

- **Highly cost efficient design**
- **Pin compatible with TO-220 package 78xx linear regulators**
- **Operation temperature range -40°C to +85°C without derating**
- **Efficiency up to 97%**
- **Wide input operating range 7-36 VDC**
- **Short circuit protection**
- **Excellent line / load regulation**
- **3-year product warranty**



The TSR 1.5E is a 1.5 Ampere step-down switching regulator series and a drop-in replacement for inefficient LM78xx linear regulators. This series comes in a compact SIP-3 open frame package and complements our existing POL portfolio with a series focusing strongly on a cost efficient design while maintaining our quality standards. There are 3 output voltages available: 3.3, 5.0 and 12V-DC. The effective design allows full load operation up to +85°C ambient temperature without the need of any heat sink or forced cooling. The TSR 1.5E switching regulators provide other significant features over linear regulators, i.e. better output accuracy, lower standby current and no requirement of external capacitors. The TSR 1.5E series offers a broad application range in many environments and is especially suited for high volume projects where the series will help to reduce production cost by delivering not only a highly cost efficient but also reliable solution.

### Models

Order Code	Output Current max.	Input Voltage Range	Output Voltage nom.	Efficiency typ.
TSR 1.5-2433E	1'500 mA	7 - 36 VDC (24 VDC nom.)	3.3 VDC	93 % (at Vin min.)
TSR 1.5-2450E			5 VDC	95 % (at Vin min.)
TSR 1.5-24120E	1'000 mA	15 - 36 VDC (24 VDC nom.)	12 VDC	97 % (at Vin min.)

Note - For input voltage higher 24 VDC an input capacitor of 22 µF is required

### Input Specifications

Input Current	- At no load	15 mA max.
Surge Voltage		40 VDC max. (1 s max.)
Input Inrush Current		70 A typ. (12 Vout model) 30 A typ. (other models)
Recommended Input Fuse		2'000 mA (fast acting) (The need of an external fuse has to be assessed in the final application.)
Input Filter		Internal Capacitor

### Output Specifications

Voltage Set Accuracy		±4% max. (at 50% load)
Regulation	- Input Variation (Vmin - Vmax) - Load Variation (25 - 100%)	0.7% max. 0.7% max.
Ripple and Noise (20 MHz Bandwidth)	3.3 Vout models: 5 Vout models: 12 Vout models:	40 mVp-p max. (w/ 47 µF) 75 mVp-p max. (w/ 47 µF) 75 mVp-p max. (w/ 47 µF)
Capacitive Load	3.3 Vout models: 5 Vout models: 12 Vout models:	1'200 µF max. 660 µF max. 470 µF max.
Minimum Load		Not required
Temperature Coefficient		±0.02 %/K max.
Hold-up Time		40 µs min. (3.3 Vout model) 160 µs min. (5 Vout model) 1'400 µs min. (12 Vout model)
Start-up Time		2.1 ms max.
Short Circuit Protection		Continuous, Automatic recovery
Output Current Limitation		200 - 500% of Iout max.
Transient Response	- Peak Variation	70 mV max. (50% to 100% Load Step) (3.3 Vout model) 90 mV max. (50% to 100% Load Step) (5 Vout model) 130 mV max. (50% to 100% Load Step) (12 Vout model)
	- Response Time	75 µs typ. (50% to 100% Load Step)

### 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/tsr1-5e">www.tracopower.com/overview/tsr1-5e</a>

### General Specifications

Relative Humidity		95% max. (non condensing)
Temperature Ranges	- Operating Temperature - Case Temperature - Storage Temperature	-40°C to +85°C +130°C max. -55°C to +125°C
Power Derating	- High Temperature	Depending on model See application note: <a href="http://www.tracopower.com/overview/tsr1-5e">www.tracopower.com/overview/tsr1-5e</a>
Over Temperature Protection Switch Off	- Protection Mode - Measurement Point	130°C to 140°C (Automatic recovery at 130°C typ.) Internal IC temperature
Cooling System		Natural convection (20 LFM)
Altitude During Operation		2'000 m max.

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

Regulator Topology	Buck Converter
Switching Frequency	320 - 500 kHz (PWM) 410 kHz typ. (PWM)
Insulation System	Non-isolated
Reliability - Calculated MTBF	16'000'000 h (12 Vout model) 6'800'000 h (other models) (MIL-HDBK-217F, ground benign)
Washing Process	Not allowed
Pin Material	Copper Alloy
Pin Foundation Plating	Nickel (0.5 µm min.)
Pin Surface Plating	Gold (10 nm min.), bright
Housing Type	Open Frame
Mounting Type	PCB Mount
Connection Type	THD (Through-Hole Device)
Footprint Type	SIP3
Soldering Profile	Lead-Free Wave Soldering 265 °C / 5 s max.
Weight	2 g
Thermal Impedance - Case to Ambient	60 K/W typ.
Environmental Compliance - REACH 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
- RoHS Declaration	<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))
- SCIP Reference Number	1eac0446-aaf9-4e48-a349-df18b8b203b0

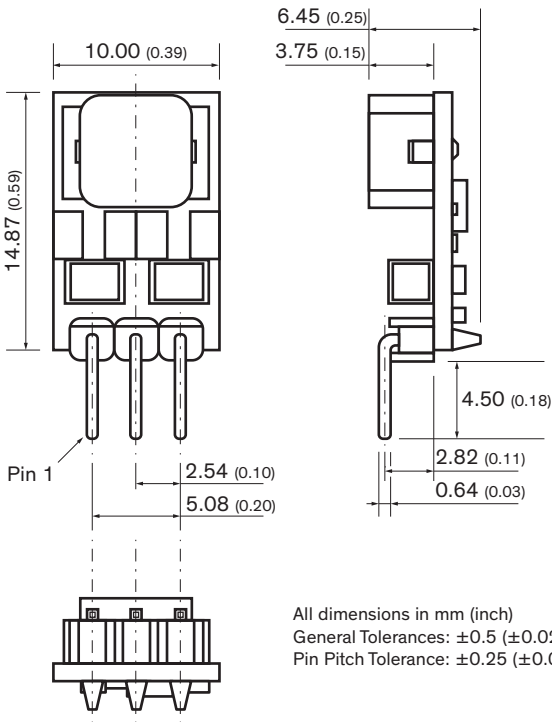
## Supporting Documents

Overview Link (for additional Documents)

[www.tracopower.com/overview/tsr1-5e](http://www.tracopower.com/overview/tsr1-5e)

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

**Outline Dimensions**



Pin Assignment	
Pin	Function
1	+ Vin
2	Common Ground
3	+ Vout