



# 150mA Low-Dropout Linear Regulators

## Features

- Low, 52µA Ground Current
- Guaranteed 150mA Output Current
- Dropout Voltage is 100mV @ 50mA Load
- Over-Temperature Protection and Short-Circuit Protection
- Adjustable Mode: from 2.5V to 5.5V
- Max. Supply Current in Shutdown Mode < 1µA
- Low Output Noise is 170 µV<sub>RMS</sub>

## Applications

- Notebook Computers
- Cellular Phones
- PDAs
- Digital still Camera and Video Recorders
- Hand-Held Devices
- Bar Code Scanners

## General Description

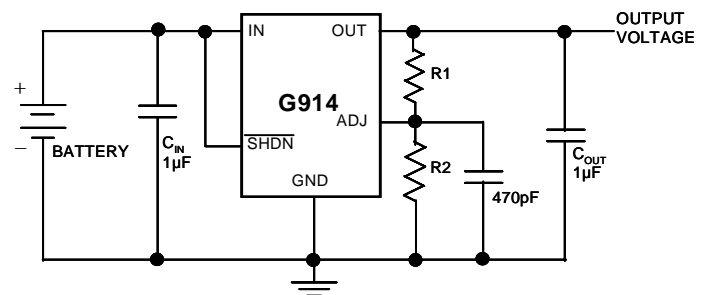
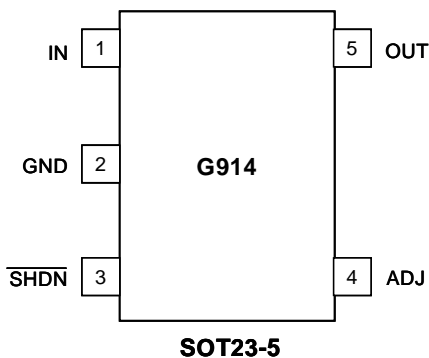
The G914 is a low supply current, low dropout linear regulator that comes in a space saving SOT23-5 package. The supply current at no-load is 52µA. In the shutdown mode, the maximum supply current is less than 1µA. Operating voltage range of the G914 is from 2.5V to 5.5V. The over-current protection limit is set at 370mA typical and 150mA minimum. An overtemperature protection circuit is built-in in the G914 to prevent thermal overload. These power saving features make the G914 ideal for use in the battery-powered applications such as notebook computers, cellular phones, and PDA's.

The G914 is an adjustable output version in a small SOT 23-5 package.

## Ordering Information

PART	MARKING	VOLTAGE	TEMP. RANGE	PIN-PACKAGE
G914	14	Adjustable	-40°C~ +85°C	SOT 23-5

## Pin Configuration



**Adjustable mode**

$$V_{OUT} = 1.250 \times \left( \frac{R_2}{R_1} + 1 \right)$$

**Absolute Maximum Ratings**

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

Continuous Power Dissipation ( $T_A = +25^\circ\text{C}$ )	
SOT23-5.....	568 mW
Operating Temperature Range.....	-40°C to +85°C
Junction Temperature.....	+150°C
$\theta_{JA}$ .....	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**

( $V_{IN} = V_{OUT} + 1V$ ;  $V_{\overline{SHDN}} = V_{IN}$ ;  $C_{IN} = C_{OUT} = 1\mu\text{F}$ ;  $T_A = T_J = +25^\circ\text{C}$ , 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 $V_{OUT}$ , $I_{OUT}=1\text{mA}$	-2		2	%	
Adjustable Output Voltage Range (Note 3)	$V_{OUT}$		2.5		5.5	V	
Maximum Output Current			150			mA	
Current Limit	$I_{LIM}$	$V_{OUT} = 0V$		370		mA	
Ground Pin Current	$I_Q$	$I_{LOAD} = 0\text{mA}$		52	80	$\mu\text{A}$	
		$I_{LOAD} = 150\text{mA}$					
Dropout Voltage (Note 3)	$V_{DROP}$	$I_{OUT} = 1\text{mA}$		2		mV	
		$I_{OUT} = 50\text{mA}$		100			
		$I_{OUT} = 150\text{mA}$		340			
Line Regulation	$\Delta V_{LNR}$	$V_{IN}=V_O + 0.1V$ to 5.5V, $I_{OUT} = 1\text{mA}$		0.1		%/V	
Load Regulation	$\Delta V_{LDR}$	$I_{OUT} = 0\text{mA}$ to 150mA		30		mV	
Output Voltage Temperature Coefficient	$\Delta V_O / \Delta T$	$I_{OUT} = 40\text{mA}$ , $T_J = 25^\circ\text{C}$ to $125^\circ\text{C}$		40		ppm/°C	
Output Voltage Noise (10HZ to 100KHZ)	$e_n$	$I_L = 150\text{mA}$	$C_{ADJ} = 470\text{pF}$		192	$\mu\text{V}_{RMS}$	
			$C_{ADJ} = 10\text{nF}$		170		
<b>SHUTDOWN</b>							
SHDN Input Threshold	$V_{IH}$	Regulator enabled		2		V	
	$V_{IL}$	Regulator shutdown			0.4		
SHDN Input Bias Current	$I_{\overline{SHDN}}$	$V_{\overline{SHDN}} = V_{IN}$	$T_A = +25^\circ\text{C}$		0.007	0.1	$\mu\text{A}$
Shutdown Supply Current	$I_{QSHDN}$	$V_{OUT} = 0V$	$T_A = +25^\circ\text{C}$		0.06	1	$\mu\text{A}$
<b>ADJ INPUT</b>							
ADJ Input Leakage Current	$I_{ADJ}$	$V_{ADJ} = 1.3V$	$T_A = +25^\circ\text{C}$		5	20	nA
<b>THERMAL PROTECTION</b>							
Thermal Shutdown Temperature	$T_{SHDN}$				150		°C
Thermal Shutdown Hysteresis	$\Delta T_{SHDN}$				15		°C

Note 1: Limits is 100% production tested at  $T_A = +25^\circ\text{C}$ . Low duty pulse techniques are used during test to maintain junction temperature 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. It also must connect $\geq 470\text{pF}$ ceramic capacitor from ADJ pin to GND for reduce output noise.
5	OUT	Regulator Output. Fixed or adjustable from +2.5V to +5.5V. Sources up to 150mA. Bypass with a 1μF, $< 0.2\Omega$ typical ESR capacitor to GND.

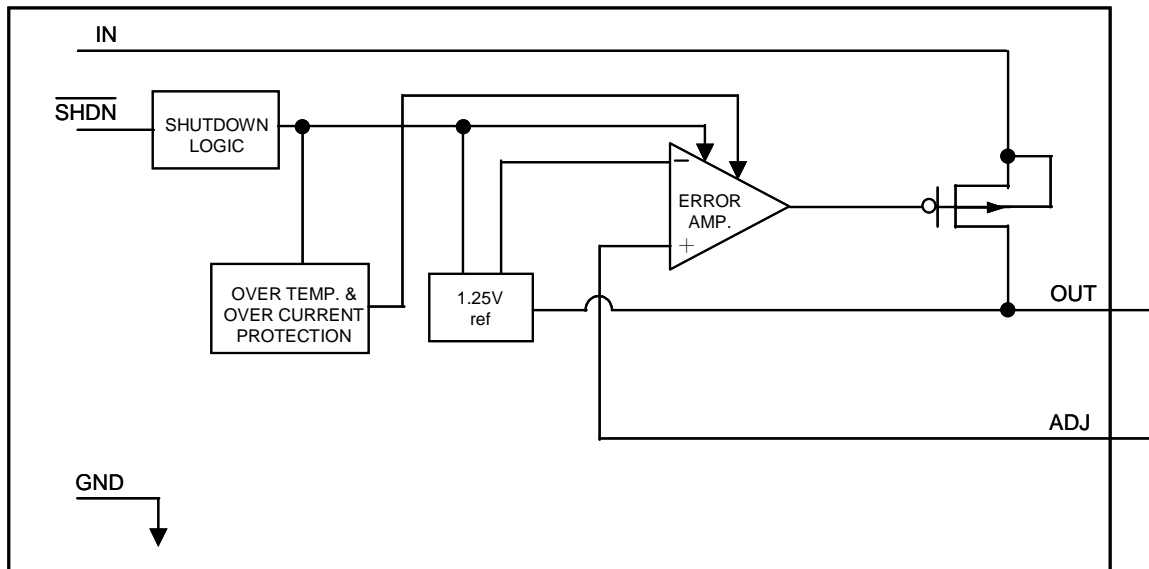
**Detailed Description**

The block diagram of the G914 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 G914 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:

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

This equation is correct due to the configuration of the bandgap reference. The bandgap voltage is relative to the output, as seen in the block diagram. Traditional regulators normally have the reference voltage relative to ground and have a different  $V_{\text{OUT}}$  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**

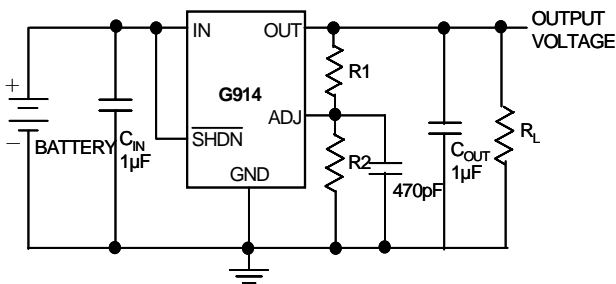


Figure 2. Adjustable Output Using External Feedback Resistors

### Over Current Protection

The G914 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 abnormal temperature from occurring, the G914 has a built-in temperature monitoring circuit. When it detects the temperature is above 150°C, the output transistor is turned off. When the IC is cooled down to below 135°C, the output is turned on again. In this way, the G914 will be protected against abnormal junction temperature during operation.

### Shutdown Mode

When the  $\overline{\text{SHDN}}$  pin is connected a logic low voltage, the G914 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 G914 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:

$$P_{\text{D(MAX)}} = (T_{\text{J}} - T_{\text{A}}) / \theta_{\text{JA}} = 150^{\circ}\text{C} - 25^{\circ}\text{C} / 220^{\circ}\text{C/W} = 568\text{mW}$$

Where  $(T_{\text{J}} - T_{\text{A}})$  is the temperature difference the G914 die and the ambient air,  $\theta_{\text{JA}}$  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 G914's lead frame is connected to pin 2, which is the GND pin. Therefore, the GND pin of G914 can carry away the heat of the G914 die very effectively. To improve the power dissipation, connect the GND pin to ground using a large ground plane near the GND pin.

## Applications Information

### Capacitor Selection and Regulator Stability

Normally, use a 1µF capacitor on the input and a 1µF capacitor on the output of the G914. 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 G914 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 G914 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 G914 use a P-channel MOSFET pass transistor, their dropout voltage is a function of  $R_{\text{DS(ON)}}$  multiplied by the load current.

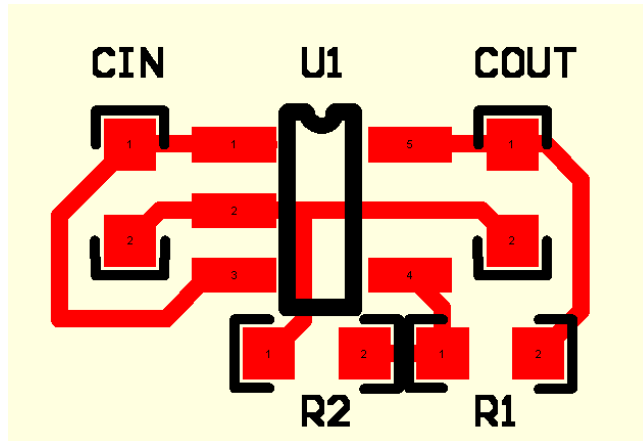
### Layout Guide

An input capacitance of  $\cong 1\mu\text{F}$  is required between the G914 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 IN pin may exceed the absolute maximum rating.

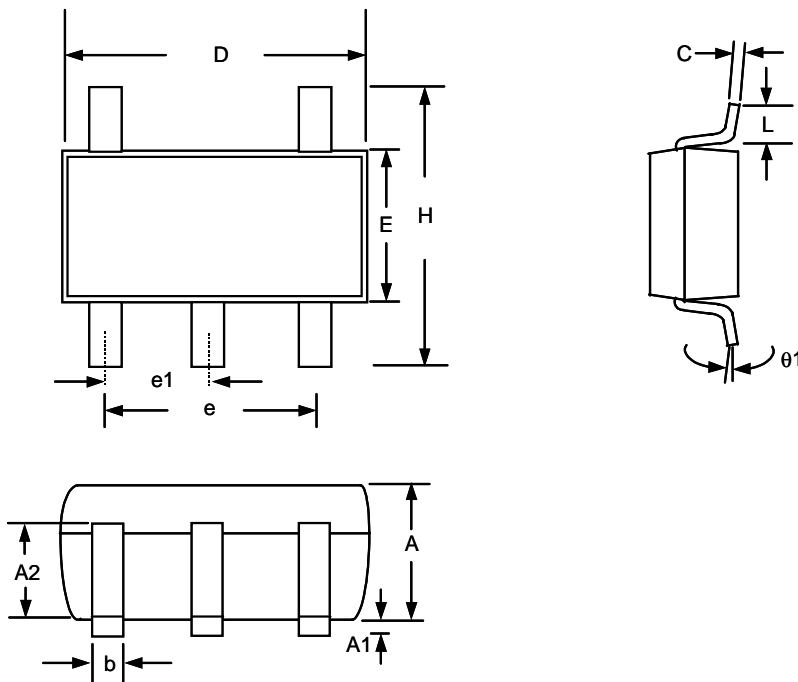
The output capacitor also must be located a distance of not more than 1cm from output to a clean analog ground. Because it can filter out the output spike caused by the surge current due to the inductive effect of the package pin and the printed circuit board's routing wire. Figure 3 is suggested PCB layout of G914.



**Figure 3. Suggested PCB Layout**

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

Package Information



Note:

1. Package body sizes exclude mold flash protrusions or gate burrs
2. Tolerance  $\pm 0.1000$  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	-----	-----
$\theta 1$	$1^\circ$	$5^\circ$	$9^\circ$

Taping Specification

