

150mA Low-Noise LDO Regulator

FEATURES

- Low output noise of 170µV (rms)
- Ultra-low no-load supply current of 52µA
- Low dropout of 100mV at 50mA load
- Guaranteed 150mA output current
- Over-temperature and short-circuit protection
- Output voltage adjustable from 2.5V to 5.5V
- Max. supply current in shutdown mode < 1µA

DESCRIPTION

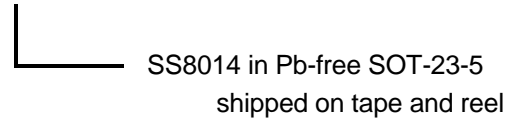
The SS8014G is a low supply-current, low-dropout linear regulator that comes in a space-saving SOT23-5 package. The supply current at no-load is 52µA. In the shutdown mode, the maximum supply current is less than 1µA. Operating voltage range of the SS8014G is from 2.5V to 5.5V. The over-current protection limit is set at 370mA typical and 150mA minimum. An over-temperature protection circuit is built-in to the SS8014G to prevent thermal overload. These power saving features make the SS8014G ideal for use in such battery-powered applications as notebook computers, cellular phones, and PDA's.

APPLICATIONS

- Notebook Computers
- Cellular Phones
- PDA's and other hand-helds
- Digital Still Cameras and Video Recorders
- Bar-code Scanners

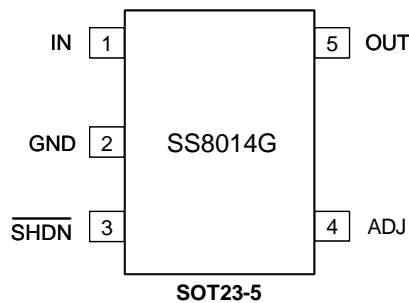
ORDERING INFORMATION

SS8014GTR

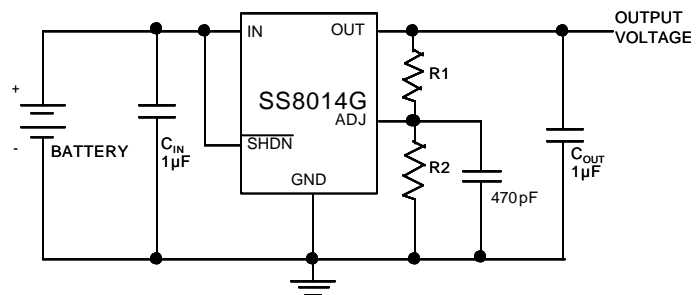


 This device is only available with Pb-free lead finish (second-level interconnect).

PIN CONFIGURATION



TYPICAL CIRCUIT



Adjustable mode

$$V_{OUT} = 1.250 \times (R_2 / R_1 + 1)$$

ABSOLUTE MAXIMUM RATINGS

V _{IN} to GND.....	-0.3V to +7V
Output Short-Circuit Duration.....	Infinite
SET to GND.....	-0.3V to +7V
SHDN to GND.....	-0.3V to +7V
SHDN to IN.....	-7V to +0.3V
OUT to GND.....	-0.3V to (V _{IN} + 0.3V)

Continuous Power Dissipation (T _A = +25°C)	
SOT23-5.....	568 mW
Operating Temperature Range.....	-40°C to +85°C
Junction Temperature.....	+150°C
θ _{JA}	220°C/Watt
Storage Temperature Range.....	-65°C to +160°C
Lead Temperature (soldering, 10sec).....	+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{IN} = V_{OUT} + 1V; V_{SHDN} = V_{IN}; C_{IN} = C_{OUT} = 1μF = T_A = T_J = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage (Note 2)	V _{IN}		Note2		5.5	V
Output Voltage Accuracy	V _{OUT}	Variation from specified V _{OUT} , I _{OUT} =1mA	-3		3	%
Adjustable Output Voltage Range (Note 3)	V _{OUT}		2.5		5.5	V
Maximum Output Current			150			mA
Current Limit	I _{LIM}	V _{OUT} = 0V	250	370		mA
Quiescent Current	I _Q	I _{LOAD} = 0mA		52	80	μA
Dropout Voltage (Note 3)	V _{DROP}	I _{OUT} = 1mA		2		mV
		I _{OUT} = 50mA		100		
		I _{OUT} = 150mA		340	410	
Line Regulation	ΔV _{LNR}	V _{IN} =V _O +0.1V to 5.5V, I _{OUT} = 1mA		0.1	0.4	%/V
Load Regulation	ΔV _{LDR}	I _{OUT} = 0mA to 150mA		8	30	mV
Output Voltage Temperature Coefficient	ΔV _O / ΔT	I _{OUT} = 40mA, T _J = 25°C to 125°C		40		ppm/°C
Output Voltage Noise (10HZ to 100KHZ)	e _n	I _L = 150mA	C _{ADJ} = 470pF		192	μV _{RMS}
			C _{ADJ} = 10nF		170	
SHUTDOWN						
SHDN Input Threshold	V _{IH}	Regulator enabled	2			V
	V _{IL}	Regulator shutdown			0.4	
SHDN Input Bias Current	I _{SHDN}	V _{SHDN} = V _{IN}		0.007	0.1	μA
Shutdown Supply Current	I _{QSHDN}	V _{OUT} = 0V		0.06	1	μA
ADJ INPUT						
ADJ Input Leakage Current	I _{ADJ}	V _{ADJ} = 1.3V		5	30	nA
THERMAL PROTECTION						
Thermal Shutdown Temperature	T _{SHDN}			150		°C
Thermal Shutdown Hysteresis	ΔT _{SHDN}			15		°C

Note 1: Limits are 100% production tested at T_A = +25°C. Low duty pulse techniques are used during tests to maintain junction temperatures as close to ambient as possible.

Note 2: V_{IN(min)} = V_{OUT} + V_{DROP}.

Note 3: The dropout voltage is defined as (V_{IN}-V_{OUT}) when V_{OUT} is 100mV below the value of V_{OUT} for V_{IN} = V_{OUT} +2V.

PIN DESCRIPTION

PIN	NAME	FUNCTION
1	IN	Regulator Input. Supply voltage can range from +2.5V to +5.5V. Bypass with 1μF to GND
2	GND	Ground. This pin also functions as a heatsink. Solder to large pads or the circuit board ground plane to maximize thermal dissipation.
3	$\overline{\text{SHDN}}$	Active-Low Shutdown Input. A logic low reduces the supply current to less than 1μA. Connect to IN for normal operation.
4	ADJ	Adjust (Input): Adjustable regulator feedback input. It can connect to an external resistor divider for adjustable output voltage. A ceramic capacitor of at least 470pF must be connected from ADJ pin to GND to reduce output noise.
5	OUT	Regulator Output. Fixed or adjustable from +2.5V to +5.5V. Sources up to 150mA. Bypass with a capacitor of 1μF, < 0.2Ω typical ESR to GND.

APPLICATIONS INFORMATION

The block diagram of the SS8014 is shown in Figure 1. It consists of an error amplifier, 1.25V bandgap reference, PMOS output transistor, shutdown logic, over-current protection circuit, and over-temperature protection circuit.

The SS8014 can be adjusted to a specific output voltage by using two external resistors (Figure 2). The resistors set the output voltage based on the following equation:

$$V_{\text{OUT}} = 1.250\text{V} \times \left[\frac{R_2}{R_1} + 1 \right]$$

Note that the bandgap voltage is relative to the output, as seen in the block diagram. Because traditional regulators normally have the reference voltage relative to ground, they have a different V_{OUT} equation. Resistor values are not critical because ADJ (adjust) has a high input impedance, but for best results use resistors of 470kΩ or less. A capacitor from ADJ to ground provides greatly improved noise performance.

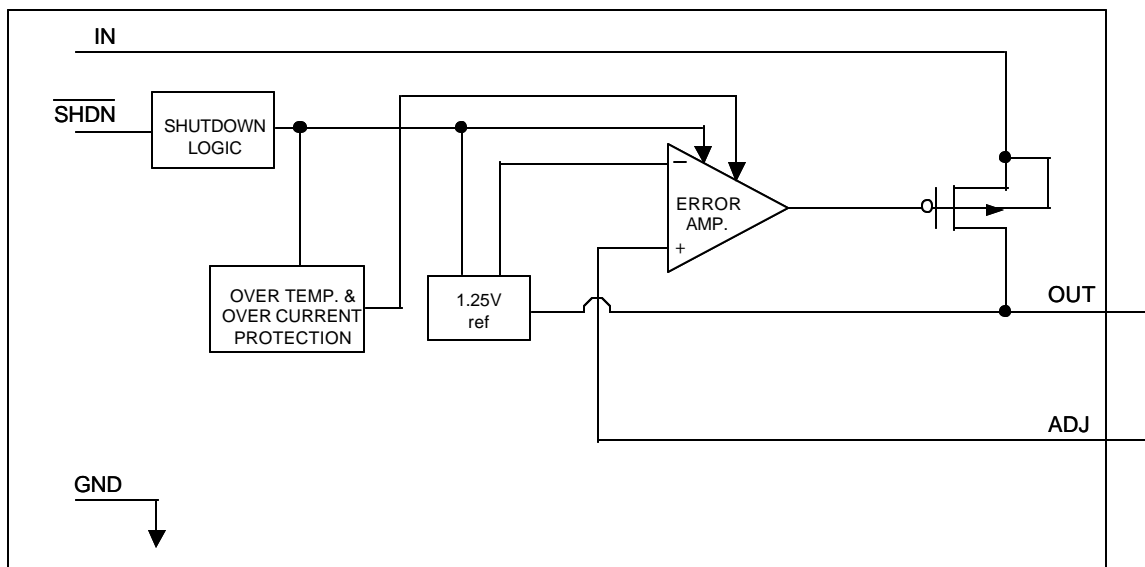


Figure 1. Functional Diagram

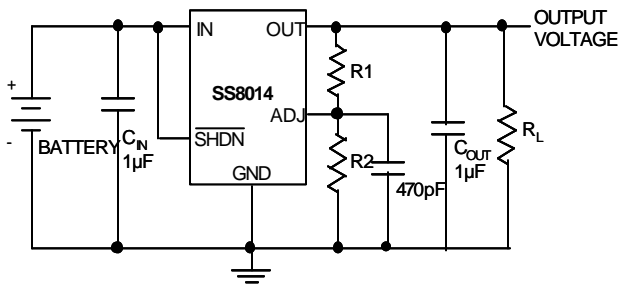


Figure 2. Adjustable Output Using External Feedback Resistors

Over Current Protection

The SS8014 use a current mirror to monitor the output current. A small portion of the PMOS output transistor's current is mirrored onto a resistor such that the voltage across this resistor is proportional to the output current. This voltage is compared against the reference voltage. Once the output current exceeds the limit, the PMOS output transistor enters constant current mode. The current is set to 370mA typically.

Over Temperature Protection

To prevent excessive temperatures from occurring, the SS8014 has a built-in temperature monitoring circuit. When it detects the temperature is above 150°C, the output transistor is turned off. When the temperature drops to below 135°C, the output is turned on again. In this way, the SS8014 is protected against excessive junction temperatures during operation.

Shutdown Mode

When the $\overline{\text{SHDN}}$ pin is connected to a logic-low voltage, the SS8014 enters shutdown mode. All the analog circuits are turned off completely, which reduces the current consumption to only the leakage current. The output is disconnected from the input. When the output has no load at all, the output voltage will be discharged to ground through the internal resistor voltage divider.

Operating Region and Power Dissipation

Since the SS8014 is a linear regulator, its power dissipation is always given by $P = I_{\text{OUT}} (V_{\text{IN}} - V_{\text{OUT}})$. The maximum power dissipation is given by:

$$P_{D(\text{MAX})} = (T_J - T_A) / \Theta_{JA} = 150^\circ\text{C} - 25^\circ\text{C} / 220^\circ\text{C}/\text{W} = 568\text{mW}$$

Where $(T_J - T_A)$ is the temperature difference the SS8014 die and the ambient air, Θ_{JA} , is the thermal resistance

of the chosen package to the ambient air. In the case of a SOT23-5 package, the thermal resistance is typically 220°C/Watt.

The die attachment area of the SS8014's lead frame is connected to pin 2, which is the GND pin. Therefore, the GND pin of SS8014 can carry away the heat of the SS8014 die very effectively. To improve the power dissipation, connect the GND pin to ground using a large ground plane near the GND pin.

Capacitor Selection and Regulator Stability

Normally, use a 1µF capacitor on the input and a 1µF capacitor on the output of the SS8014. Larger input capacitor values and lower ESR provide better supply-noise rejection and transient response. A higher-value input capacitor (10µF) may be necessary if large, fast transients are anticipated and the device is located several inches from the power source.

Power-Supply Rejection and Operation from Sources Other than Batteries

The SS8014 is designed to deliver low dropout voltages and low quiescent currents in battery powered systems. Power-supply rejection is 42dB at low frequencies.

When operating from sources other than batteries, improve supply-noise rejection and transient response by increasing the values of the input and output capacitors, and using passive filtering techniques.

Load Transient Considerations

The SS8014 load-transient response graphs show two components of the output response: a DC shift of the output voltage due to the different load currents, and the transient response. Typical overshoot for step changes in the load current from 0mA to 100mA is 12mV. Increasing the output capacitor's value and decreasing its ESR attenuates transient spikes.

Input-Output (Dropout) Voltage

A regulator's minimum input-output voltage differential (or dropout voltage) determines the lowest usable supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. Because the SS8014 use a P-channel MOSFET pass transistor, the dropout voltage is a function of $R_{\text{DS(ON)}}$ multiplied by the load current.

Layout Guide

An input capacitance of $\sim 1\mu\text{F}$ is required between the SS8014 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.

This input capacitor filters 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 IN 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. This capacitor filters 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. Figure 3 is the suggested PCB layout of SS8014.

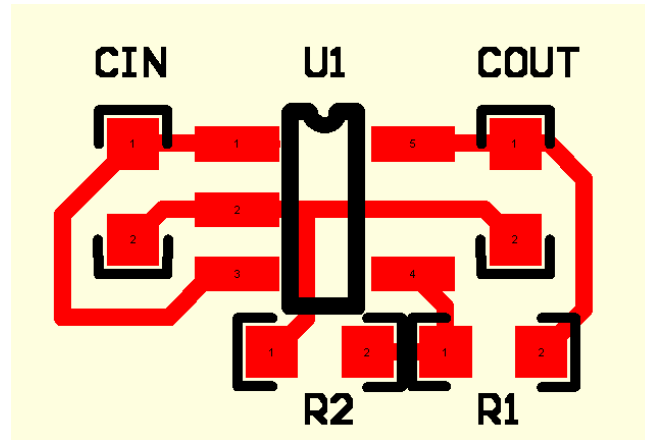
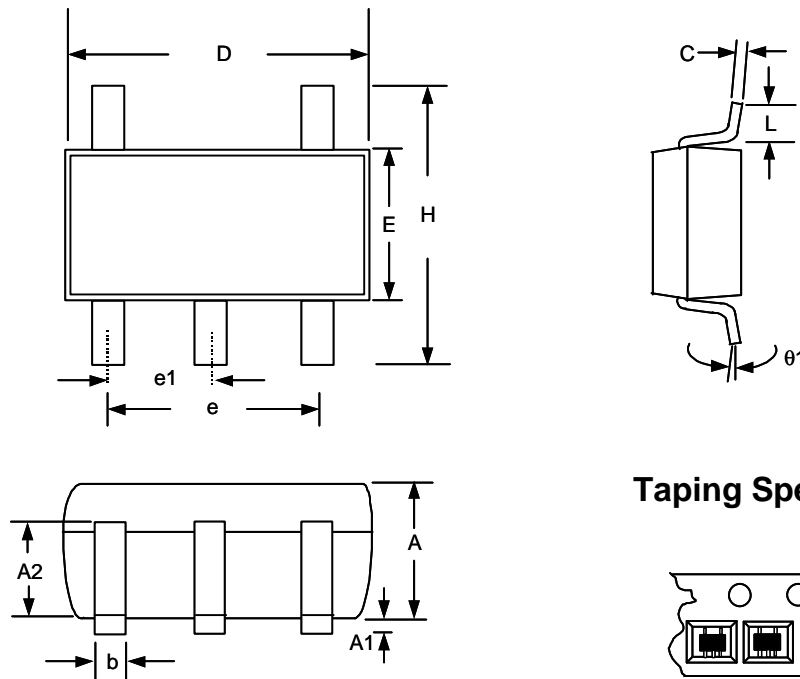
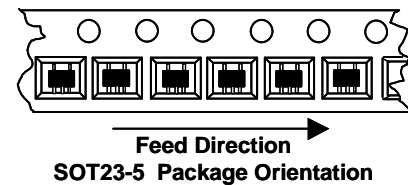


Figure 3. Suggested PCB Layout

*Distance between pin & capacitor must be no more than 1cm

PHYSICAL DIMENSIONS

Taping Specification

Note:

1. Package body sizes exclude mold flash protrusions or gate burrs
2. Tolerance ± 0.1000 mm (4mil) unless otherwise specified
3. Coplanarity: 0.1000mm
4. Dimension L is measured in gage plane

SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	1.00	1.10	1.30
A1	0.00	-----	0.10
A2	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.10	0.15	0.25
D	2.70	2.90	3.10
E	1.40	1.60	1.80
e	-----	1.90(TYP)	-----
e1	-----	0.95	-----
H	2.60	2.80	3.00
L	0.37	-----	-----
?1	1°	5°	9°

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