

### 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 TEN 60-1212N TEN 60-1213N TEN 60-1215N TEN 60-1222N TEN 60-1223N	<b>9 – 18 VDC</b> (12 VDC nominal)	5.0 VDC 12 VDC 15 VDC 24 VDC ±12 VDC ±15 VDC	12'000 mA 5000 mA 4000 mA 2500 mA ±2500 mA ±2000 mA	90.5 % 90.5 % 91.5 % 91.5 % 90 % 90 %
TEN 60-2411N TEN 60-2412N TEN 60-2413N TEN 60-2415N TEN 60-2422N TEN 60-2423N	<b>18 – 36 VDC</b> (24 VDC nominal)	5.0 VDC 12 VDC 15 VDC 24 VDC ±12 VDC ±15 VDC	12'000 mA 5000 mA 4000 mA 2500 mA ±2500 mA ±2000 mA	92 % 92 % 92 % 92 % 90 % 90 %
TEN 60-4811N TEN 60-4812N TEN 60-4813N TEN 60-4815N TEN 60-4822N TEN 60-4823N	<b>36 – 75 VDC</b> (48 VDC nominal)	5.0 VDC 12 VDC 15 VDC 24 VDC ±12 VDC ±15 VDC	12'000 mA 5000 mA 4000 mA 2500 mA ±2500 mA ±2000 mA	92 % 92 % 92 % 92 % 91 % 91 %

## Input Specifications

Input current at no load		10 mA typ.
Start-up voltage	12 Vin models: 24 Vin models: 48 Vin models:	< 9.0 VDC < 18 VDC < 36 VDC
Under voltage shut down (lock-out circuit)	12 Vin models: 24 Vin models: 48 Vin models:	8.0 VDC typ. 16 VDC typ. 32 VDC typ.
Surge voltage (1 sec.)	12 Vin models: 24 Vin models: 48 Vin models:	25 V max. 50 V max. 100 V max.
Conducted noise		EN 55022 class A with external components filter proposal to be advised
ESD (electrostatic discharge)		EN 61000-4-2, air $\pm 8$ kV, contact $\pm 6$ kV, 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 EN 61000-4-5, $\pm 2$ kV perf. criteria A
– external input capacitor	12 & 24 Vin models: 48 Vin models:	Nippon chemi-con KY 220 $\mu$ F, 100 V, ESR 48 mOhm and TVS 58V, 3000W peak (SMDJ58A) in parallel Nippon chemi-con KY 220 $\mu$ F, 100 V, ESR 48 mOhm 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: other models:	+20%, -10% $\pm 10$ %
Regulation	– Input variation Vin min. to Vin max. – Load variation 0 – 100 % – Load cross variation 25 % / 100 %	0.2 % max. single output models: 0.5 % max. dual output models: 1 % max. 5 % max.
Minimum load		not required
Temperature coefficient		$\pm 0.02$ %/K
Ripple and noise (20 MHz bandwidth)	5.0 VDC: 12 & 15 VDC: 24 VDC:	100 mVp-p max. with 10 $\mu$ F/25V X7R MLCC 125 mVp-p max. with 10 $\mu$ F/25V X7R MLCC 200 mVp-p max. with 4.7 $\mu$ F/50V X7R MLCC
Start up time (constant resistive load)	– Power On – Remote On	60 ms typ. 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: 12 VDC models: 15 VDC models: 24 VDC models:	6.2 V 15 V 20 V 30 V
Capacitive load (max. values)	5.0 VDC models: 12 VDC models: 15 VDC models: 24 VDC models: $\pm 12$ VDC models: $\pm 15$ VDC models:	30'000 $\mu$ F 5850 $\mu$ F 3900 $\mu$ F 2000 $\mu$ F 3900 $\mu$ F (each output) 2400 $\mu$ F (each output)

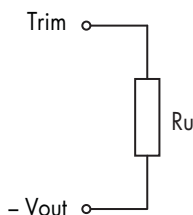
All specifications valid at nominal input voltage, full load and +25°C after warm-up time unless otherwise stated.

## General Specifications

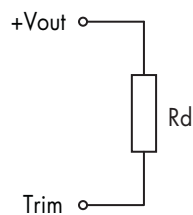
Temperature ranges	<ul style="list-style-type: none"> <li>– Operating</li> <li>– Casing temperature</li> <li>– Storage</li> </ul>	–40°C to +85°C (with derating) +105°C max. –55°C to +125°C
Power derating	<ul style="list-style-type: none"> <li>– Natural convection</li> <li>– Natural convection with heat sink (optional)</li> </ul>	2.5 %/K above +50°C 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 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 <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 0 ... 1.2 VDC or short circuit pin 3 and pin 2 3.0 mA
Reliability, calculated MTBF (MIL-HDBK-217F, at +70°C, ground benign)		880'000 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> RoHS directive 2011/65/EU

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

### Trim up



### Trim down



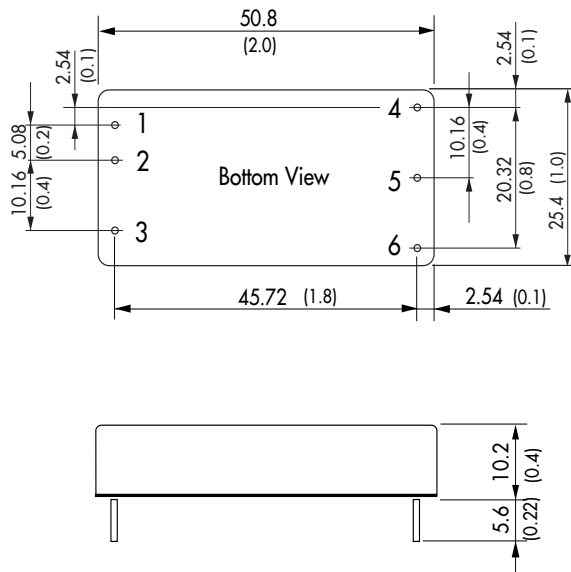
Nominal output voltage at open Trim input  
 Ru, Rd for adjustment to be advised

**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 (1.16oz)
Soldering temperature	max. +265°C / 10 sec.

## Outline Dimensions



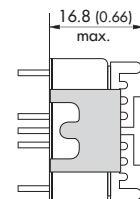
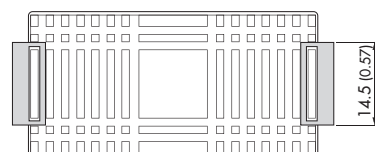
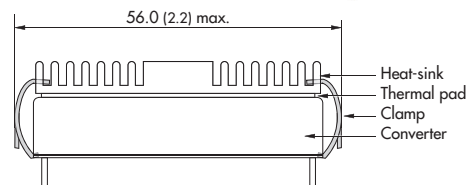
### Pin-Out

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 ±0.1 (0.04 ±0.004)  
Pin pitch tolerances: ±0.25 (±0.01)  
Case tolerances: ±0.5 (±0.02)

## 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.

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)