Charge your future – with the Siemens eBus charging infrastructure
For public transport even on the street, electrification seems the obvious alternative to keep pace with urban growth and to care for the city environment at the same time, using full electric or electric hybrid buses.

With the right charging technology, the advantages of electrified buses can be utilized: less energy consumption in comparison to buses with combustion engines, use of renewable energy, less noise, lower particle emissions, less CO₂, lower lifecycle costs, and reliable service.

Siemens is at the forefront of this technology to help operators find a tailored solution to their individual challenges.

A growing challenge
Cities are not only the engines of future economic growth, they themselves are growing day by day. To keep up the quality of city life is a huge task – and a challenge for the city’s infrastructures.

**Why should we go full electric?**
- With the right charging technology, eBuses are the perfect, versatile answer to the increasing demand for sustainable transport solutions in cities.
- Electromobility based on eBuses is locally emission-free, quiet, reliable and can use renewable energy.
- Using an Offboard High Power Charger means no compromise in service availability, capacity, and passenger comfort for your electric bus system.

**Top-Down Pantograph**
**Power Electronics**
**Offboard**

Power levels 150, 300 and 450 kW
Grid connection AC 400 V to 20 kV
<table>
<thead>
<tr>
<th>Charging</th>
<th>Siemens Offboard High-Power Charger</th>
<th>Siemens Onboard Charging System</th>
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<th>References</th>
<th>Offboard High-Power Charger Hamburg</th>
<th>Offboard High-Power Charger Stockholm</th>
<th>Offboard High-Power Charger Gothenburg</th>
<th>Onboard Charging via Catenary Vienna</th>
<th>DC Plug-In Charging Stuttgart</th>
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<tr>
<td>Power @ Catenary</td>
<td>Power Electronics</td>
<td>Onboard</td>
<td>Power levels 60 and 120 kW @ DC 750 V</td>
<td>Power levels 30 to 150 kW</td>
<td>Grid connection AC 400 V</td>
<td>Power levels 60 and 120 kW @ DC 750 V</td>
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<td>Grid connection AC 400 V</td>
<td>Power levels 60 and 120 kW @ DC 750 V</td>
<td>Power levels 30 to 150 kW</td>
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<tr>
<td>Plug-In System/Onboard</td>
<td>Onboard charging with 7 or 14 kW</td>
<td>Grid connection AC 230/400 V</td>
<td>Power levels 60 and 120 kW @ DC 750 V</td>
<td>Power levels 30 to 150 kW</td>
<td>Grid connection AC 400 V</td>
<td>Power levels 60 and 120 kW @ DC 750 V</td>
<td>Power levels 30 to 150 kW</td>
<td>Grid connection AC 400 V</td>
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</tbody>
</table>
Using the latest Siemens technology, the bus batteries are charged in regular intervals for 4 to 10 minutes before returning to service. The charging duration depends on the bus in service, driving distances, potential traffic congestion, climate conditions and the size of the batteries. The idea is to keep buses on the road in well-proven service operation all day long, instead of restricting service in terms of passenger capacity or mileage and facing other consequences as a result of over-dimensioned batteries, such as increased power demand in the depot.

By charging just enough for traveling all day from terminus to terminus (or to the next available charging point), the Offboard High Power Charger adds a lot of flexibility to eBus service. Since the buses occupy the charging station only for a few minutes, the Offboard High Power Charger is ideal for high-frequency operation conditions, since the charging infrastructure can be used by several buses per hour, even of different manufacturers.

Bus battery and charging equipment can be adapted to exactly fulfill the requirements of a sufficient bus service operation, making it a cost-efficient solution for the individual traffic volume.

**Maintenance and Remote Services**

As a global player Siemens provides maintenance services on customers’ request independently from standard warranty agreements.

The Siemens High Power Charger can be delivered with 24/7 remote condition monitoring and advanced analytics for best possible operational efficiency.
Customized charging power

The charging power at the station can be adapted in accordance with the local route profile and the available stopping times in modular steps of 150, 300 and 450 kW. This means that even quite challenging situations can be covered with charging times between 4 and 10 minutes.

Key features

- Smart grid integration and usage of renewable energy
- Opportunity charging at terminal station via 4-pole offboard pantograph
- Fully automated charging process
- Charging power: 150 / 300 / 450 kW
- Grid connection: 400 V to 20 kV AC, 50/60 Hz
- Wireless communication via WiFi IEEE 802.11a based on ISO 15118
- Remote access, service and control

References

- Germany: Hamburg
- Sweden: Stockholm, Gothenburg
- Canada: Montreal

* for 100 busses at 70,000 km/year (price basis 2014)
Onboard interfaces

The HPC’s onboard interfaces comprise

• Communication module (ComBox, VCCU)
• HV module (DC switch, DCCU)
• Contact rails
• WiFi antenna

By providing all components from a single source, Siemens guarantees a fully interoperable charging system to deliver electric charge from the same charging station to buses from different OEMs.

Communication module (ComBox)

• It implements the full control of the charging system with a communication controller (ComBox) and an I/O port controller
• Wireless communication with HPC according to ISO 15118
• CAN Bus communication with onboard components according to SAE J1939
• Temperature control of the eBus contact rails

HV module (DC-Switch)

• HV switch and protection of the DC link between battery and contact rails
• With this modular composition, Siemens provides the option to the bus OEM to supply the DC switches and link to the batteries, assuming that the HV module fulfills all Siemens requirements. In this case the control would still be handled by the communication module. This offers the possibility of saving even more space on board.

The onboard interfaces secure a working communication environment between the charger and the vehicle. It controls the delivery of power and constantly exchanges information with the vehicle by CAN according to SAE J1939 and the wireless communication according to ISO 15118.
Driving standardization and ensuring system ‘interoperability’ for our customers

Together with other OEMs Siemens plays a leading role in ensuring an open interface between electric buses and charging infrastructure and facilitating the introduction of electric bus systems in European cities.

The public transport community is preparing for electric buses in Europe, and standardization activities have begun via the European body (CEN-CENELEC) and via the international organization for standardization (ISO/IEC). European standards are expected to be in place in 2019 and international standards in 2020.

The project members are committed to contribute to European standardization activities and to share experiences with CEN/CENELEC and ISO/IEC in order to establish a common European standard for electric bus systems. The objective is to facilitate the transfer to electric bus systems in cities to ensure reliability and compatibility across bus brands and charging systems. Other bus manufacturers and charging system suppliers are invited to join the cooperation.

For opportunity charging, the system includes automatic contact by a pantograph, wireless communication, contact plates, and infrastructure equipment that automatically contacts vehicles with a top-down pantograph. For overnight-charged electric buses, the fast-charging standard for cars (CCS) will be used as a base for the plug and for communication.

Test site in Germany

Siemens installed a test site near Berlin with equipment typically offered to operators in Europe to test new function and features and to support the integration of the technology to bus OEMs.

Reference: Hamburg, interoperable charging of Volvo and Solaris buses at Siemens charging infrastructure
Siemens Onboard Charging System

The smart charging technology for electric buses

Fast, safe, and cost-efficient charging

The Siemens onboard charging solution is a fast-charging system mainly used in cities with existing DC networks, such as for tramways. Independent of bus manufacturers, it provides an electric charging capacity of up to 120 kW, minimizing the required charging time. Siemens offers all components needed for the charging system from a single source. Complementary rectifier substations are available for cities without an existing DC infrastructure.

Bottom-up pantograph

The most apparent feature of this charging solution is the bottom-up pantograph mounted on the bus roof. The electric bus is driven underneath the charging station, which consists of a bipolar catenary. The bus driver starts the charging procedure by raising the pantograph to the catenary, and stops it by lowering the pantograph again. Grounding is provided by the negative pole on the pantograph, which includes a double-isolated DC/DC inverter and appropriate isolation guards for all high-voltage components on the vehicle to ensure a safe charging procedure.
Customized charging power

Within the 60 kW and 120 kW system configurations, the charging power can be well customized to specific distance profiles and available idle times.

Key features

- Opportunity charging at terminal station through 2-pole catenary
- 750 V DC power input
- 60 kW or 120 kW of charging capacity
- Roof-mounted pantograph and DC/DC inverter

References

- Austria: Vienna
- Germany: Regensburg
Plug-In DC Charging

Proven technology for efficient plug-in charging

Siemens Plug-In DC Chargers are designed for fast charging of electric vehicles (EV). Charging Power varies from 30 kW to 150 kW. Plug-in DC chargers are available as single or twin chargers.

The twin chargers are equipped with two charging plugs and allow the operator to charge two vehicles at the same time, with the advantage of reduced infrastructure expenditure.

Based on proven technology, DC chargers are highly reliable and user-friendly, using the new, high-quality Siemens HMI touch screen, which displays information e.g. regarding state of charge, power consumption, and currently available autonomy of the EV.

After connecting the plug to the vehicle, all protection features are automatically verified and the user can start the charging process. Users can stop the charging process at any time via the touch screen display. If the batteries are fully charged, the charging process stops automatically.

Supervision capability with open interfaces

Siemens’ Plug-In DC Charger is OCPP (Open Charge Point Protocol) compliant, offering a comprehensive solution for communication with a central system, regardless of manufacturer or IT back-end vendor.

Certifications

Safety

- EN60950
- IEC 950
- UL1950
Remote access

Any user with proper credentials can monitor the state of the charging process. In addition, remote access to the chargers is possible with a computer or mobile app from anywhere in the world, through the web server.

Key features

- Fast and high-efficiency charging solution from 30 kW to 150 kW
- Safe, robust, durable, stable and user-friendly
- Charge any CCS or GB/T-compatible vehicle
- Battery charging status, power consumption, and autonomy are displayed
- Configuration customization available
- Charging cycle finishes automatically or can be interrupted by user command
- Quick and easy installation
- Available as single or twin version
- Compliant w/ OCPP
- Remote access, service and control

References

- Germany: Stuttgart
- Switzerland: Geneva
- Several test operations at airports in Europe
Modular architecture and versatility

Different combinations are available to the customer – Siemens offers a wide range of different powers and plugs to meet customers’ requirements. These flexible DC chargers are designed to withstand exposed outdoor conditions for the entire year.

High flexibility

Our standard solutions have both control and power modules. The control cabinet that includes the charging cable can be separated from the power cabinet, allowing full installation flexibility.

Easy installation and maintenance

It is quick and easy to install at almost any location due to simple floor and wall-mount connections. These features combined with a simple design also create maximum space efficiency.

Safe system

When the charging process is initiated, the charging plug locks in the vehicle to prevent arcs caused by removal when under load. Additionally, the plug is designed to withstand the highest pull-out forces. Integrated monitoring of the temperature protects the system against malfunction.
### Control module

The control module is equipped with a Siemens SIPLUS HMI KTP700 Display Panel which is found on the cabinet’s door.

### Floor Mounting / Wall / Pole Mounting

<table>
<thead>
<tr>
<th>Single Charger</th>
<th>Twin Charger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Configuration</td>
<td>Standard Configuration</td>
</tr>
</tbody>
</table>

### Dimensions

<table>
<thead>
<tr>
<th>Floor Mount Control Module Dimensions:</th>
<th>Wall / Pole Mount Control Module Dimensions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>440 x 840 x 1,890</td>
<td>440 x 840 x 800</td>
</tr>
</tbody>
</table>

- Essential for parking lots and sidewalks so users can easily access charging stations while in their parking spaces
- Weight: 150 kg

### Plugs & cables

The customer can combine two GB/T or CCS standard plugs.

### CCS type 2, Combined Charging System

### GB/T

### Cable Length and Charging Mode

**Cable Length**

- Standard cable length: 5 m

**Charging Mode 4**

- Charging via a dedicated DC electric vehicle tethered charging cable.

Dedicated vehicle inlet

Communication

Bus
## Technical description

### Nominal input

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>3 phases + N + PE, 400 V AC ±10%</td>
</tr>
<tr>
<td>Current at nominal voltage per phase</td>
<td>50–220 A</td>
</tr>
<tr>
<td>Frequency</td>
<td>47–53 Hz</td>
</tr>
<tr>
<td>Power factor</td>
<td>&gt; 0.98</td>
</tr>
<tr>
<td>Total harmonic distortion</td>
<td>&lt; 4% at full charge</td>
</tr>
</tbody>
</table>

### DC output

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated power</td>
<td>30–150 kW</td>
</tr>
<tr>
<td>Current</td>
<td>43–200 A</td>
</tr>
<tr>
<td>Voltage range</td>
<td>500 V DC to 800 V DC</td>
</tr>
<tr>
<td>Ripple</td>
<td>Less than 1% of the nominal voltage</td>
</tr>
</tbody>
</table>

### Protections

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Thermic relay</td>
</tr>
<tr>
<td>Overvoltages</td>
<td>DST's Valvetrab Modules</td>
</tr>
<tr>
<td>Output current limitation</td>
<td>Limited by reading circuit of current shunt/ Circuit independent of the output voltage</td>
</tr>
<tr>
<td>EMC</td>
<td>According to European regulations</td>
</tr>
<tr>
<td>Safety</td>
<td>Designed and built according to EN60950, IEC 950, UL1950</td>
</tr>
</tbody>
</table>

### Environmental conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation temperature</td>
<td>–25º C to +50º C environment temperature</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>–40º C to +70º C</td>
</tr>
<tr>
<td>Humidity</td>
<td>5–95% of relative humidity without condensation</td>
</tr>
<tr>
<td>Place of installation</td>
<td>Indoor/Outdoor</td>
</tr>
<tr>
<td>Altitude</td>
<td>0–1,000 m in operation</td>
</tr>
</tbody>
</table>

### General specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>Noise level</td>
<td>&lt; 55 dB</td>
</tr>
<tr>
<td>Control</td>
<td>Fisocrom RA700V</td>
</tr>
<tr>
<td>Automation system</td>
<td>Siemens SIPLUS SIMATIC S7-1200</td>
</tr>
<tr>
<td>Local interface (MMI)</td>
<td>Siemens SIPLUS HMI KTP700</td>
</tr>
<tr>
<td>Communications</td>
<td>Ethernet interface / CAN Interface</td>
</tr>
<tr>
<td>Remote maintenance</td>
<td>Web Server via IP</td>
</tr>
<tr>
<td>Charging standard</td>
<td>EN61851-1/23/24</td>
</tr>
<tr>
<td>Connectors</td>
<td>CCS with 5 m cable</td>
</tr>
</tbody>
</table>
Since December 2014, Hamburg’s Innovation line 109 has operated electric hybrid buses from Volvo, and therefore pollution-free, between the district of Alsterdorf and a newly built electric bus terminal (eZOB). At this route the charging operation is completed in less than 6 minutes.

Since August 2016, Hamburg is the first city to benefit from the interoperability of Siemens charging systems. Three full electric buses from Solaris started passenger operation. The new battery buses are equipped with Siemens onboard interfaces and can be charged at the same charging stations as the existing hybrid electric buses. This is a unique worldwide premiere in eBus technology.
Offboard High-Power Charger

Stockholm

In March 2015 Stockholm began public operation with electric hybrid buses on line 73 between Ropsten and Karolinska Institute. Siemens, together with Vattenfall, installed Siemens HPC charging technology at each end of the route.

Facts & figures

- Bus line 73 operated on a distance of 6.5 km
- Two charging points with low-voltage power supply (400 V AC 3ph+N)
- 150 kW of installed charging power per charging point
- 10-month project realization
- In public operation since March 2015
The electric bus route 55 between Lindholmen and Johanneberg in Gothenburg, Sweden, has been in scheduled service since June 2015. The 9-kilometer route is served by three full electric and seven electric hybrid buses. Siemens, together with Göteborg Energi, the municipal energy provider, installed two high-power charging stations, one at each end of the route, and supplied the entire charging system.

For the first time, a Siemens charging station was installed indoors. Instead of mounting the pantograph to a mast it is assembled to the ceiling of a building.
Onboard Charging via Catenary

Vienna

“Wiener Linien”, the municipal public transport provider in Austria’s capital, commissioned its first full electric bus (eBus), supplied by Siemens and Rampini, in 2012.

At the terminal stops at each end of the line, the electric bus receives the power charge it needs through a roof-mounted pantograph and stores it in its batteries within 15 minutes. The bus also recovers its braking energy, and has a range of 120 to 150 kilometers with one charge – with opportunity charging, the autonomy is practically unlimited.

Facts & figures

- Bus routes 2A and 3A
- Two catenary charging lines at end terminals in downtown Vienna
- Two catenary charging lines at the bus depot connected to the local metro grid for serving up to six buses per line
- Utilization of tram power supply
- Charging equipment (DC/DC inverter) on the roof of the bus including 2-pole pantograph
- 60 kW of charging power
- In public operation since October 2012
Since November 2015, six full electric buses have been taking airline passengers between planes and the terminal building at Stuttgart airport with zero emissions. The electric buses supplied by Cobus Industries are the first full electric airport buses worldwide, powered with Siemens electric motors and charged with Siemens DC plug-in chargers – charging stations designed for fast charging of electric vehicles (with GBT/ or CCS).

**Facts & figures**
- Airport transit traffic Stuttgart
- In operation since November 2015
- Six Siemens single 60 kW DC chargers
- Energy storage system
- ELFA 160 kW powertrain of the vehicles
DC Plug-In Charging

Geneva

Since November 2015, a total of four full electric buses have been taking airline passengers from the planes to the terminal building at Geneva airport with zero emissions. Based on proven technology, the DC plug-in charger is highly reliable, safe, and user-friendly. After connecting the plug to the vehicle, all safety features are automatically verified and the user can start the charging process using the modern, high-quality Siemens HMI touch screen display.

The display indicates information regarding state of charge, power consumption, and currently available autonomy of the EV, among others. The user can stop the charging process at any time using the display. When the batteries are fully charged, the charger stops automatically.

Facts & figures

• Airport transit traffic Geneva
• In operation since November 2015
• Twin chargers for all 4 buses
• Energy storage system
• ELFA 160 kW powertrain of the vehicles