DC/DC Converters
TEN 60WIN Series, 60 Watt

Features

- 2" x 1" metal package
- Wide 4:1 input voltage range
  9–36, 18–75 VDC
- High efficiency up to 92%
- Adjustable output voltage
- No minimum load required
- Operating temperature range
  −40°C to +85°C
- Input filter to meet EN 55032, class A
- Remote On/Off
- Under voltage lockout
- Lead free design, 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.

<table>
<thead>
<tr>
<th>Models</th>
<th>Input voltage range</th>
<th>Output voltage</th>
<th>Output current max.</th>
<th>Efficiency typ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEN 60-2411WIN</td>
<td>9 – 36 VDC</td>
<td>5.0 VDC</td>
<td>12’000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-2412WIN</td>
<td></td>
<td>12 VDC</td>
<td>5000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-2413WIN</td>
<td></td>
<td>15 VDC</td>
<td>4000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-2415WIN</td>
<td></td>
<td>24 VDC</td>
<td>2500 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-2422WIN</td>
<td>±12 VDC</td>
<td>24 VDC</td>
<td>±2500 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-2423WIN</td>
<td>±15 VDC</td>
<td></td>
<td>±2000 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-2425WIN</td>
<td>±24 VDC</td>
<td></td>
<td>±1250 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-4811WIN</td>
<td>18 – 75 VDC</td>
<td>5.0 VDC</td>
<td>12’000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4812WIN</td>
<td></td>
<td>12 VDC</td>
<td>5000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4813WIN</td>
<td></td>
<td>15 VDC</td>
<td>4000 mA</td>
<td>92 %</td>
</tr>
<tr>
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<td></td>
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<td></td>
<td>±1250 mA</td>
<td>91 %</td>
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</tbody>
</table>
## Input Specifications

**Input current (no load)**
- 24 Vin models: 10 mA typ.
- 48 Vin models: 10 mA typ.

**Start-up voltage**
- 24 Vin models: < 9.0 VDC
- 48 Vin models: < 18 VDC

**Under voltage shut down (lock-out circuit)**
- 24 Vin models: 8.0 VDC typ.
- 48 Vin models: 16 VDC typ.

**Surge voltage (1 sec.)**
- 24 Vin models: 50 V max.
- 48 Vin models: 100 V max.

**Conducted noise**
- EN 55032 class A with external components

**ESD (electrostatic discharge)**
- EN 61000-4-2, air ±8 kV, contact ±6 kV, perf. criteria A

**Radiated immunity**
- EN 61000-4-3, 20 V/m, perf. criteria A

**Fast transient / surge (with external input capacitor)**
- external input capacitor
  - 24 Vin models: Nippon chemi-con KY 220 µF, 100 V, ESR 48 mOhm and TVS 58V, 3000W peak (SMDJ58A) in parallel
  - 48 Vin models: Nippon chemi-con KY 220 µF, 100 V, ESR 48 mOhm and TVS 120V, 3000W peak (SMDJ120A) in parallel

## Output Specifications

**Voltage set accuracy**
- 15 & 24 VDC models: ±20%, -10%
- other models: ±10%

**Voltage adjustment range**
- 15 & 24 VDC models: ±1 %
- other models: ±10 %

**Regulation**
- Input variation Vin min. to Vin max.
  - 24 Vin models: 0.2 % max.
  - 48 Vin models: 0.5 % max.
- Load variation 0 – 100 % single output models:
  - 24 Vin models: 1 % max.
  - 48 Vin models: 5 % max.
- Load cross variation 25 % / 100 %
  - 24 Vin models: 5 % max.
  - 48 Vin models: 5 % max.

**Minimum load**
- not required

**Temperature coefficient**
- ±0.02 %/K

**Ripple and noise**
- 5 VDC: 100 mVp-p max. with 10µF/25V X7R MLCC
- 12 & 15 VDC: 125 mVp-p max. with 10µF/25V X7R MLCC
- 24 VDC: 200 mVp-p max. with 4.7µF/50V X7R MLCC

**Start up time**
- Power On: 60 ms typ.
- Remote On: 60 ms typ.

**Transient response**
- 250 µs typ.

**Short circuit protection**
- continuous, automatic recovery

**Over load protection**
- 150 % of Iout max. typ. hiccup

**Over-voltage protection**
- 5 VDC models: 6.2 V
- 12 VDC models: 15 V
- 15 VDC models: 20 V
- 24 VDC models: 30 V

**Capacitive load**
- 5 VDC models: 30’000 µF
- 12 VDC models: 5850 µF
- 15 VDC models: 3900 µF
- 24 VDC models: 2000 µF
- ±12 VDC models: 3900 µF (each output)
- ±15 VDC models: 2400 µF (each output)
- ±24 VDC models: 1000 µF (each output)

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

**Temperature ranges**
- Operating: -40°C to +85°C (with derating)
- Casing temperature: +105°C max.
- Storage: -55°C to +125°C

**Power derating**
- Natural convection: 2.5 %/K above +50°C
- Natural convection with heat sink (optional): 2.25 %/K above +55°C

**Thermal impedance**
- Natural convection: 10.8 K/W
- Natural convection with heat sink (optional): 10.3 K/W

**Over-temperature protection**
- at 115°C

**Humidity** (non condensing)
- 5 – 95 % rel. H

**Isolation voltage** (60 sec.)
- Input / Output: 1500 VDC

**Isolation resistance**
- Input / Output: >1 GOhm

**Isolation capacitance**
- Input / Output: 2'200 pF max.

**Switching frequency**
- 250 kHz typ. (pulse width modulation PWM)

**Thermal shock, mechanical shock & vibration**
- MIL-STD-810F

**Safety standards**
- UL/cUL 60950-1, IEC/EN 60950-1
- Certification documents: www.tracopower.com/overview/ten60win

**Remote On/Off**
- On: 3.0 ... 12 VDC or open circuit
- Off: 0 ... 1.2 VDC or short circuit pin 3 and pin 2
- Off idle current: 3.0 mA typ.
- Input current fo Remote pin: 0.5 to 0.5 mA

**Reliability, calculated MTBF** (MIL-HDBK-217F, at +70°C, ground benign)
- 850'000 h

**Environmental compliance**
- Reach: www.tracopower.com/info/reach-declaration.pdf
- RoHS: RoHS directive 2011/65/EU

Output Voltage Adjustment (for single output models only)

Trim up

Trim

Ru

Vout

Nominal output voltage at open Trim input
Ru, Rd for adjustment

Trim down

+Vout

Rd

Trim

Supporting Documents: www.tracopower.com/overview/ten60win
Specifications can be changed without notice! Make sure you are using the latest documentation, downloadable at www.tracopower.com

# Physical Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casing material</td>
<td>copper</td>
</tr>
<tr>
<td>Baseplate material</td>
<td>non conductive FR4</td>
</tr>
<tr>
<td>Potting material</td>
<td>silicone (UL94V-0 rated)</td>
</tr>
<tr>
<td>Weight</td>
<td>33 g (1.16oz)</td>
</tr>
<tr>
<td>Soldering temperature</td>
<td>max. +265°C / 10 sec.</td>
</tr>
</tbody>
</table>

# Outline Dimensions

![Outline Dimensions Diagram]

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# Pin-Out

<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></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>
</tbody>
</table>

Dimensions in [mm], ( ) = Inch
- Pin diameter: 1.0 ±0.1 (0.04 ±0.004)
- Pin pitch tolerances: ±0.25 ±0.01
- Case tolerances: ±0.5 ±0.02

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# Heat-Sink (Option)

**Order code:** TEN-HS1
(cont.: heat-sink, thermal pad, 2 clamps)

**Material:** Aluminum

**Finish:** Anodic treatment (black)

**Weight:** 17 g (0.60oz) without converter

Thermal impedance after assembling: 10.3 K/W

**Note:**
Before attaching the heatsink, the product label on converter has to be removed for optimal performance.

For volume orders we can supply the converters with heatsink already mounted. Please contact us for a relative quotation.

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Dimensions in mm, ( ) = Inch