

## DC/DC Converter

## TEN 60WIN Series, 60 Watt

- 2" x 1" metal package
- Wide 4:1 input voltage range  
9–36, 18–75 VDC
- High efficiency up to 92%
- Adjustable output voltage
- Operating temperature range  
–40°C to +85°C
- EN 55032 class A (with external components)
- Remote On/Off
- Under voltage lockout
- RoHS compliant
- 3-year product warranty



The TEN 60WIN series is a family of high performance 60 Watt DC/DC converter modules featuring ultra wide 4:1 input voltage ranges in a six side shielded 2" x 1" metal package with industry standard footprint. Standard features include remote On/Off, over voltage protection, under voltage lockout and short circuit protection. High efficiency across load range and low input current characteristics at no load make these converters 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 60-2411WIN | 9 - 36 VDC<br>(24 VDC nom.)  | 5 VDC    | 12'000 mA        |          |                  | 92 %            |
| TEN 60-2412WIN |                              | 12 VDC   | 5'000 mA         |          |                  | 92 %            |
| TEN 60-2413WIN |                              | 15 VDC   | 4'000 mA         |          |                  | 92 %            |
| TEN 60-2415WIN |                              | 24 VDC   | 2'500 mA         |          |                  | 92 %            |
| TEN 60-2422WIN |                              | +12 VDC  | 2'500 mA         | –12 VDC  | 2'500 mA         | 91 %            |
| TEN 60-2423WIN |                              | +15 VDC  | 2'000 mA         | –15 VDC  | 2'000 mA         | 91 %            |
| TEN 60-2425WIN |                              | +24 VDC  | 1'250 mA         | –24 VDC  | 1'250 mA         | 91 %            |
| TEN 60-4811WIN | 18 - 75 VDC<br>(48 VDC nom.) | 5 VDC    | 12'000 mA        |          |                  | 92 %            |
| TEN 60-4812WIN |                              | 12 VDC   | 5'000 mA         |          |                  | 92 %            |
| TEN 60-4813WIN |                              | 15 VDC   | 4'000 mA         |          |                  | 92 %            |
| TEN 60-4815WIN |                              | 24 VDC   | 2'500 mA         |          |                  | 91 %            |
| TEN 60-4822WIN |                              | +12 VDC  | 2'500 mA         | –12 VDC  | 2'500 mA         | 91 %            |
| TEN 60-4823WIN |                              | +15 VDC  | 2'000 mA         | –15 VDC  | 2'000 mA         | 91 %            |
| TEN 60-4825WIN |                              | +24 VDC  | 1'250 mA         | –24 VDC  | 1'250 mA         | 91 %            |

### 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>                                                                                                                                               |
| TEN-HS8                                                | - Optional Heat Sink with Height = 0.3 inch: <a href="http://www.tracopower.com/overview/ten-hs8">www.tracopower.com/overview/ten-hs8</a>                                                                                                                                                |
| on demand<br>(backorder with MOQ<br>non stocking item) | - Optional Heat Sink with Height = 0.8 inch: <a href="http://www.tracopower.com/overview/ten-hs10">www.tracopower.com/overview/ten-hs10</a><br>- Optional Heat Sink with Height = 0.5 inch: <a href="http://www.tracopower.com/overview/ten-hs9">www.tracopower.com/overview/ten-hs9</a> |

## Input Specifications

|                        |              |                                                                                                                                                              |
|------------------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input Current          | - At no load | 24 Vin models: 10 mA typ.<br>48 Vin models: 10 mA typ.                                                                                                       |
| Surge Voltage          |              | 24 Vin models: 50 VDC max. (1 s max.)<br>48 Vin models: 100 VDC max. (1 s max.)                                                                              |
| Under Voltage Lockout  |              | 24 Vin models: 7 VDC min. / 8 VDC typ. / 8.8 VDC max.<br>48 Vin models: 15 VDC min. / 16 VDC typ. / 17.5 VDC max.                                            |
| Recommended Input Fuse |              | 24 Vin models: 10'000 mA (fast acting)<br>48 Vin models: 6'300 mA (slow blow)<br>(The need of an external fuse has to be assessed in the final application.) |
| Input Filter           |              | Internal Pi-Type                                                                                                                                             |

## Output Specifications

|                                        |                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Output Voltage Adjustment              |                                                                                                                         | -10% to +20% (15 & 24 Vout models)<br>±10% (other models)<br>(single output models only)<br>(By external trim resistor)<br>See application note: <a href="http://www.tracopower.com/overview/ten60win">www.tracopower.com/overview/ten60win</a><br>Output power must not exceed rated power!                                                                                             |
| Voltage Set Accuracy                   |                                                                                                                         | ±1% max.                                                                                                                                                                                                                                                                                                                                                                                 |
| Regulation                             | - Input Variation (Vmin - Vmax)<br><br>- Load Variation (0 - 100%)<br><br>- Cross Regulation<br>(25% / 100% asym. load) | single output models: 0.2% max.<br>dual output models: 0.2% max.<br>single output models: 0.5% max.<br>dual output models: 1% max. (Output 1)<br>1% max. (Output 2)<br>dual output models: 5% max.                                                                                                                                                                                       |
| Ripple and Noise<br>(20 MHz Bandwidth) | - single output<br><br>- dual output                                                                                    | 5 Vout models: 100 mVp-p max. (w/ 10 µF X7R)<br>12 Vout models: 125 mVp-p max. (w/ 10 µF X7R)<br>15 Vout models: 125 mVp-p max. (w/ 10 µF X7R)<br>24 Vout models: 200 mVp-p max. (w/ 4.7 µF X7R)<br>12 / -12 Vout models: 125 / 125 mVp-p max. (w/ 10 µF X7R)<br>15 / -15 Vout models: 125 / 125 mVp-p max. (w/ 10 µF X7R)<br>24 / -24 Vout models: 200 / 200 mVp-p max. (w/ 4.7 µF X7R) |
| Capacitive Load                        | - single output<br><br>- dual output                                                                                    | 5 Vout models: 30'000 µF max.<br>12 Vout models: 5'850 µF max.<br>15 Vout models: 3'900 µF max.<br>24 Vout models: 2'000 µF max.<br>12 / -12 Vout models: 3'900 / 3'900 µF max.<br>15 / -15 Vout models: 2'400 / 2'400 µF max.<br>24 / -24 Vout models: 1'000 / 1'000 µF max.                                                                                                            |
| Minimum Load                           |                                                                                                                         | Not required                                                                                                                                                                                                                                                                                                                                                                             |
| Temperature Coefficient                |                                                                                                                         | ±0.02 %/K max.                                                                                                                                                                                                                                                                                                                                                                           |
| Start-up Time                          |                                                                                                                         | 60 ms typ. (Power On)<br>60 ms typ. (Remote On)                                                                                                                                                                                                                                                                                                                                          |
| Short Circuit Protection               |                                                                                                                         | Continuous, Automatic recovery                                                                                                                                                                                                                                                                                                                                                           |
| Output Current Limitation              |                                                                                                                         | 150% typ. of Iout max.                                                                                                                                                                                                                                                                                                                                                                   |
| Overshoot Protection                   |                                                                                                                         | 133% typ. of Vout nom. (15 Vout single models)<br>125% typ. of Vout nom. (other single models)<br>(By Zener diode)                                                                                                                                                                                                                                                                       |
| Transient Response                     | - Peak Variation<br>- Response Time                                                                                     | 500 mV max. (25% Load Step)<br>250 µs typ. (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             |
|                       | - Certification Documents   | <a href="http://www.tracopower.com/overview/ten60win">www.tracopower.com/overview/ten60win</a> |
| Pollution Degree      |                             | PD 2                                                                                           |
| Over Voltage Category |                             | Not mains connected                                                                            |

## EMC Specifications

|                 |                             |                                                                                                        |
|-----------------|-----------------------------|--------------------------------------------------------------------------------------------------------|
| EMI (Emissions) | - Conducted Emissions       | EN 55032 class A (with external filter)<br>EN 55032 class B (with external filter)                     |
|                 | - Radiated Emissions        | 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/ten60win">www.tracopower.com/overview/ten60win</a>         |
| EMS (Immunity)  |                             | EN 55024 (IT Equipment)<br>EN 55035 (Multimedia)                                                       |
|                 | - Electrostatic Discharge   | 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:       | 24 Vin models: KY 220 $\mu$ F    TVS SMDJ58A<br>48 Vin models: KY 220 $\mu$ F    TVS SMDJ120A          |
|                 | - 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   |

## General Specifications

|                                        |                                                                                                          |                                                                                                                                             |
|----------------------------------------|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Relative Humidity                      |                                                                                                          | 95% max. (non condensing)                                                                                                                   |
| Temperature Ranges                     | - Operating Temperature<br>- Case Temperature<br>- Storage Temperature                                   | -40°C to +85°C<br>+105°C max.<br>-55°C to +125°C                                                                                            |
| Power Derating                         | - High Temperature                                                                                       | Depending on model                                                                                                                          |
|                                        | See application note:                                                                                    | <a href="http://www.tracopower.com/overview/ten60win">www.tracopower.com/overview/ten60win</a>                                              |
| Over Temperature Protection Switch Off | - Protection Mode                                                                                        | 115°C typ.                                                                                                                                  |
| Cooling System                         |                                                                                                          | Natural convection (20 LFM)                                                                                                                 |
| Remote Control                         | - Voltage Controlled Remote (passive = on)<br><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 0.5 mA |
| Altitude During Operation              |                                                                                                          | 5'000 m max.                                                                                                                                |
| Switching Frequency                    |                                                                                                          | 225 - 275 kHz (PWM)<br>250 kHz typ. (PWM)                                                                                                   |
| Insulation System                      |                                                                                                          | Functional Insulation                                                                                                                       |
| Isolation Test Voltage                 | - Input to Output, 60 s<br>- Input to Case, 60 s<br>- Output to Case, 60 s                               | 1'600 VDC<br>1'600 VDC<br>1'600 VDC                                                                                                         |
| Isolation Resistance                   | - Input to Output, 500 VDC                                                                               | 1'000 M $\Omega$ min.                                                                                                                       |
| Isolation Capacitance                  | - Input to Output, 100 kHz, 1 V                                                                          | 2'200 pF max.                                                                                                                               |
| Reliability                            | - Calculated MTBF                                                                                        | 860'000 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.

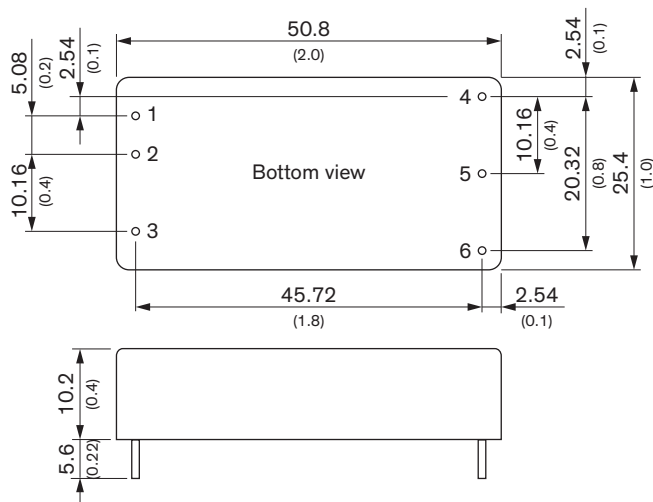
|                          |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Washing Process          |                                                                              | According to Cleaning Guideline<br><a href="http://www.tracopower.com/info/cleaning.pdf">www.tracopower.com/info/cleaning.pdf</a>                                                                                                                                                                                                                                                                                                                                                             |
| Environment              | - Vibration<br>- Thermal Shock                                               | MIL-STD-810F<br>MIL-STD-810F                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Housing Material         |                                                                              | Copper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 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                   |                                                                              | 33 g                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Thermal Impedance        | - Case to Ambient                                                            | 10.8 K/W typ. (without heatsink)<br>10.3 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>9fc1983f-4b92-48b3-b1d0-eb1ac932eaf2 |

### Additional Information

|                            |                                                                                                |
|----------------------------|------------------------------------------------------------------------------------------------|
| Supporting Documents       | <a href="http://www.tracopower.com/overview/ten60win">www.tracopower.com/overview/ten60win</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> |

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

## Outline Dimensions



Dimensions in mm (inch)

Tolerances: X.X  $\pm$ 0.5 (X.XX  $\pm$ 0.02)

$$X.XX \pm 0.25 \text{ (} X.XXX \pm 0.01 \text{)}$$

Pin diameter:  $1.0 \pm 0.1$  ( $0.04 \pm 0.004$ )

Case tolerances:  $\pm 0.5$  ( $\pm 0.02$ )

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