cULus
UL 60950-1

Features

- **Highest power density: 60W in a 51x51x10mm (2"x2"x0.4") package**
- **Wide 2:1 input voltage range**
- **Very high efficiency up to 90%**
- **No minimum load required**
- **Over temperature protection**
- **Under voltage lock-out circuit**
- **Remote On/Off**
- **Shielded metal case with insulated baseplate**
- **Optional heatsink**
- **Lead free design - RoHS compliant**
- **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 compact low profile case with industry-standard footprint. A very high efficiency allows an operating temperature range of –40°C to 85°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, everywhere where isolated, tightly regulated voltages are required and space is limited on the PCB.

Models

Order code	Input voltage range	Output voltage	Output current max.	Efficiency typ.
TEN 60-2410		3.3 VDC	14.0 A	89 %
TEN 60-2411	**18 – 36 VDC**	5.0 VDC	12.0 A	90 %
TEN 60-2412	(24 VDC nominal)	12 VDC	5.0 A	90 %
TEN 60-2413		15 VDC	4.0 A	90 %
TEN 60-2415		24 VDC	2.5 A	89 %
TEN 60-4810		3.3 VDC	14.0 A	89 %
TEN 60-4811	**36 – 75 VDC**	5.0 VDC	12.0 A	90 %
TEN 60-4812	(48 VDC nominal)	12 VDC	5.0 A	90 %
TEN 60-4813		15 VDC	4.0 A	90 %
TEN 60-4815		24 VDC	2.5 A	89 %

Input Specifications

Input current at no load (nominal input 24/48 Vin)	3.3 V output models:	100 / 80 mA typ.
	5.0 V output models:	130 / 90 mA typ.
	12 V, 15 V & 24 V output models:	50 / 30 mA typ.
Input current at full load (nominal input 24/48 Vin)	3.3 V output models:	2260 / 1140 mA typ.
	5.0 V output models:	2940 / 1450 mA typ.
	12 V & 15 V output models:	2900 / 1450 mA typ.
	24 V output models:	2940 / 1470 mA typ.
Input voltage variation (dv/dt)		5 V/ms, max. (complies with ETS300 132 part 4.4)
Start-up voltage	24 Vin models:	17 VDC (or lower)
	48 Vin models:	34 VDC (or lower)
Under voltage shut down (lock-out circuit)	24 Vin models:	15 VDC typ.
	48 Vin models:	32 VDC typ.
Surge voltage (100 msec. max.)	24 Vin models:	50 V
	48 Vin models:	100 V
Conducted noise (input)		EN 55022 level A, FCC part 15, level A with external capacitor, see application note:
ESD (input)		EN 61000-4-2, perf. criteria A
Fast transient (input)		EN 61000-4-4, perf. criteria A
Surge (input)		EN 61000-4-5, perf. criteria A

Output Specifications

Voltage set accuracy		±1 %
Output voltage adjustment		±10 %
Regulation	– Input variation Vin min. to Vin max.	0.2 % max.
	– Load variation 0 – 100 %	0.5 % max.
Temperature coefficient		±0.02 %/K max.
Ripple and noise (20 MHz Bandwidth)	3.3 V & 5 V output models:	75 mVpk-pk max.
	12 V & 15 V output models:	100 mVpk-pk max.
	24 V output models:	200 mVpk-pk max.
Start up time (nominal Vin and constant resistive load)		20 ms typ.
Transient response time (25% load change)		250 µs typ.
Short circuit protection		indefinite (automatic recovery)
Over load protection		150 % of Iout max typ.
Minimum Load		not required
Thermal shutdown		at +110°C typ
Over voltage protection	3.3 V output models:	3.7 V
	5 V output models:	5.6 V
	12 V output models:	13.8 V
	15 V output models:	16.8 V
	24 V output models:	30.0 V
Capacitive load	3.3 V output models:	36'000 µF
	5 V output models:	20'400 µF
	12 V output models:	3'550 µF
	15 V output models:	2'300 µF
	24 V output models:	885 µF

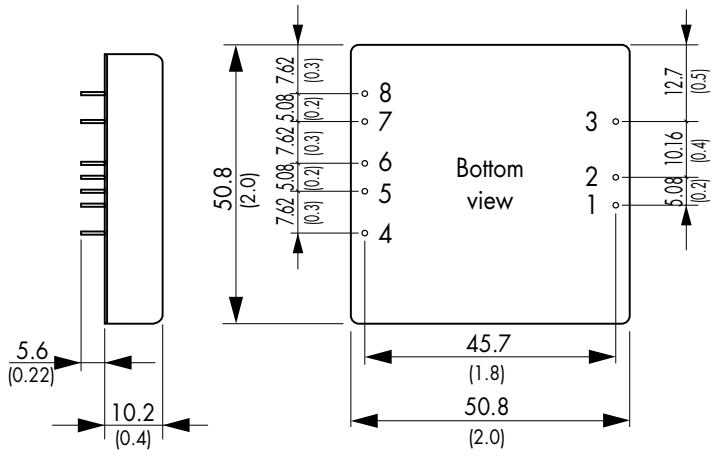
General Specifications

Temperature ranges	– Operating – Case temperature – Storage	–40°C to +85°C +110°C max. –55°C to +125°C
Derating		see application note:
Humidity (non condensing)		95 % rel H max.
Reliability, calculated MTBF (MIL-HDBK-217F, at +70°C, ground benign)		>400'000 h
Isolation (Input/Output)	– Voltage – Capacitance – Resistance	1'600 VDC 1'500 pF max. >1'000 MOhm
Remote On/Off	– On: – Off: – Off idle current:	3.0 ... 12 VDC or open circuit. 0 ... 1.2 VDC or short circuit pin 3 and pin 2 3.0 mA max.
Switching frequency (fixed)		300 kHz typ. (Pulse width modulation PWM)
Vibration		10 – 55Hz, 10G, 30 minutes along X,Y,Z
Safety standards		UL 60950-1, IEC/EN 60950-1
Safety approvals	– UL/cUL	www.ul.com > UL File no.: e188913
Environmental compliance	– Reach – RoHS	 RoHS directive 2011/65/EU

Physical Specifications

Casing material	copper, nickel plated
Baseplate material	none conductive FR4
Potting material	epoxy (UL 94V-0-rated)
Weight	60 g (2.1oz)
Soldering temperature	max. 265°C / 10 sec.

Outline Dimensions



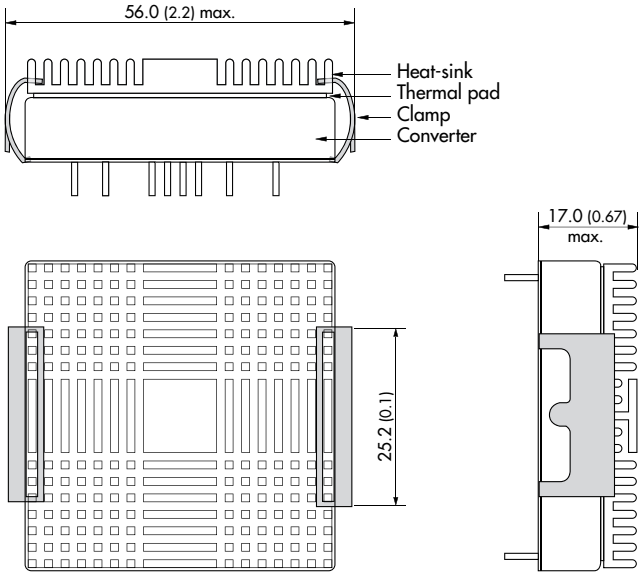
Pin-Out	
Pin	
1	+Vin (Vcc)
2	–Vin (GND)
3	Remote On/Off
4	–Sense
5	+Sense
6	+Vout
7	–Vout
8	Trim

Dimensions in [mm], () = Inch
Pin diameter: 1.0 ±0.05 (0.02 ±0.002)
Pin pitch tolerances: ±0.35 (±0.014)
Case tolerances: ±0.5 (±0.02)

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

Outline Dimensions

Heat-sink TEN-HS3



Order code: **TEN-HS3** (cont.: heat-sink, thermal pad, 2 clamps)
Material: Aluminum
Finish: Anodic treatment (black)
Weight: 22 g (0.78oz) (without converter)

Note:
The product label on converter has to be removed before mounting the heat-sink.
For volume orders converters will be supplied with heat-sinks already mounted. Please contact factory for quotation.
Separate heat-sinks are only available for prototypes and small quantity orders.