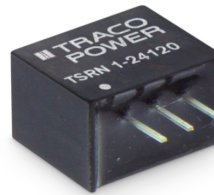


- SIP-package fits existing TO-220 footprint
- Suitable for positive & negative output circuit
- Pin compatible with LMxx linear regulators
- Built in filter capacitors
- Operation temp. range  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- No heat-sink required
- Over-temperature & short circuit protection
- Wide input range up to 36 VDC
- Excellent line/load regulation
- 3-year product warranty



The new TSRN-1 series step-down switching regulators are drop-in replacement for inefficient 78xx linear regulators. A high efficiency up to 95% allows full load operation up to  $+70^{\circ}\text{C}$  ( $+85^{\circ}\text{C}$  with derating) ambient temperature without the need of any heat-sink or forced air cooling.

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

### Models

Order Code	Output Current max.	Input Voltage Range	Output Voltage nom.	Efficiency typ.
TSRN 1-2415	1'000 mA	4.6 - 36 VDC (12 VDC nom.)	1.5 VDC	77 % (at $V_{in}$ min.)
TSRN 1-2418			1.8 VDC	81 % (at $V_{in}$ min.)
TSRN 1-2425			2.5 VDC	84 % (at $V_{in}$ min.)
TSRN 1-2433			3.3 VDC	88 % (at $V_{in}$ min.)
TSRN 1-2450		6.5 - 36 VDC (12 VDC nom.)	5 VDC	92 % (at $V_{in}$ min.)
TSRN 1-2465		8 - 36 VDC (12 VDC nom.)	6.5 VDC	93 % (at $V_{in}$ min.)
TSRN 1-2490		10.5 - 36 VDC (12 VDC nom.)	9 VDC	95 % (at $V_{in}$ min.)
TSRN 1-24120		13.5 - 36 VDC (24 VDC nom.)	12 VDC	95 % (at $V_{in}$ min.)
TSRN 1-24150	16.5 - 36 VDC (24 VDC nom.)	15 VDC	96 % (at $V_{in}$ min.)	

### Options

Suffix A	- Models with angular pin version (see outline dimensions)
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Note - For external circuit proposal for negative output voltage, refer to application note

### Input Specifications

Input Current	- At no load	12 Vin models: <b>2 mA typ.</b> 24 Vin models: <b>3 mA typ.</b>
Reflected Ripple Current		12 Vin models: <b>100 mAp-p typ.</b> 24 Vin models: <b>100 mAp-p typ.</b>
Recommended Input Fuse		12 Vin models: <b>2'000 mA (slow blow)</b> 24 Vin models: <b>2'000 mA (slow blow)</b> (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) - Load Variation (10 - 100%)	<b>0.2% max.</b> <b>0.6% max.</b> (1.5 Vout models, straight pin vers.) <b>1.2% max.</b> (1.5 Vout models, angular pin vers.) <b>0.4% max.</b> (1.8 Vout models, straight pin vers.) <b>1.2% max.</b> (1.8 Vout models, angular pin vers.) <b>0.4% max.</b> (other output models, both pin vers.)
Ripple and Noise (20 MHz Bandwidth)		1.5 Vout models: <b>50 mVp-p max.</b> 1.8 Vout models: <b>50 mVp-p max.</b> 2.5 Vout models: <b>50 mVp-p max.</b> 3.3 Vout models: <b>50 mVp-p max.</b> 5 Vout models: <b>50 mVp-p max.</b> 6.5 Vout models: <b>50 mVp-p max.</b> 9 Vout models: <b>75 mVp-p max.</b> 12 Vout models: <b>75 mVp-p max.</b> 15 Vout models: <b>75 mVp-p max.</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>
Start-up Overshoot Voltage		<b>1% max.</b>
Short Circuit Protection		<b>Continuous, Automatic recovery</b>
Output Current Limitation		<b>200% typ. of Iout max.</b>
Transient Response	- Peak Variation - Response Time	<b>150 mV typ. / 250 mV max. (50% Load Step)</b> <b>250 µs typ. / 350 µs max. (50% Load Step)</b>

### General Specifications

Relative Humidity		<b>95% max. (non condensing)</b>
Temperature Ranges	- Operating Temperature - Case Temperature - Storage Temperature	<b>-40°C to +85°C</b> <b>+100°C max.</b> <b>-55°C to +125°C</b>
Power Derating	- High Temperature	<b>2.86 %/K above 65°C</b>
Over Temperature Protection Switch Off	- Protection Mode - Measurement Point	<b>170°C typ. (Automatic recovery)</b> <b>Internal IC temperature</b>
Cooling System		<b>Natural convection (20 LFM)</b>
Switching Frequency		<b>240 - 360 kHz (PWM) (1.5 - 3.3 Vout models)</b> <b>464 - 696 kHz (PWM) (5 - 15 Vout models)</b>
Insulation System		<b>Non-isolated</b>
Reliability	- Calculated MTBF	<b>20'000'000 h (MIL-HDBK-217F, ground benign)</b>

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

Environment	- Vibration - Mechanical Shock - Thermal Shock	MIL-STD-810F EN 61373 MIL-STD-810F EN 61373 MIL-STD-810F EN 61373
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 $\mu\text{m}$ )
Pin Surface Plating		Tin (3 - 5 $\mu\text{m}$ ), matte
Soldering Profile		Wave Soldering 265°C / 10 s max.
Connection Type		THD (Through-Hole Device)
Weight		1.9 g
Environmental Compliance	- Reach - RoHS	<a href="http://www.tracopower.com/info/reach-declaration.pdf">www.tracopower.com/info/reach-declaration.pdf</a> <a href="http://www.tracopower.com/info/rohs-declaration.pdf">www.tracopower.com/info/rohs-declaration.pdf</a>

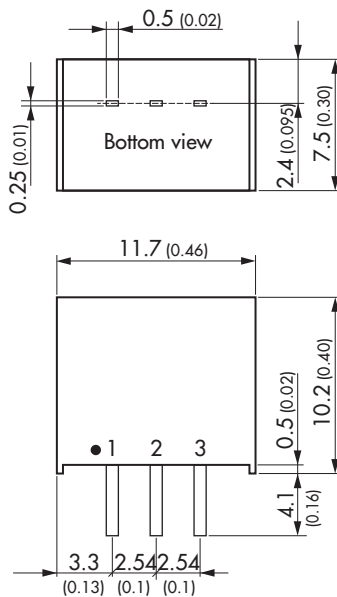
### Supporting Documents

Overview Link (for additional Documents)

[www.tracopower.com/overview/tsrn1](http://www.tracopower.com/overview/tsrn1)

### Outline Dimensions

#### Straight pin version (Standard)

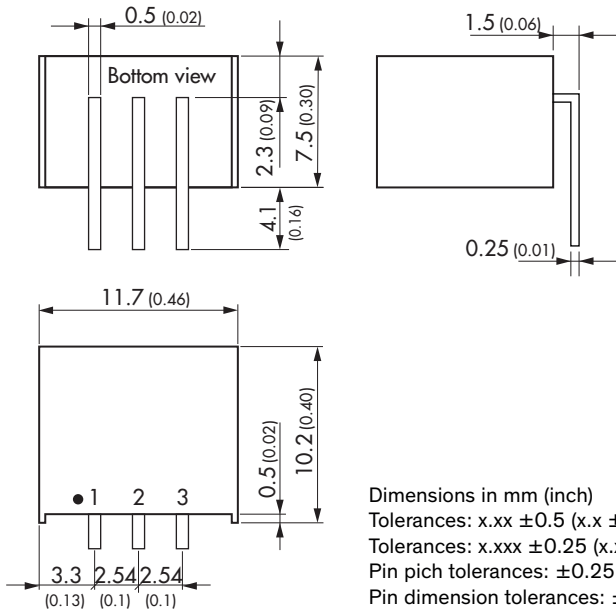


Dimensions in mm (inch)  
Tolerances: x.xx  $\pm$ 0.5 (x.x  $\pm$ 0.02)  
Tolerances: x.xxx  $\pm$ 0.25 (x.xx  $\pm$ 0.01)  
Pin pitch tolerances:  $\pm$ 0.25 ( $\pm$ 0.01)  
Pin dimension tolerances:  $\pm$ 0.1 ( $\pm$ 0.004)

Pinout	
Pin	Function
1	+Vin
2	GND
3	+Vout

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

### Angular pin version (Suffix A)



Pinout	
Pin	Function
1	+Vin
2	GND
3	+Vout