

- 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



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 typ.
		Vnom	I <sub>max</sub>	Vnom	I <sub>max</sub>	
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: <a href="http://www.tracopower.com/products/ten-hs1.pdf">www.tracopower.com/products/ten-hs1.pdf</a>
TEN-HS8	- Optional Heat Sink with Height = 0.3 inch: <a href="http://www.tracopower.com/products/ten-hs8.pdf">www.tracopower.com/products/ten-hs8.pdf</a>
on demand (backorder with MOQ non stocking item)	- Optional Heat Sink with Height = 0.8 inch: <a href="http://www.tracopower.com/products/ten-hs10.pdf">www.tracopower.com/products/ten-hs10.pdf</a> - Optional Heat Sink with Height = 0.5 inch: <a href="http://www.tracopower.com/products/ten-hs9.pdf">www.tracopower.com/products/ten-hs9.pdf</a>

## Input Specifications

Input Current	- At no load	24 Vin models: <b>10 mA typ.</b> 48 Vin models: <b>10 mA typ.</b>
Surge Voltage		24 Vin models: <b>50 VDC max.</b> (1 s max.) 48 Vin models: <b>100 VDC max.</b> (1 s max.)
Under Voltage Lockout		24 Vin models: <b>7 VDC min. / 8 VDC typ. / 8.8 VDC max.</b> 48 Vin models: <b>15 VDC min. / 16 VDC typ. / 17.5 VDC max.</b>
Recommended Input Fuse		24 Vin models: <b>10'000 mA</b> (fast acting) 48 Vin models: <b>6'300 mA</b> (slow blow) (The need of an external fuse has to be assessed in the final application.)
Input Filter		<b>Internal Pi-Type</b>

## Output Specifications

Output Voltage Adjustment		-10% to +20% (15 & 24 Vout single models) <b>±10%</b> (other single models) (By external trim resistor) See application note: <a href="http://www.tracopower.com/overview/ten60win">www.tracopower.com/overview/ten60win</a> Output power must not exceed rated power!
Voltage Set Accuracy		<b>±1% max.</b>
Regulation	- Input Variation (Vmin - Vmax)	single output models: <b>0.2% max.</b> dual output models: <b>0.2% max.</b>
	- Load Variation (0 - 100%)	single output models: <b>0.5% max.</b> dual output models: <b>1% max.</b> (Output 1) <b>1% max.</b> (Output 2)
	- Cross Regulation (25% / 100% asym. load)	dual output models: <b>5% max.</b>
Ripple and Noise (20 MHz Bandwidth)	- single output	5 Vout models: <b>100 mVp-p max.</b> (w/ 10 µF X7R) 12 Vout models: <b>125 mVp-p max.</b> (w/ 10 µF X7R) 15 Vout models: <b>125 mVp-p max.</b> (w/ 10 µF X7R) 24 Vout models: <b>200 mVp-p max.</b> (w/ 4.7 µF X7R)
	- dual output	12 / -12 Vout models: <b>125 / 125 mVp-p max.</b> (w/ 10 µF X7R) 15 / -15 Vout models: <b>125 / 125 mVp-p max.</b> (w/ 10 µF X7R) 24 / -24 Vout models: <b>200 / 200 mVp-p max.</b> (w/ 4.7 µF X7R)
Capacitive Load	- single output	5 Vout models: <b>30'000 µF max.</b> 12 Vout models: <b>5'850 µF max.</b> 15 Vout models: <b>3'900 µF max.</b> 24 Vout models: <b>2'000 µF max.</b>
	- dual output	12 / -12 Vout models: <b>3'900 / 3'900 µF max.</b> 15 / -15 Vout models: <b>2'400 / 2'400 µF max.</b> 24 / -24 Vout models: <b>1'000 / 1'000 µF max.</b>
Minimum Load		<b>Not required</b>
Temperature Coefficient		<b>±0.02 %/K max.</b>
Start-up Time		<b>60 ms typ.</b> (Power On) <b>60 ms typ.</b> (Remote On)
Short Circuit Protection		<b>Continuous, Automatic recovery</b>
Output Current Limitation		<b>150% typ. of Iout max.</b>
Overvoltage Protection		<b>133% typ. of Vout nom.</b> (15 Vout single models) <b>125% typ. of Vout nom.</b> (other single models) (By Zener diode)
Transient Response	- Peak Variation	<b>500 mV max.</b> (25% Load Step)
	- Response Time	<b>250 µs typ.</b> (25% Load Step)

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

### 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	<a href="http://www.tracopower.com/overview/ten60win">www.tracopower.com/overview/ten60win</a>
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:	<a href="http://www.tracopower.com/overview/ten60win">www.tracopower.com/overview/ten60win</a>
EMS Immunity		EN 55024 (IT Equipment) EN 55035 (Multimedia)
	- Electrostatic Discharge	Air: EN 61000-4-2, $\pm 8$ kV, perf. criteria A Contact: EN 61000-4-2, $\pm 6$ kV, perf. criteria A
	- RF Electromagnetic Field	EN 61000-4-3, 20 V/m, perf. criteria A
	- EFT (Burst) / Surge	EN 61000-4-4, $\pm 2$ kV, perf. criteria A EN 61000-4-5, $\pm 2$ kV, perf. criteria A
	- Conducted RF Disturbances	Ext. input component: 24 Vin models: KY 220 $\mu$ F    TVS SMDJ58A 48 Vin models: KY 220 $\mu$ F    TVS SMDJ120A
	- 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:	<a href="http://www.tracopower.com/overview/ten60win">www.tracopower.com/overview/ten60win</a>
Over Temperature Protection Switch Off	- Protection Mode	115°C typ.
Cooling System		Natural convection (20 LFM)
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	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 M $\Omega$ 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)

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

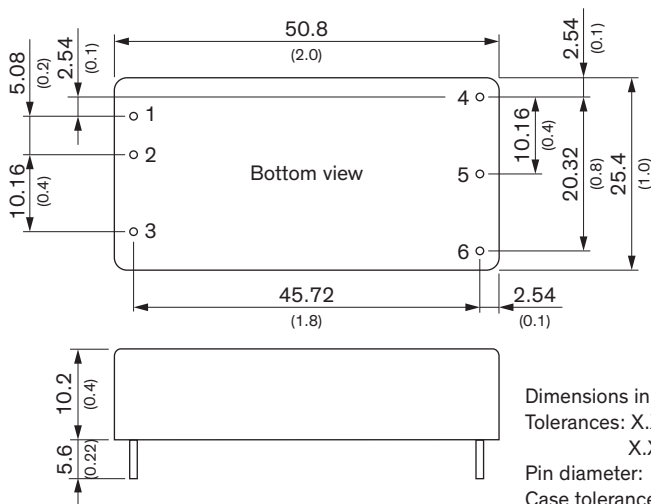
Washing Process		According to Cleaning Guideline <a href="http://www.tracopower.com/info/cleaning.pdf">www.tracopower.com/info/cleaning.pdf</a>
Environment	- Vibration - Thermal Shock	MIL-STD-810F MIL-STD-810F
Housing Material		Copper
Base Material		Non-conductive FR4 (UL 94 V-0 rated)
Potting Material		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		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) 8.3 K/W typ. (with heatsink TEN-HS8) 7.0 K/W typ. (with heatsink TEN-HS9) 5.7 K/W typ. (with heatsink TEN-HS10)
Environmental Compliance	- REACH Declaration  - RoHS Declaration	<a href="http://www.tracopower.com/info/reach-declaration.pdf">www.tracopower.com/info/reach-declaration.pdf</a> REACH SVHC list compliant REACH Annex XVII compliant <a href="http://www.tracopower.com/info/rohs-declaration.pdf">www.tracopower.com/info/rohs-declaration.pdf</a> 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/ten60win](http://www.tracopower.com/overview/ten60win)

### Outline Dimensions



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