TRACO POWER

DC/DC Converter

TEN 60WIN Series, 60 Watt

- **2" x 1" metal package**
- **Wide 4:1 input voltage range 9–36, 18–75 VDC**
- **High efficiency up to 92%**
- **Adjustable output voltage**
- **Operating temperature range –40°C to +85°C**
- **EN 55032 class A (with external components)**
- **Remote On/Off**
- **Under voltage lockout**
- **RoHS compliant**
- **3-year product warranty**



UL 62368-1 IEC 62368-1

The TEN 60WIN series is a family of high performance 60 Watt DC/DC converter modules featuring ultra wide 4:1 input voltage ranges in a six side shielded 2" x 1" metal package with industry standard footprint. Standard features include remote On/Off, over voltage protection, under voltage lockout and short circuit protection. High efficiency across load range and low input current characteristics at no load make these converters the ideal solution for battery-operated systems. Typical applications are in wireless networks, telecom/datacom, industry control systems and measurement equipment.

Models

Order Code	Input Voltage Range	Output 1		Output 2		Efficiency
		Vnom	Imax	Vnom	Imax	typ.
TEN 60-2411WIN	9 - 36 VDC (24 VDC nom.)	5 VDC	12'000 mA			92 %
TEN 60-2412WIN		12 VDC	5'000 mA			92 %
TEN 60-2413WIN		15 VDC	4'000 mA			92 %
TEN 60-2415WIN		24 VDC	2'500 mA			92 %
TEN 60-2422WIN		+12 VDC	2'500 mA	–12 VDC	2'500 mA	91 %
TEN 60-2423WIN		+15 VDC	2'000 mA	–15 VDC	2'000 mA	91 %
TEN 60-2425WIN		+24 VDC	1'250 mA	–24 VDC	1'250 mA	91 %
TEN 60-4811WIN	18 - 75 VDC (48 VDC nom.)	5 VDC	12'000 mA			92 %
TEN 60-4812WIN		12 VDC	5'000 mA			92 %
TEN 60-4813WIN		15 VDC	4'000 mA			92 %
TEN 60-4815WIN		24 VDC	2'500 mA			91 %
TEN 60-4822WIN		+12 VDC	2'500 mA	–12 VDC	2'500 mA	91 %
TEN 60-4823WIN		+15 VDC	2'000 mA	–15 VDC	2'000 mA	91 %
TEN 60-4825WIN		+24 VDC	1'250 mA	–24 VDC	1'250 mA	91 %

Options

TEN-HS1	- Optional Heat Sink with Height = 0.22 inch: www.tracopower.com/products/ten-hs1.pdf
TEN-HS8	- Optional Heat Sink with Height = 0.3 inch: www.tracopower.com/products/ten-hs8.pdf
on demand (backorder with MOQ non stocking item)	- Optional Heat Sink with Height = 0.8 inch: www.tracopower.com/products/ten-hs10.pdf - Optional Heat Sink with Height = 0.5 inch: www.tracopower.com/products/ten-hs9.pdf

Input Specifications

Input Current	- At no load	24 Vin models:	10 mA typ.
		48 Vin models:	10 mA typ.
Surge Voltage		24 Vin models:	50 VDC max. (1 s max.)
		48 Vin models:	100 VDC max. (1 s max.)
Under Voltage Lockout		24 Vin models:	7 VDC min. / 8 VDC typ. / 8.8 VDC max.
		48 Vin models:	15 VDC min. / 16 VDC typ. / 17.5 VDC max.
Recommended Input Fuse		24 Vin models:	10'000 mA (fast acting)
		48 Vin models:	6'300 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% (15 & 24 Vout models)
			±10% (other models)
			(single output models only)
			(By external trim resistor)
		See application note:	www.tracopower.com/overview/ten60win
			Output power must not exceed rated power!
Voltage Set Accuracy			±1% max.
Regulation	- Input Variation (Vmin - Vmax)	single output models:	0.2% max.
		dual output models:	0.2% max.
	- Load Variation (0 - 100%)	single output models:	0.5% max.
		dual output models:	1% max. (Output 1)
			1% max. (Output 2)
	- Cross Regulation (25% / 100% asym. load)	dual output models:	5% max.
Ripple and Noise (20 MHz Bandwidth)	- single output	5 Vout models:	100 mVp-p max. (w/ 10 µF X7R)
		12 Vout models:	125 mVp-p max. (w/ 10 µF X7R)
		15 Vout models:	125 mVp-p max. (w/ 10 µF X7R)
		24 Vout models:	200 mVp-p max. (w/ 4.7 µF X7R)
	- dual output	12 / -12 Vout models:	125 / 125 mVp-p max. (w/ 10 µF X7R)
		15 / -15 Vout models:	125 / 125 mVp-p max. (w/ 10 µF X7R)
		24 / -24 Vout models:	200 / 200 mVp-p max. (w/ 4.7 µF X7R)
Capacitive Load	- single output	5 Vout models:	30'000 µF max.
		12 Vout models:	5'850 µF max.
		15 Vout models:	3'900 µF max.
		24 Vout models:	2'000 µF max.
	- dual output	12 / -12 Vout models:	3'900 / 3'900 µF max.
		15 / -15 Vout models:	2'400 / 2'400 µF max.
		24 / -24 Vout models:	1'000 / 1'000 µF max.
Minimum Load			Not required
Temperature Coefficient			±0.02 %/K max.
Start-up Time			60 ms typ. (Power On)
			60 ms typ. (Remote On)
Short Circuit Protection			Continuous, Automatic recovery
Output Current Limitation			150% typ. of Iout max.
Overvoltage Protection			133% typ. of Vout nom.
			(15 Vout single models)
			125% typ. of Vout nom. (other single models)
			(By Zener diode)
Transient Response	- Peak Variation		500 mV max. (25% Load Step)
	- Response Time		250 µs typ. (25% Load Step)

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

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/ten60win
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/ten60win
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, 20 V/m, perf. criteria A
	- EFT (Burst) / Surge		EN 61000-4-4, ±2 kV, perf. criteria A EN 61000-4-5, ±2 kV, perf. criteria A
		Ext. input component:	24 Vin models: KY 220 µF || TVS SMDJ58A 48 Vin models: KY 220 µF || TVS SMDJ120A
	- 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 +85°C
	- Case Temperature		+105°C max.
	- Storage Temperature		–55°C to +125°C
Power Derating	- High Temperature		Depending on model
		See application note:	www.tracopower.com/overview/ten60win
Over Temperature Protection Switch Off	- Protection Mode		115°C typ.
Cooling System			Natural convection (20 LFM)
Remote Control	- Voltage Controlled Remote (passive = on)		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		3 mA typ.
	- Remote Pin Input Current		-0.5 to 0.5 mA
Altitude During Operation			5'000 m max.
Switching Frequency			225 - 275 kHz (PWM) 250 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		2'200 pF max.
Reliability	- Calculated MTBF		860'000 h (MIL-HDBK-217F, ground benign)

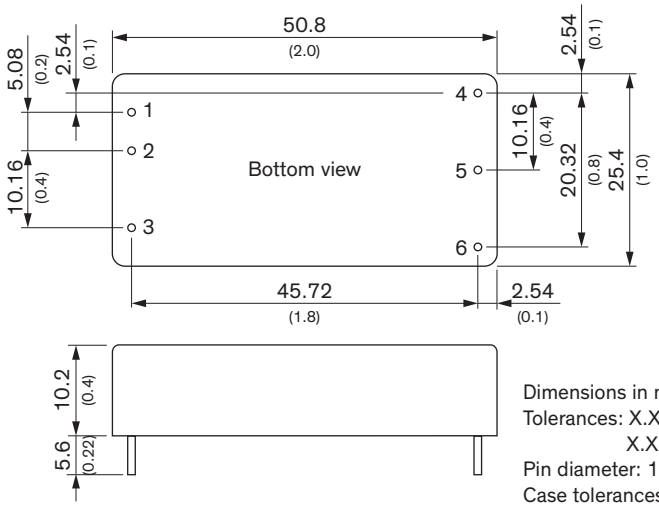
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Washing Process		According to Cleaning Guideline www.tracopower.com/info/cleaning.pdf
Environment	- Vibration	MIL-STD-810F
	- Thermal Shock	MIL-STD-810F
Housing Material		Copper
Base Material		Non-conductive FR4 (UL 94 V-0 rated)
Potting Material		Silicone (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 1"
Soldering Profile		Lead-Free Wave Soldering 265°C / 10 s max.
Weight		33 g
Thermal Impedance	- Case to Ambient	10.8 K/W typ. (without heatsink) 10.3 K/W typ. (with heatsink TEN-HS1)
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	9fc1983f-4b92-48b3-b1d0-eb1ac932eaf2

Supporting Documents

Overview Link (for additional Documents)	www.tracopower.com/overview/ten60win

Outline Dimensions



Dimensions in mm (inch)
Tolerances: X.X ±0.5 (X.XX ±0.02)
X.XX ±0.25 (X.XXX ±0.01)
Pin diameter: 1.0 ±0.1 (0.04 ±0.004)
Case tolerances: ±0.5 (±0.02)

Pinout		
Pin	**Single**	**Dual**
1	+Vin (Vcc)	+Vin (Vcc)
2	–Vin (GND)	–Vin (GND)
3	Remote On/Off	Remote On/Off
4	+Vout	+Vout
5	–Vout	Common
6	Trim	–Vout

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