DC/DC Converter

TEN 60WIR Series, 60 Watt

- Compact 2"x1" package (without heatsink)
- Wide 4:1 input voltage range: 9–36, 18–75, 36–160 VDC
- EN 50155 and EN 61373 approval for railway applications
- Qualification for fire behavior according to EN 45545-2
- Operating temperature range −40°C to +90°C
- I/O-isolation 3'000 VDC
- High efficiency up to 92%
- Under voltage lock out circuit
- Adjustable output voltage and Remote On/Off
- 3 year product warranty

The TEN 60WIR is a ruggedized 60 Watt railway approved DC/DC converter series with a wide 4:1 input voltage range and increased resistance against electromagnetic interference, shock/vibration and thermal shock. The standard version comes with a preassembled heatsink which was specifically designed for this 2" x 1" metal package converter. Together with a high efficiency of up to 92% this gives the converter an effective operating temperature range of −40° to +70°C without derating. The approvals according to standards EN 50155 and EN 61373 qualify them for railway and transportation systems. Additional qualification for the fire behavior of components according to EN 45545-2 and the safety approval according IEC/EN 62368-1, UL62368-1 support a potential compliance test of the application. All models offer an I/O-isolation voltage of 3'000 VDC and feature an active under voltage lockout function, remote on/off and adjustable outputs to ensure that these converters fit in any ruggedized application setup.

<table>
<thead>
<tr>
<th>Models</th>
<th>Input Voltage Range</th>
<th>Output 1 Vnom</th>
<th>Output 1 Imax</th>
<th>Output 2 Vnom</th>
<th>Output 2 Imax</th>
<th>Efficiency typ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEN 60-2411WIR</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>5 VDC</td>
<td>12'000 mA</td>
<td>-12 VDC</td>
<td>2'500 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-2412WIR</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>12 VDC</td>
<td>5'000 mA</td>
<td>-12 VDC</td>
<td>2'500 mA</td>
<td>93 %</td>
</tr>
<tr>
<td>TEN 60-2413WIR</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>15 VDC</td>
<td>4'000 mA</td>
<td>-12 VDC</td>
<td>2'500 mA</td>
<td>93 %</td>
</tr>
<tr>
<td>TEN 60-2415WIR</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>24 VDC</td>
<td>2'500 mA</td>
<td>-12 VDC</td>
<td>2'500 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-2418WIR</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>48 VDC</td>
<td>1'250 mA</td>
<td>-12 VDC</td>
<td>2'500 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-2422WIR</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>+12 VDC</td>
<td>2'500 mA</td>
<td>-15 VDC</td>
<td>2'000 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-2423WIR</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>+15 VDC</td>
<td>2'000 mA</td>
<td>-15 VDC</td>
<td>2'000 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-2425WIR</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>+24 VDC</td>
<td>1'250 mA</td>
<td>-24 VDC</td>
<td>1'250 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4811WIR</td>
<td>18 - 75 VDC (48 VDC nom.)</td>
<td>5 VDC</td>
<td>12'000 mA</td>
<td>-12 VDC</td>
<td>2'500 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4812WIR</td>
<td>18 - 75 VDC (48 VDC nom.)</td>
<td>12 VDC</td>
<td>5'000 mA</td>
<td>-12 VDC</td>
<td>2'500 mA</td>
<td>93 %</td>
</tr>
<tr>
<td>TEN 60-4813WIR</td>
<td>18 - 75 VDC (48 VDC nom.)</td>
<td>15 VDC</td>
<td>4'000 mA</td>
<td>-12 VDC</td>
<td>2'500 mA</td>
<td>94 %</td>
</tr>
<tr>
<td>TEN 60-4815WIR</td>
<td>18 - 75 VDC (48 VDC nom.)</td>
<td>24 VDC</td>
<td>2'500 mA</td>
<td>-15 VDC</td>
<td>2'000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4818WIR</td>
<td>18 - 75 VDC (48 VDC nom.)</td>
<td>48 VDC</td>
<td>1'250 mA</td>
<td>-15 VDC</td>
<td>2'000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4822WIR</td>
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<td>+12 VDC</td>
<td>2'500 mA</td>
<td>-24 VDC</td>
<td>1'250 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4823WIR</td>
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<td>+15 VDC</td>
<td>2'000 mA</td>
<td>-24 VDC</td>
<td>1'250 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4825WIR</td>
<td>18 - 75 VDC (48 VDC nom.)</td>
<td>+24 VDC</td>
<td>1'250 mA</td>
<td>-24 VDC</td>
<td>1'250 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-7211WIR</td>
<td>36 - 160 VDC (110 VDC nom.)</td>
<td>5 VDC</td>
<td>12'000 mA</td>
<td>-12 VDC</td>
<td>2'500 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-7212WIR</td>
<td>36 - 160 VDC (110 VDC nom.)</td>
<td>12 VDC</td>
<td>5'000 mA</td>
<td>-12 VDC</td>
<td>2'500 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-7213WIR</td>
<td>36 - 160 VDC (110 VDC nom.)</td>
<td>15 VDC</td>
<td>4'000 mA</td>
<td>-12 VDC</td>
<td>2'500 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-7215WIR</td>
<td>36 - 160 VDC (110 VDC nom.)</td>
<td>24 VDC</td>
<td>2'500 mA</td>
<td>-15 VDC</td>
<td>2'000 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-7218WIR</td>
<td>36 - 160 VDC (110 VDC nom.)</td>
<td>48 VDC</td>
<td>1'250 mA</td>
<td>-15 VDC</td>
<td>2'000 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-7222WIR</td>
<td>36 - 160 VDC (110 VDC nom.)</td>
<td>+12 VDC</td>
<td>2'500 mA</td>
<td>-24 VDC</td>
<td>1'250 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-7223WIR</td>
<td>36 - 160 VDC (110 VDC nom.)</td>
<td>+15 VDC</td>
<td>2'000 mA</td>
<td>-24 VDC</td>
<td>1'250 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-7225WIR</td>
<td>36 - 160 VDC (110 VDC nom.)</td>
<td>+24 VDC</td>
<td>1'250 mA</td>
<td>-24 VDC</td>
<td>1'250 mA</td>
<td>91 %</td>
</tr>
</tbody>
</table>
Options

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>URL</th>
</tr>
</thead>
</table>

on demand (backorder with MOQ non stocking item) - TEN 60WIR without heatsink

Input Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Conditions</th>
<th>24 Vin models</th>
<th>48 Vin models</th>
<th>110 Vin models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current</td>
<td>At no load</td>
<td>15 mA typ.</td>
<td>15 mA typ.</td>
<td>15 mA typ.</td>
</tr>
<tr>
<td></td>
<td>Surge Voltage</td>
<td>50 VDC max.</td>
<td>100 VDC max.</td>
<td>200 VDC max.</td>
</tr>
<tr>
<td></td>
<td>Under Voltage Lockout</td>
<td>7 VDC min. / 8 VDC typ. / 8.8 VDC max.</td>
<td>15 VDC min. / 16 VDC typ. / 17.5 VDC max.</td>
<td>32 VDC min. / 34 VDC typ. / 35.8 VDC max.</td>
</tr>
<tr>
<td>Recommended Input Fuse</td>
<td></td>
<td>10'000 mA (fast acting)</td>
<td>6'300 mA (slow blow)</td>
<td>3'150 mA (slow blow)</td>
</tr>
<tr>
<td></td>
<td>Internal Pi-Type</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Output Specifications

Output Voltage Adjustment

-10% to +20% (15 Vout and 24 Vout models)
±10% (other models)
(By external trim resistor)

See application note: www.tracopower.com/overview/ten60wir
Output power must not exceed rated power!

<table>
<thead>
<tr>
<th>Specification</th>
<th>Conditions</th>
<th>5 Vout models</th>
<th>12 Vout models</th>
<th>15 Vout models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Set Accuracy</td>
<td>±1% max.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulation</td>
<td>Input Variation (Vmin - Vmax)</td>
<td>single output models: 0.2% max.</td>
<td>dual output models: 0.2% max.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Load Variation (0 - 100%)</td>
<td>single output models: 0.5% max.</td>
<td>dual output models: 1% max. (Output 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cross Regulation (25% / 100% asym. load)</td>
<td>dual output models: 5% max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ripple and Noise (20 MHz Bandwidth)</td>
<td>single output: 75 mVp-p typ. (w/ 1 µF X7R)</td>
<td>dual output: 100 / 100 mVp-p typ. (w/ 1 µF X7R)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- single output</td>
<td>12 / -12 Vout models: 100 / 100 mVp-p typ. (w/ 1 µF X7R)</td>
<td>24 / -24 Vout models: 150 / 150 mVp-p typ. (w/ 1 µF X7R)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- dual output</td>
<td>5 Vout models: 100 mVp-p max. (w/ 1 µF X7R)</td>
<td>12 Vout models: 125 mVp-p max. (w/ 1 µF X7R)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- single output</td>
<td>12 / -12 Vout models: 125 / 125 mVp-p typ. (w/ 1 µF X7R)</td>
<td>24 / -24 Vout models: 200 / 200 mVp-p max. (w/ 1 µF X7R)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- dual output</td>
<td>5 Vout models: 125 mVp-p max. (w/ 1 µF X7R)</td>
<td>12 Vout models: 125 mVp-p max. (w/ 1 µF X7R)</td>
<td></td>
</tr>
</tbody>
</table>

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

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| Capacitive Load | - single output | 5 Vout models: 17'000 µF max. |
| | 12 Vout models: 3'000 µF max. |
| | 15 Vout models: 1'900 µF max. |
| | 24 Vout models: 730 µF max. |
| | 48 Vout models: 190 µF max. |
| - dual output | 12 / -12 Vout models: 1'500 / 1'500 µF max. |
| | 15 / -15 Vout models: 940 / 940 µF max. |
| | 24 / -24 Vout models: 370 / 370 µF max. |

Minimum Load
Temperature Coefficient
Start-up Time
Short Circuit Protection
Output Current Limitation
Overvoltage Protection Limitation
Transient Response

Safety Specifications

| Safety Standards | - IT / Multimedia Equipment | EN 62368-1 |
| | - Railway Applications | IEC 62368-1 |
| | - Certification Documents | UL 62368-1 |

EMC Specifications

| EMI Emissions | - Conducted Emissions | EN 55032 class A (with external filter) |
| | - Radiated Emissions | EN 55032 class B (with external filter) |

EMS Immunity

| Electrostatic Discharge | Air: EN 61000-4-2, ±8 kV, perf. criteria A |
| | Contact: EN 61000-4-2, ±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, ±2 kV, perf. criteria A |
| | EN 61000-4-5, ±2 kV, perf. criteria A |

External filter proposal:

| Ext. input component | 24 Vin models: 2x KY 220 µF // TVS SMDJ58A |
| | 48 Vin models: 2x KY 220 µF // TVS SMDJ120A |
| | 110 Vin models: 2x KXJ 150 µF // TVS SMDJ170A |

- Conducted RF Disturbances
- PF Magnetic Field

General Specifications

| Relative Humidity | 95% max. (non condensing) |
| Temperature Ranges | - Operating Temperature -40°C to +85°C |
| | - Case Temperature +105°C max. |
| | - Storage Temperature -55°C to +125°C |

Power Derating
- High Temperature 2.86 %/K above 70°C

Over Temperature Protection Switch Off
- Protection Mode 115°C typ.

Cooling System
Natural convection (20 LFM)

All specifications valid at nominal voltage, full load and +25°C after warm-up time unless otherwise stated.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote Control</td>
<td>- 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 3 mA typ. -0.5 to 0.5 mA</td>
</tr>
<tr>
<td>Altitude During Operation</td>
<td>5'000 m max.</td>
</tr>
<tr>
<td>Switching Frequency</td>
<td>200 - 275 kHz (PWM) 250 kHz typ. (PWM)</td>
</tr>
<tr>
<td>Insulation System</td>
<td>Functional Insulation</td>
</tr>
<tr>
<td>Isolation Test Voltage</td>
<td>- Input to Output, 60 s 3'000 VDC</td>
</tr>
<tr>
<td></td>
<td>- Input to Case, 60 s 2'250 VDC</td>
</tr>
<tr>
<td>Isolation Resistance</td>
<td>- Input to Output, 500 VDC 1'000 MΩ min.</td>
</tr>
<tr>
<td>Isolation Capacitance</td>
<td>- Input to Output, 100 kHz, 1 V 1'500 pF max.</td>
</tr>
<tr>
<td>Reliability</td>
<td>- Calculated MTBF 724'500 h (MIL-HDBK-217F, ground benign)</td>
</tr>
<tr>
<td>Environment</td>
<td>- Vibration MIL-STD-810F EN 61373</td>
</tr>
<tr>
<td></td>
<td>- Mechanical Shock MIL-STD-810F EN 61373</td>
</tr>
<tr>
<td></td>
<td>- Thermal Shock MIL-STD-810F EN 50155</td>
</tr>
<tr>
<td>Housing Material</td>
<td>Copper</td>
</tr>
<tr>
<td>Base Material</td>
<td>Non-conductive FR4 (UL94 V-0 rated)</td>
</tr>
<tr>
<td>Potting Material</td>
<td>Silicone (UL 94 V-0 rated)</td>
</tr>
<tr>
<td>Connection Type</td>
<td>THD [Through-Hole Device]</td>
</tr>
<tr>
<td>Weight</td>
<td>66.9 g</td>
</tr>
<tr>
<td>Thermal Impedance</td>
<td>10.8 K/W (without Heat Sink)</td>
</tr>
<tr>
<td></td>
<td>5.9 K/W (with Heat Sink)</td>
</tr>
<tr>
<td>Environmental Compliance</td>
<td>- REACH Declaration <a href="http://www.tracopower.com/info/reach-declaration.pdf">www.tracopower.com/info/reach-declaration.pdf</a> REACH SVHC list compliant REACH Annex XVII compliant</td>
</tr>
<tr>
<td></td>
<td>- RoHS Declaration <a href="http://www.tracopower.com/info/rohs-declaration.pdf">www.tracopower.com/info/rohs-declaration.pdf</a> Exemptions: 7a, 7c-I</td>
</tr>
</tbody>
</table>

Supporting Documents

Overview Link (for additional Documents) www.tracopower.com/overview/ten60wir

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

Dimensions in mm (inch)
Tolerances: x.x ±0.5 ±(±0.02)
        x.xx ±0.25 ±(±0.01)
Pin diameter ±0.1 ±(±0.004)

Pinout

<table>
<thead>
<tr>
<th>Pin</th>
<th>Single</th>
<th>Dual</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+Vin (Vcc)</td>
<td>+Vin (Vcc)</td>
</tr>
<tr>
<td>2</td>
<td>−Vin (GND)</td>
<td>−Vin (GND)</td>
</tr>
<tr>
<td>3</td>
<td>Remote On/Off</td>
<td>Remote On/Off</td>
</tr>
<tr>
<td>4</td>
<td>+Vout</td>
<td>+Vout</td>
</tr>
<tr>
<td>5</td>
<td>−Vout</td>
<td>Common</td>
</tr>
<tr>
<td>6</td>
<td>Trim</td>
<td>−Vout</td>
</tr>
<tr>
<td>7</td>
<td>NC*</td>
<td>NC*</td>
</tr>
<tr>
<td>8</td>
<td>NC*</td>
<td>NC*</td>
</tr>
</tbody>
</table>

NC: Not connected
*: No pin for converters without heat sink

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