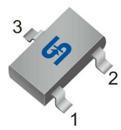
# TS9008

## 300mA High PSRR Low Noise CMOS LDO

**SOT-25**


**Pin Definition:**
1. Input
2. Ground
3. Enable
4. Bypass
5. Output

**SOT-23**




**Pin Definition:**
1. Input
2. Output
3. Ground

## General Description

The TS9008 is a low dropout, high PSRR, low noise linear regulator with very low quiescent. It can supply 300mA output current with low dropout about 250mV. The Device includes pass element, error amplifier, band-gap, current-limit and thermal shutdown circuitry. The characteristics of low dropout voltage and less quiescent current make it good for some critical current application, for example, some battery powered devices. The typical quiescent current is approximately 30µA. In the shutdown mode, the maximum supply current is less than 1uA. Built-in current-limit and thermal-shutdown functions prevent any fault condition from IC damage

## Features

- Input voltage range 2.8V~5.5V
- 250mV dropout at 300mA load
- 300mA output Current
- Low quiescent current 30µA (Typ.)
- Max. supply current <1µA at shutdown mode
- Fixed output voltage
- Current limit and thermal shutdown protection
- High PSRR 73db @ 1kHz

## Applications

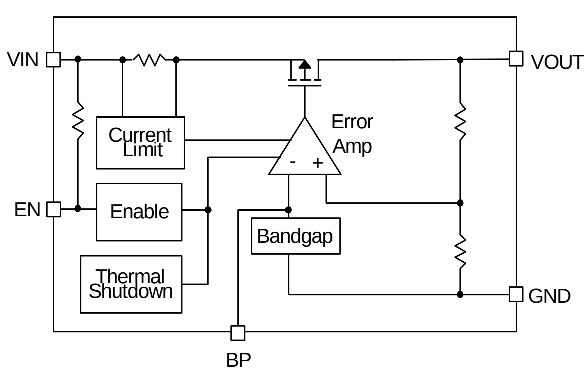
- Palmtops, PDA and Notebook Computers
- DSC, Handset Camera Modules
- PCMCIA Cards, PC Cameras
- USB Based Portable Devices (MPS, PMP)
- GSM/GPRS/3G RF Transceiver Modules

## Ordering Information

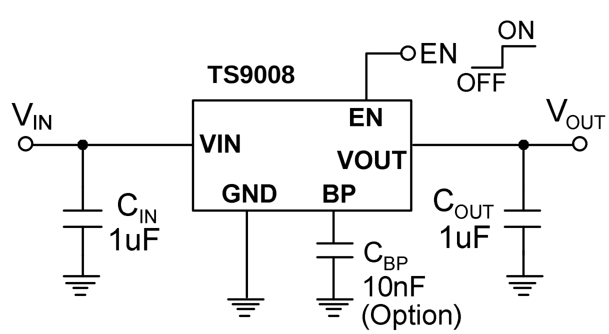
| Part No. | Package | Packing |
|---|---|---|
| TS9008**x**CX RFG | SOT-23 | 3Kpcs / 7" Reel |
| TS9008**x**CX5 RFG | SOT-25 | 3Kpcs / 7" Reel |

**Note:** "G" denote for Halogen Free Product
Where **x** denotes voltage option, available are
**1**= 1.2V,
**A**= 1.5V,
**D**= 1.8V
**K**= 2.5V
**N**= 2.8V
**P**= 3.0V
**S**= 3.3V

## Block Diagram




## Typical Application Circuit



## Absolute Maximum Rating

| Parameter | Symbol | Limit | Unit |
|---|---|---|---|
| VIN Pin Voltage | $V_{IN}$ | GND - 0.3 to GND + 6 | V |
| Output Voltage | $V_{OUT}$ | GND - 0.3 to VIN + 0.3 | V |
| Enable Voltage | $V_{EN}$ | GND - 0.3 to GND + 6 | V |
| Power Dissipation | $P_D$ | 350 | mW |
| Storage Temperature Range | $T_{STG}$ | -40 to +150 | °C |
| Operating Temperature Range | $T_{OP}$ | -40 to +85 | °C |
| Junction Temperature | $T_J$ | -40 to +125 | °C |
| Thermal Resistance from Junction to case | $\theta_{JC}$ | 230 | °C/W |
| Thermal Resistance from Junction to ambient | $\theta_{JA}$ | 280 | °C/W |

**Note:** $\theta_{JA}$ is measured with the PCB copper area of approximately 1 $in^2$ (Multi-layer).

## Electrical Characteristics

($V_{IN}$=$V_{OUT}$+1V or $V_{IN}$=2.8V whichever is greater, $C_{IN}$=$C_{OUT}$=1uF, $T_A$=25℃, unless otherwise noted)

| Characteristics | Symbol | Conditions | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | **(Note1)** | | 2.8 | -- | 5.5 | V |
| Output Voltage Accuracy | $\Delta V_{OUT}$ | $I_{OUT}$=1mA | | -2 | -- | +2 | % |
| Quiescent Current | $I_Q$ | $I_{OUT}$ =0mA | | -- | 30 | 60 | μA |
| Dropout Voltage **(Note2)** | $V_{DROP}$ | $I_{OUT}$=300mA | 1.0V≦$V_{OUT}$≦2.0V | -- | 1500 | -- | mV |
| | | | 1.5V＜$V_{OUT}$≦2.0V | -- | 1000 | -- | |
| | | | 2.0V＜$V_{OUT}$≦2.8V | -- | 350 | -- | |
| | | | 2.8V＜$V_{OUT}$≦3.3V | -- | 250 | -- | |
| Current Limit | $I_{LIMIT}$ | $R_{LOAD}$=1Ω | | 300 | -- | -- | mA |
| Line Regulation | $\Delta V_{LINE}$ | $I_{OUT}$ =1mA, $V_{IN}$=$V_{OUT}$+1V to 5V | | -- | 1 | 5 | mV |
| Load Regulation **(Note3)** | $\Delta V_{LOAD}$ | $I_{OUT}$ =0m~150mA | | -- | 6 | 20 | mV |
| Ripple Rejection | PSRR | $C_{OUT}$=1uF, $I_{OUT}$ =1mA | F=1KHz | -- | 73 | -- | dB |
| | | | F=10K | -- | 60 | -- | |
| Enable Input Threshold | $V_{ENH}$ | | | 1.4 | -- | -- | V |
| | $V_{ENL}$ | | | -- | -- | 0.4 | |
| Enable Pin Current | $I_{EH}$ | $V_{EN}$=$V_{IN}$ | | -- | -- | 0.1 | μA |
| Shutdown Current | $I_{SD}$ | $V_{IN}$=3.6V, $V_{EN}$=0V | | -- | -- | 1 | μA |
| Temperature Coefficient | $T_C$ | $I_{OUT}$=1mA, $V_{IN}$=5V | | -- | 50 | -- | ppm/℃ |
| Temperature Shutdown | $T_S$ | | | -- | 160 | -- | ºC |
| Temperature Shutdown Hysterisis | $T_{SH}$ | | | -- | 25 | -- | ºC |

**Note:**

1. Minimum $V_{IN}$ voltage is defined by output adds a dropout voltage.
2. The dropout voltage is defined as $V_{IN}$-$V_{OUT}$, which is measured when $V_{OUT}$ drop about 100mV.
3. Regulation is measured at constant junction temperature by using pulsed testing with a low ON time.

## Function Description

A minimum of 1uF capacitor must be connected from $V_{OUT}$ to ground to insure stability. Typically a large storage capacitor is connected from $V_{IN}$ to ground to ensure that the input voltage does not sag below the minimum dropout voltage during the load transient response. This pin must always be dropout voltage higher than $V_{OUT}$ in order for the device to regulate properly

## Application Information

Like any low-dropout regulator, the TS9008 requires input and output decoupling capacitors. The device is specifically designed for portable applications requiring minimum board space and smallest components. These capacitors must be correctly selected for good performance. Please note that linear regulators with a low dropout voltage have high internal loop gains which require care in guarding against oscillation caused by insufficient decoupling capacitance.

### Capacitor Selection

Normally, use a 1µF capacitor on the input and a 1µF capacitor on the output of the TS9008. Larger input capacitor values and lower ESR provide better supply-noise rejection and transient response. A large value output capacitor may be necessary if large, fast transients are anticipated and the device is located several inches from the power source. The capacitors is recommended to use 1uF X5R or X7R dielectric ceramic capacitors with 30mΩ to 50mΩ ESR range between device outputs to ground for transient stability.

### Input-Output (Dropout) Voltage

A regulator's minimum input-to-output voltage differential (dropout voltage) determines the lowest usable supply voltage. In battery-powered systems, this determines the useful end-of-life battery voltage. Because the device uses a PMOS, its dropout voltage is a function of drain-to source on-resistance, RDS (ON), multiplied by the load current:

$$V_{DROPOUT} = V_{IN} - V_{OUT} = R_{DS\,(ON)} \times I_{OUT}$$

### Current limit and Thermal Shutdown Protection

In order to prevent overloading or thermal condition from damaging the device, TS9008 regulator has internal thermal and current limiting functions designed to protect the device. It will rapidly shut off PMOS pass element during overloading or over temperature condition.

### Thermal Considerations

The TS9008 series can deliver a current of up to 300mA over the full operating junction temperature range. However, the maximum output current must be dated at higher ambient temperature to ensure the junction temperature does not exceed 125℃. With all possible conditions, the junction temperature must be within the range specified under operating conditions. Power dissipation can be calculated based on the output current and the voltage drop across regulator.

$$P_D = (V_{IN} - V_{OUT})\, I_{OUT}$$

The final operating junction temperature for any set of conditions can be estimated by the following thermal equation:

$$P_{D\,(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$$

Where $T_{J(MAX)}$ is the maximum junction temperature of the die (125℃) and TA is the maximum ambient temperature. The junction to ambient thermal resistance ($\theta_{JA}$) for SOT-23-5L package at recommended minimum footprint is 250℃/W.

## PCB Layout

An input capacitance 1µF is required between the TS9008 input pin and ground (the amount of the capacitance may be increased without limit), this capacitor must be located a distance of not more than 1cm from the input and return to a clean analog ground. Input capacitor can filter out the input voltage spike caused by the surge current due to the inductive effect of the package pin and the printed circuit board's routing wire. Otherwise, the actual voltage at the VIN pin may exceed the absolute maximum rating. The output capacitor also must be located a distance of not more than 1cm from output to a clean analog ground. Because it can filter out the output spike caused by the surge current due to the inductive effect of the package pin and the printed circuit board's routing wire.

## Electrical Characteristics Curve

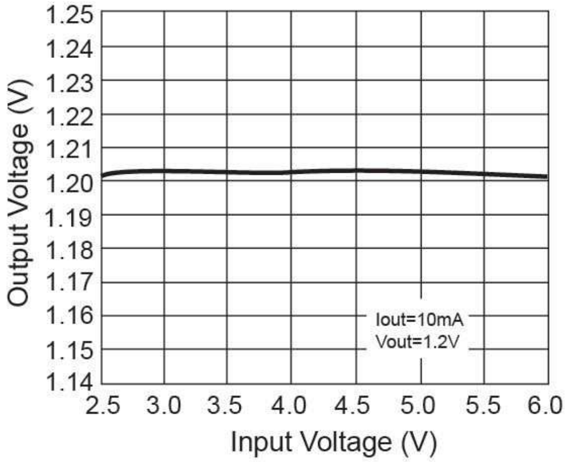



**Figure 1. Output Voltage vs. Input Voltage**

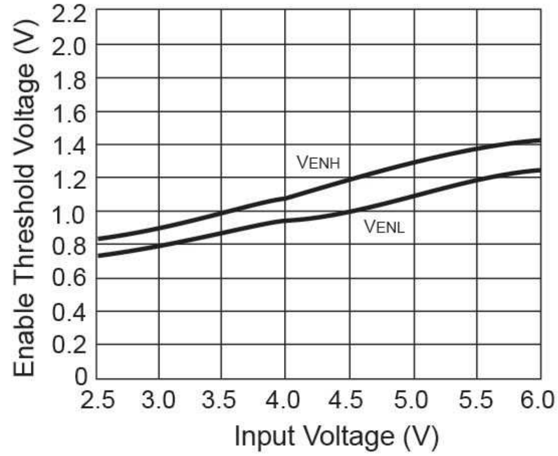



**Figure 2. Threshold Voltage vs. Input Voltage**

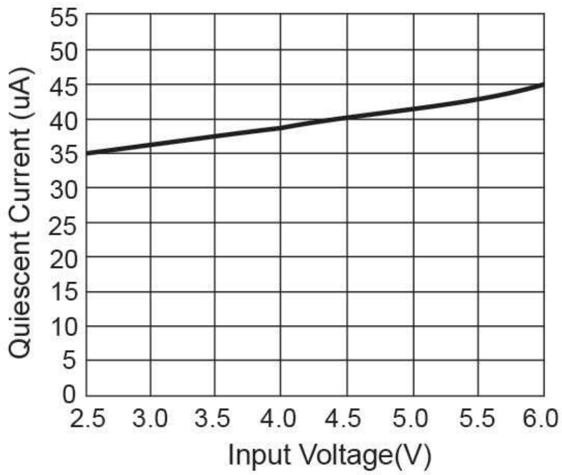



**Figure 3. Quiescent Current vs. Input Voltage**

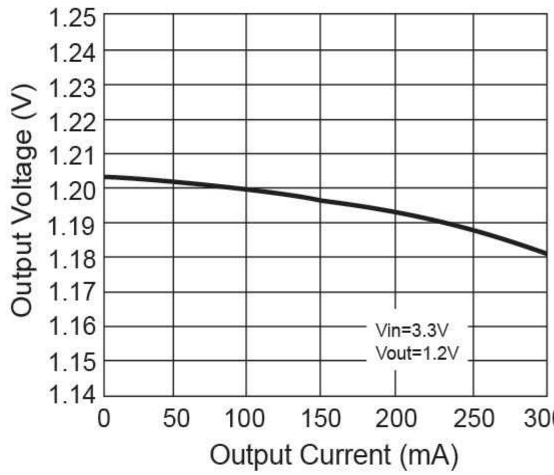



**Figure 4. Output Current vs. Output Voltage**

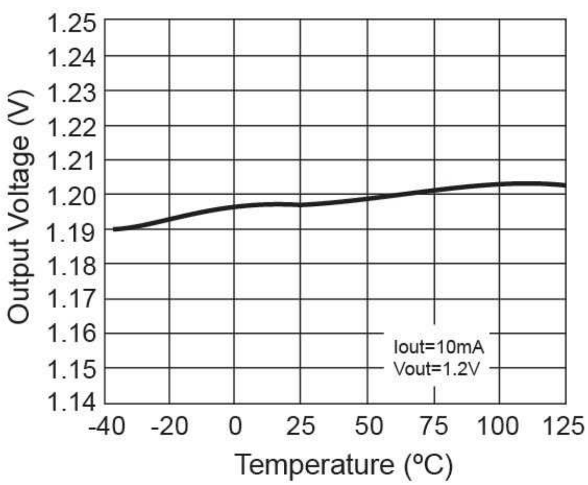



**Figure 5. Output Voltage vs. Temperature**

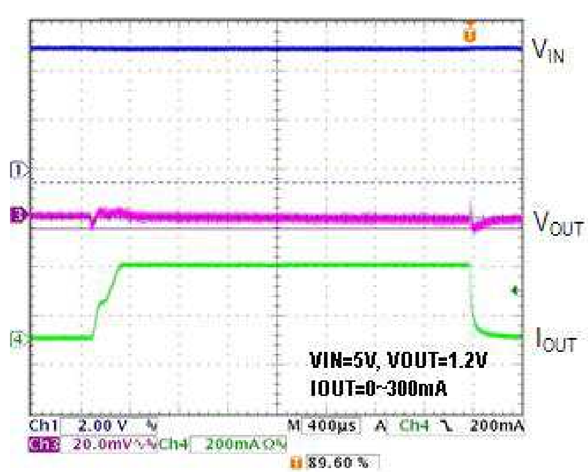



**Figure 6. Load Transient Response**

## Electrical Characteristics Curve

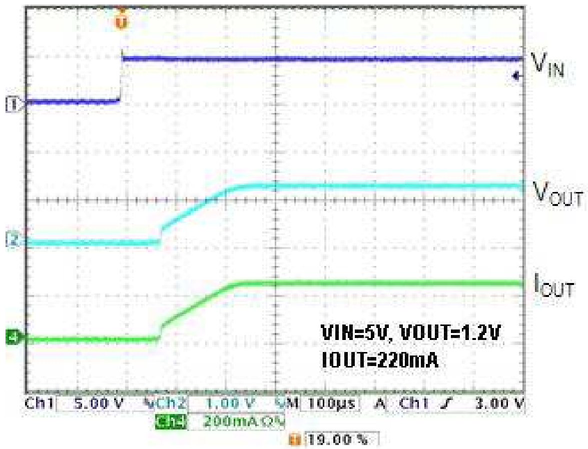



**Figure 7. Power ON**

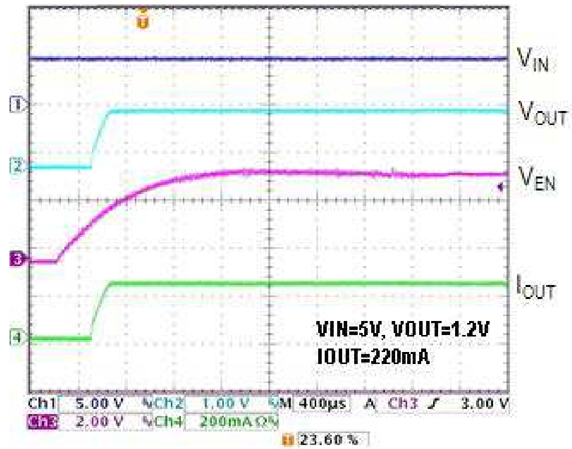
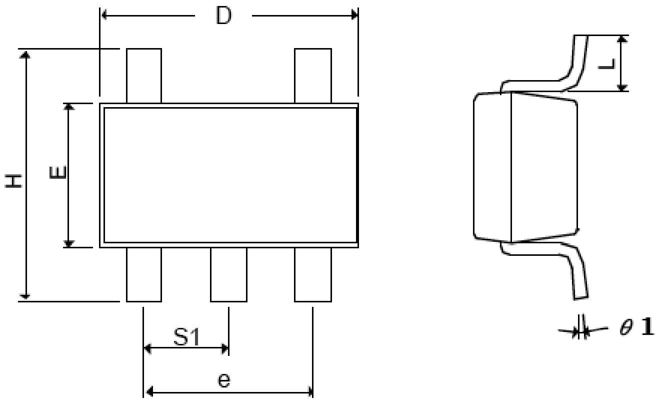


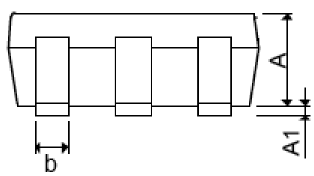

**Figure 8. Enable ON**

# SOT-25 Mechanical Drawing

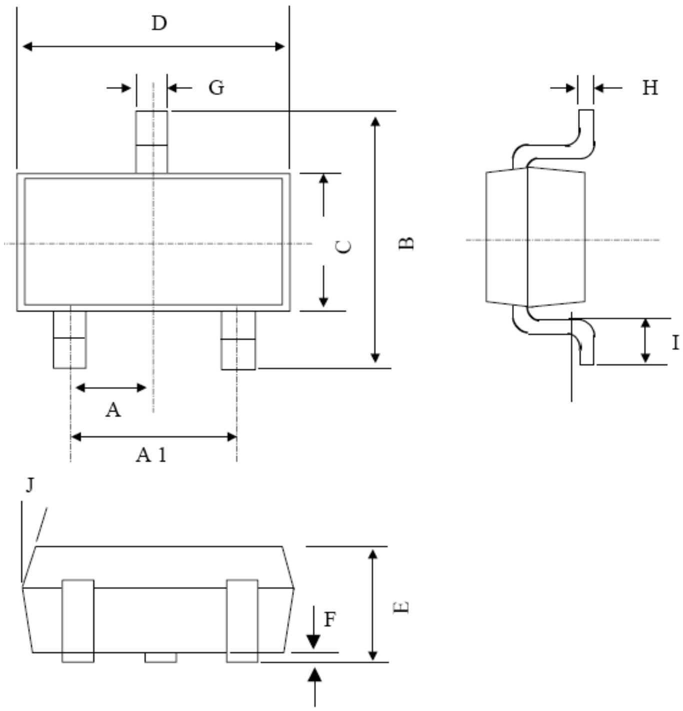



| SOT-25 DIMENSION | | | | |
|---|---|---|---|---|
| DIM | MILLIMETERS | | INCHES | |
| | MIN | MAX | MIN | MAX. |
| A+A1 | 0.09 | 1.25 | 0.0354 | 0.0492 |
| B | 0.30 | 0.50 | 0.0118 | 0.0197 |
| C | 0.09 | 0.25 | 0.0035 | 0.0098 |
| D | 2.70 | 3.10 | 0.1063 | 0.1220 |
| E | 1.40 | 1.80 | 0.0551 | 0.0709 |
| e | 1.90 BSC | | 0.0748 BSC | |
| H | 2.40 | 3.00 | 0.09449 | 0.1181 |
| L | 0.35 BSC | | 0.0138 BSC | |
| Θ1 | 0º | 10º | 0º | 10º |
| S1 | 0.95 BSC | | 0.0374 BSC | |

**Front View**



## SOT-23 Mechanical Drawing




| SOT-23 DIMENSION | | | | |
|---|---|---|---|---|
| DIM | MILLIMETERS | | INCHES | |
| | MIN | MAX | MIN | MAX. |
| A | 0.95 BSC | | 0.037 BSC | |
| A1 | 1.9 BSC | | 0.074 BSC | |
| B | 2.60 | 3.00 | 0.102 | 0.118 |
| C | 1.40 | 1.70 | 0.055 | 0.067 |
| D | 2.80 | 3.10 | 0.110 | 0.122 |
| E | 1.00 | 1.30 | 0.039 | 0.051 |
| F | 0.00 | 0.10 | 0.000 | 0.004 |
| G | 0.35 | 0.50 | 0.014 | 0.020 |
| H | 0.10 | 0.20 | 0.004 | 0.008 |
| I | 0.30 | 0.60 | 0.012 | 0.024 |
| J | 5º | 10º | 5º | 10º |

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