

DC/DC Converter

TEN 60 Series, 60 Watt

- 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: www.tracopower.com/products/ten-hs3.pdf

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)
	- At full load	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)
Surge Voltage		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)
Under Voltage Lockout		24 Vin models: 50 VDC max. (100 ms max.) 48 Vin models: 100 VDC max. (100 ms max.)
Recommended Input Fuse		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.
Input Filter		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.)
		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:	www.tracopower.com/overview/ten60 Output power must not exceed rated power!
Voltage Set Accuracy		±1% max.
Regulation	- Input Variation (Vmin - Vmax)	0.2% max.
	- Load Variation (0 - 100%)	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 µs 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	www.tracopower.com/overview/ten60
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: www.tracopower.com/overview/ten60
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, ±8 kV, perf. criteria A Contact: EN 61000-4-2, ±6 kV, perf. criteria A EN 61000-4-3, 10 V/m, perf. criteria A EN 61000-4-4, ±2 kV, perf. criteria A EN 61000-4-5, ±1 kV, perf. criteria A Ext. input component: KY 220 µF / 100 V Continuous: EN 61000-4-6, 10 Vrms, perf. criteria A 1 s: EN 61000-4-8, 100 A/m, perf. criteria A 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: www.tracopower.com/overview/ten60
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.

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Switching Frequency	270 - 330 kHz (PWM) 300 kHz typ. (PWM)
Insulation System	Functional Insulation
Isolation Test Voltage	1'600 VDC
- 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	1'000 MΩ min.
Isolation Capacitance	1'500 pF max.
Reliability	410'000 h (MIL-HDBK-217F, ground benign)
Washing Process	Allowed (hermetical product)
See Cleaning Guideline:	www.tracopower.com/info/cleaning.pdf
Environment	MIL-STD-810F
- Vibration	7.7 g, 3 axis, random waveform, 60 min
- Mechanical Shock	MIL-STD-810F
- Thermal Shock	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	www.tracopower.com/info/reach-declaration.pdf
- REACH Declaration	REACH SVHC list compliant REACH Annex XVII compliant
- RoHS Declaration	www.tracopower.com/info/rohs-declaration.pdf 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.)

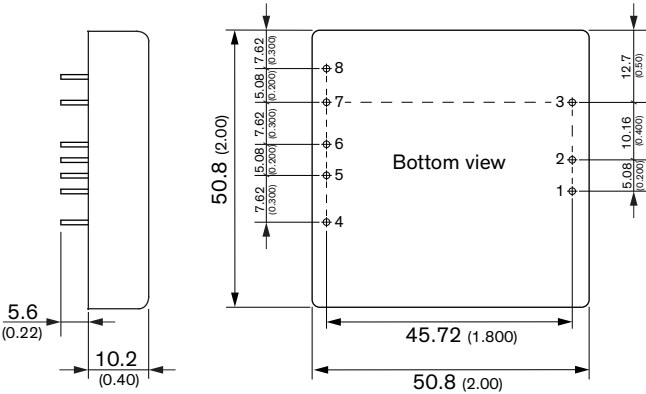
Supporting Documents

Overview Link (for additional Documents)

www.tracopower.com/overview/ten60

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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