



# TS9009

## 80mA CMOS Low Dropout Voltage Regulator with Enable

SOT-25



Pin assignment

1. Input
2. Ground
3. Enable
4. N/C
5. Output

**Low Power Consumption**  
**Low Drop Out Voltage 0.4V**  
**Enable Shutdown**

### General Description

The TS9009 series is combine high accuracy with very low power consumption (225uA at 20mA output), and very low dropout voltage (from typically 20mV at light loads to 300mV at 80mA).

The TS9009 series is designed for optimal performance with low-value, low cost ceramic capacitors. In most applications only 0.47uF of output capacitance is required for stability, and specifically for battery power devices. The Chip Enable (CE) includes a CMOS or TTL compatible input allows the output to be turned off to prolong battery life. When it is shutdown, power consumption drops practically to zero. If Chip Enable control is not required, the Enable pin can be tied to the input for 3-terminal operation. The TS9009 series is included a precision voltage reference, current limiting, over temperature shutdown, and protection against reversed battery connection.

This series are offered in 5-pin SOT-25 package.

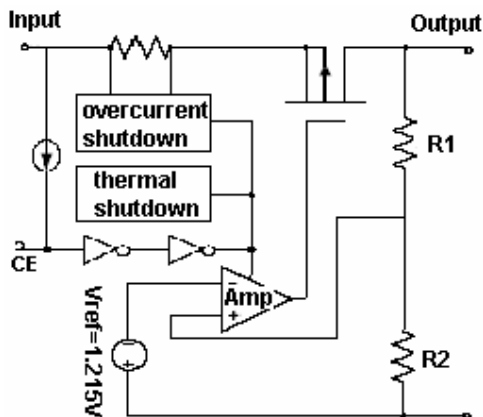
### Features

- ◇ Output current up to 80mA
- ◇ Low power consumption
- ◇ Output voltage +/-2%
- ◇ Internal current and thermal limiting
- ◇ Reversed input polarity protection
- ◇ Zero Off-mode current
- ◇ Logic controlled shutdown

### Applications

- ◇ Notebook, Palmtops and PDA
- ◇ Bar code scanners
- ◇ Battery powered equipment
- ◇ High efficiency linear power supplies
- ◇ DC to DC modules

### Block Diagram



### Ordering Information

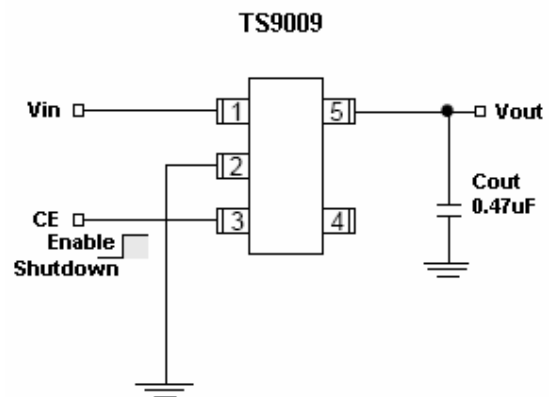
Part No.	Operating Temp. (Ambient)	Package
TS9009x <sub>CX</sub> 5	-40 ~ +85 °C	SOT-25

Note: Where **x** denotes voltage option, available are

- N**=2.8V,
- P**=3.0V,
- S**=3.3V,
- 5**=5.0V.

Contact factory for additional voltage options.

### Typical Application Circuit





<b>Absolute Maximum Rating</b> (Note 1)						
Input Supply Voltage	V <sub>in</sub>	+20			V	
Enable Input Voltage	V <sub>ce</sub>	+20			V	
Output Current	I <sub>o</sub>	80			mA	
Power Dissipation (Note 3)	P <sub>D</sub>	380			mW	
Thermal Resistance	θ <sub>ja</sub>	260			°C/W	
Operating Junction Temperature Range	T <sub>j</sub>	-40 ~ +125			°C	
Storage Temperature Range	T <sub>STG</sub>	-65 ~ +150			°C	
Lead Soldering Temperature (260 °C)		5			S	
<b>Recommend Operating Rating</b>						
Input Supply Voltage	V <sub>in</sub>	+16			V	
Enable Input Voltage	V <sub>ce</sub>	Gnd-0.3 ~ V <sub>in</sub> +0.3			V	
<b>Electrical Characteristics</b>						
Ta = 25 °C, I <sub>o</sub> =1mA, C <sub>out</sub> =0.47uF, V <sub>ce</sub> ≥2V, unless otherwise specified.						
Parameter	Conditions	Min	Typ	Max	Unit	
Output Voltage	V <sub>in</sub> =V <sub>o</sub> + 1V	0.98 V <sub>o</sub>		1.02 V <sub>o</sub>	V	
	1mA≤I <sub>L</sub> ≤80mA	0.97 V <sub>o</sub>		1.03 V <sub>o</sub>	V	
Output Voltage Temperature Coefficient (Note 4)		--	50	--	ppm/°C	
Line Regulation	V <sub>o</sub> +1V ≤ V <sub>in</sub> ≤ 16V	--	0.08	0.3	%/V	
Load Regulation (Note 5)	V <sub>in</sub> =V <sub>o</sub> +1V, 1mA≤I <sub>L</sub> ≤80mA		0.2	0.5	%/V	
Dropout Voltage (Note 6)	V <sub>ce</sub> ≥2V	I <sub>o</sub> =100uA	--	20	--	mV
		I <sub>o</sub> =20mA	--	200	--	
		I <sub>o</sub> =50mA	--	250	--	
		I <sub>o</sub> =80mA	--	300	--	
Quiescent Current	V <sub>in</sub> ≤0.4V (shutdown)	--	0.01	1	uA	
Ground Pin Current (Note 7)	V <sub>ce</sub> ≥2V	I <sub>o</sub> =0.1mA	--	180	--	uA
		I <sub>o</sub> =20mA	--	225	750	
		I <sub>o</sub> =50mA	--	850	--	
		I <sub>o</sub> =80mA	--	1800	3000	
Output Current Limit	V <sub>out</sub> =0V	--	180	--	mA	
Power Supply Rejection Ratio	At f=100Hz, I <sub>o</sub> =0.1mA,	--	70	--	dB	
Thermal Regulation (Note 8)		--	0.05	--	%/W	
<b>Enable Input</b>						
Enable Input Logic-Low Voltage	Regulation shutdown	--	--	0.6	V	
Enable Input Logic-High Voltage	Regulation enable	2.0	--	--	V	
Enable Input Current	V <sub>IL</sub> ≤0.6V	--	0.01	1	uA	
	V <sub>IL</sub> ≥2.0V	--	15	50		



## Electrical Characteristics

Note 1: Exceeding the absolute maximum rating may damage the device.

Note 2: The device is not guaranteed to function outside its operating rating.

Note 3: The maximum allowable power dissipation at any  $T_a$  is  $P_d(\max) = [T_j(\max) - T_a] * \theta_{ja}$ . Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.

Note 4: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 5: Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 1mA to 80mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

Note 6: Dropout voltage is defined as the input to output differential at which the output voltage drops 2% below its nominal value measured at 1V differential.

Note 7: Ground pin current is the regulator quiescent current plus pass transistor base current. The total current drawn from the supply is the sum of the load current plus the ground pin current.

Note 8: Thermal regulation is defined as the change in output voltage at a time "t" after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 80mA load pulse at  $V_{in}=16V$  for  $t=10mS$ .

## Applications Information

### Input Capacitor

Place an 0.1uF capacitor from  $V_{in}$  to Gnd in applications where there is more than 10 inches of wire between the input and the AC filter capacitor, or where a battery is used as the input.

### Output Capacitor

As with any PNP-based regulator, the TS9009 requires an output capacitor to prevent oscillation. However, the TS9009 is extremely stable, and requires only 0.47uF of output capacitance for stability. It can be used with any type of capacitor, but it works great with cheap, tiny ceramic capacitors, it also can be increased the output capacitor value without limit to improve transient response.

**Caveat:** used a capacitor with a resonant frequency above 500KHz. Ceramic capacitors work great, but some dielectrics have poor temperature coefficients, which affect the capacitance value over temperature. Tantalum capacitors are very stable over temperature, but are larger and much more expensive. Aluminum electrolytic capacitors also work, but they have electrolytes which freeze at  $-30^{\circ}C$ . So, used tantalum or ceramic capacitors for operation below  $-25^{\circ}C$ .

### No Load Stability

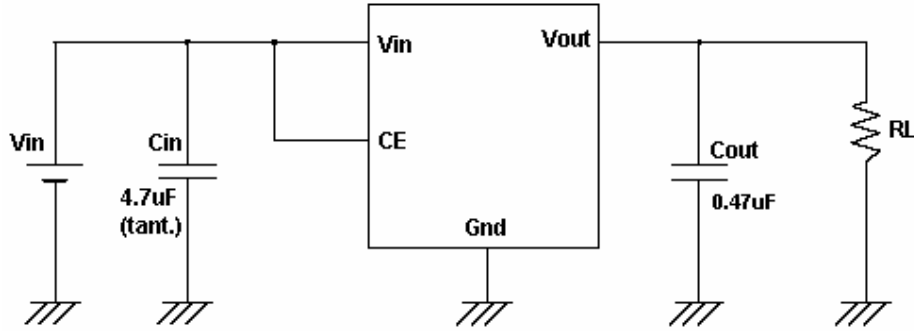
Unlike most regulators, the TS9009 will remain stable and in regulation with no load other than the internal voltage divider. The makes TS9009 ideal for CMOS RAM keep alive applications.

### Enable Input

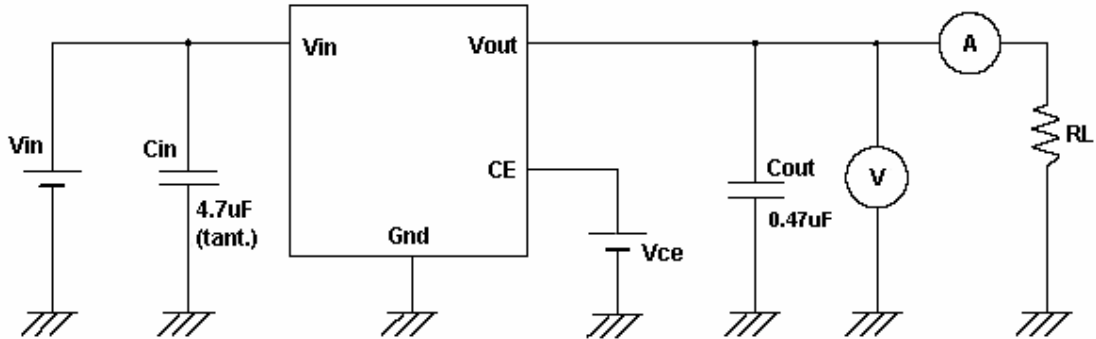
The Ts9009 have practically zero off-mode current. When the chip enable input (CE) is held below 0.6V, the TS9009 is powered off. Pulling CE high over 2V will be turned on the regulation. When the CE is held low, the regulator typically draws only 15nA of current. While the logic threshold is TTL/CMOS compatible, CE may be pulled as high as 20V, independent to  $V_{in}$ .

## Application Examples

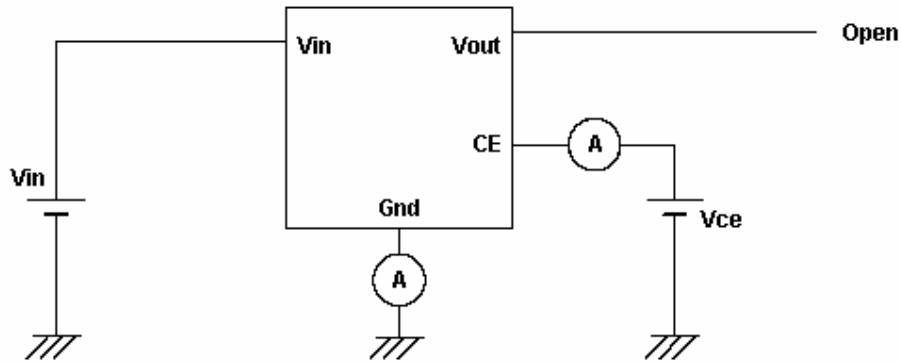
### Standard Circuit



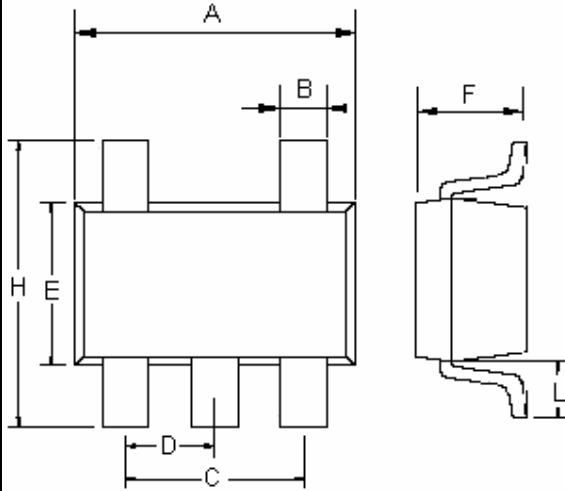
### Typical Application Circuit 1



### Typical Application Circuit 2



### SOT-25 Mechanical Drawing



SOT-23 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.70	3.00	0.106	0.118
B	0.25	0.50	0.010	0.020
C	1.90(typ)		0.075(typ)	
D	0.95(typ)		0.037(typ)	
E	1.50	1.70	0.059	0.067
F	1.05	1.35	0.041	0.053
H	2.60	3.00	0.102	0.118
L	0.60(typ)		0.024(typ)	