300mA High PSRR, Low Noise, LDO Regulators

Features

- Low, 100µA No-Load Supply Current
- Guaranteed 300mA Output Current
- Dropout Voltage is 200mV @ 150mA Load
- PSRR=65dB
- Over-Temperature Protection and Short-Circuit Protection
- Adjustable Mode: from 1.2V to 5.5V
- Max. Supply Current in Shutdown Mode < 1µA
- Stable with low cost ceramic capacitors

Applications

- Notebook Computers
- Cellular Phones
- PDAs
- Digital still Camera and Video Recorders
- Hand-Held Devices
- Audio Codec

General Description

The G917 series is a low supply current, high PSRR, low noise, and low dropout linear regulator that comes in a space saving SOT-23-5 package. The supply current at no-load is 100µA. In the shutdown mode, the maximum supply current is less than 1µA. Operating voltage range is from 2.5V to 6.0V. The over-current protection limit is set at 750mA typical. An over- temperature protection circuit is built-in in the Device to prevent thermal overload. These power saving features make the G917 series ideal for use in the battery-powered applications such as notebook computers, cellular phones, and PDA's.

The G917 has two modes of operation. When the SET pin is connected to ground, its output is a pre-set value: 3.3V. There is no external component needed. When an output other than the preset value is needed, two external resistors should be used as a voltage divider. The output voltage is then adjusted by the resistor ratio.

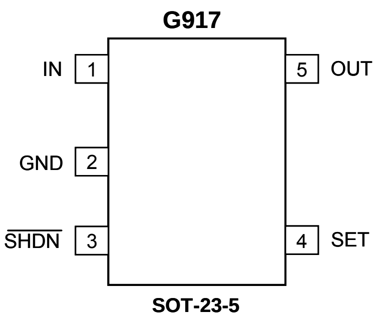
Ordering Information

ORDER NUMBER	MARKING	VOLTAGE	TEMP. RANGE	PACKAGE (Green)
G917T11U	917xx	Adjustable	-40°C~ +85°C	SOT-23-5

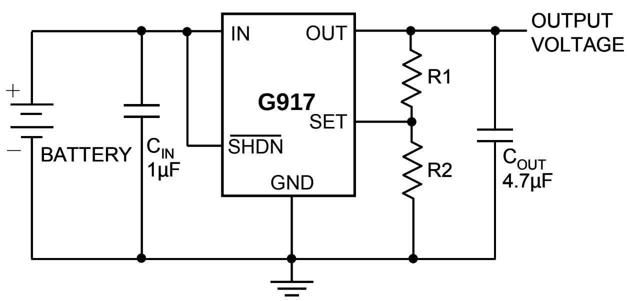
For other output voltage, please contact us at sales@gmt.com.tw

Note:T1: SOT-23-5
1: Bonding Code
U: Tape & Reel

Pin Configuration



Typical Application Circuit



Adjustable mode

Absolute Maximum Ratings

IN to GND. . . . . -0.3V to 7V
Output Short-Circuit Duration . . . . .Infinite
SET, BYP 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)
Thermal Resistance Junction to Ambient, (θ_{JA})*
SOT-23-5 . . . . 240°C/W

Continuous Power Dissipation (T_A = +25°C)*
SOT-23-5 . . . . 0.5W
Thermal Resistance Junction to Case, (θ_{JC})
SOT-23-5 . . . . 60°C/W
Operating Temperature Range . . . . -40°C to 85°C
Junction Temperture . . . . 150°C
Storage Temperature Range . . . . -65°C to 160°C
Reflow Temperature (soldering, 10sec) . . . . .260°C
ESD Rating (Human Body Model) 2kV

* Please refer to “Minimum Footprint PCB Layout Section”.

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} =3.6V, $V_{\overline{SHDN}}$ =V_{IN}, T_A =25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITION		MIN	TYP	MAX	UNIT
Input Voltage (Note 2)	V_{IN}			2.5	---	6.0	V
Output Voltage Accuracy	V_{OUT}	Variation from specified V_{OUT}, I_{OUT}=1mA		-2	---	2	%
Adjustable Output Voltage Range (Note 3)	V_{OUT}			V_{SET}	---	5.5	V
Maximum Output Current				300	---	---	mA
Current Limit (Note 4)	I_{LIM}			500	750	---	mA
Short Circuit Current	Isc			---	280	---	mA
Ground Pin Current	I_Q			---	100	---	µA
Dropout Voltage (Note 5)	V_{DROP}	I_{OUT} =300mA	V_{OUT}=1.50V	---	1.36	1.8	V
			V_{OUT}=1.80V	---	1.10	1.5	
			V_{OUT}=2.50V	---	0.58	0.8	
			V_{OUT}=3.00V	---	0.41	0.5	
			V_{OUT}=3.30V	---	0.4	0.5	
			V_{OUT}=4.75V	---	0.25	0.5	
			V_{OUT}=5.00V	---	0.24	0.5	
Line Regulation	ΔV_{LNR}	SET=GND, V_{IN}=$V_{(STD)}$+0.1V to 6.2V I_{OUT}=10mA		---	0.06	0.12	%/V
Load Regulation	ΔV_{LDR}	I_{OUT}=10mA to 300mA		---	---	0.02	%/mA
Ripple Rejection	PSRR	F=120Hz, 0.45V_{P-P}, I_{OUT}=10mA		---	65	---	dB
Output Voltage Noise (10Hz to 100kHz)	e_n	I_{OUT}=1mA,		---	120	---	μV_{RMS}

Electrical Characteristics (continued)

(V_{IN} =3.6V, $V_{\overline{SHDN}}$ =V_{IN}, T_A =25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITION		MIN	TYP	MAX	UNIT
SHUTDOWN							
$\overline{SHDN}$ Input Threshold	V_{IH}	Regulator enabled		1.5	---	---	V
	V_{IL}	Regulator shutdown		---	---	0.4	
$\overline{SHDN}$ Input Bias Current	$I_{\overline{SHDN}}$	$V_{\overline{SHDN}}$ = V_{IN}	T_A = +25°C	---	0.003	0.1	µA
Shutdown Supply Current	I_{QSHDN}	V_{OUT} = 0V	T_A = +25°C	---	0.2	1	µA
SET INPUT							
SET Reference Voltage (Note 3)	V_{SET}	V_{IN} = 2.5V to 5.5V, I_{OUT} = 1mA	T_A = +25°C	1.176	1.2	1.224	V
			T_A = T_{MIN} to T_{MAX}	---	1.2	---	
SET Input Leakage Current (Note 3)	I_{SET}	V_{SET} = 1.3V	T_A = +25°C	---	5	30	nA
THERMAL PROTECTION							
Thermal Shutdown Temperature	T_{SHDN}			---	150	---	°C
Thermal Shutdown Hysteresis	ΔT_{SHDN}			---	20	---	°C

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

Note 2: Guaranteed by line regulation test.

Note 3: Adjustable mode only.

Note 4: Not tested. For design purposes, the current limit should be considered 500mA minimum to 750mA maximum.

Note 5: The dropout voltage is defined as (V_{IN}-V_{OUT}) when V_{OUT} is 100mV below the target value of V_{OUT}.

Pin Description

PIN	NAME	FUNCTION
1	IN	Regulator Input. Supply voltage can range from +2.5V to +6.0V. 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	SET	Feedback Input for Setting the Output Voltage. Connect to an external resistor divider for adjustable-output operation.
5	OUT	Regulator Output. Sources up to 300mA. Bypass with a 4.7µF, ＜0.3Ω typical ESR capacitor to GND.

Detailed Description

The block diagram of the G917 is shown in Figure 1. It consists of an error amplifier, 1.2V bandgap reference, PMOS output transistor, internal feedback voltage divider, mode comparator, shutdown logic, over current protection circuit, and over temperature protection circuit.

The mode comparator compares the SET pin voltage with an internal 350mV reference. If the SET pin voltage is less than 350mV, the internal feedback voltage divider's central tap is connected to the non-inverting input of the error amplifier. The error amplifier compares non-inverting input with the 1.2V bandgap reference. If the feedback voltage is higher than 1.2V, the error amplifier's output becomes higher so that the PMOS output transistor has a smaller gate-to-source voltage (V_{GS}). This reduces the current carrying capability of the PMOS output transistor, as a result the output voltage decreases until the feedback voltage is equal to 1.2V. Similarly, when the feedback voltage is less than 1.2V, the error amplifier causes the output PMOS to source more current to pull the feedback voltage up to 1.2V. Thus, through this feedback action, the error amplifier, output PMOS, and the voltage dividers effectively form a unity-gain amplifier with the feedback voltage force to be the same as the 1.2V bandgap reference. The output voltage, V_{OUT}, is then given by the following equation:

$$V_{OUT} = 1.2\ (1 + R1/R2). \qquad (1)$$

Alternatively, the relationship between R1 and R2 is given by:

$$R1 = R2\ (V_{OUT}/1.2 - 1). \qquad (2)$$

For the reasons of reducing power dissipation and loop stability, R2 is chosen to be 100kΩ. For G917, R1 is 175kΩ, and the pre-set VOUT is 3.30V.

When external voltage divider is used, as shown in Figure 2, the SET pin voltage will be larger than 350mV. The non-inverting input of the amplifier will be connected to the external voltage divider. However, the operation of the feedback loop is the same, so that the conditions of Equations 1 and 2 are still true. The output voltage is still given by Equation 1.

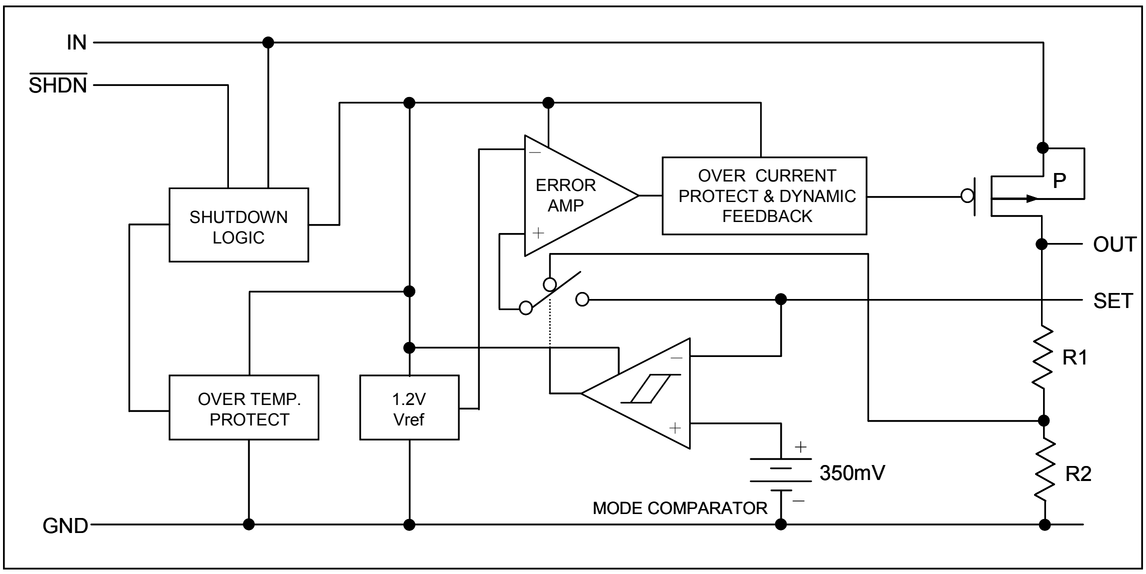


Figure 1. Functional Diagram of Adjustable-mode

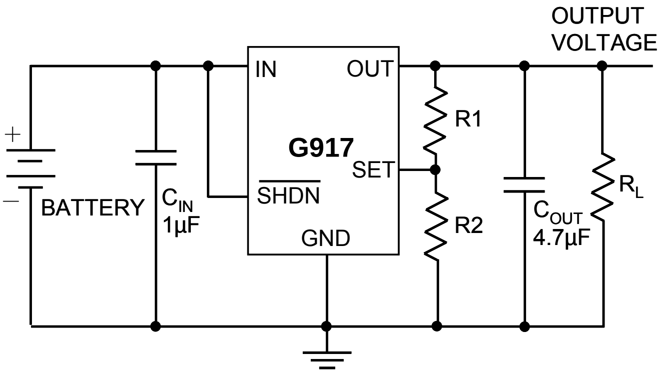


Figure 2. Adjustable Output Using External Feedback Resistors

Over Current Protection
The G917 uses a current sense-resistor to monitor the output current. A portion of the PMOS output transistor's current is mirrored to a resistor such that the voltage across this resistor is proportional to the output current. Once the output current exceeds limit threshold, G917 would be protected with a limited output current. Further more, when the output is short to ground, the output current would be folded-back to a less limit.

Over Temperature Protection
To prevent abnormal temperature from occurring, the G917 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 130°C, the output is turned on again. In this way, the G917 will be protected against abnormal junction temperature during operation.

Shutdown Mode
When the $\overline{\text{SHDN}}$ pin is connected a logic low voltage, the G917 enters shutdown mode. All the analog circuits are turned off completely, which reduces the current consumption to only the leakage current. The G917 output pass transistor would get into high impedance level. There is an internal discharge path to help to shorten discharge delay time.

Operating Region and Power Dissipation
Since the G917 is a linear regulator, its power dissipation is always given by $P = I_{OUT}$ $(V_{IN} - V_{OUT})$. The maximum power dissipation is given by:

$$P_{D(MAX)} = (T_J - T_A) / \theta_{JA}, = (150°C - 25°C)/240°C/W = 520mW$$

Where $(T_J - T_A)$ is the temperature difference the G917 die and the ambient air, θ_{JA}, is the thermal resistance of the chosen package to the ambient air. For surface mount device, heat sinking is accomplished by using the heat spreading capabilities of the PC board and its copper traces. In the case of a SOT-23-5 package, the thermal resistance is typically 240°C/Watt. (See Recommended Minimum Footprint). Refer to Figure 3a & 3b is the G917 valid operating region (Safe Operating Area) & refer to Figure 4 is maximum power dissipation of SOT-23-5.

The die attachment area of the G917's lead frame is connected to pin 2, which is the GND pin. Therefore, the GND pin of G917 can carry away the heat of the G917 die very effectively. To improve the maximum power providing capability, 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 4.7µF capacitor on the output of the G917. 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 G917 is designed to deliver low dropout voltages and low quiescent currents in battery powered systems. Power-supply rejection is 65dB at low frequencies. As the frequency increases above 20kHz, the output capacitor is the major contributor to the rejection of power-supply noise.

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 G917 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 10mA to 300mA is 20mV. 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 G917 use a P-channel MOSFET pass transistor, their dropout voltage is a function of $R_{DS(ON)}$ multiplied by the load current.

Layout Guide

An input capacitance of ≅ 1µF is required between the G917 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 5 is adjustable mode of G917 PCB layout.

Safe Operating Area of I_{OUT}=150mA
[Power Dissipation Limit]

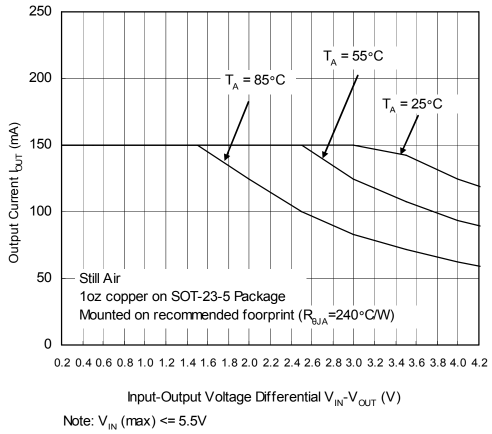


Figure 3a. Safe Operating Area (I_{OUT}=150mA)

Safe Operating Area of I_{OUT}=300mA
[Power Dissipation Limit]

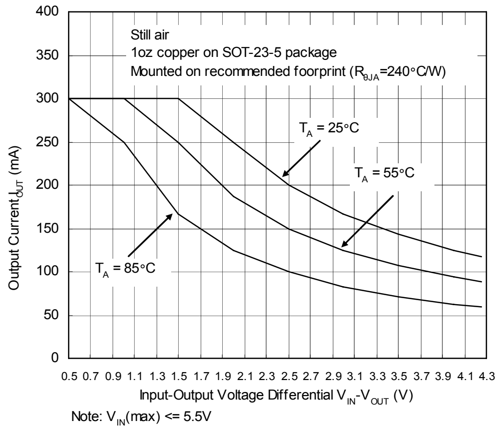


Figure 3b. Safe Operating Area (I_{OUT}=300mA)

Maximum Power Dissipation of SOT-23-5

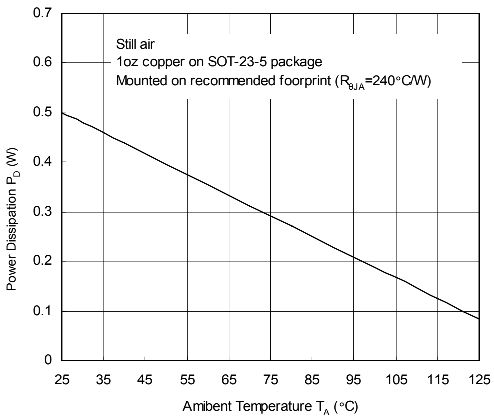
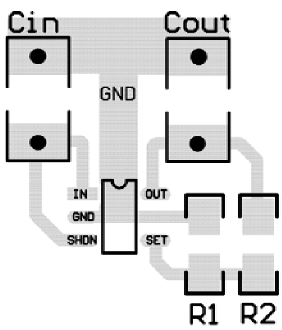


Figure 4. Power Dissipation vs. Ambient Temperature

Reference PCB Layout

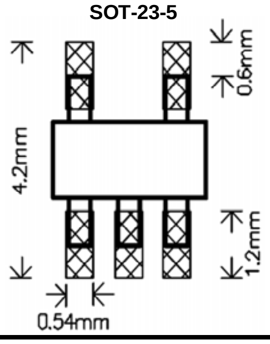
SOT-23-5



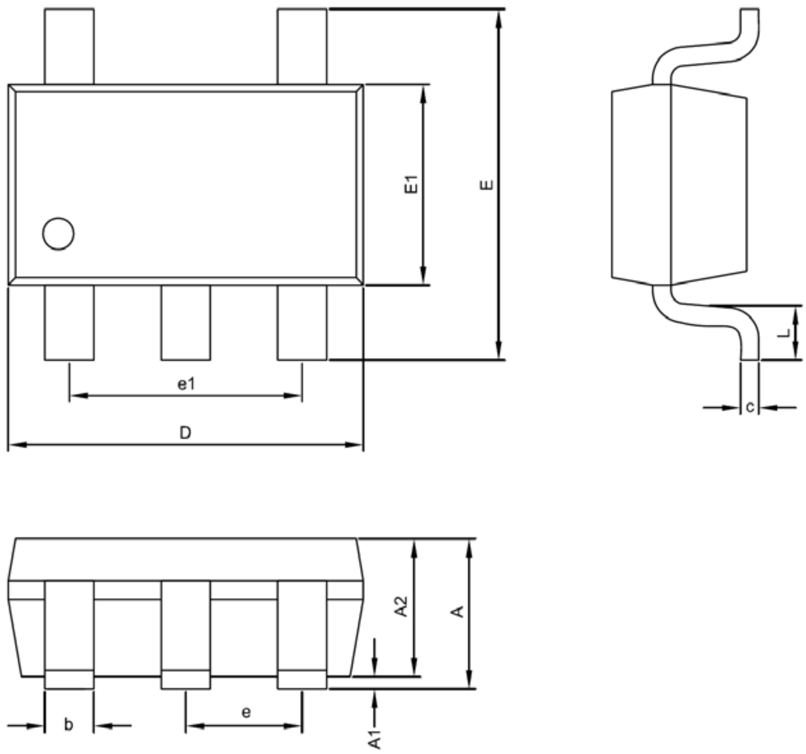
*Distance between pin & capacitor must no more than 1cm

Minimum Footprint PCB Layout Section

SOT-23-5



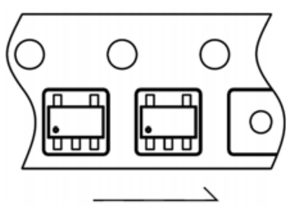
Package Information



SOT-23-5 (T1) Package

Symble	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.00	1.10	1.45	0.039	0.043	0.057
A1	0.00	- - -	0.15	0.000	- - -	0.006
A2	1.00	1.10	1.30	0.039	0.043	0.051
D	2.70	2.90	3.10	0.106	0.114	0.122
E	2.60	2.80	3.00	0.102	0.110	0.118
E1	1.50	1.60	1.70	0.059	0.063	0.067
c	0.08	0.15	0.25	0.003	0.006	0.010
b	0.30	0.40	0.50	0.012	0.016	0.020
e	0.95 BSC			0.037 BSC		
e1	1.90 BSC			0.075 BSC		
L	0.30	0.45	0.60	0.012	0.018	0.024

Taping Specification



PACKAGE	Q'TY/REEL
SOT-23-5	3,000 ea