

#### SOT-25



#### Pin Definition:

1. Input
2. Ground
3. Enable
4. Power Good
5. Output

### General Description

The TS9002 series is a positive voltage linear regulator developed utilizing CMOS technology featured low quiescent current (30uA typ.), low dropout voltage, and high output voltage accuracy, making them ideal for battery applications. The Chip Enable (CE) includes a CMOS or TTL compatible input allows the output to be turned off to prolong battery life. The TS9002 series is included a precision voltage reference, error correction circuit, a current limited output driver, over temperature shutdown, and a "Power Good" detector, which pulls low when the output is out of regulation. This series are offered in 5-pin SOT-25 package.

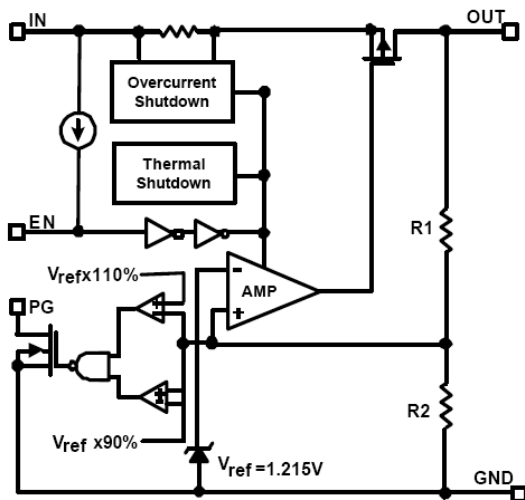
### Features

- Dropout voltage typically 0.4V@ Io=300mA (Vo>2.5V)
- Low power consumption
- Output voltage  $\pm 2\%$ ,  $\pm 3\%$  (1.2V)
- Internal current limit and thermal shutdown
- Short circuit current fold-back
- Power saving shutdown mode
- Power good output function

### Applications

- Palmtops
- Video recorders
- Battery powered equipment
- PC peripherals
- High-efficiency linear power supplies
- Digital signal camera

### Block Diagram



### Ordering Information

Part No.	Package	Packing
TS9002xCX5 RF	SOT-25	3Kpcs / 7" Reel

Note: Where x denotes voltage option, available are

1=1.2V

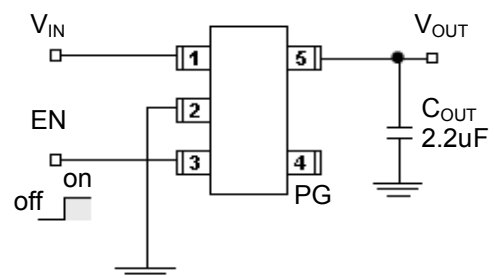
A=1.5V

K=2.5V

S=3.3V

Contact factory for additional voltage options.

### Typical Application Circuit



EN (Pin 3) may be connected directly to VIN (Pin1)  
 Connected to output for Power Good or left floating  
 Basic operation:  $C_{BYP}$ =not used,  $C_{OUT}>1\mu F$

### Absolute Maximum Rating

Parameter	Symbol	Limit	Unit
Input Supply Voltage	$V_{IN}$	+7	V
Enable Input Voltage	Vce	Gnd-0.3 ~ Vin+0.3	V
Output Current	$I_O$	$P_d / (V_{in} - V_{out})$	
Power Dissipation	$P_D$	380	mW
Thermal Resistance	$\theta_{ja}$	260	$^{\circ}C / W$
Operating Junction Temperature Range	$T_j$	-40 ~ +125	$^{\circ}C$
Storage Temperature Range	$T_{STG}$	-65 ~ +150	$^{\circ}C$
Lead Soldering Temperature (260 $^{\circ}C$ )		10	S

Notes: Stress above the listed absolute rating may cause permanent damage to the device.

### Detail Description

The TS9002 family of CMOS regulators contain a PMOS pass transistor, voltage reference, error amplifier, over-current protection, thermal shutdown, and power good function.

The P-channel pass transistor receives data from the error amplifier, over-current shutdown, and thermal protection circuits. During normal operation, the error amplifier compares the output voltage to a precision reference. Over-current and Thermal shutdown circuits become active when the junction temperature exceeds 150  $^{\circ}C$ , or the current exceeds 300mA. During thermal shutdown, the output voltage remains low. Normal operation is restored when the junction temperature drops below 120  $^{\circ}C$ .

The TS9002 switches from voltage mode to current mode when the load exceeds the rated output current. This prevents over-stress. The TS9002 also incorporates current foldback to reduce power dissipation when the output is short circuit. This feature becomes active when the output drops below 0.8volts, and reduces the current flow by 65%. Full current is restored when the voltage exceeds 0.8 volts.

### External Capacitors

The TS9002 is stable with an output capacitor to ground of 2.2mF or greater. Ceramic capacitors have the lowest ESR, and will offer the best AC performance. Conversely, Aluminum Electrolytic capacitors exhibit the highest ESR, resulting in the poorest AC response. Unfortunately, large value ceramic capacitors are comparatively expensive. One option is to parallel a 0.1mF ceramic capacitor with a 10mF Aluminum Electrolytic. The benefit is low ESR, high capacitance, and low overall cost.

A second capacitor is recommended between the input and ground to stabilize Vin. The input capacitor should be at least 0.1mF to have a beneficial effect.

All capacitors should be placed in close proximity to the pins. A "Quiet" ground termination is desirable. This can be achieved with a "Star" connection

### Enable

The Enable pin normally floats high. When actively, pulled low, the PMOS pass transistor shuts off, and all internal circuits are powered down. In this state, the quiescent current is less than 1mA. This pin behaves much like an electronic switch.

### Power Good

The TS9002 includes the Power Good feature. When the output is not within 5% of the specified voltage, it pulls low. This can occur under the following conditions:

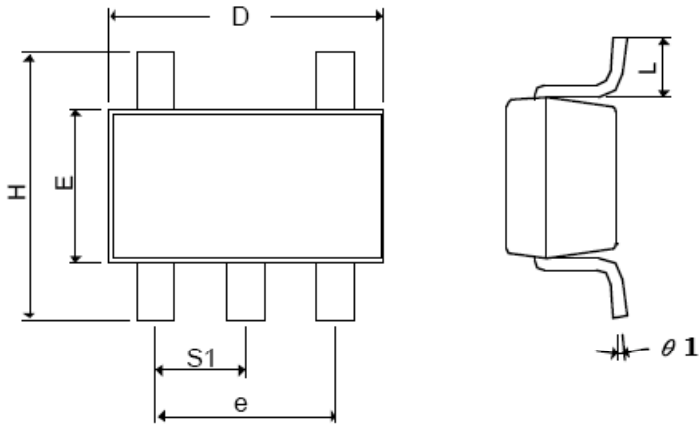
- (1) Input Voltage too low. (2) During Over-Temperature. (3) During Over-Current (4) If output is pulled up.  
(Note: PG pin is an open-drain output)

**Electrical Characteristics** (Ta = 25°C, unless otherwise noted)

Parameter	Symbol	Test Condition		Min	Typ	Max	Units
Input Voltage	V <sub>IN</sub>			Note 1	--	7	V
Output Voltage Accuracy	V <sub>O</sub>	I <sub>O</sub> =1mA		-1.5	--	1.5	%
Dropout Voltage	V <sub>DROPOUT</sub>	I <sub>O</sub> =300mA V <sub>O</sub> =V <sub>O(NOM)</sub> -2.0%	1.2V ≤ V <sub>O(NOM)</sub> ≤ 2.0V	--	--	1300	mV
			2.0V < V <sub>O(NOM)</sub> ≤ 2.8V	--	--	400	
			2.8V < V <sub>O(NOM)</sub>	--	--	300	
Output Current	I <sub>O</sub>	V <sub>O</sub> > 1.2V		300	--	--	mA
Current Limit	I <sub>LIM</sub>	V <sub>O</sub> > 1.2V		300	450	--	mA
Short Circuit Current	I <sub>SC</sub>	V <sub>O</sub> < 0.8V		--	150	300	mA
Quiescent Current	I <sub>Q</sub>	I <sub>O</sub> = 0mA		--	30	50	uA
Ground Pin Current	I <sub>GND</sub>	I <sub>O</sub> = 1mA to 300mA		--	35	--	uA
Line Regulation	REG <sub>LINE</sub>	V <sub>IN</sub> = V <sub>O</sub> + 1 to I <sub>O</sub> = 1mA V <sub>O</sub> + 2	1.2V ≤ V <sub>O</sub> ≤ 1.4V	-0.2	--	0.2	%
			1.4V < V <sub>O</sub> ≤ 2.0V	-0.15	--	0.15	
			2.0V < V <sub>O</sub> < 4.0V	-0.1	0.02	0.1	
			4.0V ≤ V <sub>O</sub>	-0.4	0.2	0.4	
Load Regulation	REG <sub>LOAD</sub>	I <sub>O</sub> = 1mA to 300mA		-1	0.2	1	%
Over Temperature Shutdown	O <sub>TS</sub>			--	150	--	°C
Over Temperature Hysteresis	O <sub>TH</sub>			--	30	--	°C
VO Temperature Coefficient	T <sub>C</sub>			--	30	--	ppm/°C
Power Supply Rejection	PSRR	I <sub>O</sub> = 100mA C <sub>O</sub> = 2.2mF	f = 100Hz	--	60	--	dB
			f = 1kHz	--	50	--	
			f = 10kHz	--	20	--	
Output Voltage Noise	eN	f = 10Hz to 100kHz I <sub>O</sub> = 10mA	Co = 2.2mF	--	30	--	mVrms
EN Input Threshold	V <sub>EH</sub>	V <sub>IN</sub> = 2.7V to 7V		2.0	--	V <sub>in</sub>	V
	V <sub>EL</sub>	V <sub>IN</sub> = 2.7V to 7V		0	--	0.4	V
EN Input Bias Current	I <sub>EH</sub>	V <sub>EN</sub> = V <sub>IN</sub> , V <sub>IN</sub> = 2.7V to 7V		--	--	0.1	mA
	I <sub>EL</sub>	V <sub>EN</sub> = 0V, V <sub>IN</sub> = 2.7V to 7V		--	--	0.5	mA
Shutdown Supply Current	I <sub>SD</sub>	V <sub>IN</sub> = 5V, V <sub>O</sub> = 0V, V <sub>EN</sub> < V <sub>EL</sub>		--	0.5	1	mA
Shutdown Output Voltage	V <sub>SD</sub>	I <sub>O</sub> = 0.4mA, V <sub>EN</sub> < V <sub>EL</sub>		0	--	0.4	V
Output Under Voltage	V <sub>UV</sub>	2.5V ≤ V <sub>O(NOM)</sub> ≤ 5.0V		--	--	85	%V <sub>O(NOM)</sub>
		1.2V ≤ V <sub>O(NOM)</sub> < 2.5V		--	--	75	
Output Over Voltage	V <sub>OV</sub>	2.5V ≤ V <sub>O(NOM)</sub> ≤ 5.0V		115	--	--	%V <sub>O(NOM)</sub>
		1.2V ≤ V <sub>O(NOM)</sub> < 2.5V		125	--	--	
PG Leakage Current	ILC	V <sub>PG</sub> = 7V		--	--	1	mA
PG Voltage Rating	VPG	V <sub>O</sub> in regulation		--	--	7	V
PG Voltage Low	VOL	I <sub>SINK</sub> = 0.4mA		--	--	0.4	V

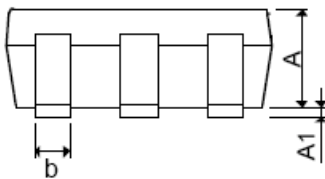
Note: V<sub>IN(MIN)</sub> = V<sub>OUT</sub> + V<sub>DROPOUT</sub>

## SOT-25 Mechanical Drawing



SOT-25 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX.
A+A1	0.09	1.25	0.0354	0.0492
B	0.30	0.50	0.0118	0.0197
C	0.09	0.25	0.0035	0.0098
D	2.70	3.10	0.1063	0.1220
E	1.40	1.80	0.0551	0.0709
E	1.90 BSC		0.0748 BSC	
H	2.40	3.00	0.09449	0.1181
L	0.35 BSC		0.0138 BSC	
θ1	0°	10°	0°	10°
S1	0.95 BSC		0.0374 BSC	

Front View



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