

## ***Railway Power Converters Reach For Wider Input Range And Other Improvements***

*by David G. Morrison, Editor, How2Power.com*

In the world of industrial-grade power supplies, railway applications represent a special niche for which power supply/power converter manufacturers must develop specialized products with rugged electrical and mechanical designs that meet a variety of regulatory standards, can operate from various railway-specific voltage buses, and endure many years of operation in harsh environments.

The applications include both those in traction and rolling stock as well as trackside equipment. Power supplies developed for these applications offer approvals for standards such as EN 50155 Railways Applications - Electronic equipment used on rolling stock; EN 61373 Rolling Stock Equipment-Shock and vibration tests; EN 50121-3-2 Railway applications- Electromagnetic Compatibility-Rolling stock-Apparatus and EN 45545-2 Fire Protection on Railway Vehicles. Additionally, some power supply descriptions cite North American AREMA requirements, the RIA12 General Specification for Protection of Traction and Rolling Stock Electronic Equipment from Transient and Surges in DC Control Systems, and IP66-rated protection against water, dust and other environmental contaminants.

While their requirements for durability, reliability and long life, and their specialized electrical and mechanical specifications set power supplies for railway applications apart as a distinct power supply category, these same products may also find uses in other industrial applications, which may have similar environmental or electrical demands. Some examples include other, non-rail transportation systems such as construction vehicles, plus medical and broadcast equipment, robotics, renewable energy systems and fuel cell applications.

This article offers a roundup of news about railway-grade power converters introduced over approximately the past two years. It mainly covers dc-dc converters at power ranges from 10 W up to 300 W for input voltages from about 9 V up to 176 V, which covers a variety of popular bus voltages. This article also includes a few converters designed for operation from a high-voltage bus of 750 V or 900 V nominal. Unless otherwise noted, all of these dc-dc converters are stepdown converters, and most are isolated.

Among the dc-dc converters featured in this roundup, "ultra-wide" input voltage range is frequently cited as a product differentiator, leading to a number of converters that can operate from a 10:1 or greater input voltage range. High power density, high efficiency (>91%), and wide operating temperature ranges are also cited as distinguishing features. Some of the newer converters may also differentiate from their competition by offering high levels of input-to-output isolation (3 kV dc or greater), special protection features or extensive sets of protection features.

This roundup also highlights some recently introduced ac-dc power supplies, mostly in the 150-W to 300-W range, plus one 3-kV unit. Universal input range, power factor correction and various features related to reliability and durability are cited as key features of these supplies. Additionally, these enclosed units are designed for conduction and convection cooling.

Other railway power supply products covered in this article include a family of USB chargers, and two series of sinewave inverters rated at 100 VA and 1000 VA. Some related manufacturer news is also presented.

In of each of the power supply categories discussed, the products are presented in approximate order of their power ratings. The following products are featured in this article.

### DC-DC Converters:

- 10-W DC-DC Converters Come In 1-in. x 1-in. Shielded Metal Package (Traco Power)
- Compact 12-W DC-DC Converters Operate Over Wide Input Voltage Range (Recom)
- 20-W DC-DC Converters Operate From 8.5 V to 160 V (Relec Electronics)
- 20-W DC-DC Converters Come In 1-in. x 1-in. Metal Package (Traco Power)
- 20-W And 25- W DC-DC Converters Accept Inputs Up To 176 V (XP Power)
- 20-W And 40-W DC-DC Converters Feature Dual Outputs (Traco Power)
- 40-W and 60-W DC-DC Converters With Wide Input Range Eliminate High Voltage Capacitors (Traco Power)
- 60-W DC-DC Converters Come in 2-in. x 1-in. Metal Package (Traco Power)

- Sixteenth Brick Delivers 50 W From 9-V To 36-V Input (Murata Power Solutions)
- Chassis-Mount 60-W DC-DC Converters Are Compact And Reliable (Bel Power Solutions)
- 120-W Eighth Bricks Offer High Performance From 9-V To 36-V Inputs (Murata Power Solutions)
- 150-W And 200-W Half Bricks Operate Over 14-V To 160-V Input Range (Relec Electronics)
- DC-DC converters Offer Pure Convection Cooling And Flexible Mounting Options (ABSOPULSE Electronics)
- 200-W DC-DC Converters Are Waterproof And Dust Proof (ABSOPULSE Electronics)
- Encapsulated 200-W DC-DC Converters Provide High Surge-Withstand Capacity (ABSOPULSE Electronics)
- Evaluation Platforms For DC-DC Railway Converters Up To 240 W (Recom)
- 250-W DC-DC Converters Raise Efficiency And Reliability, Add Features (MTM Power)
- Quarter Brick And Half Brick Converters Provide 50 W to 250 W, No Minimum Load (Aimtec)
- 250-W Half-Brick And 150-W Quarter-Brick DC-DC Converters With 10:1 Input Range (Murata Power Solutions)
- 300-W Chassis-Mount DC-DC Converter Delivers >92% efficiency, Inrush Control (Murata Power Solutions)

#### High-Voltage-Input Models:

- SiC-Based 750-V Input DC-DC Converter Delivers High Efficiency And High Power Density (ABSOPULSE Electronics)
- 750-V DC-DC Achieves High Efficiency Across Load Range (Powerbox)
- 100-W DC-DC Converters Operate From 900-V Input With Wide Input Range (ABSOPULSE Electronics)

#### AC-DC Power Supplies:

- 150-W Power Supplies Are Designed For Worldwide Use, Robustness (MTM Power)
- 250-W Dual-Output AC-DC Power Supplies Offer Convection Cooling And Active PFC (ABSOPULSE Electronics)
- 300-W AC-DC Cassette Converters Generate Two, Isolated 12-V or 15-V Outputs (Bel Power Solutions)
- 300-W AC-DC Power Supplies With PFC-Input And IP66-Rated Protection (ABSOPULSE Electronics)
- 3-kW AC-DC Power Supply Offers Built-In Redundancy And PFC (ABSOPULSE Electronics)

#### Chargers:

- USB Chargers For Railway Vehicles (MTM Power)

#### DC-AC Inverters:

- 100-VA Sine Wave Inverters Are Water And Dust Proof (ABSOPULSE Electronics)
- 1000-VA Sine Wave Inverters Feature Low Profile (ABSOPULSE Electronics)

#### Related news:

- Power Converter Maker Receives IRIS Certification (Bel Power Solutions)
- DC-DC Converters Comply with EMV 06 EMC Regulation (MTM Power)

This article, represents a follow-up to two previously published railway power supply features.<sup>[1,2]</sup> Additional information on railway power supply manufacturers may be found in How2Power's source list on industrial power supply manufacturers.<sup>[3]</sup> All of these resources may be found in How2Power's Industrial Power Supplies section.<sup>[4]</sup>

## DC-DC Converters

### 10-W DC-DC Converters Come In 1-in. x 1-in. Shielded Metal Package

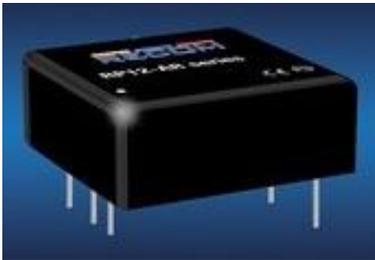
Traco Power's THN 10WIR series ruggedized 10-W dc-dc converters have a wide 4:1 input range of 9 to 36, 18 to 75 or 36 to 160 V. Housed in a six-sided, shielded 1-in. x 1-in. metal package, the converters offer increased resistance against electromagnetic interference, shock/vibration and thermal shock. The innovative design provides high efficiencies up to 90%, enabling operation from -40°C to +80°C without derating.

Featuring EN 50155 and EN 61373 railway approvals, these converters are suitable for both railway and transportation systems. In addition, the THN 10WIR series is qualified for fire behavior of components according to EN 45545-2 and safety approval according to IEC/EN 62368-1 and UL62368-1.

Built-in features like an internal EN 55032 class A filter, input undervoltage lockout, short circuit protection, remote on/off and output voltage trim make this series suitable for almost any application demands and thus facilitate the design-in process. Converters are also protected against overload and overvoltage and feature 3000-Vdc I/O-isolation. The THN 10WIR series converters also come with a three-year product warranty. For more information, see the THN 10WIR series [page](#).



### Compact 12-W DC-DC Converters Operate Over Wide Input Voltage Range



RECOM's RP12-AR dc-dc converter series offers compact 12-W 1-in. x 1-in. modules that operate with 90% efficiency and at temperatures up to +88°C ambient at full load. The converters are designed for railway rolling stock applications, but they are also suitable for non-railway high-voltage battery applications. Their 5:1 dc input voltage range of 36 to 160 V (185 V for 1s) allows for all-in-one solutions for 48-V, 72-V, 96-V and 110-V dc railway systems.

They have a built-in class A filter network and offer single or dual outputs from 3.3 V up to  $\pm 24$  V. The high efficiency of up to 90% enables these modules to be operated at a wide ambient temperature range from -40°C to +88°C without derating. Neither forced cooling nor additional heatsinks are required when operating them at full load.

The RP12-AR converters feature UVLO, OVP, SCP, and OLP, which makes them well suited for many harsh railway and industrial applications such as powering IoT sensors, battery management systems or electric forklift trucks. They are CE marked and come with a three-year warranty. Samples and OEM pricing are available from authorized distributors or directly from RECOM. For more information, see the RP12-AR series product [page](#).

### 20-W DC-DC Converters Operate From 8.5 V To 160 V

From [Relec Electronics](#), the Cincon EC7BW18-72 is a 20-W dc-dc converter with an ultra-wide input range of 8.5 V to 160 V, making it suitable for all common battery voltages from a single 12-V battery to 110-V systems. The EC7BW18-72 has been designed primarily for the railway sector as a one-size-fits-all solution for diesel sprinters (24 V), London Underground (52 V), freight locos (72 V) and electric mainline (110 V) trains. The units will also work with 12-V batteries making them suitable for use in the automotive sector.

The EC7BW18-72 series has been qualified in accordance with the following regulatory requirements: CB Test Certificate IEC62368-1, fire and smoke per EN45545-2, shock and vibrations per EN 50155 (EN 61373), EN50155/EN50121-3-2 with external circuits and UL62368-1 2nd edition (reinforced insulation). Additionally, the wide input range means the units meet the requirements of RIA12 Surge A on 24-V and 52-V systems (3.5 x  $V_i$  nom 20 ms).



CB Test Certificate IEC62368-1

Fire & Smoke Meet EN45545-2

Shock & Vibration meets EN 50155 (EN 61373)

Meets EN50155/EN50121-3-2 with External Circuits

UL62368-1 2nd edition (Reinforced Insulation)

High efficiency up to 90%, allows for a case operating temperature range of  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$ . An optional heat sink is available to extend the full power range of the unit. The EC7BW18-72 also has very low no-load power consumption (8 mA), making it well suited for energy-critical systems.

Standard control functions include remote on/off (positive or negative) and +15%, -20% adjustable output voltage (single output only). Units are fully protected against input undervoltage lockout, output overcurrent, output overvoltage, and overtemperature and continuous short circuit conditions.

Samples of the EC7BW are available. The technical team at Relec is available to guide you through the design-in process, provide samples, and offer commercial support right through to production. For more information, see the EC7BW18-72 series [page](#).

### 20-W DC-DC Converters Come In 1-in. x 1-in. Metal Package

[Traco Power's](#) THN 20WIR series 20-W high-density dc-dc converters come in the industry-standard 1-in. x 1-in. footprint with a 0.39-in. case height. These converters have been qualified for railway and rugged industrial applications with EN 50155 and EN 61373 certifications and IEC/EN/UL 62368-1 approvals. They offer high reliability in harsh environments.



The series consists of 24 models featuring 4:1 dc input ranges of 9 to 36, 18 to 75, or 36 to 160 V and single or dual outputs ranging from 3.3 to 24 V. Their high-density design provides high efficiencies up to 91%, an operating temperature range of  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and increased resistance against electromagnetic interference, shock/vibration and thermal shock.

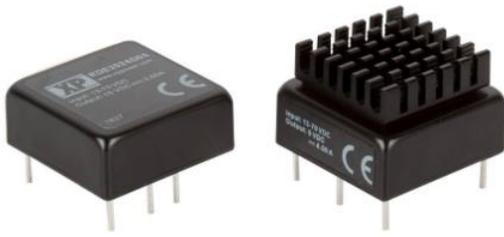
Features include an internal EN 55032 class A input filter, input undervoltage lockout, short-circuit protection, remote on/off and output voltage trim. MTBF is >1.2 million hours and these converters are supported by a three-year warranty.

Products are in stock and available through TRACO POWER's global distribution network. See the THN 20WIR series product [page](#) for specifications, drawings and safety documentation.

### 20-W And 25- W DC-DC Converters Accept Inputs Up To 176 V

[XP Power's](#) RDE20 and RDF25 series of high-power density dc-dc converters for railway traction and rolling stock applications offer wide input voltage ranges. The 20-W rated RDE20 series features a 4:1 dc input range covering 24 V, 37.5 V and 48 V nominal on the 13-V to 70-V input versions, and 72 V and 110 V nominal on the 42-V to 176-V versions. The 25-W rated RDF25 series converters boast an ultra-wide 10:1 dc input range of 16 V to 160 V covering all nominal inputs from 24 V to 110 V with one device.

Certified to EN50155 and EN50121-3-2, the converters carry the safety approvals and meet the EMC requirements for railway applications. Further, designed to EN45545-2 they meet the relevant fire protection standards. Using a small number of external filtering components, these devices offer a very high-power density compared to other products that meet these industry standards, according to the vendor, making them suitable for space-constrained applications. In particular, the RDE20 features a 1-in. x 1-in. footprint.



The converters' high efficiency means a reduced requirement for cooling, and their remote on/off facility enables simple, reduced power consumption in the off condition. The converters offer output short circuit, overload and overvoltage protection, while their 3-kV input-to-output isolation safely isolates equipment from the supply. Both series operate in an ambient temperature range of -40°C to +100°C, and provide full power output at +55°C.

Specific train-borne applications in traction and rolling stock include door control, safety monitors, communication systems, video surveillance, access and ticketing machines, drive controls, power controls, information systems, lighting, passenger device-charging USB ports, HVAC systems, sanitation control, infotainment, system monitoring and telemetry. Their construction also makes them suitable for rugged environment applications.

These series are available from Allied Electronics, Digi-Key, element14, Farnell, Newark, RS Components, approved regional distributors, or direct from XP Power and comes with a three-year warranty. For more information, see the RDE20 series [page](#) and the RDF25 series [page](#).



## 20-W And 40-W DC-DC Converters Feature Dual Outputs

[Traco Power's](#) TEQ 20WIR and 40WIR are two series of isolated high-performance railway dc-dc converter modules with 4:1 input voltage ranges which come in a rugged metal case. Featuring EN 50155 approval, these converters are designed particularly for railway and industrial applications where often no PCB mounting is possible and chassis mounting is required. Spring clamps additionally support the converters increased shock and vibration resistance.

The product range is now extended with additional dual-output models ( $\pm 12$ ,  $\pm 15$  and  $\pm 24$  V) to further increase the application range. A very high efficiency of up to 91% and the heatsink construction allow an operating temperature up to +83°C (natural convection) without power derating and up to +93°C with power derating, leading to an operating temperature range of -40°C to +93°C.

Additional features include undervoltage lockout, overtemperature protection and short-circuit protection, I/O isolation up to 3000 Vdc, and an input filter that meets EN 55032, class B. Products in this series come with a three-year warranty. For more information see the TEQ 20WIR product [page](#) and the 40WIR product [page](#).



## 40-W And 60-W DC-DC Converters With Wide Input Range Eliminate High-Voltage Capacitors

Traco Power's TEP 40UIR and TEP 60UIR are two series of high-performance railway dc-dc converters with 12:1 input voltage range featuring a compact quarter-brick (2.3-in. x 1.45-in. x 0.5-in.) metal package. The ultra-wide dc input of either 9 to 75 V or 14 to 160 V allows a single stepdown converter to act as an all-in-one solution if different voltage ranges have to be covered in the same application.

An internal circuit implemented in these modules helps to extend the hold-up time with ease as it eliminates the need for expensive high-voltage capacitors to cover the full input range. With only a 25-V capacitor (independent of the input voltage) the whole input range can be covered, effectively reducing cost, size and inrush current.



All models are approved for railway applications according to EN 50155, EN 61373 and EN 45545-2, and offer standard features such as high efficiency up to 91%, an operating temperature range of -40° to +85°C and an I/O-isolation voltage of 3000 Vac. The converters also include an adjustable undervoltage lockout function, remote on/off and adjustable output voltage.

Products in both series come with a three-year warranty. For more information, see the TEP 40UIR product [page](#) and the TEP 60UIR product [page](#).

## 60-W DC-DC Converters Come in 2-in. x 1-in. Metal Package

Traco Power's TEN 60WIR is a ruggedized 60-W railway-approved dc-dc converter series with a wide 4:1 input voltage range and increased resistance against electromagnetic interference, shock/vibration and thermal shock. The standard version comes with a preassembled heatsink which was specifically designed for this 2-in. x 1-in metal package converter. Together with a high efficiency of up to 92% this gives the converter an effective operating temperature range of -40° to +70°C without derating.



The approvals according to standards EN 50155 and EN 61373 qualify them for railway and transportation systems. Additional qualifications for the fire behavior of components according to EN 45545-2 and the safety approval according to IEC/EN 62368-1 and UL62368-1 support potential compliance tests of the application. All models offer an I/O-isolation voltage of 3000 Vdc and feature an active undervoltage lockout function, remote on/off and adjustable outputs.

Products in this series come with a three-year product warranty. For more information see the TEN 60WIR product [page](#).



## Sixteenth-Brick Delivers 50 W From 9-V to 36-V Input

Murata Power Solutions' IRS-Q12 series encapsulated sixteenth-brick dc-dc converters incorporate advanced assembly techniques, 2250-Vdc isolation with a basic insulation system, and what the company describes as industry leading efficiency. Additionally, the high reliability, safety features and optional packaging configurations offer an unmatched level of performance in harsh environmental conditions, according to the vendor.

The DOSA-compatible 50-W IRS-Q12 has an input voltage range of 9 V to 36 V, which expands the low end of the input voltage range from the 18 V to 75V range of the previously released IRS-Q48, another 50-W sixteenth-brick series for rail applications. The new line includes module variations with dc outputs of 3.3 V, 5 V, 12 V, 15 V or 24 V with up to 50 W of output power. Further, the Vin range of 9 V to 36 V meets the requirements of EN50155 for a nominal Vin of 24/28 Vdc, including brownout and transient conditions, in addition to serving industrial applications with a nominal 12-V input.

The series is available with a standard or flanged baseplate to allow for various conduction cooling configurations. Other notable features include on/off control with positive or negative logic, short circuit protection, as well as overvoltage and overtemperature protection.

The IRS-Q12 topology also supports a pre-biased output at start-up to eliminate reverse currents that can potentially damage critical circuitry. These benefits make it well suited for demanding railway, industrial, lighting, smart grid, and other harsh environment applications with system bus voltages between 9 V and 36 V dc.

“The IRS-Q12 represents an industry-leading combination of architectural design, component selection, package design, and assembly techniques that are proprietary to Murata. The result is a solution that enables the highest performance and reliability available on the market today,” said John Quinlan, senior product marketing manager, Murata Power Solutions. For more information, see the IRS-Q12 [datasheet](#).



### Chassis-Mount 60-W DC-DC Converters Are Compact And Reliable

[Bel Power Solutions](#)’ RCM60 60-W chassis-mount dc-dc converters are designed for railway applications where compactness and high reliability are required. These new RCM series products are fully isolated and highly efficient over a broad operating range of input and output voltages. In addition, their compact size and ease of installation make them well suited for various rolling stock applications, such as cab radios, HVAC systems, train control, passenger information systems, toilet systems, door control, illumination and many others.

The RCM series converters are fully compliant to international railway standards EN 50155, EN 50121-3-2, EN45545-2 and North American AREMA requirements. In addition, the RCM series is safety approved to the latest edition of IEC/EN/CSA/UL 62368-1.



Nominal on-board battery voltages from 24 V to 110 V are covered by one universal ultra-wide input range and converted into a fully regulated and isolated single output voltage of 12 V, 15 V or 24 V. The converters can operate fully loaded in a convection-cooled environment at temperatures from -40°C up to 70°C. All PCBs are conformal coated and protected against humidity and pollution which occurs during typical lifecycles of +20 years of rolling stock equipment.

The converters are fully protected against overload, overvoltage, overtemperature, undervoltage, no-load and short circuit with automatic recovery. Additional features include integrated hold-up capacitors for 20-ms interruption, ORing FET and passive current share for parallel and redundant operation, as well as enable and an output voltage monitoring signal. Optional pluggable connectors are an alternative to the standard cage-clamp terminals. These innovations make the RCM60 W dc-dc converters well suited for a broad range of applications in the global railway market.

RCM60 units are currently in stock with [Digi-Key](#), [Mouser](#), [Arrow](#), [Relec Electronics LTD](#) and [Elma Electronic AG](#). For more information, download the RCM60 series [datasheet](#). For technical inquiries, see [belfuse.com/power-solutions](http://belfuse.com/power-solutions).

### 120-W Eighth Bricks Offer High Performance From 9-V to 36-V Inputs

[Murata Power Solutions](#)’ 120-W IRE-Q12 series offers the first eighth brick in the company’s line of encapsulated dc-dc converters. The IRE-Q12 series was designed specifically for industrial, railway and transportation applications with system bus and battery voltages between 9 V and 36 V. According to the vendor, these converters provide leading performance and efficiency through advanced power supply technology for fixed-frequency switching architectures.



The IRE-Q12 converters generate fully regulated dc outputs of 5 V, 12 V or 24 V, at up to 120 W. These features meet the requirements of EN50155 for 24-V nominal battery voltages including brown out and transient conditions. Extensive testing ensures that the product can withstand the harsh environmental conditions typically found in railway and industrial applications.

In addition to providing basic insulation with 2828-Vdc input-to-output isolation, the fully encapsulated eighth bricks are available with a standard or an optional flanged baseplate to optimize typical configurations for conduction cooling. Other features include on/off control with positive or negative logic, as well as short circuit, overvoltage, and overtemperature protection. Additionally, the series supports a pre-biased output at start-up, eliminating reverse currents that can damage critical circuitry.

For more information, see the IRE-Q12 products search results [page](#) or the [datasheet](#).

### 150-W And 200-W Half Bricks Operate Over 14-V To 160-V Input Range

From [Relec Electronics](#), the Cincon CHB150W12 and CHB200W12 conduction-cooled half-brick dc-dc converters deliver 150 W and 200 W of regulated dc output while operating from an ultra-wide 14-V to 160-V dc universal input. The CHB150W12 and CHB200W12 families have been designed with the railway industry in mind, meeting the requirements of EN62368-1, EN50155 and EN45545-2, but also lend themselves to wider industrial applications, such as robotics, agricultural, medical & broadcast, where the ability to operate from multiple dc supplies is a benefit.

Units are available with 5-, 12-, 15-, 24- or 48-V outputs and have 3000-Vac reinforced input-to-output isolation as standard. Units operate with efficiencies up to 91% with case temperatures from -40°C to +100°C. Optional heat sinks are available to extend the full power range of the modules.

Control features include output adjustment from -20% to +15%, with remote on/off available with either positive or negative logic and a user-settable undervoltage lockout facility. Hold up time can be managed across the entire input voltage range by connecting capacitance to the "Bus" control pin, allowing the possibility to have a fully complaint system to the requirements of EN50155 with any input supply voltage. All CHB150W12 and CHB200W12 modules have full protection against output overcurrent (including short circuit), output overvoltage and overtemperature.



Full application support is available with recommended PCB layouts, external heatsinks or detailed thermal profiling, as well as support for series or parallel connection, and redundant operation. Larger systems can also be constructed with multiple modules with the ability to synchronize output ripple through the

use of an external clock and the modules "Sync" control pin.

Relec is able to help engineers quickly design in the CHB150W12 and CHB200W12 modules into any system. For more information, see the CHB150W12 and CHB200W12 [page](#).

### DC-DC Converters Offer Pure Convection Cooling And Flexible Mounting Options

[ABSOPULSE Electronics'](#) RWY 200-HSA-P2 series is a 200-W addition to its line of fully encapsulated railway quality dc-dc converters with pure convection cooling. The converters are cooled by a heatsink assembly attached to their under surface. This ensures operation over -40°C to +55°C temperature range for full specification without derating; wider temperature ranges are available on request.

The heatsink assembly can be mounted to a chassis or DIN-rail. The chassis-mounted option is suitable for applications in which a suitable heatsinking surface is not available and only convection cooling will suffice. The heatsink assembly is also suitable for mounting on thermally non-conductive surfaces such as wood, plastic and brick walls. All RWY 200-HSA-P2 units are shipped with DIN-rail clips, providing customers with the option of both chassis and DIN-rail mounting.



The converters are fully encapsulated with a thermally conductive MIL-grade silicon rubber compound with a UL94V-0 flammability rating. Encapsulation ensures protection from high levels of shock and vibration, moisture, dust, salt, fog and other contaminants. Encapsulation also provides heat dissipation throughout the module.

The 200-W railway converters deliver a single, regulated dc output of 12, 24, 36, 48 or 110 V. They accommodate a broad range of battery and bus distribution voltages while operating with wide input voltage tolerances. Inputs ranges comply with EN50155 and include 14.4 to 34 V (24 V nominal), 36 V (22 to 51 V), 29 to 67 V (48 V nom.), 43 to 101 V (72 V nom.) or 66 to 154 V (110 V nom.). Custom input and output voltages are available. Units specify  $\pm 1\%$  line and load regulation combined from no load to full load.

The converters meet the requirements of EN50155 for electronic equipment used on railway rolling stock. They are equipped with heavy filtering on the input and output and comply with EN50121-3-2. The units also meet EN61000-4-2 (ESD), EN61000-4-3 (RF immunity), EN61000-4-4 (fast transients), and EN61000-4-6 (conducted immunity). Other protection features include 3000-Vdc input-to-output isolation, overload protection, thermal protection and current limiting.

A P200 encapsulated unit measures 69 mm x 58 mm x 211 mm (2.7 in. x 2.3 in. x 8.3 in.) or 3.9 in. x 4.2 in. x 10.65 in. when installed on an HSA P2 4x10 heatsink assembly. For more information, see the [datasheet](#) or see the dc-dc power converters [page](#).

### 200-W DC-DC Converters Are Waterproof And Dust Proof



[ABSOPULSE Electronics](#)' RWY 200-D1 (IP66) railway-quality dc-dc converters are designed for train and mobile applications that require IP66-rated protection. Installed in die cast aluminum IP66-rated packages, the converters are protected from the ingress of water from powerful jets, metallic dust, dust, fog, sand, oil, salt, insects and other environmental contaminants. The input and output are via sealed cable glands, circular connectors or custom connections. Application-specific vents for pressure equalization ensure that pressure inside the enclosures is equalized, that the strain on connectors is minimized and the environmental seal remains impermeable.

The RWY 200-D1 (IP66) converters employ a field-proven design topology to generate 200-W output power. They convert 24 V, 48 V, 72 V, 96 V or 110 V with wide EN50155 input ranges, to 12 V, 24 V,

48 V or 110 V or any other output voltage within this range. Line and load regulation is  $\pm 1\%$  combined from zero load to full load.

The converters meet the requirements of EN50155 for electronic equipment used on railway rolling stock. The units are equipped with heavy filtering on the input and output and comply with EN50121-3-2. They also meet EN61000-4-2 (ESD), EN61000-4-3 (RF immunity), EN61000-4-4 (fast transients) and EN61000-4-6 (conducted immunity). Other protection includes 3000-Vdc input-to-output isolation, overload protection, thermal protection and current limiting. The MTBF is 150,000 hours at 45°C.

Cooling is by conduction and convection via the walls of the IP66-rated enclosure. Operating temperature range is -25°C to +55°C for full specification. The total size of the units, including baseplate, excluding connectors, is 267 x 120 x 84 mm (10.5 x 4.7 x 3.3 in.). They weigh approximately 2.4 kg (5.3 lb).

For more information see the [datasheet](#), the dc-dc power converters [page](#) or the IP66-Rated Power Solutions [page](#).

### Encapsulated 200-W DC-DC Converters Provide High Surge-Withstand Capacity

[ABSOPULSE Electronics](#)' RWR-212-P200L is a 200-W series of fully encapsulated RIA12 railway-quality dc-dc converters. The units have an input voltage surge-withstand capacity 3.5 times nominal input voltage for 20 ms and meet the requirements of RIA12 with wide margins. RIA12 is the general specification for protection of traction and rolling stock equipment from transients and surges in dc control systems.



The railway converters offer wide EN50155 dc input ranges of 24 V (14.4 to 34 V), 36 V (22 to 51 V), 48 V (29 to 67 V), 72 V (43 to 101 V), 96 V (58 to 135 V) or 110 V (66 to 154 V). The 200-W units provide outputs of 12 V, 24 V or 48 V. Custom input and output voltages are available on request. Regulation is better than 1% from zero load to full load across all line and load conditions. Efficiency is 80% to 90% depending on input/output configuration.

The RWR-212-P200L converters meet the requirements of EN50155 for electronic equipment used on railway rolling stock. They are equipped with heavy filtering on the input and output and comply with EN50121-3-2. They also meet EN45545, EN61000-4-2 (ESD), EN61000-4-3 (RF immunity), EN61000-4-4 (fast transients) and EN61000-4-6 (conducted immunity). Other protection includes

3000-Vdc input-to-output isolation, overload protection, thermal protection and current limiting.

The dc-dc converters are fully encapsulated with a thermally conductive MIL-grade silicon rubber compound with a UL94V-0 flammability rating and meet environmental criteria as requested in MIL-810C, D. Encapsulation ensures heat dissipation throughout the module as well as protection from high levels of shock and vibration.

Encapsulation also ensures immunity to moisture, fog, oil, salt, dust and other contaminants. Conduction cooling via base plate to customer chassis or heat sink enables operation over a -40°C to +70°C temperature range for full specification without derating.

The railway converters are available in a compact [P200L](#)-type chassis with flanges installed on the side of the unit, which measures 94 x 60 x 230 mm or a [P200X](#) chassis, which has flanges at each end of the chassis and measures 70 x 57 x 253 mm. For more information, see the [datasheet](#) or the dc-dc power converters [page](#).

### Evaluation Platforms For DC-DC Railway Converters Up To 240 W

[RECOM's](#) R-REF04-RIA12-1 and R-REF04-RIA12-2 are evaluation platforms for dc-dc railway converters up to 240 W. They are available in either high voltage (-1) or high current (-2) layouts and include a RIA12 surge stopper.

The R-REF04-RIA12-1 and R-REF04-RIA12-2 are complete reference designs for railway applications. The R-REF04-RIA12-1 board is populated with components rated for higher dc input voltages up to 110 V nominal input; the R-REF04-RIA12-2 board is populated with components rated for higher dc input currents up to 10 A. Both boards are input-side fused and can be used with dc-dc converters with single output currents up to 45 A. The reference designs include a RIA12-conform surge stopper capable of blocking surge voltages up to 385 Vdc. The universal pinout accommodates dc-dc converters with 2-in. x 1-in., quarter-brick or half-brick standard case dimensions including the entire RECOM portfolio of railway dc-dc converters up to 240 W.

The reference designs and OEM pricing are available from all authorized distributors or directly from RECOM. For more information, see the R-REF04-RIA12 series product [page](#).



### 250-W DC-DC Converters Raise Efficiency And Reliability, Add Features

[MTM Power's](#) PCMDS250 is a dc-dc converter series for universal applications in railway and vehicle technology. The PCMDS250 series is based on a revision of the well-proven PCMD250 converter series after more than 10 years of successful market presence. The aim of the development was a further increase in efficiency and reliability and the integration of various features such as "power good" signaling and standby operation.

The converters produce a dc output voltage of 24 V at an output power of 250 W. The design of the output voltage with U/I (constant voltage/constant current) characteristic allows the supply of critical loads and charging of batteries (optional  $V_{out} = 27.6$  V). In accordance with EN 50155, two dc input voltage ranges are available: 24 V (16.8 to 30.0) and 110 V (50.4 to 137.5 V), which allow the operation of the dc-dc converters on common battery or on-board networks in Europe, in trackside applications and in stationary railway systems.

The converters feature an "Output Voltage OK" signal as a potential-free contact as well as remote control to place the converter in a standby mode with the lowest power consumption. An undervoltage shutdown protects the converter as well as the application from damage during "brown out" effects of the supply voltage. Using a primary-side control input RC (remote control), they can be put in a standby mode with lowest power consumption; thus contributing to a longer availability of the supplied systems, especially during battery operation.



The dc-dc converters are now connected via push-in cage-clamp connectors with lever, which are designed for wire cross sections up to 4 mm<sup>2</sup>. Designed for an operating temperature range of -40°C to + 70°C (class TX according to EN 50155) the cooling is guaranteed either by the integrated heatsink (option WK) or by mounting the baseplate on a heat dissipating surface.

The converters are robust against mechanical stress such as shock and vibration. Described as maintenance free, these vacuum potted (EP 1 987 708, U.S. Patent No. 8,821,778 B2) units offer reliable protection against condensation, conductive dust and other environmental conditions. A version with protection degree IP67 is possible on customer request.

The compact dimensions of 156.6 mm x 86 mm x 55 mm or 156.6 mm x 162 mm x 55 mm (option WK) and the high packing density allow an efficient, cost-saving solution for different power supply tasks in railway applications. For more information, see the [website](#).

### Quarter Brick And Half Brick Converters Provide 50 W to 250 W, No Minimum Load

[Aimtec's](#) AM50/75/100/QB-JZ and AM150/250HB-JZ series are high-performance quarter- and half-brick dc-dc converters specifically designed for a variety of railway applications. They feature output power of 50, 75, 100, 150 and 250 W across five series with no requirement for minimum load, a wide input voltage of 43 V to 160 V, operating temperature up to 105°C and reinforced I/O isolation of 3000 Vac.

Additionally, these series also include protection against input undervoltage, output overvoltage, short-circuit, overcurrent and overtemperature. The converters also feature remote on/off control, remote sense compensation and output voltage trim adjustment while meeting EN50155 railway standards. They are widely used in railway centralized lighting, air conditioning and related on-board equipment.

For more information, see the [AM50QB-JZ](#), [AM75QB-JZ](#), [AM100QB-JZ](#), [AM150HB-JZ](#) and [AM250HB-JZ](#) datasheets.

### 250-W Half-Brick And 150-W Quarter-Brick DC-DC Converters With 10:1 Input Range

[Murata Power Solutions'](#) 250-W IRH-W80 half-brick and 150-W IRQ-W80 quarter-brick dc-dc converters feature an ultra-wide 10:1 input voltage range (16 V to 160 V), high power density, and efficiency levels above 91%. The modules are designed for embedded applications in the railway and industrial sectors.

They comply with the requirements of EN50155 for shock, vibration, extreme temperatures and humidity. Typical applications include powering equipment on board trains, such as infotainment, communications and lighting, and from a wide range of battery voltages, that require a reliable dc source. The modules also can be used in other industrial applications that operate from batteries in harsh environments.

The converters have a baseplate operating ambient temperature range of -40°C to 100°C. Single 12-V, 24-V, and 54-V output models are available with galvanic isolation between the input and output in excess of 4 kVdc. Features include remote enable on/off, a wide output voltage adjustment range of ±10%, remote sense, hold-up function, pulse out feature, positive or negative enable and overcurrent protection adjustment.

In addition, adjustable undervoltage lockout protection prevents deep discharge of the supplying batteries. The modules also feature self-protection to external short circuits, overcurrent protection, and overtemperature protection with self-resetting ability.

Evaluation boards for the 250W IRH-W80 and 150W IRQ-W80 are available on request. For more information, see the IRH-12/21-W80NB-C product [page](#) or the IRQ-12/12.5-W80NB-C product [page](#).

## 300-W Chassis-Mount DC-DC Converter Delivers >92% Efficiency, Inrush Control



[Murata Power Solutions'](#) IRV300 is a 300-W chassis-mount dc-dc converter with an ultra-wide 10:1 input range, a patented inrush current control topology and a high efficiency of >92%. The IRV300 is a fit-and-forget module designed for harsh operating environments in railway and industrial applications. It conforms to EN50155, EN50121 and EN45545, and has an operating ambient temperature range of -40°C to +85°C.

The IRV300 covers a dc input voltage range of 16.8 V to 160 V, which accommodates all potential battery sizes with a single part number. Single 300-W outputs of 12 V, 24 V, and 54 V are available with output voltage adjustment capability of up to  $\pm 15\%$ , which covers all major application voltages. Galvanic isolation between the input and output is in excess of 4 kVdc.

Standard features include enable on/off, input undervoltage lockout adjustment, wide output voltage adjustment range and LED

indicator. Optional features include a hold-up capacitance for class S2 applications and OR'ing FETs for parallel redundancy. The IRV300 also features self-protection to external short circuits, overcurrent protection and overtemperature protection with self-resetting capability. For more information, see the [IRV300 search results page](#).

### High-Voltage Input DC-DC Converters (In Order Of Voltage)

#### SiC-Based 750-V Input DC-DC Converter Delivers High Efficiency And High Power Density

[ABSOPULSE Electronics'](#) HVI 41R-F1 is a 50-W addition to the company's line of high-input-voltage railway-quality dc-dc converters. The converter employs the latest silicon carbide (SiC) semiconductor technology to deliver high conversion efficiency, and high power density. According to the vendor, the converter offers a smaller form factor than similar designs of the same output power—the units measure 114 x 51 x 201 mm.

Featuring a 750-V input with high input-surge-withstand capacity (1300 V), this dc-dc converter is suitable for railway traction control systems and similar railway rolling stock applications. The HVI 41R-F1 converter operates from a high dc input voltage of 750 V (525 V to 975 V), which is the traction voltage required for mass transit vehicles including trams, metros, light rail and mining locomotives.

The unit is also suitable for running auxiliary equipment on trolley buses. The unit delivers 24-V/2-A regulated output. Custom input/output voltages are also available. Regulation across line and load regulation is  $\pm 2\%$  combined from zero load to full load.

Optoless design contributes to long operating life and high MTBF (160,000 hours min. at 45°C). The HVI 41R-F1 railway is designed and built for an operating life of up to 30 years. The design eliminates optocouplers from the feedback loop and significantly reduces component count, which contributes to an MTBF that is significantly higher than conventional designs.

All critical components on the primary side are designed and tested for corona inception levels that are significantly higher than the operating voltages. The design is verified for 5600-Vdc input-to-output isolation and production level testing is 5000 Vdc input to output; this isolates equipment from the supply and contributes to high reliability and long operating life of the unit.



Other electronic protection includes inrush current limiting, reverse polarity protection and output current limiting with short-circuit protection. Large design headroom, and the exclusive use of components with established reliability also contribute to ensuring that the railway converter delivers many years of trouble-free operation.

The converter meets the stringent requirements of EN 50155 for electronic equipment used on rolling stock. Heavy filtering on the input and output ensures compliance with EN 50121-3-2. They also meet EN 61000-4-2 (ESD), EN 61000-4-3 (RF immunity), EN 61000-4-4 (fast transients), EN 50155 (surge), EN 61000-4-6 (conducted immunity) EMI: EN50121-3-2 and EN 50155 (voltage variations). Consult the company for any requirements you may have for compliance to other standards.

The 50-W converter is cooled by conduction via baseplate. Additional cooling is achieved by natural convection through the cooling slots. No fan cooling is required. This enables operation over a -25°C to 55°C temperature range for full specification. Wider temperature ranges are also available on request.

The HVI 41R-F1 is ruggedly constructed and is designed to withstand high levels of shock and vibration (IEC 61373 Cat 1 A&B), which ensures reliable operation in extreme environments. The internal board is conformal coated for immunity to moisture, humidity and airborne contaminants. The chassis-mountable enclosure is also available in DIN-rail format. The F1 chassis measures 114 x 51 x 201 mm (4.5 x 2 x 7.9 in.).

For more information see the [datasheet](#) or see the dc-dc power converters [page](#).

### **750-V DC-DC Achieves High Efficiency Across Load Range**

[Powerbox's](#) PRBX ENR500D is a high-efficiency 750-V input dc-dc converter for light-rail and industrial applications. The converter's switching stage is based on an enhanced resonant topology that provides a high efficiency of 95% typical across the load range. Designed for railway applications, the ENR500D fulfills the stringent requirements of the EN 50124-1 standard and delivers full performance across the temperature range of -40°C to +70°C. According to the company, the ENR500D also shortens time-to-market when a custom solution is required.



Dependent on their location and the technology available at the time of installation, a wide variety of electrically powered traction systems are used in rapid transit systems around the world. Most metros operate from dc power either at 750 V with a third rail, or 1.5 kV with a third rail or from an overhead catenary. 750 Vdc is very common in light rail, powering both the rolling-stock equipment as well as trackside signaling systems. The same voltage is also used in industrial equipment and in applications such as mining.

Taking into account the large range of applications and environmental conditions, PRBX designers have to consider where a power converter will be installed and as such, the environmental conditions it has to withstand. As specified in the European Standard EN 50124-1, Macro-environmental conditions (PD1 to PD4B), power converters can be part of hermetically sealed equipment varying from no ventilation up to forced ventilation using clean filtered air from outdoors, and requiring a flexible, robust design able to meet such a large range of environmental conditions.

The 500-W ENR500D platform is built on a resonant topology combined with the latest MOSFET technology and the use of high-performance magnetics. The enhanced topology confers to the ENR500D a high efficiency of up

to 95% from 20% to 100% load conditions. Designed to reduce the system's energy consumption, at no load the ENR500D input power is less than 5 W.

The ENR500D is designed to comply with the EN 50124-1 standard and with the so-called Pollution Degree 2 (PD2) such as control cabinets in the driver's cabin or passenger compartments. The ENR500D has ingress protection to IP20, and input-to-output double-reinforced isolation. The unit complies with EMC emissions and immunity as specified in both EN 50124-1 and EN 50124-5.

The ENR500D has a nominal dc input voltage of 750 V and operates within a range of 500 V to 900 V. The nominal dc output voltage is set to 48 V, though it can be adjusted up to 60 V. The converter can be modified to offer other output voltages such as 12 V, 24 V or any other required by the system designer. Nominal output power is 500 W constant across the temperature range of -40°C to +70°C in natural cooling conditions. Different output powers can also be provided in optimized mechanical formats.

In accordance with EN50124-1, rated impulse voltage of 4.4 kV, the input to output has a double reinforced insulation of 1000 V, with a clearance 8.0 mm, creepage ISO Class I and 10.0 mm, ISO Class II 14.2 mm.

Enclosed in an aluminum chassis with integral heatsink, the ENR500D measures 163 x 230 x 80 mm. For reliability and availability all printed circuit boards have a protective coating. For more information, see the ENR500D product [page](#).

### 100-W DC-DC Converters Operate From 900-V Nom. Input With Wide Input Range

[ABSOPULSE Electronics](#)' HVT 100R-1K-F2 series is a 100-W addition to the company's line of high-input-voltage railway dc-dc converters. The converters in this series operate from a nominal input of 900 V with a wide input range of 525 V to 1270 V, and deliver regulated output voltages of 24 V, 48 V, or 110 V. Custom input/output values are available on request. An optional built-in redundancy diode would allow for a number of units to be connected in parallel to achieve higher output power or N+1 redundancy.

The HVT 100R-1K-F2 converters meet the stringent requirements of EN50155 for electronic equipment used on rolling stock. They are typically installed in on-board and trackside infrastructure applications. The units have heavy filtering on the input and output and comply with EN50121-3-2. They also meet EN61000-4-2 (ESD), EN61000-4-3 (RF immunity), EN61000-4-4 (fast transients) and EN61000-4-6 (conducted immunity).

To ensure high reliability and long operating life, all critical components on the primary side are designed and tested for corona inception levels that are significantly higher than the operating voltages. The design is verified for 5600-Vdc input-to-output isolation and production level testing is 3000 Vdc input to output, which isolates equipment from the supply. Other protection includes inrush current limiting, reverse-polarity protection, output current limiting, short-circuit protection and self-resetting thermal shutdown in the case of insufficient airflow.

Low component count, large design headroom and the exclusive use of components with established reliability also contribute to ensuring that the unit delivers many years of trouble-free operation.

Cooling is by conduction via baseplate with additional cooling by natural convection through the cooling slots. All heat generating components are installed on aluminum heatsink blocks which are thermally connected to the base plate. This enables operation over a -25°C to 55°C temperature range for full specification. Requirements for wider temperature ranges can be accommodated. Units specify  $\pm 1\%$  line and load regulation combined from 5% load to full load.

The units measure 114 x 58 x 256 mm. They are ruggedized to ensure immunity to shock and vibration (per IEC 61373 Cat 1 A&B), which makes them suitable for operation in extreme environments. The internal boards are conformal coated for protection from moisture, humidity and airborne contaminants. Heavy-duty industrial quality versions of this design are available on request.

The HVT 100R-1K-F2 converters feature an F2 chassis that measures 114 x 58 x 256 mm (4.5 x 2.3 x 10.1 in.). For more information see the [datasheet](#) or see the dc-dc power converters [page](#).



## AC-DC Power Supplies

### 150-W Power Supplies Are Designed For Worldwide Use, Robustness

[MTM Power's](#) PCMAT150 S24 power supplies are a new generation of ac-dc modules which can be installed as a decentralized power supply for industrial and railway applications. Operating from a universal ac input range of 90 to 264 V for worldwide use in industrial networks, the supplies generate a 12-V or 24-V dc output. The conduction-cooled devices have a power good signal as well as active power factor correction (PFC). Other notable features include an operating temperature of -40°C to +70°C, remote control and 150% power boost.

The design of the isolation coordination according to overvoltage category OV 3 enables the use of these supplies in applications with high transients as e. g. energy technology. For the use on rail vehicles, the devices were tested according to the standards of EN 50155 and EN 50121-3-2/EN 50121-4. In compliance with the conditions of the railway regulations, the units can be used on railway vehicles on the 400-/230-Vac internal on-board train power system, in trackside applications and in stationary railway systems.

The PCMAT150 supplies have an efficiency of 92.5% and are resistant against shock and vibration due to the well-proven encapsulation technology and its extremely rugged design. The vacuum encapsulated (EP 1 987 708, U.S. Patent No. 8,821,778 B2) power supplies offer reliable protection against condensation, conductive dust and other environmental conditions. In addition, they are connected via industrial connectors which meet the demands for vibration resistance, reduced wiring time and no maintenance. Thus the use of these supplies as plug-and-play solutions in sensitive electronic sub-systems is possible.



Due to the rugged design in baseplate cooling (BPC) technology, the supplies' thermal losses are dissipated specifically via the mounting plate while increasing the lifetime of the devices at the same time. For more information, see the [website](#).

### 250-W Dual-Output AC-DC Power Supplies Offer Convection Cooling And Active PFC

ABSOPULSE Electronics' PFC 252R-HSA-F3 series 250-W railway-quality power supplies feature pure convection cooling and employ active power factor correction (PFC) to convert a universal ac input (95 V to 264 V) to two outputs. Output V1 provides any dc voltage from 12 V to 110 V at 10 A to 14 A max while output V2 offers any dc voltage from 5 V to 24 V at 8 A to 2 A. Both outputs are individually regulated, but returns are common. Other input/output voltages are available on request.

The power supplies are designed for applications where only pure convection cooling is feasible. A heatsink assembly is attached to the under surface of the F3 power supply module, providing a pure convection-cooled solution. This enables operation within a -40°C to +55°C temperature range for full specification without derating. Wider temperature ranges are available on request.

The power supplies comply with the EN 61000-3-2 directive for low input harmonic distortion. They meet the requirements of EN 50155 for electronic equipment used on railway rolling stock. The units are equipped with heavy filtering on the input and output and comply with EN 50121-3-2. They also meet EN 50121-4, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4 and EN 61000-4-6. Other electronic protection includes 4300-Vdc input-to-output isolation, overload protection and output overvoltage protection.

For more information see the [datasheet](#) or the ac-dc power supplies & battery chargers [page](#). Or contact ABSOPULSE for further information on this or similar designs, as well as pricing and delivery.

### 300-W AC-DC Cassette Converters Generate Two, Isolated 12-V or 15-V Outputs

[Bel Power Solutions'](#) Melcher LR series 300-W ac-dc cassette converters, which are an enhancement to the company's broad range of 19-in. cassette power supplies, are designed for railway and rugged industrial applications. The products feature a universal ac input voltage range including active inrush current limitation and power factor correction (PFC).

Two highly efficient, isolated outputs of 12 V or 15 V up to 300 W offer maximized flexibility in system architecture and make them well suited for various railway applications. These include signaling, rugged communication, heavy duty industrial control as well as mission-critical defense and security systems.

The converters are housed in a rugged aluminum extruded case and can operate in a convection- and conduction-cooled environment at temperatures from -40°C up to 85°C. All PCBs are conformal coated and protected against humidity and pollution which occurs during typical lifecycles of +20 years. The LR series converters are fully compliant and safety approved to the latest edition of IEC/EN 62368-1 and UL/CSA 62368-1. Underlining the high quality and reliability of the LR series, Bel Power Solutions is offering an extended warranty of five years on all LR series power converters.

The converters are fully protected against overload, overvoltage, overtemperature, undervoltage, no-load and short circuit with automatic recovery. Additional features include integrated hold-up capacitors for 20-ms interruption, active current share for parallel and redundant operation, rectangular current limit characteristic and remote voltage adjust, inhibit and fail signal.

The LR series units are in stock with [Digi-Key](#), [Mouser](#) and [Arrow](#). For more information, download the [LR series datasheet](#) or visit the [product page](#). For technical inquiries, see [belfuse.com/power-solutions](#).

### 300-W AC-DC Power Supplies With PFC-Input And IP66-Rated Protection

[ABSOPULSE Electronics](#)' PFC 65R-D3 is a series of rugged IP66-rated railway-quality ac-dc power supplies with active PFC-input that deliver up to 300 W of output power. They convert a universal ac-input voltage (95 V to 264 V) to a dc output of 24 V, 48 V or 110 V. Custom input/output voltages are also available. Line and load regulation is  $\pm 1\%$  combined from zero-load to full-load. An optional built-in redundancy diode allows for parallel and N+1 operation. Other options include a Form C output fail alarm and remote shutdown.



The PFC-input railway power supplies comply with EN61000-3-2 directive for low input harmonic distortion. This design meets the requirements of EN50155 for electronic equipment used on railway rolling stock. With heavy filtering on the input and output, the converters comply with EN50121-3-2 electromagnetic compatibility requirements, ensuring that interference with the operation of other electronic apparatus is minimized.

The PFC 65R-D3 railway power supplies are packaged in robust, waterproof, dust-proof, die cast aluminium IP66-rated enclosures. The input and output are via sealed cable glands, circular connectors or custom connections.

The internal boards are ruggedized and conformal coated for immunity to high levels of shock and vibration. Application-specific vents for pressure equalization are available as an option.

Cooling is by internal conduction to the walls of the IP66-rated enclosure and by baseplate to an external chassis or cabinet wall, with additional convection via the outside surface. If installed on a heat-sinking surface, cooling is further enhanced and the converters achieve higher output power. The power supplies have generous design headroom and are rated for operation over a -25°C to 50°C temperature range without derating.

The power supplies are suitable for operation in transportation, heavy industry, mining, military, marine and telecom applications where protection from the ingress of water from powerful jets, sand, metal dust, oil, fire and other contaminants is required.

Comprehensive electronic protection includes 4300-Vdc input-to-output isolation and inrush current limiting. They also have rectangular current limiting, overload, overvoltage and short-circuit protection. The D3 IP66 enclosure measures 360 x 160 x 90 mm (14.2 x 6.3 x 3.5 in.) For more information see the [datasheet](#) or the ac-dc power supplies & battery chargers [page](#).

### 3-kW AC-DC Power Supply Offers Built-In Redundancy And PFC

[ABSOPULSE Electronics](#)' PFC 3KR-E/110-3U3 rugged ac-dc power supply is designed for 3-kW railway trackside applications that require redundant operation and power factor correction (PFC). The power supply uses field-proven PFH65F technology to deliver a solution with high system reliability and power efficiency.

The PFC 3KR-E/110-3U3 functions as a redundant power supply, ensuring high system reliability in critical applications. It is built with three PFH65F internal modules, connected in parallel via built-in redundancy diodes. If one internal module fails, the system will remain operational at 2000-W output power.

The power supply employs active PFC to convert 230 V (195 to 264 V ac operating range) to a 110-V/27-A single dc output. Custom input/output voltages are available on request. The power supply complies with EN61000-3-2 and EN61000-3-12 directives for low input harmonic distortion. Power factor is better than 0.97 at full load for the entire input range.

An industrial-quality version of this design, the PFC 3K-E/XX-3U3 series, is also available. This industrial power supply provides 24-V, 48-V, 110-V, 125-V dc or custom output voltages.

The power supply is designed for compliance with EN/UL60950-1 and equivalent safety standards. Filtering on the input and output contributes to low output ripple and noise. The input meets EN55032 Class A with wide margins; Class B is available as an option.

The power supply meets EN50155 for electronic equipment used on railway rolling stock. The units are equipped with heavy filtering on the input and output and comply with EN 50121-3-2. They also meet EN 50121-4, EN 61000-4-2 (ESD), EN 61000-4-3 (RF immunity), EN 61000-4-4 (fast transients), and EN 61000-4-6 (conducted immunity). Electronic protection includes 4300-Vdc input-to-output isolation, inrush current limiting, overload protection, thermal shutdown with automatic reset in case of insufficient cooling (self-resetting) and current limiting.

Cooling is by high-quality built-in fans with which draw air into the unit, and by additional conduction via the baseplate which provide sufficient cooling for operation over a 0°C to +50°C temperature range for full specification without derating. Wider temperature ranges are available on request. All heat generating components are installed on aluminium heatsink blocks which are thermally connected to the base plate. This also ensures exceptional mechanical ruggedness.

The PFC 3KR-E/110-3U3 power supply is heavily ruggedized for immunity to shock and vibration. The internal boards are conformal coated for protection from moisture and airborne contaminants. Its 3U3 chassis measures 132 x 187 x 407 mm (5.2 x 7.4 x 16 in.).

For more information see the PFC 3KR-E/110-3U3 railway model [datasheet](#), the PFC 3K-E/XX-3U3 industrial model [datasheet](#) or the ac-dc power supplies & battery chargers [page](#).



### Chargers

#### USB Chargers For Railway Vehicles Guard Against ESD

[MTM Power](#) has developed a series of USB chargers that are suitable for mobile use, especially for supplying charging stations on railway vehicles. Special attention was paid to an ESD-protected design of the charging ports to avoid charger damages from electrostatic discharge. They are available with one or two charging ports with operation from 115/230-Vac mains (PCMAS24-USB) or 24- or 72/110-Vdc battery voltages according to EN 50155 (PCMGS14-USB).

The devices supply up to 2 A per charging port; the charging current between the charger and the charging client is determined by communication lines based on USB specifications. If the communication lines are not connected or there is no communication, the charging client is



supplied with the standard charging current of 500 mA according to the USB specification. This prevents overloading and damage of the end devices.

The encapsulated and maintenance-free devices are primary and secondary connected via spring clamps. The chargers fulfill all relevant railway standards including the fire protection directive. For more information, see the [website](#).

### DC-AC Inverters

#### 100-VA Sine Wave Inverters Are Water And Dust Proof

[ABSOPULSE Electronics](#)' RSI 100-D1 series of railway dc-ac sine wave inverters are designed for train and mobile applications that require IP66-rated protection. Installed in IP66-rated waterproof, dust-proof die cast aluminum packages with sealed connectors, the inverters are also protected from the ingress of rain, humidity, sand, oil, metallic dust and other contaminants. The units meet the requirements of EN50155 for electronic equipment used on railway rolling stock. In addition, internal boards are ruggedized and conformal coated to withstand high levels of shock and vibration.



The RSI 100-D1 series uses microprocessor-controlled high-frequency PWM technology to deliver 100-VA pure sine wave output voltage. The inverters convert dc inputs of 24 V, 48 V, 72 V, 96 V or 110 V with wide EN50155 input ranges, to 115 Vac at 60 Hz or 400 Hz, 230 Vac at 50 Hz or a custom output. Regulation is  $\pm 3\%$  from no load to full load.

The units are equipped with heavy filtering on the input and output and comply with EN50121-3-2. They also meet EN61000-4-2 (ESD), EN61000-4-3 (RF immunity), EN61000-4-4 (fast transients) and EN61000-4-6 (conducted immunity). Other protection features includes 3000-Vdc input-to-output isolation, overload protection, thermal protection and current limiting. The MTBF is 150,000 hours at 45°C.

Cooling is by internal conduction to the walls of the IP66 enclosure and by baseplate to an external chassis or cabinet wall. Additional natural convection occurs via the surface of the IP66 enclosure. This enables operation within a -25°C to +55°C temperature range without derating.

If wider temperature ranges from -40°C to +70°C are required, full encapsulation of the internal inverter module in a MIL-grade silicon rubber compound is available as an option. Application-specific vents for pressure equalization are also available as an option. The RSI 100-D1 series' D1 IP66 enclosure measures 220 x 120 x 80 mm (8.7 x 4.7 x 3.1 in.) For more information, see the [datasheet](#) or the dc-ac & ac-ac sine wave converters [page](#). Or [contact the vendor](#) to discuss your requirements.

#### 1000-VA Sine Wave Inverters Feature Low Profile

[ABSOPULSE Electronics](#)' RSI 1K-F31 series railway dc-ac inverters use field-proven microprocessor-controlled high-frequency PWM technology to deliver up to 1000-VA pure sine wave output voltage. High frequency conversion enables high efficiency, compact construction and low weight.

The inverters accept dc supply voltages of 24 V (17 to 34 V), 36 V (25 to 51 V), 48 V (33 to 67 V), 72 V (50 to 101 V), 96 V (67 to 135 V), 110 V (77 to 154 V) or custom input. The series provides a single sine wave output of 115 Vac continuous at 60 Hz or 400 Hz, or 230 Vac continuous at 50 Hz, or custom output values. Efficiency at full load is typically 80%, depending on input voltage. An optional output-fail alarm (Form C) and



remote shutdown or enable are available.

The dc-ac inverters meet the requirements of EN50155 for electronic equipment used on railway rolling stock and are suitable for a broad range of on-board and trackside railway applications. They are equipped with heavy filtering on the input and output and comply with EN50121-3-2. The units meet EN61000-4-2, EN61000-4-3, EN61000-4-4 and EN61000-4-6.

They also meet the requirements of C22.2 No. 107.1-01, UL 458 and EN/UL60950-1 and equivalent industrial safety standards. Other forms of protection include 1500-Vdc input-to-output isolation, overload protection, thermal protection and current limiting.

Cooling by baseplate to a cold plate surface and by natural convection ensures continuous operation over a -25°C to +55°C operating range for full specification. Wider temperature ranges are available on request. All heat-generating components are installed on aluminium heatsink blocks which are thermally connected to the base plate. This also ensures exceptional mechanical ruggedness. Conformal coating provides protection against humidity and airborne contaminants.

A version of this design with fully encapsulated internal modules, the RSI 1KP-F31, is available for applications that require immunity to extreme levels of shock and vibration as well as to humidity, moisture, dust, salt, oil, insects and other contaminants. The internal modules are potted with a thermally conductive MIL-grade silicon rubber compound full encapsulation with thermally UL94V-0 flammability rating and meet environmental criteria as requested in MIL-810 C, D.

A heavy-duty industrial-grade version of this design, the CSI 1K-F31 series, is available for operation in industrial automation, mining, military, marine, telecom, utility and other extreme environments. Dimensions of the F31 chassis measure 483 x 68 x 356 mm (19 x 2.7 x 14 in.).

For more information, see the datasheet for the [railway model](#) or the [industrial model](#), or see the dc-ac & ac-ac sine wave converters [page](#). For further information including pricing, please [contact the company](#).

### ***Railway Power Supply Related News***

#### **Power Converter Maker Receives IRIS Certification**

In June 2019, [Bel Power Solutions](#), announced that its Bel Power Solutions location, based in Dubnica nad Vahom, Slovakia, had become IRIS Certified. The International Railway Industry Standard (IRIS) is an initiative led by the Association of European Railway Industries (UNIFE) and an internationally recognized management system standard specific to the railway industry. It is based on the ISO 9001 structure, but stipulates additional, railway specific requirements for business management systems.

The Dubnica nad Vahom manufacturing facility is Bel's Center of Excellence for the company's Melcher Railway brand of products and, according to the company, becoming IRIS certified affirms its continued dedication as a premier manufacturer of railway, transportation and harsh environment solutions.

Under the Melcher brand, Bel provides high-performance, rugged dc-dc and ac-dc converters. To learn more see about Melcher's dc-dc product line, see the Melcher cassettes & chassis mount [page](#) and for more on the company's ac-dc product line, see the Melcher ac-dc cassettes [page](#). To learn more about the entire range of railway solutions offered by Bel Fuse and the other Bel groups, see the Railway [page](#).

#### **DC-DC Converters Comply with EMV 06 EMC Regulation**

In addition to the existing certificates for the compliance of EMC characteristics according to EN 50121-3-2, [MTM Power](#) can now also prove compliance with the technical regulation EMV 06—verification of the radio compatibility of rail vehicles with railway radio communication services—through certificates from an accredited laboratory.

Interference-free railway radio communication services are one of the basic requirements for safe and reliable railway transportation. EMV 06 describes the requirements for the radio compatibility of rail vehicles and the used systems and components. The regulation aims to allow only vehicles, systems and components for use in railway transportation, in which electromagnetic interference can be nearly eliminated within the railway radio services.

Therefore, MTM Power has examined a representative selection of dc-dc converters for railway applications carried out by an independent, accredited laboratory with regard to the requirements of the EMV 06 regulation. All tested devices remain well below the critical values of the highest protection class S0 and thus can be used without restrictions. For more information, see the [website](#).

### References

1. "[Power Supplies Keep Railway Systems On Track](#)" by Spencer Chin, How2Power Today, August 2017.
2. "[DC-DC Converters For Railway Applications](#)," How2Power Today, December 2013.
3. "[Where To Find Power Supplies For Industrial Applications](#)"
4. [Power Supplies for Industrial Applications](#)