

## DC/DC Railway Converter

## TEN 20WIR Series, 20 Watt

- 2" x 1" x 0.4" metal package
- Ultra wide 4:1 input voltage range  
9–36, 18–75, 43–160 VDC
- EN 50155 approval for railway applications
- Thermal shock and vibration resistant according EN 61373
- Input filter meets EN 55032 class B without external components
- High efficiency up to 89%
- Operating temperature range  
–40°C to +85°C
- Under voltage lock-out circuit
- Remote On/Off and Output voltage adjustable
- 3-year product warranty



The TEN 20WIR series is a family of high performance 20 Watt DC/DC converter modules featuring ultra wide 4:1 input voltage ranges in a 2" x 1" x 0.4" package with industry-standard footprint. Input voltages up to 160 VDC, excellent EMC characteristics and EN 50155 approval make this product the best choice for many demanding applications in railroad and transportation systems. Further standard features include remote On/Off, over voltage protection, under voltage lockout and short circuit protection. Low input current characteristics at minimal load make these converters also the ideal solution for battery-operated systems. Typical applications are in wireless networks, telecom/datacom, industry control systems and measurement equipment.

| Models         |                                |          |                  |          |                  |                 |
|----------------|--------------------------------|----------|------------------|----------|------------------|-----------------|
| Order Code     | Input Voltage Range            | Output 1 |                  | Output 2 |                  | Efficiency typ. |
|                |                                | Vnom     | I <sub>max</sub> | Vnom     | I <sub>max</sub> |                 |
| TEN 20-2410WIR | 9 - 36 VDC<br>(24 VDC nom.)    | 3.3 VDC  | 4'500 mA         |          |                  | 85 %            |
| TEN 20-2411WIR |                                | 5 VDC    | 4'000 mA         |          |                  | 88 %            |
| TEN 20-2412WIR |                                | 12 VDC   | 1'670 mA         |          |                  | 89 %            |
| TEN 20-2413WIR |                                | 15 VDC   | 1'330 mA         |          |                  | 88 %            |
| TEN 20-2422WIR |                                | +12 VDC  | 833 mA           | –12 VDC  | 833 mA           | 88 %            |
| TEN 20-2423WIR |                                | +15 VDC  | 667 mA           | –15 VDC  | 667 mA           | 89 %            |
| TEN 20-4810WIR | 18 - 75 VDC<br>(48 VDC nom.)   | 3.3 VDC  | 4'500 mA         |          |                  | 85 %            |
| TEN 20-4811WIR |                                | 5 VDC    | 4'000 mA         |          |                  | 88 %            |
| TEN 20-4812WIR |                                | 12 VDC   | 1'670 mA         |          |                  | 89 %            |
| TEN 20-4813WIR |                                | 15 VDC   | 1'330 mA         |          |                  | 89 %            |
| TEN 20-4822WIR |                                | +12 VDC  | 833 mA           | –12 VDC  | 833 mA           | 88 %            |
| TEN 20-4823WIR |                                | +15 VDC  | 667 mA           | –15 VDC  | 667 mA           | 89 %            |
| TEN 20-7210WIR | 43 - 160 VDC<br>(110 VDC nom.) | 3.3 VDC  | 4'500 mA         |          |                  | 85 %            |
| TEN 20-7211WIR |                                | 5 VDC    | 4'000 mA         |          |                  | 87 %            |
| TEN 20-7212WIR |                                | 12 VDC   | 1'670 mA         |          |                  | 88 %            |
| TEN 20-7213WIR |                                | 15 VDC   | 1'330 mA         |          |                  | 88 %            |
| TEN 20-7222WIR |                                | +12 VDC  | 833 mA           | –12 VDC  | 833 mA           | 88 %            |
| TEN 20-7223WIR |                                | +15 VDC  | 667 mA           | –15 VDC  | 667 mA           | 89 %            |

| Options |                                                                                                                                            |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------|
| TEN-HS1 | - Optional Heat Sink with Height = 0.22 inch: <a href="http://www.tracopower.com/overview/ten-hs1">www.tracopower.com/overview/ten-hs1</a> |

## Input Specifications

|                          |              |                                                                                                                                                                                                                        |
|--------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input Current            | - At no load | 24 Vin models: <b>6 mA typ.</b><br>48 Vin models: <b>4 mA typ.</b><br>110 Vin models: <b>3 mA typ.</b>                                                                                                                 |
| Surge Voltage            |              | 24 Vin models: <b>50 VDC max.</b> (100 ms max.)<br>48 Vin models: <b>100 VDC max.</b> (100 ms max.)<br>110 Vin models: <b>170 VDC max.</b> (100 ms max.)                                                               |
| Under Voltage Lockout    |              | 24 Vin models: <b>7.5 VDC min. / 8 VDC typ. / 8.8 VDC max.</b><br>48 Vin models: <b>15.5 VDC min. / 16 VDC typ. / 17.5 VDC max.</b><br>110 Vin models: <b>38.5 VDC min. / 40 VDC typ. / 42 VDC max.</b>                |
| Reflected Ripple Current |              | <b>30 mA<sub>p-p</sub> typ.</b>                                                                                                                                                                                        |
| Recommended Input Fuse   |              | 24 Vin models: <b>4'000 mA</b> (slow blow)<br>48 Vin models: <b>2'000 mA</b> (slow blow)<br>110 Vin models: <b>1'000 mA</b> (slow blow)<br>(The need of an external fuse has to be assessed in the final application.) |
| Input Filter             |              | <b>Internal Pi-Type</b> (110 Vin models)<br><b>Common Choke</b> (other models)                                                                                                                                         |

## Output Specifications

|                                        |                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Output Voltage Adjustment              |                                                                                                                                       | <b>±10%</b> (single output models only)<br>(By external trim resistor)<br>See application note: <a href="http://www.tracopower.com/ten20wir-adj/">www.tracopower.com/ten20wir-adj/</a><br>Output power must not exceed rated power!                                                                                                                                                                                                                                                                                                        |
| Voltage Set Accuracy                   |                                                                                                                                       | <b>±1% max.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Regulation                             | - Input Variation (V <sub>min</sub> - V <sub>max</sub> )<br>- Load Variation (10 - 90%)<br>- Cross Regulation (25% / 100% asym. load) | single output models: <b>0.2% max.</b><br>dual output models: <b>0.5% max.</b><br>single output models: <b>0.1% max.</b><br>dual output models: <b>0.8% max.</b> (Output 1)<br><b>0.8% max.</b> (Output 2)<br>dual output models: <b>5% max.</b>                                                                                                                                                                                                                                                                                           |
| Ripple and Noise<br>(20 MHz Bandwidth) | - single output<br>- dual output                                                                                                      | 3.3 V <sub>out</sub> models: <b>75 mV<sub>p-p</sub> typ.</b> (w/ 1 µF, 50 V X7R)<br>5 V <sub>out</sub> models: <b>75 mV<sub>p-p</sub> typ.</b> (w/ 1 µF, 50 V X7R)<br>12 V <sub>out</sub> models: <b>100 mV<sub>p-p</sub> typ.</b> (w/ 1 µF, 50 V X7R)<br>15 V <sub>out</sub> models: <b>100 mV<sub>p-p</sub> typ.</b> (w/ 1 µF, 50 V X7R)<br>12 / -12 V <sub>out</sub> models: <b>100 / 100 mV<sub>p-p</sub> typ.</b> (w/ 1 µF, 50 V X7R)<br>15 / -15 V <sub>out</sub> models: <b>100 / 100 mV<sub>p-p</sub> typ.</b> (w/ 1 µF, 50 V X7R) |
| Capacitive Load                        | - single output<br>- dual output                                                                                                      | 3.3 V <sub>out</sub> models: <b>7'000 µF max.</b><br>5 V <sub>out</sub> models: <b>5'000 µF max.</b><br>12 V <sub>out</sub> models: <b>850 µF max.</b><br>15 V <sub>out</sub> models: <b>700 µF max.</b><br>12 / -12 V <sub>out</sub> models: <b>500 / 500 µF max.</b><br>15 / -15 V <sub>out</sub> models: <b>350 / 350 µF max.</b>                                                                                                                                                                                                       |
| Minimum Load                           |                                                                                                                                       | <b>Not required</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Temperature Coefficient                |                                                                                                                                       | <b>±0.02 %/K max.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Hold-up Time                           |                                                                                                                                       | <b>10 ms min.</b> (acc. to EN 50155 Class S2, see application note for ext. capacitor calculation:<br><a href="http://www.tracopower.com/info/holdup_en50155.pdf">www.tracopower.com/info/holdup_en50155.pdf</a> )                                                                                                                                                                                                                                                                                                                         |
| Start-up Time                          |                                                                                                                                       | <b>30 ms max.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Short Circuit Protection               |                                                                                                                                       | <b>Continuous, Automatic recovery</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Output Current Limitation              |                                                                                                                                       | <b>125 - 188% of I<sub>out</sub> max.</b><br><b>150% typ. of I<sub>out</sub> max.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Overvoltage Protection                 |                                                                                                                                       | <b>110 - 165% of V<sub>out</sub> nom.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Transient Response                     | - Response Time                                                                                                                       | <b>250 µs typ.</b> (25% Load Step)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

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

## Safety Specifications

|                       |                             |                                                                                                                                                                                                          |
|-----------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Standards             | - IT / Multimedia Equipment | EN 60950-1<br>EN 62368-1<br>IEC 60950-1<br>IEC 62368-1<br>UL 60950-1<br>UL 62368-1<br>EN 50155<br><a href="http://www.tracopower.com/ten20wir-safety-cert/">www.tracopower.com/ten20wir-safety-cert/</a> |
|                       | - Railway Applications      |                                                                                                                                                                                                          |
|                       | - Certification Documents   |                                                                                                                                                                                                          |
| Energy Source         | - Output, acc. to 62368-1   | ES1                                                                                                                                                                                                      |
| Power Source          | - Output, acc. to 62368-1   | PS3                                                                                                                                                                                                      |
| Pollution Degree      |                             | PD 2                                                                                                                                                                                                     |
| Over Voltage Category |                             | Not mains connected                                                                                                                                                                                      |

## EMC Specifications

|                     |                             |                                                                                                                                                       |
|---------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| EMI (Emissions)     | - Conducted Emissions       | EN 50121-3-2 (EMC for Rolling Stock)<br>EN 55032 class A (internal filter)<br>EN 55032 class B (internal filter)                                      |
|                     | - Radiated Emissions        | EN 55032 class A (internal filter)<br>EN 55032 class B (internal filter)                                                                              |
|                     | External filter proposal:   | <a href="http://www.tracopower.com/ten20wir-emc-filter/">www.tracopower.com/ten20wir-emc-filter/</a><br>(110 Vin models: external filter for class B) |
| EMS (Immunity)      | - Electrostatic Discharge   | EN 50121-3-2 (EMC for Rolling Stock)<br>Air: EN 61000-4-2, $\pm 8$ kV, perf. criteria A<br>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<br>EN 61000-4-5, $\pm 2$ kV, perf. criteria A                                                              |
|                     | Ext. input component:       | 220 $\mu$ F, 100 V, KY (24 & 48 Vin models)<br>100 $\mu$ F, 250 V, BXF (110 Vin model)                                                                |
|                     | - 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<br>1 s: EN 61000-4-8, 1000 A/m, perf. criteria A                                                  |
| EMC / Environmental | - Certification Documents   | <a href="http://www.tracopower.com/ten20wir-emc-cert/">www.tracopower.com/ten20wir-emc-cert/</a>                                                      |

## General Specifications

|                           |                                            |                                                                                                              |
|---------------------------|--------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Relative Humidity         |                                            | 95% max. (non condensing)                                                                                    |
| Temperature Ranges        | - Operating Temperature                    | -40°C to +86°C<br>-40°C to +91°C (with heatsink TEN-HS1)<br>+105°C max.                                      |
|                           | - Case Temperature                         | -55°C to +125°C                                                                                              |
|                           | - Storage Temperature                      |                                                                                                              |
| Power Derating            | - High Temperature                         | Depending on model                                                                                           |
|                           | See application note:                      | <a href="http://www.tracopower.com/ten20wir-cc/">www.tracopower.com/ten20wir-cc/</a>                         |
| Cooling System            |                                            | Natural convection (20 LFM)                                                                                  |
| Remote Control            | - Voltage Controlled Remote (passive = on) | On: 3.0 to 15 VDC or open circuit<br>Off: 0 to 1.2 VDC or short circuit<br>Refers to 'Remote' and '-Vin' Pin |
|                           | - Off Idle Input Current                   | 2.5 mA typ.                                                                                                  |
|                           | - Remote Pin Input Current                 | -0.5 to 1.0 mA                                                                                               |
| Altitude During Operation |                                            | 5'000 m max.                                                                                                 |
| Regulator Topology        |                                            | Flyback Converter                                                                                            |
| Switching Frequency       |                                            | 297 - 363 kHz (PWM)<br>330 kHz typ. (PWM)                                                                    |
| Insulation System         |                                            | Functional Insulation                                                                                        |
| Isolation Test Voltage    | - Input to Output, 60 s                    | 2'250 VDC                                                                                                    |
|                           | - Input to Case, 60 s                      | 1'600 VDC                                                                                                    |

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

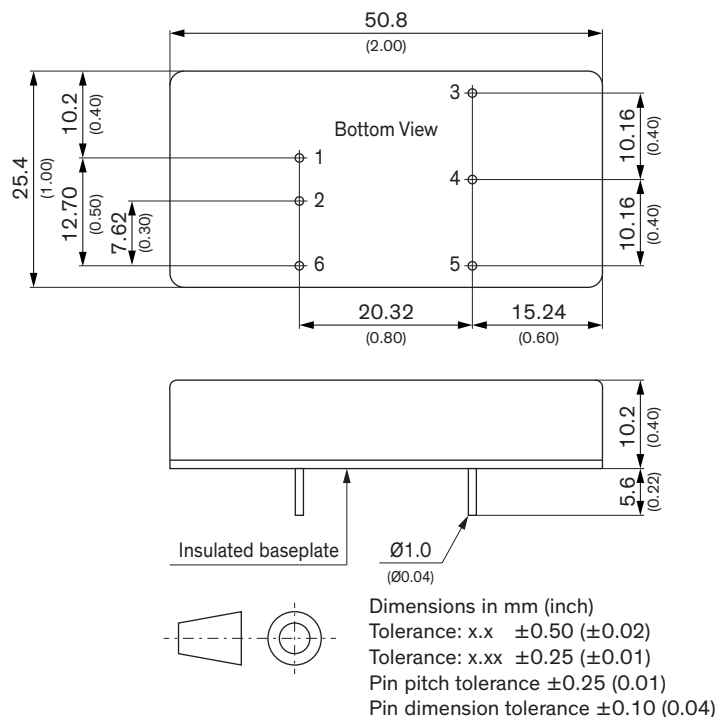
|                          |                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Isolation Resistance     | - Input to Output, 500 VDC                                                     | 1'000 MΩ min.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Isolation Capacitance    | - Input to Output, 100 kHz, 1 V                                                | 3'000 pF max.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Reliability              | - Calculated MTBF                                                              | 1'500'000 h (MIL-HDBK-217F, ground benign)                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Washing Process          |                                                                                | According to Cleaning Guideline<br><a href="http://www.tracopower.com/info/cleaning.pdf">www.tracopower.com/info/cleaning.pdf</a>                                                                                                                                                                                                                                                                                                                                                             |
| Environment              | - Vibration<br><br>- Mechanical Shock<br><br>- Thermal Shock<br>- Flammability | MIL-STD-810F<br>EN 61373<br>MIL-STD-810F<br>EN 61373<br>MIL-STD-810F<br>EN 45545-2<br><a href="http://www.tracopower.com/info/en45545-declaration.pdf">www.tracopower.com/info/en45545-declaration.pdf</a>                                                                                                                                                                                                                                                                                    |
| Housing Material         |                                                                                | Copper, Nickel plated                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Base Material            |                                                                                | Non-conductive FR4 (UL 94 V-0 rated)                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Potting Material         |                                                                                | Silicone (UL 94 V-0 rated)                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Pin Material             |                                                                                | Copper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Pin Foundation Plating   |                                                                                | Nickel (2 - 3 μm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Pin Surface Plating      |                                                                                | Tin (3 - 5 μm), matte                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Housing Type             |                                                                                | Metal Case                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Mounting Type            |                                                                                | PCB Mount                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Connection Type          |                                                                                | THD (Through-Hole Device)                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Footprint Type           |                                                                                | 2" x 1"                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Soldering Profile        |                                                                                | Lead-Free Wave Soldering<br>265°C / 10 s max.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Weight                   |                                                                                | 30 g                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Thermal Impedance        | - Case to Ambient                                                              | 12.0 K/W typ.<br>10.0 K/W typ. (with heatsink TEN-HS1)                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Environmental Compliance | - REACH Declaration<br><br>- RoHS Declaration<br><br>- SCIP Reference Number   | <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<br><a href="http://www.tracopower.com/info/rohs-declaration.pdf">www.tracopower.com/info/rohs-declaration.pdf</a><br>Exemptions: 7(a), 7(c)-I<br>(RoHS exemptions refer to the component concentration only, not to the overall concentration in the product (O5A rule).)<br>adacaa16-264a-497b-ab20-9b54c430be79 |

## Additional Information

|                            |                                                                                                |
|----------------------------|------------------------------------------------------------------------------------------------|
| Supporting Documents       | <a href="http://www.tracopower.com/overview/ten20wir">www.tracopower.com/overview/ten20wir</a> |
| Frequently Asked Questions | <a href="http://www.tracopower.com/glossary-faq">www.tracopower.com/glossary-faq</a>           |
| Glossary                   | <a href="http://www.tracopower.com/info/glossary.pdf">www.tracopower.com/info/glossary.pdf</a> |
| Service Portal             | <a href="http://www.tracoserviceportal.com">www.tracoserviceportal.com</a>                     |

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

## Outline Dimensions



### Pinout

| Pin | Single        | Dual          |
|-----|---------------|---------------|
| 1   | +Vin (Vcc)    | +Vin (Vcc)    |
| 2   | -Vin (GND)    | -Vin (GND)    |
| 3   | +Vout         | +Vout         |
| 4   | Trim          | Common        |
| 5   | -Vout         | -Vout         |
| 6   | Remote On/Off | Remote On/Off |

Avoid routing PCB traces under the converter.