

### Features

- ◆ Highest power density: 60W in a 51x51x10mm (2"x2"x0.4") package
- ◆ Wide 2:1 input voltage range
- ◆ Very high efficiency up to 90%
- ◆ No minimum load required
- ◆ Over temperature protection
- ◆ Under voltage lock-out circuit
- ◆ Remote On/Off
- ◆ Shielded metal case with insulated baseplate
- ◆ Optional heatsink
- ◆ Lead free design - RoHS compliant
- ◆ 3-year product warranty



The TEN 60 series is a family of high performance 60W dc-dc converter modules with wide 2:1 input voltage ranges in a compact low profile case with industry-standard footprint. A very high efficiency allows an operating temperature range of -40°C to 85°C. Built-in filters for both input and output minimizes the need for external filtering. Further standard features include remote On/Off, output voltage trimming, over voltage protection, under voltage lockout and short circuit protection.

Typical applications for these products are battery operated equipment and distributed power architectures in communication and industrial electronics, everywhere where isolated, tightly regulated voltages are required and space is limited on the PCB.

### Models

| Order code  | Input voltage range                    | Output voltage | Output current max. | Efficiency typ. |
|-------------|--|----------------|---------------------|-----------------|
| TEN 60-2410 | <b>18 – 36 VDC</b><br>(24 VDC nominal) | 3.3 VDC        | 14.0 A              | 89 %            |
| TEN 60-2411 |  | 5.0 VDC        | 12.0 A              | 90 %            |
| TEN 60-2412 |  | 12 VDC         | 5.0 A               | 90 %            |
| TEN 60-2413 |  | 15 VDC         | 4.0 A               | 90 %            |
| TEN 60-2415 |  | 24 VDC         | 2.5 A               | 89 %            |
| TEN 60-4810 | <b>36 – 75 VDC</b><br>(48 VDC nominal) | 3.3 VDC        | 14.0 A              | 89 %            |
| TEN 60-4811 |  | 5.0 VDC        | 12.0 A              | 90 %            |
| TEN 60-4812 |  | 12 VDC         | 5.0 A               | 90 %            |
| TEN 60-4813 |  | 15 VDC         | 4.0 A               | 90 %            |
| TEN 60-4815 |  | 24 VDC         | 2.5 A               | 89 %            |

### Input Specifications

|   |   |
|---|---|
| Input current at no load<br>(nominal input 24/48 Vin)   | 3.3 V output models: 100 / 80 mA typ.<br>5.0 V output models: 130 / 90 mA typ.<br>12 V, 15 V & 24 V output models: 50 / 30 mA typ.  |
| Input current at full load<br>(nominal input 24/48 Vin) | 3.3 V output models: 2260 / 1140 mA typ.<br>5.0 V output models: 2940 / 1450 mA typ.<br>12 V & 15 V output models: 2900 / 1450 mA typ.<br>24 V output models: 2940 / 1470 mA typ. |
| Input voltage variation (dv/dt)                         | 5 V/ms, max. (complies with ETS300 132 part 4.4)  |
| Start-up voltage  | 24 Vin models: 17 VDC (or lower)<br>48 Vin models: 34 VDC (or lower)  |
| Under voltage shut down (lock-out circuit)              | 24 Vin models: 15 VDC typ.<br>48 Vin models: 32 VDC typ.  |
| Surge voltage (100 msec. max.)                          | 24 Vin models: 50 V<br>48 Vin models: 100 V   |
| Conducted noise (input)                                 | EN 55022 class A / B (with external capacitor)<br>see application note: <a href="http://www.tracopower.com/overview/ten60">www.tracopower.com/overview/ten60</a>                  |
| ESD (input)   | air: EN 61000-4-2, ±8 kV, perf. criteria A<br>contact: EN 61000-4-2, ±6 kV, perf. criteria A  |
| Radiated immunity (input)                               | EN 61000-4-3, 10 V/m, perf. criteria A  |
| Fast transient (input)                                  | EN 61000-4-4, ±2 kV, perf. criteria A w/ 220 µF KY  |
| Surge (input)   | EN 61000-4-5, ±1 kV, perf. criteria A w/ 220 µF KY  |
| Conducted immunity (input)                              | EN 61000-4-6, 10 V r.m.s, perf. criteria A  |
| PF magnetic field (input)                               | 1s: EN 61000-4-8, 100 A/m perf. criteria A<br>continuous: EN 61000-4-8, 10 A/m perf. criteria A   |

### Output Specifications

|   |  |
|---|--|
| Voltage set accuracy                                    | ±1 %   |
| Output voltage adjustment                               | ±10 %  |
| Regulation  | - Input variation Vin min. to Vin max. 0.2 % max.<br>- Load variation 0 – 100 % 0.5 % max.   |
| Temperature coefficient                                 | ±0.02 %/K max.   |
| Ripple and noise (20 MHz Bandwidth)                     | 3.3 V & 5 V output models: 75 mVpk-pk max.<br>12 V & 15 V output models: 100 mVpk-pk max.<br>24 V output models: 200 mVpk-pk max.                            |
| Start up time (nominal Vin and constant resistive load) | 20 ms typ.   |
| Transient response time (25% load change)               | 250 µs typ.  |
| Short circuit protection                                | indefinite (automatic recovery)  |
| Over load protection                                    | 150 % of lout max typ.   |
| Minimum Load  | not required   |
| Thermal shutdown  | at +110°C typ  |
| Over voltage protection                                 | 3.3 V output models: 3.7 V<br>5 V output models: 5.6 V<br>12 V output models: 13.8 V<br>15 V output models: 16.8 V<br>24 V output models: 30.0 V             |
| Capacitive load   | 3.3 V output models: 36'000 µF<br>5 V output models: 20'400 µF<br>12 V output models: 3'550 µF<br>15 V output models: 2'300 µF<br>24 V output models: 885 µF |

**General Specifications**

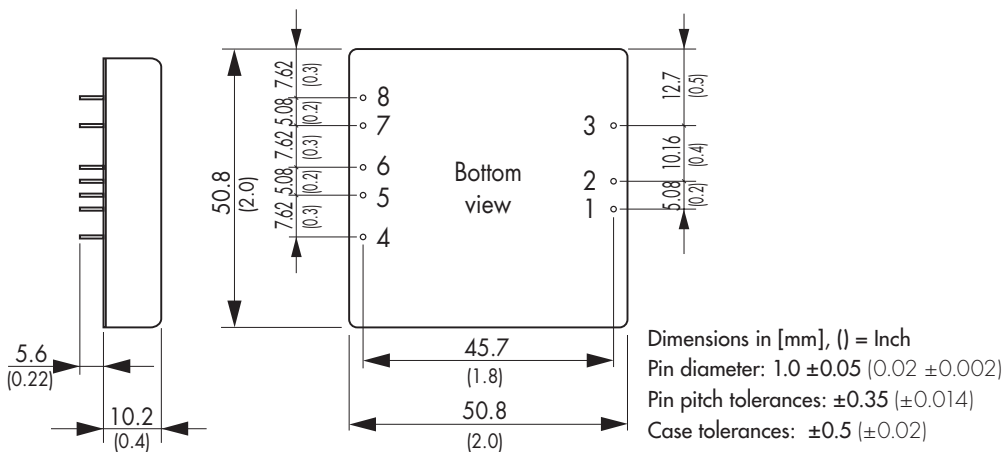
|   |  |  |
|---|--|--|
| Temperature ranges  | <ul style="list-style-type: none"> <li>- Operating</li> <li>- Case temperature</li> <li>- Storage</li> </ul>                           | <ul style="list-style-type: none"> <li>-40°C to +85°C</li> <li>+110°C max.</li> <li>-55°C to +125°C</li> </ul>   |
| Derating  | see application note: <a href="http://www.tracopower.com/overview/ten60">www.tracopower.com/overview/ten60</a>                         |  |
| Sense Function  | 10% max. of $V_{out}$ nom.<br>(Sense line to be connected to the output either at the module or at the load under regard of polarity.) |  |
| Humidity (non condensing)   | 95 % rel H max.  |  |
| Reliability, calculated MTBF (MIL-HDBK-217F, at +70°C, ground benign) | >400'000 h   |  |
| Isolation (Input/Output)  | <ul style="list-style-type: none"> <li>- Voltage</li> <li>- Capacitance</li> <li>- Resistance</li> </ul>                               | <ul style="list-style-type: none"> <li>1'600 VDC</li> <li>1'500 pF max.</li> <li>&gt;1'000 MOhm</li> </ul>   |
| Remote On/Off   | <ul style="list-style-type: none"> <li>- On:</li> <li>- Off:</li> <li>- Off idle current:</li> </ul>                                   | <ul style="list-style-type: none"> <li>3.0 ... 12 VDC or open circuit.</li> <li>0 ... 1.2 VDC or short circuit pin 3 and pin 2</li> <li>3.0 mA max.</li> </ul> |
| Altitude during operatin  | 2'000 m max.   |  |
| Switching frequency (fixed)   | 300 kHz typ. (Pulse width modulation PWM)  |  |
| Vibration   | 10 – 55Hz, 10G, 30 minutes along X,Y,Z   |  |
| Safety standards  | UL 62368-1, IEC/EN 62368-1<br>UL 60950-1, IEC/EN 60950-1   |  |
| Safety approvals  | - Certification documents  | <a href="http://www.tracopower.com/overview/ten60">www.tracopower.com/overview/ten60</a>   |
| Environmental compliance  | <ul style="list-style-type: none"> <li>- Reach</li> <li>- RoHS</li> </ul>  | <a href="http://www.tracopower.com/products/reach-declaration.pdf">www.tracopower.com/products/reach-declaration.pdf</a><br>RoHS directive 2011/65/EU          |

**Physical Specifications**

|                       |                        |
|-----------------------|------------------------|
| Casing material       | copper, nickel plated  |
| Baseplate material    | none conductive FR4    |
| Potting material      | epoxy (UL 94V-0-rated) |
| Weight                | 60 g (2.1oz)           |
| Soldering temperature | max. 265°C / 10 sec.   |

**Supporting documents:** [www.tracopower.com/overview/ten60](http://www.tracopower.com/overview/ten60)

**Outline Dimensions**

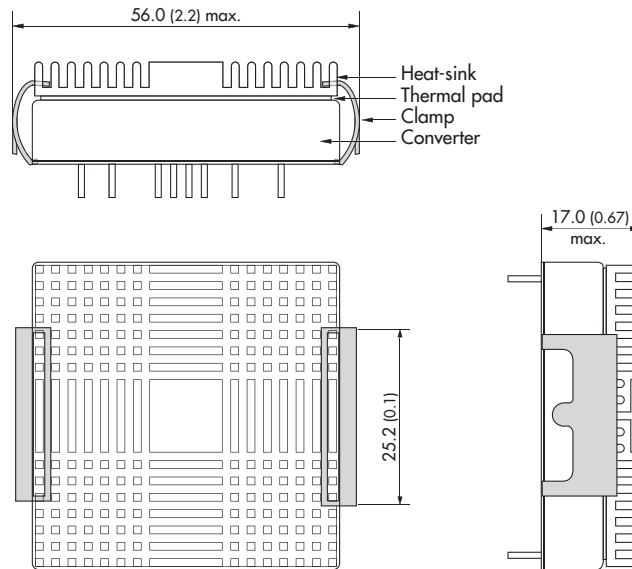


| Pin-Out |               |
|---------|---------------|
| Pin     |               |
| 1       | +Vin (Vcc)    |
| 2       | -Vin (GND)    |
| 3       | Remote On/Off |
| 4       | -Sense        |
| 5       | +Sense        |
| 6       | +Vout         |
| 7       | -Vout         |
| 8       | Trim          |

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

**Outline Dimensions**

**Heat-sink TEN-HS3**



**Order code:** TEN-HS3 (cont.: heat-sink, thermal pad, 2 clamps)

**Material:** Aluminum

**Finish:** Anodic treatment (black)

**Weight:** 22 g (0.78oz) (without converter)

**Note:**

The product label on converter has to be removed before mounting the heat-sink.

For volume orders converters will be supplied with heat-sinks already mounted. Please contact factory for quotation.

Separate heat-sinks are only available for prototypes and small quantity orders.