The Following Components Will Be Covered in Detail

A. ESS
   1. Battery Composition
   2. MSD's
   3. Battery CAN
   4. Battery ID's
   5. Power and Ground
   6. Battery Isolation

B. ESS Junction Box
   1. High Voltage Disconnect Switch
   2. High Voltage Contactors
   3. Fuses

C. High Voltage Junction Box
   1. Fuses

D. Propulsion Invertor and Wiring

E. Traction Motor and Wiring
   1. Speed Sensor and Tone Wheel

F. DC To DC Convertors and Wiring

G. DC to AC Convertors and Wiring

H. System Controllers and Wiring
   1. SCM (System Control Module)
   2. Charger Control Unit
   3. BMS (Battery Management Controller)

I. Charging receptacles and charging procedures

J. Ebus Specific Indicator Lights

K. Kissling Battery Saver Function

L. High Voltage cabling and Inspection

M. High Voltage Shut Down and Verification Using Meter

N. High Voltage Safety Equipment (PPE)

O. HVIL (High Voltage Interlock)

P. Battery Thermo Management System
   1. Operation and Components
   2. Maintenance

3. Fill Procedures

Q. Air Compressor and Maintenance

R. Power Steering Maintenance

S. Electronics Cooling Package (ECP)
   1. Operation and Components
   2. Maintenance

ENTRANCE/EXIT DOOR SYSTEM

SCOPE:

This is a four to eight hour program for a maximum of twelve technicians. The program will be conducted entirely on the bus. The customer shall make available a suitable bus for training that is appropriately equipped.

OBJECTIVE:

This program is designed to help the technician be familiar with and understand the mechanical, pneumatic, and electrical componentry of the entrance and exit door systems. This will promote a better understanding of the system, resulting in less time consuming and more accurate diagnosis. Topics included in this program are:

A. Entrance Door Motor Operation of Both Pneumatic and Electric Doors.
   1. Differential/Electric Door Motor Discussion
   2. Opening, Closing and Cushioning Speed Adjustments (Pneumatic Motor)
   3. Opening, Closing and Cushioning Speed Adjustments (Electric Motor)
   4. Emergency Dump/Unlock Valve

B. Entrance Door Mechanical Adjustments
   1. Door Rods
   2. Door Centering
   3. Roller Brackets
   4. Checking Door Opening for Square
   5. Door Lubrication

C. Entrance Door Electrical Adjustments
   1. Door Open Solenoid
   2. Door Air Switch Location and Function
   3. Proximity Switches
   4. Electric Door Motor Adjustments and Speed Programing

D. Exit Door Pneumatics

1. Door Motor
2. Opening, Closing and Cushioning Speed Adjustments

E. Exit Door Mechanical Adjustments
1. Door Stops
2. Door Motor Shaft
3. Door Rods
4. Door Unlock Solenoid
5. Emergency Release System Maintenance
6. Door Closing Spring
7. Door Lubrication

F. Exit Door Electrical Adjustments
1. Micro/Proximity Switch Adjustments
2. Electric Motor Speed Adjustments and Software
3. Door Open Solenoid

GILLIG LLC

LOW FLOOR TRANSIT COACH

STANDARD LIMITED WARRANTY & EXTENDED COVERAGE FOR

PSTA - CLEARWATER, FLORIDA
FLORIDA ELECTRIC TRANSIT BUSES BID - RFP 21-980369 – SEPTEMBER 23, 2021

GILLIG LLC warrants to the original purchaser, that its transit coaches, save and except for those major component assemblies and other parts described below which are separately warranted by their respective manufacturer's (OEM's), will be **FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP UNDER NORMAL USE AND SERVICE**, for the distance or time periods specified in the attached, and agrees to REPAIR or REPLACE the defective parts AT NO COST TO THE PURCHASER. This is a limited warranty subject to the provisions stated below and is referred to as GILLIG's Standard Limited Warranty.

This warranty **DOES NOT COVER** malfunction or failure resulting from the purchaser's or its agents or employees alteration, misuse, abuse, accident, neglect or failure to perform normal preventive maintenance as outlined in GILLIG's Service Manual, nor does it cover components or assemblies not originally provided by GILLIG. Further, this warranty **DOES NOT APPLY** to normal replacement items such as light bulbs, seals, filters or bushings, nor to consumable items such as belts, tires, brake linings or drums.

PURCHASER'S SOLE REMEDIES FOR LIABILITY OF ANY KIND WITH RESPECT TO THE PRODUCTS FURNISHED UNDER THIS WARRANTY AND ANY OTHER PERFORMANCE BY GILLIG UNDER OR PURSUANT TO THIS WARRANTY, OR WITH RESPECT TO PURCHASER'S USE THEREOF, INCLUDING NEGLIGENCE, SHALL BE LIMITED TO THE REMEDIES PROVIDED IN THIS WARRANTY AND SHALL IN NO EVENT INCLUDE ANY INCIDENTAL, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES OR LOSS OF USE, REVENUE OR PROFIT. IN NO EVENT SHALL GILLIG'S LIABILITY FOR DAMAGES WITH RESPECT TO ANY OF THE PRODUCTS COVERED UNDER THIS WARRANTY EXCEED THE AMOUNT PAID BY THE PURCHASER TO GILLIG FOR SUCH PRODUCTS.

GILLIG **DOES NOT WARRANT** some major component assemblies (such as the engines, transmissions and air conditioning systems) which are warranted by their respective manufacturers (OEM's) and identified as Category 3 items on page three (3) of this Warranty. **Warranty coverage for these items is as defined in those manufacturer's own warranty documents** and per their terms and conditions, and as administered by their own support networks.

GILLIG makes **NO OTHER WARRANTIES,** except as stated herein, and GILLIG's obligation under this warranty is **LIMITED AND FULLY DESCRIBED HEREIN**. Determination of warrantable defects is at GILLIG's (or the OEM's) discretion and will require inspection of failed components. Correction or compensation under this warranty for Category 1 and Category 2 items cannot be made unless requested on a GILLIG Application for Warranty Claim form and in accordance with the claim procedure established by GILLIG.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY OTHER WARRANTY EXPRESSED OR IMPLIED, but if such has legal status, it **CANNOT EXCEED THE DURATIONS STATED HEREIN**. This warranty gives the purchaser specific legal rights and some state statutes may include other rights.

This is GILLIG's sole warranty with respect to its transit coaches. **GILLIG MAKES NO OTHER WARRANTY OF ANY KIND WHATEVER, EXPRESS OR IMPLIED; AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WHICH EXCEED THE AFORESAID OBLIGATION ARE HEREBY DISCLAIMED BY GILLIG AND EXCLUDED FROM THIS AGREEMENT.**

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LOW FLOOR TRANSIT COACH

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GILLIG's Standard Limited Warranty which covers Category 1 and Category 2 parts, components and assemblies, covers the following systems, components or assemblies for the period specified, and includes 100% PARTS AND LABOR to repair or replace the defective components as determined by GILLIG. (See Page 3 for explanation of notes (1)-(7).)

CATEGORY 1

Includes GILLIG manufactured or assembled components and systems as well as some purchased assemblies. Warranty and warranty claims administration provided by GILLIG.

	Coverage Period [1]	
	Months	Miles
FULL COACH WARRANTY [2] [3] [7]	12	50,000
BODY STRUCTURE WARRANTY [4]	36	150,000
CORROSION & STRUCTURAL INTEGRITY WARRANTY [5]	144	500,000

CATEGORY 2

Includes major components purchased and installed by GILLIG. Warranty provided by component OEM's. Warranty claims administration provided by GILLIG.

AXLE		
Meritor Front Steering	60	300,000
Meritor Rear Driving	60	300,000
BRAKE SYSTEM		
(Excludes Friction Material)		
Bendix Valves	24	100,000
Meritor Brakes	24	100,000
ELECTRONIC COOLING PACKAGE		
Modine System	36	Unlimited

GILLIG LLC

LOW FLOOR TRANSIT COACH

STANDARD LIMITED WARRANTY & EXTENDED COVERAGE FOR

PSTA - CLEARWATER, FLORIDA
FLORIDA ELECTRIC TRANSIT BUSES BID - RFP 21-980369 – SEPTEMBER 23, 2021

Major components listed below under "Category 3" are covered by warranties or extended coverages[6], for the miles and/or months indicated, provided by the manufacturer (OEM's) of those components. Purchasers should refer to specific OEM warranty documents for details. Warranty claims are and will be administered by the respective manufacturers (OEM's) and all warranty claims must be made directly to said manufacturers. GILLIG will assist purchasers in dealing with these OEM's and warranty issues that may arise from time to time.

CATEGORY 3

	Coverage Period [1]	
	Months	Miles
POWERTRAIN [7]		
CUMMINS	36	100,000
Energy Storage System	72	300,000 (80% of original capacity)
Extended Warranty – If Selected		
Energy Storage System	72	200,000 (Proactive scheduled replacement of batteries at midlife (parts and labor) to achieve same total usable capacity as originally installed. Replacement batteries to include 6-year warranty with same or better terms as above.)
AIR CONDITIONING SYSTEM		
Thermo King TE18 All electric	24	Unlimited
WHEELCHAIR RAMP		
Lift-U LU18	24	Unlimited
DOOR SYSTEM [7]		
Vapor	36	150,000
INTERIOR LIGHTING		
I/O Controls	144	500,000

Low Floor Transit Coach Emission Warranty

GILLIG warrants to the ultimate purchaser and each subsequent purchaser that the new vehicle is designed, built and equipped so it conforms at the time of sale to the ultimate purchaser with all U.S. federal emissions regulations applicable at the time of manufacture and that it is free from defects in materials or workmanship which would cause the vehicle to fail to not meet these regulations within five years or 100,000 miles of operation, whichever occurs first, as measured from the date the vehicle is placed into service. In no case may this period be less than the Standard Limited Warranty where applicable to emission warrantable parts. If the ultimate purchaser registers the vehicle in the state of California (or any other state following the applicable California Air Resources Board regulations) a separate California Emissions Warranty applies.

GILLIG LLC

LOW FLOOR TRANSIT COACH

STANDARD LIMITED WARRANTY & EXTENDED COVERAGE FOR

PSTA - CLEARWATER, FLORIDA

FLORIDA ELECTRIC TRANSIT BUSES BID - RFP 21-980369 – SEPTEMBER 23, 2021

GILLIG warrants to the ultimate purchaser that registers the vehicle in the state of California (or any other state following the applicable California Air Resources Board regulations), and each subsequent purchaser, that the new vehicle is designed, built and equipped so it conforms at the time of sale to the ultimate purchaser with all applicable regulations adopted by the California Air Resources Board at the time of manufacture and that it is free from defects in materials or workmanship which would cause the vehicle to fail to not meet these regulations within five years, 100,000 miles or 3000 hours of operation, whichever occurs first, as measured from the date the vehicle is placed into service. In no case may this period be less than the basic mechanical warranty provided to the purchaser of the engine.

GILLIG warrants to the ultimate purchaser and each subsequent purchaser that the tires on this vehicle conform at the time of sale to the ultimate purchaser with all U.S federal emissions regulations and all applicable regulations adopted by the California Air Resources Board at the time of manufacture and are free from defects in materials or workmanship which would cause the vehicle to fail to not meet these regulations for a period of 2 years or 24,000 miles, whichever occurs first.

This list of emission control parts may be covered by the Emission Warranty under certain failure modes.

- Ambient Air Temperature Sensor
- Wire harness circuits connected at both ends to emissions warrantable components
- On-Board Diagnostic (OBD) Malfunction Indicator Lamp (MIL)
- OBD Connector

NOTES

1) Coverage ceases at the first expiration of the time or distance noted.
2) Full coach warranty includes and applies to electrical, doors, seats, flooring, roof hatches, destination signs, wheelchair ramp, handrails, radio, P.A., etc., but not to IVS systems or special options.
3) Fleet defect coverage is for a maximum of 12 months or 50,000 miles and includes all warrantable components and assemblies on the vehicle.
4) Basic body structure warranty includes and applies to structural members in the body and undercarriage including the structural members in the suspensions.
5) The corrosion and structural integrity guarantee covers against a significant loss of structural integrity of the assembly or its functional performance, resulting from a pertinent loss of cross-section due to corrosion caused by normal environmental elements but excludes corrosion caused by aggressive road de-icers such as Magnesium Chloride or equivalents, unless Gillig approved preventative measures are taken (see Service Manual).
6) Extended coverage may not duplicate Standard Limited warranty coverage. Note: Please refer to OEM warranty documents for details.
7) For consumable components like brushes, seals, air wave switches and related wear items a one year parts and labor warranty applies.

WARRANTY SUPPORT

GILLIG stands behind the quality of our products and we have selected supplier partners who share this belief as well. We have provided our GILLIG APPLICATION FOR WARRANTY PROCEDURE which describes the process by which GILLIG handles warranty claims. Normal warranty work (other than that work required to be performed by sub-suppliers as discussed below) will be performed by the Agency's maintenance department and reimbursed by GILLIG at the documented warranty labor rate. In the unlikely event that abnormal warranty is required, GILLIG will work with the Agency to resolve any such warranty projects which Agency believes should be repaired directly by GILLIG.

Due to the nature of some components and the associated warranties, GILLIG believes that warranty work on the following should initially be managed by the sub-suppliers:

- Powertrain
- Air Conditioning Unit
- Axles
- Destination Signs
- Surveillance Systems
- Intelligent Transit Systems
- Batteries

GILLIG routinely assists customers in resolving warranty matters when local vendors are unable or unwilling to provide necessary support by involving GILLIG's contacts either at the local service facilities or through the component manufacturer's corporate levels.

Feel free to contact our Field Service Department for assistance or if you have questions:

Vy Vu
Field Service Coordinator
(510) 264-5073
Email: vvu@GILLIG.com

GILLIG Service Department
451 Discovery Drive
Livermore, CA 94551

Warranty Department
The Field Service Department is available to assist the procuring Agency in processing warranty claims as required. GILLIG's Field Service Representatives will assist the procuring agency in the proper procedure for obtaining warranty parts, completion of the warranty forms, and the handling of parts for warranty claims processing. In-house qualified Field Service Representatives are available to troubleshoot questions by phone Monday through Friday, 5:00 a.m. to 2:00 p.m. and have direct access to GILLIG's Engineering Department in order to provide quick turnaround should additional technical assistance be required.

- **EXECUTIVE DIRECTOR, CUSTOMER CARE**
  VICTOR DORAN
- **WARRANTY MANAGER**
  Micah Denecour
- **SERVICE MANAGER**
  Eric Ocampo
- **WARRANTY PARTS SPECIALIST**
  Dominic Nava
- **TECHNICAL ADVISOR**
  Bo Vongamath
- **WARRANTY PROCESSING SPECIALISTS**
  Johnny Phothipanya
- **FIELD SERVICE COORDINATOR**
  Vy Vu

Our Warranty group essentially deals with repair, replacement, or reimbursement for product failures during the warranty period of a particular product. A warranty claim, describing the failure (and other relevant details) must be filed in order to start the process of getting the failure fixed.

The warranty claim is reviewed by the Warranty Processing Specialist and a determination on its status (accept, accept with adjustments, or reject) is made, often after discussions with GILLIG's Q.A., Manufacturing, or Engineering Departments, or with vendor OEMs. The claim response is then sent back to the customer, as well as being relayed to relevant GILLIG departments for corrective action, including as necessary, reimbursement or replacement for the customer, design or manufacturing review at GILLIG, reporting to and recovery from the vendor, as well as additional information collection, testing and/or redesign for GILLIG or the vendor, when needed. We usually ask for failed parts to be returned to help with failure analysis and vendor recovery.

If you disagree with a warranty claim decision, you can resubmit the claim along with additional justification supporting your position, to the Service Manager for reconsideration. Your claim will be reviewed and you will be notified of the review decision within a week or two.

GILLIG INSTRUCTIONS

FOR COMPLETING APPLICATION FOR WARRANTY CLAIM

GILLIG requires only one failure per claim. A single claim can be for multiple buses as long as they're for the same failure, and have identical labor claimed. The VIN and mileage of each bus on the claim should accompany the Application for Warranty.

GILLIG uses the information on the Application for Warranty to detect failure trends and make improvements, failure descriptions such as "B.O.", "Inop" or "Found Bad" will not suffice. The reason for removal and any troubleshooting procedures should be included to help expedite claims. GILLIG prefers the Repair Order be included with the claim.

Warranty repairs exceeding "Standard Repair Times", (SRT), should have prior authorization to prevent large cuts in reimbursement. To obtain prior authorization, please contact your Warranty Processing Specialist by calling GILLILG Field Service or emailing WarrantyClaims@gillig.com.

Claims for normal replacement items, such as light bulbs, and mechanical adjustments, such as doors or alignments, are not normally approved unless their failure was caused by a warrantable defect. In addition, consumables, such as belts, tires and brake linings, are not warrantable, unless their failure was caused by a warrantable defect of another component.

Warranty claims should be submitted to GILLIG within 30 days of the date of failure. Claims can be emailed to WarrantyClaims@gillig.com.

Claims need to have unique claim numbers assigned. Each property should have a unique prefix, and then whatever number best suits your operation, (such as the Repair Order number). If you do not have or do not know your unique prefix, please contact your Warranty Processing Specialist.

GILLIG will pay at the direction of the bus owner, not the hired contractor or repair shop, until and unless the bus owner directs it.

GILLIG cannot pay an invoice not made out to GILLIG, unless it's listed as a sublet bill on an Application for Warranty Claim.

GILLIG APPLICATION FOR WARRANTY

It is not necessary to use GILLIG pre-printed forms, but any form used will need the following information:

1. Unique Claim Number (must be pre-approved by GILLIG Warranty).
2. Date claim is being filled out
3. Unit Serial # (Last six digits of the VIN)
4. Coach Number
5. Bus Owner, or Bus Property Name
6. Date bus placed in Revenue Service
7. Odometer or Hub mileage at time of failure
8. Date of Failure
9. Where Repaired (if not at the owner's property)
10. If Claim concerns the Engine, the Engine Serial Number
11. If Claim concerns the HVAC, the Air Conditioning Unit Serial Number
12. If Claim concerns the Transmission, the Transmission Serial Number
13. Complete description of failure, (Repair Order preferred)
14. Were any parts used? (Yes or No)
15. Description of parts used with the GILLIG Part Number
16. Original Part Number (If replacement Part Number differs Original Part Number)
17. Price of the part(s) unless provided by GILLIG
18. Number of parts used
19. Provide subtotal for each part
20. Total all the parts used for this claim
21. Provide contractual warranty labor rate
22. Number of hours worked
23. Multiply number of hours by the labor rate for the total labor claimed
24. Work done by outside firm or tow to be entered and copy of invoice attached
25. Total Sublet cost(s)
26. Total amount for the claim
27. If bus is in California and claim is emission-related, Engine Hours (from ECM or hourmeter)
28. Name & Contact Information of warranty person to answer any questions of claim
29. Email or Phone Number for person having knowledge of claim
30. Name & Contact Information of person who submitted claim
31. Email or Phone Number for person who submitted claim
32. Address of where to send reimbursement or parts credit.

See attached copy of claim with corresponding numbers to indicate where to put the above information.

GILLIG

GILLIG APPLICATION FOR WARRANTY

GILLIG

APPLICATION FOR WARRANTY

Required fields are marked with an asterisk (*)

*CLAIM NUMBER: #1 *DATE: #2

MAIN (510) 785-1500 | FAX (510) 785-1348

*UNIT SERIAL # #3

BUS OR COACH # #4

*IN SERVICE DATE #6

*DATE OF FAILURE #8

A/C SERIAL # #11

*OWNER #5

*MILEAGE AT FAILURE #7

WHERE REPAIRED #9

ENGINE SERIAL # #10

TRANSMISSION SERIAL #12

*DESCRIBE SPECIFIC (COMPLAINT, CAUSE, CORRECTION) REPAIRS REQUIRED AND ATTACH COPY OF REPAIR ORDER

#13

IF REPLACEMENT PART NUMBER DIFFERS FROM ORIGINAL PART NUMBER, LIST THE ORIGINAL PART NUMBER HERE: #16
(IF MORE SPACE IS NEEDED, PLEASE USE SEPARATE SHEET AND ATTACH TO BACK OF CLAIM)

#14

REPLACEMENT PART NUMBERS	PRICE		
PARTS USED: YES ☐ NO ☐	PRICE EACH	QTY. USED	SUBTOTAL
#15	#17	#18	#19

PARTS TOTAL $ #20

*LABOR RATE #21 / *HR. #22

*LABOR TOTAL $ #23

SUBLET (ATTACHED INVOICE COPIES)	PARTS	LABOR	TOTAL
1. #24			
2.			

SUBLET TOTAL $ #25

*GRAND TOTAL $ #26

NOTE: IF CALIFORNIA BUS, NEED ENGINE HOURS FROM HOURMETER OR ECM #27

*NAME/PHONE OF CONTACT FOR ADDITIONAL INFO #28 //

//

E-MAIL ADDRESS(ES) #29

*SUBMITTED BY / PROPERTY NAME & ADDRESS #30

E-MAIL ADDRESS(ES) #31

*REIMBURSEMENT NAME AND ADDRESS (IF DIFFERENT FROM ABOVE) #32

E-MAIL ADDRESS(ES)

NOTE: Warranty will be denied if the defective material is not received by GILLIG within 30 days of the failure date.

WARRANTY PARTS ORDERING PROCEDURE

1. Determine part(s) being ordered by referring to the parts manual for the specific bus in question. If the part can't be found or isn't listed, you can call GILLIG's Warranty Parts Specialist at 510-264-4433 or WarrantyParts@gillig.com.

2. The information needed:
   a. GILLIG part number
   b. Quantity
   c. Description of part (pump, motor, etc.)
   d. VIN, (Last 6 digits of VIN)
   e. Description of Failure
   f. Mileage at failure
   g. Instructions on where to send parts, (if applicable)

3. If bus is within the base bus warranty, GILLIG will ship the warranty part(s) to your location. Parts will be sent prepaid, best way, (normally second day). If the part is needed there the next day, it can be sent overnight and the difference of shipping cost will be charged back.

4. Normally, GILLIG will want the failed part returned. If so, then we will email an RGA. The defective part should be returned to:

GILLIG, LLC
ATTN: RGA # _____
1100 Voyager Street, Dock B
Livermore, CA 94551

PARTS THAT ARE REQUESTED TO BE RETURNED SHOULD BE SENT WITHIN 30 DAYS. IF THE PARTS ARE NOT RETURNED WITHIN THAT TIME, THE COST WILL BE INVOICED BACK.

5. If the bus is outside the base bus warranty, but the failed component still has warranty coverage from the supplier, the part will have to be purchased from GILLIG's Parts Department, which can then be claimed on an Application for Warranty Claim. GILLIG will roll that over to the supplier, and whatever reimbursement the supplier makes will then be forwarded to the end user.

PARTS RETURN PROCEDURE

Defective part should be returned to GILLIG within 30 days of receipt of GILLIG's Return Goods Authorization, (RGA).

All parts should be capped or plugged to prevent leakage, if applicable. Excess dirt or grease should be removed to facilitate handling.

Removed part should be handled/packed as if new.

Parts should never be sent "COD". GILLIG may provide a call tag, or the shipping cost can be included on the Application for Warranty.

Call tags are only utilized when the bus is still covered by the base bus warranty. If a call tag is being requested, we will need to know 1) RGA # & 2) Total weight of package.

Part(s) must be tagged with the following information:

A. Last 6 digits of VIN
B. Date bus went into Service & Mileage at Failure
C. Concise reason for removal
D. Bus owner's name/name of transit agency

CHANGE CONTROL

GILLIG's change control process involves several departments within the organization and working with our component suppliers as their products reach end of life. GILLIG believes in a constant improvement process, this is controlled thru an Engineering Production Change (EPC) process managed by our Materials Department. A meeting is scheduled once a month with Materials, Purchasing, Engineering, Manufacturing, Sales and Parts, to discuss product improvements/new design and supplier end of life notifications.

Once a change has been identified the subject matter is reviewed by Engineering for design, Purchasing for cost, Manufacturing for production impact, Parts for aftermarket support and Materials/Sales for customer implications. Once approved by all departments, Engineering and the Bill of Material group will release the component details (parts, installation drawings, customer, dates) and production implementation plan thru our documented EPC control process.

FIELD MODIFICATIONS

GILLIG's focus on designing and building the most reliable and cost effective bus in the industry necessitates selecting supplier partners who share our philosophies on quality and reliability. As a result of this focus, GILLIG has no major fleet defects (grounded fleet), a minor number of vendor defects and the lowest warranty claim experience in the industry.

Over the past five years, GILLIG has sent out a number of Field Service Bulletins which communicate suggested maintenance procedures, clarifications of previously released procedures and supplier or GILLIG proposed repairs. Seven of these bulletins were minor field repairs resulting from design improvements intended to prevent future failures.

We have provided a sample for your reference.

GILLIG

FIELD SERVICE BULLETIN

FS-2019-02: Product Alert - *FS 300 Hose Identification*

Date: May 6, 2019

Model: All

Model Years: 1997 – 2019

Because of a supply issue with the blue hose covering, Eaton is temporarily making FC-300 hose using black covering. FC-300 hose assemblies made between October 2018 to May 2019 will be affected by this change.

To avoid being mistaken for FC-350 hose, Eaton has applied the following unique identifiers to the FC-300 hose assemblies:

1. ***Yellow ink markings to the hose identifying it as FC-300.***
   Note: White ink markings are used on FC-350 hose assemblies.
2. ***Blue stripe around the hose identifying it as FC-300.***
   a. ***Hoses 2-ft and shorter will have a blue stripe located in the center of the hose length.***
   b. ***Hoses longer than 2-ft, up to 4-ft in length have a blue stripe located at each end, adjacent to the fitting.***
   c. ***Hoses longer than 4-ft have a blue stripe located at each end, adjacent to the fitting, and an additional stripe located in the center of the hose length.***

In addition, the hose will still have a foil tag with the Gillig part number.

Note: FC-300 and FC-350 have different pressure ratings, so it's important to not mix them.

Approved:

Robert L. Birdwell, Executive Director
Quality Control & Field Service

Product Alert

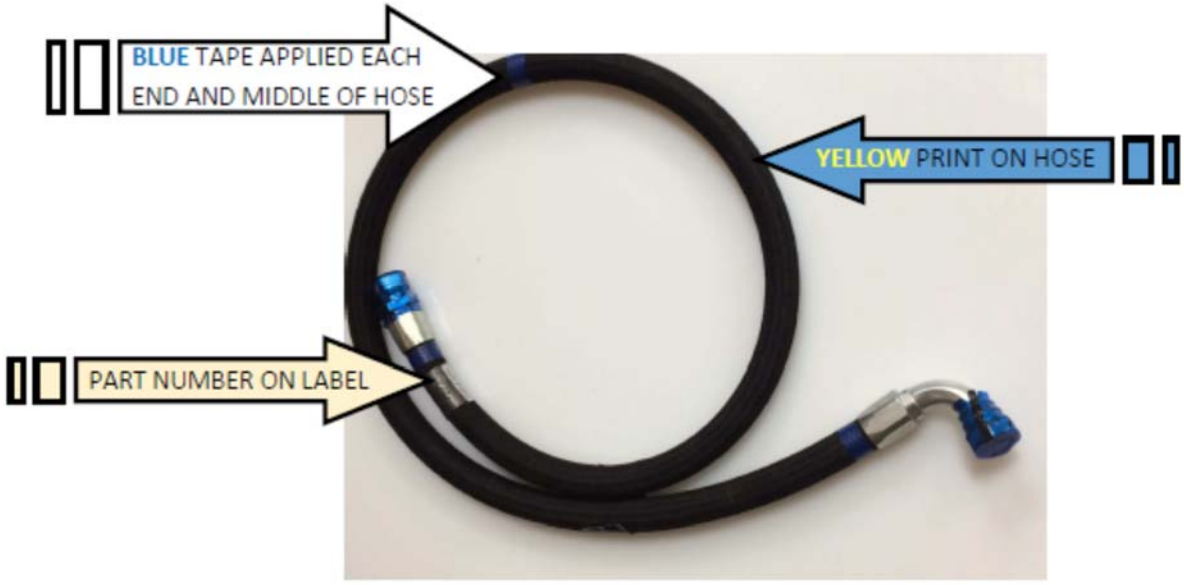
Affected products: Gillig hose assemblies part numbers 46-xx**B**xxxx-xxxx

Gillig hose assemblies made with Eaton FC300 hose, which typically have a blue yarn cover will temporarily have a black cover.

Due to a supply issue with blue yarn Eaton is temporarily making FC300 hose with black colored yarn and applying yellow print instead of white print. The hose is otherwise identical to what has always been supplied and meets all specifications for use.

HOW TO IDENTIFY THIS HOSE AS CORRECT

1. **BLUE TAPE IS BEING APPLIED TO EACH ASSEMBLY AS A QUICK CHECK THAT IT IS FC300 HOSE**
2. **HOSE WILL HAVE YELLOW PRINTING INSTEAD OF WHITE**
3. **PART NUMBER ON LABEL WILL IDENTIFY THE CORRECT HOSE ASSEMBLY**



Original blue FC-300











GILLIG AFTERMARKET PARTS WAREHOUSE

Our larger facility allows us to better serve our aftermarket customers via this more efficient warehouse.

GILLIG recently made a significant investment in our Parts business with the purchase of the 108,000 sq ft warehouse and office building located in Hayward, California. This is a true “class A” facility, with eight docks, 35' clear height, and a two-level small parts mezzanine.

GILLIG — PARTS —

GILLIG

PARTS SERVICE DEPARTMENT

GILLIG supplies service parts to customers through our Parts Division, located in Hayward, California. All parts are produced to our original vehicle specifications and are either manufactured in-house or purchased to our drawings from OEM's.

GILLIG is proud to advise that all parts (100%) are stocked in the U.S. in our Hayward facility. We do not stock parts in other countries.

All in-stock bus-down orders received by 3:00 p.m. PST are shipped the same day (2nd day air freight at no charge or next day air, at your expense).

All backordered requirements are shipped within 24 hours of receipt from the vendor.

All orders are shipped UPS 2nd day air, freight prepaid at no charge to you (subject to UPS size and weight limitations).

Our current order response is - 92% of all transit bus orders received are shipped within 48 hours and the percentage rises to 96% in an additional 72 hours (excluding weekends) and 99% within 3 working days.

GILLIG's simple bus designs, as well as our parts service programs, help you control your parts cost. Common industry parts, flat skirt panels, and American supplied components, such as Meritor axles, help reduce your parts costs. Our increased warehouse stocking levels in Hayward and our second day air shipments at no charge help you reduce your inventory costs as well.

PARTS SUPPORT REFERENCE LIST

GILLIG's Part Division is committed to the same GILLIG mission and goal of customer satisfaction and friendly service. We are proud of our on time delivery at competitive pricing. GILLIG's customers are not only impressed with the performance and quality of our buses but they are also pleased with our overall parts support and our quick and accurate parts deliveries. We request that you call the following representative customers and ask about our unmatched performance.

Hampton (Hampton Roads Trans.), VA
Anita Brown
Buyer
757-222-6000 x 6325
abrown@hrtransit.org

St. Louis (Bi-State Develop. Agency), MO
Diana Hill
Director of Purchasing
314-923-3084
dhill@metrostlouis.org

Youngstown (WRTA), OH
Becky Koenig
Maintenance Director
330-744-8431
rkoenig@wrtaonline.com

Salt Lake City (Utah Transit Authority), UT
Jolene Higgins
Sr Buyer
801-237-1925
Jhiggins@rideuta.com

Ft. Wright (TANK), KY
Wayne Bey
Purchasing Agent
859-814-2142
wbey@tankbus.org

St. Petersburg (PSTA), FL
Jody Sibley
Storeroom Superintendent
727-540-1884
jsibley@psta.net

Inter-City Transit (Olympia, WA)
Steve Krueger
Procurement Manager
360-705-5833
skreuger@intercitytransit.com

Jacksonville Transportation Authority (FL)
Michael West
Manager of Inventory Control & Stores
904-630-3179
mwest@jtafla.com

Richmond (GRTC), VA
Mark Donavon
Purchasing Manager
804-358-3871 x 352
mark.donavon@ridegrtc.com

GILLIG

PARTS SERVICE DEPARTMENT

In order to provide the most comprehensive and most economical service possible, GILLIG uses a central warehouse and compensates for distance by shipping second day air. Consequently, the nearest parts warehouse to supply your service parts needs is:

Central Location:

GILLIG
25972 Eden Landing Road
Hayward, CA 94545
Phone: 510-264-5160
Email: parts-sales@gillig.com

Central Contact:

Chuck O'Brien - Vice President, Parts Division
Eiji Kinoshita - Director of Sales - Parts Division

Regional Contacts:

Northwest Region:
Lee Petersen - Regional Sales Manager
Cell Phone: 510-867-5108
Email: Lee.Petersen@gillig.com

Western Region:
Sean Solis – Regional Sales Manager
Cell Phone: 510-512-2638
Email: Sean.Solis@gillig.com

Hawaii:
John Lum, Manager Parts Sales
Phone: 510-264-5125
Email: John.Lum@gillig.com

Southwest Region:
Joe Saldana – Regional Sales Manager
Cell Phone: 510-303-0202
Email: Joe.Saldana@gillig.com

Central Region:
Tom Wagner - Regional Sales Manager
Cell Phone: 510-737-2283
Email: Tom.Wagner@gillig.com

South Central Region:
Randy Brewer – Regional Sales Manager
Cell Phone: 925-409-6585
Email: Randy.Brewer@gillig.com

Northeast Region:
Jerry Sheehan – Regional Sales Manager
Cell Phone: 510-329-0320
Email: Jerry.Sheehan@gillig.com

Mid-West Region:
Jenna Van Harpen – Regional Sales Manager
Cell Phone: 510-512-2856
Email: Jenna.Vanharpen@gillig.com

Southeast Region:
Butch Sibley - Regional Sales Manager
Cell Phone: 510-589-9430
Email: Butch.Sibley@gillig.com

Parts Availability:	**Over 92% of all regular parts orders are shipped within 48 hours of ordering and almost 97% within 3 days.**
Freight Policy:	Regular parts orders are shipped freight free and normal shipments to Central and Eastern locations are shipped 2nd day air, at no charge.
Availability Life:	Replacement parts will be available for a period of twelve (12) years after the date of purchase of your coaches.

CUSTOMER SATISFACTION

The GILLIG Service Parts Division is committed to the same GILLIG mission and goals of customer satisfaction and friendly service with reliable and durable products that are also economical to use.

To justify the district's purchase of GILLIG products and to assist the district in attaining its own goals, the Parts Division has established the following programs and objectives.

Unit Down

Our objective is to expedite these orders and ship them within 24 hours. Unit down orders receive the highest priority throughout our manufacturing, purchasing, and shipping organizations, and can be accepted up to as late as 3:00 p.m. (Pacific time) and shipped same day if in stock. If the customer chooses, these orders can be shipped overnight at customer's cost.

Inventory

GILLIG maintains an extensive, continually growing, inventory of genuine GILLIG and OEM parts, in our central warehouse. All locations and parts are bar coded for accuracy and quick response. Computer programs monitor usage and minimum stocking levels in real time to maximize parts availabilities. We also stock or can get, common non-GILLIG parts.

Parts Lists

We can prepare, on request, a recommended initial stocking list of expected high usage or long lead-time parts for the vehicles proposed. A detailed price list is also available with the recommended initial stocking list.

Hot Line
GILLIG has a toll-free telephone number to enable customers to contact us at no charge for advice, explanations, recommendations or orders.

Personalized Service
To provide better service, representatives are assigned to specific accounts so that they can provide personal service while also providing account familiarity, history and consistency.

Regional Coverage
Regional Sales Managers are available to visit customers to assist in all facets of this business, including problem solving, introducing new kit and parts availabilities and making recommendations.

Troubleshooting
We also provide a troubleshooting service; if you can’t find a part, call your representative and we’ll find it for you, if possible, and even stock it in the future if your demand warrants it.

GILLIG

GILLIG PARTS | 25972 EDEN LANDING ROAD | HAYWARD, CALIFORNIA 94545 | 800.735.1500

TERRITORIES OF PARTS SALES REPS



Alaska

- Cynthia Millan
- Linda Omaque
- Nigel Hill
- Rick Dominquez
- Sue Kearns
- Terry Walker
- Mark Roth
- John Edmondson Jr
- Rodrigo Mendoza
- Michael Warren
- Val Alparaque
- Carlos Gonzales
- Hung Le
- Pranesh Ram
- Todd Nunnally
- Gabriel Avila



Hawaii

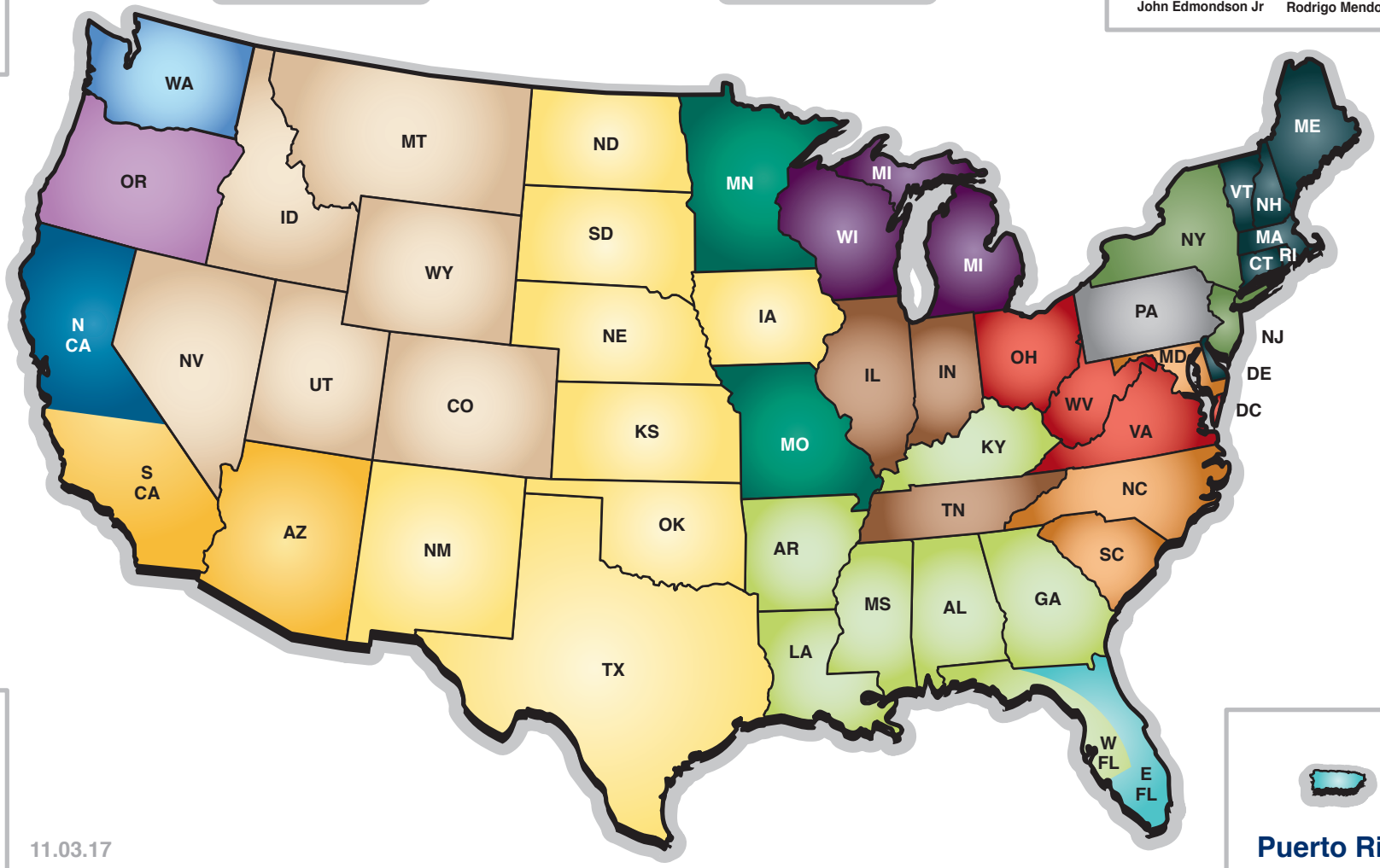
Hilo

11.03.17

British Columbia | Calgary

Canada

Ontario | Quebec



WEST COAST	EAST COAST
Linda Omaque	Todd Nunnally
Cynthia Millan	Gabriel Avila
Sue Kearns	Carlos Gonzales
Terry Walker	Val Alparaque
Mark Roth	Michael Warren
Nigel Hill	Pranesh Ram
Rick Dominquez	Hung Le
John Edmondson Jr	Rodrigo Mendoza

Puerto Rico

CER 5. Form for Proposal Deviation

This form shall be completed for each condition, exception, reservation or understanding (i.e., Deviation) in the Proposal according to "Conditions, Exceptions, Reservations or Understandings." One copy without any price/cost information is to be placed in the Technical Proposal as specified in "Technical Proposal Requirements," and a separate copy with any price/cost information placed in the Price Proposal as specified in "Price Proposal Requirements."

PSTA
[RFP 21-980369]

Deviation No.: 1	**Contractor:** GILLIG	**RFP section:** CER 6 PRICING SCHEDULE	**Page:** 216

Complete description of Deviation:

GILLIG wishes to advise that prices are for base bus and options shall be fixed for ONE (1) year from execution date of the contract. Prices for the base bus and options for years 2-5 shall be adjusted using the Bureau of Labor and Statistics Producer's Price Index (PPI), Category 1413 WPU Truck and Bus Bodies.

Rationale (pros and cons):

For multi-year procurements the use of the Producer Price Index, Category 1413 WPU Truck and Bus Bodies (PPI 1413), is standard practice in the transit industry to adjust the price of future orders (years 2, 3, 4, and 5), based upon the change in economic conditions from the date of contract award to the date the option order is placed.

The use of the PPI 1413 avoids the need for bidders to make arbitrary inflation estimates which unnecessarily raises the option bus prices quoted, thereby increasing the total cost to the Procuring Agency. This price adjustment method allows for a mutual sharing of project risk and minimizes the bus bid price.

CER 10. Vehicle Technical Information

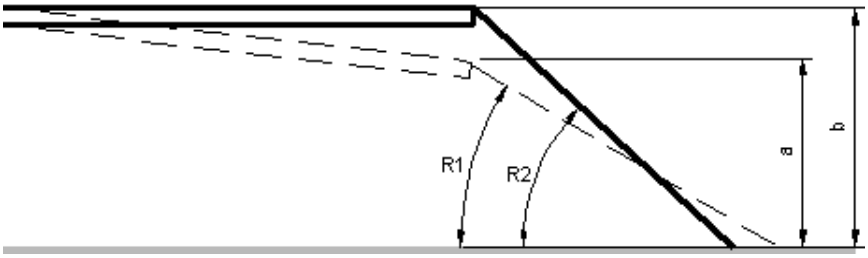
This form must be completed and included in the Technical Proposal. NOTE—one form must be completed for each type of bus submitted in response to this RFP

GENERAL COACH DATA SHEET						
Bus manufacturer:	GILLIG LLC					
Bus model:	40 Floor Low Floor All Electric					
Understructure manufacturer:	GILLIG LLC					
Model number:	G28D102H4					
Size/Type of Bus	40 Floor Low Floor All Electric					
Basic Body Construction						
Type:	Extruded Aluminum					
Tubing or frame member thickness and dimensions						
Overstructure	Aluminum ASTM 6061-T6, 6063-T6 Thickness .118in					
Understructure	3CR12 Stainless Steel ASTM A240 UNS Thickness .25in					
Skin thickness and material						
Roof	Fiberglass .12in					
Sidewall	Aluminum .118in					
Skirt panel	Aluminum .118in					
Front end	Fiberglass .125in					
Rear end	Fiberglass .125in					
Dimensions						
Overall length	Over bumpers	40	ft	11	in.	
	Over body	40	ft	1	in.	
Overall width	Over body excluding mirrors		ft	102	in.	
	Over body including mirrors–driving position		ft	120	in.	
	Over tires front axles		ft	100	in.	
	Over tires center axle		ft	N/A	in.	
	Over tires rear axles		ft	100	in.	
Overall height (maximum)		11	ft	0.3	in.	
Overall height (main roof line)		9	ft	8	in.	

Angle of approach	8.6	deg
Breakover angle	9.9	deg
Breakover angle (rear)	n/a	deg
Angle of departure	9.7	deg

Doorway Dimensions	Front		Rear	
Width between door posts	40	in.	34	in.
Door width between panels	35.7	in.	30	in.
Clear door width	32.3	in.	24.8	in.
Doorway height	75	in.	77	in.
Knuckle clearance	1.5	in.	1.5	in.

Step height from ground measured at center of doorway



	Front doorway, empty			Ramp angle			Rear Doorway, empty		
Kneeled	a.	11.7	in.	R1	9.3	deg	a.	14.1	in.
Unkneeled	b.	15.3	in.	R2	13.6	deg	b.	15.2	in.

Interior head room (center of aisle)

Front axle location	95	in.
Center axle location	n/a	in.
Rear axle location	76.5	in.

Aisle width between transverse seats	24	in.

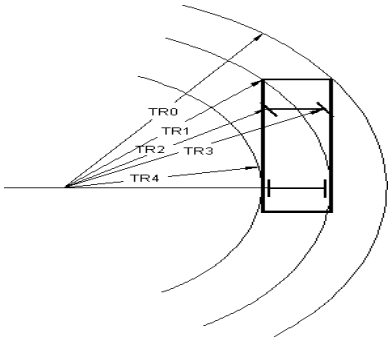
Floor height above ground (centerline of bus)

At front door	15.9	in.
At front axle	15.9	in.
At drive axle	35.6	in.
At rear door	17	in.

Minimum ground clearance (between bus and ground, with bus unkneeled)

Excluding axles	11.2	in.
Including axles	7.03	in.

Horizontal turning envelope (see diagram below)				
Outside body turning radius, TR0 (including bumper)	44	ft	9	in.
Front inner corner radius, TR1	39	ft	6	in.
Front wheel inner turning radius, TR2	34	ft	1	in.
Front wheel outer turning radius, TR3	40	ft	6	in.
Inside Body Turning Radius innermost point, TR4 (including bumper)	23	ft	9	in.



Wheel base		
Front	290	in.
Rear	n/a	in.

Overhang, centerline of axle over bumper		
Front	90.1	in.
Rear	110.4	in.

Floor				
Interior length	33	ft	1	in.
Interior width (excluding coving)	7	ft	4	in.
Total standee area (approximately)	40	sq ft		
Minimum distance between wheelhouses:	Front		36.1	in.
	Rear		36.1	in.
	Center		n/a	in.
Maximum interior floor slope (from horizontal)	4	deg		

Passenger capacity provided		
Total maximum seating	38	
Standee capacity	37	
Minimum hip to knee room	26.8	in.
Minimum foot room	14	in.

Weight

	No. of people	**Front axle**			**Center axle**			**Rear axle**			**Total bus**
		Left	Right	Total	Left	Right	Total	Left	Right	Total	

Empty bus, full fuel and farebox	0	6335	6335	12670	n/a	n/a	n/a	10115	10115	20,230	32,900
Fully seated, full fuel and farebox	39	7461	7461	14922	n/a	n/a	n/a	11,914	11,914	23,828	38,750
Fully loaded standee and fully seated, full fuel and farebox	76	8530	8530	17060	n/a	n/a	n/a	13,620	13,620	27,240	44,300
Crush load (1.5x fully loaded)	114	9627	9627	19254	n/a	n/a	n/a	15,373	15,373	30,746	50,000
GVWR											47,180
GAWR				18,180						29,000	47,180

Energy Storage

Batteries – low voltage

Manufacturer	Odyssey	
Type	Group 31 AGM	
Model number	PC2150	
Cold Cranking Amps	1150	Amps

Cranking Amps	1150	Amps
Reserve Capacity	n/a	Amps

Batteries – high voltage

Manufacturer	AKASOL Inc.
Type	Lithium Ion NMC
Model Number	9AKM150CYCUHE
Total Battery Capacity (kWh)	98 kWh per pack (5 Packs per bus = 490 kWh)
Standard Charge Time	Variable: 102 - 195 minutes (based on current available market chargers)
Charging Capacity	Variable on charger used. rated to meet beyond current top charger in market
Operating Temperature Range	-40F to 136F (Normal Operating Temp range: 68F to 118F)
Cooling/Heating System	Liquid-to-air (Thermo King)

Performance

Fuel Economy (w/full passenger load, HVAC, and all electric accessories in use)	2.29kWh per mile Orange County route	kWh
Fuel Economy (w/full passenger load, HVAC, and all electric accessories in use)	N/A, same answer as above	MPGE
Max Gradeability	8	%
Top Speed	65	MPH
Battery Range	160	Miles
Acceleration (20 MPH)	7.4	Seconds
Acceleration (40 MPH)	16.5	Seconds
Top Speed (stated above)	33.4	Seconds

Performance information/graphs to be attached with this form:

Energy consumption vs. Vehicle speed

Vehicle speed vs. time (both loaded and unloaded)

Vehicle speed vs. grade (both loaded and unloaded)

Acceleration vs. time

Change of acceleration vs. time

Traction Motor/Drive Motor

Manufacturer	Cummins				
Type	Permanent Magnet Alternating Current (PMAC)				
Speeds	3500 N-m max torque up to 30 seconds				
Traction motor horsepower rating	2060N-m continuous torque				
Type ventilation/cooling	liquid-to-air cooling				
Gear ratios	Forward:	n/a	Reverse:	n/a	

Voltage Equalizer

Manufacturer	Vanner
Model	Vann-Bus 85-CAN

Auxiliary Inverter (120/240)

Manufacturer	Cummins
Model	n/a
Inverter Technology	DC to 9 phase AC
Output Voltage	n/a

Traction/Drive Motor			
Manufacturer	See above in previous Traction/Drive Motor section		
Type			
Model			
Quantity			
Torque Rating			
kWh Rating			
Air compressor			
Manufacturer	Powerex		
Type	Scroll Compressor		
Rated capacity		13.3	CFM
Capacity at idle (approximately)		n/a	CFM
Capacity at maximum speed (engine)		n/a	CFM
Maximum warranted speed		n/a	rpm
Speed idle		n/a	rpm
Drive type	Direct Drive Electric		
Governor:			
Cut-in pressure	120	psi	
Cut-out pressure	130	psi	
Axles			
First			
Manufacturer	Meritor (Rockwell)		
Type	Deep Drop		
Model number	FH946		
Gross axle weight rating	18,180	lb	
Axle load	18,180	lb	
Second			
Manufacturer			
Type			
Model number			
Gross axle weight rating		lb	
Axle load		lb	
Rear			
Manufacturer	Meritor (Rockwell)		
Type	Single Reduction		
Model number	79163		
Gross axle weight rating	29,000	lb	

Axle load	29,000	lb	
Axle ratio	6.14:1		
Suspension system			
Manufacturer	Gillig Front / Hendrickson Rear		
Type:	First:	Air Suspension	
	Second:	n/a	
	Third:	Air Suspension	
Springs:	First:	4 Bag	
	Second:	n/a	
	Third:	4 Bag	
Joint			
Manufacturer			
Type			
Model number			
Wheels and tires			
Wheels			
Make	Alcoa Aluminum		
Size	front: 22.5" x 9.0" , Rear: 22.5" x 8.25"		
Capacity	Front: 9090 lbs per wheel, Rear: 8050 lbs per wheel		
Material	Full Polished		
Tires			
Manufacturer	Agency Supplied		
Type	Agency Supplied		
Size	315/80R22.5		
Load range/air pressure	TBD	psi	
Steering, power			
Pump			
Manufacturer and model number	Concentric - EHS		
Type	Electric Motor-driven hydraulic pump		
Relief pressure	2175	psi	
Booster/gear box			
Manufacturer and model number	ZF		
Type	Hydraulic Assist steering gear		
Ratio	23.3:1 (6.2 wheel turns to 95 degree rotation)		
Power steering fluid capacity	1.5	gal	
Maximum effort at steering wheel	10	lb (unloaded stationary coach on dry asphalt pavement)	
Steering wheel diameter	18	in.	

Brakes			
Make of fundamental brake system		Meritor / EX225H3 (Disc)	
Brake chambers vendor size and part number:		First:	MGM Type 24
		Second:	n/a
		Third:	MGM MJB 3030ET
Brake operation effort	6:1 Pressure Ratio		
Slack adjuster's vendor's type and part numbers			
First:	Right:	Integral to Brake	
	Left:	Integral to Brake	
Second:	Right:	n/a	
	Left:	n/a	
Third:	Right:	Integral to Brake	
	Left:	Integral to Brake	
Length:	First take-up:	n/a	
	Second take-up:	n/a	
	Third take-up:	n/a	
Brake _____Drums _____Discs (Place X denoting type)			
First:	Manufacturer	Meritor / Rotors	
	Part number	23123647098	
	Diameter	17	in.
Second:	Manufacturer	n/a	
	Part number	n/a	
	Diameter	n/a	in.
Third:	Manufacturer	Meritor / Rotors	
	Part number	23123647098	
	Diameter	17	in.
Brake lining/pad manufacturer		Meritor	
Type		MA703	
Brake lining/pad identification			
First:	Forward	n/a	
	Reverse	n/a	
Second:	Forward	n/a	
	Reverse	n/a	
Third:	Forward	n/a	
	Reverse	n/a	
Brake linings per shoe			

First	2 pads per brake	
Second	n/a	
Third	2 pads per brake	
Brake lining widths		
First	n/a	in.
Second	n/a	in.
Third	n/a	in.
Brake lining/pad lengths		
First	n/a	in.
Second	n/a	in.
Third	n/a	in.
Brake lining thickness/pad	56	in.
Brake lining/pad per axle		
First	112	sq. in.
Second	n/a	sq. in.
Third	112	sq. in.

Cooling system

Radiator					
Manufacturer	Modine				
Type	E-Fan System				
Model number	IA0217460000				
Number of tubes	105				
Tubes outer diameter	2.5	in./	0.75	in.	
Fins per inch	14	fins			
Fin thickness	0.004	in.			
Total cooling and heating system capacity	3.5	gal			
Radiator fan speed control	Variable Speed Pluse Width Modulation (PWM)				
Surge tank capacity	1	qt			
Thermostat temperature setting:	Initial opening (fully closed)	n/a	°F		
	Fully open	n/a	°F		
Overheat alarm temperature sending unit setting		°F Cummins Set			
Shutdown temperature setting		°F Cummins Set			

Air reservoir capacity

Supply reservoir	1000	cu in.
Primary reservoir	1516	cu in.
Secondary reservoir	2095	cu in.

Packing reservoir	n/a	cu in.
Accessory reservoir	1090	cu in.
Other reservoir type	n/a	cu in.

Heating, ventilation and air conditioning equipment

Heating system capacity	68,280	BTU/hr
Air conditioning capacity	92,500	BTU
Ventilating capacity	2400	CFM

Compressor

Manufacturer	Thermo King				
Model	Horizontal Scroll Compressor				
Number of cylinders		n/a			
Drive ratio		n/a			
Maximum warranted speed		90 Hz		rpm	
Operating speed		25-90 Hz		rpm (recommended)	
Weight		109		lb	
Oil capacity	Dry	n/a		gal	
	Wet	0.71		gal	
Refrigerant:	Type	R407C		14	lb

Condenser

Manufacturer	Thermo King		
Model	Microchannel Brazed Aluminum		
Number of fins/in.	23		
Outer diameter of tube	n/a	in.	
Fin thickness	0.003	in.	

Condenser fan

Manufacturer	Thermo King		
Model	Axial		
Fan diameter	12	in.	
Speed maximum	3300	rpm	
Flow rate (maximum)	Variable	~~CFM~~	

Receiver

Manufacturer	Thermo King	
Model	n/a	
Capacity	4.0	lb

Condenser fan drive motors

Manufacturer	Thermo King

Model	Integral Fan / Motor	
Type	Brushless	
Horsepower	0.30	hp
Operating speed	3300	rpm
Evaporator fan drive motors		
Manufacturer	Thermo King	
Model	Integral Fan / Motor	
Type	Brushless	
Horsepower	Variable	hp
Operating speed	Variable	rpm
Evaporator(s)		
Manufacturer	Thermo King	
Model	TE18	
Number of rows	5	
Number of fins/in.	9	
Outer diameter of tube	3/8	in.
Fin thickness	0.008	in.
Number of evaporators	1	
Expansion valve		
Manufacturer	Thermo King	
Model	Thermal Externally Equalized	
Filter-drier		
Manufacturer	Thermo King	
Model	n/a	
Heater cores		
Manufacturer	Thermo King	
Model	TE18	
Capacity	102,000	Btu/hr
Number of rows	2	
Number of fins/in.	8	
Outer diameter of tube	3/8	in.
Fin thickness	0.008	in.
Number of heater cores	1	
Floor heater blowers		
Front	n/a	
Rear	n/a	

Controls			
Manufacturer	Thermo King		
Model	Intelligaire 3		
Driver's heater			
Manufacturer	Mobile Climate Control		
Model	Brushless Motors		
Capacity	64,000	Btu/hr	
Ventilation system			
Type	Doors & Hatches		
Coolant heater			
Make	Valeo		
Model	Thermo DC200		
Capacity	68,300	Btu	21 kW consumption

Interior lighting		
Manufacturer	I/O Controls Corporation	
Type	LED	
Number of fixtures	10	
Size of fixtures	12 ft	
Power pack	24 Volt	

Doors	
Front	
Manufacturer of operating equipment	Vapor
Type of door	Slide-Glide
Type of operating equipment	Air Open / Air Close
Rear	
Manufacturer of operating equipment	Vapor
Type of door	Swing-Out
Type of operating equipment	Air Open / Air Close

Passenger windows			
Front			
Manufacturer	Arow Global		
Model	Picture Frame		
Type	Full Fixed		
Number:	Side	14	

	Rear	n/a		
Sizes:	(10) 46"		(2) 56"	(1) 34"
	(1) 30"			
Glazing:	Type	Welded Spline		
	Thickness	6mm		
	Color of tint	Gray		
	Light transmission	28%		

Mirrors

	Size	Type	Manufacturer	Part no.	Model no.
Right side exterior	10" x 11"	FF/CVX	Safe Fleet	M20A13AE	
Left side exterior	10" x 11"	FF/CVX	Safe Fleet	M20A12AA	
Center rearview	8.25"x16"	Flat Face	Safe Fleet	53-35868-000	
Front entrance area	6" Round	Flat Face	Safe Fleet	50-02104-007	
Upper-right corner	n/a				
Rear exit area	12"	Convex	Safe Fleet	50-11574-002	

Seats

Passenger	
Manufacturer	American Seating Company
Model	Insight Prime
Type	Molded Thermoformed Plastic Seats

Operator	
Manufacturer	Recaro
Model and part number	Ergo Metro AM80
Type	3-Point Belt seat

Paint

Manufacturer	Axalta
Type	Imron Elite Low VOC 2.8

Wheelchair ramp equipment

Manufacturer	Lift-U		
Model number	LU18		
Capacity	1000	lb	
Width of platform	30	in.	
Length of platform	48	in.	
System fluid capacity	n/a	qt	
Type of fluid used	n/a		
Operating hydraulic pressure	n/a	psi	
Hydraulic cylinders: n/a	Size		

	Number		
Wheelchair securement equipment			
Manufacturer	AMSECO / Q'Straint		
Model number	ARM with Q'Straint Belts		
Destination signs			
Manufacturer	Twin Vision		
Type	Smart Series 3 Silver Signs		
Character length			
Front destination	4.5	in.	
Front route	n/a	in.	
Curbside destination	2.8	in.	
Rear route	n/a	in.	
Character height			
Front destination	8.0	in.	
Front route	n/a	in.	
Curbside destination	4.3	in.	
Rear route	n/a	in.	
Number of characters			
Front destination	13		
Front route	n/a		
Curbside destination	11		
Rear route	n/a		
Message width			
Front destination	64.8	in.	
Front route	n/a	in.	
Curbside destination	42.3	in.	
Rear route	n/a	in.	
Electrical			
Multiplex system			
Manufacturer	I/O Controls Corporation		
Model number	Dinex G5		
Batteries			
Manufacturer	Odyssey		
Model number	PC2150S		

Type	Group 31 AGM Maintenance Free		
Communication system			
GPS			
Manufacturer	n/a		
Model number			
PA system			
	Manufacturer	**Model number**	**Number**
Amplifier	REI	710438A	
Microphone	Soundview	SVA505F	
Internal speakers	Proline	80HM	
External speaker	Midwest	#1180	
Energy storage			
Type	MNC Lithium Ion		
Number of cells	5 packs	V	
Battery pack voltage	94	V kWh per pack	
Weight	1260	lb per pack	
Security camera system			
Manufacturer	n/a		
Model number			
Number of cameras			
Storage capacity			
Bike racks			
Manufacturer	n/a		
Model number			
Fire detection system			
Manufacturer	Amerex		
Model number	V25		
Fire detectors	3		
Type (thermal or optical)	(2) Linear & (1) Spot	Sensor	
Number of detectors	3		
Automatic voice annunciator system			
Manufacturer	n/a		
Model and part number	n/a		

Annunciator LED sign		
Number of signs	n/a	
Housing dimensions		
Character length		in.
Character height		in.
Character width		in.
GPS antenna		
Manufacturer	n/a	
Model and part number		
Automatic passenger counter		
Manufacturer	n/a	
Model and part number	a.	
	b.	
	c.	
Sensor type		

Real-time bus arrival prediction system

	Manufacturer	Model number
Router	n/a	
Cellular modem	n/a	
Charge protection	n/a	

NOTE: All information above is accurate to the timeframe upon submission. The Agency reserves the right to update above data if changes occur, upon consultation with the customer.

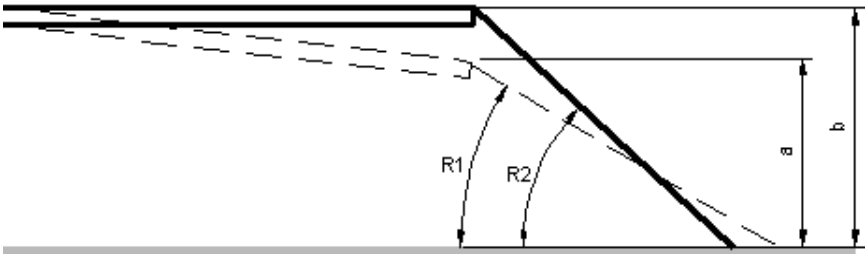
CER 10. Vehicle Technical Information

This form must be completed and included in the Technical Proposal. NOTE—one form must be completed for each type of bus submitted in response to this RFP

GENERAL COACH DATA SHEET						
Bus manufacturer:	GILLIG LLC					
Bus model:	35 Floor Low Floor All Electric					
Understructure manufacturer:	GILLIG LLC					
Model number:	G28B102H4					
Size/Type of Bus	35 Floor Low Floor All Electric					
Basic Body Construction						
Type:	Extruded Aluminum					
Tubing or frame member thickness and dimensions						
Overstructure	Aluminum ASTM 6061-T6, 6063-T6 Thickness .118in					
Understructure	3CR12 Stainless Steel ASTM A240 UNS Thickness .25in					
Skin thickness and material						
Roof	Fiberglass .12in					
Sidewall	Aluminum .118in					
Skirt panel	Aluminum .118in					
Front end	Fiberglass .125in					
Rear end	Fiberglass .125in					
Dimensions						
Overall length	Over bumpers	36	ft	9	in.	
	Over body	35	ft	11	in.	
Overall width	Over body excluding mirrors		ft	102	in.	
	Over body including mirrors–driving position		ft	120	in.	
	Over tires front axles		ft	100	in.	
	Over tires center axle		ft	N/A	in.	
	Over tires rear axles		ft	100	in.	
Overall height (maximum)		11	ft	0.3	in.	
Overall height (main roof line)		9	ft	8	in.	
Angle of approach	8.5	deg				
Breakover angle	11.9	deg				
Breakover angle (rear)	n/a	deg				
Angle of departure	10.5	deg				

Doorway Dimensions	Front		Rear	
Width between door posts	40	in.	34	in.
Door width between panels	35.7	in.	30	in.
Clear door width	32.3	in.	24.8	in.
Doorway height	75	in.	77	in.
Knuckle clearance	1.5	in.	1.5	in.

Step height from ground measured at center of doorway



	Front doorway, empty			Ramp angle			Rear Doorway, empty		
Kneeled	a.	11.7	in.	R1	9.3	deg	a.	14.1	in.
Unkneeled	b.	15.3	in.	R2	13.6	deg	b.	15.2	in.

Interior head room (center of aisle)

Front axle location	95	in.
Center axle location	n/a	in.
Rear axle location	76.5	in.

Aisle width between transverse seats	24	in.

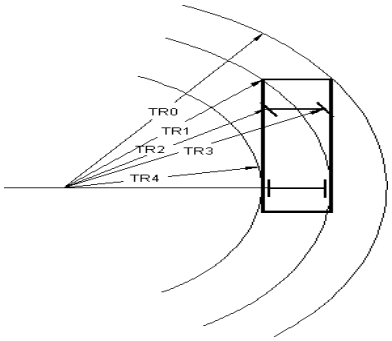
Floor height above ground (centerline of bus)

At front door	15.9	in.
At front axle	15.9	in.
At drive axle	35.6	in.
At rear door	17	in.

Minimum ground clearance (between bus and ground, with bus unkneeled)

Excluding axles	11.2	in.
Including axles	7.03	in.

Horizontal turning envelope (see diagram below)				
Outside body turning radius, TR0 (including bumper)	34	ft	7	in.
Front inner corner radius, TR1	33	ft	7	in.
Front wheel inner turning radius, TR2	28	ft	1	in.
Front wheel outer turning radius, TR3	34	ft	6	in.
Inside Body Turning Radius innermost point, TR4 (including bumper)	19	ft	5	in.



Wheel base		
Front	241	in.
Rear	n/a	in.

Overhang, centerline of axle over bumper		
Front	90.1	in.
Rear	110.4	in.

Floor				
Interior length	29	ft	0	in.
Interior width (excluding coving)	7	ft	4	in.
Total standee area (approximately)	35	sq ft		
Minimum distance between wheelhouses:	Front		36.1	in.
	Rear		36.1	in.
	Center		n/a	in.
Maximum interior floor slope (from horizontal)	4	deg		

Passenger capacity provided		
Total maximum seating	31	
Standee capacity	31	
Minimum hip to knee room	26.5	in.
Minimum foot room	14	in.

Weight

	No. of people	**Front axle**			**Center axle**			**Rear axle**			**Total bus**
		Left	Right	Total	Left	Right	Total	Left	Right	Total	

Empty bus, full fuel and farebox	0	6169	6169	12338	n/a	n/a	n/a	9851	9851	19702	32,040
Fully seated, full fuel and farebox	32	7094	7094	14187	n/a	n/a	n/a	11,326	11,326	22,652	36,840
Fully loaded standee and fully seated, full fuel and farebox	63	7989	7989	15977	n/a	n/a	n/a	12,756	12,756	25,513	41,490
Crush load (1.5x fully loaded)	94	8884	8884	17768	n/a	n/a	n/a	14,186	14,186	28,372	46,140
GVWR											47,180
GAWR				18,180						29,000	47,180

Energy Storage

Batteries – low voltage

Manufacturer	Odyssey	
Type	Group 31 AGM	
Model number	PC2150	
Cold Cranking Amps	1150	Amps

Cranking Amps	1150	Amps
Reserve Capacity	n/a	Amps

Batteries – high voltage

Manufacturer	AKASOL Inc.
Type	Lithium Ion NMC
Model Number	9AKM150CYCUHE
Total Battery Capacity (kWh)	98 kWh per pack (5 Packs per bus = 490 kWh)
Standard Charge Time	Variable: 102 - 195 minutes (based on current available market chargers)
Charging Capacity	Variable on charger used. rated to meet beyond current top charger in market
Operating Temperature Range	-40F to 136F (Normal Operating Temp range: 68F to 118F)
Cooling/Heating System	Liquid-to-air (Thermo King)

Performance

Fuel Economy (w/full passenger load, HVAC, and all electric accessories in use)	2.29kWh per mile Orange County route	kWh
Fuel Economy (w/full passenger load, HVAC, and all electric accessories in use)	N/A, same answer as above	MPGE
Max Gradeability	8	%
Top Speed	65	MPH
Battery Range	160	Miles
Acceleration (20 MPH)	7.4	Seconds
Acceleration (40 MPH)	16.5	Seconds
Top Speed (stated above)	33.4	Seconds

Performance information/graphs to be attached with this form:

Energy consumption vs. Vehicle speed

Vehicle speed vs. time (both loaded and unloaded)

Vehicle speed vs. grade (both loaded and unloaded)

Acceleration vs. time

Change of acceleration vs. time

Traction Motor/Drive Motor

Manufacturer	Cummins				
Type	Permanent Magnet Alternating Current (PMAC)				
Speeds	3500 N-m max torque up to 30 seconds				
Traction motor horsepower rating	2060N-m continuous torque				
Type ventilation/cooling	liquid-to-air cooling				
Gear ratios	Forward:	n/a	Reverse:	n/a	

Voltage Equalizer

Manufacturer	Vanner
Model	Vann-Bus 85-CAN

Auxiliary Inverter (120/240)

Manufacturer	Cummins
Model	n/a
Inverter Technology	DC to 9 phase AC
Output Voltage	n/a

Traction/Drive Motor			
Manufacturer	See above in previous Traction/Drive Motor section		
Type			
Model			
Quantity			
Torque Rating			
kWh Rating			
Air compressor			
Manufacturer	Powerex		
Type	Scroll Compressor		
Rated capacity		13.3	CFM
Capacity at idle (approximately)		n/a	CFM
Capacity at maximum speed (engine)		n/a	CFM
Maximum warranted speed		n/a	rpm
Speed idle		n/a	rpm
Drive type	Direct Drive Electric		
Governor:			
Cut-in pressure	120	psi	
Cut-out pressure	130	psi	
Axles			
First			
Manufacturer	Meritor (Rockwell)		
Type	Deep Drop		
Model number	FH946		
Gross axle weight rating	18,180	lb	
Axle load	18,180	lb	
Second			
Manufacturer			
Type			
Model number			
Gross axle weight rating		lb	
Axle load		lb	
Rear			
Manufacturer	Meritor (Rockwell)		
Type	Single Reduction		
Model number	79163		
Gross axle weight rating	29,000	lb	

Axle load	29,000	lb	
Axle ratio	6.14:1		
Suspension system			
Manufacturer	Gillig Front / Hendrickson Rear		
Type:	First:	Air Suspension	
	Second:	n/a	
	Third:	Air Suspension	
Springs:	First:	4 Bag	
	Second:	n/a	
	Third:	4 Bag	
Joint			
Manufacturer			
Type			
Model number			
Wheels and tires			
Wheels			
Make	Alcoa Aluminum		
Size	front: 22.5" x 9.0" , Rear: 22.5" x 8.25"		
Capacity	Front: 9090 lbs per wheel, Rear: 8050 lbs per wheel		
Material	Full Polished		
Tires			
Manufacturer	Agency Supplied		
Type	Agency Supplied		
Size	315/80R22.5		
Load range/air pressure	TBD	psi	
Steering, power			
Pump			
Manufacturer and model number	Concentric - EHS		
Type	Electric Motor-driven hydraulic pump		
Relief pressure	2175	psi	
Booster/gear box			
Manufacturer and model number	ZF		
Type	Hydraulic Assist steering gear		
Ratio	23.3:1 (6.2 wheel turns to 95 degree rotation)		
Power steering fluid capacity	1.5	gal	
Maximum effort at steering wheel	10	lb (unloaded stationary coach on dry asphalt pavement)	
Steering wheel diameter	18	in.	

Brakes			
Make of fundamental brake system		Meritor / EX225H3 (Disc)	
Brake chambers vendor size and part number:		First:	MGM Type 24
		Second:	n/a
		Third:	MGM MJB 3030ET
Brake operation effort	6:1 Pressure Ratio		
Slack adjuster's vendor's type and part numbers			
First:	Right:	Integral to Brake	
	Left:	Integral to Brake	
Second:	Right:	n/a	
	Left:	n/a	
Third:	Right:	Integral to Brake	
	Left:	Integral to Brake	
Length:	First take-up:	n/a	
	Second take-up:	n/a	
	Third take-up:	n/a	
Brake _____Drums _____Discs (Place X denoting type)			
First:	Manufacturer	Meritor / Rotors	
	Part number	23123647098	
	Diameter	17	in.
Second:	Manufacturer	n/a	
	Part number	n/a	
	Diameter	n/a	in.
Third:	Manufacturer	Meritor / Rotors	
	Part number	23123647098	
	Diameter	17	in.
Brake lining/pad manufacturer		Meritor	
Type		MA703	
Brake lining/pad identification			
First:	Forward	n/a	
	Reverse	n/a	
Second:	Forward	n/a	
	Reverse	n/a	
Third:	Forward	n/a	
	Reverse	n/a	
Brake linings per shoe			

First	2 pads per brake	
Second	n/a	
Third	2 pads per brake	
Brake lining widths		
First	n/a	in.
Second	n/a	in.
Third	n/a	in.
Brake lining/pad lengths		
First	n/a	in.
Second	n/a	in.
Third	n/a	in.
Brake lining thickness/pad	56	in.
Brake lining/pad per axle		
First	112	sq. in.
Second	n/a	sq. in.
Third	112	sq. in.

Cooling system

Radiator					
Manufacturer	Modine				
Type	E-Fan System				
Model number	IA0217460000				
Number of tubes	105				
Tubes outer diameter	2.5	in./	0.75	in.	
Fins per inch	14	fins			
Fin thickness	0.004	in.			
Total cooling and heating system capacity	3.5	gal			
Radiator fan speed control	Variable Speed Pluse Width Modulation (PWM)				
Surge tank capacity	1	qt			
Thermostat temperature setting:	Initial opening (fully closed)	n/a	°F		
	Fully open	n/a	°F		
Overheat alarm temperature sending unit setting		°F Cummins Set			
Shutdown temperature setting		°F Cummins Set			

Air reservoir capacity

Supply reservoir	1000	cu in.
Primary reservoir	1516	cu in.
Secondary reservoir	2095	cu in.

Packing reservoir	n/a	cu in.
Accessory reservoir	1090	cu in.
Other reservoir type	n/a	cu in.

Heating, ventilation and air conditioning equipment

Heating system capacity	68,280	BTU/hr
Air conditioning capacity	92,500	BTU
Ventilating capacity	2400	CFM

Compressor

Manufacturer	Thermo King				
Model	Horizontal Scroll Compressor				
Number of cylinders		n/a			
Drive ratio		n/a			
Maximum warranted speed		90 Hz		rpm	
Operating speed		25-90 Hz		rpm (recommended)	
Weight		109		lb	
Oil capacity	Dry	n/a		gal	
	Wet	0.71		gal	
Refrigerant:	Type	R407C		14	lb

Condenser

Manufacturer	Thermo King		
Model	Microchannel Brazed Aluminum		
Number of fins/in.	23		
Outer diameter of tube	n/a	in.	
Fin thickness	0.003	in.	

Condenser fan

Manufacturer	Thermo King		
Model	Axial		
Fan diameter	12	in.	
Speed maximum	3300	rpm	
Flow rate (maximum)	Variable	~~CFM~~	

Receiver

Manufacturer	Thermo King	
Model	n/a	
Capacity	4.0	lb

Condenser fan drive motors

Manufacturer	Thermo King

Model	Integral Fan / Motor	
Type	Brushless	
Horsepower	0.30	hp
Operating speed	3300	rpm
Evaporator fan drive motors		
Manufacturer	Thermo King	
Model	Integral Fan / Motor	
Type	Brushless	
Horsepower	Variable	hp
Operating speed	Variable	rpm
Evaporator(s)		
Manufacturer	Thermo King	
Model	TE18	
Number of rows	5	
Number of fins/in.	9	
Outer diameter of tube	3/8	in.
Fin thickness	0.008	in.
Number of evaporators	1	
Expansion valve		
Manufacturer	Thermo King	
Model	Thermal Externally Equalized	
Filter-drier		
Manufacturer	Thermo King	
Model	n/a	
Heater cores		
Manufacturer	Thermo King	
Model	TE18	
Capacity	102,000	Btu/hr
Number of rows	2	
Number of fins/in.	8	
Outer diameter of tube	3/8	in.
Fin thickness	0.008	in.
Number of heater cores	1	
Floor heater blowers		
Front	n/a	
Rear	n/a	

Controls			
Manufacturer	Thermo King		
Model	Intelligaire 3		
Driver's heater			
Manufacturer	Mobile Climate Control		
Model	Brushless Motors		
Capacity	64,000	Btu/hr	
Ventilation system			
Type	Doors & Hatches		
Coolant heater			
Make	Valeo		
Model	Thermo DC200		
Capacity	68,300	Btu	21 kW consumption

Interior lighting		
Manufacturer	I/O Controls Corporation	
Type	LED	
Number of fixtures	10	
Size of fixtures	12 ft	
Power pack	24 Volt	

Doors	
Front	
Manufacturer of operating equipment	Vapor
Type of door	Slide-Glide
Type of operating equipment	Air Open / Air Close
Rear	
Manufacturer of operating equipment	Vapor
Type of door	Swing-Out
Type of operating equipment	Air Open / Air Close

Passenger windows			
Front			
Manufacturer	Arow Global		
Model	Picture Frame		
Type	Full Fixed		
Number:	Side	14	

	Rear	n/a		
Sizes:	(10) 46"		(2) 56"	(1) 34"
	(1) 30"			
Glazing:	Type	Welded Spline		
	Thickness	6mm		
	Color of tint	Gray		
	Light transmission	28%		

Mirrors

	Size	Type	Manufacturer	Part no.	Model no.
Right side exterior	10" x 11"	FF/CVX	Safe Fleet	M20A13AE	
Left side exterior	10" x 11"	FF/CVX	Safe Fleet	M20A12AA	
Center rearview	8.25"x16"	Flat Face	Safe Fleet	53-35868-000	
Front entrance area	6" Round	Flat Face	Safe Fleet	50-02104-007	
Upper-right corner	n/a				
Rear exit area	12"	Convex	Safe Fleet	50-11574-002	

Seats

Passenger	
Manufacturer	American Seating Company
Model	Insight Prime
Type	Molded Thermoformed Plastic Seats

Operator	
Manufacturer	Recaro
Model and part number	Ergo Metro AM80
Type	3-Point Belt seat

Paint

Manufacturer	Axalta
Type	Imron Elite Low VOC 2.8

Wheelchair ramp equipment

Manufacturer	Lift-U		
Model number	LU18		
Capacity	1000	lb	
Width of platform	30	in.	
Length of platform	48	in.	
System fluid capacity	n/a	qt	
Type of fluid used	n/a		
Operating hydraulic pressure	n/a	psi	
Hydraulic cylinders: n/a	Size		

	Number		
Wheelchair securement equipment			
Manufacturer	AMSECO / Q'Straint		
Model number	ARM with Q'Straint Belts		
Destination signs			
Manufacturer	Twin Vision		
Type	Smart Series 3 Silver Signs		
Character length			
Front destination	4.5	in.	
Front route	n/a	in.	
Curbside destination	2.8	in.	
Rear route	n/a	in.	
Character height			
Front destination	8.0	in.	
Front route	n/a	in.	
Curbside destination	4.3	in.	
Rear route	n/a	in.	
Number of characters			
Front destination	13		
Front route	n/a		
Curbside destination	11		
Rear route	n/a		
Message width			
Front destination	64.8	in.	
Front route	n/a	in.	
Curbside destination	42.3	in.	
Rear route	n/a	in.	
Electrical			
Multiplex system			
Manufacturer	I/O Controls Corporation		
Model number	Dinex G5		
Batteries			
Manufacturer	Odyssey		
Model number	PC2150S		

Type	Group 31 AGM Maintenance Free		
Communication system			
GPS			
Manufacturer	n/a		
Model number			
PA system			
	Manufacturer	**Model number**	**Number**
Amplifier	REI	710438A	
Microphone	Soundview	SVA505F	
Internal speakers	Proline	80HM	
External speaker	Midwest	#1180	
Energy storage			
Type	MNC Lithium Ion		
Number of cells	5 packs	V	
Battery pack voltage	94	V kWh per pack	
Weight	1260	lb per pack	
Security camera system			
Manufacturer	n/a		
Model number			
Number of cameras			
Storage capacity			
Bike racks			
Manufacturer	n/a		
Model number			
Fire detection system			
Manufacturer	Amerex		
Model number	V25		
Fire detectors	3		
Type (thermal or optical)	(2) Linear & (1) Spot	Sensor	
Number of detectors	3		
Automatic voice annunciator system			
Manufacturer	n/a		
Model and part number	n/a		

Annunciator LED sign		
Number of signs	n/a	
Housing dimensions		
Character length		in.
Character height		in.
Character width		in.
GPS antenna		
Manufacturer	n/a	
Model and part number		
Automatic passenger counter		
Manufacturer	n/a	
Model and part number	a.	
	b.	
	c.	
Sensor type		

Real-time bus arrival prediction system

	Manufacturer	Model number
Router	n/a	
Cellular modem	n/a	
Charge protection	n/a	

NOTE: All information above is accurate to the timeframe upon submission. The Agency reserves the right to update above data if changes occur, upon consultation with the customer.

BIR -00271
Customer Request
Please provide this info for the bid:

Performance Information/Graphs to be include with Proposal submittal shall include:
• Energy Consumption vs. Road Speed
• Torque vs. Road Speed
• Energy consumption vs. torque.
• Vehicle speed vs. time (both loaded and unloaded)
• Vehicle speed vs. grade (both loaded and unloaded)
• Acceleration vs. time
• Change of acceleration vs. time

Supply a computer simulation of bus performance, utilizing the physical and mechanical characteristics of a specific bus, for each type of bus offered. Performance simulation data to be prepared with 130% passenger load and all accessories on. Supply a performance summary for the exact bus(es) to be built, utilizing a 130% passenger load. Data to show AT LEAST the following: time to speed on flat ground, 5%, 7%, 10% and maximum grade for speeds of 5, 10, 15, 25, 35 mph (or maximum for each grade). Describe to what extent and in what manner software controlled load shedding will be utilized to achieve the desired performance. Include a list of parameter set points that can be adjusted to suite operating environment and performance requirements of transit buses in the State of Florida.

Nominal conditions
• Ambient temperature: 90 °F
• Bus weight: SLW
Worst-case conditions
• Ambient temperature: Worst-case heating and cooling loads when operating in State of Florida environmental conditions as defined by NOAA.com, or other website.
• Bus weight: GVWR

Bus Specification

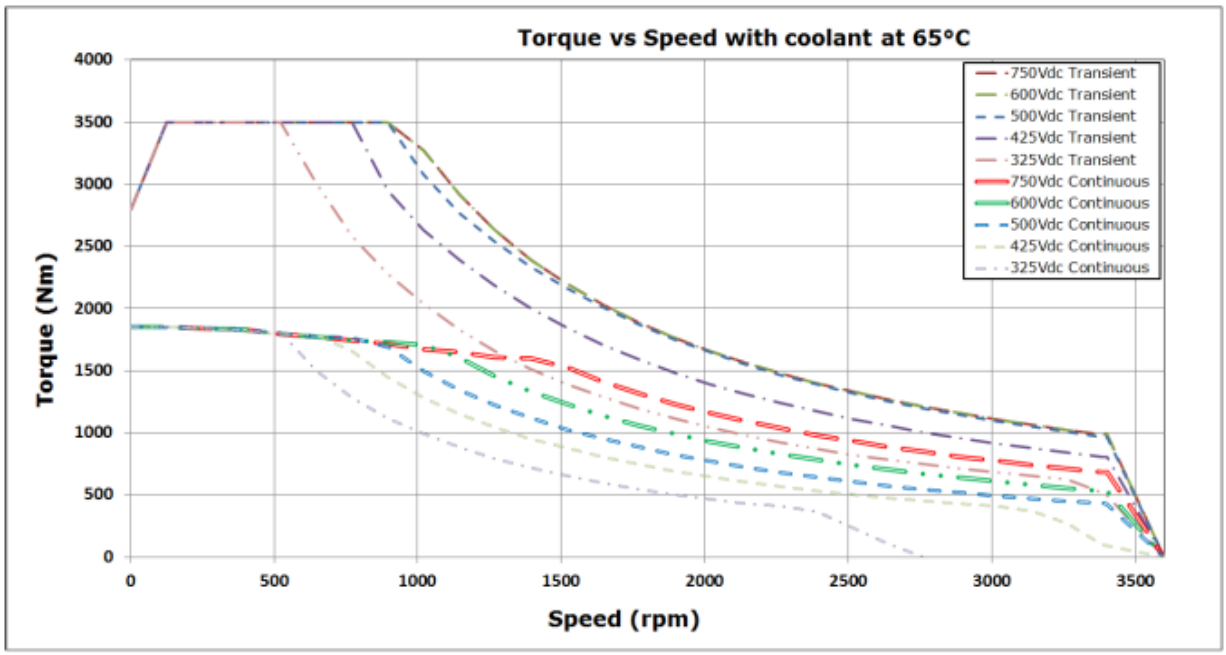
- 40' Gen 2.5
- 6 pack
- Typical configuration (w/o overhead or inductive charging)
- Curb Weight: 34,240 Lbs.
- Seated Weight: 40,090 Lbs.
- GVWR: 47,180 Lbs.

Engineering Responses

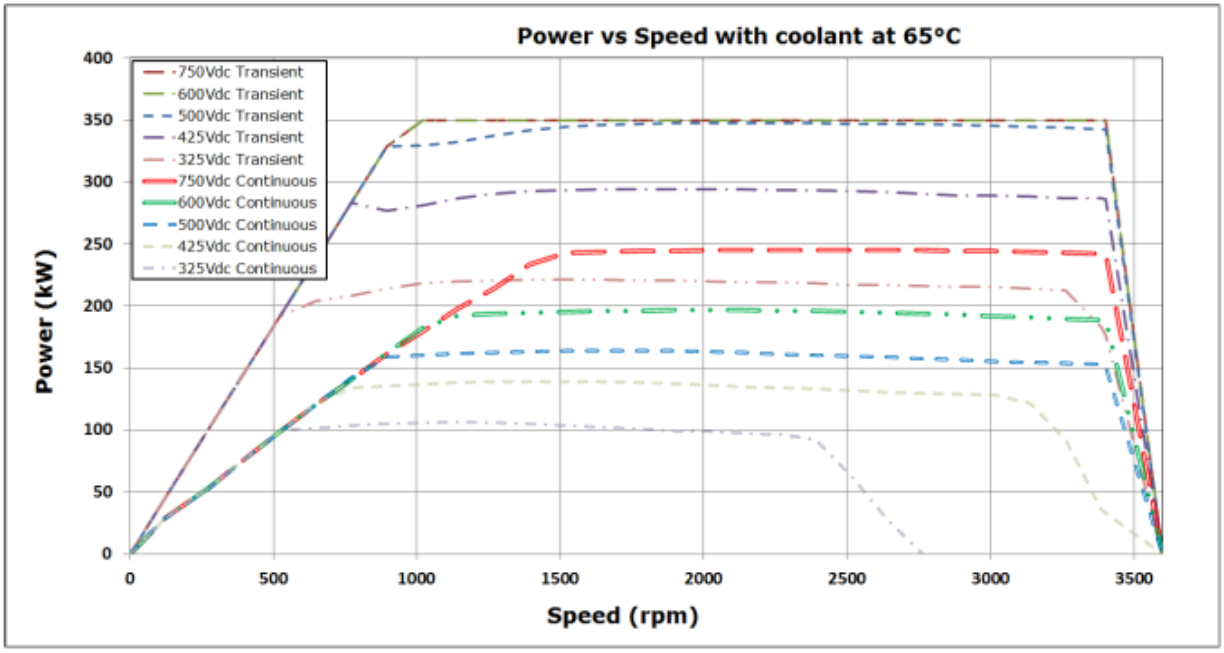
1. Energy Consumption Vs Road speed. Provide standard values per Altoona cycles

Waiting for Cummins (Colby table)

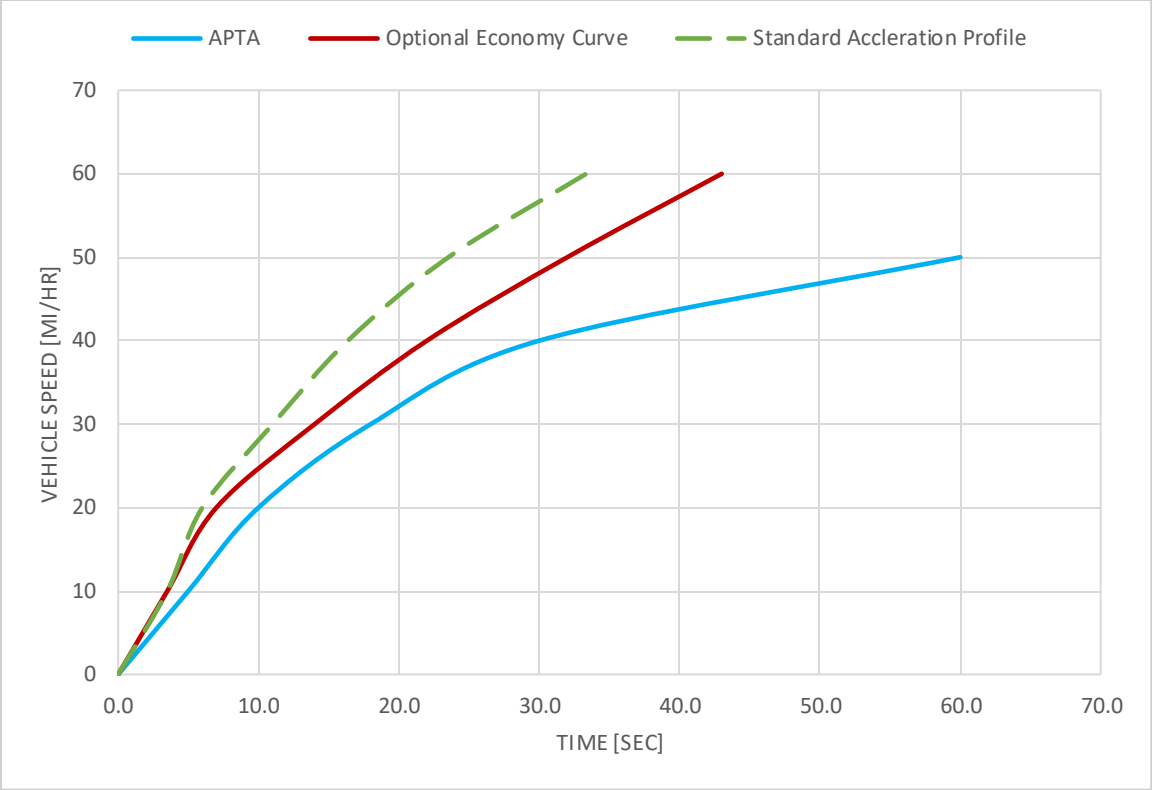
2. Torque vs road speed. Curve below provides the motor torque curve showing available motor torque vs motor speed. Torque vs road speed is a function of vehicle grade, driver determined road speed, current rate of acceleration. The curve defines what the motor is capable of.



3. Energy Consumption vs torque. Curve below provides motor power consumption vs motor speed at maximum torque at that motor speed



4. Vehicle speed vs time. The curves below define the standard acceleration curve, optional reduced acceleration curve and the curve per APTA.



5. Vehicle speed vs grade Not sure yet
6. Acceleration vs time. Currently provide time to a speed in 10 mph increments. Could add to this table avg acceleration rate in each 10 mph bracket to show change in acceleration time as the speed increases.
7. Change of acceleration over time use response 6

130% Crush load. Gillig does not provide performance data at a 130% crush load. Gillig designs the vehicle GVWR to allow for full seated and standee load without exceeding any GAWR. Standee load is determined by 1.5 square feet per passenger. Per standard use of crush load the practical limit for crush load is 6 passengers per 1.2 square yards or 1.75 square feel per passenger. Gillig already uses 1.5 square foot per passenger which is 17% above this practical limit. Vehicle use above GVWR is not approved and performance above GVWR is not defined to prevent implying vehicle operation above GVWR is approved. Performance data can be provided at curb, seated or GVWR.

Temperature

- Average Low is 55F use 50 F
- Average high is 88F use 90 F

Performance Table Build with help from Cummins

Load Shedding

No load shedding is done to achieve this performance. This ensures vehicle performance will remain constant and predicable. Some load shedding of non-propulsion features such as HVAC is employed at very low SoC to maximize remaining range, but vehicle performance will remain constant.

Adjustable Parameter Set Points

- Regen curves are not adjustable. Regen curves are set to provide the maximum possible regen while ensuring passenger comfort and meet the requirements of the axle manufacturer.
- A reduced acceleration curve for a slightly slower rate of acceleration is available. This can either be confirmed before delivery or changed using Cummins software.
- No other propulsion system parameters are adjustable.

Performance

Gradeability: 47,180 Lbs. GVWR

Tires		Goodyear Metro Miler G652 B315 80R 22.5 RPM 485 SLR 19.9" Crr 6.5				
Rear axle ratio		6.14		GVWR	47,180 Lbs.	
Operating voltage		660 V				
Motor coolant temp		65 C				
		Continuous	**30 Seconds**	**1 Minute**	**2 Minutes**	**4 Minutes**
	Grade %	MPH at GVWR				
	0	70.56	70.56	70.56	70.56	70.56
	1	68.40	69.81	69.81	69.81	69.81
	2	65.85	69.04	69.06	69.06	69.06
	3	62.54	63.29	65.03	66.10	66.35
	4	55.09	57.04	58.16	58.77	58.87
	5	48.80	51.38	52.05	52.35	52.39
	6	43.47	46.35	46.71	46.84	46.85
	7	38.95	41.93	42.12	42.16	42.17
	8	31.74	38.10	38.19	38.20	38.20
	9	0.00	34.67	34.73	34.74	34.74
	10	0.00	31.75	31.77	31.78	31.78
	11	0.00	28.93	28.94	28.94	28.94
	12	0.00	26.63	26.63	26.63	1.75
	13	0.00	25.04	25.04	25.04	0.00
	14	0.00	23.45	23.45	2.41	0.00
	15	0.00	21.87	19.78	0.00	0.00
	16	0.00	20.03	0.00	0.00	0.00
	17	0.00	9.10	0.00	0.00	0.00
	18	0.00	0.00	0.00	0.00	0.00
	19	0.00	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00	0.00

Time to Speed: Standard Acceleration Curve at GVWR

	Maximum Time in Seconds			
Speed				
mph	0% Grade	5% Grade	7% Grade	10% Grade
10	4.6	6.6	7.9	11.4
20	7.4	10.6	12.7	18.2
30	11	16.5	20.9	39.2
40	16.5	29.5	50.5	-
50	23.5	60	-	-
60	33.4	-	-	-

Acceleration Curve, Acceleration Rate and Change in Acceleration Rate

Maximum Time In Seconds		
Speed	Standard Acceleration	Average Acceleration Rate From Previous Speed
mph	Seconds	Ft/Sec Sq
10	4.6	3.19
20	7.4	5.24
30	11	4.075
40	16.5	2.67
50	23.5	2.096
60	33.4	1.48

Response Reference Information. Not to be included in response to customer.

Crush Load Definition

In the context of transport economics and planning, crush load refers to the maximum level of passenger load for a particular vehicle or rail carriage. Crush loads are calculated for the number of passengers per unit area, standing up.

Crush loads are not an issue for passengers that are seated, as passengers will not normally sit on one another.

Crush loads are most common on city buses and rail metro systems, where passenger loading is high, and most passengers stand. Airlines almost never have crush loads, nor do high speed and/or long-distance rail or long-distance bus routes, where all passengers are generally seated.

Crush loads are normally measured using number of standing passengers per 1 square metre (1.2 sq yd).[2] Six passengers per square metre is often considered the practical limit on what can be accepted without serious discomfort to passengers. However, severe crush loads can be much in excess of this.[3]

6 passenger in 1.2 sq yard = 10.8 square feet = 1.75 square feet per passenger

APTA standard is 1.5 square feet per passenger which is

7. REFERENCES AND NON-PRICED INFORMATION

GILLIG is a **100% U. S. owned and operated** manufacturing company located in Livermore, California. All our transit bus models are manufactured at this one (1) location only, on the same production line.

We have manufactured and delivered our LOW FLOOR heavy-duty ZERO EMISSION BATTERY ELECTRIC, DIESEL, HYBRID-ELECTRIC, and CNG model transit buses throughout the United States, in all climates (including Alaska and Hawaii).

We operate 12 months of the year and employ over 850 full-time qualified and experienced employees in all departments to meet our production requirements.

References attached are:

- ZERO EMISSION CUSTOMER REFERENCE LIST
- SUCCESSFUL BATTERY ELECTRIC BUS LAUNCH CUSTOMER LIST
- CUSTOMER REFERENCE LETTERS

- Reference the aerial photo of our Livermore location.



CUSTOMER REFERENCE LIST (BEB)

Our **ZERO EMISSIONS BATTERY ELECTRIC BUS (BEB)** offering joins GILLIG's industry leading Low Floor bus platform to bring the most comprehensive, advanced battery electric bus to the market.

GILLIG's Zero Emission Battery Electric bus incorporates the Cummins electrified powertrain, which provides the advantage of full local service support with hundreds of service centers throughout the country to provide the necessary training, warranty administration, and after-market parts. All designed, built, and supported right here in the United States.

Please see the below reference list for current Battery Electric Bus customers. GILLIG has built and delivered well over 60 Battery Electric Buses to over 25 different customers.

Customer: **Santa Monica, CA (Big Blue Bus)**
Address: 1660 7TH Street Santa Monica, CA 90401
Contact: Adrian H. Garcia, Transit Maintenance Vehicle Supervisor
Phone: (310) 633-1852
Email: adrian.garcia@smgov.net

Customer: **Tucson, AZ (Sun Tran)**
Address: 3920 N. Sun Tran Blvd. Tucson, AZ 85705
Contact: Jim Gleason, Director Maintenance
Phone: (520) 206-8891
Email: james.gleason@tucsonaz.gov

Customer: **Honolulu, HI (The Bus)**
Address: 650 South King St. Third Floor Honolulu, HI 96813
Contact: Adam Tamayoshi, VP of Maintenance
Phone: 808-768-9463
Email: adam.tamayoshi@thebus.org

Customer: **Kansas City, MO (Kansa City Area Transit Authority)**
Address: 1350 East 17TH St. Kansas City, MO 64108
Contact: Chuck Ferguson, VP, Bus Operations
Phone: (816) 346-0353
Email: cferguson@kcata.org

Customer: **Kitsap, WA (Kitsap Transit)**
Address: 60 Washington Ave, Ste. 200, Bremerton, WA 98337
Contact: Dennis Griffey, Vehicle & Facilities Maintenance Director
Phone: (360) 478-6229
Email: dennisg@kitsaptransit.com

CUSTOMER REFERENCE LIST (BEB)

Customer: **Bellingham, WA (Whatcom Transportation Authority)**
Address: 4111 Bakerview Spur, Bellingham, WA 98226
Contact: Michael Bozzo, Director of Fleet and Facilities
Phone: (360) 788-9351
Email: mikeb@ridewta.com

Customer: **Portland, OR (Trimet)**
Address: 1800 SW 1st Avenue, Suite 300, Portland, OR 97201
Contact: Samuel Rumhizha, Director, Bus Maintenance
Phone: (503) 962-5840
Email: rumhizhs@trimet.org

Successful Battery Electric Bus Launch

Over the past 20 years, GILLIG has manufactured 3,500 electrified drivetrain buses leading up to our current generation of BEB offerings. In 2017, GILLIG partnered with Cummins to announce the next generation of battery electric buses. GILLIG commenced production of the current generation of Battery Electric buses in September 2020. As of September 18, 2021, GILLIG has delivered 95 of the current generation of Battery Electric Buses. Current Battery Electric bus production starts are set at 3 per week and GILLIG anticipates delivering 150+ Battery Electric Buses in 2021. The excitement about the GILLIG Battery Electric Low Floor has resulted in over 64 unique customer orders to over the last 15 months.



ATHENS CLARKE COUNTY

MEMORANDUM FOR RECORD

To Whom It May Concern; Date: March 2, 2021

Letter of Reference for Gillig LLC

I have been working in various positions in the public transit industry for the last 25 years. I started as a bus mechanic, then, worked as a back –up driver, in Operations, Maintenance Management and Administration. I have been the Director of Athens-Clarke County Transit department since October of 2001.

Over the years, I have either worked on, driven, or helped facilitate the purchase more than 300+ Gillig buses. The various 30, 35, and 40-foot standard and low-floor heavy-duty transit buses, with diesel, hybrid, and/or electric propulsion systems have been reliable vehicles for this system, as well as many other transit systems across this county. Gillig's customer services from product order, though production and delivery, to their after the sale, replacement parts and repair programs, their staff and services have always been exemplary.

I believe that Gillig builds the best heavy-duty transit buses in the industry. From their sales staff, the engineers, the workers on the assembly line, to the parts department folks, they all are reliable partners to our organization and they stand behind their products as a company and as a member of the team.

I would highly recommend Gillig LLC, their staff and their products to any system in the industry.

Thank you,



Butch McDuffie
Director,
Athens-Clarke County Transit Department
Athens, GA 30601
706-621-0667

Big Blue Bus
Transit Maintenance
1660 7th Street
Santa Monica, CA 90401

City of
Santa Monica®

September 14, 2020

Mr. Joe Policarpio
Vice President of Sales and Marketing
GILLIG LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Policarpio,

Big Blue Bus (BBB) would like to thank GILLIG for helping us provide safe and reliable buses that represent the latest in bus technology and clean fuel sources. Since 2012, you have helped us maintain the highest quality fleet and become the first transit agency in Southern California to purchase buses with near-zero compressed natural gas (CNG) engines. With GILLIG, BBB crossed a historic threshold in August 2019: the in-service deployment of our first zero-emission battery-electric bus, which is performing beautifully.

Our GILLIG battery-electric bus has exceeded our expectations and those of our customers. It performs as well as our other 124 GILLIG buses. Your cutting-edge bus uses state-of-the-art battery-electric technology, design features, and power capabilities while offering an unparalleled quiet and smooth ride. Because of the incredible reliability and serviceability of our in-service GILLIG battery-electric bus, BBB will be deploying 18 additional GILLIG zero-emission battery-electric buses by 2021.

Our GILLIG battery-electric bus deployment also marks a significant step toward preserving our environment and protecting our communities as we complete the transition to a zero-emissions fleet by 2030. We can't think of a better partner to provide safe, reliable, and efficient transportation services that improve and enhance our community's quality of life. We look forward to a long, mutually beneficial partnership with GILLIG.

Sincerely,

Getty Modica
Transit Maintenance Manager

tel: 310 458-1975 • fax: 310 399-6275 • e-mail: TransitMaintenance@smgov.net

September 14, 2020

Mr. Joe Policarpio
Vice President of Sales and Marketing
GILLIG LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Policarpio,

We couldn't be prouder to partner with GILLIG on 2 FTA Lo or No Emission Grant programs as we invest in creating an innovative and smart transportation system through our in-service GILLIG zero-emission battery-electric bus.

For almost 20 years, GILLIG has provided Tucson with the most reliable buses—diesel-electric hybrid, near-zero emission compressed natural gas, and clean-diesel—all designed on the proven GILLIG Low Floor platform to maximize fleet commonality.

In April 2020, our first zero-emission electric bus from GILLIG hit the streets, and we couldn't be more impressed with its performance. Our bus performs as well as our current GILLIG fleet and now confirms our perception that GILLIG is providing the safest, highest quality, most reliable, and best-supported battery-electric bus on the market. With its advanced technology, our GILLIG electric bus also provides a quieter and more comfortable ride for our passengers. Sun Tran looks forward to receiving our 10 additional GILLIG electric buses as we build a more sustainable community and cleaner air.

Thank you for providing market-leading, dependable solutions as we begin our zero-emissions journey, electrifying our city's vehicle and transit fleet. With the help of GILLIG buses, Sun Tran is an industry leader in safe, reliable, and sustainable transportation solutions.

Sincerely,

Kevin Faulkner
Director of Procurement
Sun Tran

Oahu Transit Services, Inc.
811 Middle St. Honolulu, HI 96819-2316
telephone (808) 848-4400 facsimile (808) 848-4419
www.thebus.org

TheBus
TheHandi-Van

June 23, 2020

Mr. Joe Policarpio
Vice President of Sales and Marketing
Gillig L.L.C.
451 Discovery Drive
Livermore, CA 94511

Dear Mr. Policarpio,

I would like to express my eagerness on taking this momentous step towards the electrification of mass transit with Gillig. There is absolutely no other manufacturer that I would prefer to partner with on such an important endeavor. Your dependable product and outstanding customer support are the cornerstones of the strong relationship that has continued over the years between the City and County of Honolulu, Oahu Transit Services, Inc. and your Corporation.

Currently, the City and County of Honolulu operates a fleet of 367 Gillig buses. The durability and dependability of your buses are evident in our oldest fleet aged at 23 years and in our most utilized fleet having traveled over 1,000,000 miles. Impressionably, we consistently witness your revolutionary advancements with improved fuel economy and lowered operational cost. Reinforcing our reasons why we have confidence in your new electric bus. We know that it will be reliable, well-engineered and environmentally beneficial.

The only factor that surpasses your amazing product is the outstanding customer support that we consistently receive. It is obvious from working with your staff throughout the company, how strongly Gillig is dedicated to their clients and how much they believe in their product. Everyone on staff has proven to be extremely knowledgeable, courteous, and always willing to go the extra mile.

As we anxiously wait for the arrival of our first electric bus, we are anticipating that it will to be a success. I am confident that these buses will provide reliable and efficient public transportation for the people of Honolulu for many years to come. I foresee a promising future with a continued partnership between the City and County of Honolulu and Gillig.

Sincerely,

Adam Tamayoshi
Vice President of Maintenance

GWINNETT COUNTY
DEPARTMENT OF TRANSPORTATION
GWINNETT COUNTY TRANSIT DIVISION

75 Langley Drive | Lawrenceville, GA 30046-6935
770.822.7446
www.gwinnettcounty.com | www.gctransit.com

Karen Winger AICP CCTM, Transit Division Director
Gwinnett County Department of Transportation
770.822.7422
Karen.winger@gwinnettcounty.com

To Whom It May Concern,

This letter is for the recommendation of GILLIG bus manufacture. Gwinnett County purchased the first set of 28 forty-foot long local buses in 2015 as part of the Athens-Clarke County bus consortium. We have since purchased an additional 10 buses with GILLIG through this same contract, receiving our final 3 buses as recently as June of 2020.

Since our first bus arrived, GILLIG has always been prompt, professional and courteous at every step of the process. Whether it be from the presale to finalizing the order, all the way to delivery of our brand new bus, GILLIG has always been responsive to our needs and concerns, in addition to being quick to rectify any issues.

When it comes to sales and service, not only is the GILLIG product a quality and dependable product in the best of times but it is also a product that can come through when need them the most. During the height of the COVID-19 pandemic, GILLIG was able to ship us operator barriers for our entire fleet in less than a month of request.

I am happy to recommend GILLIG to anybody who is looking for a quality bus product.

Karen A Winger

Karen Winger AICP CCTM
Transit Division Director, Gwinnett County

Indianapolis Public Transportation Corporation
1501 W. Washington Street
Indianapolis, IN 46222
317.635.3344
www.IndyGo.net
@IndyGoBus

June 9, 2020

Mr. Jim Ryan
Regional Sales Manager
Gillig Sales
GILLIG LLC
25800 Clawiter Road
Hayward, CA 94545

Dear Mr. Ryan,

I'm writing today to thank you and the Gillig team for your continued partnership and service in providing vehicles for the Indianapolis Public Transportation Corporation (IndyGo).

IndyGo currently operates a fleet of 172 Gillig buses. The Gillig team recently provided exceptional service by working with IndyGo to expedite an order of thirteen additional buses to assist with the future implementation of system changes. Gillig's dedication to customer service is evident, and felt even more so as we navigate a new environment for both businesses and transit agencies. We are proud to have partnered with Gillig for over twenty-five years.

Our Operators and riders know they can rely on Gillig's vehicles to transport them around the city. In a time when most travel is for essential trips, we know how important it is to have vehicles we can count on. The Gillig team continues to provide excellent customer service and high-quality products to our agency. We look forward to our continued partnership.

I would be happy to recommend Gillig's products and services to prospective customers.

Sincerely,

Inez Evans
President and CEO
IndyGo

METRO REGIONAL TRANSIT AUTHORITY

June 2, 2020

Mr. Jim Ryan
Regional Sales Manager
GILLIG LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Ryan;

For more than 30 years, the METRO Regional Transit Authority has been doing business with GILLIG. I have personally had the pleasure of being able to use GILLIG vehicles at all three transit properties with whom I have been associated. From the time, I was a bus operator in Akron, Ohio to overseeing the maintenance department in Nashville to managing Knoxville's transit system in Tennessee one bus company has remained the focal point of these transit systems, GILLIG.

GILLIG has an outstanding product they stand behind and a customer service driven mission that is the best in the industry. From the day the bus comes off the production line to the day the bus runs its final mile into retirement, GILLIG provides superior quality, training, service, and support to this organization. Their business model shows their passion, integrity, and quality for their customers. You are truly never alone when you have made the commitment to purchase GILLIG vehicles. You become part of the family. They seek out your input into future ideas and projects while advancing the bus technology that makes their buses the ones operators want to drive, passengers want to ride, and organizations want to buy.

Top this all off with the amazing dedication and assistance my organizations have always received from you as our sales representative and you have what I consider to be the best of the best. It is with great pleasure that I provide this letter of recommendation to perspective customers of the GILLIG Corporation.

Yours in accessible transportation,

Dawn Distler
Chief Executive Officer

416 KENMORE BOULEVARD AKRON, OHIO 44301
phone: 330.762.7267 / *fax:* 330.762.0854

web: AKRONMETRO.ORG

Jeff Mundstock
Interim Director of Fleet and Facilities
1401 Bank Street
Cincinnati, OH 45214
(513) 632-7612 PH
(513) 513-632-7505 FAX
jmundstock@go-metro.com

June 2, 2020

Mr. Jim Ryan
Regional Sales Manager
Gillig LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Ryan,

I have had the pleasure in working with Gillig for almost 10 years. SORTA/Metro as an organization has participated with Gillig in over 10 builds, totaling over 550 buses in recent decades for heavy duty transit coaches.

In my experience, Gillig has been paramount in build quality and customer service. From the preproduction meeting, to support years after the coach is in service, right down to replacement parts, Gillig has always focused on being customer-driven and has supported SORTA as an organization through the entire time we have been partners. SORTA has had other bus manufacturers in recent years, and I will personally say that Gillig well exceeds rival manufacturers in regards to customer service, support, and quality.

Within the past year, Gillig sent a team of engineers and production managers to our facility to inspect older buses that we still had in service well past their 12 year useful life. We took them out to see some of our 2004 Phantoms we still had in service at the time. The purpose of this visit was to investigate how the buses held up over time in our climate, and how that information will help them in future designs and builds. This process demonstrates Gillig's attention to detail and commitment to building a product to last well past the FTA useful life expectancy.

Our relationship with Gillig will extend well into the future of our organization, as we have recently started yet another 5 year contract for the purchase of 40' heavy duty transit buses. I am looking forward to our future endeavors as a partnership and would be pleased to recommend Gillig to any future potential customers.

Sincerely,

Jeff Mundstock
Interim Director of Fleet and Facilities

KRT KANAWHA VALLEY REGIONAL TRANSPORTATION AUTHORITY
P.O. Box 1188
Charleston, WV 25324
1550 Fourth Avenue
Charleston, WV 25387
PHONE 304.343.3840
FAX 304.343.3877
WEB RIDEONKRT.COM

June 2, 2020

Mr. Jim Ryan
Regional Sales Manager
Gillig L.L.C.
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Ryan:

On behalf of the Kanawha Valley Regional Transportation Authority (KVRTA), I would like to take this opportunity to thank you and the entire Gillig team for the excellent service, support and buses that have been afforded to KVRTA over the past seventeen years. Our entire organization feel that the Gillig buses are the finest buses that we have ever operated at KVRTA. During my thirty-eight-year career in public transit, the relationship established with you, David Clawson and others at Gillig has been unmatched, and makes my life as Executive Director of the Authority much easier knowing I don't have to worry about our Gillig fleet.

KVRTA appreciates the fact that Gillig and its employees pride themselves on being a customer-driven organization and has always exceeded our expectations. The assistance that you, David, and others at Gillig provide not only KVRTA, but all the transit systems in West Virginia is truly unparalleled. Keeping us updated on industry trends, technological advancements and changes in the industry further demonstrates Gillig's dedication to meeting its customer needs as well as the needs of others.

Industrywide, Gillig is highly respected and undoubtably is a leader in the bus manufacturing field and is known for producing quality vehicles. Our operators, maintenance staff and passengers all reap the benefits by KVRTA purchasing quality products from Gillig.

It has been a pleasure to work with you, David and the entire Gillig team over the years. I am more than willing to recommend Gillig to any of your prospective customers.

Sincerely,

J. Douglas Hartley
Executive Director

Cc: David Clawson

Western Reserve Transit Authority
WRTA
People On The Move.

Phone 330•744•8431 Fax 330•744•7611

604 Mahoning Avenue • Youngstown, Ohio 44502

June 2, 2020

Mr. Jim Ryan
Regional Sales Manager
Gillig LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Ryan,

I have had the pleasure of doing business with Gillig for over 30 year. During this time, I have found Gillig and its employees to be a customer-driven organization that has provided the highest levels of customer support. Gillig employees are dedicated and knowledgeable about their products, whether it is the coaches they produce or parts they provide to maintain the coaches.

Part of the success Gillig and WRTA have had is the continued support that is provided from the day a purchase order is issued until the day the coach is retired from service. The whole procurement and production process are well thought out and completed in a very effective manner. Gillig's coach manufacturing facility is one of the best examples in how to build a heavy-duty transit coach.

We appreciate the input Gillig seeks from WRTA and others in the transit industry as they continually make advancements in the design of the coach to provide a better product each year to meet the needs of its customers.

It is always a pleasure to work with you and your team. I would highly recommend Gillig to any of your prospective customers.

Sincerely,

Dean J Harris
Executive Director

Carm Basile
Chief Executive Officer
518-437-6840
carmb@cdta.org

May 27, 2020

Mr. Joseph Policarpio, Vice President
Sales & Marketing
GILLIG, LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Policarpio:

The Capital District Transportation Authority (CDTA) is in the final year of our third five-year contract with Gillig for the purchase of transit vehicles.

Gillig consistently delivers a quality product, on time and according to our specifications. The Gillig staff are professional, attentive, and top-notch representatives of your company. We know that buses will be delivered in accordance with the contract requirements, and any issues which are usually few and minor in nature, are attended to in a timely manner.

We appreciate Gillig's ability to stay at the forefront of the latest developments in transit technology and the fact that these developments are consistently communicated to us. Jerry Sheehan has been our principal contact for close to 15 years, and we appreciate his efforts on our behalf.

Cordially,

Carm Basile
Chief Executive Officer

Jayme B. Lahut
Chairman
Schenectady County

Michael J. Criscione
Vice Chairman
Albany County

Mark Schaeffer
Secretary
Albany County

David M. Stackrow
Treasurer
Rensselaer County

Georgeanna M. Nugent
Saratoga County

Jaclyn Falotico
Schenectady County

Denise A. Figueroa
Albany County

Patrick M. Lance
Labor Representative

Carm Basile
Chief Executive Officer

Jeremy Peterson
Chief Executive Officer

ERIE METROPOLITAN TRANSIT AUTHORITY

127 East 14th Street
Erie, Pennsylvania 16503

May 21st 2020

Mr. Jerry Sheehan
Regional Sales Manager
GILLIG LLC
451 Discovery Drive
Livermore, CA 94551

Mr. Jerry Sheehan:

The Erie Metropolitan Transit Authority has maintained a multi-decade strong relationship with Gillig as a result of outstanding customer service, performance reliability and toughness.

If anyone knows anything about Erie, Pennsylvania is that Erie is annually in competition for snow capitol U.S.A. Despite the toughest of blizzards that have at times dropped five, six, and even seven feet of snow over a period of a few days, EMTA has been able to and will continue to rely on our fleet of Gillig buses. The Gillig bus has performed superbly under the harshest of conditions over the decades. As a result, Erie has gained a reputation as the Authority within our Commonwealth to 'never shutdown' operations despite our notorious Erie winter weather.

The Erie Metropolitan Transit Authority highly values our relationship with Gillig as we continue to expand and outfit our fleet with Gillig buses. I highly recommend the Gillig team and product to any Authority in search of reliability, performance and great service.

Sincerely,

Jeremy Peterson
CEO

CITY OF GAINESVILLE

Regional Transit System

May 21, 2020

Joe Policarpio
Vice President, Sales & Marketing
GILLIG LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Policarpio:

I would like to express my most sincere appreciation to you and your staff for the outstanding service to the City of Gainesville Regional Transit System (RTS). I am impressed not only by the level of quality service, but also the consistency of that quality year after year. For over 20 years, RTS has done business with GILLIG because we trust the vehicles, the parts and the people who help make our operation a success.

I want also to commend your staff for the training, technical, and warranty support that has allowed our team to place a good product and service on the road. The Sales and Parts staff has been extremely responsive to our demands and needs.

It is through Gillig's performance and reliability that RTS pursued the goal to be have a 100% GILLIG fleet. Looking toward the future, GILLIG's reputation for quality vehicles and services made it easy to take the next big step and embark on a new partnership project - Electric buses. We are eager to begin our new chapter in transportation, knowing that we can trust the GILLIG brand to deliver safe, comfortable, reliable vehicles to convey our passengers.

Sincerely,

Jesus Gomez, Transit Director
Regional Transit System

May 21, 2020

Mr. Derek Maunus
President and CEO
Gillig LLC
451 Discovery Drive
Livermore, CA 94551

Derek,

I would like to take a moment to express my sincere appreciation to the entire Gillig organization for the many years of your unwavering support, highest degree of integrity, expertise and product quality that has been and continues to be provided to our agency.

Sun Tran is a small 14 bus agency providing fixed route transit service on seven routes in Ocala, Florida. Subsequently, it is of paramount importance that we have the most reliable and dependable buses available to serve our community and that's why we purchased and operate Gillig buses.

Twenty plus year ago when Sun Tran was determining the best manufacturer to supply our buses, there were several very important factors that need to be considered. Of primary importance to us was having the confidence and assurance to choose a manufacturer with the corporate stability, integrity, commitment, experience and financial capability to support us in a long-term partnership that will span far beyond the life of purchase. Gillig has demonstrated their ability to successfully meet and exceed those expectations and continue to do so.

It is very comforting to place an order with a manufacturer knowing the buses will be built to specification and delivered on time. The reliability of the Gillig Low-Floor bus has enabled us to

City of Ocala
Growth Management Department

201 SE 3rd Street (2nd Floor)
Ocala, FL 34471
Phone: 352-629-8287

maintain high bus availability with minimal operating costs. The high-performance standards of the Gillig Low-Floor can be attributed to Gillig's on-going commitment to product improvement.

Gillig has consistently demonstrated that you are a world class organization and we are truly honored to be your partner.

Sincerely,

Steven Neal
Transportation Director
Growth Management Department
City of Ocala

City of Ocala
Growth Management Department

201 SE 3rd Street (2nd Floor)
Ocala, FL 34471
Phone: 352-629-8287

May 20, 2020

GILLIG
451 Discovery Drive
Livermore, CA 94551

To whom it may concern,

The City of Albany is a long-standing customer of GILLIG. As former owners of model years 2005, 2006, 2009 to currently owning 2016 (4), 2018 (3), and 2020 (8), the customer service & support *before* and *after* delivery remains phenomenal.

I evaluate customer service delivery in both, professional and personal settings. I attest that the customer service and support statements of GILLIG are not just words written on paper; moreover, it is **action** willingly, or better yet, generously performed by dedicated GILLIG employees. Since 2015, I have been a witness to this action from not just the sales and administrative staff, but also the production team and upward to the President!

In sum, the overall performance and operational enhancements of a GILLIG bus meets the need of our organizational requirement.

Angela S Calhoun
Angela S Calhoun
Superintendent
Fleet Management Department

JACKSONVILLE TRANSPORTATION AUTHORITY

July 13, 2018

Mr. Joseph Policarpio, Vice President
Gillig LLC
451 Discovery Drive
Livermore, CA 94551

Dear Mr. Policarpio:

I want to take this opportunity to thank you and your team. I have had the pleasure of doing business with Gillig over the past twenty years. Gillig is now on their fourth five-year contract for the State of Florida.

During this time, I have found Gillig and its employees to be a customer-driven organization that exceeds our expectations. Employees are dedicated, knowledgeable, and professional whether they are dealing with new bus orders or when dealing with routine matters.

I appreciate the input sought by Gillig as they continually advance in the area of technology in an effort to meet the needs of the JTA and other industry customers.

Gillig buses are highly regarded throughout the transit industry and Gillig has a solid reputation of building a quality product. The JTA is one that has certainly benefited by purchasing those quality products from Gillig. Satisfying your customers, including delivering on your promises is exemplary.

It is a pleasure to work with you and your team. I would be pleased to recommend Gillig to any of your prospective customers.

Sincerely,

Lisa Darnall
Vice President/CTO

Administration
121 West Forsyth St.,Suite 200
Jacksonville, Fl 32202

Main: (904) 630-3181
www.jtafla.com

Operations
P.O. Drawer "0" 100 N. Myrtle Ave.
Jacksonville, FL 32203

8. ENGINEERING ORGANIZATION CHART, ENGINEERING CHANGE CONTROL PROCEDURE, FIELD MODIFICATION PROCESS

ENGINEERING DEPARTMENT

We maintain a fully experienced, qualified Engineering Department, directed by the Vice President of Engineering. The Engineering staff are available on request to assist in the resolution of engineering or design problems that may arise within the scope of the specifications during the warranty period.

The GILLIG Engineering Department is located at the manufacturing plant in Livermore, CA, and is continually available to assist the manufacturing process. The integrated staff performs all vehicle engineering, including the research and development of all systems integrated on our vehicles.

All current products were designed and developed by GILLIG Engineering. The entire GILLIG Low Floor transit bus is manufactured in the United States at this one location in Livermore, CA.

ENGINEERING CHANGE CONTROL PROCEDURE

Reference following item 12. QUALITY ASSURANCE PROGRAM for detailed information on the Engineering Department change control procedure.

GILLIG's change control process involves several departments within the organization and working with our component suppliers as their products reach end of life. GILLIG believes in a constant improvement process, this is controlled thru an Engineering Production Change (EPC) process managed by our Materials Department. A meeting is scheduled once a month with Materials, Purchasing, Engineering, Manufacturing, Sales and Parts, to discuss product improvements/new design and supplier end of life notifications.

Once a change has been identified the subject matter is reviewed by Engineering for design, Purchasing for cost, Manufacturing for production impact, Parts for aftermarket support and Materials/Sales for customer implications. Once approved by all departments, Engineering and the Bill of Material group will release the component details (parts, installation drawings, customer, dates) and production implementation plan thru our documented EPC control process.

FIELD MODIFICATION PROCESS

Our FIELD SERVICE DEPARTMENT is responsible for the proper functioning of your buses after they leave our plant in Livermore.

GILLIG's focus on designing and building the most reliable and cost effective bus in the industry necessitates selecting supplier partners who share our philosophies on quality and reliability. As a result of this focus, GILLIG has no major fleet defects (grounded fleet), a minor number of vendor defects and the lowest warranty claim experience in the industry.

Over the past five years, GILLIG has sent out several Field Service Bulletins which communicate suggested maintenance procedures, clarifications of previously released procedures and supplier or GILLIG proposed repairs. Seven of these bulletins were minor field repairs resulting from design improvements intended to prevent future failures.

GILLIG ENGINEERING ORGANIZATION

Name	Function	Education	Background
G. Vismara	Vice President, Engineering	BSME	32 yrs. industry experience at Peterbilt, Loral Space Systems & GILLIG
T. Meagher	Director, Design Engineering	BSME, BSEE	33 yrs. industry experience at Ford, Caterpillar, Case New Holland & GILLIG
D. Jayasinghe	Program Mgmt.	BSAE & MSME	16 yrs. industry experience at CAT, Cummins & GILLIG
R. Quebbeman	Manager, Specifications & Bill of Material	AS Mech. Engr.	51 yrs. industry experience bus and truck design - Mack, International & GILLIG
S. Vanderlip	Manager, Mechanical Engineering Systems	BSETME,PE	34 yrs. industry experience at Peterbilt & GILLIG
C. Ababseh	Manager, Mechanical Engr Body & Interior	BSME	14 yrs. industry experience at GILLIG
K. Vorsatz	Manager, Mechanical Engineering Powertrain	BSME	14 yrs. industry experience at BAE & GILLIG
J. Abrew	Bill of Material Order Technician	H.S.	31 yrs. industry experience at GILLIG
T. Agawa	Bill of Material Order Technician	BSIT	29 yrs. industry experience at GILLIG & Peerless Lighting
F. Andrade	Supervisor, Controls	BSEE	7 yrs. industry experience at E-N-G Mobile & GILLIG
D. Aranovich	Mechanical Designer	BS Engr Tech	19 yrs. industry experience at Metaldyne, Ford, LightSail Energy & GILLIG
M. Banwait	Mechanical Design Engineer	BS	2 yrs. industry experience at GILLIG
R. Brar	Mechanical Design Engineer	MS Aerospace Engineering	9 yrs. industry experience at Int'l Cars & Motors, Heil Trailer & GILLIG
B. Burdick	CAD Designer	HS	44 yrs. industry experience at Altamont Mfgr, Lawrence Livermore Lab & GILLIG

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ENGINEERING SUPPORT

L. Bush	Electrical Engineer	BSIT	20 yrs. industry experience at Compass, Autocam, TPI, Dow Jones & GILLIG
N. Clopton	Supervisor, Body	BSME	14 yrs. industry experience Parker Hannifin, Racor Division
F. Cruz	Bill of Material Technician	BSC-Mgmt.	20 yrs. industry experience at GILLIG
J. Dalmeida	Sr. Mechanical Engineer	BSME	8 yrs. industry experience at New Flyer & GILLIG
B. Den Hollandar	Electrical Engineer	BSEE	8 yrs. industry experience at Proficient Machining, Optimal & GILLIG
S. Dunbar	Electrical Engineer	BSEE	4 yrs. industry experience at GILLIG
J. Edmondson	Bill of Material Order Technician	H.S.	41 yrs. industry experience Peterbilt & GILLIG
C. Espinosa	Supervisor, Passenger Compartment	MSME	9 yrs. industry experience at Lawrence Livermore Lab, SFMTA & GILLIG
G. Estantino	Mechanical Engineer I	BSME	4 yrs. industry experience at ICON Aircraft & GILLIG
S. Faria	Bill of Material Technician	BSBA	27 yrs. industry experience Mack, Xerox & GILLIG
K. Fernandez	Bill of Material Technician	H.S.	9 yrs. industry experience at GILLIG
S. Finley	Supervisor, Power Distribution	BSEE	28 yrs. industry experience at Georgia-Pacific, Walk-Haydel & GILLIG
J. Fisher	Mechanical Designer	HS	23 yrs. industry experience at Burke Porter Machinery, Stewart & Stevenson & GILLIG
F. Fotos	Electrical Engineer I	BSEE, MEM	6 yrs. industry experience at Northrop Grumman & GILLIG
A. Frey	Engineer 2, Powertrain	BSME	12 yrs. industry experience at Cummins & GILLIG

GILLIG

ENGINEERING SUPPORT

D. Garcia	Bill of Material Technician	H.S.	7 yrs. industry experience at GILLIG
M. Genova	Mngr. Product Safety & Compliance	MSAE	19 yrs. industry experience at AVL, Fiat, Landirenzo-Baytech USA, & GILLIG
J. Graves	Bill of Material Order Technician	BSCJ/S	11 yrs. industry experience at GILLIG
J. Hackney	Electrical Engineer II	BSEE	13 yrs. industry experience at IoT, Davis Instruments & GILLIG
D. Haiduk	CAD Designer	BS	16 yrs. industry experience at AGAT, Yo-Engineering, RenyMed & GILLIG
B. Haley	Mechanical Engineer	BSME	6 yrs. industry experience Product development
N. Henderson	Mechanical Design Engineer	BSME	7 yrs. industry experience at Zodiac Aerospace & GILLIG
E. Hughes	Assoc. Mechanical Engineer	BS	2 yrs. industry experience at GILLIG
M. Itanna	Sr. Electrical Engineer	MSc. EE	7 yrs. industry experience at Vertiv & GILLIG
T. Jones	Mechanical Drafter Design	AA Mechanical	18 yrs. industry experience NABI & GILLIG
T. Junge	Mechanical Engineer	BSME	5 yrs. industry experience at Durst-field, Cessna Aircraft-Interior & GILLIG
S. Loyd	Supervisor, ITS & Surveillance	B.S. Physics	10 yrs. industry experience at Areias Systems
EJ Mariscal	Bill of Material Technician	HS	21 yrs. industry experience at GILLIG
M. Mohammedkair	Power Distribution Engineer	BSEE	10 yrs. industry experience at GILLIG
A. Monserret	Associate Mech Engineer	BSME	2 yrs. industry experience at GILLIG

GILLIG

ENGINEERING SUPPORT

G. Mortazavi	Electrical Engineer	MSEE	3 yrs. industry experience at Chicago Transit Authority & GILLIG
W. Nairn	Liaison Engineer	College	20 yrs. industry experience at GILLIG
B. Nguyen	Design Engineer, Electrical	BSEE	13 yrs. industry at HP, Kla-Tencor & GILLIG
L. Nguyen	Supervisor, Drivers Area	BSEE	14 yrs. industry experience Panasonic Automotive & GILLIG
J. Ocampo	Bill of Materials Technician	College	31 yrs. industry experience at GILLIG
M. Ortega	Associate Electrical Engineer	BSEE	2 yrs. industry experience at GILLIG
H. Perez	Production Support Tech	H.S	5 yrs. industry experience at GILLIG
M Pinto	Program Manager CPI	BSME, MSME, MSPM and PMP	17 yrs. industry experience at Ford, Volkswagen & GILLIG
P. Pruscha	Industrial Designer	BS Industrial Design	35 yrs. industry experience at Peterbilt, Jacuzzi & GILLIG
M. Rands	Bill of Material Technician	H.S.	8 yrs. industry experience at GILLIG
J. Reekie	Sr. Mechanical Engineer	MSME	9 yrs. industry experience at Caterpillar & Castrol
M. Roberts	Mechanical Design Engineer	MSME	7 yrs. industry experience at BHJ Dynamics & GILLIG
G. Roderick	Supervisor, Order Processing	AA	36 yrs. industry experience at GILLIG
M. Ruth	Powertrain Systems Engineer	BS EMET	19 yrs. industry experience at Harley Davidson, Voith & GILLIG.
H. Sanchez	Mechanical Engineer	BSME	7 yrs. industry experience GCM & GILLIG

GILLIG

ENGINEERING SUPPORT

T. Scheumann	Sr. Mechanical Design Engr	MSME	8 yrs. industry experience at Hyster-Yale, Mizuho OSI & GILLIG
J. Seei	Bill of Material Technician	HS	23 yrs. experience at GILLIG
M. Shaieb	Project Engineer Technician	BSME	38 yrs. industry experience at BAE Systems & GILLIG
C. Silva	Bill of Material Technician	HS	34 yrs. industry experience at GILLIG
H. Tuft	Supervisor, Powertrain	BSME	14 yrs. experience at Electroglas Inc & AutoCat USA Inc.
J. Turner	Electrical Design Engineer	BSEE	5 yrs. industry exp at GILLIG
A.vanHaeften	Supervisor, Chassis	BSME, PE	14 yrs. industry experience at Westinghouse, Park Hannifin & GILLIG
D. Williamson	Proj. Mngr./Mechanical Engineer I	BSME	4 yrs. industry experience at Kratos Unmanned Aerial Sys. & GILLIG
R. Williamson	Sr. Design Engineer	MS, MEng ME	11 yrs. industry experience GE, Tesla & GILLIG
B. Wu	Design Engineer Electrical Systems	BSEE EIT	21 yrs. industry experience at Pulver Genau & GILLIG
C. Xue	Program Manager NPI	BSME	7 yrs. industry experience at BYD & GILLIG
J. Yang	Electrical Engineer	MSEE	12 yrs. industry experience at Auto, Commercial Avionics, BAE & GILLIG

9. MANUFACTURING FACILITIES PLANT LAYOUT, OTHER CONTRACTS, STAFFING.

- GILLIG is a ***100% U.S. owned and operated*** manufacturing company.
- GILLIG was founded over 130 years ago (in 1890) in San Francisco, California, and is now located 40 miles southeast of San Francisco in Livermore, California. In the 1930's we moved to Hayward and were located there until the move to our current state of the art manufacturing plant in 2017, located at the following address:

GILLIG LLC
451 Discovery Drive, Livermore, CA 94551
Phone: 800-735-1500
Email: sales@gillig.com
Web Site: www.gillig.com

- The Manufacturing plant and entire office staff (Executive, Sales, Purchasing, Engineering, Service/Warranty and Finance) are located at this one (1) location only on 41 acres. We do not sub-contract the manufacture of our vehicles.
- **We manufacture all of our vehicles at this one (1) location on the same production line**, using the same qualified, experienced staff -- this includes our ZERO EMISSION BATTERY ELECTRIC transit bus, DIESEL LOW FLOOR transit bus, CNG LOW FLOOR transit bus, HYBRID LOW FLOOR transit bus, and BRT (Bus Rapid Transit) custom model buses. Vehicles Manufactured are Low Floor 29 foot, 35 foot and 40 foot by 102 inch heavy duty transit models.
- We employ over 850 qualified and experienced employees, and the factory operates 12 months of the year to manufacture our vehicles on time to meet promised delivery dates, and to provide Service and Support to our customers.
- Additional information can be provided on request.

New State-of-the-Art Manufacturing Plant



9. OTHER CONTRACTS

GILLIG confirms we have received other contracts awarding the purchase of our heavy duty Low Floor transit bus models for delivery throughout the U.S. The vehicles are scheduled for manufacture during the coming years to meet the transit agencies requirements.

GILLIG confirms that we can bid, manufacture, and deliver the vehicles proposed for this procurement on schedule to meet the requirements of your specifications.

Additional information can be provided on request.

10. PRODUCTION & DELIVERY SCHEDULE

DELIVERY SCHEDULE - 40 FOOT MODEL or 35 FOOT MODEL:

Deliveries of orders up to 10 buses will be delivered within fifteen (15) months after receipt of order.

Deliveries of orders over 10 buses will be negotiated a time of order placement.

Delivery shall occur on Monday – Friday, except State and Federal holidays, between the hours of 8:00AM and 4:00PM, unless otherwise agreed to by both parties.

10. PRODUCTION SCHEDULE AND OTHER CONTRACT COMMITMENTS FOR THE DURATION OF THIS CONTRACT

A. GILLIG's current production rate is 35 buses per week. GILLIG's firm orders and option orders will require us to maintain this production rate or increase that production rate in the future. Every day seven buses are entered into our production line, every day seven buses come off our production line and every day seven buses are bought off by our customers for delivery to their agencies. GILLIG has the necessary processes and procedures to consistently perform on our promised delivery schedules.

B. GILLIG's success has been a result of our disciplined approach to growth and production. GILLIG has established a moderate production growth rate over the years and even with a large firm order backlog, GILLIG's business philosophy is to include small periodic production increases. This allows for the proper hiring and training of workers, proper implementation of quality control and avoidance of large production swings (either up or down). GILLIG avoids increases to our production rate on a temporary basis because it eventually leads back to production rate reductions which tend to create company and job instability.

   GILLIG delivered 100% of the proposed vehicles within the contractual delivery requirements that the customers ordered in the last three years.

C. To support your transit agency production throughout the 5 years of this contract, as well as other current and planned customer contracts, GILLIG has built a new, ground-up, state of the art bus production facility in Livermore, CA which was fully operational in May 2017 and provides for 100% of our production. This will allow us to increase our planned growth to a sustainable level and reduce the lead time of our buses. Your bus order would be an integral part of our plans for this sustainable growth.

D. GILLIG has not been late on any delivery schedule commitments in the past three years, or for that fact, in recent history. GILLIG has not paid any liquidated damages for late delivery.

<u>OTHER CONTRACT COMMITMENTS</u>

GILLIG is the manufacturer of heavy-duty Low Floor transit buses proposed for this procurement and we currently have other contract commitments to transit agencies throughout the United States that are scheduled to be manufactured and delivered during the next few years.

GILLIG confirms that the current contract commitments will not impact the proposed delivery schedule for your procurement.

GILLIG'S history of on-time contract performance is unmatched in the industry because we believe it is the responsibility of the bus manufacturer to deliver to the customer a cost-effective yet quality-built bus on time, every time. GILLIG's high degree of conformance to the customer

bus specifications (as indicated elsewhere in this proposal) guarantees that you have and will continue to receive the bus that you want within the time frame in which you need it.

Our unsurpassed record of on-time deliveries demonstrates our ability to satisfy commitments made to our customers. This is evidenced by the fact that, unlike most other bus manufacturers, GILLIG has never been required to pay liquidated damages because of a late delivery. It is our goal to not only deliver on time but to improve upon the quoted delivery.

We have NEVER been late on a promised delivery date.

11. MANAGEMENT PLAN

GILLIG is a 100% U. S. owned and operated manufacturing company. All vehicles will be manufactured at one (1) location only – 451 Discovery Drive, Livermore, California 94551. All our staff will be located at this same location – this includes our manufacturing plant, engineering, service/warranty, sales, purchasing, executives, and accounting.

The **GILLIG Sales Department** will manage the project from initial award through manufacture and delivery.

RESUME KEY PERSONNEL

GILLIG assigns one (1) PROJECT SALES MANAGER to accounts from bid award through manufacture, factory inspection and delivery to assure compliance with your specifications.

Timothy McCunney, Project Sales Manager

Tim joined GILLIG in 2006 and has served as a Cost Accountant, Senior Buyer & Production Supervisor as part of a Management Training Program to learn the various operations of the company before becoming a Project Manager in Sales starting in 2010. As a Project Sales Manager, Tim is responsible for processing customer orders from RFP's through delivery of our buses to the customer. Prior to joining GILLIG, Tim earned a Bachelor's degree in Finance from California State University Fresno.

Below is information on the Sales Department Key Personnel and Key Contacts:

William F. Fay, Jr., Vice President Sales

Bill joined GILLIG in August of 2016 and brings nearly 30 years' industry experience. During his tenure, Bill has held multiple executive level management positions with a proven track record for leading sales, operations and service organizations at both the OEM and supplier levels. As the Director of National Sales, Bill manages the Company's Regional Sales Managers and is responsible for the customer relationship management and overall customer satisfaction. Bill earned a Bachelor of Science degree in Mechanical Engineering from the University of Lowell. As Vice President, Bill is responsible for all sales functions at GILLIG.

Greg Vismara, Vice President Engineering

Greg has nearly 31 years of industry experience having previously worked for Peterbilt Motors Company, and Space Systems Loral. Since joining GILLIG in 1998, Greg has overseen the development of new systems and models including the launch of the GILLIG Low Floor, CNG, BAE Hybrid, and Allison Hybrid models. As Vice President, Greg is responsible for all aspects of GILLIG's engineering. Greg earned a Bachelor of Science Degree in Mechanical Engineering from Santa Clara University. Greg is very involved with the day to day project engineering that is focused on providing the highest degree of quality possible.

Chris Turner, Executive Vice President of Operations
Chris joined GILLIG in 2013 as Vice President of Supply Chain after working for Abbott Laboratories, a global healthcare leader, for the previous 15 years. At Abbott, Chris served in multiple controllership functions around the globe with responsibilities in sales, marketing, supply chain and manufacturing. As Executive Vice President of Operations at GILLIG, Chris is responsible for Production, Purchasing, Receiving, Warehousing, Freight, Quality and Field Service. Chris has a fantastic management support team consisting of veteran GILLIG employees and consistently emphasizes quality, execution and continuous improvement. Chris earned a Bachelor of Science Degree in Finance from the University of Illinois.

Arminder Dhillon, Director Sales Operations
Arminder has over 20 years of GILLIG product and customer experience, including various Supply Chain roles and leading the Publications group. As the Director Sales Operations, he is responsible for all areas of Project Sales Management and Contract Administration. Arminder and his group have dozens of cumulative years successfully building customer relationships, processing hundreds of customer orders from RFP through delivery, and working diligently and tirelessly to exceed our customer's expectations. Arminder earned a Bachelor of Science Degree in Finance from San Jose State University.

Javier Hernandez Jr., Director of National Sales
Javier is responsible for all areas of Project Sales Management and Contract Administration. His department is directly responsible for processing customer orders from RFP's through delivery of our buses to the customer. Javier has over 25 years of GILLIG experience where he has served as a Working Foreman, Production Supervisor, Sales Engineer, Regional Sales Manager, Director of Project Sales Management and recently as a Production Superintendent. Javier and his group have successfully processed hundreds of orders and work diligently to exceed our customer's expectations.

ACCOUNT REPRESENTATIVE (FLORIDA)
Butch Sibley - Regional Sales Manager
Cell Phone: 510-589-9430
Email: Butch.Sibley@gillig.com

WARRANTY ADMINISTRATOR
Victor Doran, Executive Director, Customer Care
Phone: 800-735-1500 or 510-264-5075
Email: victor.doran@gillig.com

Field Service Coordinator
Phone: (510) 264-5073
Email: FieldService@gillig.com

PARTS SUPPORT MANAGER
Butch Sibley - Regional Sales Manager
Cell Phone: 510-589-9430
Email: Butch.Sibley@gillig.com

GILLIG understands the requirements of this solicitation, and is confident we have the expertise, resources and capabilities to fully meet your requirements in this and future purchases. This management plan, which is organized in the following categories -- past experience, current build program and future build and support plan is intended to assure you that we can.

PAST EXPERIENCE AND QUALIFICATIONS

GILLIG LLC is a 130 year old company that is a Federal Transit Administration (FTA) qualified Transit Vehicle Manufacturer (TVM), and as such meets all FTA requirements imposed on grantees of Federal funding, including DBE goals, Buy America provisions and Bus Test requirements.

GILLIG has designed, built and delivered over 25,000 transit buses to transit properties around the U.S.A. over the past 20 years. GILLIG has also **never been late on a contracted or promised delivery** in the past decade and all buses have been accepted and used in transit service (some with over 2 million miles) without a major problem or recall. Consequently, GILLIG is familiar with and can fully satisfy all the terms, conditions and requirements of building and selling transit buses that are safe, effective, comfortable and suitable for revenue service in a transit application, and purchased with FTA and local funding. **In addition, we are proud of our vehicles' reputation for reliability and operating economy**.

The vehicle proposed in this submission is a heavy duty, purpose-built transit bus, designed specifically for revenue service in a transit application. It is designed to exceed FTA requirements of a 12 year or 500,000 mile service life. The vehicle will also meet all applicable FMVSS requirements and all applicable EPA emission standards.

In addition, it will be capable of safe operation at legal freeway speeds, have industry acceptable acceleration and gradeability exceeding 15%, while fully complying with the specifications of this solicitation and any applicable modifications or addenda approved by your agency and made part of this solicitation.

GILLIG's qualifications are based on:

- A proven history of **Product and Company Performance**
- Extensive and **Proven Engineering** Expertise
- Extensive and **Proven Manufacturing** Expertise
- Extensive and **Proven Management** Expertise
- Appropriate and **Proven Engineering, Manufacturing** and **Support** Facilities
- Abundant **Financial Strength** and **Organizational Stability**
- An excellent history of **Customer Testimonials**

Some of our buses are still in active service after 17 years and 2 million miles of transit duty service, an excellent testimonial to our **Experience and Qualifications**.

GILLIG's history and experience relevant to your needs include delivering multi-year contracts of hundreds of buses to Seattle, St. Paul, Cincinnati, Richmond, Hampton and Lynx - Orlando, to name a few. All of these buses were of similar complexity to your order, had similar costs and

were built and managed by most of the same people in the GILLIG organization. A complete customer list with all details is included in our submission.

CURRENT BUILD PROGRAM

GILLIG's management plan for this current build includes the appropriate commitment of resources, expertise and time to fulfill your build requirements as covered in the following:

- Specification compliance
- Build capability and delivery plan
- Support structure and plan
- Employee and management experience
- Organizational stability

Specification Compliance is ensured by our experience and ability in exceeding other larger and smaller transit agencies' transit bus needs. In addition, GILLIG has certified in this submission that it completely understands the procurement's specifications and expectations and will fully comply with them.

Build Capability is ensured by our Engineering expertise (meeting design requirements), which includes 37 degreed and experienced engineers supported by 14 additional engineers with transit bus experience and other clerical support exclusively for bus programs. Our financial strength also ensures build capability (allows purchase of inventory and supplies), and our existing plant and facilities have been proven to support our current build rate, which is also the build rate we plan to operate at while building the proposed buses. Additionally, our management, manufacturing and quality programs have been proven over the years and are responsible for our excellent reputation in the industry.

Our Delivery Plan is enclosed and is based on our proven and practical timing schedule, which includes a proposed delivery of about 5 buses per week to suit your preferred acceptance and commissioning rate. Our proposed delivery schedule is submitted in the appropriate section of this proposal. Subsequent builds will be achieved in less than current industry lead time; and noteworthy at this time, is our unblemished record of on-time deliveries, ensuring that these commitments will and can be met.

Our Support Structure and Support Plan includes competent and experienced field service technicians (most are ASE or MACS certified), customized in-class and video training programs supplemented with appropriate service and parts manuals, a toll-free over-the-phone troubleshooting system and appropriate in-house and contracted engineering support and test capabilities. We also have a fully staffed Parts Division, with extensive inventory stocks and no-charge 2nd day air delivery of parts orders (under 150 lbs. each).

Our Employee and Management Experience includes an extremely competent and stable workforce with an average of well over 12 years of GILLIG experience, and many more industry-experience years. our top fourteen senior executives have over 400 years of combined vehicle manufacturing experience (that's 32 years each).

GILLIG's employees represent a superbly experienced and solidly entrenched team of people committed to satisfying customers by manufacturing quality buses.

Our Organization Stability is an industry landmark and ensures consistency in build and performance which ultimately results in customer satisfaction. A seasoned company with seasoned people is your best assurance of an outstanding procurement.

FUTURE BUILD AND SUPPORT PLAN

GILLIG ensures your future needs will be met by making you a partner in our business venture and thus including your requirements into our philosophy, commitments and plans.

GILLIG's philosophy is that we have 4 partners in our business venture -- our customers, our owners, our employees and our suppliers -- and it is management's responsibility to ensure that each partners' interests are addressed and appropriately served.

Consequently, **our customers are our partners** and so our customers' future interests must be included in our future plans. Therefore, GILLIG is committed to continuous improvement and continuous technological advancements, without compromising our goals of reliable, durable, and economical products or complete customer satisfaction.

GILLIG's 3-year and 20-year future plans include gradual and limited growth (to ensure quality and employee stability) along with practical research and new product development. **GILLIG is committed to long-term relationships and to supporting our customer-partners future changing needs**.

Your future build requirements are incorporated into GILLIG's build plans which ensures timely delivery of subsequent orders. GILLIG has followed the same procedure in the past with other transit agencies with multi-year contracts and has performed satisfactorily and on-time, on every procurement -- thus ensuring similar performance on future orders in this procurement.

However, perhaps the strongest indicator of GILLIG's ability to support your future vehicle needs in our uncompromising performance history of product improvement, financial strength, and customer satisfaction.

We believe GILLIG is uniquely capable and qualified, to satisfy your current and future needs, and we believe our proven management plan ensures complete customer satisfaction if we win this award. Your trust in us has been earned and is without compromise.

YOU CAN COUNT ON US!

- Specific Checks:
  - Chassis (4a, 4b, 4c) — 103 checks
  - Body Dept. (5a, 5b) — 57 checks
  - Sheet Metal Dept.(6) — 39 checks
  - Rack Dept. (9) — 61 checks
  - Paint Dept. (7) — 36 checks
  - Trim Dept. (8a, 8b) — 60 checks
  - Electrical Dept. (3) — 91 checks
  - Final Line Dept. (11) — 20 checks
  - Final Delivery Dept. (10, Ready Row) — 26 checks
  - Alignment, Dyno, Road Test (10, Ready Row) — 53 checks
- Total Documented QA Checks = 546

QUALITY ASSURANCE OVERVIEW

GILLIG's Quality Assurance Program effectively ensures only the highest quality products and services reach our customers. Due to GILLIG's unique management and operating style, we rely more on total commitment to satisfying our customers, than to conforming to documented standards that fall short of assuring quality. We feel continual process and product improvement, and increased customer satisfaction meets our main focus of attention.

The following is an overview of GILLIG'S Quality Assurance Program that has a proven track record of ensuring that customer satisfaction and product reliability remain at the highest possible levels.

Design Review Participation
The Director of Quality & Service participates in meetings and other communication forms on design and customer issues pertaining to the quality performance and acceptance of GILLIG'S product and services. Quality is designed in.

Manufacturing and Vendor Qualification
Manufacturing procedures are reviewed to ensure achievement of quality goals. Vendors are pre-qualified to ensure their products meet GILLIG'S standards, and periodic reviews ensure standards are maintained, as needed.

Receiving Inspection
Inspection of the majority of incoming materials takes place at the actual location of assembly by Production associates. Any concerns of material quality are directed to the designated Area Quality Inspector, or to the Quality Manager for investigation. When deemed appropriate, certain incoming parts, components, assemblies, or materials are reviewed prior to acceptance into storage or delivery to the assembly line. All rejected material is identified and held from further use until proper disposition is resolved. Disposition is coordinated in a timely manner with Purchasing and Production to eliminate line shortages.

In-Process Inspection
Fourteen Quality Inspectors, with a combined GILLIG experience of over 230 years, are assigned to monitor and verify compliance to specifications, including specific customer requirements. Customers' Resident Inspectors are also encouraged to work closely with Production and Quality personnel throughout all phases of assembly. Their knowledge is continually passed on to the assemblers in the form of instructions and information to ensure compliance. Any discrepancies found during in-process inspection that cannot be corrected in-station are recorded on the Green Inspection Report that accompanies each bus throughout production. Production Management reviews each discrepancy, and the appropriate production associate is assigned to correct the discrepancy. Communication of discrepancies caused by previous operations is also accomplished in real time to help eliminate error redundancy. Production and Quality personnel utilize direct feedback from Post Delivery Inspection reports in an ongoing effort to improve assembly quality.

Final, Inspection & Acceptance

Each bus is inspected after final assembly for completeness, conformance to specifications and customer requirements. When it is deemed ready, a road test is performed to check for operational quality, often with the customer's inspectors present. After road testing, all open issues are reviewed by Quality and Production personnel, along with Resident Inspector/s if present, and resolved. Upon acceptance, the Resident Inspector signs the Green Sheet, authorizing delivery to the customer's property. Final acceptance occurs when all Post Delivery Inspection issues are amended by GILLIG'S Field Service Department. All inspection and test records are maintained for the life of the bus.

Enclosed please find a copy of our Quality Assurance Manual and the individual bus Inspection Record for your review. Note that the GILLIG Inspection Record includes (527) independent and documented checks on each bus. These documents are used to ensure the highest quality buses and assist GILLIG with meeting and exceeding customer expectations.

Continuous Improvement

Customer, Field Service, Sales, and Warranty data are used to provide feedback of the performance of the buses and components. This feedback is utilized to bring about product improvements on a continuous basis through weekly management meetings.

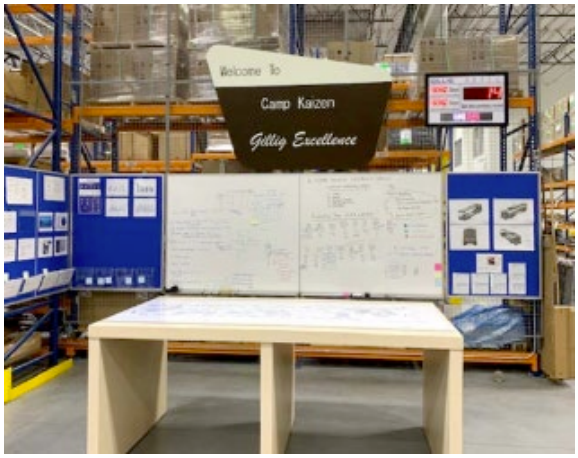
CONTINUOUS IMPROVEMENT PROGRAM

GILLIG continuous to enhance our manufacturing process through our Continuous Improvement (CI) Program. Using Lean methods, our CI Program employs metrics and specific tools, like 5S (Sort, Set in order, Shine, Standardize, and Sustain), to streamline our manufacturing process, increasing efficiency and reducing waste. Armed with tools like 5S, our team ensures GILLIG Excellence by working together to identify, devise, implement, and sustain CI solutions.

5S Rollout

We've rolled out 5S in all areas of our manufacturing process with great success, including improved material workflow, storage location, and rack consolidation. Other accomplishments include:

- Increased efficiency
- Enhanced use of space
- Inventory control
- Improved safety
- Advanced kitting





Team-led Solutions

Team-led solutions are central to our GILLIG Excellence CI Program. Visual management tools, like our Team Huddle Boards, enhance team-led problem-solving by helping our team identify, implement, and sustain their solutions. All production department teams devise questions about how to improve the workplace while empowering team members to come up with answers to these questions. Our "Camp Kaizen" work area is designed for collaboration. On any given day, multiple team members are working together on CI projects in different areas of our production facility. Every production employee takes ownership of the Continuous Improvement program.

GILLIG will always make the pursuit of excellence and the practice of Continuous Improvement a priority and a shared experience. The end goal of all of our efforts is to continue building the highest-quality, lowest cost, safest, and most reliable buses in the United States.

Quality Assurance
Manual



GILLIG

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Introduction

The GILLIG Quality Manual describes the quality system that assures conformance to customer requirements during the bid process, product definition, product design, supplier procurement, assembly testing, and shipment of the GILLIG Bus. This manual documents the general quality policies, procedures and practices of GILLIG LLC.

The quality philosophy of GILLIG stresses continuous measurable improvements in the quality of products, services, and processes at our Livermore design and assembly facility as well as at our suppliers. Our goal is to produce durable, reliable, cost-effective vehicles which satisfy our customer's expectations.

Our customer is an integral part our quality focus. We carefully review contract specifications, elicit continuous improvement recommendations, and drive back quality issues into our designs and assembly processes. We understand timely and accurate communications leads to customer confidence and satisfaction.

Each GILLIG employee is also a customer of a preceding assembler, designer, supplier, sales specialist, warranty administrator or field service representative. GILLIG's quality focus requires a continuous feedback loop to recommend, validate, document, and incorporate improvements.

There has been a revised emphasis within GILLIG to have Quality Assurance provide real time feedback to Sales with respect to potential suppliers. In an environment where much of the critical supply base is chosen by the customer, GILLIG is committed through internal communications through Sales, to ensuring that the customer is well informed regarding supplier's quality, and potential design limitations; thus, helping to create a realistic customer expectation. With an overall goal being "customer satisfaction".

GILLIG performs minimal machining and stamping. Much of the dollar content of our product are customer specified major components including the engine, transmission, mobility impaired lift, wheelchair positions, seating, axles, tires, wheels, air conditioner, windows, filters, coolers, floor cover, destination signs, and ITS systems. It is GILLIG Quality's responsibility to reliably and safely integrate these components to meet the supplier's application requirements, American Disability Act Laws, National Highway Traffic Safety Laws, State Codes, FTA Specifications, Maintenance Accessibility Criteria, and the Customers Expectations.

Strategies for Success

- Standardization
    - Inspection standards based on Engineering designs, rules, and regulations.
    - Revise GILLIG Quality Manual & update GILLIG Supplier Quality Manual.
    - GILLIG PPAP education and guidelines.
- Continuous Improvement
    - In station quality through error proofing.

  - Lean methodology creates more enablers through elimination of waste.
  - Be Effective by doing the right thing.
  - Be Efficient by doing things right.
  - Supplier Quality Management focused on defect prevention.
- Teamwork
  - Champion Quality culture.
  - Communication and feedback loop.
  - Respect.
  - Strong partnerships with other departments to enable future activity successes.

Quality Control

- Develops and maintains quality standards and inspections.
- Confirm functionality.
- Confirm installed components.
- Identify defects.
- Identify process errors.
- Driving correction action using Practical Problem-Solving techniques.

Quality Assurance

- Quality issues management.
- Assistance in field troubleshoot at customer site.
- Analytics and reporting.
- Focusing on the process, building it Right First Time (RFT).
- Driving quality issue throughout the GILLIG organization (re-affirming ownership).
- Driving design recommendations on new and existing products based on field performance/reliability.

Supplier Quality Management

- Supplier Quality Management and Development.
- Works closely with Supply Chain and QAE/QCE.
- Travels ~50%.
- Compliance to SQAM determines level of involvement of SQE at supplier.

- Zero compliance, business decision on stability of supplier.
- Compliance with some improvement needed.
- Complete error proof process, role model supplier.
- Component inspections.
- First Article review and scheduled part inspections.
- Supplier Quality audits, inspections, and evaluations.

Standards and Requirements

Contract Review and Change Authorization

The purpose of this section is to document how we coordinate activities related to defining and documenting of customer requirements, resolving issues, and determining the capability of GILLIG to meet customer requirements.

GILLIG produces a heavy-duty transit bus of 102" width and 29', 35', or 40' length. These are FTA defined standard lengths and widths and Federal and State mandated compliance features.

The customer bid document offered to multiple U.S., Canadian and Off-shore heavy duty transit bus builders, details the standard and non-standard major components and design variations that the specific transit district customer expects on their bus order. GILLIG, in their bid response has the option of accepting the bus property bid features or proposing an "approved equal."

It is the responsibility of GILLIG Sales to inform the bus property, in writing why an "approved equal" is preferred for durability, reliability, safety, federal compliance, standardization, or cost control reasons. The customer then has the option of approving or disapproving the "approved equal" proposal. GILLIG Sales reviews all approved equals requests, updates the internal documentation and prepares the bid submission package.

The sales contract for a bus may be hundreds of pages. There will be one or multiple pre-build meetings to help with the customer and GILLIG Sales reviews the contract for final definition of the customer's specifications. These GILLIG/customer pre-bid meetings will be documented by the GILLIG Sales with a copy forwarded to the GILLIG affected departments, a copy maintained in the contract file for that order, and a copy forwarded to the customer. This will contain the agreed-on interpretation and modifications of the specifications.

As the bus is built, the customer may assign a "Resident Inspector" to review the contract and document revised specifications. As the bus is built the Inspector sometimes has personal specification preferences that vary from the contract. The Inspector may observe a singular or multiple frequency quality control concern.

If the Inspector requests a Contract Change, the change cannot be made Manufacturing until it is approved in writing by GILLIG Sales through issue of a Production Change Order

(PCO) to Engineering to document the design change for future service parts support. Without a PCO there can be no Engineering change documentation.

Engineering Design and Specification Controls

All production material shall be designed to specifications established by the Engineering Department and controlled by supplier drawings, GILLIG proprietary drawings, and part number databases. In addition to ANSI standard dimensions and specification requirements, drawings shall specify materials and test processes where applicable.

Customer contract requirements shall be converted to GILLIG specifications and drawings by the Engineering Department who is also responsible for maintaining and distributing all drawings to the latest revisions.

Engineering Drawings

Identify the requirements for the supplier, and aide manufacturing. New component drawings may have Critical To Quality (CTQ) dimensions to assure suppliers can meet First Article requirements.

Engineering Design Bulletins

- Quality Assurance Codes (QAC) Bulletin 240.000
- Quality Assurance Codes Appendix Bulletin 240.000A

Bill of Materials (BOM)

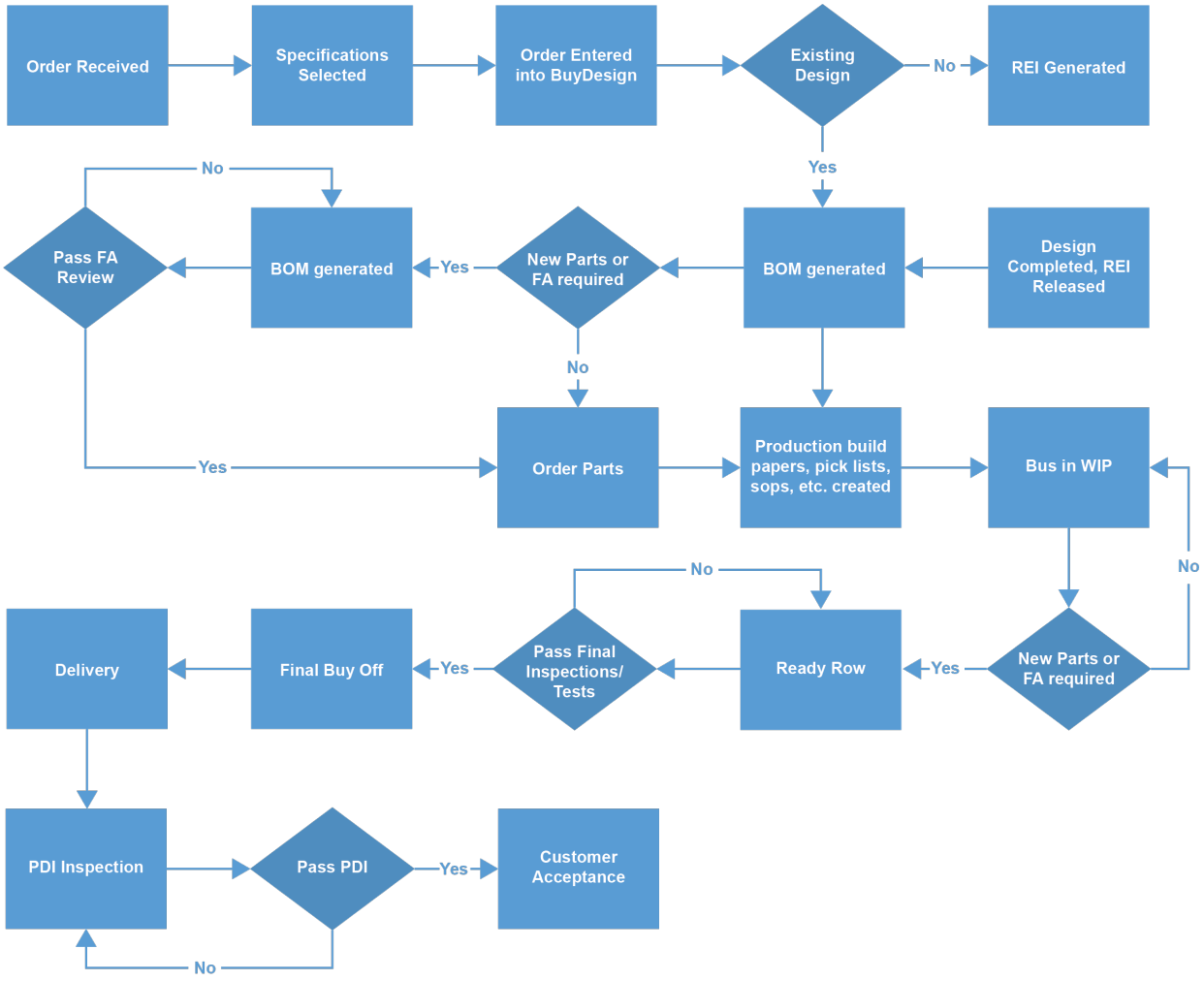
- All documentation requirements for manufacturing
- Customer Meeting Notes
- Customer requirements from By Design

Regulations

Engineering is responsible for reviewing the applicable bus Federal Motor Vehicle Safety Standards and State Regulations, designing for compliance to the FMVSS and State Regulations, and auditing compliance to the attached FVMSS list.

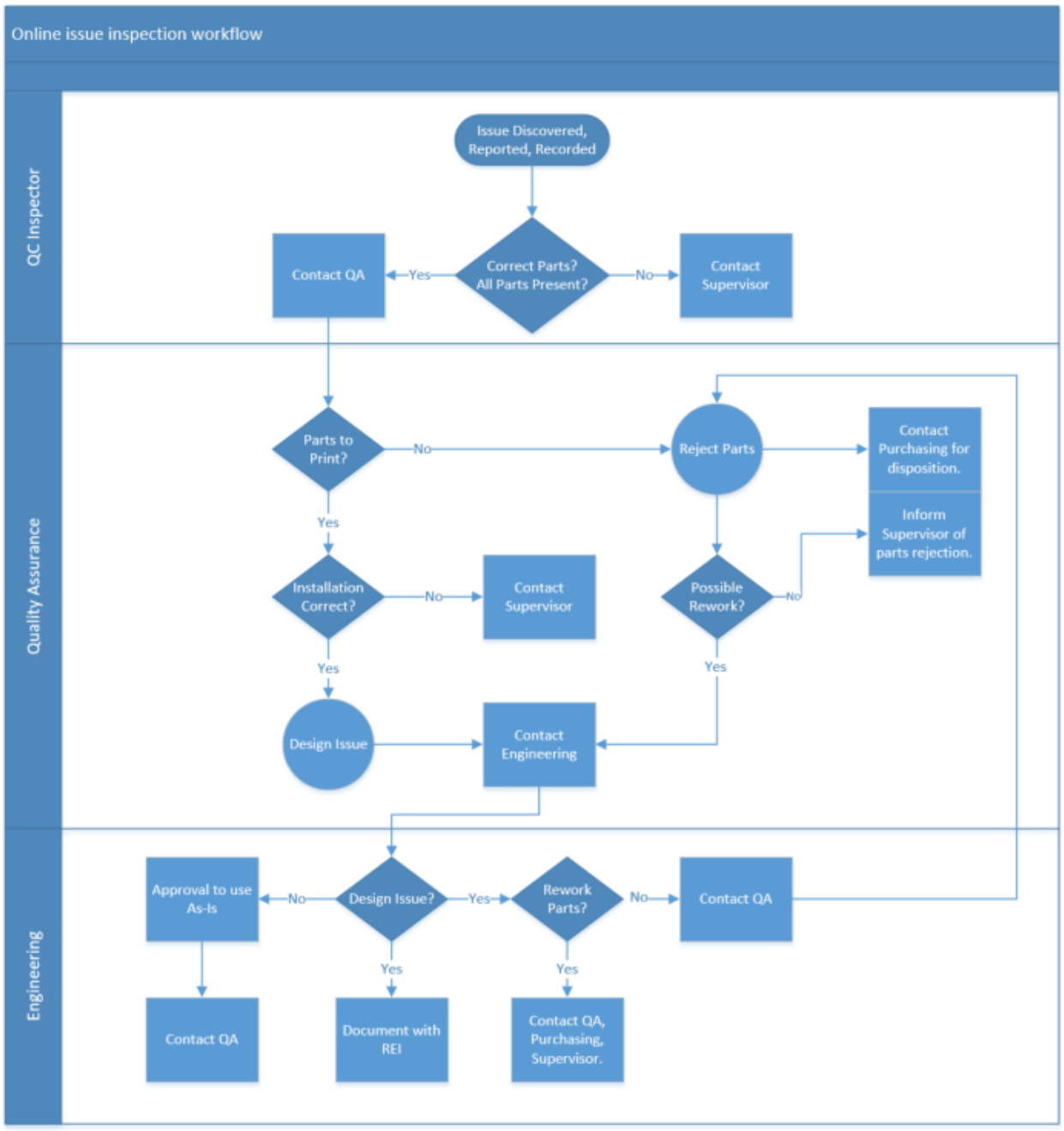
Build Process

The GILLIG bus build process uses the following workflow.



Inspection Process

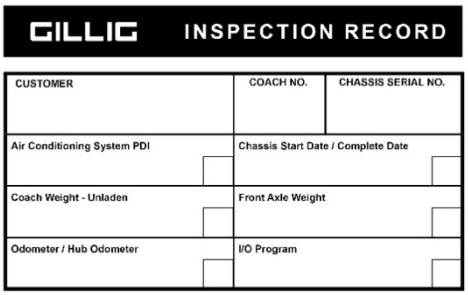
The standard GILLIG inspection process uses the following workflow.



Documentation

GILLIG Inspection Record - "Hardcard"

All bus inspections are documented and recorded on the Hardcard.



GILLIG INSPECTION RECORD

CUSTOMER	COACH NO.	CHASSIS SERIAL NO.
Air Conditioning System PDI	Chassis Start Date / Complete Date	
Coach Weight - Unladen	Front Axle Weight	
Odometer / Hub Odometer	I/O Program	

Attachment Check List	PROD	QC
1. Weigh Slip / Green Sheet		
2. Final Bus Parking & Walk Through Sheet		
3. CNG Agility Packet		
4. BAE Health Check Packet		
5. ITS ATP		
6. ITS Prewire Acceptance Sheet		
7. Camera View Sheet		
8. Day-Wireless 2-Way Radio ATP		
9. Customer Discrepancy Sheet		
10.		
11.		
12.		
13.		
14.		



CHASSIS DEPARTMENT (04A & C)

CUSTOMER CHASSIS SERIAL NO.

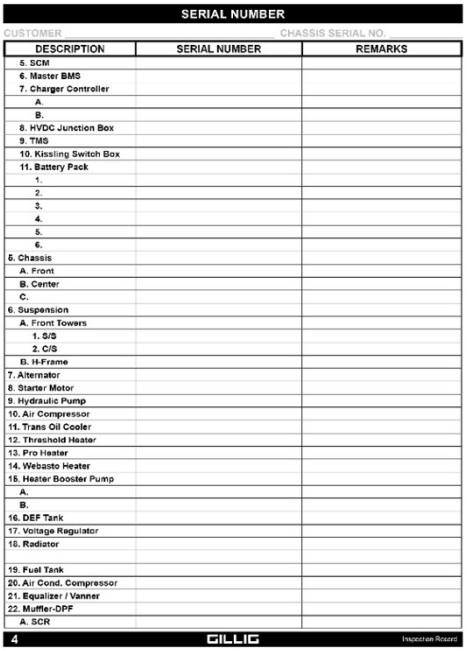
04A OPERATIONS	PROD	QC
1. Chassis Length, Brake, Wheelchair Door Opt		
2. Fire Suppression Cable Routing		
3. Front S/S + C/S Wheel Houss		
4. Chassis Model + ID		
5. Chassis Eng. Mounts + Cushy Floats		
6. Chassis Hook Bolts		
7. AC Platform + Pulley Brkt		
8. Elec/Air Routing + Inst Pwd to Aft of Chassis		
9. Rear Brake lines Routing & Clamping		
10. Air System Install, Air Dryer, Ping Tank, Purge Tank, Kneeling + Leveling Valves		
11. S/S Wheelwell Prop. Piping, & Mtr Box		
12. Hyd/Fuel Lines Routing & Clamped Apart		
13. DEF Tank Installation		
14. Heater Lines + Clamps & Insulation		
15. Front Brake lines Routing & Clamping		
16. Steering Gear & Pitman Arm Install & Torque		
17. Steering Shaft & Torque		
18. Insulation / Corrosion Package		
19. Skid Plate, Heater Valve		
20. Front & Rear Sloop Air + Tow Connection		
21. Tow Connection, Tow Switches		
22. Throttle & Brake Pedals		
23. Trans Retarder PSI Switches		
24. Axle Sub		
1. (FRONT) Axle ASM Verification		
A. Torque Rod Install & Torque		
B. Towers, Air Bags, Shocks Install & Torque		
2. (REAR) Axle ASM Verification		
A. Axle Oil Type		
B. Oil Hub - Oil Amount		
C. Grease Hub - Oil Level		
D. Air Bags, Shocks Install & Torque		
25. FR/RR Axle Pods, Cage Bolts, Blocks, & Lock Clips		
26. Front Suspension Install & Torque		
27. Dieglisk Installation		
28. Rear Suspension Install & Torque		
29. Center Rear Axle (VIF)		
30. Pinion Angle °		
31. Battery Box		
32. Hybrid Cable Continuity Test		
33. No Dielectric Grease at Hybrid Transducer		

04C OPERATIONS	PROD	QC
1. Flag Panel Instl. & Torque: 140 in-lb		
2. A/C Compressor Installation		
3. CAC Installation & Clamping		
4. Turbo Piping & Clamping		
5. Exhaust Test Ports and Plugs		
6. Air Restriction Indicator		
7. Air Compressor Piping		
8. Air Intake System		
9. Surge Tank & Hoses		
10. Electrical Harnesses & Clamps		
11. J-1939 Connections		
12. Fuel Tank Installation		
13. Fuel Lines Routing & Clamping Torque		
14. Tires & Wheels Verification		
15. Rear Wheel Lug Torque		
16. Front Wheel Lug Torque		
17. Power Cables & Vonner Torque		
18. Fuse Box Install		
19. Power Cables & Cut-off Switch Torque		
20. Batt. Cables Clearance		
21. Battery Fuse Installation		
22. Engine Oil Type & Level		
23. Transmission Oil Type & Level		
24. Radiator Coolant		
25. Hydraulic Fluid Type & Level		
26. Engine Startup		
27. ABS Initial Check		
28. Air Test (Wet Test)		
29. Coolant Hose Leak Test		
30. Isolcop Coolant Hose Routing & Clamping		
31. Verify Surge Tank Coolant Sensor-Level Location		
32. FR/RR Axle Pods, Cage Bolts, & Lock Clips		
33. Hybrid Sub Station Comp. Instl. & Torque		
34. FR/RR Brake Hose Clearance on Bump Stops		
35. RR Brake Hose Clearance, Raised		

DEPT	DC	BS	DISCREPANCIES	PROD	QC
1.					
2.					
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14.					
15.					

6 GILLIG Inspection Record

Serial numbers required for tracking, warranty and service are also recorded in the Hardcard.

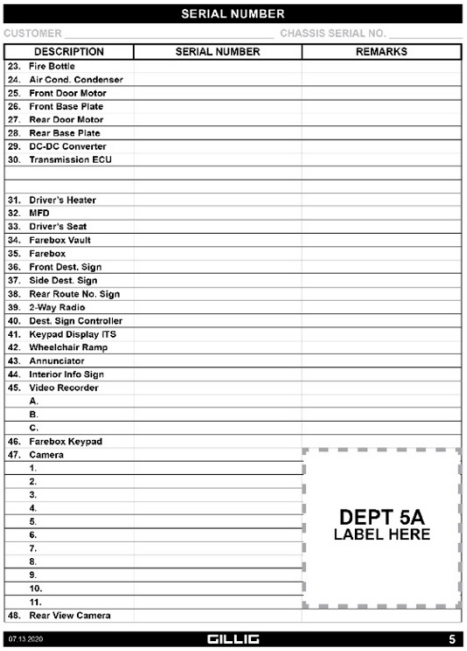


SERIAL NUMBER

CUSTOMER CHASSIS SERIAL NO.

DESCRIPTION	SERIAL NUMBER	REMARKS
5. SCM		
6. Master BMS		
7. Charger Controller		
A.		
B.		
8. HVDC Junction Box		
9. TMS		
10. Kissling Switch Box		
11. Battery Pack		
1.		
2.		
3.		
4.		
5.		
6.		
5. Chassis		
A. Front		
B. Center		
C.		
6. Suspension		
A. Front Towers		
1. S/S		
2. C/S		
B. H-Frame		
7. Alternator		
8. Starter Motor		
9. Hydraulic Pump		
10. Air Compressor		
11. Trans Oil Cooler		
12. Threshold Heater		
13. Pro Heater		
14. Webasto Heater		
15. Heater Booster Pump		
A.		
B.		
16. DEF Tank		
17. Voltage Regulator		
18. Radiator		
19. Fuel Tank		
20. Air Cond. Compressor		
21. Equalizer / Vanner		
22. Muffler-DPF		
A. SCR		

4 GILLIG Inspection Record



SERIAL NUMBER

CUSTOMER CHASSIS SERIAL NO.

DESCRIPTION	SERIAL NUMBER	REMARKS
23. Fire Bottle		
24. Air Cond. Condenser		
25. Front Door Motor		
26. Front Base Plate		
27. Rear Door Motor		
28. Rear Base Plate		
29. DC-DC Converter		
30. Transmission ECU		
31. Driver's Heater		
32. MFD		
33. Driver's Seat		
34. Farebox Vault		
35. Farebox		
36. Front Dest. Sign		
37. Side Dest. Sign		
38. Rear Route No. Sign		
39. 2-Way Radio		
40. Dest. Sign Controller		
41. Keypad Display ITS		
42. Wheelchair Ramp		
43. Annunciator		
44. Interior Info Sign		
45. Video Recorder		
A.		
B.		
C.		
46. Farebox Keypad		
47. Camera		
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
48. Rear View Camera		

DEPT 5A LABEL HERE

07.13.2020 GILLIG 5

Authorization to Ship – "Greensheet"

The Greensheet requires customer sign off (or their designated inspector representative) in order to ship/invoice the bus. Normally customers will have their inspectors on site. However, there are times, the customer does not designate a representative or the inspectors have already left and there are buses still to ship. In those cases, a written document (letter, e-mail, etc.) from the customer stating the buses can ship with GILLIG QC approval or GILLIG Sales can be the voice of the customer by providing the same written documentation on behalf of the customer.

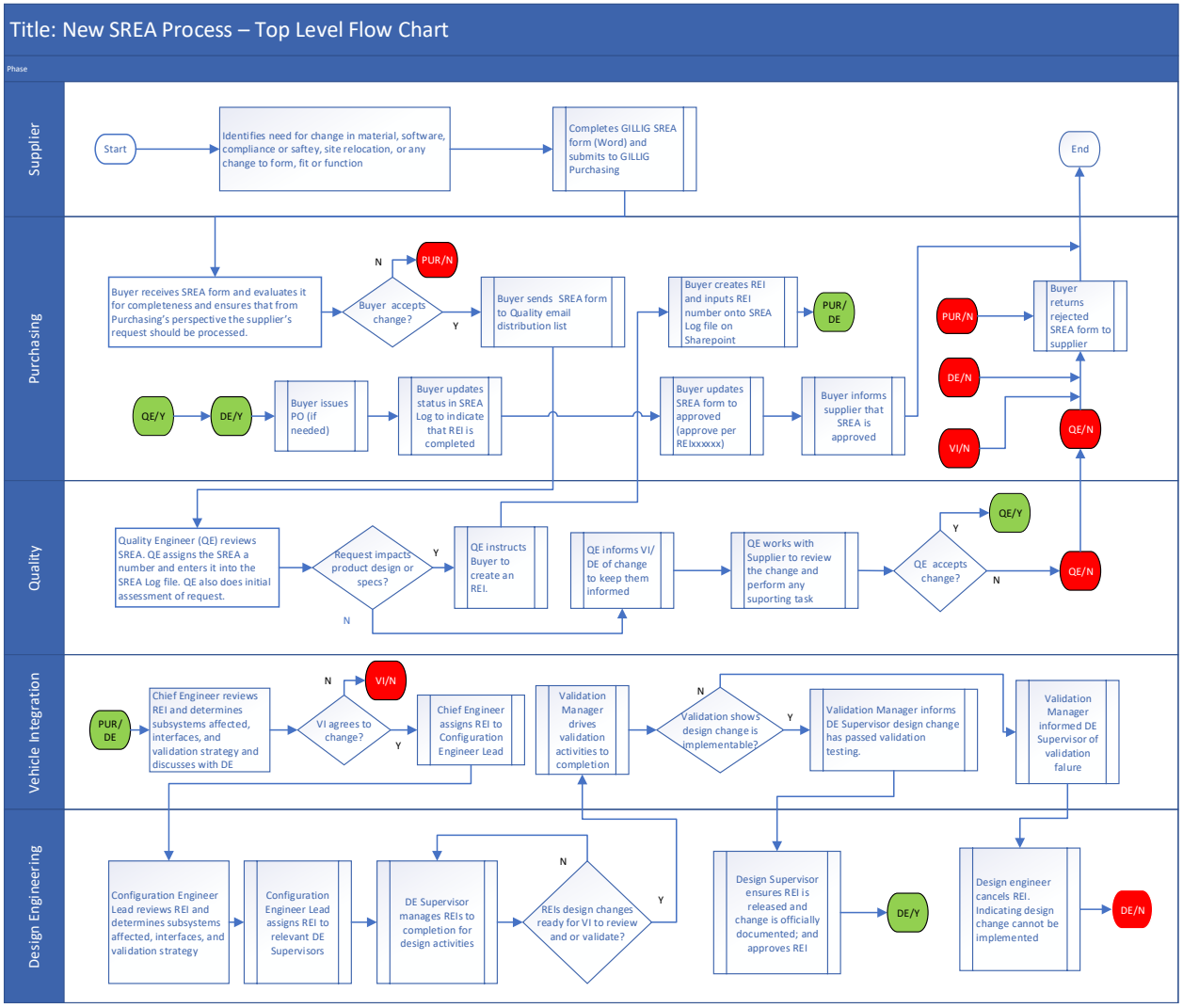
Part Control

SREA – Supplier Request for Engineering Approval

As the name implies, SREA is a request from a supplier for a change to GILLIG Engineering Drawing, or for Supplier to inform GILLIG of a critical process change.

- Plant Move: The supplier is notifying GILLIG of a move of their manufacturing site from one location to another. GILLIG is not in control of the supplier's plant move, but GILLIG does control the decision to use product that is coming out of the new plant. Hence GILLIG will decide what steps GILLIG and "potentially" the supplier will take, in order for GILLIG to feel confident that the product coming out the new location is as good or better that product coming out of the old location.
- Change In Products Form, Fit or Function: The supplier is asking GILLIG to make a change to a released drawing that may affect their product's form, fit, or function (FFF) and would like GILLIG to evaluate samples of their changed part (a "new" part). This type of change would involve GILLIG's Quality, Design Engineering, and Purchasing Department's involvement; in order to determine if the new part would be acceptable to use.
- Significant Change In Their Manufacturing Process: The supplier is making a significant change to the process that may or may not impact its' performance/reliability in GILLIG's bus (as in a system or subsystem's performance). An example of this change is the supplier has a "burn-in" process when their product is running a series of test at an elevated temperature; and now the supplier is going to eliminate the burn in process for this specific product. This type of change would also involve GILLIG's Quality, Vehicle Integration, Design Engineering, and Purchasing Department's involvement; in order to determine if the new part would be acceptable to use.

GILLIG will follow the process details identified in the below flowchart to ensure that GILLIG always ships buses that are reliable and meet the customer's quality expectations.

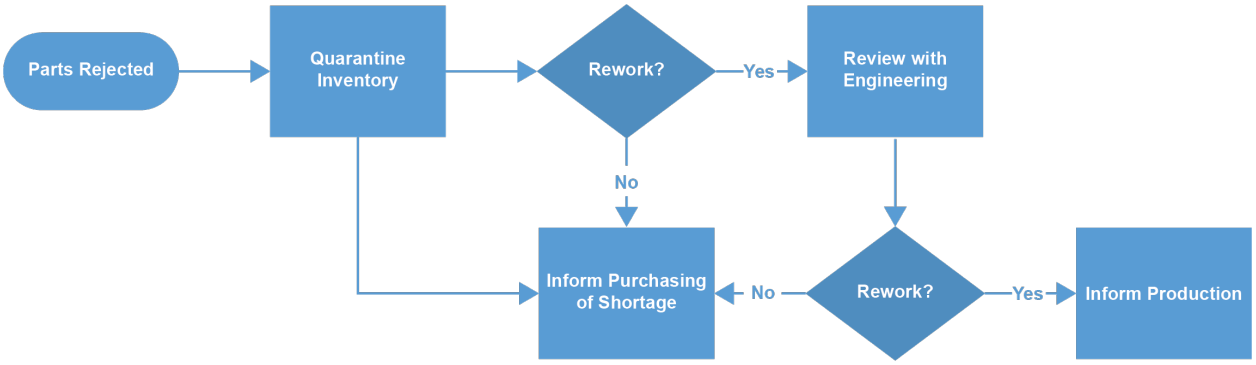


Receiving Inspection

GILLIG performs receiving inspection (RI) in manufacturing as a standard practice. As GILLIG moves into e-Bus manufacturing, RI will occur on complex electronic subassemblies (batteries, junction boxes, etc). The RI for the e-Bus subassemblies is based on corrective action recommendations from historical quality issues and GILLIG's Design Engineering recommendations. Each subassembly selected for inspection has inspection procedures with well-defined pass/fail criteria and disposition instructions for any failures identified during the RI process.

Non-conformance

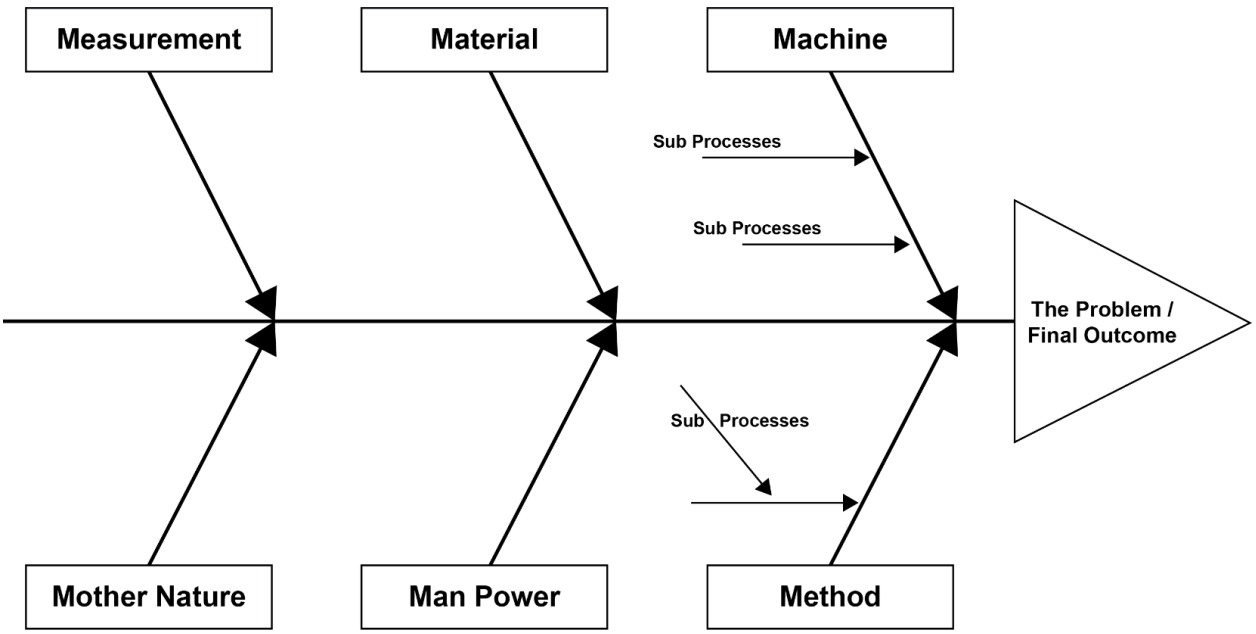
Parts that are rejected are processed with the following workflow.



Problem Solving and Resolution

GILLIG Quality Control (QC) and Quality Assurance (QA) are trained in Practical Problem-Solving techniques aiding the Quality Management System. GILLIG QA/QC leverages standard Six Sigma Quality practices and tools, such as Fishbone Diagrams, 5 Whys, Lean Manufacturing, 8D Problem Resolution, and DMAIC principles.

Fishbone Diagram



8D Problem Resolution

The 8D approach is used to resolve problems, establishes a permanent corrective action by determining the root causes.

Gillig - 8D Response Report

WHO IS EFFECTED BY THE PROBLEM?		**Date Open:**		**8D No.:**		
Company:		**Initial Response:**				
Address:		**Target Close Date:**				
		Revision Date(s):				
Fleet:		**8D Initiator:**				
Part No.		**Actual Close Date:**				
D1 TEAM MEMBER NAMES/TITLES:		**D2 PROBLEM STATEMENT/DESCRIPTION (quantify) (one defect per 8D)**				
Champion:						
Team Leader:						
Team Members:						
D3 CHOOSE AND VERIFY INTERIM CONTAINMENT ACTION(S) (ICA):				**% Effective:**	**Target Date:**	**Actual Date:**
HOW DID YOU VERIFY THE EFFECTIVENESS OF THE ICA?						
D4 DEFINE AND VERIFY ROOT CAUSE(S):					**% Contribution:**	
HOW DID YOU VERIFY THE ROOT CAUSE(S)?						
D5 CHOOSE AND VERIFY PERMANENT CORRECTIVE ACTION(S) (PCA):					**% Effective:**	
HOW DID YOU VERIFY THE EFFECTIVENESS OF THE PCA?:						
D6 IMPLEMENT AND VALIDATE PERMANENT CORRECTIVE ACTION(S) (PCA):					**Target Date:**	**Actual Date:**
HOW WILL YOU VALIDATE THE PCA?						
D7 SYSTEM PREVENTION ACTIONS TO PREVENT RECURRENCE: **Mistake Proofing:** How are you going to ensure it can't happen again?					**Target Date:**	**Actual Date:**
D8 TEAM AND INDIVIDUAL RECOGNITION: Recognize the collective efforts of the team.						

Acceptable Quality Level (AQL)

Acceptable Quality Level for sample inspections should follow MIL-STD-105E sampling plan. GILLIG's supplier minimum AQL requirement level is 2.5 at general inspection level C sample size 5.

MIL-STD-105E Sampling Plan

Sample Size Code Letters

Lot/Batch Size			Special inspection levels				General inspection levels		
			S-1	S-2	S-3	S-4	I	II	III
2	to	8	A	A	A	A	A	A	B
9	to	15	A	A	A	A	A	B	C
16	to	25	A	A	B	B	B	C	D
26	to	50	A	B	B	C	C	D	E
51	to	90	B	B	C	C	C	E	F
91	to	150	B	B	C	D	D	F	G
151	to	280	B	C	D	E	E	G	H
281	to	500	B	C	D	E	F	H	J
501	to	1200	C	C	E	F	G	J	K
1201	to	3200	C	D	E	G	H	K	L
3201	to	10000	C	D	F	G	J	L	M
10001	to	35000	C	D	F	H	K	M	N
35001	to	150000	D	E	G	J	L	N	P
150001	to	500000	D	E	G	J	M	P	Q
500001	and	over	D	E	H	K	N	Q	R

Sample size code letter	Sample	Sample size	Cumulative sample size	Acceptable Quality Levels (Double-normal inspection)																												
				####	####	####	####	####	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25	40	65	100	150	250	400	650	1000
				Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re
A																	↓	*		↓	*	*	*	*	*	*	*	*	*	*	*
B	First	2	2														*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16	17 22	25 31		
	Second	2	4																	1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27	37 38	56 57		
C	First	3	3													*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16	17 22	25 31			
	Second	3	6																1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27	37 38	56 57			
D	First	5	5												*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16	17 22	25 31				
	Second	5	10															1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27	37 38	56 57				
E	First	8	8											*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16	17 22	25 31					
	Second	8	16														1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27	37 38	56 57					
F	First	13	13										*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16	17 22	25 31						
	Second	13	26													1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27	37 38	56 57						
G	First	20	20									*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16									
	Second	20	40												1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27									
H	First	32	32								*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16										
	Second	32	64											1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27										
J	First	50	50							*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16											
	Second	50	100										1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27											
K	First	80	80						*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16												
	Second	80	160									1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27												
L	First	125	125					*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16													
	Second	125	250								1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27													
M	First	200	200				*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16														
	Second	200	400							1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27														
N	First	315	315			*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16															
	Second	315	630						1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27															
P	First	500	500		*			0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16																
	Second	500	1000					1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27																
Q	First	800	800	*			0 2	0 3	1 4	2 5	3 7	5 9	5 9	11 16																	
	Second	800	1600				1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27																	
R	First	1250	1250	↑		0 2	0 3	1 4	2 5	3 7	5 9	7 11	11 16	↑																	
	Second	1250	2500			1 2	3 4	4 5	6 7	8 9	12 13	18 19	26 27																		

↓ = Use first sampling plan below arrow. If sample size equals, or exceeds, lot or batch size, do 100 percent inspection.

↑ = Use first sampling plan above arrow.

Ac = Acceptance number.

Re = Rejection number.

* = Use corresponding single sampling plan (or alternatively, use double sampling plan below, where available).

PPAP Guidance for Suppliers

Introduction

The GILLIG Production Part Approval Process (PPAP) defines the approval process of new or revised parts, or parts that are from new or significantly revised production process. As a supplier to GILLIG, it is your responsibility to ensure that only parts are shipped that have been approved to meet GILLIG's specifications.

If supplier has any questions regarding the contents or process described in this document, please contact the GILLIG Quality Department.

For further information about the contents of this guide, please refer to the Automotive Industry Action Groups (AIAG) Production Part Approval Process (PPAP) 4th edition.

Purpose

The purpose of the Production Part Approval Process (PPAP) is:

- To provide evidence that all GILLIG engineering design records and specification requirements are properly understood and fulfilled by the supplier.
- To demonstrate that the established manufacturing process produces product that consistently meets all requirements during an actual production run.

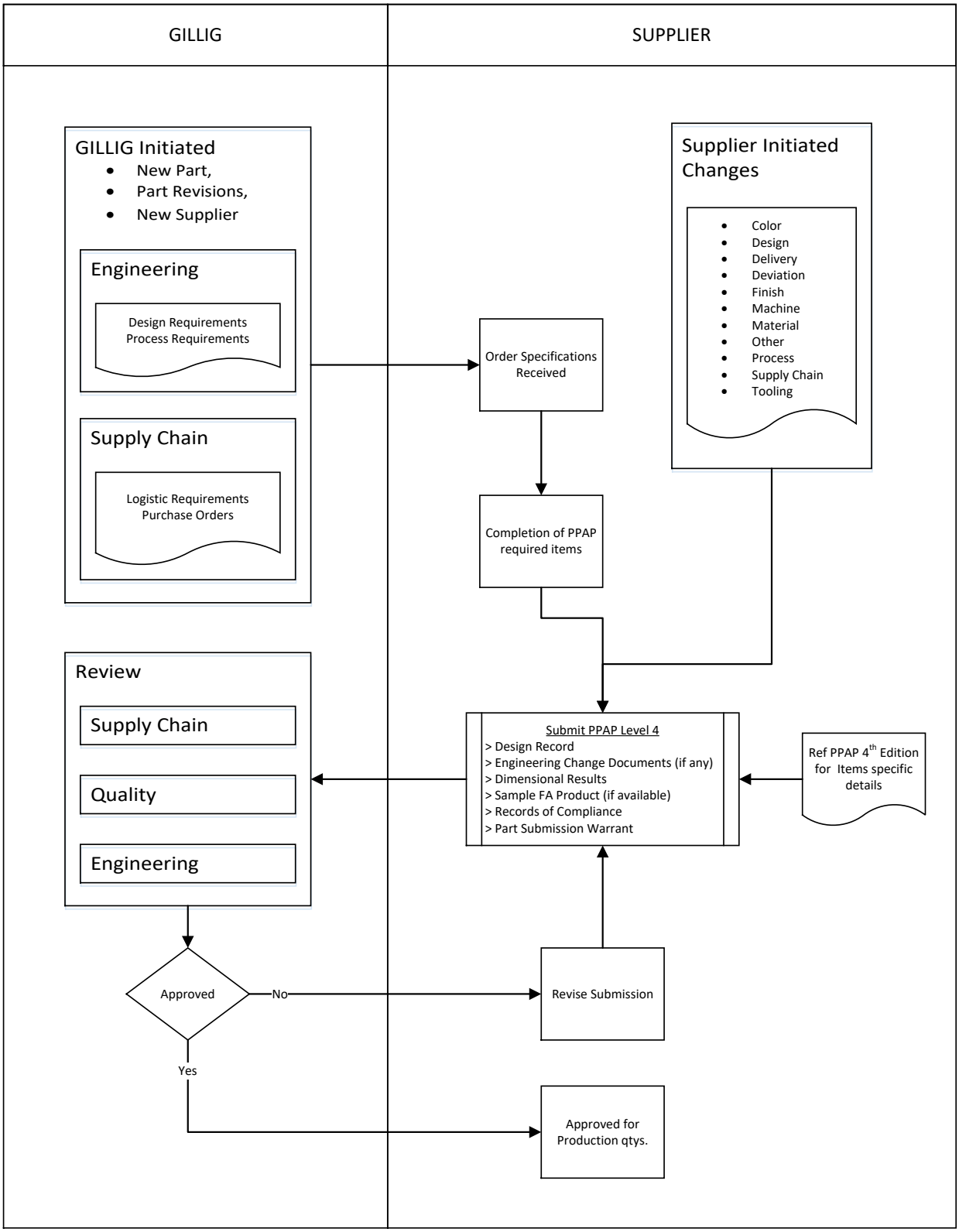
PPAP Submission Guideline

In general, PPAP is use as a guideline anytime a new part or a change to an existing part or process is being implemented. GILLIG retains the right to determine whether a PPAP will be required. See the below PPAP Process Flow Chart between GILLIG and the supplier for PPAP submission workflow.

As a supplier to GILLIG, your quality system should be capable of meeting the requirements of the PPAP submission regardless of whether a submission has been requested.

The GILLIG PPAP submission follows the AIAG standard Level 2 with the following required items for submission:

1. Design Record
2. Engineering Change Documents (if any)
3. Dimensional Results
4. Sample FA Product (if available)
5. Records of Compliance
6. Part Submission Warrant (PSW)


GILLIG
SUPPLIER
GILLIG Initiated
New Part,
Part Revisions,
New Supplier
Engineering
Design Requirements
Process Requirements
Supply Chain
Logistic Requirements
Purchase Orders
Supplier Initiated Changes
Color
Design
Delivery
Deviation
Finish
Machine
Material
Other
Process
Supply Chain
Tooling
Order Specifications Received
Completion of PPAP required items
Review
Supply Chain
Quality
Engineering
Submit PPAP Level 4
> Design Record
> Engineering Change Documents (if any)
> Dimensional Results
> Sample FA Product (if available)
> Records of Compliance
> Part Submission Warrant
Ref PPAP 4th Edition for Items specific details
Approved
No
Yes
Revise Submission
Approved for Production qtys.

Request to waive specific requirements in the PPAP submission must be submitted to GILLIG within a timely manner prior to the application of the part in production. The approved waiver document/correspondence must be submitted in lieu of original PPAP requirement as part of PPAP submission package. If part of the waiver request is a deviation to the part specifications, the GILLIG Part Deviation Form must be submitted as part of the PPAP submission package.

PPAP Forms

Please ask your GILLIG buyer or QA contact for the PPAP forms. Supplier PPAP forms that follow the PPAP standard are acceptable.

PPAP Submissions Timing

PPAP submissions are required minimum 4 months prior to the application in GILLIG production. Submission timing will vary depending on the complexity and manufacturing lead time of the Supplier. In general, the Supplier must submit the PPAP with enough time for approval and any unforeseen changes.

Forever Requirements

In addition to the PPAP process all suppliers are to adhere to the Forever Requirements.

The Forever Requirements are terms used in the industry to denote requirements that apply forever (i.e. throughout the life of the contract with the suppliers). Suppliers shall proactively communicate with GILLIG any plan to change something in the product or process or sub-suppliers.

Deviation Requests

In the event a part deviation is requested, the supplier shall submit this request using the Part Deviation Request Form shown below. Please ask your GILLIG buyer or QA contact for a copy of this form.

Part Deviation Request Form

SUPPLIER NAME:		REQUEST DATE:	
ORIGINATOR:		EMAIL:	
		PHONE#:	

GILLIG PART#:		REVISION:	
SUPPLIER PART#:			
PART DESCRIPTION:			

DEVIATION AND REASON:

ENGINEERING APPROVAL/COMMENTS:

TO BE COMPLETED BY GILLIG			
☑ APPROVED	DURATION OF APPROVAL:	DISTRIBUTION:	DATE:
		SUPPLY CHAIN:	
☐ APPROVED W/REWORK	EXPRIRATION DATE:	QUALITY:	
		ENGINEERING:	
☐ DISAPPROVED			

GILLIG INSPECTION RECORD

CUSTOMER	COACH NO.	CHASSIS SERIAL NO.

Air Conditioning System PDI	Chassis Start Date / Complete Date
Coach Weight - Unladen	Front Axle Weight
Odometer / Hub Odometer	I/O Program

Attachment Check List	PROD	QC
1. Weigh Slip / Green Sheet		
2. Final Bus Parking & Walk Through Sheet		
3. CNG Agility Packet		
4. BAE Health Check Packet		
5. ITS ATP		
6. ITS Prewire Acceptance Sheet		
7. Camera View Sheet		
8. Day-Wireless 2-Way Radio ATP		
9. Customer Discrepancy Sheet		
10.		
11.		
12.		
13.		
14.		

DATA PLATE INFORMATION VERIFICATION

DEFECT CODES		
10 - Leak	30 - Workmanship	80 - Rubbing
11 - Air	40 - Loose	90 - Voids
12 - Fuel	41 - Flooring	100 - Damaged
13 - Hydraulic	42 - Component	101 - Online
14 - Coolant	43 - Securement	102 - Vendor
15 - Oil	50 - Bubble	110 - Wrong Part Installed
16 - Water	60 - Routing	111 - Online
20 - Incomplete	70 - Nonfunctional	112 - Vendor
21 - Shortage	71 - Vendor	
22 - Engineering	72 - Engineering Design	
23 - Production	73 - Programming	
24 - Vendor	74 - Production Error	

QC STAMP	INITIAL
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24.	

VIN
LABEL HERE

EMISSIONS
LABEL HERE

SERIAL REGISTER FOR FEDERAL REQUIREMENTS

CUSTOMER _____ **CHASSIS SERIAL NO.** _____

COACH MODEL NO._____ **DATE COMPLETED.** _____

DESCRIPTION	MODEL NO.	SERIAL NO.	QC
FRONT AXLE			
REAR AXLE			
TRANSMISSION			
TRANS A-R NO.			
STEER. GEAR			
ENGINE			

TIRES	SERIAL NO.	MANUFACTURER	SIZE/PLY RATING	BRAND	PSI	PROD
LF						
LI						
LO						
RI						
RO						
RF						
SPARE						

SERIAL NUMBER LOG

DESCRIPTION	SERIAL NUMBER	REMARKS
1. Hybrid		
A. ESS (Battery)		
A. ECP		
C. Drive Unit		
D. DPIM		
2. CNG Tank ASM		
3. BAE Systems		
1. ECP		
2. APS		
3. PCS		
4. ESS		
5. ACTM		
6. ISG		
7. SCU		
4. E-Bus		
1. Traction Motor		
2. Traction Motor Inverter		
3. DC-DC Converter		
A.		
B.		
4. DataHub		

SERIAL NUMBER

CUSTOMER _____ CHASSIS SERIAL NO. _____

DESCRIPTION	SERIAL NUMBER	REMARKS
5. SCM		
6. Master BMS		
7. Charger Controller		
A.		
B.		
8. HVDC Junction Box		
9. TMS		
10. Kissling Switch Box		
11. Battery Pack		
1.		
2.		
3.		
4.		
5.		
6.		
5. Chassis		
A. Front		
B. Center		
C.		
6. Suspension		
A. Front Towers		
1. S/S		
2. C/S		
B. H-Frame		
7. Alternator		
8. Starter Motor		
9. Hydraulic Pump		
10. Air Compressor		
11. Trans Oil Cooler		
12. Threshold Heater		
13. Pro Heater		
14. Webasto Heater		
15. Heater Booster Pump		
A.		
B.		
16. DEF Tank		
17. Voltage Regulator		
18. Radiator		
19. Fuel Tank		
20. Air Cond. Compressor		
21. Equalizer / Vanner		
22. Muffler-DPF		
A. SCR		

SERIAL NUMBER

CUSTOMER _____ CHASSIS SERIAL NO. _____

DESCRIPTION	SERIAL NUMBER	REMARKS
23. Fire Bottle		
24. Air Cond. Condenser		
25. Front Door Motor		
26. Front Base Plate		
27. Rear Door Motor		
28. Rear Base Plate		
29. DC-DC Converter		
30. Transmission ECU		
31. Driver's Heater		
32. MFD		
33. Driver's Seat		
34. Farebox Vault		
35. Farebox		
36. Front Dest. Sign		
37. Side Dest. Sign		
38. Rear Route No. Sign		
39. 2-Way Radio		
40. Dest. Sign Controller		
41. Keypad Display ITS		
42. Wheelchair Ramp		
43. Annunciator		
44. Interior Info Sign		
45. Video Recorder		
A.		
B.		
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46. Farebox Keypad		
47. Camera		DEPT 5A LABEL HERE
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48. Rear View Camera		

CHASSIS DEPARTMENT (04A & C)

CUSTOMER _____ CHASSIS SERIAL NO. _____

04A OPERATIONS	PROD	QC	04C OPERATIONS	PROD	QC
1. Chassis Length, Brake, Wheelchair, Door Opt			1. Flag Panel Instl. & Torque 140 In-Lb		
2. Fire Suppression Cable Routing			2. A/C Compressor Installation		
3. Front S/S + C/S Wheel House			3. CAC Installation & Clamping		
4. Chassis Model + ID			4. Turbo Piping & Clamping		
5. Chassis Eng. Mounts + Cushy Floats			5. Exhaust Test Ports and Plugs		
6. Chassis Huck Bolts			6. Air Restriction Indicator		
7. AC Platform + Pulley Brkt			7. Air Compressor Piping		
8. Elect/Air Routing + Inst Fwd to Aft of Chassis			8. Air Intake System		
9. Rear Brake lines Routing & Clamping			9. Surge Tank & Hoses		
10. Air System Install, Air Dryer, Ping Tank, Purge Tank, Kneeling + Leveling Valves			10. Electrical Harnesses & Clamps		
			11. J-1939 Connections		
11. S/S Wheelwell Prep, Piping, & Miter Box			12. Fuel Tank Installation		
12. Hyd/Fuel Lines Routing & Clamped Apart			13. Fuel Lines Routing & Clamping Torque		
13. DEF Tank Installation			14. Tires & Wheels Verification		
14. Heater Lines + Clamps & Insulation			15. Rear Wheel Lug Torque		
15. Front Brake lines Routing & Clamping			16. Front Wheel Lug Torque		
16. Steering Gear & Pitman Arm Install & Torque			17. Power Cables & Vanner Torque		
17. Steering Shaft & Torque			18. Fuse Box Install		
18. Insulation / Corrosion Package			19. Power Cables & Cut-off Switch Torque		
19. Skid Plate, Heater Valve			20. Batt. Cables Clearance		
20. Front & Rear Shop Air + Tow Connection			21. Battery Fuse Installation		
21. Tow Connection, Toe Switches			22. Engine Oil Type & Level		
22. Throttle & Brake Pedals			23. Transmission Oil Type & Level		
23. Trans Retarder PSI Switches			24. Radiator Coolant		
24. Axle Sub			25. Hydrualic Fluid Type & Level		
1. (FRONT) Axle ASM Verification			26. Engine Startup		
A. Torque Rod Install & Torque			27. ABS Initial Check		
B. Towers, Air Bags, Shocks Install & Torque			28. Air Test (Wet Test)		
2. (REAR) Axle ASM Verification			29. Coolant Hose Leak Test		
A. Axle Oil Type			30. Isoloop Coolant Hose Routing & Clamping		
B. Oil Hub - Oil Amount			31. Verify Surge Tank Coolant Sensor-Level Location		
C. Grease Hub - Oil Level			32. FR/RR Axle Pods, Cage Bolts, & Lock Clips		
D. Air Bags, Shocks Install & Torque			33. Hybrid Sub Station Comp. Instl. & Torque		
25. FR/RR Axle Pods, Cage Bolts, Slacks, & Lock Clips			34. FR/RR Brake Hose Clearance on Bump Stops		
26. Front Suspension Install & Torque			35. RR Brake Hose Clearance, Raised		
27. Draglink Installation					
28. Rear Suspension Install & Torque					
29. Center Rear Axle (1/8")					
30. Pinion Angle °					
31. Battery Box					
32. Hybrid Cable Continuity Test					
33. No Dielectric Grease at Hybrid Transducer					

DEPT		DC	BS	DISCREPANCIES	PROD	QC	
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DEPT 04B LABEL HERE

CUSTOMER_____ CHASSIS SERIAL NO._____

ENGINE LINE & DEPT. 4B OPERATIONS

Operations		PROD	QC	Operations	PROD	QC
1. Trans Install & Torque				8. Tans. Dipstick Tube Install		
a. Allison	b. Voith			9. Hyd. Pump Install / Torque		
1. Turn Bolts	1. Inner Ring			10. Coolant Hose / Filter Install		
2. Flex Plate	2. Hydrodamp			11. Starter Install / Torque		
3. Outer Housing	3. Intermediate Ring			12. Fuel Hose Install		
4. Flywheel	4. Outer Housing			a. Top fuel Hose Torque		
5. Damper (Hybrid)				b. Bottom fuel Hose Torque		
c. BAE	d. ZF			13. Starter Cable Torque		
1. Generator	1. Inner Ring			14. Air Compressor Hose		
a. Inner Bolts	2. Outer Ring			15. DeAiration Hose Routing Inst.		
b. Cover plate	3. Turn Bolts			16. Radiator Power Cable Inst.		
2. Outer Housing				17. Alt. Cable Clamp / Torque		
2. BAE or Allison Hybrid Cable Inst.				18. Aux Coolant Heater Piping		
a. Ring Terminal Install / Torque				19. Trans. Cooler Hose Install		
b. Connector Install / Torque				20. Engine Installation & Torque		
c. Cover Plate Install / Torque				21. Air Piping: RR lvl/Ping/Purge/Dryer/Gov		
3. Engine Fill Tube Installation				22. Hydraulic Reservior Hoses		
4. Alternator Install				23. DEF Coolant Piping & Clamping		
5. Crank Case Filter Install				24. Radiator Mounting & Hoses		
6. Motor Mount Inst / Torque				25. Booster Pump Piping & Clamping		
7. Drive Shaft Install / Torque				26. Settee Installation / Drive Shaft Greased		

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BODY DEPARTMENT (05)

CUSTOMER _____ CHASSIS SERIAL NO. _____

CUSTOMER_____CHASSIS SERIAL NO._____

Body Department (05A)

Operations	PROD S/S	PROD C/S	QC	Operations	PROD S/S	PROD C/S	QC
1. Roof Framing Installation				14. Roof Harness			
2. Roof Gussets Assy. (15Ft-Lb)				15. Destination Sign Harness			
3. Roof Skin Installation				16. APC Cables			
4. Emergency Hatch Install				17. Grab Rails			
5. Hyb/CNG/Ebus Roof Comp.				18. Grab Straps / Ad Panels			
6. Insulation				19. Camera Installation			
7. Int. Passenger Ceiling Panels				20. DPF & SCR / Record Serial #			
8. Int. Driver Ceiling Panel				21. Bulkhead Inst. / Frame			
9. Antenna Locations				22. Fire Suppression Inst. @ A/C			
10. Air Tank Installation & Piping				23. A/C Inst. / Record Serial #			
11. Antenna Cable Routing				24. Fire Wire Inst. @ A/C			
12. Electrical Panel Installation				25. Fire Bottle / Record Serial #			
13. Interior Light Kit				26. Bulkhead Int. Panel / Sealer			

DEPT	BS	DC	Discrepancies	PROD	QC	

CUSTOMER_____CHASSIS SERIAL NO._____

Body Department (05B)

Operations	PROD S/S	PROD C/S	QC	Operations	PROD S/S	PROD C/S	QC
1. A/C & Side Frame Install				16. Body Squareness			
2. Window Post Installation				18. Exit Door Header Install			
3. Settee Frame / Seal				19. Steering Column Brkt.			
4. Rear Frame Installation				20. Rear Wheel Well Install			
5. Destination Sign Comp.				21. Front Wheel Well Install			
6. Frnt & RR Door Stress Panels				22. CNG Component Installation			
7. Interior Post Caps				23. Hybrid Comp. Roof Install			
8. Speaker Panels				24. Hybrid High Voltage Cables			
9. Exterior Post Caps				25. Hyb Roof Comp Connections			
10. Side Frame Stress Panels				26. 12 / 24V Connections @ Flag			
11. Side Frame Gusset (15 FT-LB)				27. AC Power Cable @ Flag			
12. Air Filter				28. Floor Installation			
13. Flex Pipe / Surge Tank Install				29. Floor Sealer			
14. Body to Chassis Coating				30. Fire Wire Routing			
15. Body to Chassis Asm.				31. Eng. Compt. Harn/Hose RTG			

DEPT	BS	DC	Discrepancies	PROD	QC	

SHEET METAL DEPARTMENT (06)

CUSTOMER _____ CHASSIS SERIAL NO. _____

06 OPERATIONS	PROD	QC	06 OPERATIONS	PROD	QC
1. HVAC Deaeration Hose Routing			21. Qpod Harness Routing		
2. Dest. Sign Compt/HVAC Piping & Clamping			22. Chime Harness Routing		
3. Fire Suppression System Installation			23. Front Cap Prep		
4. Engine Compt Harn/Hose Routing & Clamping			24. Front Cap Installation		
5. Skirt Panel Brkt Installation			25. BRT Windshield Opening		
6. Front Door Harness Interference			26. BRT Windshield Squareness		
7. Front Door Header Installation			27. Driver's Side Console Installation		
8. Front Door Installation			28. Dash Prep & Installation		
9. Air Piping @ Driver's Platform			29. Rear Cap Prep		
10. Air Tank Closeout Installation			30. Rear Cap & HVAC Door Installation		
11. Rear Electrical Panel Installation			31. Tail Pipe Installation		
12. Elec.Panel Closeout & Side Access Door Instl.			32. Driver's Barrier Installation		
13. 12/24v Cable Torque Frt Panel			33. Elec. Equipment Box Verification		
14. 12/24v Cable Torque Rear Panel			34. Side Overhead Grabrail Installation		
15. Engine Compt Routing @ Settee Hatch			35. Engine Door & Light Corner Installation		
16. Skirt Panel Prep, Locks, Latches & Primer			36. Engine Belt Guard Installation		
17. Skirt Panel Installation			37. Drivers Heater/Washer Bottle Installation		
18. Exit Door & Nosing Installation			38. Sawtooth/ B Post Closeout Installation		
19. Wheel Tub Prep			39. Headlamp Installation		
20. Wheel Tub Installation					

DEPT		DC	BS	DISCREPANCIES	PROD	QC	
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ROCKWELL/WABCO D VERSION ANTI-LOCK BRAKE SYSTEM CHECKLIST

CUSTOMER _____ CHASSIS SERIAL NO. _____

Step 1. Clear stored faults with Pro-Link STORED FAULT menu.

Step 2. Record the following ECU information from Pro-Link PROGRAM ID menu.

ECU Rev. _____ ECU Part Number _____

ECU MFG Date Code _____ ECU Serial Number _____

Valve Function Tests	Identification	OK	Not OK	N/A
Modulator Valve Cycle	Left Front (A) Steer Axle			
Modulator Valve Cycle	Right Front (B) Steer Axle			
Modulator Valve Cycle	Left Rear (C) Drive Axle			
Modulator Valve Cycle	Right Rear (D) Drive Axle			

Step 3. Component test for Sensors. Check the location and voltage output of each sensor. The AC voltage output should be greater than .5 volts @ 30 rpm.

Sensor Function Tests	Identification	OK	Not OK	N/A
Sensor Output	Left Front Wheel (A) Steer Axle			
Sensor Output	Right Front Wheel (B) Steer Axle			
Sensor Output	Left Rear (C) Drive Axle			
Sensor Output	Right Rear (D) Drive Axle			

Step 4: Miscellaneous Component Testing

Other Function Tests	Identification	OK	Not OK	N/A
ATC Modulator Valve	Full System Only			
ATC Lamp (Wheel Spin)	Full System Only			
ABS Lamp (Tractor ABS)	D Basic and Full			
ABS Check Switch, Disable ATC	D Full. Hold switch for just over 3 sec.			
Engine Datalink (Eng Torque) ATC	D Full			
Retarder Datalink	D Basic and Full (when equipped)			
Retarder Relay	D Basic and Full (when equipped)			

Step 5: Air System Function and Leak Test

Air System End of Line Test	Required	Fail	Pass	Corrected By	Retested By
0 psi in tanks, LPS on, Dash gauge low	Confirm				
Both needles rise together, max 5 psi diff.	Confirm				
LPS off above 60 psi below 80 psi	Confirm				
Build-up time 25 seconds or less	Confirm				
Compressor Cut-out psi	125–135 psi				
Supply System Leakage test	Not to exceed 4 psi in 2 minutes				
Service Brake Leakage test	Not to exceed 6 psi in 2 minutes				
Pull up PP-1	Confirm spring brakes apply				
Push in PP-1	Confirm spring brakes release				
Wet Tank Drain Down	No drop on either gauge				
Secondary Tank Drain Down	Red needle drop, max 2 psi drop in green needle				
Service Brake Application	Rear brakes apply, front brakes do not apply, stop light lights				
Primary Tank Drain Down	Green needle drops				
Primary Tank Drain Down	PP-1 pops at 35–45 psi				
Primary Tank Drain Down	Green needle drops, red drops 2 psi max				
Primary Tank at 0 psi	Front brakes apply, Rear brakes apply with spring brake, stop lights light				
Drain Accessory Tank	Verify flow from accessory tank drain				
Front Brake Interlock	Verify operation				
Rear Brake Interlock	Verify operation				

RACK DEPARTMENT (09)

CUSTOMER _____ CHASSIS SERIAL NO. _____

OPERATIONS	PROD	QC	OPERATIONS	PROD	QC
1. J1939 Ohms Verifcation			1. ABS Test		
2. Charging System Voltage			2. ATC Test		
3. Dash Panel Install & Function			3. Air Tank Drain Test		
4. Rear Run Box Function			4. Low Air Alarm		
5. Rear Throttle			5. Parking Brake Alarm 9-10-10 w/ Ignition Off & Park		
6. Fan Control Static Test					
7. Engine Comp. Lights			6. Check Air System / Wet Test		
8. Ignition Start - Front			7. Engine Oil Level		
9. Lamp Indicator			8. Transmission Fluid Level		
10. Booster Fan Low/High			9. Radiator Coolant Level		
11. Check Fast Idle/Interlock			10. Hydraulic Fluid Level		
12. Driver's Defroster			11. Rear Run Box Installation		
13. Hazard Lights			12. Retardent Seal @ Eng. Cmpt		
14. Headlight Function			13. Fire Wire Alarm Test		
15. Turn Signals			14. Fire Suppression System Inst.		
16. Retarder On/Off Light			15. Wiper Motor Installation		
17. Interior Lights			16. Air Dryer		
18. Windshield Washers			17. Check Speedometer		
19. Wiper Function			18. Transmission Shifter		
20. Engine Test Switch			19. Interior Lights - Reverse		
21. Front Stepwell Heater			20. Seal Exterior Wheelwells		
22. Yield Sign Switch			21. Verify Skirt Panel Hardware		
23. Engine Shutdown w/ Fire Test			22. Hose/Wire Routing Underside		
24. Engine Programming			23. FR/RR Axle Pods, Cage Bolts, & Clips		
25. Transmission Program			24. Clevis & Cotter Pins - FR & RR Axles		
26. Program Rev			25. Front Brake Line Clearance		
27. Brake Interlock Operation			26. Steering Column Installation		
28. Kneeling System			27. Driver Foot Area For Clearance		
29. Kneeling Interlock Warning			28. Farebox Gnd Strap		
30. Retarder - Brake Activation			29. Farebox Harness Routing		
31. Dept. 9 Elect. Comp/Harn Routing & Inst.			30. Settee Installation		
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DEPT		DC	BS	DISCREPANCIES	PROD	QC	
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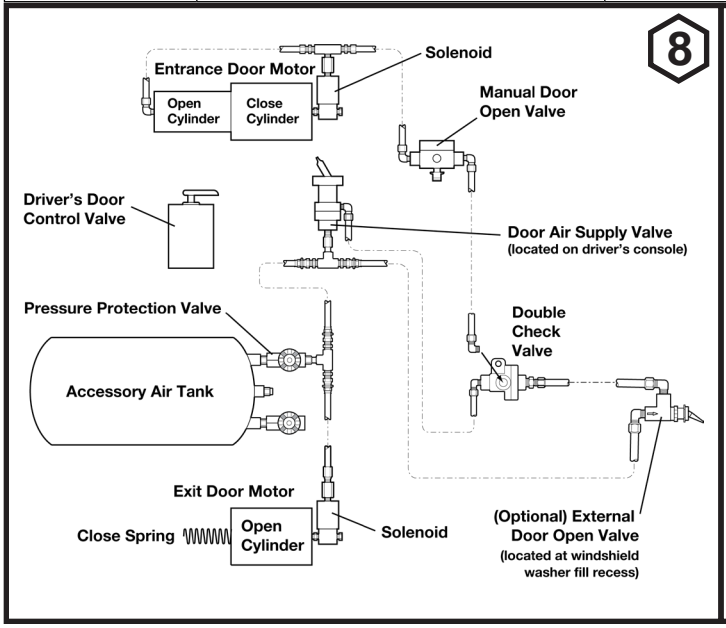
AIR LEAK TRACKER SHEET

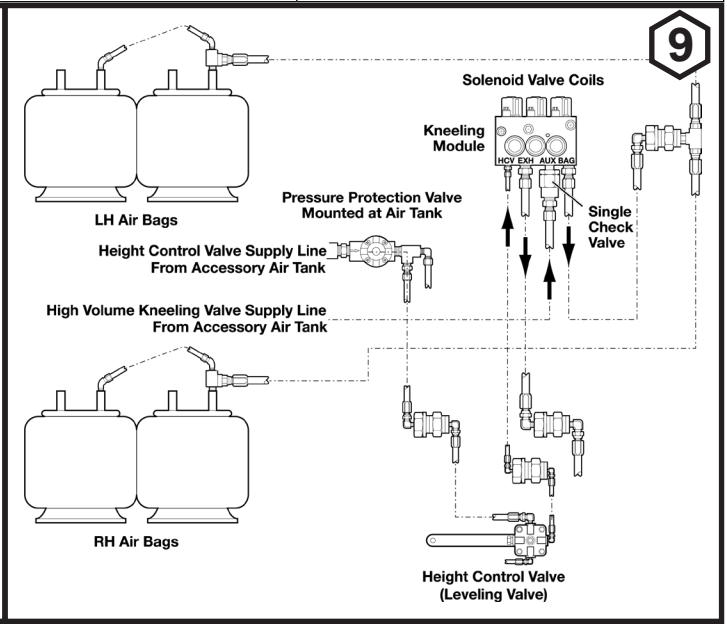
CUSTOMER _____ CHASSIS SERIAL NO. _____

Dept. Air Leak Found In	Section #	Commodity	Criteria	Details	PROD	QC	

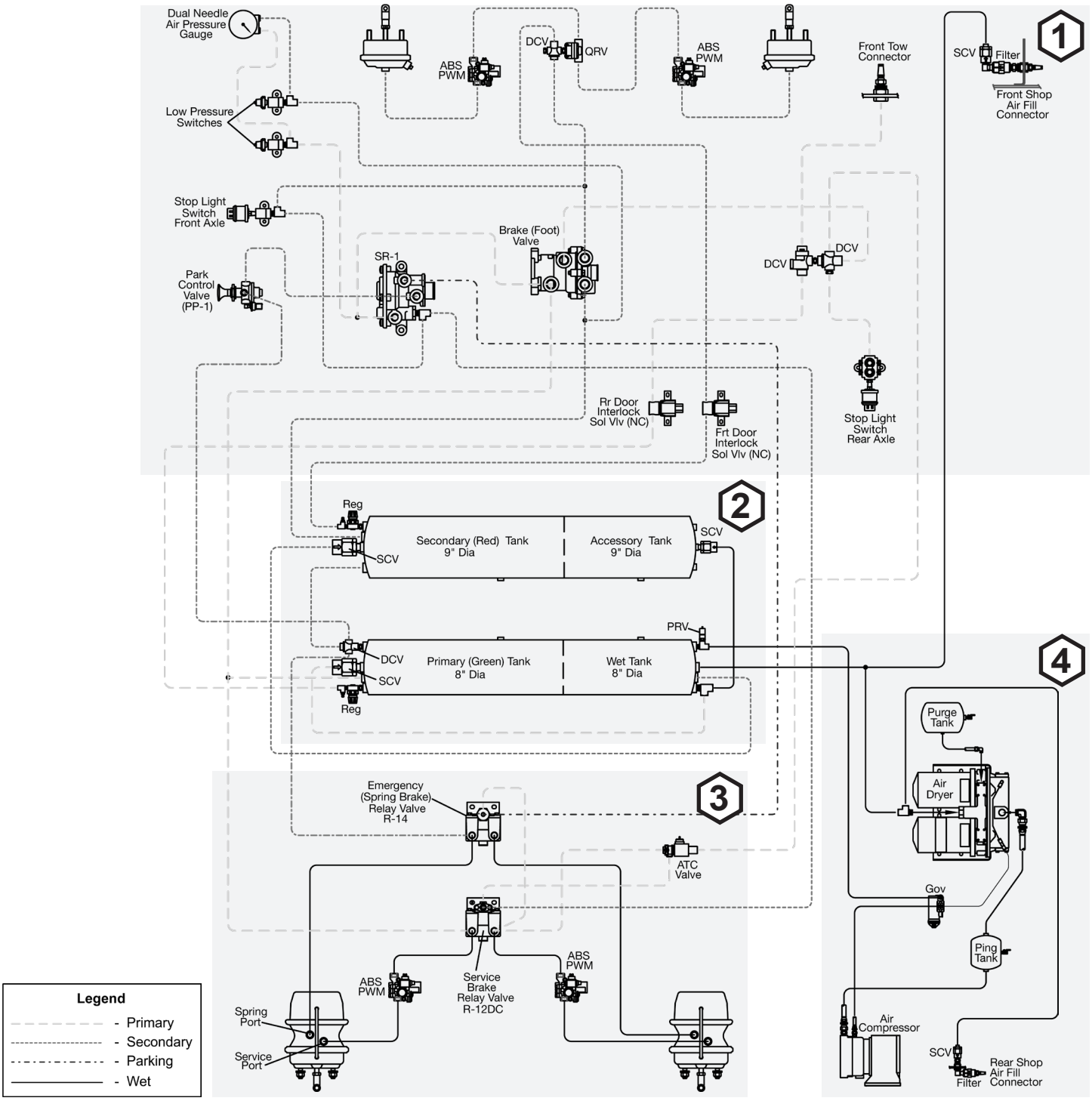
Air Leak Inspection Criteria

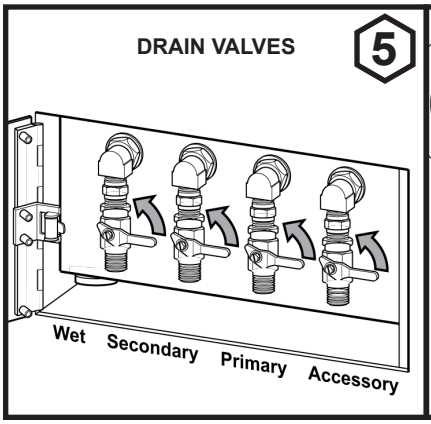
Commodity	A. Indication of an air leak by a few air bubbles.	B. Slow steady release of small bubbles and/or foaming.	C. Roaring boil, Rapid release of bubbles, Hear air release or one Large Bubble.
Valves	No Action	No Action	Action Needed
Push to Connect Fittings	No Action	No Action	Action Needed
NTA / JIC / SAE / NPT Fittings	Action Needed	Action Needed	Action Needed

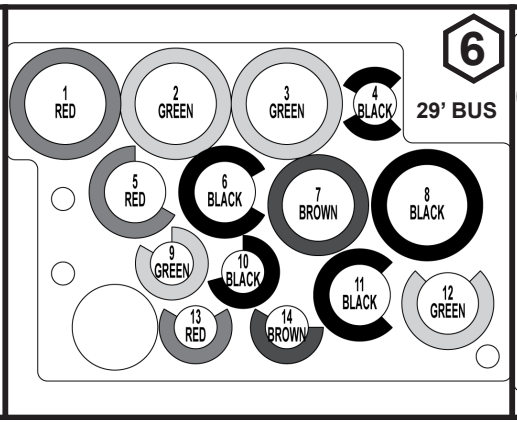


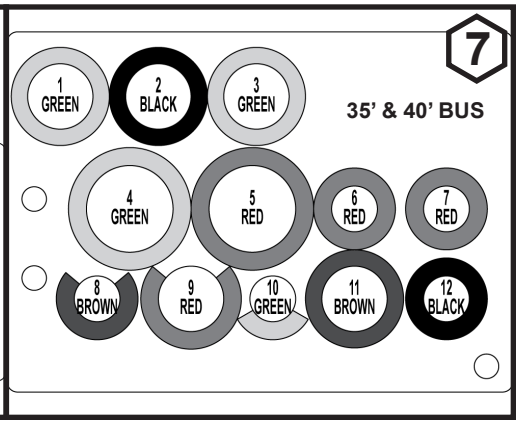


AIR LEAK TRACKER SHEET









NEW PRODUCTION INSPECTION CHECK SHEET DIWA.5 TRANSMISSION SHEET 1

CUSTOMER _____ CHASSIS SERIAL NO. _____

VOITH

Transmission Serial Number		Transmission Design Pattern #	
End User Name		ECU Serial Number.	
Vehicle Manufacturer		ECU Part Number	
Vehicle Model	GILLIG LLC	Engine Manufacturer / Type	Cummins L9 / L9N
Type of Vehicle	Bus	Engine Max HP / @RPM	
Chassis No.		Oil Manufacturer / Oil Type	

Item #	Description of Test / Description of Check	Yes / OK	Remarks / Notes
1.0	**At Standstill, Engine is not running.**		
1.1	All cable connections properly fitted and connected.	O	_____
1.2	Cables installed correctly (Min Bend radius, no rubbing, 100mm away from heat source)	O	_____
1.3	Transmission Accessibility:		
	- Transmission periphery	O	_____
	- Diagnostic Port	O	_____
	- Top cover / Solenoid Valves	O	_____
	- Measuring oil level	O	_____
	- Measuring Ports	O	_____
	- Oil pan / Draining oil	O	_____
	- Filling transmission fluid	O	_____
1.4	No vehicle components secured to the transmission	O	_____
1.5	Electronic Control unit location approved & protected from splash	O	_____
2.0	**At Standstill, Engine is not running.**		
2.1	Verify that oil level on Voith dipstick (@ transmission) matches the level indicated on OEM dipstick (@ engine compartment)	O	_____
2.2	Inspect for leaks	O	_____
3.0	**Test Drive**		
3.1	Functional Check		
	- Starter Inhibitor while button is pressed	O	_____
	- Gear Guard Function (Gear should not engage without depressing floor brake)	O	_____
	- ANS Function If Installed	O	_____
	- Retarder Off Switch (If Installed)	O	_____
3.2	Retarder Operation: Verify Retarder inputs FB1, FB2 & FB3 activate in the correct order and that FB1 & FB2 are active before shoe to drum or pad to disc contact is made.	O	_____
3.3	Read Fault Memory, rectify fault and clear memory if applicable	O	_____
3.4	Stall Speed n1 [1/min]	O	_____
3.5	Check oil level at operating temp (~175°F), top off if necessary	O	_____
3.6	Inspect for leaks	O	_____
4.0	**Results of Commissioning**		
	Complaints eliminated	O	_____

Notes:

Date: _____ Inspected By: _____

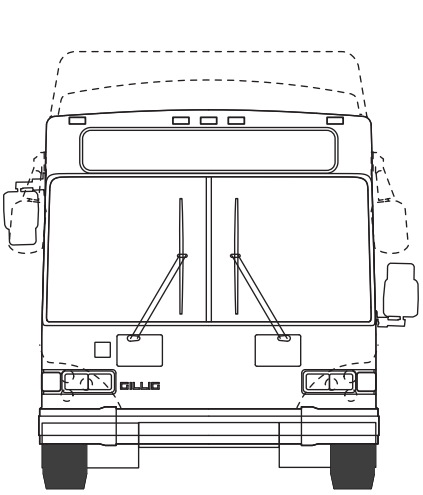
ACCEPTANCE TEST PROCEDURE WORKSHEET (MFD 2)

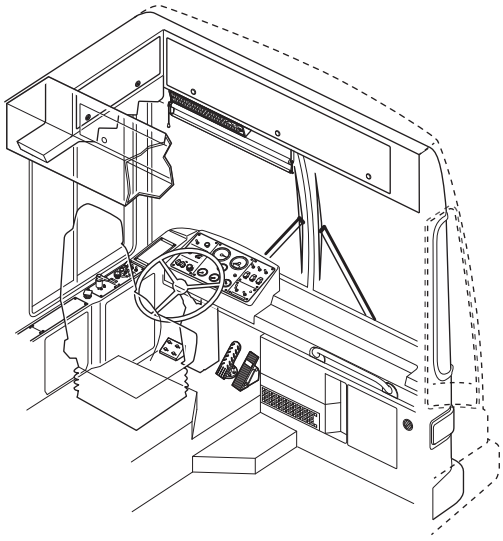
CUSTOMER _____ CHASSIS SERIAL NO. _____

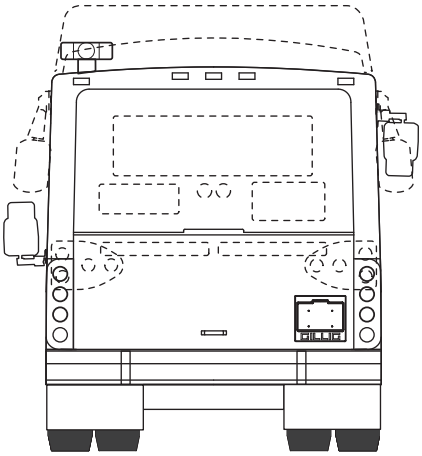
Line #	Description	Pass/Fail	Tested By	Comments
1	General Functions			
	Verify Primary Screen gauges match Programming Spec and display proper values.			
	Verify Secondary Screen gauges match Programming Spec and display proper values.			
	Verify Engine Test switch triggers Check Engine indicator			
	Verify ABS test switch (if applicable) triggers ABS indicator momentarily.			
	Verify Lamp Test switch illuminates all on-screen and physical telltale indicators for 10 seconds (or as noted).			
2	Day Run / Night Run Modes			
	Ensure Day Run shows a white background with colored graphics			
	Ensure Night Run shows a black background with colored graphics			
	Verify screen toggles properly with specified screen control (i.e. run sw or ambient light sensor)			
3	Camera viewing (if applicable)			
	Verify Rear door camera image appears when rear door open is triggered.			
	Verify Back-up camera image appears when transmission is set to reverse. Ensure image displays the curb side on the right and street side on the left (i.e. mirrored)			
	When interlock is ACTIVATED, verify that the REAR DOOR camera image appears, when BOTH rear door open and reverse signals are active.			
	When interlock is DEACTIVATED, verify that the BACK-UP camera image appears, when BOTH rear door open and reverse signals are active.			
4	Seat Cushion Alarm (if applicable)			
	Verify that the “Set Parking Brake” image functions as described.			
5	Seat Belt Alarm (if applicable)			
	Verify that the “Check Seatbelt” image functions as described.			
6	Maintenance / Driver mode			
	Verify that the Maintenance/Driver mode switch toggles the screen between Maintenance Mode and Driver mode.			
	In Maintenance Mode			
	Verify J1939 button displays J1939 signals.			
	Ensure “System Status” button displays all I/O modules on bus and show as “Online”			
	Verify that the screen remains on the current screen while the bus is moving more than 3 mph.			
	In Driver Mode			
	Verify Diag. Menu button does not appear on the Primary Screen.			
	Verify that the screen returns to the Primary Screen when the bus is moving more than 3 mph.			
7	Shutdown			
	Turn Ignition off, and Verify screen remains on while I/O multiples system is on.			
	Set the Maintenance/Driver mode switch to “Driver” before leaving the bus.			

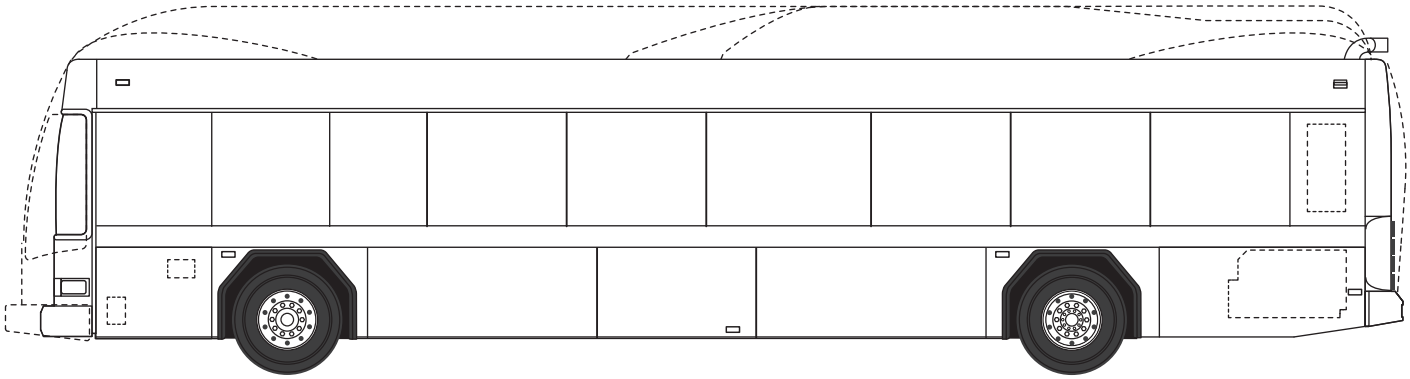
PAINT DEPARTMENT (07)

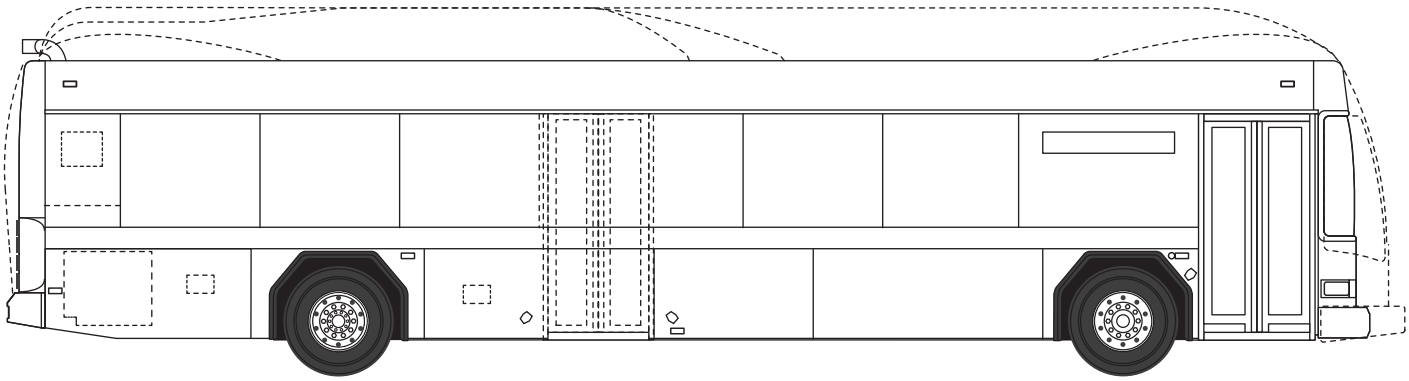
CUSTOMER _____ CHASSIS SERIAL NO. _____

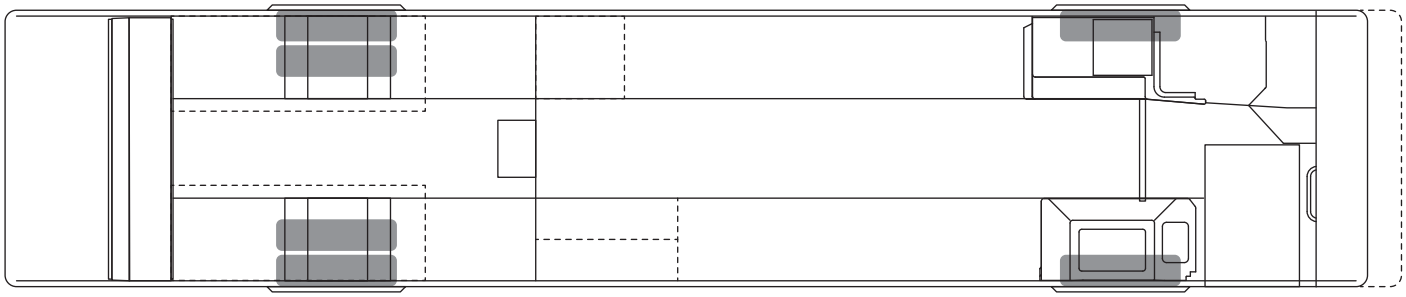












PAINT DEPARTMENT (07)

CUSTOMER _____ CHASSIS SERIAL NO. _____

DEFECT LIST			
160 - Bondo Sore	210 - Overspray	260 - Chips	310 - Low Mils - Single Stage 3.5 - 4.5
170 - Dents	220 - Water Marks	270 - Dirt	320 - Low Mils - Two Stage 4.5 - 5.5
180- Sand Marks	230 - Runs / Sag	280 - Pinholes	330 - Buffing Compound Residue
190 - Fish Eye	240 - Dry Spray	290 - Bad Repair	340 - Orange Peel
200 - Scratch	250- Peeling	300 - Solvent Pop	350 - Incomplete Repair

EXTERIOR INSPECTION CHECK LIST	PROD	QC
1. Layout		
2. Skirt Panels Lower Edge		
3. Front Door Rubber		
4. Rear Door Rubber		
5. Hubs Painted		
6. Roof Numbers		
7. Battery Compartment		

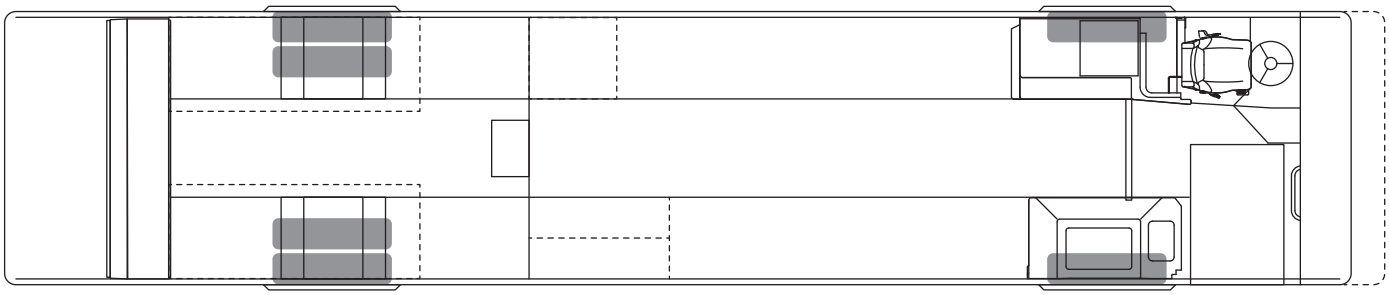
INTERIOR INSPECTION CHECK LIST	PROD	QC
1. OVERSPRAY @		
A. Post Caps		
B. Kick Panels		
C. Side Console		
D. Dash		
E. Below Driver's Window		
F. Entrance Doors		
G. Exit Doors		
H. Electrical Box / Wheel Tubs		
I. Entry Threshold Panels		

DEPT		DC	BS	DISCREPANCIES	PROD	QC	
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TRIM DEPARTMENT (08A & 08B)

CUSTOMER _____ CHASSIS SERIAL NO. _____

08A OPERATIONS	PROD	QC	08B OPERATIONS	PROD	QC
1. Flooring Installation			1. Sun Screens / Driver		
2. Tail Lights & Installaiton			2. Modesty Panels		
3. Interior Panels			3. Passenger Windows		
4. Turn Signals & Installation			4. Driver's Window		
5. Marker Lights & Installation			5. BRT Dash Trim		
6. Rear Mudflaps			6. Exterior Mirrors		
7. Front Mudflaps			7. Driver's Seat & Serial #		
8. Rear Bumper Installation			8. Side Destination Sign(s) & Serial #		
9. Stepwell Lights & Installation			9. Passenger Signals		
10. Front Bumper			10. Interior Mirrors		
11. Fender Installation			11. Interior Ad Frames		
12. Farebox Platform			12. Grab Handles @ Wheelwells		
13. Cowling Installation			13. Entrance Grab Handles		
14. Door Seals			14. Fire Extinguisher		
15. Door Glazing & Seal			15. First Aid Kit		
16. Seat Rail Installation/ T-Bolts			16. Road Warning Kit		
17. Exhaust Diffuser Installation			17. Window Bars		
18. Rear Run Sign			18. Farebox & Serial #		
19. Front Destination Sign & Serial #			19. Farebox Guard		
20. Windshield Installation			20. Exterior Side Ad Frames		
21. Passenger Heater(s)			21. Drip Rail Installation		
22. Wiper Arm Asm			22. Exterior Ad Frames		
23. Front License Plate			23. Ext. Foam Tape, Reflectors & Latches		
24. Coolant ISO-Loop			24. Check Floor Sealer		
25. A/C Belt Alignment Verification			25. ADA Spacing		
26. Bike Rike Installation			26. Shoulder Belt & Floor		
27. Torque Wheel Lug Nuts			27. Stanchion Location & Torque		
28. Tire Air Pressure			28. Seat Location / Hip to Knee		
29.			29. Seat Mounting Torque		
30.			30. Hubodometer		
31.			31. Exterior Graphics		
32.			32. Driver Shield		



DEPT		DC	BS	DISCREPANCIES	PROD	QC	
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ELECTRICAL DEPARTMENT (03)

CUSTOMER _____ CHASSIS SERIAL NO. _____

OPERATIONS	PROD	QC	OPERATIONS	PROD	QC
1. Rear Start & Reverse Fan Check			32. Crime Alarm		
2. Fire Suppression Sys Components			33. Interior Destination Sign		
3. Fire Alarm / With AC Shutdown			34. Dash Mounted Front Run Sign		
4. Front & RR Electrical Panel / Wiring			35. Front Destination Sign		
5. Kneeling System			36. Rear Route Sign		
6. Interlock Test / Verification			37. Side Sign(s)		
7. Entrance Door Lights & Switches			38. Heated Destination Sign Glazing		
8. Clearance @ Entry Door Linkage			39. Heated Mirrors		
9. Exit Door Harness Route & Securement			40. Remote Mirrors		
10. Exit Door Sensitive Edge Operation			41. Headlamps		
11. Exit Door Lights & Switches			42. Turn Signal / Hazard Lights		
12. Driver's Fan - Low & High			43. Brake Lights		
13. Stepwell Heater			44. Tail Lights		
14. Underseat Pass. Heaters			45. Reverse Lights & Beeper		
15. Driver Seat Belt Alarm			46. Roof Marker Lights		
16. Driver Seat Cushion Alarm			47. License Plate Light		
17. Passenger Signals			48. Yield Sign		
18. ADA Seat Touch Pads			49. Engine Comparment Lights		
19. Voice/Data Radio			50. Passenger Lights w/ Front Door		
20. Annunciator Type			51. Video Surveillance System;		
21. ITS GPS/WLAN			A. Number Of Cameras		
22. Aux ITS Module(s)			B. Camera Location		
23. Covert Mic / Ambient Mic			C. Event Switch & LED		
24. Passenger Counter			D. GPS / WLAN		
25. Dash Panel Layout Verification			52. Ohms (Ω) Data Port		
26. EEB Tray Layout Verification			53. Data Port Power		
27. EEB Trays Deploy w/o Interference			54. Voltage Regulator Test		
28. Heel Switch			55. 2-Way Radio		
29. Farebox Connection;			56. Super Cap Function		
A. GFI			<u>Additional Options</u>		
B. Odyssey					
30. Farebox OCU Location					
31. Farebox Lamp					

DEPT	DC	BS	DISCREPANCIES	PROD	QC
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DEPARTMENT (11)

CUSTOMER _____ CHASSIS SERIAL NO. _____

OPERATIONS	PROD	QC	OPERATIONS	PROD	QC
1. Driver's Seat Functions			12. Entrance Door Operation		
2. Check Wiper Operation			A. Open		
3. Check Windshield Washer Operation			B. Close		
4. Bike Rack & Sensor			C. Sensitive Edge		
5. Interior Detail			13. Exit Door Operation		
A. Paint			A. Open		
B. Floor			B. Close		
C. Ceiling			C. Sensitive Edge		
D. Foam Tape Int. Compt. Doors					
6. Interior & Exterior Gillig Decals					
7. AC Return Grill					
8. Ship Loose Items					
9. Clear Open items On Inspection Card					
10. Air System Function & Leak Test					
11. Electrical Function Check					

FINAL DEPARTMENT (10)

UNDERSIDE OPERATIONS	PROD	QC	UNDERSIDE OPERATIONS	PROD	QC
1. Check Torque Seal All Hardware			15. Under Seal Complete		
2. Eng. Comp. Wire & Hose Routing			16. Check Front Hub Oil Level		
3. Engine Comp. Clearances			17 Cleanliness		
4. Check Fuel Leaks			18. RAMP INSTALLATION		
5. Check Hydraulic Leaks			A. Ramp Hardware Torqued		
6. Check Coolant Leaks			B. Ramp Trim		
7. Check Oil Leaks			C. Ramp Nosing		
8. Proper Clamps & Hanger			D. Ramp Beeper		
9. Brake Hose Routing			E. Interlock Works w/ Ramp Deployed		
10. Slack Adjuster Angle			F. Interlock w/ Ramp Manually Deployed		
11. Clevis & Cotter Pins – Front			G. Cycle Ramp Minimum 6 Times		
12. Clevis & Cotter Pins – Rear			19. Aisle Lamps		
13. Underside Wire & Hose Routing			20. Stanchion Chime / Function		
14. Susp. Hardware Torque & Seal					

DEPT		DC	BS	DISCREPANCIES	PROD	QC	
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ALIGNMENT & DYNO / ROAD TEST

CUSTOMER _____ CHASSIS SERIAL NO. _____

ALIGNMENT	PROD	QC	DYNAMOMETER / ROAD TEST	PROD	QC
1. Alignment To Specificaitons			1. Max Water Temp: Degrees		
2. Set Turn Angle			2. HVAC System Function		
3. Bleed Steering Gear			3. Heater/Defroster Function		
4. Adjust Draglink			4. Aux. Coolant Heater Function		
5. Torque Draglink & Key			5. Engine Performance		
6. Rear Suspension Air Bag Height			6. Transmission Shifting		
7. Headlight Adjustment			7. Full Brake Retarder		
8. Check Horn Operation			8. 1/3 Throttle & 2/3 Brake Retarder		
9. Torque Steering Wheel & Stake			9. Aux Brake Test		
10. Step Height			10. Speedometer Accuracy		
11. Clear Front Brake Lines			11. Maximum Speed: MPH		
12. Front Air Bags Clearance			12. Test Interlock		
13. Snow Chain Adjustment & Angles			13. Hydraulic Leaks		
14.			14. Coolant Leaks		
15.			15. Check For Codes		
16.			16. Check Engine Oil Level		
17.			17. Check Transmission Oil Level		
18.			18. Check Engine Coolant Level		
19.			19. Check Hydraulic Fluid Level		
20.			20. Axle Oil Level		
21.			21. Fire Suppression System Armed		
22.			22. A/C Belt Tension		
23.			23. CNG Methane Leak Check		
24.			24. Eng. Shut Down w/ Methane Leak		
25.			25. Start / Stop		
			26. Depot Mode		
			27. Water Test		
			28. E-Bus 1,000 Mile Road Test		

DEPT		DC	BS	DISCREPANCIES	PROD	QC	
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FINAL ACCEPTANCE

OPERATION	INSPECTOR
1. VIN Plate Installed	
2. All Shortages Addressed	
3. All Write-Ups Completed	
4. All Final Operations Completed	
5. All Safety Gear Installed	
6. All Interior Doors Secured	
7. All Exterior Doors Secured	
8. Ship Loose Items (Noted On Green Sheet)	
9. Function Check Complete	
10. Fire Suppression Sys. Activated	
11. End-Of-Line Air System Test	
12. Attachment Check Off List Complete	

RED TAG

MISCELLANEOUS DISCREPANCIES

CUSTOMER _____ CHASSIS SERIAL NO. _____

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FLUIDS

CUSTOMER _____ CHASSIS SERIAL NO. _____

TYPE	SPEC	04	09	FINAL	READY ROW
Coolant					
Hydraulic					
Transmission					
Engine					
Fuel					

SHORTAGES

DEPT	PART NO.	P.O. #	DESCRIPTION	QTY REQ'D	DUE DATE	INSTALLED BY	DATE

BACK COVER

CUSTOMER _____ CHASSIS SERIAL NO. _____