

- 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 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 mAp-p
Input filter	internal capacitors see application notes (page 3) to meet EN55032 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>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	$\pm 0.015\%/K$ 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></li> <li>- Storage: <math>-55^{\circ}\text{C}</math> to <math>+125^{\circ}\text{C}</math></li> </ul>
Derating	2.4 %/K above $60^{\circ}\text{C}$
Thermal shock and vibration	acc. MIL-STD-810F
Humidity (non condensing)	95 % rel H max.
Reliability, calculated MTBF (MIL-HDBK-217F, at $+25^{\circ}\text{C}$ , ground benign)	$>25'710'000$ h
Isolation voltage	none
Switching frequency	400 – 500 kHz (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>

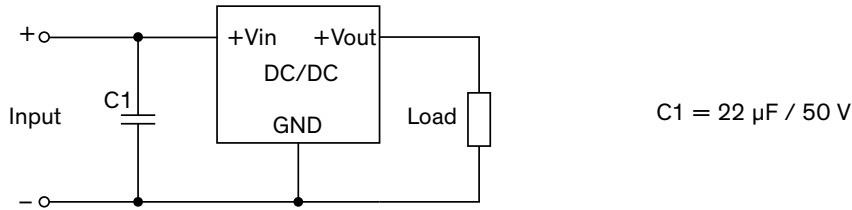
### Physical Specifications

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)

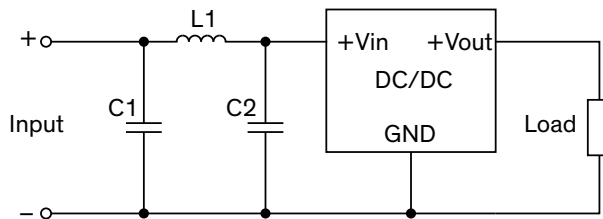
All specifications valid at nominal input voltage, full load and  $+25^{\circ}\text{C}$  after warm-up time unless otherwise stated.

### Applications notes

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

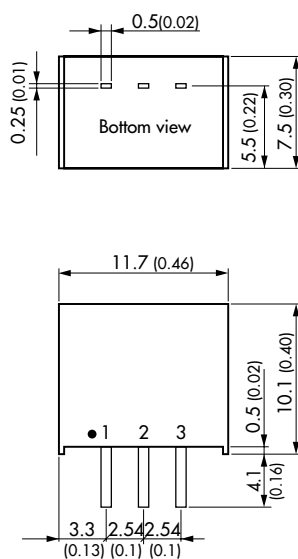


Suggested filter to comply with EN55032 Class A limits



Models	C1 & C2	L1	inductor (accessory)	
			order code	datasheet
all models	10 $\mu\text{F}$ / 50 V 1206 MLCC	5.6 $\mu\text{H}$ / 3.5 A	<b>TCK-141</b>	<a href="http://www.tracopower.com/products/tck141.pdf">www.tracopower.com/products/tck141.pdf</a>

### Outline Dimensions



#### Pin-Out

1	+Vin
2	GND
3	+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:  $\pm 0.5$  ( $\pm 0.02$ )