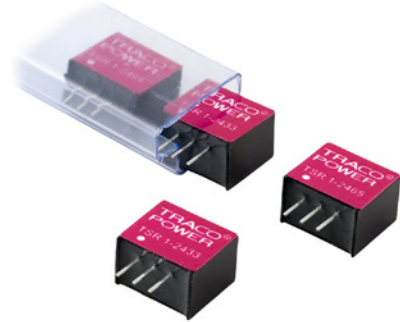


### Features

- ◆ 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  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- ◆ Short circuit protection
- ◆ Wide input operating range
- ◆ Excellent line / load regulation
- ◆ Low standby current
- ◆ 3-year product warranty



The new 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  $+60^{\circ}\text{C}$  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 ( $\pm 2\%$ ), 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	Input voltage range	Output voltage	Output current max.	Efficiency typ.	
				@ Vin min.	@ Vin max.
TSR 1-2412	4.6 – 36 VDC*	1.2 VDC	1.0 A	74 %	62 %
TSR 1-2415	4.6 – 36 VDC*	1.5 VDC		78 %	65 %
TSR 1-2418	4.6 – 36 VDC*	1.8 VDC		82 %	69 %
TSR 1-2425	4.6 – 36 VDC*	2.5 VDC		87 %	75 %
TSR 1-2433	4.75 – 36 VDC*	3.3 VDC		91 %	78 %
TSR 1-2450	6.5 – 36 VDC*	5.0 VDC		94 %	84 %
TSR 1-2465	9.0 – 36 VDC*	6.5 VDC		93 %	87 %
TSR 1-2490	12 – 36 VDC*	9.0 VDC		95 %	90 %
TSR 1-24120	15 – 36 VDC*	12 VDC		95 %	92 %
TSR 1-24150	18 – 36 VDC*	15 VDC		96 %	94 %

\* For input voltage higher than 32 VDC an input capacitor 22  $\mu\text{F}$  / 50 V is required. See application notes (page 3)

### Input Specifications

Maximum input current (at $V_{in}$ min. and 1 A output current)	1 A
No load input current	1 mA typ.
Reflected ripple current	150 mA
Input filter	internal capacitors, see application notes for to meet EN55022 class A

### Output Specifications

Voltage set accuracy	$\pm 2\%$ (at full load)
Regulation	<ul style="list-style-type: none"> <li>- Input variation 0.2 %</li> <li>- Load variation (10 – 100 %) 1.2 &amp; 1.5 VDC models: 0.6 %</li> <li style="padding-left: 100px;">other models: 0.4 %</li> </ul>
Overshoot startup voltage	1.0 % max.
Minimum load	not required
Ripple and noise (20 MHz Bandwidth)	<ul style="list-style-type: none"> <li>1.2 – 6.5 VDC models: 50 mV max.</li> <li>9 – 15 VDC models: 75 mV max.</li> </ul>
Temperature coefficient	$\pm 0.015\%$ / °C max.
Dynamic load response 50% load change (upper half)	150 mV max. peak variation 250 $\mu$ S max. response time
Startup rise time 10 % to 90 % $V_{out}$	2 mS
Short circuit protection	continuous, automatic recovery
Current limitation	at 2.5 A typ.
Capacitive load	470 $\mu$ F max.

### General Specifications

Temperature ranges	<ul style="list-style-type: none"> <li>- Operating <math>-40^{\circ}\text{C}</math> to <math>+85^{\circ}\text{C}</math> (<math>-40^{\circ}\text{F}</math> to <math>+185^{\circ}\text{F}</math>)</li> <li>- Storage <math>-55^{\circ}\text{C}</math> to <math>+125^{\circ}\text{C}</math> (<math>-67^{\circ}\text{F}</math> to <math>+257^{\circ}\text{F}</math>)</li> </ul>
Derating	2.4 %/K above $60^{\circ}\text{C}$
Thermal shock	acc. MIL-STD-810F
Humidity (non condensing)	95 % rel H max.
Reliability, calculated MTBF (MIL-HDBK-217F, at $+25^{\circ}\text{C}$ , ground benign)	$>5'350'000$ h
Isolation voltage	none
Switching frequency	500 kHz $\pm 10\%$ (pulse width modulation)
Environmental compliance	<ul style="list-style-type: none"> <li>- Reach <a href="http://www.tracopower.com/products/reach-declaration.pdf">www.tracopower.com/products/reach-declaration.pdf</a></li> <li>- RoHS RoHS directive 2011/65/EU</li> </ul>

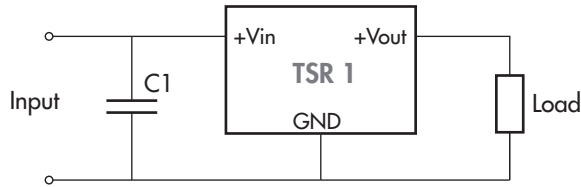
### Physical Specifications

Casing material	non-conductive plastic
Potting material	silicon (flammability to UL 94V-0 rated)
Package weight	1.9 g (0.07 oz)
Soldering profile	max. $265^{\circ}\text{C}$ / 10 sec. (wave soldering)

All specifications valid at nominal input voltage, full load and  $+25^{\circ}\text{C}$  after warm-up time unless otherwise stated.

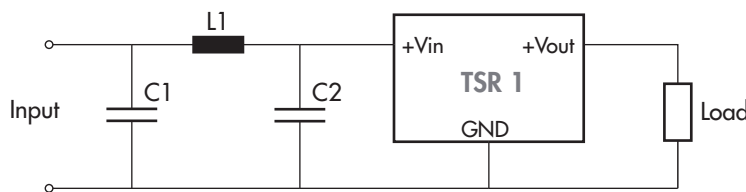
**Applications notes**

For input voltage higher than 32 VDC (max. 36 VDC)



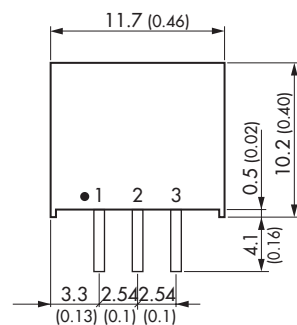
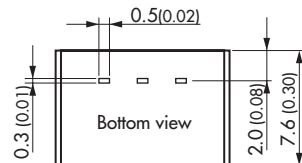
C1 = 22  $\mu$ F / 50 V

Input filter to meet EN 55022 class A



C1 = 4.7  $\mu$ F / 50 V  
C2 = 4.7  $\mu$ F / 50 V  
L1 = 8.2  $\mu$ H / 1.5 A / 0.08 Ohm

**Outline Dimensions**



**Pin-Out**

<b>1</b>	+Vin
<b>2</b>	GND
<b>3</b>	+Vout

Dimensions in [mm], ( ) = Inch  
Pin pitch tolerances:  $\pm 0.25$  ( $\pm 0.01$ )  
Pin profile tolerance:  $\pm 0.1$  ( $\pm 0.004$ )  
Other tolerances:  $\pm 0.5$  ( $\pm 0.02$ )

Specifications can be changed without notice! Make sure you are using the latest documentation, downloadable at [www.tracopower.com](http://www.tracopower.com)