



TS9005

600 mA CMOS LDO



SOT-89



SOT-223

Voltage Range 1.5 to 3.8 Volts

General Description

The TS9005 family of positive, linear regulators feature low ground current (30 μ A typ.) with low dropout voltage, making them ideal for battery applications. The space-saving SOT-89 and SOT-223 packages are attractive for "Pocket" and "Hand Held" applications.

These rugged devices have both Thermal Shutdown, and Current Fold-back to prevent device failure under the "Worst" of operating conditions.

The TS9005 is stable with an output capacitance of 2.2 μ F or greater.

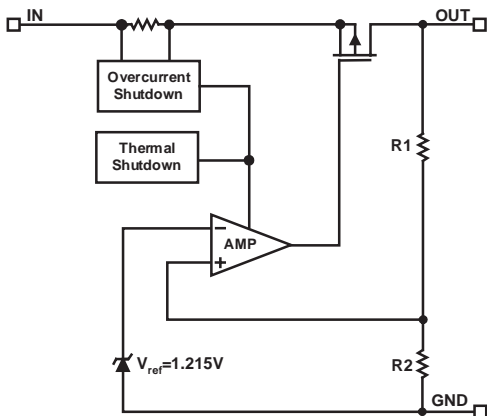
Features

- ◇ Very Low Dropout Voltage
- ◇ Guaranteed 600mA Output
- ◇ Accurate to within 1.5%
- ◇ 30 μ A Quiescent Current
- ◇ Over-Temperature Shutdown
- ◇ Current Limiting
- ◇ Short Circuit Current Fold-back
- ◇ Space-Saving SOT-89, SOT-223
- ◇ Factory Pre-set Output Voltages
- ◇ Low Temperature Coefficient

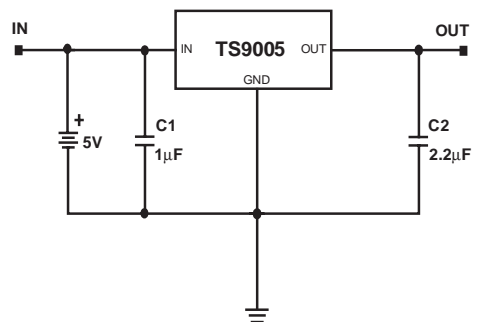
Applications

- ◇ Instrumentation
- ◇ Portable Electronics
- ◇ Wireless Devices
- ◇ Cordless Phones
- ◇ PC Peripherals
- ◇ Battery Powered Widgets
- ◇ Electronic Scales

Functional Block Diagram

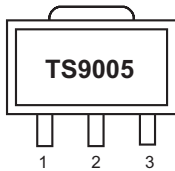


Typical Application



Pin configuration

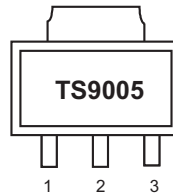
**SOT-89
Top View**



TS9005

1. GND
2. V_{IN}
3. V_{OUT}

**SOT-223
Top View**



TS9005

1. V_{IN}
2. GND
3. V_{OUT}

Ordering Information

PART NUMBER	MARKING	OUTPUT VOLTAGE	PACKAGE	OPERATING TEMP. RANGE
TS9005AEFT	T9005 AEFww	3.3V	SOT-89	- 40°C to + 85°C
TS9005BEFT	T9005 BEFww	3.0V	SOT-89	- 40°C to + 85°C
TS9005CEFT	T9005 CEFww	2.8V	SOT-89	- 40°C to + 85°C
TS9005DEFT	T9005 DEFww	2.5V	SOT-89	- 40°C to + 85°C
TS9005EEFT	T9005 EEFww	3.8V	SOT-89	- 40°C to + 85°C
TS9005FEFT	T9005 FEFww	3.6V	SOT-89	- 40°C to + 85°C
TS9005GEFT	T9005 GEFww	3.5V	SOT-89	- 40°C to + 85°C
TS9005HEFT	T9005 HEFww	2.7V	SOT-89	- 40°C to + 85°C
TS9005IEFT	T9005 IEFww	3.4V	SOT-89	- 40°C to + 85°C
TS9005JEFT	T9005 JEFww	2.85V	SOT-89	- 40°C to + 85°C
TS9005KEFT	T9005 KEFww	3.7V	SOT-89	- 40°C to + 85°C
TS9005LEFT	T9005 LEFww	1.5V	SOT-89	- 40°C to + 85°C
TS9005MEFT	T9005 MEFww	1.8V	SOT-89	- 40°C to + 85°C
TS9005NEFT	T9005 NEFww	2.9V	SOT-89	- 40°C to + 85°C
TS9005OEFT	T9005 OEFww	3.1V	SOT-89	- 40°C to + 85°C
TS9005YEFT	T9005 YEFww	1.9V	SOT-89	- 40°C to + 85°C



Ordering Information(contd.)

PART NUMBER	MARKING	OUTPUT VOLTAGE	PACKAGE	OPERATING TEMP. RANGE
TS9005AEGT	TDByww	3.3V	SOT-223	- 40°C to + 85°C
TS9005BEGT	TDCyww	3.0V	SOT-223	- 40°C to + 85°C
TS9005CEGT	TDDyww	2.8V	SOT-223	- 40°C to + 85°C
TS9005DEGT	TDEyww	2.5V	SOT-223	- 40°C to + 85°C
TS9005EEGT	TDFyww	3.8V	SOT-223	- 40°C to + 85°C
TS9005FEGT	TDGyww	3.6V	SOT-223	- 40°C to + 85°C
TS9005GEGT	TDHyww	3.5V	SOT-223	- 40°C to + 85°C
TS9005HEGT	TEJyww	2.7V	SOT-223	- 40°C to + 85°C
TS9005IEGT	TERyww	3.4V	SOT-223	- 40°C to + 85°C
TS9005JEGT	TGTyww	2.85V	SOT-223	- 40°C to + 85°C
TS9005KEGT	THVyww	3.7V	SOT-223	- 40°C to + 85°C
TS9005MEGT	TJJyww	1.8V	SOT-223	- 40°C to + 85°C
TS9005NEGT	TKSyww	2.9V	SOT-223	- 40°C to + 85°C
TS9005OEGT	TKTyww	3.1V	SOT-223	- 40°C to + 85°C

Note: ww represents the date code

Please consult TSC sales office or authorized Rep./Distributor for other output voltage and package type availability.



Absolute Maximum Ratings

PART NUMBER	MAXIMUM	UNIT
Input Voltage	8	V
Output Current	1	A
Input, Output Voltage	GND - 0.3 to $V_{IN} + 0.3$	V
ESD Classification	B	

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

Recommended Operating Conditions

PART NUMBER	RATING	UNIT
Supply Voltage	4.5 to 5.5	V
Ambient Temperature Range	- 40 to + 85	°C
Junction Temperature	- 40 to + 125	°C

Thermal Information

SYMBOL		MAXIMUM	UNIT
Thermal Resistance (θ_{ja})	SOT-89	180	°C / W
	SOT-223	160	
Thermal Resistance (θ_{jc})	SOT-89	18	°C / W
	SOT-223	15	
Internal Power Dissipation (P_D) ($\Delta T = 100^\circ\text{C}$, No Heat Sink)	SOT-89	550	mW
	SOT-223	625	
Internal Power Dissipation (P_D) ($\Delta T = 100^\circ\text{C}$, With Heat Sink)	SOT-89	2750*	mW
	SOT-223	3300*	
Maximum Junction Temperature		150	°C
Maximum Lead Temperature (10 Sec)		300	°C

* Using twice the θ_{jc} for this calculation.



Electrical Characteristics

TA=25 °C unless otherwise noted

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
Input Voltage	V_{IN}		Note 1		7	V	
Output Voltage Accuracy	V_O	$I_O=1mA$	-1.5		1.5	%	
Dropout Voltage	$V_{DROPOUT}$	$I_O=600mA$ $V_O=V_{O(NOM)}-2.0%$	$1.4V < V_{O(NOM)} \leq 2.0V$		See chart	1400	mV
			$2.0V < V_{O(NOM)} \leq 2.8V$			800	
			$2.8V < V_{O(NOM)}$			600	
Output Current	I_O	$V_O > 1.2V$	600			mA	
Current Limit	I_{LIM}	$V_O > 1.2V$	600	800		mA	
Short Circuit Current	I_{SC}	$V_O < 0.8V$		300	600	mA	
Quiescent Current	I_Q	$I_O=0mA$		30	50	μA	
Ground Pin Current	I_{GND}	$I_O=1mA$ to 600mA		35		μA	
Line Regulation	REG_{LINE}	$I_O=1mA$ $V_{IN}=V_O+1$ to V_O+2	$V_O < 2.0V$	-0.15		0.15	%
			$4.0V > V_O \geq 2.0V$	-0.1	0.02	0.1	%
			$V_O \geq 4.0V$	-0.4		0.4	%
Load Regulation	REG_{LOAD}	$I_O=1mA$ to 600mA		0.2	1	%	
Over Temperature Shutdown	OTS			150		$^{\circ}C$	
Over Temperature Hysteresis	OTH			30		$^{\circ}C$	
V_O Temperature Coefficient	TC			30		ppm/ $^{\circ}C$	
Power Supply Rejection	PSRR	$I_O=100mA$ $C_O=2.2\mu F$	$f=1kHz$		50		dB
			$f=10kHz$		20		
			$f=100kHz$		15		
Output Voltage Noise	eN	$f=10Hz$ to 100kHz $I_O=10mA, C_{BYP}=0\mu F$	$C_O=2.2\mu F$		30	μV_{rms}	

Note 1 : $V_{IN(MIN)}=V_{OUT} + V_{DROPOUT}$

Note 2 : To prevent the Short Circuit Current protection feature from being prematurely activated, the input voltage must be applied before a current source load is applied.



Detailed Description

The TS9005 family of CMOS regulators contain a PMOS pass transistor, voltage reference, error amplifier, over-current protection, and thermal shutdown.

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°C, or the current exceeds 600mA. During thermal shutdown, the output voltage remains low. Normal operation is restored when the junction temperature drops below 120°C.

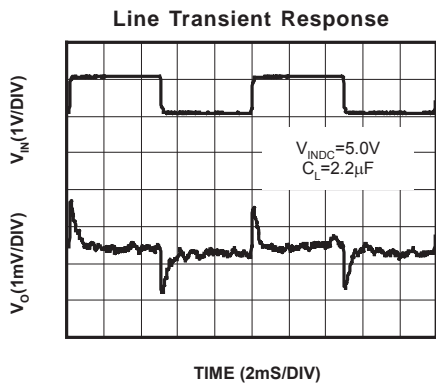
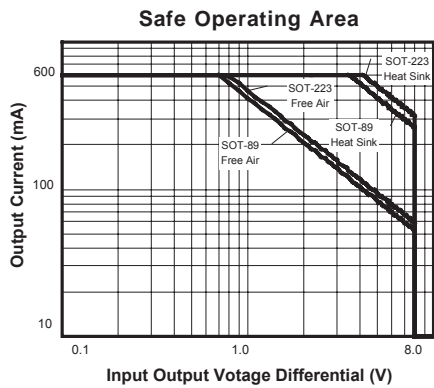
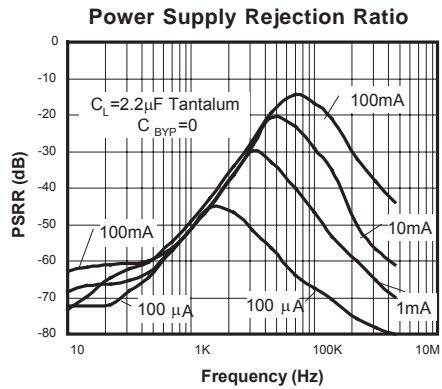
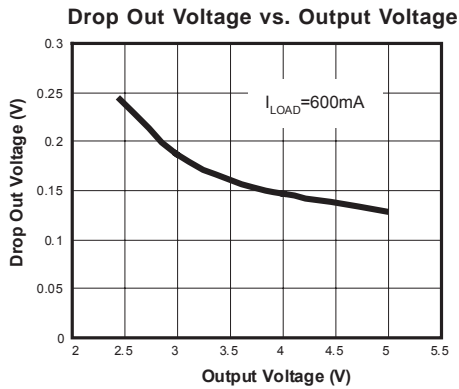
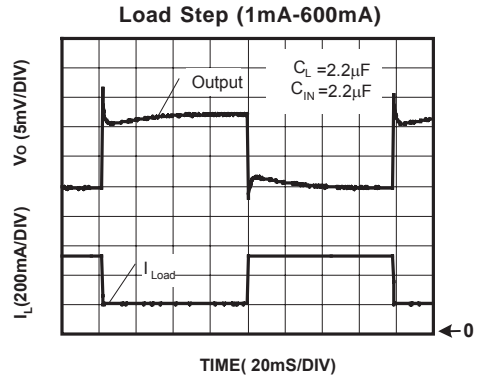
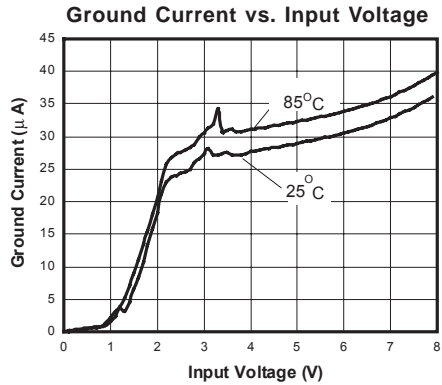
The TS9005 switches from voltage mode to current mode when the load exceeds the rated output current. This prevents over-stress. The TS9005 also incorporates current foldback to reduce power dissipation when the output is short circuited. This feature becomes active when the output drops below 0.8 volts, and reduces the current flow by 65%. Full current is restored when the voltage exceeds 0.8 volts.

External Capacitors

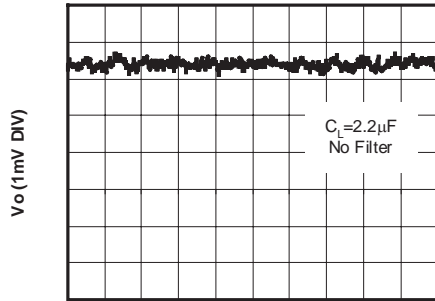
The TS9005 is stable with an output capacitor to ground of 2.2 μ F or greater. Ceramic capacitors have the lowest ESR, and will offer the best AC performance. Conversely, Aluminum Electrolytic capacitors exhibit the highest ESR, resulting in the poorest AC response. Unfortunately, large value ceramic capacitors are comparatively expensive. One option is to parallel a 0.1 μ F ceramic capacitor with a 10 μ F 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 V_{in} . The input capacitor should be at least 0.1 μ F 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.

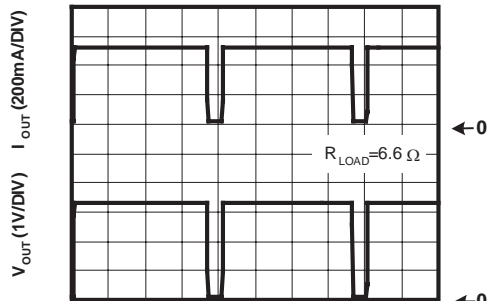


Noise Measurement



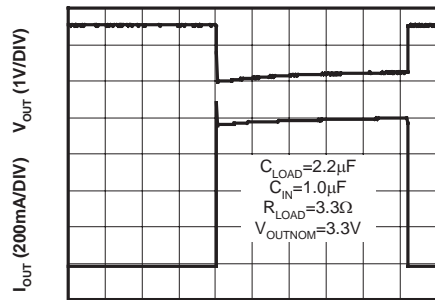
TIME (20ms/DIV)

Overtemperature Shutdown



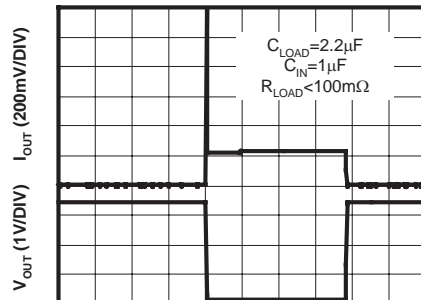
TIME (0.5Sec/DIV)

Current Limit Response



TIME (2mS/DIV)

Short Circuit Response

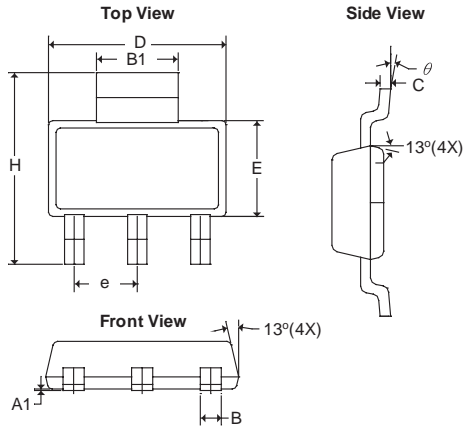


TIME (2mS/DIV)



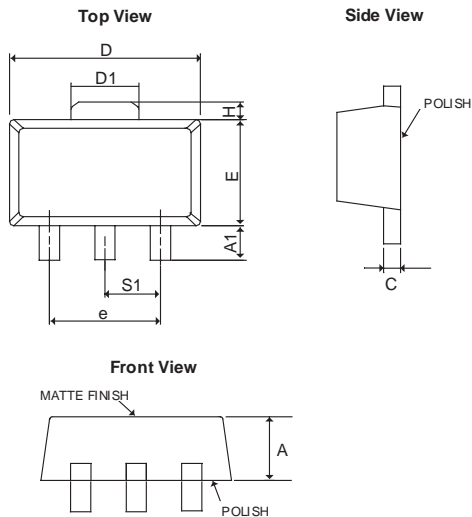
Package Dimension

SOT-223



SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A1	0.02	0.10	0.0008	0.0039
B	0.60	0.84	0.0236	0.0330
B1	2.90	3.15	0.1140	0.1240
C	0.24	0.38	0.0094	0.0150
D	6.30	6.71	0.2480	0.2640
E	3.30	3.71	0.1299	0.1460
e	2.30BSC		0.0906BSC	
F	1.40	1.80	0.0560	0.0702
H	6.70	7.30	0.2638	0.2874
θ	0°	10°	0°	10°

SOT-89



SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.39	1.60	0.05472	0.06299
A1	0.8REF		0.0315REF	
C	0.35	0.44	0.01378	0.01732
D	4.39	4.60	0.17283	0.18110
D1	1.35	1.83	0.05315	0.07205
E	2.28	3.60	0.08976	0.14173
e	3.00REF		0.1181REF	
H	0.70REF		0.0276REF	
S1	1.50REF		0.0590REF	