

#### Features

- ◆ 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
- ◆ No minimum load required
- ◆ Operating temperature range  
–40°C to +85°C
- ◆ Input filter to meet EN55022, class A
- ◆ Remote On/Off
- ◆ Under voltage lockout
- ◆ Lead free design, 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.

#### Models

| Order code                                                                                   | Input voltage range                    | Output voltage                                              | Output current max.                                                | Efficiency typ.                                      |
|----------------------------------------------------------------------------------------------|----------------------------------------|-------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------------|
| TEN 60-1211N<br>TEN 60-1212N<br>TEN 60-1213N<br>TEN 60-1215N<br>TEN 60-1222N<br>TEN 60-1223N | <b>9 – 18 VDC</b><br>(12 VDC nominal)  | 5.0 VDC<br>12 VDC<br>15 VDC<br>24 VDC<br>±12 VDC<br>±15 VDC | 12'000 mA<br>5000 mA<br>4000 mA<br>2500 mA<br>±2500 mA<br>±2000 mA | 90.5 %<br>90.5 %<br>91.5 %<br>91.5 %<br>90 %<br>90 % |
| TEN 60-2411N<br>TEN 60-2412N<br>TEN 60-2413N<br>TEN 60-2415N<br>TEN 60-2422N<br>TEN 60-2423N | <b>18 – 36 VDC</b><br>(24 VDC nominal) | 5.0 VDC<br>12 VDC<br>15 VDC<br>24 VDC<br>±12 VDC<br>±15 VDC | 12'000 mA<br>5000 mA<br>4000 mA<br>2500 mA<br>±2500 mA<br>±2000 mA | 92 %<br>92 %<br>92 %<br>92 %<br>90 %<br>90 %         |
| TEN 60-4811N<br>TEN 60-4812N<br>TEN 60-4813N<br>TEN 60-4815N<br>TEN 60-4822N<br>TEN 60-4823N | <b>36 – 75 VDC</b><br>(48 VDC nominal) | 5.0 VDC<br>12 VDC<br>15 VDC<br>24 VDC<br>±12 VDC<br>±15 VDC | 12'000 mA<br>5000 mA<br>4000 mA<br>2500 mA<br>±2500 mA<br>±2000 mA | 92 %<br>92 %<br>92 %<br>92 %<br>91 %<br>91 %         |

## Input Specifications

|                                                        |                                                    |                                                                                                                                                                                                                |
|--------------------------------------------------------|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input current at no load                               |                                                    | 10 mA typ.                                                                                                                                                                                                     |
| Start-up voltage                                       | 12 Vin models:<br>24 Vin models:<br>48 Vin models: | < 9.0 VDC<br>< 18 VDC<br>< 36 VDC                                                                                                                                                                              |
| Under voltage shut down (lock-out circuit)             | 12 Vin models:<br>24 Vin models:<br>48 Vin models: | 8.0 VDC typ.<br>16 VDC typ.<br>32 VDC typ.                                                                                                                                                                     |
| Surge voltage (1 sec.)                                 | 12 Vin models:<br>24 Vin models:<br>48 Vin models: | 25 V max.<br>50 V max.<br>100 V max.                                                                                                                                                                           |
| Conducted noise                                        |                                                    | EN 55022 class A with external components<br>filter proposal to be advised                                                                                                                                     |
| ESD (electrostatic discharge)                          |                                                    | EN 61000-4-2, air $\pm 8$ kV, contact $\pm 6$ kV,<br>perf. criteria A                                                                                                                                          |
| Radiated immunity                                      |                                                    | EN 61000-4-3, 20 V/m, perf. criteria A                                                                                                                                                                         |
| Fast transient / surge (with external input capacitor) |                                                    | EN 61000-4-4, $\pm 2$ kV, perf. criteria A<br>EN 61000-4-5, $\pm 2$ kV perf. criteria A                                                                                                                        |
| – external input capacitor                             | 12 & 24 Vin models:<br>48 Vin models:              | Nippon chemi-con KY 220 $\mu$ F, 100 V, ESR 48 mOhm<br>and TVS 58V, 3000W peak (SMDJ58A) in parallel<br>Nippon chemi-con KY 220 $\mu$ F, 100 V, ESR 48 mOhm<br>and TVS 120V, 3000W peak (SMDJ120A) in parallel |
| Conducted immunity                                     |                                                    | EN 61000-4-6, 10 Vrms, perf. criteria A                                                                                                                                                                        |

## Output Specifications

|                                                                  |                                                                                                                       |                                                                                                                                            |
|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Voltage set accuracy                                             |                                                                                                                       | $\pm 1$ %                                                                                                                                  |
| Voltage adjustment range (single output models only)             | 15 & 24 VDC models:<br>other models:                                                                                  | +20%, -10%<br>$\pm 10$ %                                                                                                                   |
| Regulation                                                       | – Input variation Vin min. to Vin max.<br>– Load variation 0 – 100 %<br>– Load cross variation 25 % / 100 %           | 0.2 % max.<br>single output models: 0.5 % max.<br>dual output models: 1 % max.<br>5 % max.                                                 |
| Minimum load                                                     |                                                                                                                       | not required                                                                                                                               |
| Temperature coefficient                                          |                                                                                                                       | $\pm 0.02$ %/K                                                                                                                             |
| Ripple and noise (20 MHz bandwidth)                              | 5.0 VDC:<br>12 & 15 VDC:<br>24 VDC:                                                                                   | 100 mVp-p max. with 10 $\mu$ F/25V X7R MLCC<br>125 mVp-p max. with 10 $\mu$ F/25V X7R MLCC<br>200 mVp-p max. with 4.7 $\mu$ F/50V X7R MLCC |
| Start up time<br>(constant resistive load)                       | – Power On<br>– Remote On                                                                                             | 60 ms typ.<br>60 ms typ.                                                                                                                   |
| Transient response (25% load step change)                        |                                                                                                                       | 250 $\mu$ s typ.                                                                                                                           |
| Short circuit protection                                         |                                                                                                                       | continuous, automatic recovery                                                                                                             |
| Over load protection                                             |                                                                                                                       | 150 % of Iout max. typ. hiccup                                                                                                             |
| Over-voltage protection (Zener diode, single output models only) | 5 VDC models:<br>12 VDC models:<br>15 VDC models:<br>24 VDC models:                                                   | 6.2 V<br>15 V<br>20 V<br>30 V                                                                                                              |
| Capacitive load (max. values)                                    | 5.0 VDC models:<br>12 VDC models:<br>15 VDC models:<br>24 VDC models:<br>$\pm 12$ VDC models:<br>$\pm 15$ VDC models: | 30'000 $\mu$ F<br>5850 $\mu$ F<br>3900 $\mu$ F<br>2000 $\mu$ F<br>3900 $\mu$ F (each output)<br>2400 $\mu$ F (each output)                 |

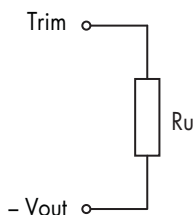
All specifications valid at nominal input voltage, full load and +25°C after warm-up time unless otherwise stated.

## General Specifications

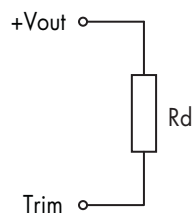
|                                                                      |                                                                                                                                |                                                                                                                                                       |
|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Temperature ranges                                                   | <ul style="list-style-type: none"> <li>– Operating</li> <li>– Casing temperature</li> <li>– Storage</li> </ul>                 | –40°C to +85°C (with derating)<br>+105°C max.<br>–55°C to +125°C                                                                                      |
| Power derating                                                       | <ul style="list-style-type: none"> <li>– Natural convection</li> <li>– Natural convection with heat sink (optional)</li> </ul> | 2.5 %/K above 50°C<br>2.25 %/K above 55°C                                                                                                             |
| Thermal impedance                                                    | <ul style="list-style-type: none"> <li>– Natural convection</li> <li>– Natural convection with heat sink (optional)</li> </ul> | 10.8 K/W<br>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                          | – Test conditions                                                                                                              | MIL-STD-810F<br><a href="http://www.tracopower.com/products/mil810.pdf">www.tracopower.com/products/mil810.pdf</a>                                    |
| Safety standards                                                     |                                                                                                                                | UL/cUL 60950-1, IEC/EN 60950-1                                                                                                                        |
| Safety approvals                                                     | – UL/cUL (entry pending)                                                                                                       | <a href="http://www.ul.com">www.ul.com</a> -> certifications -> File e188913                                                                          |
| Remote On/Off                                                        | <ul style="list-style-type: none"> <li>– On:</li> <li>– Off:</li> <li>– Off idle current:</li> </ul>                           | 3.0 ... 12 VDC or open circuit<br>0 ... 1.2 VDC or short circuit pin 2 and pin 6<br>3.0 mA                                                            |
| Reliability, calculated MTBF (Telcordia SR-332, 50% stress, Ta=40°C) |                                                                                                                                | 2.6 Mio. h                                                                                                                                            |
| 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 2002/95/EC |

## Output Voltage Adjustment (for single output models only)

### Trim up



### Trim down



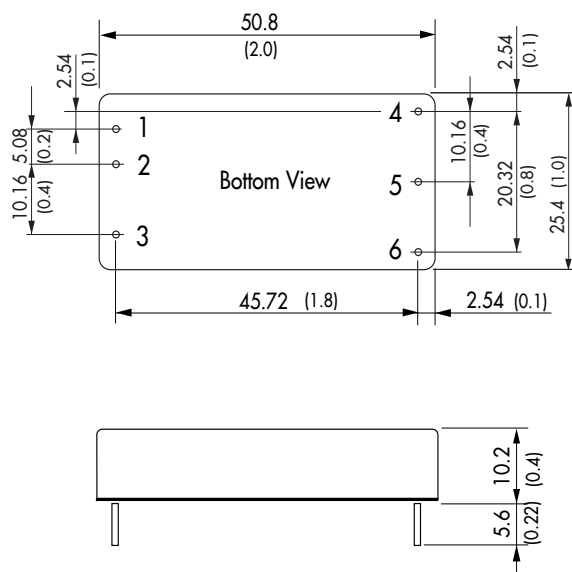
Nominal output voltage at open Trim input  
 Ru, Rd for adjustment to be advised

**Application note:** [www.tracopower.com/products/ten60n-application.pdf](http://www.tracopower.com/products/ten60n-application.pdf)

## Physical Specifications

|                       |                         |
|-----------------------|-------------------------|
| Casing material       | copper                  |
| Baseplate material    | non conductive FR4      |
| Potting material      | silicon (UL94V-0 rated) |
| Weight                | 33 g (1.16 oz)          |
| Soldering temperature | max. +265°C / 10 sec.   |

## Outline Dimensions



## Pin-Out

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

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

## Heat-Sink (Option)

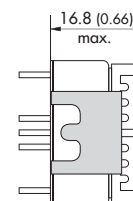
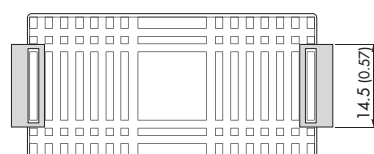
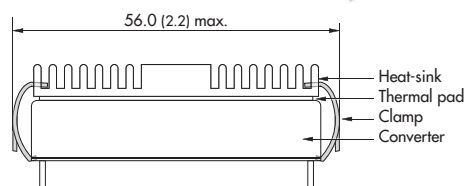
**Order code: TEN-HS1**  
(cont.: heat-sink, thermal pad, 2 clamps)

**Material:** Aluminum

**Finish:** Anodic treatment (black)

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

Thermal impedance after assembling: 10.3 K/W



**Note:**

**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.

Dimensions in mm, ( ) = Inch

Specifications can be changed without notice! Make sure you are using the latest documentation, downloadable at [www.tracopower.com](http://www.tracopower.com)