SMA provides auxiliary power supplies for the redundant board supply and independently controllable air conditioning for the tram-trains of RegioTram Kassel. The tram-trains designed as two-system and hybrid vehicles are manufactured by ALSTOM LHB in Salzgitter and belong to the family of regional light rail vehicles RegioCITADIS™.
Innovative, customized auxiliary power supply for sophisticated two-system vehicle

The auxiliary power supplies belong to SMA’s product family MEE-NTSD (SD = Short Distance) for regional traffic and are based on the MEE-NT platform. SMA has thus an innovative and sophisticated modular platform proven in daily use for auxiliary power supplies in different applications.

Each vehicle for RegioTram Kassel has three auxiliary power supplies. Two MEE-NTSD RegioTram “Generic” are responsible for the partly redundant AC and DC board supply of the vehicle. One MEE-NTSD RegioTram “Air Con” provides an independent, variable frequency and variable voltage supply for each of the three air-conditioning units of the vehicle.

The tram-trains for RegioTram Kassel are designed as two-system and hybrid vehicles. The auxiliary power supply must thus comply with the requirements for both trams and mainline trains. In addition, challenges such as low weight, compact design, natural cooling under partial load conditions, minimum noise emission and high availability arose.

MEE-NTSD RegioTram “Generic”

The MEE-NTSD RegioTram “Generic” consists of an input converter with integrated battery charger and a 3-phase output inverter.

Each input converter features a hard-switching step-up converter on the input side followed by a soft-switching inverter. This inverter produces a high-frequency AC voltage transferred via a HF-transformer. The HF-transformer has 2 secondary windings. One of these windings generates an output DC voltage for supplying the DC loads within the coach and charging the batteries via an uncontrolled rectifier. The system features a battery charging control with temperature compensation and charging current limitation. The second winding on the secondary side of the HF-transformer supplies the connected 3-phase inverter.

The input converter is designed to be used at nominal input voltages of 600 or 750 V DC coming directly from catenary or 3rd rail. The input current may be influenced in terms of control by the step-up converter on the input side. Using comparatively low input inductivities distortion currents can be suppressed at certain frequencies and a defined input impedance to the feeding grid is generated.

Figure 1: Simplified block circuit diagram of the MEE-NTSD RegioTram “Generic”

Figure 2: MEE-NTSD RegioTram “Generic” in roof-mounted, non-welded aluminum enclosure
A special feature of the MEE-NTSD RegioTram “Generic” is the integration of additional functions into the system. A workshop supply from 3 x 400 V AC, an AC and DC distribution, output and coupling contactor and a maintenance-free emergency start-up unit are already included in the system.

**MEE-NTSD RegioTram “Air Con”**

This auxiliary power supply includes an electrically separating input converter with three identical 3-phase output inverters connected to it. Each output inverter supplies an air-conditioning unit with a frequency-variable output voltage. The inverters’ setpoint is specified by the air-conditioning control of each vehicle.

The power electronic modules are identical to the modules of the MEE-NTSD RegioTram “Generic”. The high-frequency transformer of the input converter has only one secondary winding supplying all connected output inverters.

Contrary to the sine filter in the MEE-NTSD RegioTram “Generic” the output inverters of the “Air Con” have one du/dt-filter, each. The power electronic modules are identical.
All roof-mounted enclosures are aluminum containers that are not welded making it possible to design ultra-lightweight enclosures. A modular system is also used for the containers allowing to simply adjust them to the vehicle requirements.

When designing the enclosure it was important to realize a natural cooling under partial load conditions. All power electronic modules have a vertically positioned heat sink. It was possible to generate a "chimney effect" at the heat sink despite of the low height. Operating the system with up to 40% rated load under all environmental conditions is therefore possible without forced cooling.

The fans are mounted into the container with regard to a minimum noise emission. In addition, they are speed-variable. Each power supply system may be switched to a "whisper mode".

Non-welded aluminum enclosures

Technical Data

MEE-NTSD RegioTram “Generic”

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage</td>
<td>600/750 V DC</td>
</tr>
<tr>
<td>AC output</td>
<td>3 x 230/400 V, 50 Hz, 15 kVA</td>
</tr>
<tr>
<td>DC output</td>
<td>24 V DC, 465 A</td>
</tr>
<tr>
<td>Dimensions</td>
<td>1,800 x 700 x 460 (mm)</td>
</tr>
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</table>

MEE-NTSD RegioTram “Air Con”

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage</td>
<td>600/750 V DC</td>
</tr>
<tr>
<td>3 AC outputs with resp.</td>
<td>3 x 0...480 V, 0...60 Hz, 18 kVA</td>
</tr>
<tr>
<td>Dimensions</td>
<td>1,800 x 700 x 460 (mm)</td>
</tr>
</tbody>
</table>

Conclusion

The MEE-NTSD RegioTram “Generic” and “Air Con” are an innovative, sophisticated and reliable solution for the tram-trains for RegioTram Kassel that is optimized for the vehicle concept. Specifically the natural cooling under partial load conditions and the “whisper mode” are outstanding system features.

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