

- SMD-package
- Up to 96% efficiency
- No thermal layer required
- 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-1SM series models of step-down switching regulators have a high efficiency up to 96% which allows full load operation up to  $+65^{\circ}\text{C}$  ambient temperature without the need of any heat transmission layer. Excellent output voltage accuracy ( $\pm 2\%$ ) and low standby current ( $\sim 1\text{ mA}$ ) are features that distinguish these switching regulators from linear regulators.

Models					
Order Code	Output Current max.	Input Voltage Range	Output Voltage nom.	Efficiency typ.	
TSR 1-0512SM	1'000 mA	3 - 5.5 VDC (5 VDC nom.)	1.2 VDC	91 % (at Vin min.)	
TSR 1-0515SM			1.5 VDC	92 % (at Vin min.)	
TSR 1-0518SM		3.8 - 5.5 VDC (5 VDC nom.)	1.8 VDC	93 % (at Vin min.)	
TSR 1-0525SM			2.5 VDC	95 % (at Vin min.)	
TSR 1-2412SM		4.6 - 36 VDC (12 VDC nom.)	1.2 VDC	74 % (at Vin min.)	
TSR 1-2415SM			1.5 VDC	79 % (at Vin min.)	
TSR 1-2418SM			1.8 VDC	82 % (at Vin min.)	
TSR 1-2425SM			2.5 VDC	87 % (at Vin min.)	
TSR 1-2433SM			4.75 - 36 VDC (12 VDC nom.)	3.3 VDC	91 % (at Vin min.)
TSR 1-2450SM			6.5 - 36 VDC (12 VDC nom.)	5 VDC	94 % (at Vin min.)
TSR 1-2465SM			9 - 36 VDC (12 VDC nom.)	6.5 VDC	94 % (at Vin min.)
TSR 1-2490SM			12 - 36 VDC (24 VDC nom.)	9 VDC	95 % (at Vin min.)
TSR 1-24120SM		15 - 36 VDC (24 VDC nom.)	12 VDC	95 % (at Vin min.)	
TSR 1-24150SM		18 - 36 VDC (24 VDC nom.)	15 VDC	96 % (at Vin min.)	

### Input Specifications

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

### Output Specifications

Voltage Set Accuracy		<b>±2% max.</b>
Regulation	- Input Variation (Vmin - Vmax)	<b>0.2% max.</b>
	- Load Variation (0 - 100%)	<b>0.6% max.</b>
Ripple and Noise (20 MHz Bandwidth)		5 Vin models: <b>50 mVp-p typ.</b> 12 Vin models: <b>50 mVp-p typ.</b> 24 Vin models: <b>75 mVp-p typ.</b>
Capacitive Load		<b>470 µF max.</b>
Minimum Load		<b>Not required</b>
Temperature Coefficient		<b>±0.015 %/K max.</b>
Start-up Time		<b>5 ms typ.</b>
Short Circuit Protection		<b>Continuous, Automatic recovery</b>
Output Current Limitation		<b>480% typ. of Iout max. (5 Vin models)</b> <b>250% typ. (other models)</b>
Transient Response	- Peak Variation	<b>200 mV typ. / 400 mV max. (50% Load Step)</b>
	- Response Time	<b>250 µs typ. / 350 µs max. (50% Load Step)</b>

### Safety Specifications

Over Voltage Category	<b>Not mains connected</b>
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### EMC Specifications

EMI (Emissions)	- Conducted Emissions	<b>EN 55032 class A</b> (with external filter) <b>EN 55032 class B</b> (with external filter)
	- Radiated Emissions	<b>EN 55032 class A</b> (with external filter) <b>EN 55032 class B</b> (with external filter)
	External filter proposal:	<a href="http://www.tracopower.com/tsr1sm-emc-filter">www.tracopower.com/tsr1sm-emc-filter</a>

### General Specifications

Relative Humidity		<b>95% max. (non condensing)</b>
Temperature Ranges	- Operating Temperature	<b>-40°C to +85°C</b>
	- Case Temperature	<b>+105°C max.</b>
	- Storage Temperature	<b>-55°C to +125°C</b>

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

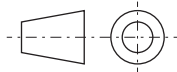
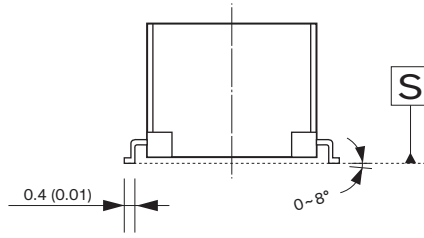
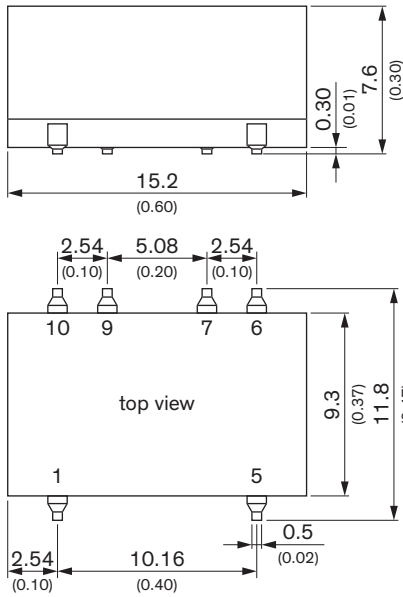
Power Derating	- High Temperature	2.5 %/K above 65°C
		See application note: <a href="http://www.tracopower.com/tsr1sm-cc">www.tracopower.com/tsr1sm-cc</a>
Over Temperature Protection Switch Off	- Protection Mode - Measurement Point	150°C typ. (Automatic recovery) Internal IC temperature
Cooling System		Natural convection (20 LFM)
Regulator Topology		Buck Converter
Switching Frequency		1200 kHz typ. (PWM) (5 Vin models) 500 kHz typ. (PWM) (other models)
Insulation System		Non-isolated
Reliability	- Calculated MTBF	12'000'000 h (MIL-HDBK-217F, ground benign)
Moisture Sensitivity (MSL)		Level 1 (J-STD-033C)
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		Non-conductive Plastic (UL 94 V-0 rated)
Base Material		Non-conductive Plastic (UL 94 V-0 rated)
Potting Material		Epoxy (UL 94 V-0 rated) (Converter halfway potted on top of the PCB, not visible through vent hole)
Pin Material		Copper
Pin Foundation Plating		Nickel (2 - 3 µm)
Pin Surface Plating		Tin (3 - 5 µm), matte
Housing Type		Plastic Case
Mounting Type		PCB Mount
Connection Type		SMD (Surface-Mount Device)
Footprint Type		SMD10
Soldering Profile		Lead-Free Reflow Soldering (acc. J-STD-020E) 245°C max. (Tc) 30 s max. (tp, at Tp - 5°C) 65 s max. (tL, time above 217°C)
		See application note: <a href="http://www.tracopower.com/info/reflow-soldering.pdf">www.tracopower.com/info/reflow-soldering.pdf</a>
Weight		1.7 g
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: 7(a), 7(c)-I (RoHS exemptions refer to the component concentration only, not to the overall concentration in the product (O5A rule).)
	- SCIP Reference Number	88c49d6d-d291-4109-a33e-aaca264fda7b

### Additional Information

Supporting Documents	<a href="http://www.tracopower.com/overview/tsr1sm">www.tracopower.com/overview/tsr1sm</a>
Frequently Asked Questions	<a href="http://www.tracopower.com/glossary-faq">www.tracopower.com/glossary-faq</a>
Glossary	<a href="http://www.tracopower.com/info/glossary.pdf">www.tracopower.com/info/glossary.pdf</a>
Service Portal	<a href="http://www.tracoserviceportal.com">www.tracoserviceportal.com</a>

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

**Outline Dimensions**



Dimensions in mm (inch)  
 Tolerances: x.xx ±0.5 (x.x ±0.02)  
 Tolerances: x.xxx ±0.25 (x.xx ±0.01)  
 Pin pitch tolerances: ±0.25 (±0.01)  
 Pin dimension tolerances: ±0.1 (±0.004)

Pinout	
Pin	Function
1	+Vin
5	+Vout
6	NC
7	GND
9	GND
10	NC

NC: Not connected

**Recommended Solder Pad Layout**

