

#### Features

- ◆ Compact SMD package
- ◆ Suitable for positive & negative output circuit
- ◆ Adjustable output voltage
- ◆ Wide input up to 42 VDC
- ◆ Remote On/Off input
- ◆ Built in filter capacitors
- ◆ Operation temp. range  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- ◆ No heat-sink required
- ◆ Excellent line / load regulation
- ◆ Low standby current
- ◆ Moisture sensitivity level (MSL) 1
- ◆ 3-year product warranty



The new TSRN-1SM series are step-down non-isolated switching regulators in compact SMD package. They are an ideal solution to replace inefficient linear regulators. The high efficiency up to 95 % allows full load operation up to  $+55^{\circ}\text{C}$  ( $+85^{\circ}\text{C}$  with derating) ambient temperature without the need of forced aircooling.

The TSRN-1SM switching regulators provide other significant features over linear regulators, i.e. better output accuracy ( $\pm 2\%$ ), lower standby current of  $\sim 4\text{ mA}$  and no requirement of external capacitors. They are suitable for positive or negative output circuits and offer a trim input for output voltage adjustment. The high efficiency, low standby power consumption and remote On/Off function make these regulators an ideal solution for energy sensitive applications.

#### Models

Order code <sup>1)</sup>	Input voltage range <sup>2)</sup> / (nominal)	Output voltage		Output current max.	Efficiency typ.	
		nominal	trim range <sup>3)</sup>		@ Vin min.	@ Vin 36VDC
Positive output circuit						
TSRN 1-0525SM	3.0 – 5.5 VDC (5 VDC)	2.5 VDC	1.2 – 3.6 VDC	1.0 A	95.5 %	95 % (at 5.5VDC)
TSRN 1-2433SM	4.6 – 42 VDC (12 VDC)	3.3 VDC	1.5 – 5.5 VDC		87.5 %	80 %
TSRN 1-2450SM	6.5 – 42 VDC (12 VDC)	5.0 VDC	2.5 – 8.0 VDC		91.5 %	83.5 %
TSRN 1-2490SM	10.5 – 42 VDC (12 VDC)	9.0 VDC	4.5 – 12.6 VDC		94.5 %	89 %
TSRN 1-24120SM	13.5 – 42 VDC (24 VDC)	12 VDC	4.5 – 13.5 VDC		95.0 %	91 %
TSRN 1-24150SM	16.5 – 42 VDC (24 VDC)	15 VDC	4.5 – 15.5 VDC		95.5 %	92.5 %
Negative output circuit						
TSRN 1-2433SM	4.6 – 32 VDC (12 VDC)	-3.3 VDC	-1.5 – -5.5 VDC	0.6 A	74 %	77.5 %
TSRN 1-2450SM	4.6 – 31 VDC (12 VDC)	-5.0 VDC	-2.5 – -8.0 VDC	0.4 A	80 %	78.5 %
TSRN 1-2490SM	7 – 27 VDC (12 VDC)	-9.0 VDC	-4.5 – -12.6 VDC	0.3 A	85 %	82 %
TSRN 1-24120SM	7 – 24 VDC (12 VDC)	-12 VDC	-4.5 – -13.5 VDC	0.3 A	84.5 %	86 %
TSRN 1-24150SM	7 – 21 VDC (12 VDC)	-15 VDC	-4.5 – -15.5 VDC	0.2 A	85.5 %	84 %

1) Same order code for positive and negative output operation, see page 3 for circuits.

2) For input voltage higher 36 VDC an input capacitor 22  $\mu\text{F}$ / 50 V is required.

3) For positive output circuit, input voltage must be higher than output voltage set:  $>0.5\text{ V}$  for TSRN1-0525SM and  $>1.5\text{ V}$  for other models.  
For negative output circuit, input voltage plus absolute output voltage set must not exceed 36 VDC ( $V_{in} + |V_{out}| < 36\text{ VDC}$ )

### Input Specifications

No load input current	– positive output circuit	TSRN 1-0525SM: 6 mA typ. TSRN 1-2433SM: 1.5 mA typ. TSRN 1-2450SM: 3 mA typ. other models: 4 mA typ.
	– negative output circuit	-3.3 / -5.5 Vout models: 3 mA typ. -9.0 / -12 Vout models: 7 mA typ. TSRN 1-24150SM: 10 mA typ.
Reflected ripple current		100 mA <sub>p-p</sub> typ.
Input filter		internal capacitors

### Output Specifications

Voltage set accuracy		±2 % (at full load)
Regulation	– Input variation	0.2 %
	– Load variation 0 – 100 %	0.6 %
	– Load variation 10 – 90 %	0.3 %
Temperature coefficient		±0.015 %/K max.
Startup voltage overshoot		1.0 % max.
Minimum load		not required
Ripple and noise (20 MHz Bandwidth)	–  Vout  = 1.2V – 8V	50 mV <sub>p-p</sub> max.
	–  Vout  = 8.1V – 15.5V	75 mV <sub>p-p</sub> max.
Dynamic load response (change of 50% to 100% load)		150 mV typ. peak variation 250 μs typ. response time
Startup time	– start up time at nominal Vin, constant resistive load	5 ms typ.
Short circuit protection		continuous, automatic recovery
Capacitive load		470 μF max.

### General Specifications

Temperature ranges	– Operating	–40°C to +85°C
	– case temperature	+100°C. max.
	– Storage	–55°C to +125°C
Derating	– positive output circuit	1.7 %/K above +55°C
	– negative output circuit	2.5 %/K above +65°C
Thermal shock, mechanical shock & vibration	– Test conditions	EN 61373, MIL-STD-810F <a href="http://www.tracopower.com/products/mil810.pdf">www.tracopower.com/products/mil810.pdf</a>
Overtemperature protection		at +170°C (on internal IC)
Humidity (non condensing)		5 to 95 % rel. H max.
Reliability, calculated MTBF (MIL-HDBK-217F, at +25°C, ground benign)		>14'000'000 h
Isolation voltage		none
Switching frequency	TSRN 1-0525SM:	410 kHz typ.
	TSRN 1-2433SM:	300 kHz typ.
	other models:	580 kHz typ.
Safety standards (designed to meet)		UL/cUL 60950-1, IEC/EN 60950-1
Remote On/Off	– Control pin reference for positive output circuit	GND
	– Control pin reference for negative output circuit	-Vout
	– On:	2 – 5 VDC or open circuit.
	– Off:	0 – 0.8 VDC or short circuit
	– Off idle current:	1.2 mA typ.
Environmental compliance	– Reach – RoHS	<a href="http://www.tracopower.com/info/reach-declaration.pdf">www.tracopower.com/info/reach-declaration.pdf</a> RoHS directive 2011/65/EU

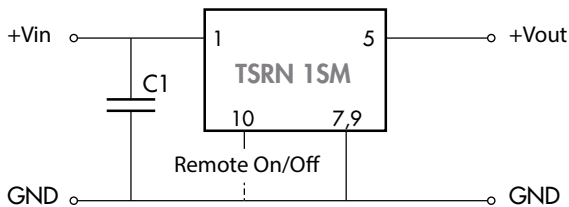
All specifications valid at nominal input voltage, full load and +25°C after warm-up time unless otherwise stated.

**Physical Specifications**

Casing material	non-conductive plastic (UL94V-0 rated)
Potting material	epoxy, (UL 94V-0 rated)
Weight	1.7 g (0.06 oz)
Lead-free reflow solder process – max. peak body temperature	as per J-STD-020D.01 245°C
Moisture sensitivity level (MSL)	level 1 as per IPC J-STD-033B.1
Washing	baking after washing: 100°C for 30 min.

**Applications notes**

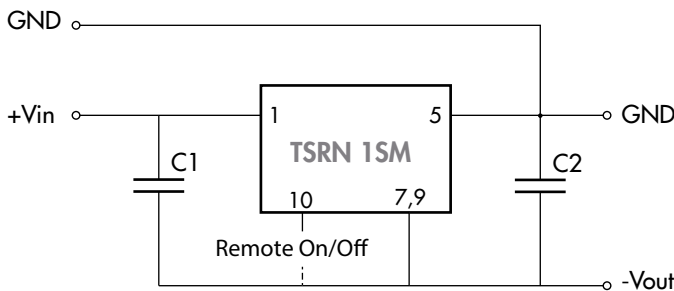
Positive output operation:



C1 = 22 µF / 50 V (required only if input voltage is higher than 36 V)

(Open Remote On/Off input = On)

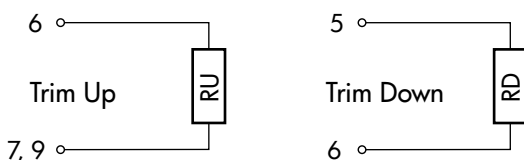
Negative output operation (not for model TSRN 1-0525SM):



C1 = 10 µF / 50 V, 1210 X5R MLCC  
C2 = 10 µF / 25 V, 1206 X5R MLCC

(Open Remote On/Off input = On)

Output voltage adjustment:



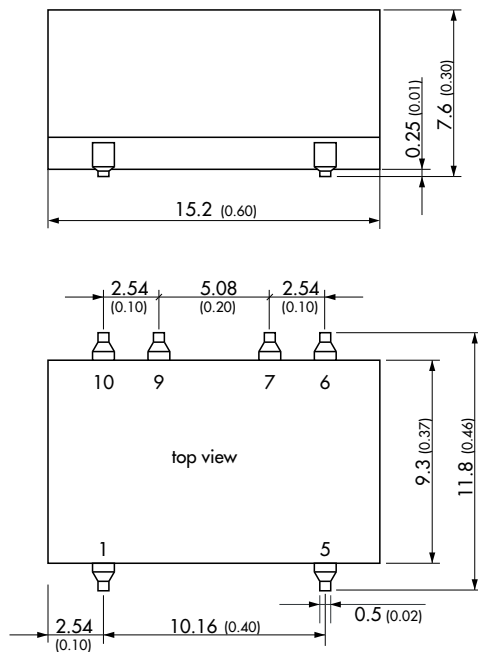
Model	RU [KOhm]	RD [KOhm]
TSRN 1-0525SM	$40.75 / (V_o - 2.5)$	$(V_o \cdot 50.75 - 40.75) / (2.5 - V_o)$
TSRN 1-2433SM	$26.4 / (V_o - 3.3)$	$(V_o \cdot 33 - 26.4) / (3.3 - V_o)$
TSRN 1-2450SM	$160 / (V_o - 5)$	$(V_o \cdot 200 - 160) / (5 - V_o)$
TSRN 1-2490SM	$80 / (V_o - 9)$	$(V_o \cdot 100 - 80) / (9 - V_o)$
TSRN 1-24120SM	$240 / (V_o - 12)$	$(V_o \cdot 300 - 240) / (12 - V_o)$
TSRN 1-24150SM	$240 / (V_o - 15)$	$(V_o \cdot 300 - 240) / (15 - V_o)$

$V_o$  = output voltage to be adjusted.

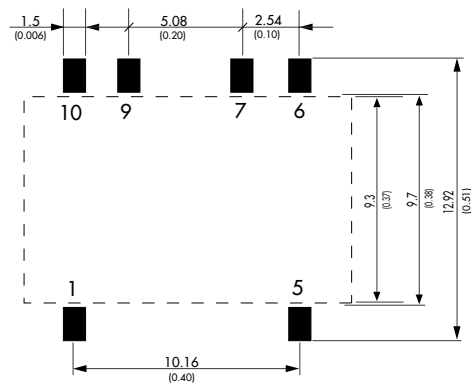
Calculate with absolute values for negative output circuit

Open Trim = nominal output voltage

**Outline Dimensions**



Solder Pad Dimension



Pin-Out		
Pin	pos.	neg.
1	+Vin	+Vin
5	+Vout	GND
6	Trim	
7	GND	-Vout
9	GND	-Vout
10	Remote On/Off	

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