

- Wide 2:1 input voltage range
- High efficiency up to 91%
- No minimum load required
- Over temperature protection
- Under voltage lock-out circuit
- Remote On/Off
- 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 low profile case with industry-standard 2" x 2" footprint. High efficiency allows for an operating temperature range of -40°C to 75°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.

Models				
Order Code	Input Voltage Range	Output Voltage nom. (adjustable)	Output Current max.	Efficiency typ.
TEN 60-2410	18 - 36 VDC (24 VDC nom.)	3.3 VDC (2.97 - 3.63 VDC)	14'000 mA	89 %
TEN 60-2411		5 VDC (4.5 - 5.5 VDC)	12'000 mA	90 %
TEN 60-2412		12 VDC (10.8 - 13.2 VDC)	5'000 mA	90 %
TEN 60-2413		15 VDC (13.5 - 16.5 VDC)	4'000 mA	90 %
TEN 60-2415		24 VDC (21.6 - 26.4 VDC)	2'500 mA	89 %
TEN 60-4810	36 - 75 VDC (48 VDC nom.)	3.3 VDC (2.97 - 3.63 VDC)	14'000 mA	89 %
TEN 60-4811		5 VDC (4.5 - 5.5 VDC)	12'000 mA	91 %
TEN 60-4812		12 VDC (10.8 - 13.2 VDC)	5'000 mA	90 %
TEN 60-4813		15 VDC (13.5 - 16.5 VDC)	4'000 mA	90 %
TEN 60-4815		24 VDC (21.6 - 26.4 VDC)	2'500 mA	90 %

Options	
TEN-HS3	- Optional Heat Sink: <a href="http://www.tracopower.com/products/ten-hs3.pdf">www.tracopower.com/products/ten-hs3.pdf</a>

## Input Specifications

Input Current	- At no load	24 Vin models: 100 mA typ. (3.3 Vout model) 130 mA typ. (5 Vout model) 50 mA typ. (12 Vout model) 50 mA typ. (15 Vout model) 50 mA typ. (24 Vout model)
		48 Vin models: 80 mA typ. (3.3 Vout model) 90 mA typ. (5 Vout model) 30 mA typ. (12 Vout model) 30 mA typ. (15 Vout model) 30 mA typ. (24 Vout model)
	- At full load	24 Vin models: 2'260 mA typ. (3.3 Vout model) 2'940 mA typ. (5 Vout model) 2'900 mA typ. (12 Vout model) 2'900 mA typ. (15 Vout model) 2'940 mA typ. (24 Vout model)
		48 Vin models: 1'140 mA typ. (3.3 Vout model) 1'450 mA typ. (5 Vout model) 1'450 mA typ. (12 Vout model) 1'450 mA typ. (15 Vout model) 1'470 mA typ. (24 Vout model)
Surge Voltage		24 Vin models: 50 VDC max. (100 ms max.) 48 Vin models: 100 VDC max. (100 ms max.)
Under Voltage Lockout		24 Vin models: 14.5 VDC min. / 15.5 VDC typ. / 17.5 VDC max. 48 Vin models: 31 VDC min. / 32 VDC typ. / 35.5 VDC max.
Recommended Input Fuse		24 Vin models: 6'300 mA (slow blow) 48 Vin models: 3'150 mA (slow blow) (The need of an external fuse has to be assessed in the final application.)
Input Filter		Internal Pi-Type

## Output Specifications

Output Voltage Adjustment		-10% to +20% (24 Vout models) ±10% (other output models) (By external trim resistor)
		See application note: <a href="http://www.tracopower.com/overview/ten60">www.tracopower.com/overview/ten60</a> Output power must not exceed rated power!
Voltage Set Accuracy		±1% max.
Regulation	- Input Variation (Vmin - Vmax) - Load Variation (0 - 100%)	0.2% max. 0.5% max.
Ripple and Noise (20 MHz Bandwidth)		3.3 Vout models: 75 mVp-p typ. 5 Vout models: 75 mVp-p typ. 12 Vout models: 100 mVp-p typ. 15 Vout models: 100 mVp-p typ. 24 Vout models: 200 mVp-p typ.
Capacitive Load		3.3 Vout models: 36'000 µF max. 5 Vout models: 20'400 µF max. 12 Vout models: 3'550 µF max. 15 Vout models: 2'300 µF max. 24 Vout models: 885 µF max.
Minimum Load		Not required
Temperature Coefficient		±0.02 %/K max.
Start-up Time		20 ms max.
Short Circuit Protection		Continuous, Automatic recovery
Output Current Limitation		150% typ. of Iout max.

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

Overvoltage Protection		112 - 164% of Vout nom. (depending on model) 3.7 - 5.4 VDC (3.3 VDC model) 5.6 - 7 VDC (5 VDC model) 13.8 - 17.5 VDC (12 VDC model) 16.8 - 20.5 VDC (15 VDC model) 30 - 33 VDC (24 VDC model)
Transient Response	- Response Deviation - Response Time	8% max. (25% Load Step) 250 $\mu$ s typ. (25% Load Step)

## 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
	- Certification Documents	<a href="http://www.tracopower.com/overview/ten60">www.tracopower.com/overview/ten60</a>
Pollution Degree		PD 2
Over Voltage Category		Not mains connected

## EMC Specifications

EMI Emissions	- Conducted Emissions  - Radiated Emissions	EN 55032 class A (with external filter) EN 55032 class B (with external filter) EN 55032 class A (with external filter) EN 55032 class B (with external filter)
		External filter proposal: <a href="http://www.tracopower.com/overview/ten60">www.tracopower.com/overview/ten60</a>
EMS Immunity	- Electrostatic Discharge  - RF Electromagnetic Field - EFT (Burst) / Surge  - Conducted RF Disturbances - PF Magnetic Field	EN 55024 (IT Equipment) Air: EN 61000-4-2, $\pm 8$ kV, perf. criteria A Contact: EN 61000-4-2, $\pm 6$ kV, perf. criteria A EN 61000-4-3, 10 V/m, perf. criteria A EN 61000-4-4, $\pm 2$ kV, perf. criteria A EN 61000-4-5, $\pm 1$ kV, perf. criteria A Ext. input component: KY 220 $\mu$ F / 100 V Continuous: EN 61000-4-6, 10 Vrms, perf. criteria A 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 - Case Temperature - Storage Temperature	-40°C to +75°C +110°C max. -55°C to +125°C
Power Derating	- High Temperature	See application note: <a href="http://www.tracopower.com/overview/ten60">www.tracopower.com/overview/ten60</a>
Over Temperature Protection Switch Off	- Protection Mode - Measurement Point	120°C typ. (Automatic recovery at 100°C typ.) Case
Cooling System		Natural convection (20 LFM)
Sense Function		10% max. of Vout nom. (If sense function is not used, sense pins should be connected to output pins.)
Remote Control	- Voltage Controlled Remote  - Off Idle Input Current - Remote Pin 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 4 mA typ. -0.5 to 1.0 mA
Altitude During Operation		2'000 m max.

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

Switching Frequency		270 - 330 kHz (PWM) 300 kHz typ. (PWM)
Insulation System		Functional Insulation
Isolation Test Voltage	- Input to Output, 60 s - Input to Case, 60 s - Output to Case, 60 s	1'600 VDC 1'600 VDC 1'600 VDC
Isolation Resistance	- Input to Output, 500 VDC	1'000 MΩ min.
Isolation Capacitance	- Input to Output, 100 kHz, 1 V	1'500 pF max.
Reliability	- Calculated MTBF	410'000 h (MIL-HDBK-217F, ground benign)
Washing Process		Allowed (hermetical product)
	See Cleaning Guideline:	<a href="http://www.tracopower.com/info/cleaning.pdf">www.tracopower.com/info/cleaning.pdf</a>
Environment	- Vibration  - Mechanical Shock  - Thermal Shock	MIL-STD-810F 7.7 g, 3 axis, random waveform, 60 min MIL-STD-810F 50 g, 3 axis, terminal peak sawtooth, 11 ms MIL-STD-810F -55°C to +125°C, 72 cycles, 30 min each
Housing Material		Copper, Nickel plated
Base Material		Non-conductive FR4 (UL 94 V-0 rated)
Potting Material		Epoxy (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 2"
Soldering Profile		Wave Soldering 265°C / 10 s max.
Weight		60 g
Environmental Compliance	- REACH Declaration  - RoHS Declaration	<a href="http://www.tracopower.com/info/reach-declaration.pdf">www.tracopower.com/info/reach-declaration.pdf</a> REACH SVHC list compliant REACH Annex XVII compliant <a href="http://www.tracopower.com/info/rohs-declaration.pdf">www.tracopower.com/info/rohs-declaration.pdf</a> Exemptions: 7a, 7c-I (RoHS exemptions refer to the component concentration only, not to the overall concentration in the product (O5A rule). The SCIP number is provided on request.)

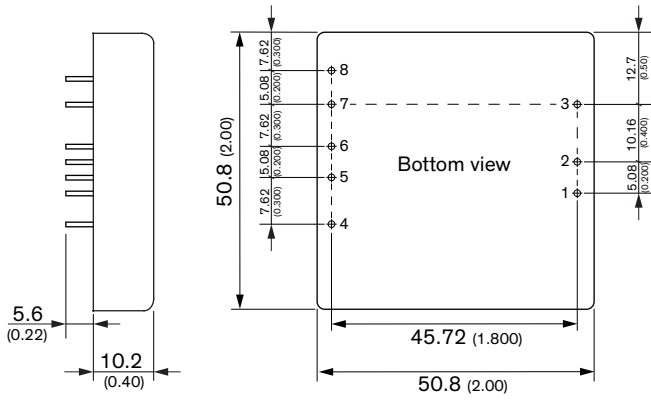
## Supporting Documents

Overview Link (for additional Documents)

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

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### Outline Dimensions



Dimensions in mm (inch)  
 Pin diameter: 1.0 ±0.1 (0.04 ±0.004)  
 Tolerances: x.x ±0.5 (x.xx ±0.02)  
 x.xx ±0.25 (x.xxx ±0.01)

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