TAIWAN SEMICONDUCTOR

RoHS COMPLIANCE

TS9004 Series

300mA CMOS LDO
Adjustable Voltage with Enable & Power Good

SOT-26

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

SOT-25

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

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.

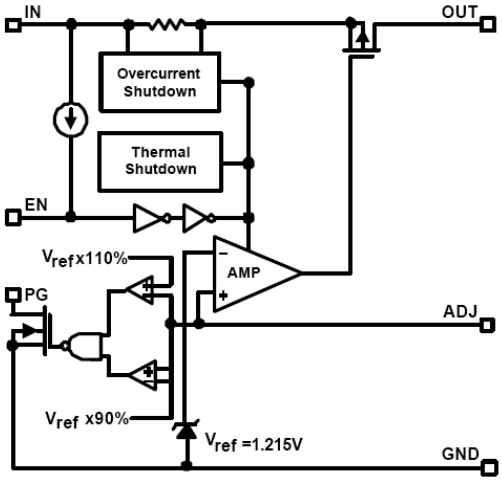
Features

- Very Low Dropout
- Low power consumption: 35uA(typ.)
- Output voltage ±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

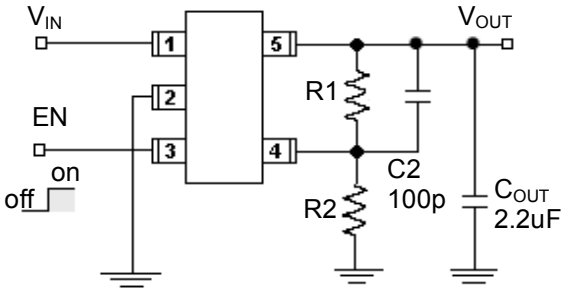
Block Diagram

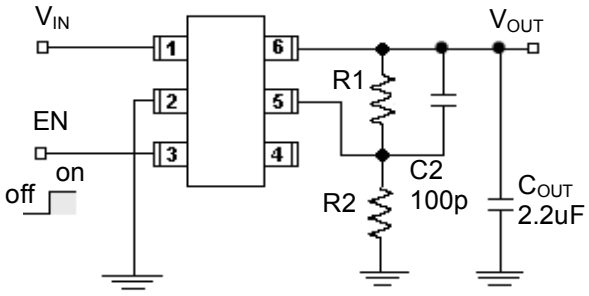


Ordering Information

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

TS9004 Series

300mA CMOS LDO
Adjustable Voltage with Enable & Power Good

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	°C/W
Operating Ambient Temperature Range	T_A	-40 ~ +85	°C
Operating Junction Temperature Range	T_J	-40 ~ +125	°C
Storage Temperature Range	T_{STG}	-65 ~ +150	°C
Lead Soldering Temperature (260°C)		10	S
ESD Classification	HBM	2k	V

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

Electrical Characteristics (Ta = 25°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 =1mA		-2	--	+2	%
Dropout Voltage	V_{DROP}	I_O =300mA V_O =$V_{O(NOM)}$ -2.0%	1.5V< $V_{O(NOM}$ ≤2.0V	--	See chart	1300	mV
			2.0V< $V_{O(NOM}$ ≤2.8V	--		400	
			2.8V< $V_{O(NOM}$ <3.8V	--		300	
Output Current	I_O	V_O >1.2V		300	--	--	mA
Current Limit	I_{LIM}	V_O >1.2V		300	450	--	mA
Short Circuit Current	I_{SC}	V_O <0.8V (Note 2)		--	150	300	mA
Ground Pin Current	I_{GND}	I_O =1mA to 300mA		--	35	--	mA
Line Regulation	REG_{LINE}	I_O =5mA V_{IN}= V_O +1 to V_O +2	V_O < 2.0V	--	--	0.15	%
			V_O ≥ 2.0V	--	0.02	0.1	%
Load Regulation	REG_{LOAD}	I_O =1mA to 300mA		--	0.2	1	%
Over Temperature Shutdown	OTS			--	150	--	°C
Over Temperature Hysterisis	OTH			--	30	--	°C
VO Temperature Coefficient	T_C			--	30	--	ppm/°C
Power Supply Rejection	PSRR	I_O =100mA C_O=2.2mF	f=100Hz	--	60	--	dB
			f=1kHz	--	50	--	
			f=10kHz	--	20	--	
Output Voltage Noise	eN	f=10Hz to 100kHz I_O =10mA,CBYP=0mF	C_O =2.2nF	--	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}=2.7V to 7V		2.0	--	V_{IN}	V
	V_{EL}	V_{IN} =2.7V 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, VO=0V V_{EN} < V_{EL}	--	0.5	1	mA
Shutdown Output Voltage	VO,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

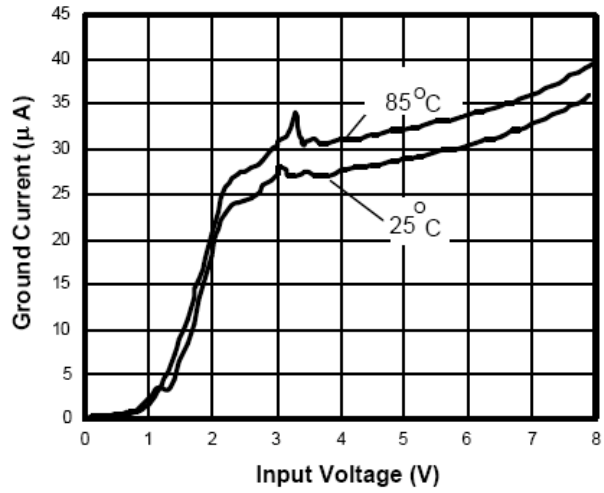


Figure 1. Ground Current vs. Input Voltage

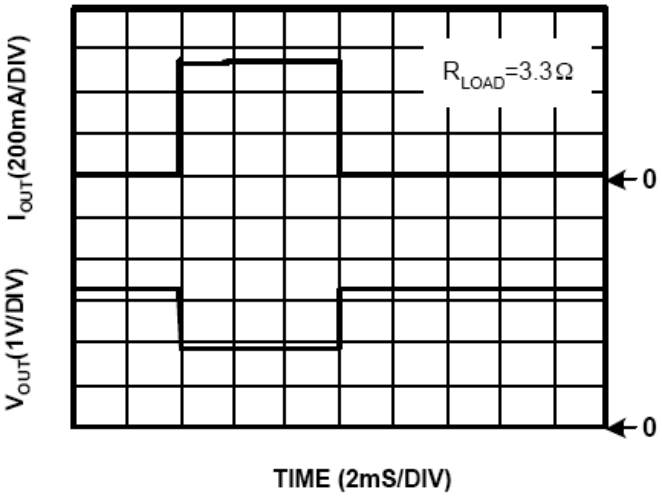


Figure 2. Current Limit Response

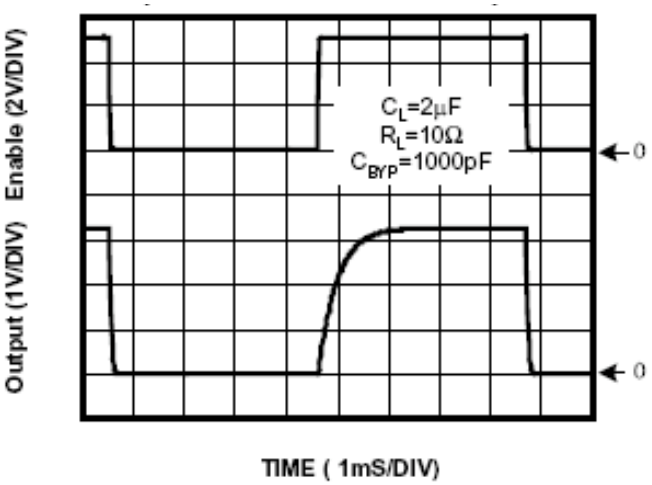


Figure 3. Line Transient Response

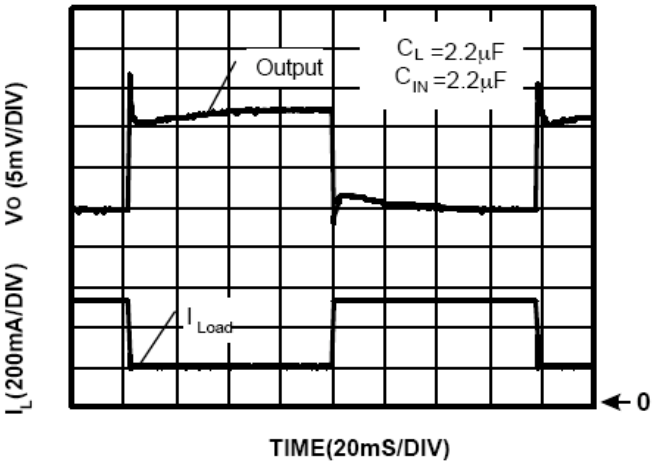


Figure 4. Load Step (1mA~300mA)

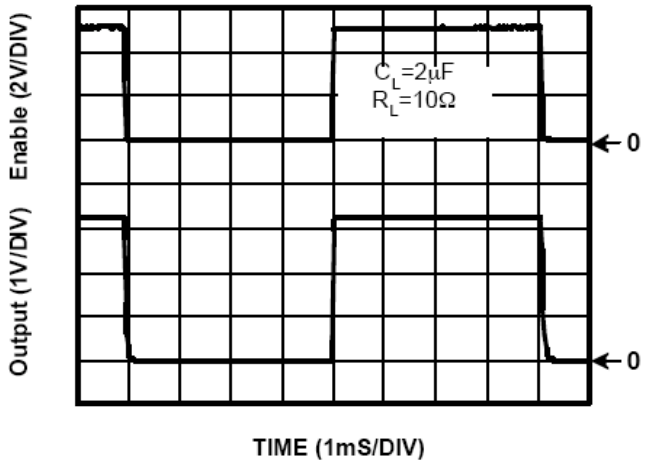


Figure 5. Chip Enable Transient Response

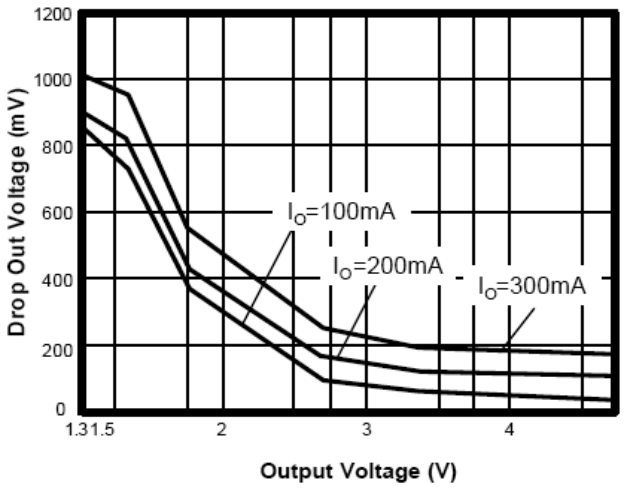
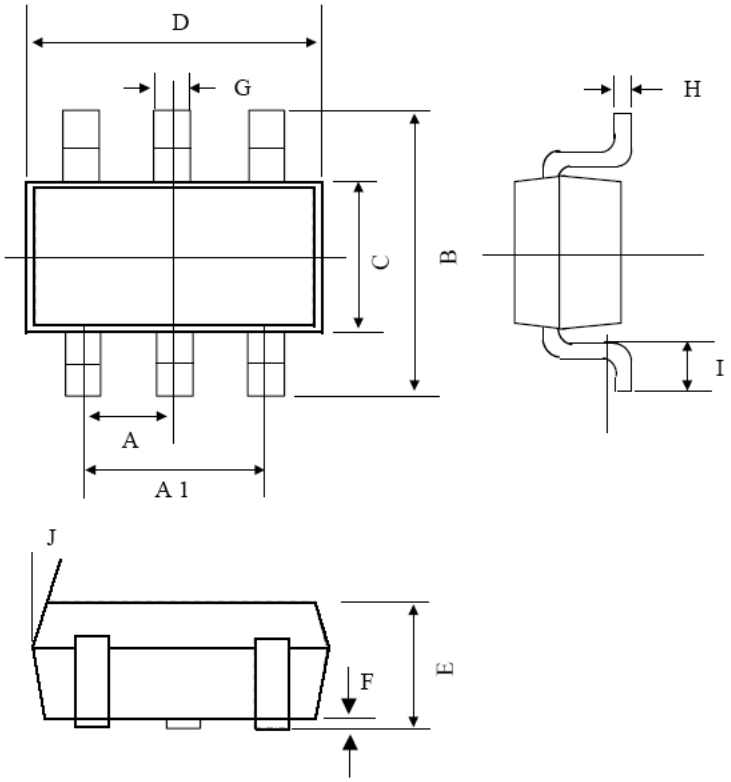


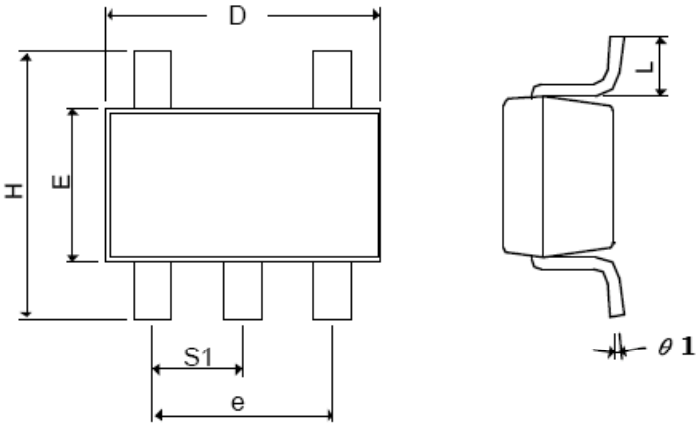
Figure 6. Vdrop vs. Vout

SOT-26 Mechanical Drawing

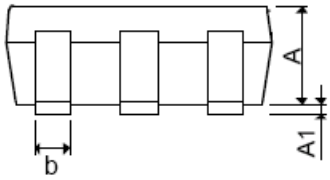


SOT-26 DIMENSION						
DIM	MILLIMETERS			INCHES		
	MIN	TYP	MAX	MIN	TYP	MAX
A	0.95 BSC			0.0374 BSC		
A1	1.9 BSC			0.0748 BSC		
B	2.60	2.80	3.00	0.1024	0.1102	0.1181
C	1.40	1.50	1.70	0.0551	0.0591	0.0669
D	2.80	2.90	3.10	0.1101	0.1142	0.1220
E	1.00	1.10	1.20	0.0394	0.0433	0.0472
F	0.00	--	0.10	0.00		0.0039
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



Front View



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	

Notice

Specifications of the products displayed herein are subject to change without notice. TSC or anyone on its behalf, assumes no responsibility or liability for any errors or inaccuracies.

Information contained herein is intended to provide a product description only. No license, express or implied, to any intellectual property rights is granted by this document. Except as provided in TSC's terms and conditions of sale for such products, TSC assumes no liability whatsoever, and disclaims any express or implied warranty, relating to sale and/or use of TSC products including liability or warranties relating to fitness for a particular purpose, merchantability, or infringement of any patent, copyright, or other intellectual property right.

The products shown herein are not designed for use in medical, life-saving, or life-sustaining applications. Customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify TSC for any damages resulting from such improper use or sale.