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

<table>
<thead>
<tr>
<th>Order Code</th>
<th>Input Voltage Range</th>
<th>Output 1</th>
<th>Output 2</th>
<th>Efficiency typ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEN 60-2411WIN</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>5 VDC</td>
<td>12’000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-2412WIN</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>12 VDC</td>
<td>5’000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-2413WIN</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>15 VDC</td>
<td>4’000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-2415WIN</td>
<td>9 - 36 VDC (24 VDC nom.)</td>
<td>24 VDC</td>
<td>2’500 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-2422WIN</td>
<td>12 VDC</td>
<td>+12 VDC</td>
<td>2’500 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-2423WIN</td>
<td>15 VDC</td>
<td>+15 VDC</td>
<td>2’000 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-2425WIN</td>
<td>24 VDC</td>
<td>+24 VDC</td>
<td>1’250 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-4811WIN</td>
<td>18 - 75 VDC (48 VDC nom.)</td>
<td>5 VDC</td>
<td>12’000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4812WIN</td>
<td>18 - 75 VDC (48 VDC nom.)</td>
<td>12 VDC</td>
<td>5’000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4813WIN</td>
<td>18 - 75 VDC (48 VDC nom.)</td>
<td>15 VDC</td>
<td>4’000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4815WIN</td>
<td>18 - 75 VDC (48 VDC nom.)</td>
<td>24 VDC</td>
<td>2’500 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-4822WIN</td>
<td>+12 VDC</td>
<td>+12 VDC</td>
<td>–12 VDC</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-4823WIN</td>
<td>+15 VDC</td>
<td>+15 VDC</td>
<td>–15 VDC</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-4825WIN</td>
<td>+24 VDC</td>
<td>+24 VDC</td>
<td>–24 VDC</td>
<td>91 %</td>
</tr>
</tbody>
</table>

### Options

- **TEN-HS1**: Optional Heat Sink with Height = 0.22 inch: [www.tracopower.com/products/ten-hs1.pdf](http://www.tracopower.com/products/ten-hs1.pdf)
**Input Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>24 Vin models:</th>
<th>48 Vin models:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current</td>
<td>10 mA typ.</td>
<td>10 mA typ.</td>
</tr>
<tr>
<td>Surge Voltage</td>
<td>50 VDC max. (1 s max)</td>
<td>100 VDC max. (1 s max)</td>
</tr>
<tr>
<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>
</tr>
<tr>
<td>Recommended Input Fuse</td>
<td>10'000 mA (fast acting)</td>
<td>6'300 mA (slow blow)</td>
</tr>
<tr>
<td>(The need of an external fuse has to be assessed in the final application)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Filter</td>
<td>Internal Pi-Type</td>
<td></td>
</tr>
</tbody>
</table>

**Output Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>5 Vout models:</th>
<th>12 Vout models:</th>
<th>15 Vout models:</th>
<th>24 Vout models:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Set Accuracy</td>
<td>±1% max.</td>
<td>±1% max.</td>
<td>±1% max.</td>
<td>±1% max.</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>- Load Variation (0 - 100%)</td>
</tr>
<tr>
<td>Ripple and Noise</td>
<td>- single output</td>
<td>100 mVp-p max. (w/ 10 µF X7R)</td>
<td>125 mVp-p max. (w/ 10 µF X7R)</td>
<td>125 mVp-p max. (w/ 10 µF X7R)</td>
</tr>
<tr>
<td>(20 MHz Bandwidth)</td>
<td>- dual output</td>
<td>125 / 125 mVp-p max. (w/ 10 µF X7R)</td>
<td>125 / 125 mVp-p max. (w/ 10 µF X7R)</td>
<td>200 / 200 mVp-p max. (w/ 4.7 µF X7R)</td>
</tr>
<tr>
<td>Capacitive Load</td>
<td>- single output</td>
<td>30'000 µF max.</td>
<td>5'850 µF max.</td>
<td>3'900 µF max.</td>
</tr>
<tr>
<td></td>
<td>- dual output</td>
<td>3'900 / 3'900 µF max.</td>
<td>2'400 / 2'400 µF max.</td>
<td>1'000 / 1'000 µF max.</td>
</tr>
<tr>
<td>Minimum Load</td>
<td>Not required</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Coefficient</td>
<td>±0.02 %/K max.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start-up Time</td>
<td>60 ms typ. (Power On)</td>
<td>60 ms typ. (Remote On)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Circuit Protection</td>
<td>Continuous, Automatic recovery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Current Limitation</td>
<td>150% typ. of Iout max.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overvoltage Protection</td>
<td>133% typ. of Vout nom. (15 Vout single models)</td>
<td>125% typ. of Vout nom. (other single models) (By Zener diode)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient Response</td>
<td>- Peak Variation</td>
<td>500 mV max. (25% Load Step)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Response Time</td>
<td>250 µs typ. (25% Load Step)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

- **Safety Standards**
  - IT / Multimedia Equipment: EN 60950-1
  - EN 62368-1
  - IEC 60950-1
  - IEC 62368-1
  - UL 60950-1
  - UL 62368-1
- **Pollution Degree**
  - PD 2
- **Over Voltage Category**
  - Not mains connected

**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
  - 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
    - 1 s: EN 61000-4-8, 1000 A/m, perf. criteria A

**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: 115°C typ.
  - Protection Mode: Depending on model
    - See application note: www.tracopower.com/overview/ten60win
- **Over Temperature Protection Switch Off**
  - Voltage Controlled Remote: Natural convection (20 LFM)
  - Off Idle Input Current: On: 3.0 to 12 VDC or open circuit
    - Off: 0 to 1.2 VDC or short circuit
    - Refers to 'Remote' and '-Vin' Pin
  - Remote Pin Input Current: 3 mA typ.
    - -0.5 to 0.5 mA
- **Altitude During Operation**
  - 5'000 m max.
- **Switching Frequency**
  - 225 - 275 kHz (PWM)
    - 250 kHz typ. (PWM)
- **Insulation System**
  - Functional Insulation
- **Isolation Test Voltage**
  - Input to Output, 60 s: 1'600 VDC
  - Input to Case, 60 s: 1'600 VDC
  - Output to Case, 60 s: 1'600 VDC
- **Isolation Resistance**
  - Input to Output, 500 VDC: 1'000 MΩ min.
- **Isolation Capacitance**
  - Input to Output, 100 kHz, 1 V: 2'200 pF max.
- **Reliability**
  - Calculated MTBF: 880'000 h (ML-HDBK-217F; ground benign)

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

Environment
- Vibration [MIL-STD-810F]
- Thermal Shock [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 265°C / 10 s max.

Weight
33 g

Thermal Impedance
- Case to Ambient
  10.8 K/W typ. (without heatsink)
  10.3 K/W typ. (with heatsink TEN-HS1)

Environmental Compliance
- REACH Declaration [www.tracopower.com/info/reach-declaration.pdf]
  REACH SVHC list compliant
  REACH Annex XVII compliant
- RoHS Declaration [www.tracopower.com/info/rohs-declaration.pdf]
  Exemptions: 7a, 7c-1
  (RoHS exemptions refer to the component concentration only, not to the overall concentration in the product (0.5% rule))
- SCIP Reference Number 9fc1983f-4b92-48b3-b1d0-eb1ac932eaf2

Supporting Documents
Overview Link (for additional Documents) [www.tracopower.com/overview/ten60win]

Outline Dimensions

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>
</tbody>
</table>

Dimensions in mm (inch)
- Tolerances: X.X ±0.5 (X.XX ±0.02)
- X.X ±0.25 (X.XXX ±0.01)
- Pin diameter: 1.0 ±0.1 (0.04 ±0.004)
- Case tolerances: ±0.5 (±0.02)

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www.tracopower.com
Rev. September 20, 2023
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