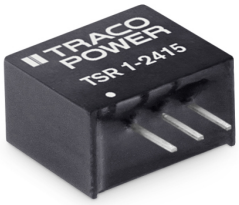
TRACO POWER

Non-Isolated DC/DC Converter (POL) — TSR 1 Series, 1 A

- **Up to 96% efficiency – No heat-sink required**
- **Pin compatible with LMxx linear regulators**
- **SIP-package fits existing TO-220 footprint**
- **Built in filter capacitors**
- **Operation temp. range –40°C to +85°C**
- **Short circuit protection**
- **Wide input operating range**
- **Excellent line / load regulation**
- **Low standby current**
- **3-year product warranty**



The TSR 1 series step-down switching regulators are drop-in replacement for inefficient 78xx linear regulators. A high efficiency up to 96% allows full load operation up to +60°C ambient temperature without the need of any heat-sink or forced cooling. The TSR 1 switching regulators provide other significant features over linear regulators, i.e. better output accuracy (±2%), lower standby current of 2 mA and no requirement of external capacitors. The high efficiency and low standby power consumption makes these regulators an ideal solution for many battery powered applications.

Models

Order Code	Output Current max.	Input Voltage Range	Output Voltage nom.	Efficiency typ.
TSR 1-2412	1'000 mA	4.6 - 36 VDC (9 VDC nom.)	1.2 VDC	74 % (at Vin min.)
TSR 1-2415			1.5 VDC	78 % (at Vin min.)
TSR 1-2418			1.8 VDC	82 % (at Vin min.)
TSR 1-2425			2.5 VDC	87 % (at Vin min.)
TSR 1-2433		4.75 - 36 VDC (9 VDC nom.)	3.3 VDC	91 % (at Vin min.)
TSR 1-2450		6.5 - 36 VDC (12 VDC nom.)	5 VDC	94 % (at Vin min.)
TSR 1-2465		9 - 36 VDC (12 VDC nom.)	6.5 VDC	93 % (at Vin min.)
TSR 1-2490		12 - 36 VDC (24 VDC nom.)	9 VDC	95 % (at Vin min.)
TSR 1-24120		15 - 36 VDC (24 VDC nom.)	12 VDC	95 % (at Vin min.)
TSR 1-24150		18 - 36 VDC (24 VDC nom.)	15 VDC	96 % (at Vin min.)

Note - For input voltage higher than 32 VDC an external input capacitor (22 µF) is required.

Input Specifications

Input Current	- At no load	9 Vin models:	1 mA typ.
		12 Vin models:	1 mA typ.
		24 Vin models:	1 mA typ.
	- At full load	9 Vin models:	1'000 mA max.
		12 Vin models:	1'000 mA max.
		24 Vin models:	1'000 mA max.
			(at Vin min.)
Reflected Ripple Current		9 Vin models:	150 mAp-p typ.
		12 Vin models:	150 mAp-p typ.
		24 Vin models:	150 mAp-p typ.
Recommended Input Fuse	- 9 Vin input	1.2 Vout models:	630 mA (slow blow)
		1.5 Vout models:	800 mA (slow blow)
		1.8 Vout models:	800 mA (slow blow)
		2.5 Vout models:	1'250 mA (slow blow)
		3.3 Vout models:	1'250 mA (slow blow)
	- 12 Vin input	5 Vout models:	1'600 mA (slow blow)
		6.5 Vout models:	1'250 mA (slow blow)
	- 24 Vin input	9 Vout models:	1'250 mA (slow blow)
		12 Vout models:	1'600 mA (slow blow)
		15 Vout models:	1'600 mA (slow blow)
			(The need of an external fuse has to be assessed in the final application.)
Input Filter			Internal Capacitor

Output Specifications

Voltage Set Accuracy			±2% max.
Regulation	- Input Variation (Vmin - Vmax)		0.2% max.
	- Load Variation (10 - 100%)		0.6% max. (1.2 & 1.5 Vout models)
			0.4% max. (other models)
Ripple and Noise (20 MHz Bandwidth)		1.2 Vout models:	50 mVp-p typ.
		1.5 Vout models:	50 mVp-p typ.
		1.8 Vout models:	50 mVp-p typ.
		2.5 Vout models:	50 mVp-p typ.
		3.3 Vout models:	50 mVp-p typ.
		5 Vout models:	50 mVp-p typ.
		6.5 Vout models:	50 mVp-p typ.
		9 Vout models:	75 mVp-p typ.
		12 Vout models:	75 mVp-p typ.
		15 Vout models:	75 mVp-p typ.
Capacitive Load			470 µF max.
Minimum Load			Not required
Temperature Coefficient			±0.015 %/K max.
Start-up Overshoot Voltage			1% max.
Short Circuit Protection			Continuous, Automatic recovery
Output Current Limitation			250% typ. of Iout max.
Transient Response	- Peak Variation		150 mV typ. / 200 mV max. (50% Load Step)
	- Response Time		250 µs typ. / 350 µs max. (50% Load Step)

EMC Specifications

EMI Emissions	- Conducted Emissions		EN 55032 class A (with external filter)
	- Radiated Emissions		EN 55032 class A (with external filter)
		External filter proposal:	www.tracopower.com/overview/tsr1

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

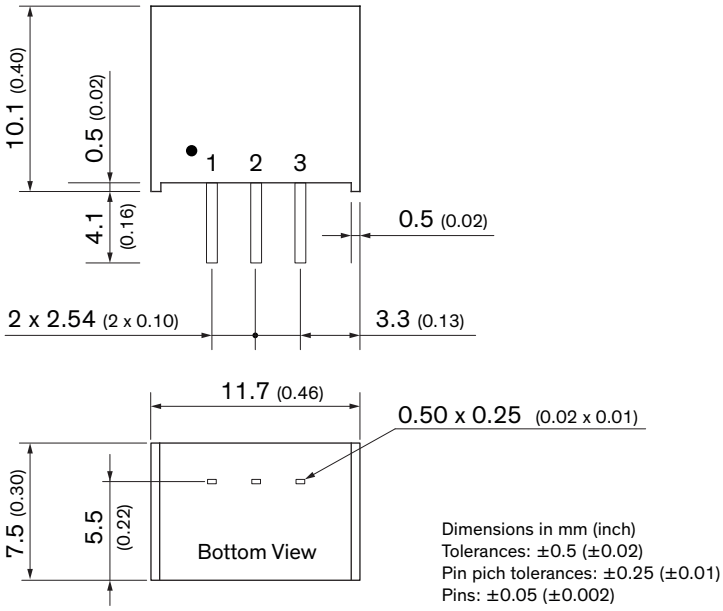
General Specifications

Relative Humidity		95% max. (non condensing)
Temperature Ranges	- Operating Temperature	–40°C to +85°C
	- Storage Temperature	–55°C to +125°C
Power Derating	- High Temperature	2.4 %/K above 60°C
Over Temperature Protection Switch Off	- Protection Mode	150°C typ. (Automatic recovery)
	- Measurement Point	Internal IC temperature
Cooling System		Natural convection (20 LFM)
Switching Frequency		400 - 600 kHz (PWM)
		500 kHz typ. (PWM)
Insulation System		Non-isolated
Reliability	- Calculated MTBF	25'710'000 h (MIL-HDBK-217F, ground benign)
Environment	- Vibration	MIL-STD-810F
	- Thermal Shock	MIL-STD-810F
Housing Material		Non-conductive Plastic (UL94 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
Soldering Profile		265°C / 10 s max.
Connection Type		THD (Through-Hole Device)
Weight		1.9 g
Environmental Compliance	- Reach	www.tracopower.com/info/reach-declaration.pdf
	- RoHS	www.tracopower.com/info/rohs-declaration.pdf

Supporting Documents

Overview Link (for additional Documents)	www.tracopower.com/overview/tsr1

Outline Dimensions



Dimensions in mm (inch)
Tolerances: ±0.5 (±0.02)
Pin pich tolerances: ±0.25 (±0.01)
Pins: ±0.05 (±0.002)

Pinout

Pin	Function
1	+Vin
2	GND
3	+Vout

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TRACO Power:

TSR 1-2415 TSR 1-2465 TSR 1-2433 TSR 1-24120 TSR 1-2450 TSR 1-2490 TSR 1-24150 TSR 1-2412 TSR 1-2418 TSR 1-2425