

SOT-26



Pin Definition:

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

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General Description

The TS9004 is a positive voltage linear regulator developed utilizing CMOS technology featured low quiescent current (35uA 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 TS9004 is included a precision voltage reference, current fold-back, 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.

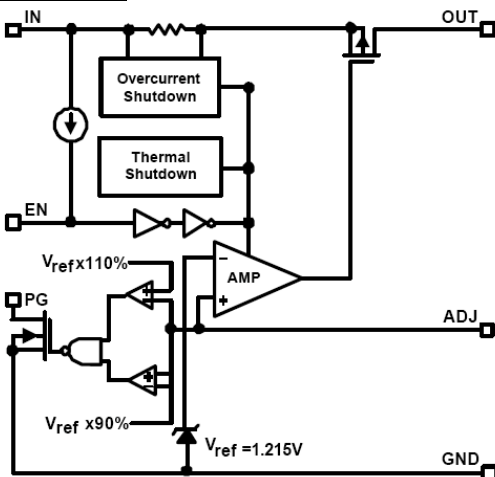
Features

- Very Low Dropout
- Low power consumption: 35uA(typ.)
- Output voltage $\pm 2\%$
- Internal current limit and thermal shutdown
- Short circuit current fold-back
- Power saving shutdown mode
- Power good output function
- Adjustable output voltage

Applications

- Palmtops
- Video recorders
- Battery powered equipment
- PC peripherals
- High-efficiency linear power supplies
- Digital Signal Camera

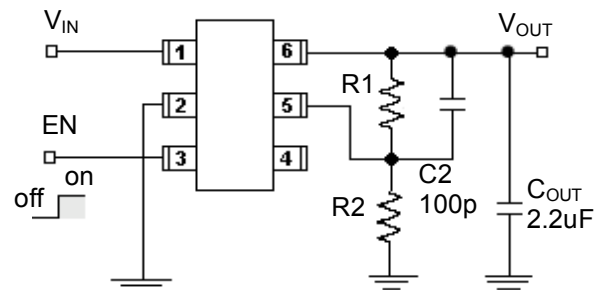
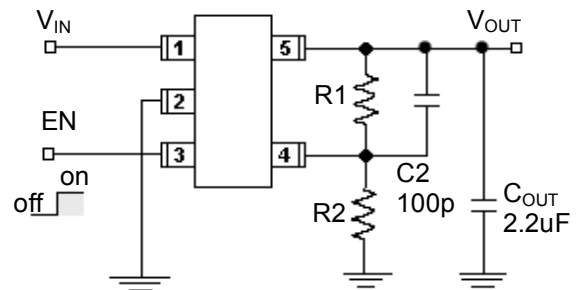
Block Diagram



Ordering Information

Part No.	Package	Packing
TS9004CX5 RF	SOT-25	3Kpcs / 7" Reel
TS9004CX6 RF	SOT-26	3Kpcs / 7" Reel

Typical Application Circuit



$V_{OUT} = 1.215 (R1+R2)/R2$
 C2 is unnecessary when R1 or R2 < 20K
 PG pin is only available in the SOT-26 package
 Connected to output for Power Good or left floating

Absolute Maximum Rating

Parameter	Symbol	Limit	Unit
Input Supply Voltage	V_{IN}	+8	V
Enable Input Voltage	V_{CE}	Gnd-0.3 ~ $V_{IN} + 0.3$	V
Output Current	I_O	$P_D / (V_{IN} - V_{OUT})$	mA
Power Dissipation	P_D	Internal Limited	
Thermal Resistance	Θ_{JA}	140	$^{\circ}\text{C}/\text{W}$
Operating Ambient Temperature Range	T_A	-40 ~ +85	$^{\circ}\text{C}$
Operating Junction Temperature Range	T_J	-40 ~ +125	$^{\circ}\text{C}$
Storage Temperature Range	T_{STG}	-65 ~ +150	$^{\circ}\text{C}$
Lead Soldering Temperature (260 $^{\circ}\text{C}$)		10	S
ESD Classification	HBM	2k	V

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

Electrical Characteristics ($T_a = 25^{\circ}\text{C}$, unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units	
Input Voltage	V_{IN}	(Note 1)	--	--	7	V	
Output Voltage Accuracy	V_O	$I_O = 1\text{mA}$	-2	--	+2	%	
Dropout Voltage	V_{DROP}	$I_O = 300\text{mA}$ $V_O = V_{O(NOM)} - 2.0\%$	$1.5\text{V} < V_{O(NOM)} \leq 2.0\text{V}$	--	See chart	1300	mV
			$2.0\text{V} < V_{O(NOM)} \leq 2.8\text{V}$	--		400	
			$2.8\text{V} < V_{O(NOM)} < 3.8\text{V}$	--		300	
Output Current	I_O	$V_O > 1.2\text{V}$	300	--	--	mA	
Current Limit	I_{LIM}	$V_O > 1.2\text{V}$	300	450	--	mA	
Short Circuit Current	I_{SC}	$V_O < 0.8\text{V}$ (Note 2)	--	150	300	mA	
Ground Pin Current	I_{GND}	$I_O = 1\text{mA}$ to 300mA	--	35	--	mA	
Line Regulation	REG_{LINE}	$I_O = 5\text{mA}$ $V_{IN} = V_O + 1$ to $V_O + 2$	$V_O < 2.0\text{V}$	--	--	0.15	%
			$V_O \geq 2.0\text{V}$	--	0.02	0.1	%
Load Regulation	REG_{LOAD}	$I_O = 1\text{mA}$ to 300mA	--	0.2	1	%	
Over Temperature Shutdown	OTS		--	150	--	$^{\circ}\text{C}$	
Over Temperature Hysteresis	OTH		--	30	--	$^{\circ}\text{C}$	
VO Temperature Coefficient	T_C		--	30	--	ppm/ $^{\circ}\text{C}$	
Power Supply Rejection	PSRR	$I_O = 100\text{mA}$ $C_O = 2.2\text{mF}$	f=100Hz	--	60	--	dB
			f=1kHz	--	50	--	
			f=10kHz	--	20	--	
Output Voltage Noise	eN	f=10Hz to 100kHz $I_O = 10\text{mA}, \text{CBYP} = 0\text{mF}$	$C_O = 2.2\text{nF}$	--	30	--	mVrms
ADJ Input Bias Current	I_{ADJ}		--	1	--	mA	
ADJ Reference Voltage	V_{REF}		1.2	1.215	1.23	V	
EN Input Threshold	V_{EH}	$V_{IN} = 2.7\text{V}$ to 7V	2.0	--	V_{IN}	V	
	V_{EL}	$V_{IN} = 2.7\text{V}$ to 7V	0	--	0.4	V	

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

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
EN Input Bias Current	I _{EH}	V _{EN} = V _{IN} , V _{IN} = 2.7V to 7V	--	--	0.1	mA
	I _{EL}	V _{EN} = 0V, V _{IN} = 2.7V to 7V	--	--	0.5	mA
Shutdown Supply Current	I _{SD}	V _{IN} = 5V, V _O = 0V, V _{EN} < V _{EL}	--	0.5	1	mA
Shutdown Output Voltage	V _{O,SD}	I _O = 35mA, V _{EN} < V _{EL}	0	--	0.1	V
Output Under Voltage	V _{UV}		--	--	85	% V _{O (NOM)}
Output Over Voltage	V _{OV}		115	--	--	% V _{O (NOM)}
PG Leakage Current	I _{LC}	V _{PG} = 7V	--	--	1	mA
PG Voltage Rating	V _{PG}	V _O in regulation	--	--	7	V
PG Voltage Low	V _{OL}	I _{SINK} = 0.4mA	--	--	0.4	V

Note1: V_{IN(MIN)} = V_{OUT} + V_{DROPOUT}

Note2: 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 TS9004 family of CMOS regulators contain a PMOS pass transistor, voltage reference, error amplifier, over-current protection, thermal shutdown, and Power Good detection circuitry. 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 300mA. During thermal shutdown, the output voltage remains low. Normal operation is restored when the junction temperature drops below 120 C. The TS9004 switches from voltage mode to current mode when the load exceeds the rated output current. This prevents over-stress. The TS9004 also incorporates current foldback to reduce power dissipation when the output is short circuited. 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 TS9004 is stable with an output capacitor to ground of 2.2uF 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 0.1uF ceramic capacitor with a 10uF 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 0.1uF 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 TS9004 includes the Power Good feature. When the output is not within +10% 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 Curve

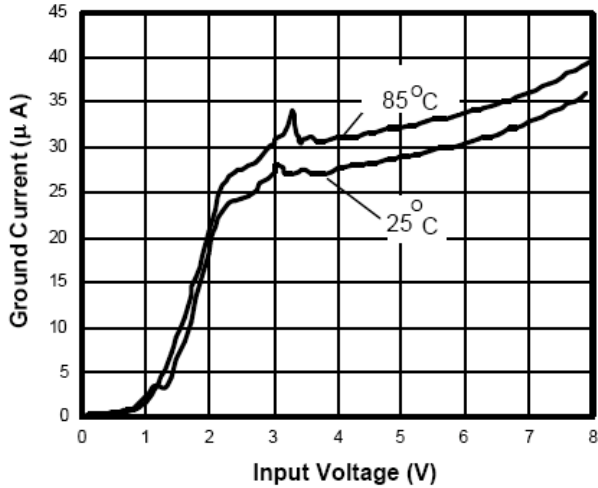


Figure 1. Ground Current vs. Input Voltage

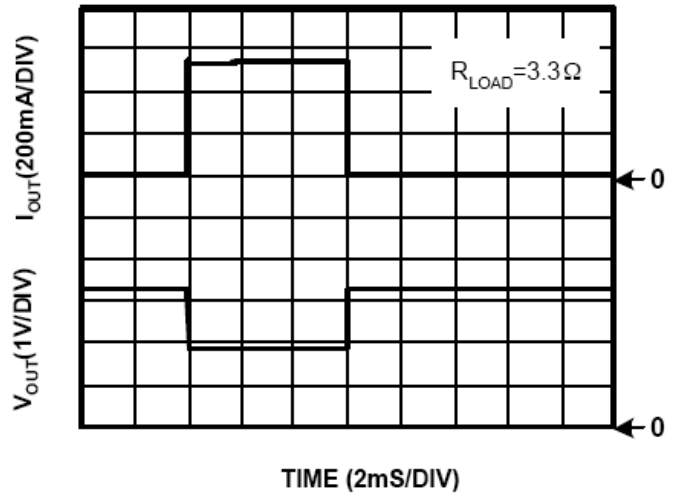


Figure 2. Current Limit Response

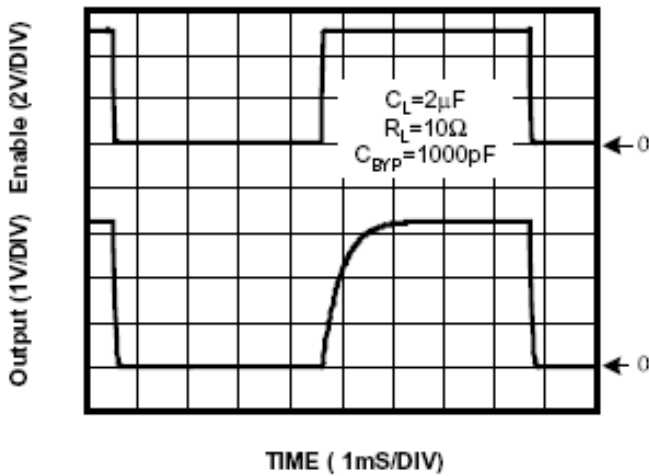


Figure 3. Line Transient Response

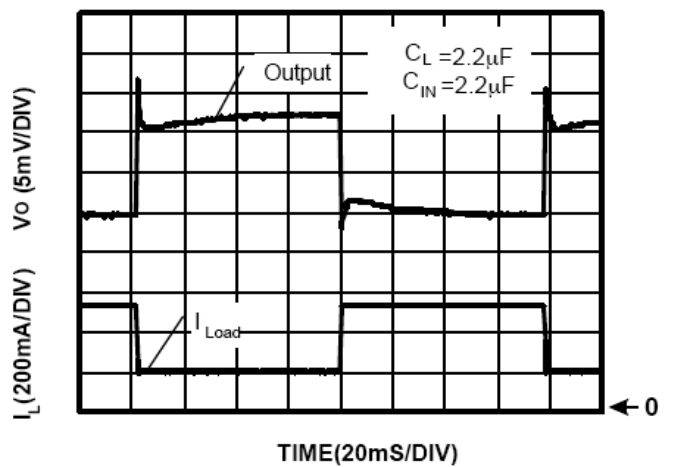


Figure 4. Load Step (1mA~300mA)

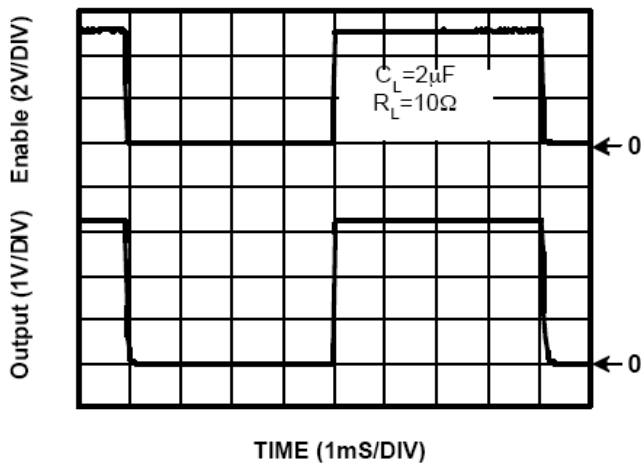


Figure 5. Chip Enable Transient Response

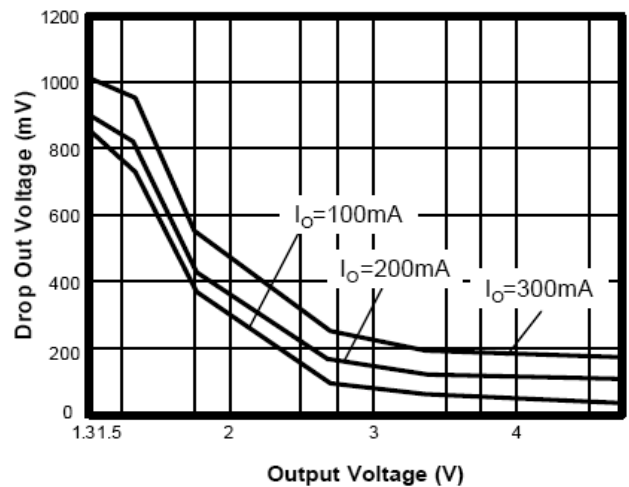
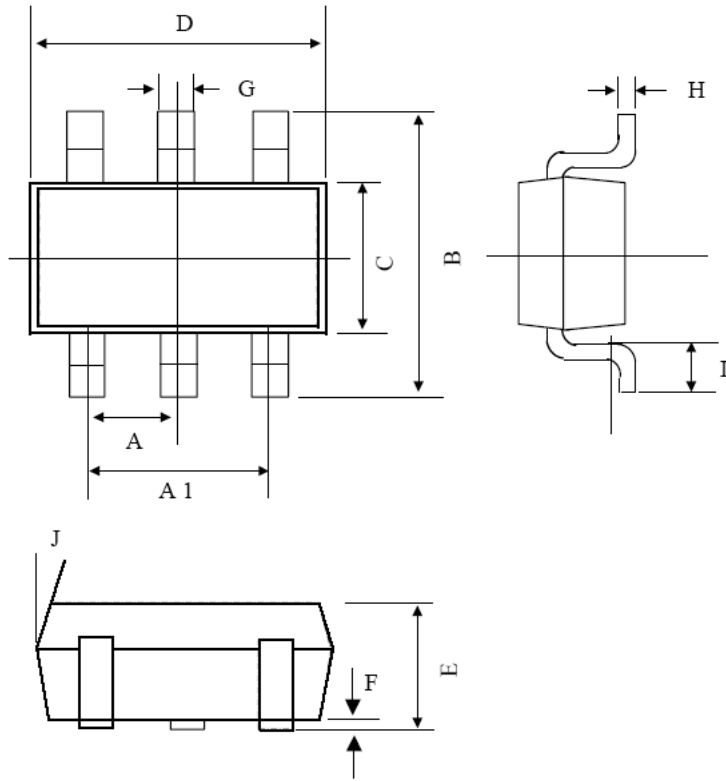


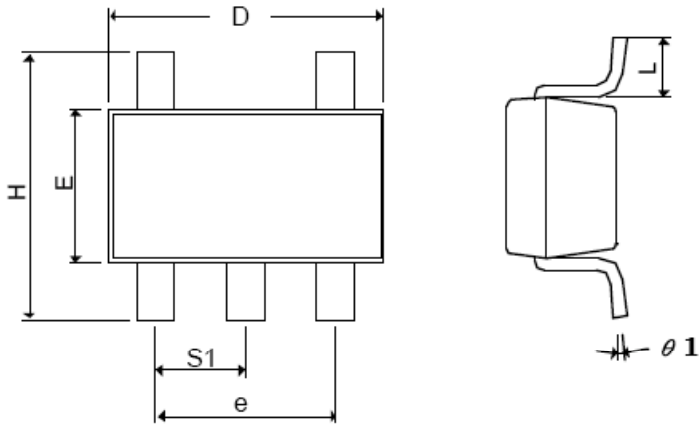
Figure 6. Vdrop vs. Vout

SOT-26 Mechanical Drawing

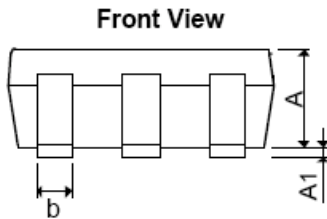


DIM	SOT-26 DIMENSION					
	MILLIMETERS			INCHES		
	MIN	TYP	MAX	MIN	TYP	MAX
A	0.95 BSC			0.0374 BSC		
A1	1.9 BSC			0.0748 BSC		
B	2.60	2.80	3.00	0.1024	0.1102	0.1181
C	1.40	1.50	1.70	0.0551	0.0591	0.0669
D	2.80	2.90	3.10	0.1101	0.1142	0.1220
E	1.00	1.10	1.20	0.0394	0.0433	0.0472
F	0.00	--	0.10	0.00		0.0039
G	0.35	0.40	0.50	0.0138	0.0157	0.0197
H	0.10	0.15	0.20	0.0039	0.0059	0.0079
I	0.30	--	0.60	0.0118	--	0.0236
J	5°	--	10°	5°	--	10°

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	



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