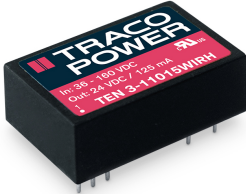


## DC/DC Railway Converter

## TEN 3WIRH Series, 3 Watt

- Fully encapsulated DIP-24 package
- 3000 VAC I/O isolation (reinforced)
- 4:1 input voltage range: 36 – 160 VDC
- EN 50155 and EN 61373 certified
- Internal class A EMI filter
- -40°C up to +95°C without derating
- EN 45545-2 fire behavior
- Remote on/off function
- Undervoltage lockout (UVLO), short-circuit protection (SCP), and overvoltage protection (OVP)
- 3-year product warranty



The TEN 3WIRH is a series of railway-certified DC/DC converters with reinforced I/O isolation for highest reliability in harsh environments. The proven and certified design guarantees highest resistance against thermal shocks, moisture, mechanical shocks, and vibration. The TEN 3WIRH comes with additional EN 62368-1 safety approvals for IT equipment and EN 45545-2 certification for fire behavior. Thanks to its favorable operating temperature range of -40°C to +95°C without derating (depending on the model), the TEN 3WIRH presents a first choice for demanding applications.

| Models          |                                |          |                  |          |                  |                 |
|-----------------|--------------------------------|----------|------------------|----------|------------------|-----------------|
| Order Code      | Input Voltage Range            | Output 1 |                  | Output 2 |                  | Efficiency typ. |
|                 |                                | Vnom     | I <sub>max</sub> | Vnom     | I <sub>max</sub> |                 |
| TEN 3-11010WIRH | 36 - 160 VDC<br>(110 VDC nom.) | 3.3 VDC  | 1'000 mA         |          |                  | 80 %            |
| TEN 3-11011WIRH |                                | 5 VDC    | 600 mA           |          |                  | 82 %            |
| TEN 3-11012WIRH |                                | 12 VDC   | 250 mA           |          |                  | 85 %            |
| TEN 3-11013WIRH |                                | 15 VDC   | 200 mA           |          |                  | 84 %            |
| TEN 3-11015WIRH |                                | 24 VDC   | 125 mA           |          |                  | 85 %            |
| TEN 3-11021WIRH |                                | +5 VDC   | 300 mA           | -5 VDC   | 300 mA           | 81 %            |
| TEN 3-11022WIRH |                                | +12 VDC  | 125 mA           | -12 VDC  | 125 mA           | 84 %            |
| TEN 3-11023WIRH |                                | +15 VDC  | 100 mA           | -15 VDC  | 100 mA           | 85 %            |

| Options                                                    |                                                  |
|------------------------------------------------------------|--------------------------------------------------|
| <b>on demand</b><br>(backorder with MOQ non stocking item) | - Optional models with adjustable output voltage |

|                        |              |                                                                                                   |
|------------------------|--------------|---------------------------------------------------------------------------------------------------|
| Input Current          | - At no load | 3 mA typ.                                                                                         |
| Surge Voltage          |              | 200 VDC max. (1 s max.)                                                                           |
| Input Inrush Current   |              | 35 A typ.                                                                                         |
| Under Voltage Lockout  |              | 32 VDC min. / 34 VDC typ. / 35.8 VDC max.                                                         |
| Recommended Input Fuse |              | 315 mA (slow blow)<br>(The need of an external fuse has to be assessed in the final application.) |
| Input Filter           |              | Internal Pi-Type                                                                                  |

|                                        |                                               |                                                                                                                                                                                                                                                                                                               |
|----------------------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Voltage Set Accuracy                   |                                               | ±1% max.                                                                                                                                                                                                                                                                                                      |
| Regulation                             | - Input Variation (Vmin - Vmax)               | single output models: 0.2% max.<br>dual output models: 0.5% max.                                                                                                                                                                                                                                              |
|                                        | - Load Variation (0 - 100%)                   | single output models: 0.2% max.<br>dual output models: 1% max. (Output 1)<br>1% max. (Output 2)                                                                                                                                                                                                               |
|                                        | - Voltage Balance<br>(symmetrical load)       | dual output models: 2% max.                                                                                                                                                                                                                                                                                   |
|                                        | - Cross Regulation<br>(25% / 100% asym. load) | dual output models: 5% max.                                                                                                                                                                                                                                                                                   |
| Ripple and Noise<br>(20 MHz Bandwidth) | - single output                               | 3.3 Vout models: 50 mVp-p typ. (w/ 10 µF)<br>5 Vout models: 50 mVp-p typ. (w/ 10 µF)<br>12 Vout models: 75 mVp-p typ. (w/ 10 µF)<br>15 Vout models: 75 mVp-p typ. (w/ 10 µF)<br>24 Vout models: 75 mVp-p typ. (w/ 4.7 µF)                                                                                     |
|                                        | - dual output                                 | 5 / -5 Vout models: 75 / 75 mVp-p typ. (w/ 10 µF)<br>12 / -12 Vout models: 75 / 75 mVp-p typ. (w/ 10 µF)<br>15 / -15 Vout models: 75 / 75 mVp-p typ. (w/ 10 µF)                                                                                                                                               |
|                                        |                                               |                                                                                                                                                                                                                                                                                                               |
|                                        |                                               |                                                                                                                                                                                                                                                                                                               |
|                                        |                                               |                                                                                                                                                                                                                                                                                                               |
|                                        |                                               |                                                                                                                                                                                                                                                                                                               |
| Capacitive Load                        | - single output                               | 3.3 Vout models: 1'050 µF max.<br>5 Vout models: 750 µF max.<br>12 Vout models: 130 µF max.<br>15 Vout models: 100 µF max.<br>24 Vout models: 39 µF max.                                                                                                                                                      |
|                                        | - dual output                                 | 5 / -5 Vout models: 430 / 430 µF max.<br>12 / -12 Vout models: 75 / 75 µF max.<br>15 / -15 Vout models: 56 / 56 µF max.                                                                                                                                                                                       |
|                                        |                                               |                                                                                                                                                                                                                                                                                                               |
|                                        |                                               |                                                                                                                                                                                                                                                                                                               |
|                                        |                                               |                                                                                                                                                                                                                                                                                                               |
|                                        |                                               |                                                                                                                                                                                                                                                                                                               |
| Minimum Load                           |                                               | Not required                                                                                                                                                                                                                                                                                                  |
| Temperature Coefficient                |                                               | ±0.02 %/K max.                                                                                                                                                                                                                                                                                                |
| Start-up Time                          |                                               | 30 ms typ. / 60 ms max.                                                                                                                                                                                                                                                                                       |
| Short Circuit Protection               |                                               | Continuous, Automatic recovery                                                                                                                                                                                                                                                                                |
| Output Current Limitation              |                                               | 150% typ. of Iout max.                                                                                                                                                                                                                                                                                        |
| Overvoltage Protection                 |                                               | 112 - 151% of Vout nom.<br>(depending on model)<br>3.7 - 5 VDC (3.3 VDC model)<br>5.6 - 7 VDC (5 VDC model)<br>13.5 - 16 VDC (12 VDC model)<br>18.3 - 22 VDC (15 VDC model)<br>29.1 - 34.5 VDC (24 VDC model)<br>5.6 - 7 VDC (±5 VDC model)<br>13.5 - 18.2 VDC (±12 VDC model)<br>17 - 22 VDC (±15 VDC model) |
| Transient Response                     | - Peak Variation                              | 125 mV typ. / 160 mV max. (75% to 100% Load Step)                                                                                                                                                                                                                                                             |
|                                        | - Response Time                               | 250 µs typ. / 300 µs max. (75% to 100% Load Step)                                                                                                                                                                                                                                                             |

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## Safety Specifications

|                       |                             |                                                                                                |
|-----------------------|-----------------------------|------------------------------------------------------------------------------------------------|
| Safety Standards      | - IT / Multimedia Equipment | EN 62368-1<br>IEC 62368-1<br>UL 62368-1                                                        |
|                       | - Railway Applications      | EN 50155                                                                                       |
|                       | - Certification Documents   | <a href="http://www.tracopower.com/overview/ten3wirh">www.tracopower.com/overview/ten3wirh</a> |
| Pollution Degree      |                             | PD 2                                                                                           |
| Over Voltage Category |                             | OVC II                                                                                         |

## EMC Specifications

|               |                             |                                                                                                |
|---------------|-----------------------------|------------------------------------------------------------------------------------------------|
| EMI Emissions |                             | EN 50121-3-2 (EMC for Rolling Stock)                                                           |
|               | - Conducted Emissions       | EN 55032 class A (internal filter)                                                             |
|               |                             | EN 55032 class B (with external filter)                                                        |
|               | - Radiated Emissions        | EN 55032 class A (internal filter)                                                             |
|               |                             | EN 55032 class B (with external filter)                                                        |
|               | External filter proposal:   | <a href="http://www.tracopower.com/overview/ten3wirh">www.tracopower.com/overview/ten3wirh</a> |
| EMS Immunity  |                             | EN 50155 (Railway Applications)                                                                |
|               |                             | EN 50121-3-2 (EMC for Rolling Stock)                                                           |
|               |                             | EN 55024 (IT Equipment)                                                                        |
|               | - Electrostatic Discharge   | Air: EN 61000-4-2, $\pm 8$ kV, perf. criteria A                                                |
|               |                             | Contact: EN 61000-4-2, $\pm 6$ kV, perf. criteria A                                            |
|               | - RF Electromagnetic Field  | EN 61000-4-3, 20 V/m, perf. criteria A                                                         |
|               | - EFT (Burst) / Surge       | EN 61000-4-4, $\pm 2$ kV, perf. criteria A                                                     |
|               |                             | EN 61000-4-5, $\pm 2$ kV, perf. criteria A                                                     |
|               | Ext. input component:       | 2x 220 $\mu$ F, 200 V, KXJ // SMBJ220A                                                         |
|               | - Conducted RF Disturbances | EN 61000-4-6, 10 Vrms, perf. criteria A                                                        |
|               | - PF Magnetic Field         | Continuous: EN 61000-4-8, 100 A/m, perf. criteria A                                            |
|               |                             | 1 s: EN 61000-4-8, 1000 A/m, perf. criteria A                                                  |

## General Specifications

|                           |                                 |                                                                                                                      |
|---------------------------|---------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Relative Humidity         |                                 | 95% max. (non condensing)                                                                                            |
| Temperature Ranges        | - Operating Temperature         | -40°C to +95°C                                                                                                       |
|                           | - Case Temperature              | +105°C max.                                                                                                          |
|                           | - Storage Temperature           | -55°C to +125°C                                                                                                      |
| Power Derating            | - High Temperature              | See application note: <a href="http://www.tracopower.com/overview/ten3wirh">www.tracopower.com/overview/ten3wirh</a> |
| Cooling System            |                                 | Natural convection (20 LFM)                                                                                          |
| Remote Control            | - Voltage Controlled Remote     | On: 3.0 to 12 VDC or open circuit                                                                                    |
|                           |                                 | Off: 0 to 1.2 VDC or short circuit                                                                                   |
|                           |                                 | Refers to 'Remote' and '-Vin' Pin                                                                                    |
|                           | - Off Idle Input Current        | 2.5 mA typ. / 3 mA max.                                                                                              |
| Altitude During Operation |                                 | 5'000 m max.                                                                                                         |
| Switching Frequency       |                                 | 215 - 265 kHz (PWM)                                                                                                  |
|                           |                                 | 240 kHz typ. (PWM)                                                                                                   |
| Insulation System         |                                 | Reinforced Insulation                                                                                                |
| Working Voltage (rated)   |                                 | 189 VAC                                                                                                              |
| Isolation Test Voltage    | - Input to Output, 60 s         | 3'000 VAC                                                                                                            |
|                           | - Input to Case, 60 s           | 3'000 VAC                                                                                                            |
|                           | - Output to Case, 60 s          | 2'000 VAC                                                                                                            |
| Creepage                  | - Input to Output               | 4.5 mm min.                                                                                                          |
| Clearance                 | - Input to Output               | 4.5 mm min.                                                                                                          |
| Isolation Resistance      | - Input to Output, 500 VDC      | 1'000 M $\Omega$ min.                                                                                                |
| Isolation Capacitance     | - Input to Output, 100 kHz, 1 V | 650 pF typ.                                                                                                          |
|                           |                                 | 1'000 pF max.                                                                                                        |
| Reliability               | - Calculated MTBF               | 5'069'000 h (MIL-HDBK-217F, ground benign)                                                                           |

All specifications valid at nominal voltage, resistive full load and +25°C after warm-up time, unless otherwise stated.

|                          |                             |                                                                                                                                                                                                                                                                                                            |
|--------------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Washing Process          |                             | Allowed (hermetical product)<br><a href="http://www.tracopower.com/info/cleaning.pdf">www.tracopower.com/info/cleaning.pdf</a>                                                                                                                                                                             |
|                          | See Cleaning Guideline:     |                                                                                                                                                                                                                                                                                                            |
| Environment              | - Vibration                 | MIL-STD-810F<br>EN 61373                                                                                                                                                                                                                                                                                   |
|                          | - Mechanical Shock          | MIL-STD-810F<br>EN 61373                                                                                                                                                                                                                                                                                   |
|                          | - Thermal Shock             | MIL-STD-810F<br>EN 50155                                                                                                                                                                                                                                                                                   |
| Housing Material         |                             | Non-conductive Plastic (UL 94 V-0 rated)                                                                                                                                                                                                                                                                   |
| Base Material            |                             | Non-conductive Plastic (UL 94 V-0 rated)                                                                                                                                                                                                                                                                   |
| Potting Material         |                             | Silicone (UL 94 V-0 rated)                                                                                                                                                                                                                                                                                 |
| Pin Material             |                             | Tinned Copper                                                                                                                                                                                                                                                                                              |
| Pin Foundation Plating   |                             | Nickel (2 - 3 µm)                                                                                                                                                                                                                                                                                          |
| Pin Surface Plating      |                             | Tin (3 - 5 µm), matte                                                                                                                                                                                                                                                                                      |
| Housing Type             |                             | Plastic Case                                                                                                                                                                                                                                                                                               |
| Mounting Type            |                             | PCB Mount                                                                                                                                                                                                                                                                                                  |
| Connection Type          |                             | THD (Through-Hole Device)                                                                                                                                                                                                                                                                                  |
| Footprint Type           |                             | DIP24                                                                                                                                                                                                                                                                                                      |
| Soldering Profile        |                             | Wave Soldering<br>260°C / 6 s max.                                                                                                                                                                                                                                                                         |
| Weight                   |                             | 14 g                                                                                                                                                                                                                                                                                                       |
| Thermal Impedance        | - Case to Ambient           | 19.2 K/W typ.                                                                                                                                                                                                                                                                                              |
| Environmental Compliance | - REACH Declaration         | <a href="http://www.tracopower.com/info/reach-declaration.pdf">www.tracopower.com/info/reach-declaration.pdf</a><br>REACH SVHC list compliant<br>REACH Annex XVII compliant                                                                                                                                |
|                          | - RoHS Declaration          | <a href="http://www.tracopower.com/info/rohs-declaration.pdf">www.tracopower.com/info/rohs-declaration.pdf</a><br>Exemptions: 7a, 7c-I<br>(RoHS exemptions refer to the component concentration only, not to the overall concentration in the product (O5A rule). The SCIP number is provided on request.) |
|                          | - Flammability (EN 45545-2) | <a href="http://www.tracopower.com/info/en45545-declaration.pdf">www.tracopower.com/info/en45545-declaration.pdf</a>                                                                                                                                                                                       |

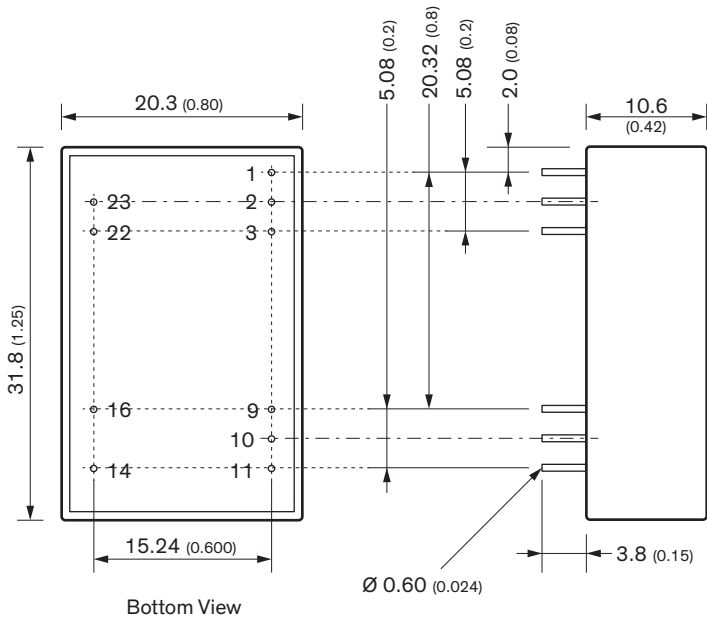
## Supporting Documents

Overview Link (for additional Documents)

[www.tracopower.com/overview/ten3wirh](http://www.tracopower.com/overview/ten3wirh)

All specifications valid at nominal voltage, resistive full load and +25°C after warm-up time, unless otherwise stated.

## Outline Dimensions



All dimension in mm (inch)  
Tolerance: X.X  $\pm 0.5$  (X.XX  $\pm 0.02$ )  
X.XX  $\pm 0.25$  (X.XXX  $\pm 0.010$ )  
Pin dimension tolerance  $\pm 0.10$  ( $\pm 0.004$ )

| Pinout |                        |        |
|--------|------------------------|--------|
| Pin    | Single                 | Dual   |
| 1      | Remote On/Off          |        |
| 2      | -Vin                   |        |
| 3      | -Vin                   |        |
| 9      | NC                     | Common |
| 10     | No pin / Trim (option) |        |
| 11     | NC                     | -Vout  |
| 14     | +Vout                  |        |
| 16     | -Vout                  | Common |
| 22     | +Vin                   |        |
| 23     | +Vin                   |        |

NC: Not connected