TRACO POWER

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**

UL 62368-1 IEC 62368-1

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)
		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:	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		3.3 Vout models:	**75 mVp-p typ.**
(20 MHz Bandwidth)		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	8% max. (25% Load Step)
	- Response Time	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		EN 55032 class A (with external filter) EN 55032 class B (with external filter)
	- Radiated Emissions		EN 55032 class A (with external filter) EN 55032 class B (with external filter)
		External filter proposal:	www.tracopower.com/overview/ten60
EMS Immunity			EN 55024 (IT Equipment) EN 55035 (Multimedia)
	- Electrostatic Discharge	Air:	EN 61000-4-2, ±8 kV, perf. criteria A
		Contact:	EN 61000-4-2, ±6 kV, perf. criteria A
	- RF Electromagnetic Field		EN 61000-4-3, 10 V/m, perf. criteria A
	- EFT (Burst) / Surge		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
	- Conducted RF Disturbances		EN 61000-4-6, 10 Vrms, perf. criteria A
	- PF Magnetic Field	Continuous:	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		–40°C to +75°C
	- Case Temperature		+110°C max.
	- Storage Temperature		–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		120°C typ. (Automatic recovery at 100°C typ.)
	- Measurement Point		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.)

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Remote Control	- Voltage Controlled Remote	On: 3.0 to 12 VDC or open circuit Off: 0 to 1.2 VDC or short circuit Refers to 'Remote' and '-Vin' Pin
	- Off Idle Input Current	4 mA typ.
	- Remote Pin Input Current	-0.5 to 1.0 mA
Altitude During Operation		2'000 m max.
Switching Frequency		270 - 330 kHz (PWM) 300 kHz typ. (PWM)
Insulation System		Functional Insulation
Isolation Test Voltage	- 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	- 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	MIL-STD-810F 7.7 g, 3 axis, random waveform, 60 min
	- Mechanical Shock	MIL-STD-810F 50 g, 3 axis, terminal peak sawtooth, 11 ms
	- Thermal Shock	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	www.tracopower.com/info/reach-declaration.pdf 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).)
	- SCIP Reference Number	527286fc-5b1c-4797-b181-26e69d91a288

Supporting Documents

Overview Link (for additional Documents)	www.tracopower.com/overview/ten60

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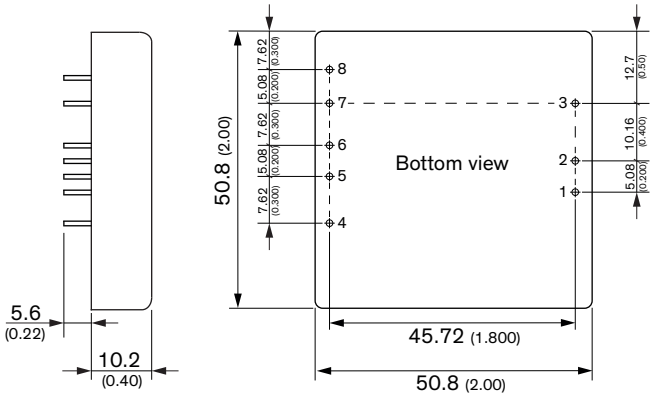
Outline Dimensions



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