

## ***DC-DC Converters For Railway Applications***

This Power Product Roundup highlights dc-dc converters and battery chargers developed for railway applications. These power converters are industrial-grade products that satisfy the specific electrical, mechanical and environmental requirements of railroad applications. Many are designed to meet specific electrical standards such as EN50155, and like other industrial-grade power supplies, many of these power converters are convection cooled. In terms of electrical specifications, input voltage ranges are typically tailored to accommodate a number of application-specific battery voltages and supply rails, while the generated output voltages are typically 5, 12, 15 or 24 V in various single, dual or other multi-output variations. These products span a range of output power levels from 30 W all the way up to 20 kW and are presented here in order of rated power. The power converters featured in this article were introduced over the past 12+ months.

Product stories featured here:

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### 30-W Converter Complies With Railway Transient And EMC Standards

[XP Power's](#) RDC30 series of highly efficient metal-cased and isolated 30-W dc-dc converters for railway applications accommodate wide input voltage ranges, which are based around the popular railway input voltages of either 72 V (36 V to 140 V) or 110 V (55 V to 176 V). These converters are available with single, dual or triple outputs and conform to the railway industry transient standards EN50155, NF F 01-510 and RIA12.

The single-output models provide the standard regulated output voltage of 3.3 V, 5 V, 12 V or 15 V, while the duals provide  $\pm 5$  V,  $\pm 12$  V or  $\pm 15$  V. Triple output models provide a 3.3-V output with either  $\pm 12$ -V or  $\pm 15$ -V outputs, or a 5-V output with either  $\pm 12$ -V or  $\pm 15$ -V outputs.

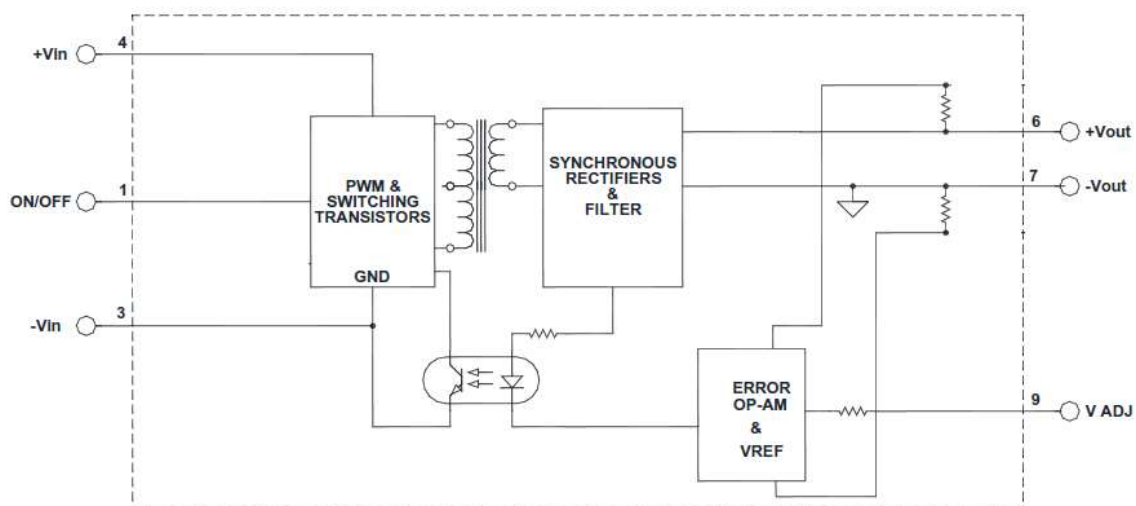
These convection-cooled converters have an efficiency rating of up to 91%, and deliver a power density of 37.5 W/in.<sup>3</sup> from a package that measures 25.4 x 50.8 x 10.16 mm (1 x 2 x 0.4 in.). When convection cooled, the operating temperature ranges from -40°C to 75°C. An optional heatsink extends this up to 80°C. Maximum case temperature is 105°C. Other specifications include 1500-V ac basic isolation between input and output, and 1600-V dc isolation between input/output.



The RDC30 series complies with the internationally recognized EMC standard EN50121-3-2 as required for railway applications and rolling stock apparatus. A remote On/Off function gives external control of the output while a trim input provides the capability to adjust the output voltage within  $\pm 10\%$  of the nominal output voltage. The RDC30 is available from Farnell, element14, approved regional distributors, or direct from XP Power. For more information, see the RDC30 product [page](#).

### High-Efficiency 40-W Converter Operates Over >5:1 Input Range

[Beta Dyne's](#) BHE30006 is a high-performance, low-noise, isolated 40-W dc-dc converter. Operating from a 10-V to 110-V input (which is >5:1 input range), the dc-dc converter produces a single 13-V output typ. with a 5% typ. adjustment range. This unit does not include transient protection, which must be provided by the user. The converter incorporates low-noise switching techniques at its input and synchronous rectification on the output to provide 40 W of output power at 85% efficiency in a 1.98-in. x 1.58-in. x 0.55-in. case. Output noise is specified at less than 20 mV.



In addition to targeting railway applications, the converter is suitable for use in instrumentation, test and measurement, and telecom applications.

The BHE30006's high efficiency and surface-mount technology allow the converter to operate from -40°C to +70°C without derating. Other features include six-sided shielding, soft start, hiccup short circuit protection, 1-mA off state current, 100- $\mu$ s transient response, and industry-standard pinouts. The BHE30006 is designed to meet the BASIC requirements of UL/EN60950-1 and the CE mark. For more information, contact Nikie Fikis at sales@beta-dyne.com.

### **Baseplate-Cooled 50-W Quarter Bricks Suit Rolling Stock And Trackside Equipment**

[TDK-Lambda's](#) CN50A24 series of 50-W railway dc-dc converters are quarter-brick modules that operate off a wide range of dc inputs from 14.4 V to 36.0 V, a range that is widely used in the railway industry, and for 24-V vehicles. Available with output voltages of 5 V, 12 V, or 24 V (adjustable  $\pm 10\%$ ), these fully-regulated and isolated power modules are said to deliver exceptional performance.



The CN50A24 modules are suitable for both rolling stock and trackside equipment, enabling users to design cost-effective IEC61373-compliant systems without the risks associated with custom product designs and in a much shorter timescale. In addition, 100-W versions of these converters are included in the CN100A24 series. Moreover, TDK-Lambda also offers higher input range versions of these modules, the CNA-110 series, with an input range of 60 V to 160 V and output ratings from 30 W to 200 W.

Designed for harsh environments, the CN50A24 series meets the stringent shock and vibration requirements of IEC61373 Category 1, Grade B. In addition, a conformal coating option (add /CO suffix to model number) complies with the EN50155 requirements. These

baseplate-cooled power converters provide full output power from -40°C to +100°C at the baseplate without derating. The 50-watt model CN50A24-12, for example, delivers 4.2 A at 12 V with an efficiency of 86% at full load. These modules measure 1.45 x 2.28 in. and are only 0.50 in. high.

Standard features include remote sense, remote on/off, overvoltage and overcurrent protection circuitry. All CN50A24 models have an input-to-output isolation of 3 kV ac, are safety-approved to UL/CSA/EN60950-1 and carry the CE mark in accordance with the LV Directive.

For more information, see the product [page](#), or by calling 800-LAMBDA-4. Product availability for the CN50A24 series can be found via the link to TDK-Lambda's distributor network (see "Check Distributor Stock to Buy") at <http://www.us.tdk-lambda.com/lp/>.

### **75-W Converter Targets Mission Critical Railway Applications**

[Schaefer's](#) MTQZ75 Series by Minmax is a 75-W dc-dc converter designed specifically for mission critical transit and railway solutions. The MTQZ75 Series is designed predominantly for applications in the railway industry requesting compliance to railway standards EN50155 (IEC751) and EN50121-3-2. The converter family consists of single-output models offering 5-V, 12-V, 15-V and 24-V outputs with input voltages of either 72 V or 110 V. Each model is capable of delivering up to 75 W in a quarter-brick footprint (2.28 in. x 1.45 in. x 0.50 in.) with isolated baseplate.

Advanced circuit topology allows for a high efficiency rating up to 92% and an operating temperature range of -40°C to 85°C. For



improved heat dissipation, an optional heatsink is available. Standard features include reinforced insulation of 3000 V ac rms, remote on/off control, undervoltage shutdown as well as overload and overtemperature protection.

Unit pricing in quantities of 100 starts at \$61.50 each. Full product specifications can be viewed at [www.schaeferpower.com](http://www.schaeferpower.com). For further information, email [sales@schaeferpower.com](mailto:sales@schaeferpower.com).

### **80-W Converters Accommodate A Wide Range Of Battery Voltages**

The PCMDS80 primary-switched dc-dc converters from [MTM Power](http://www.mtm-power.com) are specially designed for applications in vehicle and rail technology but also for use in industrial and telecom applications. They are available with 80-W output power and operate according to the forward principle; i. e. the dc input voltage is chopped by a transistor with a frequency of 50 kHz. With the help of a transformer and a secondary linear choke, a galvanically isolated output voltage (12 V, 13.8 V, 24 V, 27.6 V or 48 V) is produced which is adjusted by pulse-width modulation according to the current-mode principle.



The converters are available with three wide input ranges thus covering the battery voltages of 24 V, 36 V, 48 V, 60 V, 72 V, 80 V, 96 V and 110 V in accordance with EN 50 155. The dimensions of the base plate version are 119 x 100 x 40 mm and of the heatsink version are 119 x 115 x 65 mm. The thermoselective vacuum encapsulation guarantees homogeneous heat dissipation within the modules as well as an excellent resistance against environmental influences such as shock, vibration and humidity.

The converters need no ground load and are short-circuit protected by primary and secondary power limiting. The converters are maintenance-free, prepared for the use in devices with Protection Class II and fulfill the low voltage directive.

They offer a mechanically and electrically rugged design using SMD technology and undergo an automatic piece-by-piece test. Cooling is achieved by free convection. The converters without heatsink have to be mounted on a heat-dissipating surface. For

more information see the PCMDS80 product [page](#).

### **100-W To 140-W Converters Generate Tightly Regulated Outputs**

[Schaefer's](#) PRC-120 series dc-dc converters produce 100-W to 140-W output, operate with high efficiency (up to 92%) while producing an adjustable output of 5 V, 12 V, 24 V or 48 V that is tightly regulated to 0.2% or better. Offered in railway (EN50155) and industrial (EN60950) versions, these units accept an input of 24 V, 48 V, 72 V or 110 V, and feature a 140-kHz switching frequency. The units measure 6.30 in. x 3.94 in. x 1.38 in.

Other features include a wide operating temperature range (-25°C to +60°C full load, per EN50155 Class 1), high input-to-output isolation (3000 V ac or 4200 V dc for 1 minute) as well as high reliability and efficiency. Also included are remote sense and inhibit, comprehensive protection, and input/output LED status indicators. For more information, see the [datasheet](#).

## **Corona-Free 120-W Converter Features 20-kV Isolation**

[Absopulse Electronics](#)' DIO 120 Series of dc-dc converters were developed for powering electronic circuits floating on several kilovolts of operating voltage. They are typically used for high-power gate drivers and similar applications in oil and gas, mining, railway and industrial environments.

The 120-W converters accept a 24-V (22-V to 28-V range) or 48-V (44-V to 56-V range) input and deliver a single output of 12 V, 15 V or 24 V (5-A current limit). Other inputs and outputs, as well as a built-in redundancy diode for parallel and N+1 operation, are available on request.

The DIO 120 converters are tested for corona (partial discharge) extinction at a minimum of 10 kV rms and Hi-Pot tested for 20 kV rms. The feedback system on the primary side employs a special sensing circuit instead of optical components, further enhancing reliability. Typical operating voltage potential between primary and secondary is 2 to 5 kV rms. This value depends on the specific application and contamination class, and is limited by the creepage distance of 76 mm (3.0 in.) on the PCB.

Generous design headroom, 20-kV isolation input/output and output/chassis, the use of transformers engineered with Absopulse's field-proven proprietary technology and comprehensive protection circuitry further contribute to the high MTBF.

These convection-cooled units are rated for operation over a -20°C to 50°C temperature range for full specification. They are filtered to meet EN55022 Class A conducted and radiated requirements with wide margins and comply with UL 508 and equivalent industrial safety standards. The open-frame format has a footprint of 102 x 305 mm and maximum component height is 70 mm.



## **DC Power System Solution Targets Positive Train Control Applications**

[Eltek](#) has announced expanded functionality for its Micropack Modular Power System, which makes it well suited for powering wayside equipment installations used for the U.S. positive train control (PTC) initiative. A new 12-V dc-dc converter makes the Micropack one of the few solutions that integrates in the same system both the converters, which provide an isolated power source for PTC radio equipment and 12-V power rectifiers for wayside interface units (WIUs). The Micropack DC power system is optimized with AREMA-compliant shock and vibration protection for use in wayside enclosures.

Conventional power solutions provide no redundancy, and the loss of a converter would leave the radio with no power. The Micropack System has a modular architecture in which multiple rectifier or converter modules can be plugged into a shelf to provide N+1 redundancy in a very cost-effective manner.

Micropack rectifiers and converters each have a dc output of 120 W. Their dimensions are 1.5 in. wide x 3.5 in. high x 5.9 in. deep and they weigh just over one pound each. The Micropack system can be configured as a rectifier-only, converter-only, or combined system.

PTC systems improve railroad safety by controlling train movements through wireless communication links between central wayside facilities, dispatching centers and on-board computers in locomotives.

"PTC represents a significant upgrade of railway communications infrastructure and Eltek is encouraging railroads to use this opportunity to put into place the latest generation of state-of-the-art dc power systems to significantly improve reliability, control, monitoring and performance," says David Leal, Eltek vice president of sales for North America.

The 12-V rectifiers and converters feature Eltek's high efficiencies of 89% and 90%, respectively. This can reduce power consumption by as much as 28% versus existing solutions, according to Eltek. The Micropack modules are convection cooled, meeting the AREMA specification for such applications.

With the advanced Smartpack2 controller, PTC technicians can remotely monitor Micropack systems and the associated batteries to troubleshoot problems or log important operational data that can help with maintenance. The controller features an Ethernet port for web-based monitoring and LEDs for local visual alarming and simple system management.

The Smartpack2 has extensive battery management capabilities to improve performance, including thermal compensation charging with algorithms for various battery types, support for boost charging, automated battery monitoring and testing, and capacity and lifetime indicators.

### **150-W Plug-In Converter Steps Down 110-V Battery Supply To 24 V**

A 19-in. plug-in dc-dc converter offering 150-W output, the PCMD519 150 from [MTM Power](#) is specially designed for applications in vehicle and railway technology. The converter, which measures 164.5 x 70.8 x 128.4 mm, is available with a wide input range of 50.4 V to 154 V for battery voltage of 110 V according to EN 50 155 and features an isolation of 2.2 kV ac.



The PCMD519 150 operates according to the push-pull principle; i.e. the input dc-voltage is chopped by two push-pull working transistors with a frequency of approx. 70 kHz. With the help of a transformer and a secondary linear choke, a galvanically isolated output voltage of 24 V with 6.25 A is produced which is adjusted by pulse-width modulation according to the current mode principle.

The thermoselective vacuum encapsulation guarantees uniform heat dissipation within the module as well as excellent resistance against environmental influences such as shock, vibration and humidity. Furthermore the converter is additionally cooled via the already mounted heatsink.

The device needs no ground load and is short-circuit protected by primary and secondary power limiting. The maintenance-free converter can be operate in parallel and is prepared for the use in devices with protection class II. It features a mechanically and electrically rugged design using SMD technology and undergoes

an automatic piece-by-piece test.

### **200-W Converters Mount To Curved, Uneven And Non-Conductive Surfaces**

From [Absopulse Electronics](#), the BAP 236RTH series railway-quality dc-dc converters employ a high-frequency power conversion topology to generate up to 200-W output power. They have generous design headroom and are rated for operation over a -20°C to 50°C temperature range for full specification. Cooling is by heatsink fins on the top of the units—neither fans nor attachment to a heatsinking surface are required. The converters can be installed on curved, uneven and non-conductive surfaces, and are ideal for installation on locomotive chassis.

The BAP 236RTH converters comply with all relevant railway standards including EN50155, EN50121-3-2 conducted and radiated EMI, EN55022 Class B, EN61000-4-2, EN61000-4-3, EN61000-4-4 and EN61000-4-6 standards. An industrial-grade version that complies with EN/UL60950-1 and equivalent safety standards is also available.

Nominal input voltages include 24 V, 36 V, 48 V, 72 V, 96 V or 110 V with EN50155 input ranges. The converters deliver any customer-specified output between 12 V and 125 V. Other input/output configurations are available on request. An optional built-in redundancy diode allows for paralleling and N+1 operation. The redundancy diode also allows for connection to a back-up battery.

Efficiency is 85% at full load, depending on the input/output configuration. A green LED can be installed to indicate an output "ON" condition. An optional output fail alarm (Form C) can be installed.

The units are housed in compact, ruggedly constructed 114- x 114- x 261-mm chassis-mount enclosures. They are ruggedized and all printed circuits are conformal coated, providing immunity to shock, vibration (IEC 61373 Categories 1 A&B) and moisture.

Protection features include 3000-V dc input/output isolation, reverse-polarity protection, current limiting and overvoltage protection. For more information see the specifications [page](#).

### **300-W Converters Feature Wide Input Range And Network Rail Certification**

[Relec Electronics](#) has been awarded Network Rail approval for its HR series dc-dc converters. These are versatile power supplies well suited for use in transportation and other advanced electronic systems. The wide input range of 12 V to 168 V and configurable output provide a single unit solution for a vast range of applications. Features include high efficiency (typically 94%), high reliability, low output noise, and excellent dynamic response to load/line changes. The HR series delivers up to 300 W of output power with no derating over the entire ambient temperature range of -40°C to 70°C and the reduced losses result in cooler component temperatures leading to higher reliability.



The converters are particularly suitable for railway applications and can be operated from all common dc traction supplies of 24 V, 36 V, 48 V, 72 V, 96 V, 110 V and 120 V nominal. The output is configurable as 12 V,  $\pm 12$  V or 24 V. The converters comply with EN51055 and EN50121-3-2, IEC/EN 60950-1, IEC61000-4-2, -3, -4, -5, -6. The HR2320-9RG is Network Rail approved, certificate number PA05/05958 catalogue number 086/034203.

Standard features include current share, 10-ms hold-up time with internal capacitor, reverse polarity protection, inrush current limitation, overvoltage and programmable undervoltage lockout, remote on/off, and adjustable output voltage. LED indicators display the status of the converter and allow for visual monitoring of the system at any

time. Units are suitable for parallel operation with current sharing.

The converters may either be plugged into a 19-in. rack system according to IEC60297-3, or be chassis mounted. Cooling plates are available for conduction-cooled applications or heatsinks for convection cooling. Typical train applications include cab CCTV systems, on board Wi-Fi for passengers, electronically controlled washroom facilities, and GSM-R train radios for driver-to-control center communication. Track-side applications include level-crossing monitoring, train-location systems, and passenger information systems. For more information, see <http://www.relec.co.uk/article21.html>.

### **Low-Voltage Power Supply And Battery Charger Delivers 12 kW**

[Applied Power Systems](#) recently completed a follow-on contract for the company's 12-kW low-voltage power supply (battery charger) for passenger rail. Although the existing contract employs a version that accepts 480-V ac input, another version accepts 600-V dc input. This supply produces 74-V dc output to power the cars' auxiliary loads and charge batteries.

The APS AP-6612 low-voltage power supply and battery charger (LVPS/BC) was designed for commuter rail car applications with abilities to communicate with the car systems to indicate LVPS/BC status. Displays on the front panel include a numeric readout of voltage and current as well as LED indicators for nominal battery voltage, normal input voltage, battery overtemperature, LVPS/BC failure, low battery voltage, overload latch and phase loss. Internally, there are a series of LED indicators to determine the status of the full-bridge IGBT power stage.

The APS LVPS/BC is designed to have seamless transition from voltage mode to current mode. In voltage mode, the LVPS/BC will regulate to 74 V when the battery is at 25°C. As the temperature of the battery changes, the LVPS/BC will remain in voltage mode and adjust its output to the optimum value for charging the battery.

If the output current exceeds 150 A, the LVPS/BC will seamlessly transition from voltage mode to current mode. The output voltage of the LVPS/BC folds back to limit the current to 150 A. As the load decreases to a value less than 150 A, the LVPS/BC will seamlessly return to voltage mode and return to the voltage determined by the battery temperature. For more information, contact Jim Murphy at sales@appliedps.com.











### Liquid-Cooled Converters Deliver 20 kW

The dc-dc converters in [Schaefer's](#) CW/BW 5600 Series, which also includes ac-dc power supplies and battery chargers, are liquid-cooled power converters that deliver 20 kW of adjustable voltage output at 24 V, 28 V, 48 V, 60 V, 110 V, 200 V, 220 V or 400 V nominal, while operating from an input voltage range of 320 V to 380 V, 320 V to 640 V, or 450 V to 800 V. Features include input-to-output isolation, continuous short circuit protection, overvoltage protection, and thermal shutdown with auto restart. Units are operational from -40°C to 75°C. For more information, see the product [brief](#).

DC in  DC out

## DC / DC Converters

▶ 20 kW						
Input VDC				Cooling	Output VDC	
320–380 <sup>1)</sup> VDC	320–640 VDC	450–800 VDC	Output Amps		Adj.	Range
CW 5684 Z	CW 5674 G	CW 5674 K	350		24	23– 26
CW 5685 Z	CW 5675 G	CW 5675 K	350		28	26– 30
CW 5689 Z	CW 5679 G	CW 5679 K	350		48	45– 55
CW 5686 Z	CW 5676 G	CW 5676 K	294		60	58– 68
CW 5687 Z	CW 5677 G	CW 5677 K	153		110	100– 130
CW 5687 Z	CW 5677 G	CW 5677 K	100		200	190–200
CW 5688 Z	CW 5678 G	CW 5678 K	80		220	200–250
CW 5688 Z	CW 5678 G	CW 5678 K	50		400	380–400

Other power converter news relating to rail applications:

- Absopulse Electronics's BCP 130-PEL heavy-duty switch-mode battery charger was designed for charging an external 100-Ah/12-V (10-cell) NiMH battery in railway and industrial environments, see the [press release](#).
- Vicor plans to introduce several new dc-dc converter products in 2014 for use in rail applications.