DC/DC Converter TEN 60N Series, 60 Watt

- 2" x 1" metal package
- Wide 2:1 input voltage range 9–18, 18–36, 36–75 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 60N series is a family of high performance 60 Watt DC/DC converter modules featuring wide 2:1 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 1</th>
<th>Output 2</th>
<th>Efficiency typ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEN 60-1211N</td>
<td>9 - 18 VDC</td>
<td>5 VDC</td>
<td>12'000 mA</td>
<td>90 %</td>
</tr>
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</tr>
<tr>
<td>TEN 60-1213N</td>
<td>9 - 18 VDC</td>
<td>15 VDC</td>
<td>4'000 mA</td>
<td>91 %</td>
</tr>
<tr>
<td>TEN 60-1215N</td>
<td>9 - 18 VDC</td>
<td>24 VDC</td>
<td>2'500 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-1222N</td>
<td>+12 VDC</td>
<td>2'500 mA</td>
<td>–12 VDC</td>
<td>2'500 mA</td>
</tr>
<tr>
<td>TEN 60-1223N</td>
<td>+15 VDC</td>
<td>2'000 mA</td>
<td>–15 VDC</td>
<td>2'000 mA</td>
</tr>
<tr>
<td>TEN 60-1225N</td>
<td>+24 VDC</td>
<td>1'250 mA</td>
<td>–24 VDC</td>
<td>1'250 mA</td>
</tr>
<tr>
<td>TEN 60-2411N</td>
<td>18 - 36 VDC</td>
<td>5 VDC</td>
<td>12'000 mA</td>
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<td>TEN 60-2412N</td>
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</tr>
<tr>
<td>TEN 60-4811N</td>
<td>36 - 75 VDC</td>
<td>5 VDC</td>
<td>12'000 mA</td>
<td>92 %</td>
</tr>
<tr>
<td>TEN 60-4812N</td>
<td>36 - 75 VDC</td>
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<td>5'000 mA</td>
<td>92 %</td>
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<td>TEN 60-4825N</td>
<td>+24 VDC</td>
<td>1'250 mA</td>
<td>–24 VDC</td>
<td>1'250 mA</td>
</tr>
</tbody>
</table>

Options

| TEN-HS1 | Optional Heat Sink with Height = 0.22 inch: www.tracopower.com/products/ten-hs1.pdf |

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### Input Specifications

<table>
<thead>
<tr>
<th>Input Current</th>
<th>- At no load</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Vin models</td>
<td>15 mA typ.</td>
</tr>
<tr>
<td>24 Vin models</td>
<td>10 mA typ.</td>
</tr>
<tr>
<td>48 Vin models</td>
<td>10 mA typ.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surge Voltage</th>
<th>12 Vin models</th>
<th>25 VDC max. (1 s max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Vin models</td>
<td>50 VDC max. (1 s max.)</td>
<td></td>
</tr>
<tr>
<td>48 Vin models</td>
<td>100 VDC max. (1 s max.)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Under Voltage Lockout</th>
<th>12 Vin models</th>
<th>7 VDC min. / 8 VDC typ. / 8.8 VDC max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Vin models</td>
<td>15 VDC min. / 16 VDC typ. / 17.5 VDC max.</td>
<td></td>
</tr>
<tr>
<td>48 Vin models</td>
<td>32 VDC min. / 33.5 VDC typ. / 35 VDC max.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recommended Input Fuse</th>
<th>12 Vin models</th>
<th>10'000 mA (fast acting)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Vin models</td>
<td>6'300 mA (slow blow)</td>
<td></td>
</tr>
<tr>
<td>48 Vin models</td>
<td>3'150 mA (slow blow)</td>
<td></td>
</tr>
</tbody>
</table>

(The need of an external fuse has to be assessed in the final application)

### Output Specifications

#### Output Voltage Adjustment

-10% to +20% (15 & 24 Vout models)

±10% (other models)

(same output models only)

(By external trim resistor)

See application note: [www.tracopower.com/overview/ten60n](http://www.tracopower.com/overview/ten60n)

Output power must not exceed rated power!

#### Voltage Set Accuracy

±1% max.

#### Regulation

- Input Variation (Vmin - Vmax)

  - single output models: 0.2% max.
  - dual output models: 0.2% max.

- Load Variation (0 - 100%)

  - single output models: 0.5% max.
  - dual output models: 1% max. (Output 1)
  - dual output models: 1% max. (Output 2)

- Cross Regulation

  (25% / 100% asym. load)

  - dual output models: 5% max.

#### Ripple and Noise

(20 MHz Bandwidth)

- single output

  - 5 Vout models: 100 mVp-p max. (w/ 10 µF X7R)
  - 12 Vout models: 125 mVp-p max. (w/ 10 µF X7R)
  - 15 Vout models: 125 mVp-p max. (w/ 10 µF X7R)
  - 24 Vout models: 200 mVp-p max. (w/ 4.7 µF X7R)

- dual output

  - 12 / -12 Vout models: 125 / 125 mVp-p max. (w/ 10 µF X7R)
  - 15 / -15 Vout models: 125 / 125 mVp-p max. (w/ 10 µF X7R)
  - 24 / -24 Vout models: 200 / 200 mVp-p max. (w/ 4.7 µF X7R)

#### Capacitive Load

- single output

  - 5 Vout models: 30'000 µF max.
  - 12 Vout models: 5'850 µF max.
  - 15 Vout models: 3'900 µF max.
  - 24 Vout models: 2'000 µF max.

- dual output

  - 12 / -12 Vout models: 3'900 / 3'900 µF max.
  - 15 / -15 Vout models: 2'400 / 2'400 µF max.
  - 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)

60 ms typ. (Remote On)

#### Short Circuit Protection

Continuous, Automatic recovery

#### Output Current Limitation

150% typ. of Iout max.

#### Overvoltage Protection

133% typ. of Vout nom.

(15 Vout single models)

125% typ. of Vout nom. (other single models)

(By Zener diode)

All specifications valid at nominal voltage, resistive full load and +25°C after warm-up time, unless otherwise stated.
### Transient Response
- Peak Variation: 650 mV max. (25% Load Step)
- Response Time: 250 µs typ. (25% Load Step)

### Safety Specifications

<table>
<thead>
<tr>
<th>Safety Standards</th>
<th>EN 60950-1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EN 62368-1</td>
</tr>
<tr>
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<td>IEC 60950-1</td>
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<tr>
<td>Certification Documents</td>
<td><a href="http://www.tracopower.com/overview/ten60n">www.tracopower.com</a></td>
</tr>
</tbody>
</table>

**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, ±8 kV, perf. criteria A
- RF Electromagnetic Field
  - EN 61000-4-3, 20 V/m, perf. criteria A
  - EN 61000-4-4, ±2 kV, perf. criteria A
  - EN 61000-4-5, ±2 kV, perf. criteria A
- Conducted RF Disturbances
- 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
  - Ext. input component: 12 Vin models: KY 220 µF || TVS SMDJ68A
  - 24 Vin models: KY 220 µF || TVS SMDJ68A
  - 48 Vin models: KY 220 µF || TVS SMDJ120A

**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: Depending on model
  - See application note: [www.tracopower.com](http://www.tracopower.com/overview/ten60n)

**Over Temperature Protection Switch Off**
- Protection Mode: 115°C typ.

**Cooling System**
- Natural convection (20 LFM)

**Remote Control**
- Voltage Controlled Remote
  - On: 3.0 to 12 VDC or open circuit
  - Off: 0 to 1.2 VDC or short circuit
  - Refers to ‘Remote’ and ‘-Vin’ Pin
  - 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
  - 1600 VDC
- Input to Case: 60 s
  - 1600 VDC
- Output to Case: 60 s
  - 1600 VDC

All specifications valid at nominal voltage, resistive full load and +25°C after warm-up time, unless otherwise stated.
### 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 (MIL-HDBK-217F, ground benign)

### Washing Process
According to Cleaning Guideline
www.tracopower.com/info/cleaning.pdf

### 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
  - www.tracopower.com/info/rohs-declaration.pdf

- RoHS Declaration
- Exemptions: 7a, 7c-I
  - (RoHS exemptions refer to the component concentration only, not to the overall concentration in the product (O5A rule))

- SCIP Reference Number
  - f5ef3249-6dd8-439b-be42-7f4d801b347f

### Supporting Documents
Overview Link (for additional Documents)
www.tracopower.com/overview/ten60n

### Outline Dimensions

![Outline Dimensions Diagram](image)

Dimensions in mm (inch)
- Tolerances: X.X ±0.5 (X.XX ±0.02)
  - X.XX ±0.25 (X.XXX ±0.01)
- Pin diameter: 1.0 ±0.1 (0.04 ± 0.004)
- Case tolerances: ±0.8 (±0.02)

### 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>

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