

### Description

The GM2950 and GM2951 is a low power voltage regulator. This device is an excellent choice for use in battery powered application such as cordless telephone, radio control systems, and portable computers.

The GM2950/GM2951 features very low quiescent current (75 $\mu$ A Typ.) and very low drop output voltage (Typ. 40mV at light load and 380mV at 100mA). This includes a tight initial tolerance of 0.5% typ., extremely good load and line regulation of 0.05% typ., and very low output temperature coefficient, making the GM2950/ GM2951 useful as a low power voltage reference.

The GM2951 is available in 8-pin plastic packages. The regulator output voltage may be pin-strapped for a -XX volt or programmed from 1.24 volt to 29 volts with external pair of resistors.

The GM2950 is offered in 3-pin TO-92 package compatible with other fixed regulator.

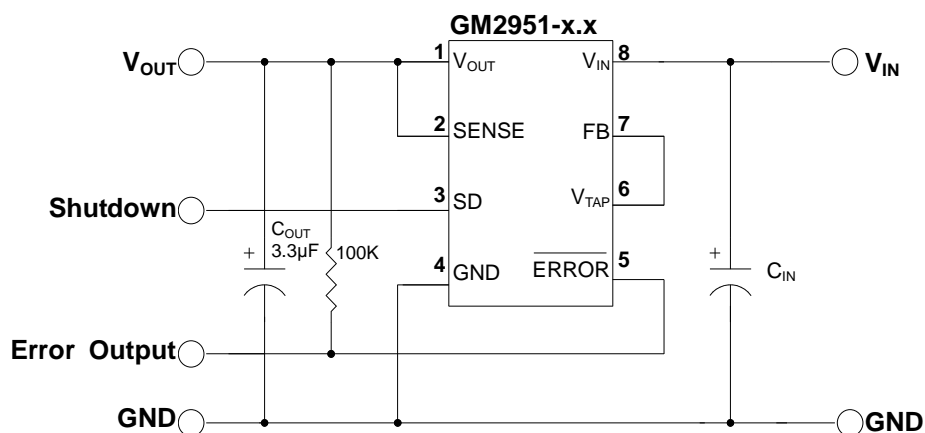
### Features

- High accuracy output voltage
- Guaranteed 100mA output
- Very low quiescent current
- Low dropout voltage
- Extremely tight load and line regulation
- Very low temperature coefficient
- Needs only 1 $\mu$ F capacitor for stability
- Error flag warns of output dropout
- Logic-controlled electronic shutdown
- Output programmable from 1.24V to 29V

### Applications

- Battery powered systems
- Cordless telephones
- Radio control systems
- Portable/Palm top/Notebook computers
- Portable consumer equipments
- Portable Instruments
- Automotive electronics
- SMPS Post regulator
- Voltage Reference

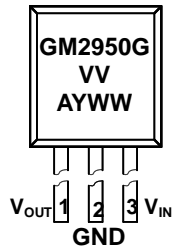
### Typical Application Circuit



## Marking Information and Pin Configurations (Top View)

### GM2950-x.x

TO-92

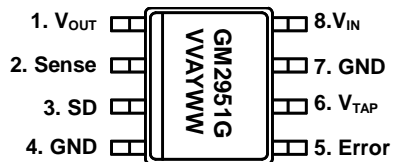


G: Green Product  
 VV: Output Voltage Codes (05: 5.0V, ...12:12V)  
 A: Assembly/Test Site Code  
 Y: Year  
 WW: Week

## Marking Information and Pin Configurations (Top View)

### GM2951-x.x

SO8



G: Green Product  
 VV: Output Voltage Codes (A: Adj, 05: 5.0V, ...12:12V)  
 A: Assembly/Test Site Code  
 Y: Year  
 WW: Week

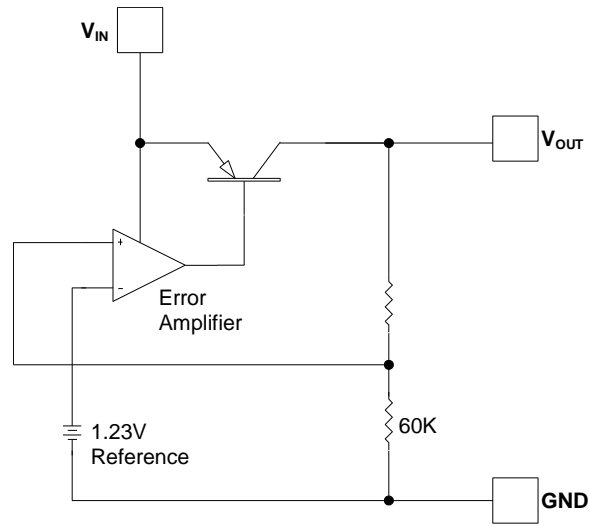
## Ordering Information

GM2950-x.x			
Ordering Number	Output voltage	Package	Shipping
GM2950-3.3T92BG	3.3V	TO-92	1,000 Units/ESD Bag
GM2950-3.3T92RLG	3.3V	TO-92	2,000 Units/Ammo Pack (Tape)
GM2950-5.0T92BG	5.0V	TO-92	1,000 Units/ESD Bag
GM2950-5.0T92RLG	5.0V	TO-92	2,000 Units/Ammo Pack (Tape)
GM2951-x.x			
GM2951-3.3S8RG	3.3V	SO-8	2,500 Units/Tape & Reel
GM2951-5.0S8RG	5.0V	SO-8	2,500 Units/Tape & Reel

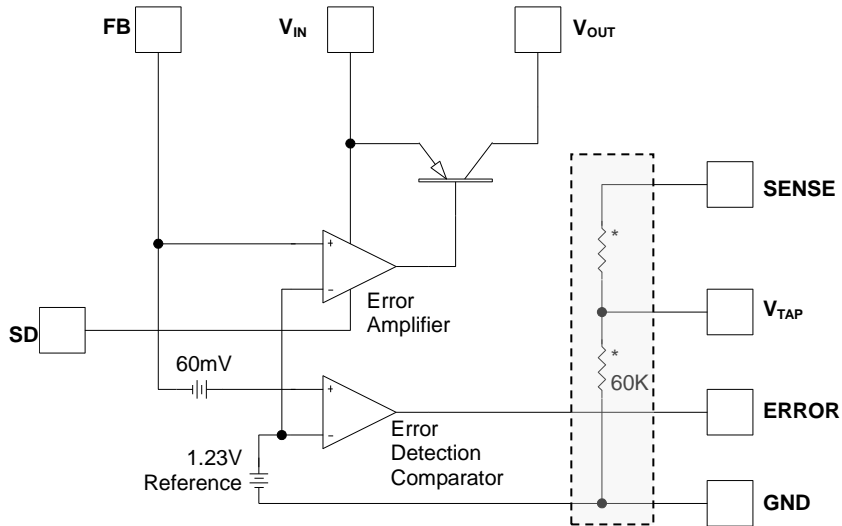
## Absolute Maximum Ratings

PARAMETER	SYMBOL	RATINGS	UNITS
V <sub>IN</sub> Pin Voltage	V <sub>IN</sub>	-0.3 to +30	V
FB Pin Voltage	V <sub>FB</sub>	-1.5 to +30	V
SD Pin Voltage	V <sub>SD</sub>	-0.3 to +30	V
Error Pin Voltage	V <sub>ERR</sub>	-0.3 to +30	V
Operating Junction Temperature Range	T <sub>J</sub>	- 40 to +150	°C
Storage Temperature	T <sub>STG</sub>	- 65 to +150	°C
Thermal Resistance, Junction to Ambient (SO8 package)	θ <sub>JA</sub>	180	°C/W
Thermal Resistance, Junction to Ambient (SO8 package)	θ <sub>JC</sub>	45	°C/W
Lead Temperature 1.6mm (1/6 inch) from case for 5 seconds	T <sub>LEAD</sub>	260	°C
ESD Rating (Human Body Model)	ESD	2	kV

## Block Diagram



GM2950-x.x Block Diagram



GM2951-x.x Block Diagram

\* for fixed output voltage option only

**Electrical Characteristics** (Unless otherwise noted,  $V_{IN} = V_{OUT} + 1V$ ,  $I_{OUT} = 100\mu A$ ,  $C_{OUT} = 1\mu F$ , and  $T_J = 25^\circ C$ )

Parameter	Symbol	Test Condition (Note 1)	Min	Typ	Max	Unit
Output Voltage	$V_{OUT}$	$T_J = 25^\circ C$	$0.99V_{OTYP}$	$V_{OTYP}$	$1.01V_{OTYP}$	V
		$-25^\circ C \leq T_J \leq 85^\circ C$	$0.985V_{OTYP}$	$V_{OTYP}$	$1.015V_{OTYP}$	
		Full Operating Temperature	$0.98V_{OTYP}$	$V_{OTYP}$	$1.02V_{OTYP}$	
Output Voltage Temperature Coefficient		(Note 2)		50	150	ppm/ $^\circ C$
Line Regulation	LNR	$V_{OUT} + 1V \leq V_{IN} \leq 30V$		0.04	0.2	%
Load Regulation (Note 3)	LDR	$100\mu A \leq I_{OUT} \leq 100mA$		0.1	0.3	%
Dropout Voltage (Note 4)	$V_D$	$I_{OUT} = 100\mu A$		50	80	mV
		$I_{OUT} = 100mA$		380	450	
Ground Current	$I_{GND}$	$I_{OUT} = 100\mu A$		75	120	$\mu A$
		$I_{OUT} = 100mA$		3	12	mA
Dropout Ground Current	$I_{DG}$	$V_{IN} = V_{OUT} - 0.5V$ , $I_{OUT} = 100\mu A$		110	170	$\mu A$
Current Limit	$I_{CL}$	$V_{OUT} = 0V$		160	200	mA
Thermal Regulation	$T_{REG}$			0.05	0.2	%/W
Output Noise, 10Hz to 100KHz		$C_{OUT} = 1\mu F$		430		$\mu V_{RMS}$
		$C_{OUT} = 200\mu F$		160		
		$C_{OUT} = 3\mu F$ (Bypass = 0.01, pin 7 to pin 1, GM2951-x.x Only)		100		
<b>GM2951-x.x Only</b>						
Reference Voltage	$V_{REF}$		1.21	1.235	1.26	V
		Full Operating Temperature	1.185		1.285	
Feedback Pin Bias Current	$I_{FB}$			20	40	nA
Reference Voltage Temperature Coefficient		(Note 2)		50		ppm/ $^\circ C$
Feedback Pin Bias Current Temperature Coefficient				0.1		nA/ $^\circ C$
<b>ERROR COMPARAMETER</b>						
Output Leakage Current	$I_{LK}$	$V_{OH} = 30V$		0.01	1.0	$\mu A$
Output Low Voltage	$V_{OL}$	$V_{IN} = 4.5V$ , $I_{OUT} = 400\mu A$		150	250	mV
Upper Threshold Voltage	$V_{THH}$	Note 6	40	60		mV
Lower Threshold Voltage	$V_{THL}$	Note 6		75	95	mV
Hysteresis	$V_{HYS}$			15		mV

### Electrical Characteristics

(Unless otherwise noted,  $V_{IN} = V_{OUT} + 1V$ ,  $I_{OUT} = 100\mu A$ ,  $C_{OUT} = 1\mu F$ , and  $T_J = 25^\circ C$ )

Parameter	Symbol	Test Condition (Note 1)	Min	Typ	Max	Unit
<b>SHUTDOWN INPUT</b>						
Input Logic Voltage Low		Regulator ON			0.7	V
Input Logic Voltage Low		Regulator OFF	2			
Shutdown Pin Input Current	$I_{SD}$	$V_{SD} = 2.4V$		30	50	$\mu A$
		$V_{SD} = 30V$		450	600	
Regulator Output Current in Shutdown (Note 7)		$V_{OUT} = 5.0V$		3	10	$\mu A$
		$3.3V \leq V_{OUT} < 5.0V$			20	
		$2.0V \leq V_{OUT} < 3.3V$			30	

#### Notes:

- Additional conditions for GM2951 series are the FB tied to  $V_{TAP}$  and  $V_{OUT}$  Tied to SENSE and  $V_{SD} \leq 0.8V$
- Output or Reference voltage temperature coefficients are defined as the worst case voltage change divided by the total temperature range.
- The Regulation is measured at a constant junction temperature using pulse testing with a low duty cycle. Changes in the output voltage due to heating effects are covered under the specification for thermal regulation.
- The Dropout voltage is defined as the input-to-output differential, at which the output voltage drops 100mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage (2V) (2.3V over temperature) must be taken into account.
- $V_{REF} \leq V_{OUT} \leq (V_{IN} - 1V)$ ,  $2.3V \leq V_{IN} \leq 30V$ ,  $100\mu A \leq I_{OUT} \leq 100mA$ ,  $T_J \leq T_{JMAX}$
- Comparator thresholds are expressed in terms of a voltage differential at the FB terminal below the nominal reference voltage measured at  $V_{OUT} + 1V$  input. To express these thresholds in terms of an output voltage change, multiply by the error amplifier gain  $= V_{OUT}/V_{REF} = (R1 + R2)/R2$ . For examples, at a programmed output voltage of 5V, the Error output is guaranteed to go low when the output drops by  $95mV \times 5V/1.235V = 384mV$ . Thresholds remain constant as a percent of  $V_{OUT}$  as  $V_{OUT}$  is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.
- $V_{SD} \geq 2V$ ,  $V_{IN} \leq 30V$ ,  $V_{OUT} = 0$ , the FB pin is tied to  $V_{TAP}$ .

### Application Notes

#### External Capacitors

For better stability, it is recommended to use a 1.0µF or greater capacitor tied between  $V_{OUT}$  and GND. The ESR of about 5Ω or less and resonant frequency above 500KHz are important parameters in the value of capacitor. The capacitor value can be varied, at lower output current, less output capacitance is required. For the currents below 10mA, the value of capacitor can be reduced to 0.33µF, and 0.1µF for 1mA.

More output capacitance is needed for GM2951 family at voltage below 5V since it runs the error amplifier at lower gain. At worst case, 3.3µF or greater must be used for condition of 100mA load at 1.25V output.

If GM2951 is connected to battery or between AC filter capacitor and input is 10 inches wire then 1µF tantalum or aluminum electrolytic capacitor should be connected between  $V_{IN}$  and GND.

Instability can occur if stray capacitor to FB terminal (Pin 7). This could be eliminated by a 100pF capacitor between  $V_{OUT}$  and FB pins and increasing output capacitor to 3.3µF.

#### Reducing Output Noise

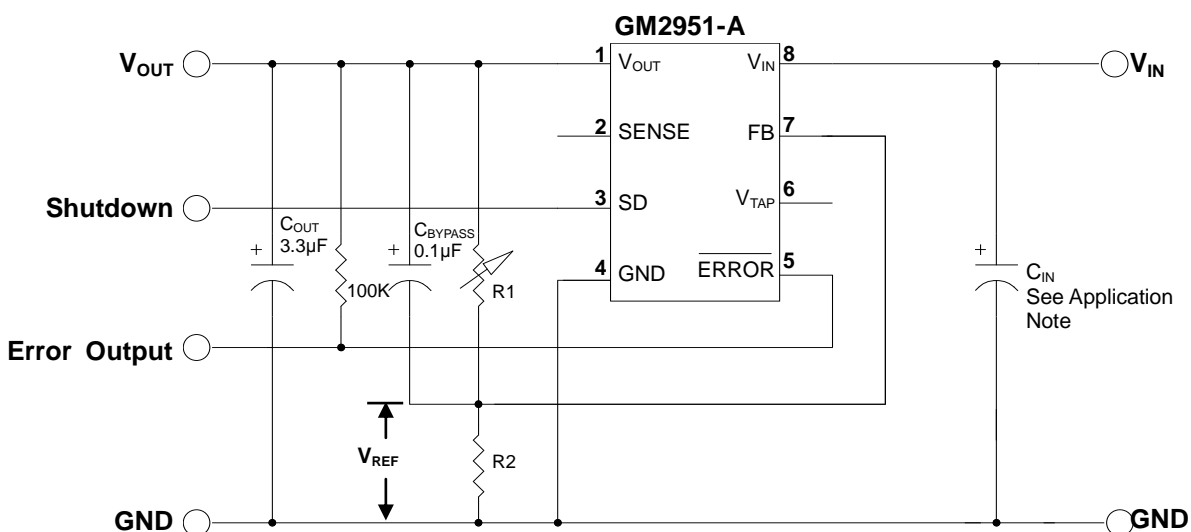
To reduce the AC noise presented at  $V_{OUT}$  pins, one of the workable approaches is to reduce the regulator bandwidth by increasing the output capacitor value. However, this approach is not relatively efficient. It is recommended to use a bypass capacitor across R1 since it reduces the high frequency gain from 4 to unity. With the bypass capacitor, noise no longer scales with output voltage so the improvements are more efficient.

#### Programming the Output Voltage

The GM2951 output voltage is programmable from 1.24V to 29V by external resistors shown in figure below. Compared with fixed output voltage option, Pin 2 and Pin 6 are left open and the external resistors R1 and R2 set the  $V_{OUT}$  by the formula:

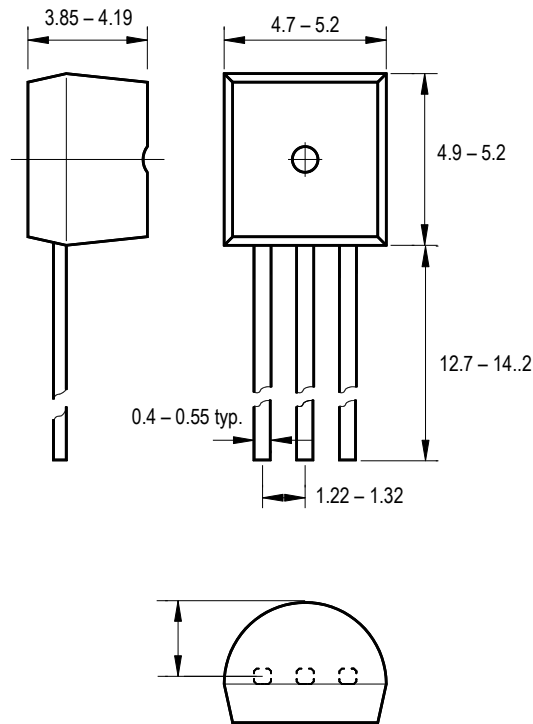
$$V_{OUT} = V_{REF} \times (1 + R1/R2)$$

Where  $V_{REF}$  is 1.235V

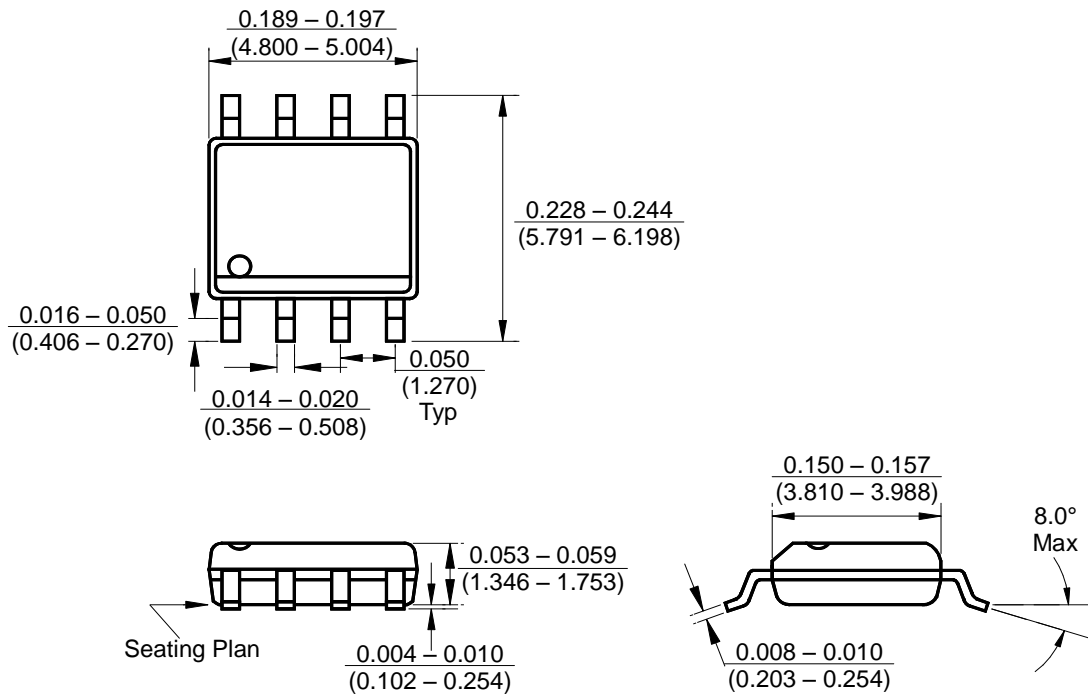




## Package Outline Dimensions – TO 92



## Package Outline Dimensions – SO 8



## Ordering Number

**GM 2950 - 3.3 T92 B G**

APM Gamma Micro	Circuit Type	Output Voltage	Package Type	Shipping Type
		3.3 = 3.3V 5.0 = 5.0V	T92: TO 92 ST89: SOT 89 ST23: SOT 23	B: Bag RL: Ammo Pack (Tape) T: Tube R: Tape & Reel
				G:Green

## Ordering Number

**GM 2951 - 2.2 S8 R G**

APM Gamma Micro	Circuit Type	Output Voltage	Package Type	Shipping Type
		A = Adj 3.3 = 3.3V 5.0 = 5.0V	S8: SO 8	T: Tube R: Tape & Reel
				Blank:Pb-free G:Green

Note:

### Pb-free products:

- ◆ RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- ◆ Suitable for use in Pb-free soldering processes with 100% matte tin (Sn) plating.

### Green products:

- ◆ Lead-free (RoHS compliant)
- ◆ Halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight)