

- Ultra-wide 12:1 input voltage range 9–75, 14–160 VDC
- Compact 2.3"x1.45"x0.5" standard package (quarter brick)
- Bus pin to easily extend hold-up time
- EN 50155 and EN 61373 approval for railway applications
- Qualification for fire behavior according to EN 45545-2
- Operating temperature range -40°C to +75°C
- I/O-isolation 3'000 VAC
- High efficiency up to 91%
- Adjustable output voltage, Remote On/Off and adjustable under voltage lockout
- 3 year product warranty



The TEP 60UIR is a series of high performance 60 Watt railway DC/DC converters with ultra wide 12:1 input voltage range featuring a compact ¼ brick (2.3"x1.45"x0.5") metal package. The ultra wide input allows the converter to act as an all-in-one solution if different voltage ranges have to be covered in the same application, resolving the issue of having multiple different converters installed. An internal circuit implemented in these modules helps to extend the hold-up time with ease as it eliminates the need of expensive high voltage capacitors to cover the full input range. With only a 25V capacitor (independent of the input voltage) the whole input range can be covered effectively reducing cost, size and inrush current. All models are approved for railway applications according to EN 50155, EN 61373, EN 45545-2 and offer standard features such as high efficiency up to 91%, an operating temperature range of -40° to +75°C and an I/O-isolation voltage of 3'000 VAC. An adjustable under voltage lockout function, remote on/off and adjustable outputs round out the features and ensure that these converter modules fit in any application setup.

| Models         |                                |                                  |                     |                 |
|----------------|--------------------------------|----------------------------------|---------------------|-----------------|
| Order Code     | Input Voltage Range            | Output Voltage nom. (adjustable) | Output Current max. | Efficiency typ. |
| TEP 60-3611UIR | 9 - 75 VDC<br>(36 VDC nom.)    | 5 VDC (4.0 - 5.5 VDC)            | 12'000 mA           | 89 %            |
| TEP 60-3612UIR |                                | 12 VDC (9.6 - 13.2 VDC)          | 5'000 mA            | 89 %            |
| TEP 60-3613UIR |                                | 15 VDC (12.0 - 16.5 VDC)         | 4'000 mA            | 90 %            |
| TEP 60-3615UIR |                                | 24 VDC (19.2 - 26.4 VDC)         | 2'500 mA            | 90 %            |
| TEP 60-3618UIR |                                | 48 VDC (38.4 - 52.8 VDC)         | 1'250 mA            | 91 %            |
| TEP 60-7211UIR | 14 - 160 VDC<br>(110 VDC nom.) | 5 VDC (4.0 - 5.5 VDC)            | 12'000 mA           | 89 %            |
| TEP 60-7212UIR |                                | 12 VDC (9.6 - 13.2 VDC)          | 5'000 mA            | 89 %            |
| TEP 60-7213UIR |                                | 15 VDC (12.0 - 16.5 VDC)         | 4'000 mA            | 89 %            |
| TEP 60-7215UIR |                                | 24 VDC (19.2 - 26.4 VDC)         | 2'500 mA            | 90 %            |
| TEP 60-7218UIR |                                | 48 VDC (38.4 - 52.8 VDC)         | 1'250 mA            | 90 %            |

## Options

|                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEP-HS2</b>                                             | - Optional Heat Sink: <a href="http://www.tracopower.com/products/tep-hs2.pdf">www.tracopower.com/products/tep-hs2.pdf</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>TEP-HS4</b>                                             | - Optional Heat Sink: <a href="http://www.tracopower.com/products/tep-hs4.pdf">www.tracopower.com/products/tep-hs4.pdf</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>on demand</b><br>(backorder with MOQ non stocking item) | <ul style="list-style-type: none"> <li>- Optional Heat Sink with large profile: <a href="http://www.tracopower.com/products/tep-hs3.pdf">www.tracopower.com/products/tep-hs3.pdf</a></li> <li>- Optional Heat Sink with large profile: <a href="http://www.tracopower.com/products/tep-hs5.pdf">www.tracopower.com/products/tep-hs5.pdf</a></li> <li>- Optional model with 28 VDC / 2'150 mA Output and 9 - 75 VDC Input</li> <li>- Optional model with 53 VDC / 1'140 mA Output and 9 - 75 VDC Input</li> <li>- Optional model with 28 VDC / 2'150 mA Output and 14 - 160 VDC Input</li> <li>- Optional model with 53 VDC / 1'140 mA Output and 14 - 160 VDC Input</li> <li>- Optional models with Remote On/Off function with inverse logic</li> </ul> |

## Input Specifications

|                        |              |                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input Current          | - At no load | 36 Vin models: <b>20 mA typ.</b><br>110 Vin models: <b>17 mA typ.</b>                                                                                                                                                                                                                                                                                                        |
| Surge Voltage          |              | 36 Vin models: <b>100 VDC max.</b> (1 s max.)<br>110 Vin models: <b>185 VDC max.</b> (1 s max.)                                                                                                                                                                                                                                                                              |
| Under Voltage Lockout  |              | 36 Vin models: <b>7.3 VDC min. / 7.7 VDC typ. / 8.1 VDC max.</b><br>110 Vin models: <b>10 VDC min. / 11 VDC typ. / 12 VDC max.</b><br>(The Start-up voltage as well as the Shutdown voltage can be adjusted by a resistor between UVLO and -Vin pins. See application note: <a href="http://www.tracopower.com/overview/tep60uir">www.tracopower.com/overview/tep60uir</a> ) |
| Recommended Input Fuse |              | 36 Vin models: <b>12'000 mA</b> (fast acting)<br>110 Vin models: <b>8'000 mA</b> (fast acting)<br>(The need of an external fuse has to be assessed in the final application.)                                                                                                                                                                                                |
| Input Filter           |              | <b>Internal Pi-Type</b>                                                                                                                                                                                                                                                                                                                                                      |

## Output Specifications

|                                        |                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------------------|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Output Voltage Adjustment              |                                                                | <b>-20% to +10%</b> (By external trim resistor)<br>See application note: <a href="http://www.tracopower.com/overview/tep60uir">www.tracopower.com/overview/tep60uir</a><br>Output power must not exceed rated power!                                                                                                                                                                                                  |
| Voltage Set Accuracy                   |                                                                | <b>±1% max.</b>                                                                                                                                                                                                                                                                                                                                                                                                       |
| Regulation                             | - Input Variation (Vmin - Vmax)<br>- Load Variation (0 - 100%) | <b>0.1% max.</b><br><b>0.1% max.</b>                                                                                                                                                                                                                                                                                                                                                                                  |
| Ripple and Noise<br>(20 MHz Bandwidth) |                                                                | 5 Vout models: <b>75 mVp-p typ.</b> (w/ 1 µF X7R // 22 µF poscap)<br>12 Vout models: <b>100 mVp-p typ.</b> (w/ 22 µF X7R)<br>15 Vout models: <b>100 mVp-p typ.</b> (w/ 22 µF X7R)<br>24 Vout models: <b>200 mVp-p typ.</b> (w/ 4.7 µF X7R)<br>28 Vout models: <b>200 mVp-p typ.</b> (w/ 4.7 µF X7R)<br>48 Vout models: <b>300 mVp-p typ.</b> (w/ 2.2 µF X7R)<br>53 Vout models: <b>300 mVp-p typ.</b> (w/ 2.2 µF X7R) |
| Capacitive Load                        |                                                                | 5 Vout models: <b>24'000 µF max.</b><br>12 Vout models: <b>4'200 µF max.</b><br>15 Vout models: <b>2'700 µF max.</b><br>24 Vout models: <b>1'100 µF max.</b><br>28 Vout models: <b>780 µF max.</b><br>48 Vout models: <b>260 µF max.</b><br>53 Vout models: <b>220 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 BUS connection: <a href="http://www.tracopower.com/overview/tep60uir">www.tracopower.com/overview/tep60uir</a> )                                                                                                                                                                                                                               |

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

|                           |                                                |
|---------------------------|------------------------------------------------|
| Start-up Time             | 75 ms typ. / 100 ms max.                       |
| Short Circuit Protection  | Continuous, Automatic recovery                 |
| Output Current Limitation | 120 - 140% of I <sub>out</sub> max.            |
| Overvoltage Protection    | 120 - 135% of V <sub>out</sub> nom.            |
| Transient Response        | - Response Time<br>250 µs typ. (25% Load Step) |

## Safety Specifications

|                       |                                                                                    |                                                                                                                                                       |
|-----------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Safety Standards      | - IT / Multimedia Equipment<br>- Railway Applications<br>- Certification Documents | EN 62368-1<br>IEC 62368-1<br>UL 62368-1<br>EN 50155<br><a href="http://www.tracopower.com/overview/tep60uir">www.tracopower.com/overview/tep60uir</a> |
| Pollution Degree      |                                                                                    | PD 2                                                                                                                                                  |
| Over Voltage Category |                                                                                    | OVC II                                                                                                                                                |

## EMC Specifications

|               |                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EMI Emissions | - Conducted Emissions<br>- Radiated Emissions                                                                                          | EN 50121-3-2 (EMC for Rolling Stock)<br>EN 55032 class A (with external filter)<br>EN 55032 class B (with external filter)<br>EN 55032 class A (with external filter)<br>EN 55032 class B (with external filter)                                                                                                                                                                                                                                                                                                                                                       |
|               | External filter proposal:                                                                                                              | <a href="http://www.tracopower.com/overview/tep60uir">www.tracopower.com/overview/tep60uir</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| EMS Immunity  | - Electrostatic Discharge<br>- RF Electromagnetic Field<br>- EFT (Burst) / Surge<br>- Conducted RF Disturbances<br>- PF Magnetic Field | EN 50155 (Railway Applications)<br>EN 55024 (IT Equipment)<br>Air: EN 61000-4-2, ±8 kV, perf. criteria B<br>Contact: EN 61000-4-2, ±6 kV, perf. criteria B<br>EN 61000-4-3, 20 V/m, perf. criteria A<br>EN 61000-4-4, ±2 kV, perf. criteria A<br>EN 61000-4-5, ±2 kV, perf. criteria B<br>Ext. input component: 36 V <sub>in</sub> models: 2 x KY 220 µF<br>110 V <sub>in</sub> models: 2 x KXJ 150 µF<br>Continuous: EN 61000-4-6, 10 V <sub>rms</sub> , perf. criteria A<br>1 s: EN 61000-4-8, 100 A/m, perf. criteria A<br>EN 61000-4-8, 1000 A/m, perf. criteria A |

## General Specifications

|                                        |                                                                                       |                                                                                                                                                                                               |
|----------------------------------------|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Relative Humidity                      |                                                                                       | 95% max. (non condensing)                                                                                                                                                                     |
| Temperature Ranges                     | - Operating Temperature<br>- Case Temperature<br>- Storage Temperature                | -40°C to +75°C<br>+105°C max.<br>-55°C to +125°C                                                                                                                                              |
| Power Derating                         | - High Temperature                                                                    | See application note: <a href="http://www.tracopower.com/overview/tep60uir">www.tracopower.com/overview/tep60uir</a>                                                                          |
| Over Temperature Protection Switch Off | - Protection Mode                                                                     | 110°C typ. (Automatic recovery at 95°C typ.)                                                                                                                                                  |
| Cooling System                         |                                                                                       | Natural convection (20 LFM)                                                                                                                                                                   |
| Sense Function                         |                                                                                       | 10% max. of V <sub>out</sub> nom.<br>(If sense function is not used, sense pins should be connected to output pins.)                                                                          |
| Remote Control                         | - Voltage Controlled Remote<br>- Off Idle Input Current<br>- Remote Pin Input Current | On: 3.0 to 12 VDC or open circuit<br>Off: 0 to 1.2 VDC or short circuit<br>Refers to 'Remote' and '-Vin' Pin<br>3 mA typ.<br>-0.5 to 1.0 mA<br>(Optional models with inverse logic available) |
| Altitude During Operation              |                                                                                       | 5'000 m max.                                                                                                                                                                                  |
| Switching Frequency                    |                                                                                       | 160 - 200 kHz (PWM)<br>180 kHz typ. (PWM)                                                                                                                                                     |

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

|                          |                                 |                                                                                                                                                                                                                                                                                                               |
|--------------------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Insulation System        |                                 | Reinforced Insulation (110 Vin models)<br>Basic Insulation (36 Vin models)                                                                                                                                                                                                                                    |
| Working Voltage (rated)  |                                 | 220 VAC                                                                                                                                                                                                                                                                                                       |
| Isolation Test Voltage   | - Input to Output, 60 s         | 3'000 VAC (110 Vin models)<br>2'250 VDC (36 Vin models)                                                                                                                                                                                                                                                       |
|                          | - Input to Case, 60 s           | 1'500 VAC (110 Vin models)<br>1'600 VDC (36 Vin models)                                                                                                                                                                                                                                                       |
|                          | - Output to Case, 60 s          | 1'500 VAC (110 Vin models)<br>1'600 VDC (36 Vin models)                                                                                                                                                                                                                                                       |
|                          |                                 |                                                                                                                                                                                                                                                                                                               |
| Isolation Resistance     | - Input to Output, 500 VDC      | 1'000 MΩ min.                                                                                                                                                                                                                                                                                                 |
| Isolation Capacitance    | - Input to Output, 100 kHz, 1 V | 1'000 pF max.                                                                                                                                                                                                                                                                                                 |
| Reliability              | - Calculated MTBF               | 738'000 h (MIL-HDBK-217F, ground benign)                                                                                                                                                                                                                                                                      |
| Washing Process          |                                 | Allowed (hermetical product)                                                                                                                                                                                                                                                                                  |
|                          |                                 | See Cleaning Guideline: <a href="http://www.tracopower.com/info/cleaning.pdf">www.tracopower.com/info/cleaning.pdf</a>                                                                                                                                                                                        |
| Environment              | - Vibration                     | MIL-STD-810F<br>EN 61373                                                                                                                                                                                                                                                                                      |
|                          | - Mechanical Shock              | EN 61373                                                                                                                                                                                                                                                                                                      |
|                          | - Thermal Shock                 | MIL-STD-810F<br>EN 50155                                                                                                                                                                                                                                                                                      |
|                          |                                 |                                                                                                                                                                                                                                                                                                               |
| Housing Material         |                                 | Alu base-plate w. plastic case                                                                                                                                                                                                                                                                                |
| 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             |                                 | Plastic Case                                                                                                                                                                                                                                                                                                  |
| Mounting Type            |                                 | PCB Mount                                                                                                                                                                                                                                                                                                     |
| Connection Type          |                                 | THD (Through-Hole Device)                                                                                                                                                                                                                                                                                     |
| Footprint Type           |                                 | Quarter-Brick                                                                                                                                                                                                                                                                                                 |
| Soldering Profile        |                                 | Wave Soldering                                                                                                                                                                                                                                                                                                |
| Weight                   |                                 | 64 g                                                                                                                                                                                                                                                                                                          |
| Thermal Impedance        | - Case to Ambient               | 8.3 K/W typ. (without heatsink)                                                                                                                                                                                                                                                                               |
|                          |                                 | 7.4 K/W typ. (with heatsink TEP-HS2)                                                                                                                                                                                                                                                                          |
|                          |                                 | 7.4 K/W typ. (with heatsink TEP-HS4)                                                                                                                                                                                                                                                                          |
|                          |                                 | 6.2 K/W typ. (with heatsink TEP-HS3)                                                                                                                                                                                                                                                                          |
|                          |                                 | 6.2 K/W typ. (with heatsink TEP-HS5)                                                                                                                                                                                                                                                                          |
| 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 (Q5A rule).<br>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>                                                                                                                                                                                          |
|                          |                                 |                                                                                                                                                                                                                                                                                                               |

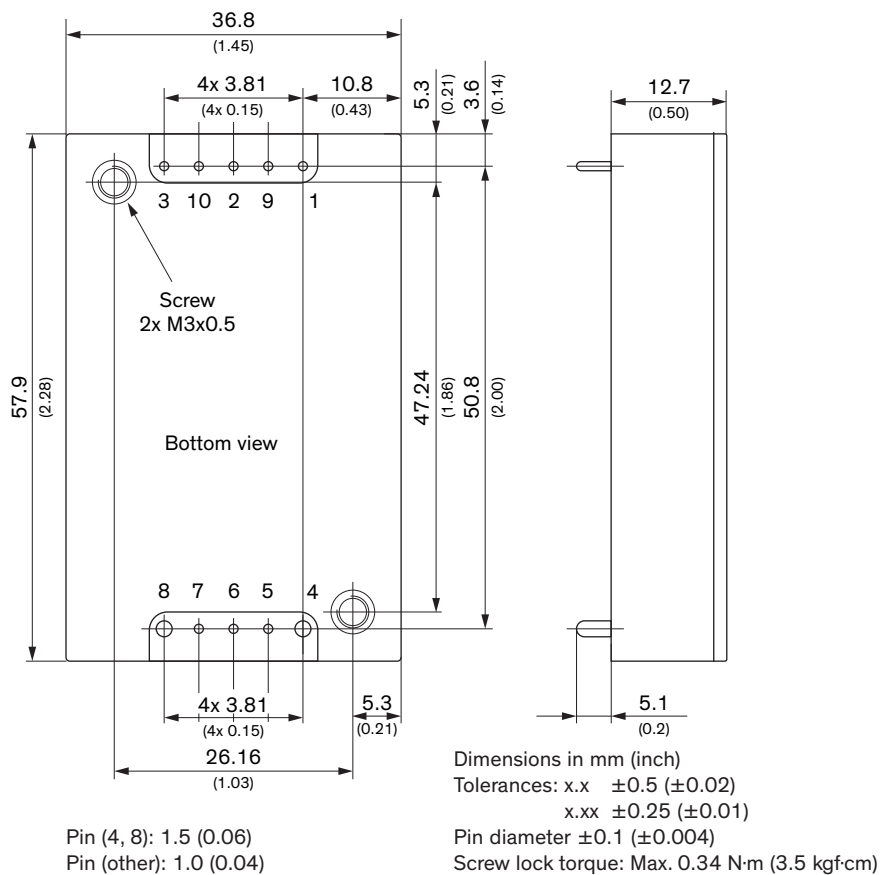
## Supporting Documents

Overview Link (for additional Documents)

[www.tracopower.com/overview/tep60uir](http://www.tracopower.com/overview/tep60uir)

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

## Outline Dimensions



### Pinout

| Pin | Function      |
|-----|---------------|
| 1   | –Vin (GND)    |
| 2   | Remote On/Off |
| 3   | +Vin (Vcc)    |
| 4   | –Vout         |
| 5   | –Sense        |
| 6   | Trim          |
| 7   | +Sense        |
| 8   | +Vout         |
| 9   | Bus           |
| 10  | UVLO          |