

DC/DC Converter

TEN 60 Series, 60 Watt

Not recommended for new designs

- 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 - 28.8 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 - 28.8 VDC)	2'500 mA	90 %

Options	
TEN-HS3	- Optional Heat Sink: www.tracopower.com/overview/ten-hs3

Note * Not recommended for new designs

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

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	EN 55024 (IT Equipment) EN 55035 (Multimedia) 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
	- Conducted RF Disturbances - PF Magnetic Field	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	Depending on model
		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 must be connected to corresponding polarity output pins.)
Remote Control	- Voltage Controlled Remote (passive = on) - 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

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

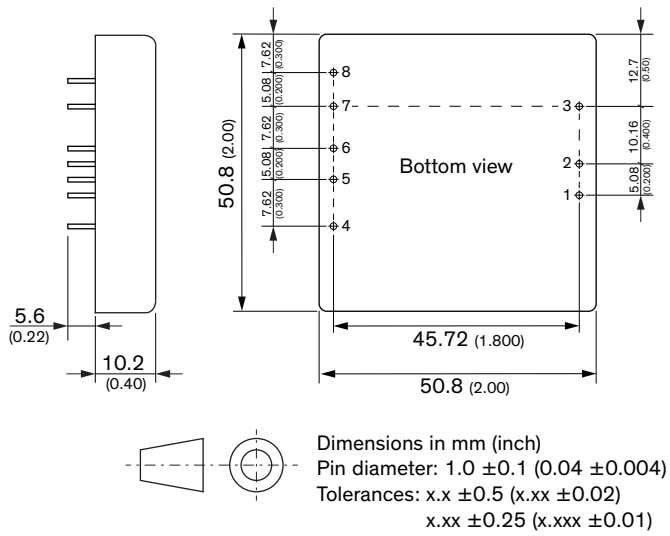
Altitude During Operation	2'000 m max.
Regulator Topology	Forward Converter
Switching Frequency	270 - 330 kHz (PWM) 300 kHz typ. (PWM)
Insulation System	Functional Insulation
Isolation Test Voltage	- Input to Output, 60 s - Input to Case, 60 s - Output to Case, 60 s
	1'600 VDC 1'600 VDC 1'600 VDC
Isolation 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	According to Cleaning Guideline www.tracopower.com/info/cleaning.pdf
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	Lead-Free Wave Soldering 265°C / 10 s max.
Weight	60 g
Thermal Impedance	- Case to Ambient
	10.5 K/W typ. 8.4 K/W typ. (with Heat Sink)
Environmental Compliance	- REACH Declaration - RoHS Declaration - SCIP Reference Number
	www.tracopower.com/info/reach-declaration.pdf REACH SVHC list compliant REACH Annex XVII compliant www.tracopower.com/info/rohs-declaration.pdf Exemptions: 7(a), 7(c)-I (RoHS exemptions refer to the component concentration only, not to the overall concentration in the product (O5A rule).) 527286fc-5b1c-4797-b181-26e69d91a288

Additional Information

Supporting Documents	www.tracopower.com/overview/ten60
Frequently Asked Questions	www.tracopower.com/glossary-faq
Glossary	www.tracopower.com/info/glossary.pdf

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Outline Dimensions



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