DC Traction Power Supply
Powerful, efficient and safe
More people, more challenges, one solution: Complete mobility.

Needed more than ever before:
Not only the world’s population will continue to grow in the coming years, urbanization will also be on the increase. So much so that experts are predicting that 90 percent of future population growth will be concentrated in cities. Such trends mean however that transport capacities all over the world will have to rise to these challenges and therefore meet the demand for intelligent, sustainable solutions for mobility.

Our approach: “Complete mobility.” Consequently, Siemens is pursuing its “Complete mobility.” approach to create integrated transport and logistics solutions for the safe, economical and environmentally compatible transport of people and goods. But tomorrow’s mobility requirements can only be met if all transportation systems harmonize with one another and interact to best advantage. Major components of “Complete mobility.” include efficient solutions for the traction power supply – for everything from the grid connection and construction of complete substations to the overhead contact lines.

Optimal service – a competent partner
You can benefit from our decades of experience in the engineering, construction and commissioning of DC traction power supply systems. As one of the world’s leading suppliers of electrotechnical plant and innovative technology partner to all major rail operators, we offer you all services from one source and enable you to tap a lot of potential savings. Savings made possible by energy-efficient, heavy-duty traction power supplies and by even more reliable systems and enhanced performance capabilities.
Demographic change, urbanization and climate change: these are the global trends of today and tomorrow. For the world population is not only growing, it’s also getting older. Current forecasts expect it to rise to 9.2 billion by 2050. These people will need efficient transportation and logistics. And that calls for innovative electrification solutions.

And by engineering tools which uncover open questions as early as the project analysis phase. Place your trust in our ability to take a good component and make an even better traction power supply system. When it comes to mass transit, regional and main-line services, we are the right partner for your DC traction power supplies, for consultation and planning, for project implementation and commissioning, and for worldwide service.
Profit from our know-how
Sustained performance for your success

Extremely well advised
We see your traction power supply within a wider context, in which the performance of your system can be directly affected through the interfaces. Our work therefore starts with a thorough analysis of the project conditions and the interfaces. It allows us to correctly estimate the overall implications of the project. We use it as the basis for developing the alternatives, the effects of which we investigate with the aid of a simulation tool which we have developed ourselves.

Saving energy and costs
By taking this wide-ranging approach to projects we avoid problems at interfaces and dimension the network correctly right from the start. This particularly affects the number, spacing, output and consequently the optimal location of the DC substations. During the system design, we work out the best compromise between the structural possibilities and the technical requirements which are determined by the following criteria:
- Voltage drop on the overhead contact line
- Operation in case of substation failure
- Stray currents / rail potentials
- Losses

Security for your decision
We evaluate your network on the basis of a train movement simulation, which then forms the basis for the system design. Our specialized Sitras® Sidytrac software makes it possible to optimize energy consumption, regenerative behavior, potential for saving energy and many other factors. Sitras Sidytrac calculates all the characteristics of the power supply for your trackside facilities as a function of train operations, taking into account the interactions between vehicle and overhead contact system during regenerative feedback. Grounding and the return current circuit are integral parts of the system design. That gives you security.
A separate concept is prepared and specifies the principles for grounding, including lightning and overvoltage protection, for all of the systems involved:

- Negative return
- High and medium voltage systems
- Traction supply
- Low voltage system
- Buildings, structures and infrastructural facilities

All this successfully results in a traction power supply system offering the lowest life cycle costs and meeting your requirements of today as well as tomorrow.

**Electromagnetic compatibility**

Our Sitras EMF simulation tool has been specially developed to calculate the magnetic fields around traction power supply systems. This calculation is a main part of the EMC planning, with which we eliminate interference and ensure operator and plant protection throughout all systems.
Economy is no accident

Efficient DC power supply for mass transit and main line services

Reliability: the all-important factor
Traction power supplies can be trimmed down for the sake of a low purchase price, but that does not help you if it is achieved at the expense of reliability. We mean something else when we speak of a cost-efficient solution: for us, it is important to place priority on the reliable operation of our customer’s trackside facilities – at optimized costs. It also means that the DC substations have to fulfill the characteristic requirements of mass transit and main-line services. In mass transit, these are above all the short distances between stations, high starting acceleration rates and high train densities combined with less space for overall network expansion and therefore more tightly intermeshed networks.

DC traction power supply solutions for main line traffic have to meet completely different requirements due to their different transportation parameters. Longer distances between stations have to be taken into account and, of course, much more electricity has to be transported over a much larger route network.

The starting situation, however, is the same for both mass transit and main line services. The voltage from the three-phase medium-voltage network is stepped down in the DC substation and the three-phase current is rectified. The direct current is then fed into the various line sections of the overhead contact system.

Short distances for higher energy efficiency
While the lower voltages of direct current offer many advantages in terms of safety and structural requirements, the crucial factor when locating the substations is to keep the path of the current to the vehicles as short as possible. We therefore locate the DC substations directly at the trackside wherever possible. Thanks to their compact modular design, this is not usually a problem so they can be positioned under optimal conditions during the system design phase. This avoids long cable routes and the energy losses associated with them.
Flexibility of construction
The extremely compact dimensions of the modules ensure high flexibility in the construction of our substations. For example, we can integrate your substation into an existing building or, as an alternative, install it in previously unused tunnel spaces. Prefabricated buildings are another cost and time-saving option. We can even install your substation in a container to give you maximum flexibility and the shortest project time. These containerized substations can reduce on-site assembly and commissioning work to a minimum.

Built-in economy
With our perfectly harmonized modular portfolio, we are one of the few complete providers of DC traction power supplies. Let your company take advantage of a comprehensive solution from a single source – a solution offering everything from engineering and system components to installation, commissioning and after-sales service.
Success through clean mobility
It is equally important to improve the eco-friendliness and economy of mass transit systems in order to make them more attractive to the public, especially in large metropolitan regions. We contribute to this endeavor by enabling you to save up to 30 percent on energy and by increasing the long-term attractiveness of your transit services.

Optimized energy balance
Sitras Sidytrac – our design and optimization program – plays a decisive role in the energy management of your system. We use it to calculate your entire DC traction supply system in advance – and with an eye on energy management even at this early stage. This analysis is then used to plan your DC traction power supply system, to meet to your requirements, and to optimize energy consumption and regenerative behavior. Thus, we not only improve the ecological aspects of your system but also, when all measures have been implemented, sustainably reduce your costs.

Storing and saving
The energy management components of our Sitras line of products all have one attribute in common: namely, the ability to store electricity quickly and without any difficulty. For you as a rail operator it opens up a multitude of innovative opportunities – both commercially and technically speaking. With the Sitras SES stationary energy storage system, you can use the braking energy generated by modern mass transit vehicles and transformed into electrical energy to feed other vehicles in the transit system at a later time. Or you can use it to improve the stabilization of your voltage network. No matter how you use Sitras SES, it will...

## Ecological and economical

A clean solution: intelligent traction power supply for sustainable mobility

<table>
<thead>
<tr>
<th>Sitras HES hybrid energy storage system</th>
<th>Sitras MES mobile energy storage unit</th>
<th>Sitras SES stationary energy storage unit</th>
<th>Sitras TCR controlled rectifier</th>
<th>Sitras TCI inverter</th>
<th>Sitras TCD two-way converter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reuse of vehicle braking energy</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Energy savings</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Voltage stabilization</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Longer distances between substations</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Feedback into the medium-voltage network for optimized power distribution</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Operation without contact line</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
</tbody>
</table>
make the operation of your systems more economical, more reliable and cleaner.

**Key innovations**

Our energy management components are based on the years of experience gained by our engineers in all areas of traction power supplies, and the latest research and development results. For example, the Sitras SES energy storage mechanism combines proven rail engineering with innovative double-layer capacitors. That makes the system practically maintenance-free, capable of operating with the highest possible degree of availability in parallel to the existing traction power supply system. Furthermore, Sitras TCR thyristor-controlled rectifiers enable substations to be located farther apart. Sitras TCI inverters can be used to optimize power distribution throughout the entire traction power supply system. The Sitras TCD two-way converter, with its combination of controlled rectifier and inverter, offers additional performance capabilities.

**Operating without a contact line**

Our company’s latest development is the Sitras HES, the hybrid energy storage system for trams. Sitras HES combines a double-layer capacitor and a battery to enable a tramcar to travel up to 2,500 meters without an overhead contact line. The complete equipment can be mounted on the roof or integrated inside the vehicle and can also be retrofitted in older cars. The good part of this is that vehicles equipped with Sitras HES use up to 30 percent less energy and emit up to 80 metric tons less CO₂ than vehicles without an energy store. An additional plus point is the operation without an overhead contact line. This is especially suitable for use in historic town centers, where the overhead contact line can be visually intrusive, or, for example, in tunnels, under bridges and at major intersections, where the installation of overhead contact lines can be difficult.

For you as a rail operator, the increasing costs of energy and other resources are making the energy management in your network more important than ever before. Profit from our ideas: transforming braking energy into electricity for later use is just one of many new perspectives that we have to offer.
Perfection in detail

One modular system for all applications
In addition to the proven standard products from the industrial area, the Sitras line of products enables us to offer an optimum solution for every function in the substation. It has been specially developed under the aspect that a large number of individual components have to be integrated to form one perfect system.
The information in this document contains general descriptions of the technical options available, which do not always have to be present in individual cases. The required features should therefore be specified in each individual case at the time of closing the contract.