

Description

The GM4275 series of fixed output, micro-power voltage regulators is designed for applications which require wide input voltage range up to 45V.

The GM4275 is an excellent choice for the use in automobile applications with the features of low quiescent current and low drop output voltage.

The GM4275 features the shutdown functions, such as over temperature protection for further power saving concerns.

A reset signal is generated for an output voltage V_Q of typ. 4.65 V. The delay time can be programmed by the external delay capacitor.

The GM4275 is in 5-Pin TO263 package. However, 5-Pin TO252 package is also available for better board area saving purpose.

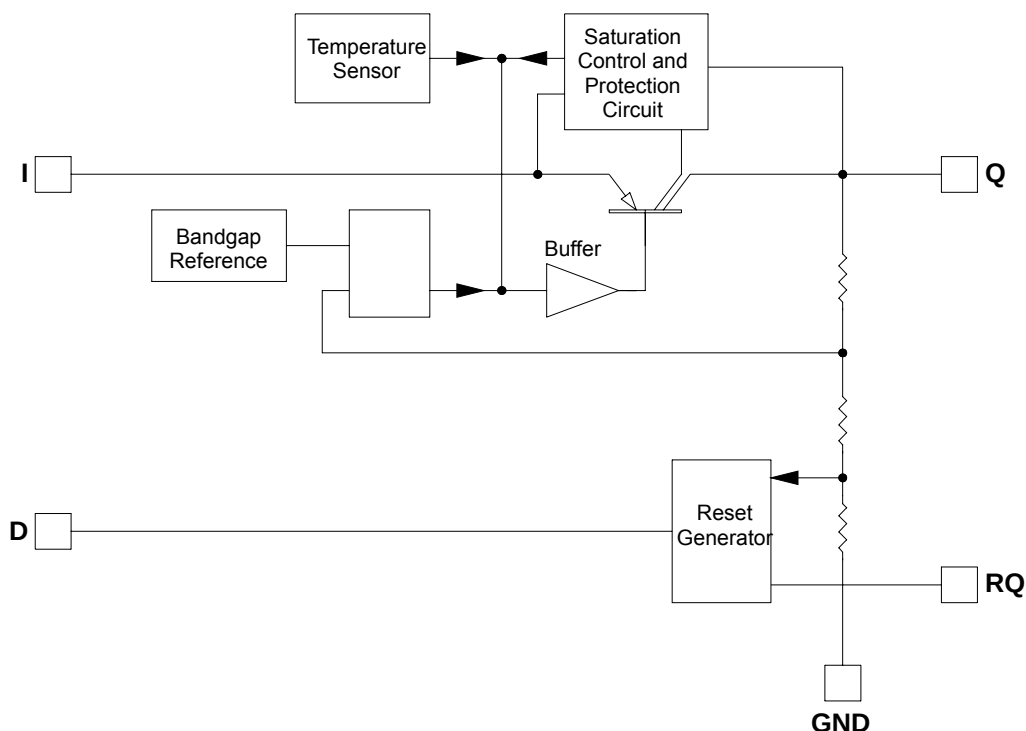
Features

- Output voltage: $5V \pm 2\%$
- Very low current consumption
- Power on and under voltage reset
- Reset low down to $V_Q = 1V$
- Very low drop out voltage
- Short circuit protection
- Reverse polarity protection
- Suitable for automotive applications

Applications

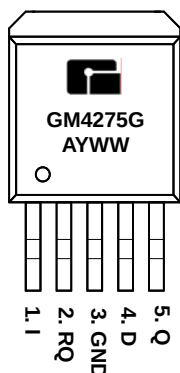
- Automotive Electronics
- Switching Power Suppliers

Block Diagram

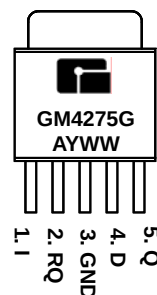


Marking Information and Pin Configurations (Top View)

TO-263-5



TO-252-5



A: Assembly / Test site code

Y: Year

WW: Week

Pin Descriptions

Pin Number	Pin Name	Pin Function
1	I	Input; block to ground directly at the IC with a ceramic capacitor.
2	RQ	Reset Output; open collector output
3	GND	Ground; internally connected to heat sink
4	D	Reset Delay; connected capacitor to GND for setting delay time
5	V _{OUT}	Output; block to ground with a $\geq 22\mu\text{F}$, $\text{ESR} < 5\Omega$ at 10kHz

Ordering Information

Ordering Number	Package	Shipping
GM4275TA5RG	TO-263-5	800 Units / Reel
GM4275TC5RG	TO-252-5	2,500 Units/Tube

Absolute Maximum Ratings

PARAMETER	SYMBOL	RATINGS		UNITS	Test Condition
		Min	Max		
Input Voltage	V_I	-42	45	V	-
Input Current	I_I	-	-	-	Internally Limited
Output Voltage	V_Q	-1.0	16	V	-
Output Current	I_Q	-	-	-	Internally Limited
Reset Output Voltage	V_{RQ}	-0.3	25	V	-
Reset Output Current	I_{RQ}	-5	5	mA	
Reset Delay Voltage	V_D	-0.3	7	V	
Reset Delay Current	I_D	-2	2	mA	
Junction Temperature	T_J	-	150	°C	
Storage Temperature	T_{stg}	-50	150	°C	

Note: Maximum ratings are absolute ratings, exceeding any one of these values may cause irreversible damage to the integrated circuit

Recommended Operating Ratings

PARAMETER	SYMBOL	LIMITS		UNITS	Remark
		Min	Max		
Input Voltage	V_I	5.5	42	V	-
Junction Temperature	T_J	-40	150	°C	-

Thermal Resistance

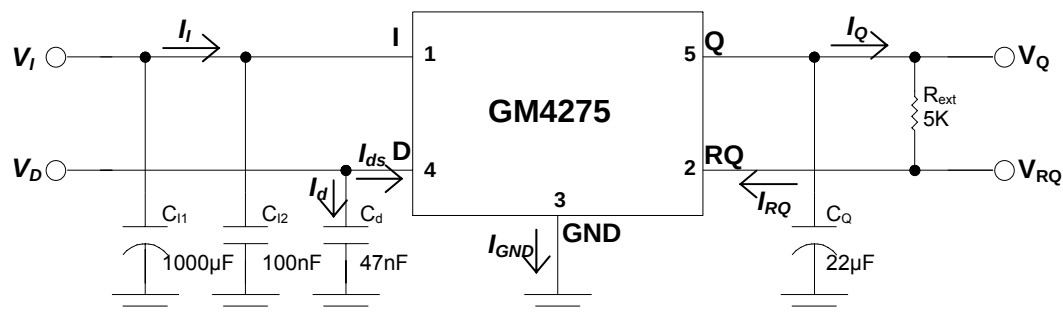
PARAMETER	SYMBOL	LIMITS		UNITS	Remark
		Min	Max		
Junction case	θ_{JC}		2	°C/W	-
Junction Ambient	θ_{JA}		50	°C /W	5L TO263
Junction Ambient	θ_{JA}		70	°C /W	5L TO252

Electrical Characteristics ($T_J = -40^{\circ}\text{C}$ to 150°C , $V_{IN}=13.5\text{V}$, unless otherwise noted)

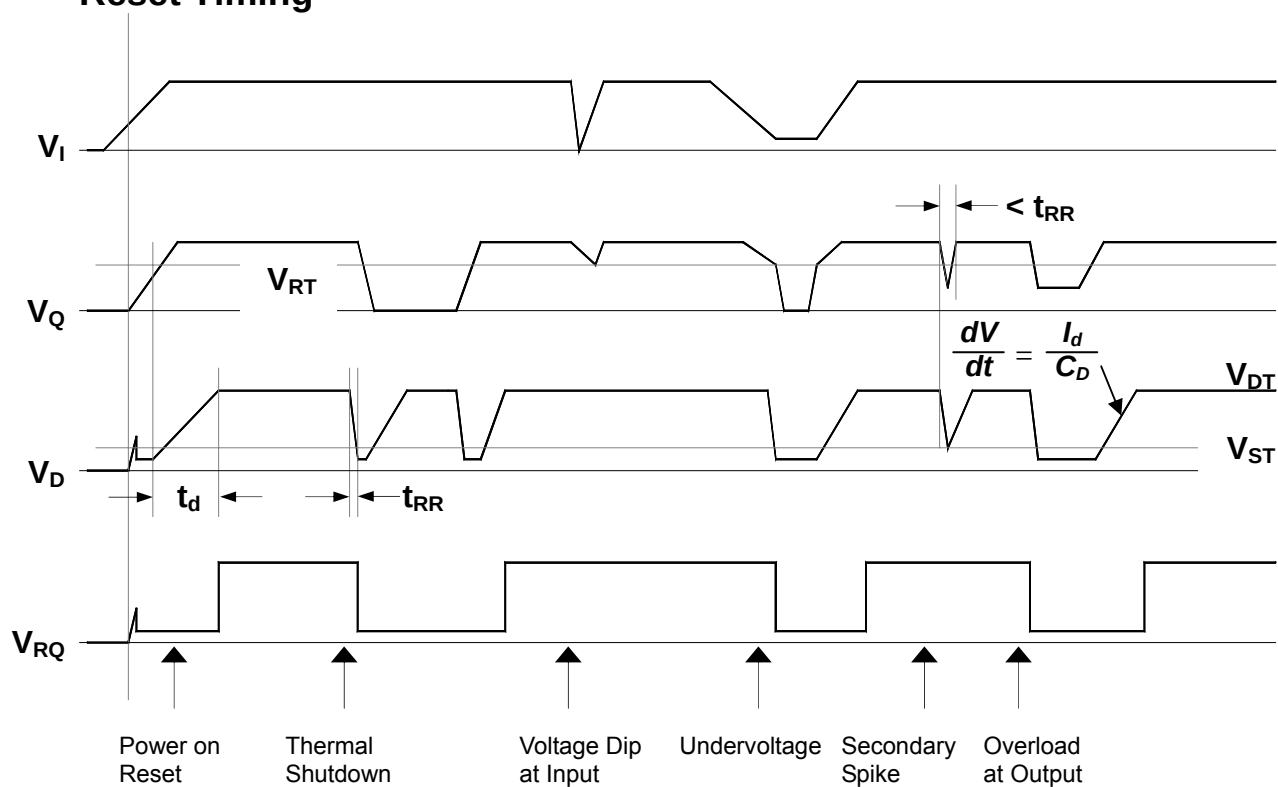
Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output						
Output voltage	V_Q	$5\text{mA} < I_Q < 400\text{mA}$ $6\text{V} < V_I < 40\text{V}$	4.9	5.0	5.1	V
Output current limitation (Note 1)	I_Q	-	450	700	-	mA
Current Consumption; $I_q = I_I - I_Q$	I_{q1}	$I_Q = 1\text{mA}$, $T_J = 25^{\circ}\text{C}$	-	150	200	μA
	I_{q2}	$I_Q = 1\text{mA}$, $T_J = 85^{\circ}\text{C}$	-	150	220	μA
	I_{q3}	$I_Q = 250\text{mA}$	-	5	10	mA
	I_{q4}	$I_Q = 400\text{mA}$	-	12	22	mA
Dropout Voltage	V_{dr}	$I_Q = 300\text{mA}$, $V_{dr} = V_I - V_Q$	-	250	500	mV
Line Regulation	ΔV_{QL}	$V_I = 8\text{V}$ to 32V , $I_Q = 5\text{mA}$	-	15	30	mV
Load Regulation	ΔV_{QL}	$I_Q = 5\text{mA}$ to 400mA	-15	5	15	mV
Power supply ripple rejection	PSRR	$f_r = 100\text{Hz}$, $V_r = 0.5\text{V}_{PP}$	-	60	-	dB
Temperature output voltage drift	dV_Q/dT		-	0.5	-	mV/K
Reset Timing D and Output RQ						
Reset switching threshold	V_{RT}		4.5	4.65	4.8	V
Reset output low voltage	V_{RQL}	$R_{EXT} \geq 5\text{K}$, $V_Q > 1\text{V}$	-	0.2	0.4	V
Reset output leakage current	I_{RQH}	$V_{RQH} > 4.5\text{V}$	-	0	2	μA
Reset charging current	I_d	$V_D = 1\text{V}$	3	6	9	μA
Upper timing threshold	V_{DU}	-	1.5	1.8	2.2	V
Lower timing threshold	V_{DL}	-	0.2	0.4	0.7	V
Reset Delay time	t_d	$C_D = 47\text{nF}$	10	16	22	ms
Reset reaction time	t_{RR}	$C_D = 47\text{nF}$	-	0.5	2	μs

Note 1. Measured when the output voltage V_Q has dropped 100mV from the nominal value obtained at $V_I = 13.5\text{V}$

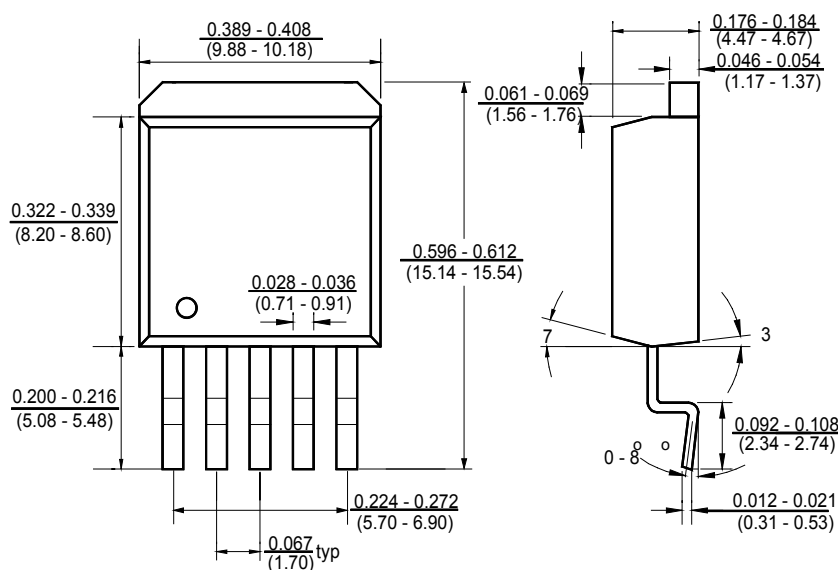
Test Circuit



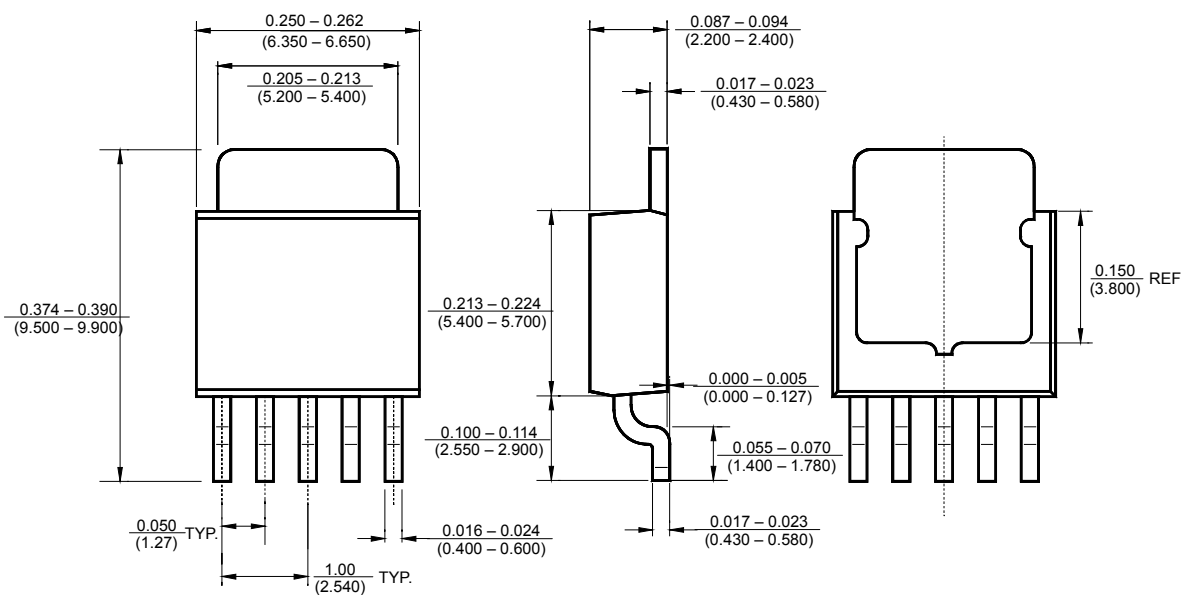
Reset Timing



Package Outline Dimensions – TO-263-5



Package Outline Dimensions – TO-252-5



Ordering Number

<u>GM</u>	<u>4275</u>	<u>TA5</u>	<u>R</u>	<u>G</u>
APM Gamma Micro	Circuit Type	Package Type TA5: TO263-5 TC5: TO252-5	Shipping Type 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 SnPb or 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)

Description

GM6155 is a high efficient LDO with features as such ultra low noise output, ultra low dropout voltage (typically 17mV at light load and 165mV at 150mA load), and low ground current (600μA at 100mA load). GM6155 provides 1% initial accuracy.

Designed especially for hand held, battery powered applications, GM6155 includes a CMOS or TTL compatible enable/shutdown control input. For shutdown mode, power consumption drops nearly to zero. Regulator ground current increases only slightly in dropout, further prolonging battery life.

Key features of GM6155 also include a reference bypass pin to further improve the low noise performance, reversed battery protection, current limiting, and over temperature protection

GM61155 is available in SOT-25 package.

Features

- ◆ Ultra low noise output
- ◆ High output voltage accuracy
- ◆ Extremely accurate output voltage
- ◆ Guaranteed 150mA output current
- ◆ Low quiescent current
- ◆ Low dropout voltage
- ◆ Logic controlled enable function

Application

Cellular telephones

Laptop, notebook, and palmtop computers

Battery powered equipments

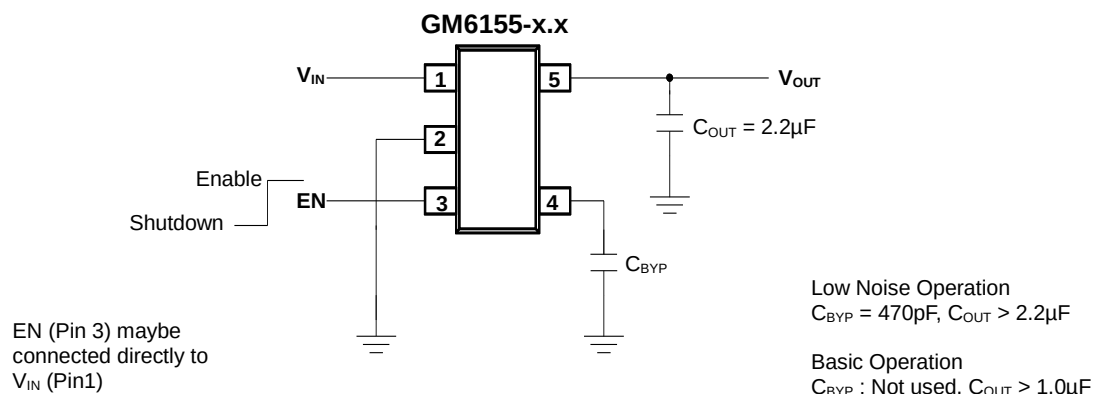
PCMCIA V_{CC} and V_{PP} regulation/switching

Consumer/personal electronics

SMPS post regulator/dc to dc modules

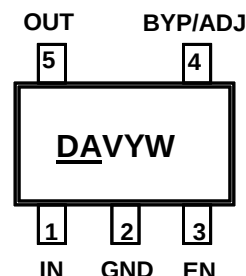
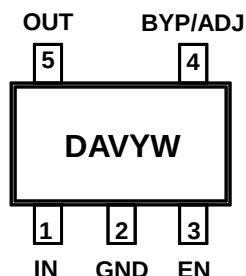
High efficiency linear power supplies

Typical Application Circuits



Marking Information and Pin Configurations (Top View)

SOT25



DA: Device Code

V: Voltage Code (see next page)

Y: Year

W: Week code

Week 1-26 : A – Z

Week 27-52 : A - Z

Week 53 : A

DA: Device Code, Green Product

V: Voltage Code (see next page)

Y: Year

W: Week code

Week 1-26 : A – Z

Week 27-52 : A - Z

Week 53 : A

Pin Descriptions

Pin Number		Pin Name	Pin Function
1		IN	Supply Input
2		GND	Ground
3		EN	Enable/Shutdown (Input): CMOS compatible input. Logic high = Enable; logic low or open = shutdown
4	Fixed output	BYP	Reference Bypass: Connect external 470pF capacitor to GND to reduce output noise. May be left open.
	Adjustable output	ADJ	Adjust (Input): Adjustable regulator feedback input. Connect to resistor voltage divider
5		OUT	Regulator Output

Ordering Information – Pb Free Products

Ordering Number	Output Voltage	Voltage Code	Package	Shipping
GM6155-AST25R	Adj	A	SOT-25	3,000 Units/Tape and Reel
GM6155-2.5ST25R	2.5V	G	SOT-25	3,000 Units/Tape and Reel
GM6155-2.7ST25R	2.7V	T	SOT-25	3,000 Units/Tape and Reel
GM6155-2.8ST25R	2.8V	H	SOT-25	3,000 Units/Tape and Reel
GM6155-2.9ST25R	2.9V	X	SOT-25	3,000 Units/Tape and Reel
GM6155-3.0ST25R	3.0V	J	SOT-25	3,000 Units/Tape and Reel
GM6155-3.3ST25R	3.3V	K	SOT-25	3,000 Units/Tape and Reel
GM6155-3.6ST25R	3.6V	L	SOT-25	3,000 Units/Tape and Reel
GM6155-3.7ST25R	3.7V	M	SOT-25	3,000 Units/Tape and Reel
GM6155-4.0ST25R	4.0V	N	SOT-25	3,000 Units/Tape and Reel
GM6155-4.2ST25R	4.2V	Y	SOT-25	3,000 Units/Tape and Reel
GM6155-5.0ST25R	5.0V	Q	SOT-25	3,000 Units/Tape and Reel

Ordering Information – Green Products

Ordering Number	Output Voltage	Voltage Code	Package	Shipping
GM6155-AST25RG	Adj	A	SOT-25	3,000 Units/Tape and Reel
GM6155-2.5ST25RG	2.5V	G	SOT-25	3,000 Units/Tape and Reel
GM6155-2.7ST25RG	2.7V	T	SOT-25	3,000 Units/Tape and Reel
GM6155-2.8ST25RG	2.8V	H	SOT-25	3,000 Units/Tape and Reel
GM6155-2.9ST25RG	2.9V	X	SOT-25	3,000 Units/Tape and Reel
GM6155-3.0ST25RG	3.0V	J	SOT-25	3,000 Units/Tape and Reel
GM6155-3.3ST25RG	3.3V	K	SOT-25	3,000 Units/Tape and Reel
GM6155-3.6ST25RG	3.6V	L	SOT-25	3,000 Units/Tape and Reel
GM6155-3.7ST25RG	3.7V	M	SOT-25	3,000 Units/Tape and Reel
GM6155-4.0ST25RG	4.0V	N	SOT-25	3,000 Units/Tape and Reel
GM6155-4.2ST25RG	4.2V	Y	SOT-25	3,000 Units/Tape and Reel
GM6155-5.0ST25RG	5.0V	Q	SOT-25	3,000 Units/Tape and Reel

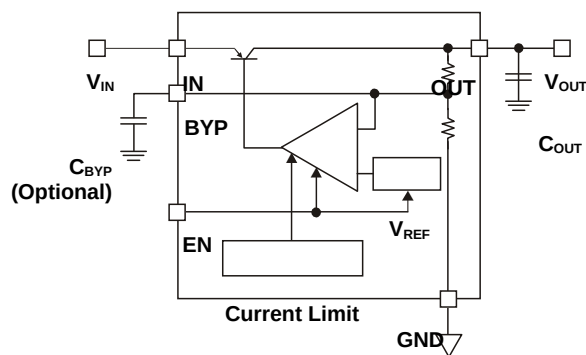
Absolute Maximum Ratings (Note 1)

PARAMETER	SYMBOL	RATINGS	UNITS
Input Voltage	V_{IN}	20	V
Enable Voltage	V_{EN}	20	V
Junction Temperature	T_J	- 40 to 125	°C
Storage Temperature	T_{stg}	- 65 to 150	°C
Lead Temperature (soldering, 5 sec)		260	°C
ESD (Human Body Mode)		2000	V

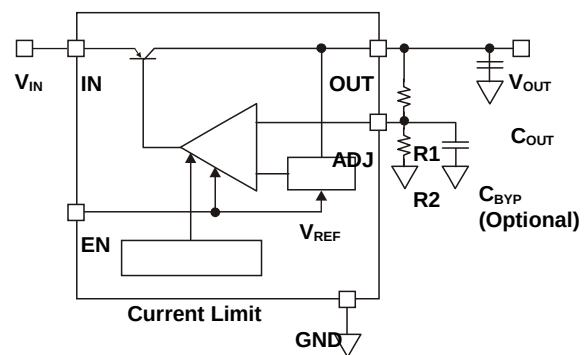
Operating Ratings (Note 2)

PARAMETER	SYMBOL	RATINGS	UNITS
Input Voltage	V_{IN}	2.5V to 16V	V
Enable Voltage	V_{EN}	0V to V_{IN}	V
Continuous Total Power Dissipation (Note 3)	P_D	Internally Limited	mW
Junction Temperature	T_J	- 40 to 125	°C
Thermal Resistance	θ_{JA}	(Note 3)	°C/W

Block Diagram



Ultra Low Noise Fixed Regulator



Ultra Low Noise Adjustable Regulator

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

$$V_{REF} = 1.242V$$

$$V_{OUT\ MIN} = 2.0V$$

$$V_{OUT\ MAX} = 8.5V$$

Electrical Characteristics ($V_{IN} = V_{OUT} + 1V$, $I_L = 100\mu A$, $C_L = 1.0\mu F$, $V_{EN} \geq 2.0V$, $T_J = 25^\circ C$, **bold** values indicate $-40^\circ C \leq T_J \leq +125^\circ C$ unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Output Voltage Accuracy (Note 4)	V_O	Variation from specified V_{OUT}	-1 -2		1 2	%
Output Voltage Temperature Coefficient	$\Delta V_O / \Delta T$	(Note 5)		40		ppm/ $^\circ C$
Line Regulation	$\Delta V_O / \Delta V_I$	$V_{IN} = V_{OUT} + 1V$ to 16V		0.004	0.012 0.05	%/V
Load Regulation	$\Delta V_O / \Delta I_L$	$I_L = 0.1mA$ to 150mA, (Note 6)		0.02	0.2 0.5	%
Dropout Voltage (Note 7)	$V_{IN} - V_O$	$I_L = 100\mu A$		10	50 70	mV
		$I_L = 50mA$		110	150 230	
		$I_L = 100mA$		140	250 300	
		$I_L = 150mA$		165	275 350	
Quiescent Current	I_Q	$V_{EN} \leq 0.4V$ (Shutdown)		0.01	1	μA
		$V_{EN} \leq 0.18V$ (Shutdown)			5	
Ground Pin Current (Note 8)	I_{GND}	$I_L = 100\mu A$		80	160 180	μA
		$I_L = 50mA$		350	600 800	
		$I_L = 100mA$		600	1000 1500	
		$I_L = 150mA$		1300	1900 2500	
Ripple Rejection	PSRR	$f = 100Hz$, $I_L = 100\mu A$		75		dB
Current Limit	I_{LIMIT}	$V_{OUT} = 0V$		320	500	mA
Thermal Regulation	$\Delta V_O / \Delta P_D$	Note 9		0.05		%/W
Output Noise	e_{no}	$I_L = 50mA$, $C_L = 2.2\mu F$, 470pF from BYP to GND		260		nV/ $\sqrt{Hz}$
Power Supply Rejection Ration	PSRR	$f = 120Hz$		60		dB
ENABLE INPUT						
Enable Input Logic Low Voltage	V_{IL}	Regulator shutdown			0.4 0.18	V
Enable Input Logic High Voltage	V_{IH}	Regulator Enabled	2.0			V
Enable Input Current	I_{IL}	$V_{IL} \leq 0.4V$		0.01	-1	μA
		$V_{IL} \leq 0.18V$			-2	
	I_{IH}	$V_{IH} \leq 2.0V$	2	5	35	
					40	

- Note 1:** Exceeding the absolute maximum rating may damage the device.
- Note 2:** The device is not guaranteed to function outside its operating rating.
- Note 3:** The maximum allowable power dissipation at any T_A (ambient temperature) is: $P_D(\max) = (T_J(\max) - T_A) \cdot \theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.
- Note 4:** For Adj version, the $V_{REF} = 1.242V \pm 1\%$, but minimum output voltage for GM6155-A must be above $V_{OUTMIN} = 2.0V$, and maximum output voltage must be lower than 8.5V
- Note 5:** Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
- Note 6:** Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 0.1mA to 150mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.
- Note 7:** Dropout Voltage is defined as the input to output differential at which the output voltage drops 2% below its nominal value measured at 1V differential.
- Note 8:** Ground pin current is the regulator quiescent current plus pass transistor base current. The total current drawn from the supply is the sum of the load current plus the ground pin current.
- Note 9:** Thermal regulation is defined as the change in output voltage at a time "t" after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 150mA load pulse at $V_{IN} = 16V$ for $t = 10ms$.

Application Information

Enable/ Shutdown

Forcing EN (enable/shutdown) high ($>2V$) enables the regulator. EN is compatible with CMOS logic gates. If enable/shutdown feature is not required, connect EN (pin 3) to IN (supply input, pin 1). See Figure 3.

Input Capacitor

A $1\mu F$ capacitor should be placed from IN to GND if there is more than 10 inches of wire between the input and the AC filter capacitor or if a battery is used as the input.

Reference Bypass Capacitor

BYP (reference bypass) is connected to the internal voltage reference. A $470pF$ capacitor (C_{BYP}) connected from BYP to GND quiets this reference, providing a significant reduction in output noise. C_{BYP} reduces the regulator phase margin, when using C_{BYP} , output capacitors of $2.2\mu F$ or greater are generally required to maintain stability.

The start-up speed of GM6155 is inversely proportional to the size of the reference bypass capacitor. Applications requiring a slow ramp-up of output voltage should consider larger values of C_{BYP} . Likewise, if rapid turn-on is necessary, consider omitting C_{BYP} . If output noise is not a major concern, omit C_{BYP} and leave BYP open.

Output Capacitor

An output capacitor is required between OUT and GND to prevent oscillation. The minimum size of the output capacitor is dependent upon whether a reference bypass capacitor is used. $1.0\mu F$ minimum is recommended when C_{BYP} is not used (see Figure 2). $2.2\mu F$ minimum is recommended when C_{BYP} is $470pF$ (see Figure 1). Larger values improve the regulator's transient response; the output capacitor value may be increased without limit.

The output capacitor should have an ESR (effective series resistance) of about $5\ m\Omega$ or less and a resonant frequency above $1MHz$. Ultra-low-ESR capacitors can cause a low amplitude oscillation on the output and under damped transient response. Most tantalum or aluminum electrolytic capacitors are adequate; film types will work, but more expensive. Since many aluminum electrolytics have electrolytes that freeze at about $-30^{\circ}C$, solid tantalums are recommended for operation below $-25^{\circ}C$.

At lower values for output current, less output capacitance is required for output stability. The capacitor can be reduced to $0.47\mu F$ for current below $10mA$ or $0.33\mu F$ for current below $1mA$.

No-Load Stability

GM6155 will remain stable and in regulation with no load (other than the internal voltage divider) unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive applications.

Thermal Considerations

Gm6155 is designed to provide 150mA of continuous current in a very small package. Maximum power dissipation can be calculated based on the output current and the voltage drop across the part. To determine the maximum power dissipation of the package, use the junction-to-ambient thermal resistance of the device and the following basic equation:

$$P_{D(max)} = \frac{T_{J(max)} - T_A}{\theta_{JA}}$$

$T_{J(max)}$ is the maximum junction temperature of the die, 125°C, and T_A is the ambient operating temperature. θ_{JA} is layout dependent; Table 1 shows examples of junction-to-ambient thermal resistance for the GM6155.

Parameter	θ_{JA} Recommended Minimum Foot print	θ_{JA} 1" Square Copper Clad	θ_{JC}
SOT23-5	220°C/W	170°C/W	130°C/W

Table 1. SOT25 Thermal Resistance

The actual power dissipation of the regulator circuit can be determined by using the equation:

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND}$$

Substituting $P_{D(max)}$ for P_D and solving for the operating conditions that are critical to the application will give the maximum operating conditions for the regulator circuit. For example, when operating GM6155 at room temperature with a minimum footprint layout, the maximum input voltage for a set output current can be determined as follows:

$$P_{D(max)} = \frac{125^\circ\text{C} - 25^\circ\text{C}}{220^\circ\text{C/W}}$$

$$P_{D(max)} = 455\text{mW}$$

The junction-to-ambient thermal resistance for the minimum footprint is 220°C/W, from Table 1. The maximum power dissipation must not be exceeded for proper operation. Using the output voltage of 3.3V and an output current of 150mA, the maximum input voltage can be determined. From the Electrical Characteristics table, the maximum ground current for 150mA output current is 2500μA or 2.5mA.

$$\text{i.e., } 455\text{mW} = (V_{IN} - 3.3\text{V}) \times 150\text{mA} + V_{IN} \times 2.5\text{mA}$$

$$\text{so, } V_{IN(max)} = 6.23\text{V}$$

Therefore, a 3.3V application at 150mA of output current can accept a maximum input voltage of 6.2V in a SOT-25 package.

Fixed Regulator Applications

Figure 3. Ultra-Low-Noise Fixed Voltage Application

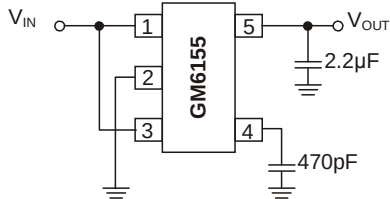


Figure 4. Low-Noise Fixed Voltage Application

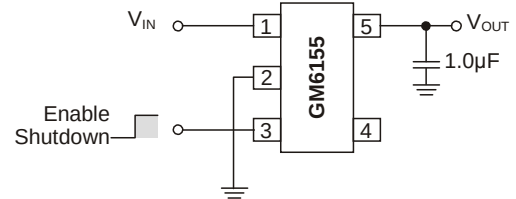


Figure 3 includes a 470pF low noise operation and shows EN (pin 3) connected to IN (pin 1) for an application where enable / shutdown is not required.

Figure 4 is an example of a low noise configuration where C_{BYP} is not required.

Adjustable Regulator Applications

The GM6155 can be adjusted to a specified output voltage by using two external resistors (Figure 5). The resistors set the output voltage based on the following equation:

$$V_{OUT} = 1.242V \times \left(\frac{R2}{R1} + 1 \right)$$

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_{OUT} equation.

Resistor values are not critical because of ADJ has a high input impedance, but for best results, use resistor of 470k or less. A capacitor from ADJ to ground provides greatly improved noise performance. In Figure 5, an optional 470pF capacitor is included as the bypass component from ADJ to GND to reduce output noise.

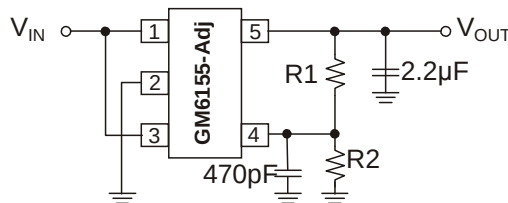


Figure 5. Ultra-Low- Noise Adjustable Voltage Application

Typical Performance Characteristics

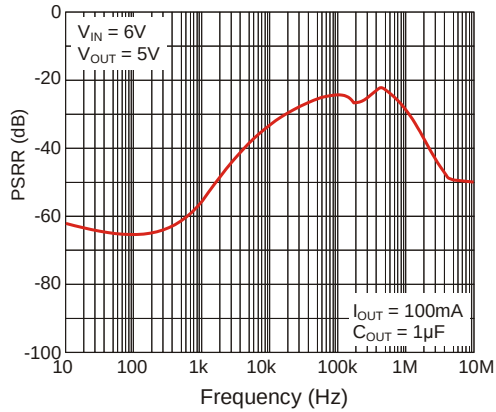


Figure 6. Power Supply Rejection Ratio

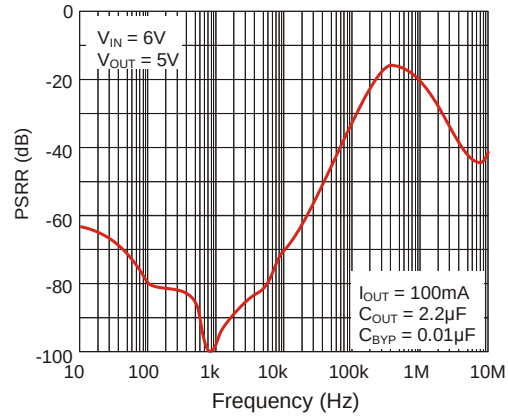


Figure 7. Power Supply Rejection Ratio

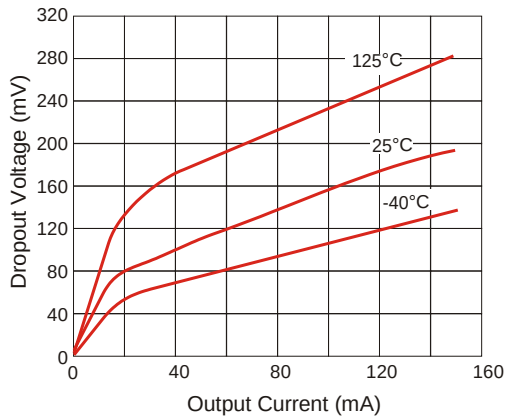


Figure 8. Dropout Voltage vs.
Output Current

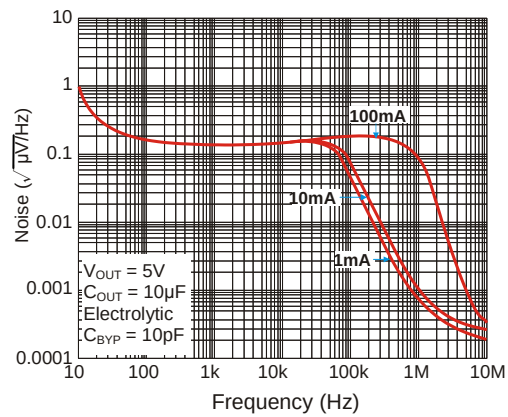
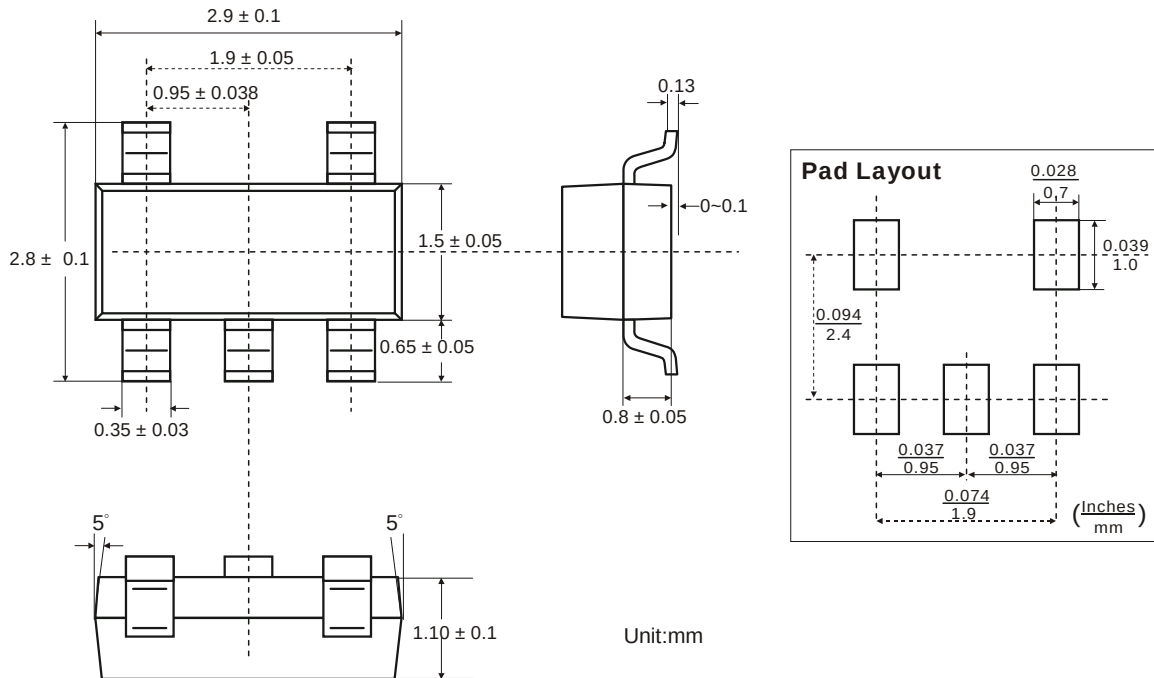


Figure 9. Noise Performance

Package Outline Dimensions – SOT 25



Ordering Number

GM 6155 - 1.8 ST25 R G

APM Gamma Micro	Circuit Type	Output Voltage	Package Type	Shipping Type	
		A = Adj 1.8 = 1.8V 2.5 = 2.5V 3.3 = 3.3V 5.0 = 5.0V	ST25: SOT 25	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)

Description

GM6250H is designed for applications requiring high input voltage (up to 25V). The GM6250H family combines high accuracy with very low power consumption, and provides high output current even when the application requires extremely low input-output voltage dropout. The quiescent current of GM6250H is typically 1 μ A, it makes it possible for wider application fields with battery supplies.

GM6250H includes a precision voltage reference, an error correction circuit, over-temperature protection, and a current limited output driver. Fast transient response to load variations provides excellent stability under dynamic loads.

GM6250H comes in SOT-23 (150mW), and SOT-89 (500mW).

Features

- ◆ Input Operating Voltage range: 2.7V to 25V
- ◆ Operating at low output current from 1 μ A
- ◆ Maximum output current up 300mA
- ◆ Output voltage accuracy : $\pm 2\%$
- ◆ CMOS low power consumption, typically 1.0 μ A at $V_{OUT} = 5.0V$
- ◆ Stable with 1 μ F MLCC or without capacitors
- ◆ SOT-23 (150mW), SOT-89 (500mW) and TO-92 packages

Application

Palmtops

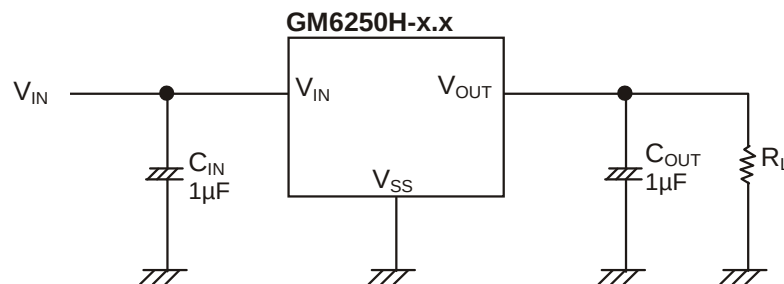
Portable Cameras

Video Recorders

Battery Powered Equipment

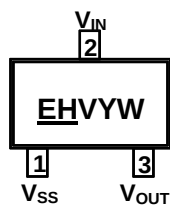
Reference Voltage Sources

Typical Application Circuits

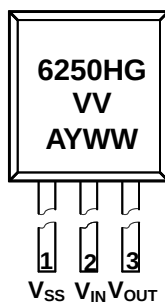


Marking Information and Pin Configurations – Green Product(Top View)

SOT23



TO92



SOT89



EH: Device Code, Green Product

V: Voltage Code (see next page)

Y: Year (8 = 2008, 9 = 2009)

W: Week Code

Week 1-26 : A – Z

Week 27-52 : A - Z

Week 53 : A

G: Green Product

VV: Voltage suffix (18 = 1.8V, 50 = 5.0V...)

A: Assembly Site Code

Y: Year (3 = 2013, 4 = 2014)

WW: Week Code

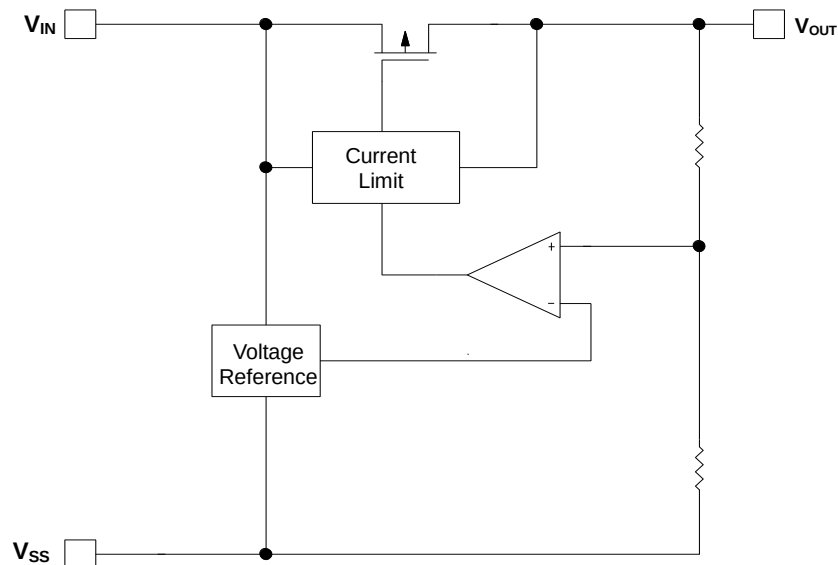
Ordering Information – Green Product

Ordering Number	Output Voltage	Voltage Code	Package	Shipping
GM6250H-1.5T92BG	1.5V		TO-92	1,000 Units/Bag
GM6250H-1.5ST23RG		C	SOT-23	3,000 Units/Tape and Reel
GM6250H-1.5ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250H-1.8T92BG	1.8V		TO-92	1,000 Units/Bag
GM6250H-1.8ST23RG		E	SOT-23	3,000 Units/Tape and Reel
GM6250H-1.8ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250H-2.5T92BG	2.5V		TO-92	1,000 Units/Bag
GM6250H-2.5ST23RG		G	SOT-23	3,000 Units/Tape and Reel
GM6250H-2.5ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250H-3.3T92BG	3.3V		TO-92	1,000 Units/Bag
GM6250H-3.3ST23RG		K	SOT-23	3,000 Units/Tape and Reel
GM6250H-3.3ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250H-4.0T92BG	4.0V		TO-92	1,000 Units/Bag
GM6250H-4.0ST23RG		M	SOT-23	3,000 Units/Tape and Reel
GM6250H-4.0ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250H-5.0T92BG	5.0V		TO-92	1,000 Units/Bag
GM6250H-5.0ST23RG		Q	SOT-23	3,000 Units/Tape and Reel
GM6250H-5.0ST89RG			SOT-89	1,000 Units/Tape and Reel

Absolute Maximum Ratings

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V_{IN}	28	V
Output Current		I_{OUT}	500	mA
Output Voltage		V_{OUT}	$V_{SS} - 0.3$ to $V_{IN} + 0.3$	V
Continuous Total Power Dissipation	SOT-23	P_D	150	mW
	SOT-89		500	
	TO-92		300	
Operating Ambient Temperature		T_A	- 40 to 125	$^{\circ}\text{C}$
Storage Temperature		T_{stg}	- 65 to 150	$^{\circ}\text{C}$
Lead Temperature (Soldering, 10 sec)			+ 260	$^{\circ}\text{C}$
ESD Protection, HBM			2000	V

Block Diagram



Electrical Characteristics

($T_A = 25^\circ\text{C}$, $V_{IN} = V_{OUT} + 1\text{V}$, but $> 2.7\text{V}$, $C_{OUT} = 2.2\mu\text{F}$, unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		2.7		25	V
Output Voltage Range	V_{OUT}		1.2		12	V
Quiescent Current	I_Q			1.0	3.0	μA
Output Voltage Accuracy	ΔV_{OUT}	$I_{OUT} = 1\text{mA}$, $V_{IN} = V_{OUT} + 1\text{V}$	-2		+2	%
		$I_{OUT} = 1\mu\text{A}$, $V_{IN} = 9\text{V}$	-5		5	
Line Regulation	ΔV_{OI}	$I_{OUT} = 1\text{mA}$, $V_{OUT} + 0.5\text{V} < V_{IN} < 20\text{V}$ or $3\text{V} < V_{IN} < 18\text{V}$		0.02	0.3	%/V
Load Regulation	ΔV_{OL}	$1\text{mA} < I_{OUT} < 250\text{mA}$	-3	1	3	%
Dropout Voltage	ΔV	$I_{OUT} = 160\text{mA}$, $V_{OUT} = 3.3\text{V}$		0.4	0.7	V
Output Current Limit	I_{CL}		500			mA
Power Supply Rejection Ration	PSRR	10kHz		10		dB

Application Note

Notes on Usage

1. It is recommended to operate the GM6250H series within the stipulated absolute maximum ratings as the IC is liable to malfunction if it is operated outside the ratings.
2. There is a possibility of heat or oscillation as a result of the impedance present between the power supply and the IC's input. Where impedance is greater than 10Ω , it is recommended to use a capacitor (C_{IN}) of at least $1\mu F$ at the input terminal.
3. With a large output current, operations can be stabilized by increasing capacitor size (C_{IN}). If C_{IN} is too small and capacitance of (C_L) is increased, there is a possibility of oscillation due to input impedance. In such case, operation can be stabilized by either increasing the size of C_{IN} or decreasing the size of C_L .
4. Please ensure the output current (I_{OUT}) is less than $P_d \div (V_{IN} - V_{OUT})$ and does not exceed the stipulated continuous for total power dissipation value (P_d) for the package.

CALCULATING POWER DISSIPATION

The GM6250H series precision linear regulators include thermal shutdown and current limit circuitry to protect the devices. However, high power regulators normally operate at high junction temperatures so it is important to calculate the power dissipation and junction temperatures accurately to be sure that you use an adequate heat sink.

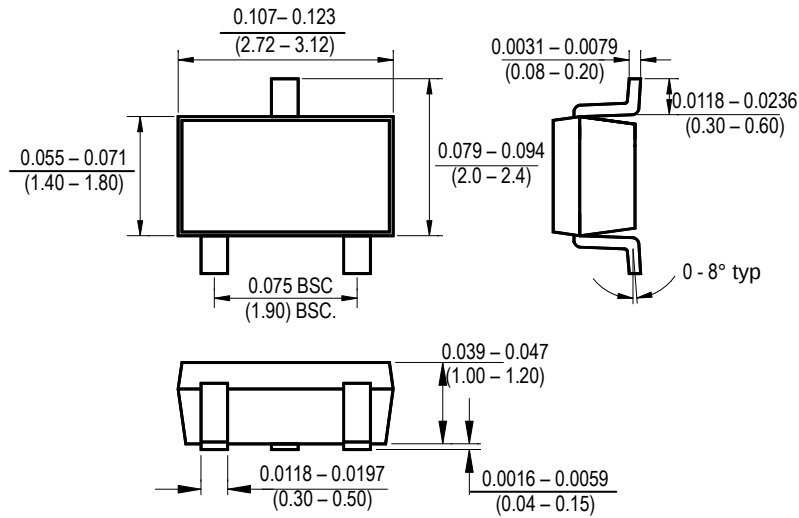
The thermal characteristics of an IC depend on four factors:

1. Maximum Ambient Temperature T_A ($^{\circ}C$)
2. Power Dissipation P_D (Watts)
3. Maximum Junction Temperature T_J ($^{\circ}C$)
4. Thermal Resistance Junction to ambient R_{JA} ($^{\circ}C/W$)

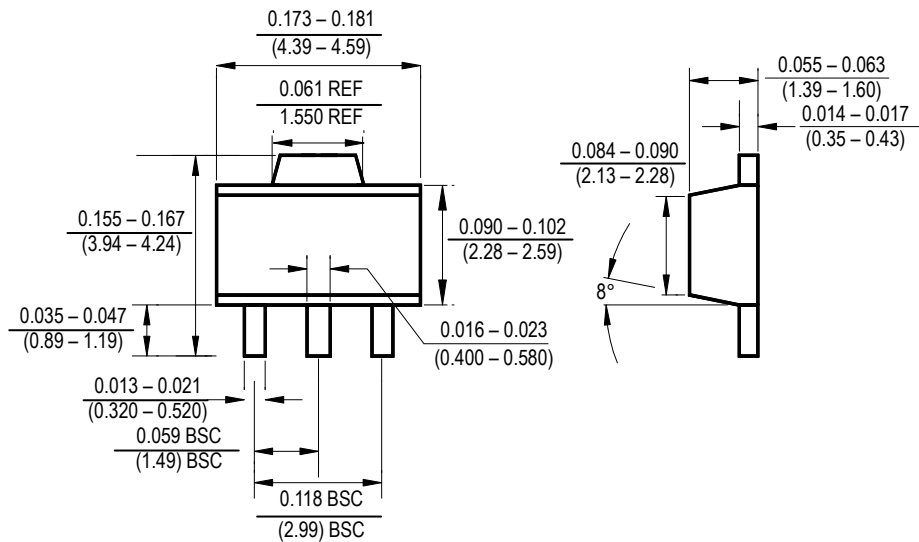
These relationships of these four factors is expressed by equation : $T_J = T_A + P_D \times R_{JA}$

Maximum ambient temperature and power dissipation are determined by the design while the maximum junction temperature and thermal resistance depend on the manufacturer and the package type.

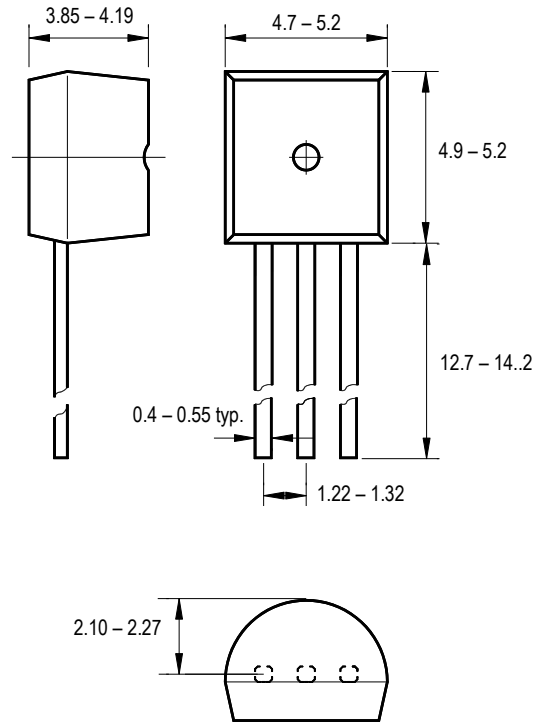
Package Outline Dimensions – SOT 23



Package Outline Dimensions – SOT 89



Package Outline Dimensions – TO 92



Ordering Number

GM 6250H - 3.3 T92 B G

APM Gamma Micro	Circuit Type	Output Voltage	Package Type	Shipping Type	
		2.5 = 2.5V	T92: TO 92	B: Bag	G: Green
		3.3 = 3.3V	ST89: SOT 89	T: Tube	
		5.0 = 5.0V	ST23: SOT 23	R: Tape & Reel	

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)

Description

GM6250 combines high accuracy with very low power consumption, and provides high output current even when the application requires extremely low input-output voltage dropout.

GM6250 includes a precision voltage reference, an error correction circuit, over-temperature protection, and a current limited output driver. Fast transient response to load variations provides excellent stability under dynamic loads.

GM6250 comes in SOT-23 (150mW), and SOT-89 (500mW).

Features

- ◆ Maximum output current up 300mA
- ◆ Output voltage from 1.5V to 5.0V in 0.1V increments
- ◆ Output voltage accuracy : $\pm 2\%$
- ◆ CMOS low power consumption, typically 1.0 μ A at $V_{OUT} = 5.0V$
- ◆ Input stability: typically 0.2%/V
- ◆ Ultra low dropout voltage: 0.38V @ $I_{OUT} = 200mA$ at $V_{OUT} = 5.0V$
- ◆ SOT-23 (150mW), SOT-89 (500mW) and TO-92 packages

Application

Palmtops

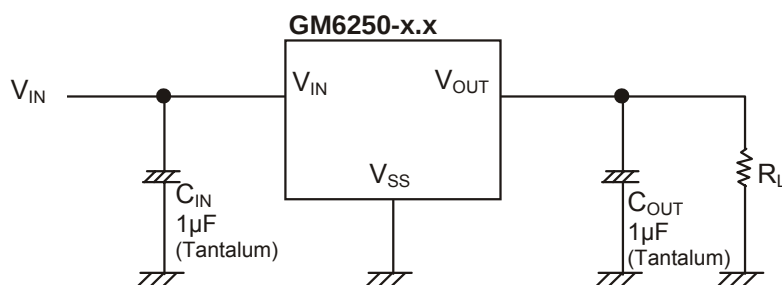
Portable Cameras

Video Recorders

Battery Powered Equipment

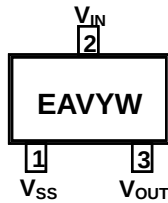
Reference Voltage Sources

Typical Application Circuits

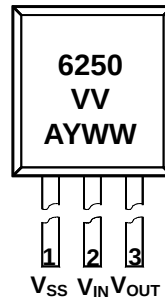


Marking Information and Pin Configurations (Top View)

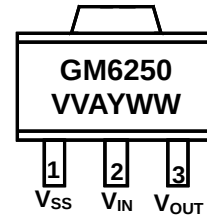
SOT23



TO92



SOT89



EA: Device Code

V: Voltage Code (see next page)

Y: Year (8 = 2008, 9 = 2009)

W: Week Code

Week 1-26 : A – Z

Week 27-52 : A - Z

Week 53 : A

VV: Voltage suffix (18 = 1.8V, 50 = 5.0V...)

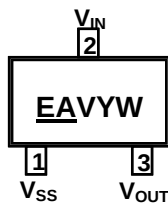
A: Assembly Site Code

Y: Year (8 = 2008, 9 = 2009)

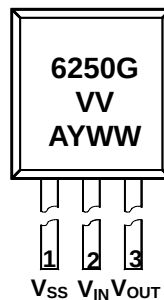
WW: Week Code

Marking Information and Pin Configurations – Green Product(Top View)

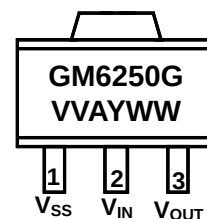
SOT23



TO92



SOT89



EA: Device Code, Green Product

V: Voltage Code (see next page)

Y: Year (8 = 2008, 9 = 2009)

W: Week Code

Week 1-26 : A – Z

Week 27-52 : A - Z

Week 53 : A

G: Green Product

VV: Voltage suffix (18 = 1.8V, 50 = 5.0V...)

A: Assembly Site Code

Y: Year (8 = 2008, 9 = 2009)

WW: Week Code

Ordering Information

Ordering Number	Output Voltage	Voltage Code	Package	Shipping
GM6250-1.5T92B	1.5V		TO-92	1,000 Units/Bag
GM6250-1.5T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-1.5ST23R		C	SOT-23	3,000 Units/Tape and Reel
GM6250-1.5ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-1.8T92B	1.8V		TO-92	1,000 Units/Bag
GM6250-1.8T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-1.8ST23R		E	SOT-23	3,000 Units/Tape and Reel
GM6250-1.8ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-2.2T92B	2.2V		TO-92	1,000 Units/Bag
GM6250-2.2T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-2.2ST23R		D	SOT-23	3,000 Units/Tape and Reel
GM6250-2.2ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-2.5T92B	2.5V		TO-92	1,000 Units/Bag
GM6250-2.5T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-2.5ST23R		G	SOT-23	3,000 Units/Tape and Reel
GM6250-2.5ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-2.7T92B	2.7V		TO-92	1,000 Units/Bag
GM6250-2.7T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-2.7ST23R		T	SOT-23	3,000 Units/Tape and Reel
GM6250-2.7ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-2.8T92B	2.8V		TO-92	1,000 Units/Bag
GM6250-2.8T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-2.8ST23R		H	SOT-23	3,000 Units/Tape and Reel
GM6250-2.8ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-2.85T92B	2.85V		TO-92	1,000 Units/Bag
GM6250-2.85T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-2.85ST23R		I	SOT-23	3,000 Units/Tape and Reel
GM6250-2.85ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-3.0T92B	3.0V		TO-92	1,000 Units/Bag
GM6250-3.0T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-3.0ST23R		J	SOT-23	3,000 Units/Tape and Reel
GM6250-3.0ST89R			SOT-89	1,000 Units/Tape and Reel



GM6250

300mA ULTRA LOW DROPOUT
POSITIVE VOLTAGE REGULATOR

Ordering Information (Continued)

Ordering Number	Output Voltage	Voltage Code	Package	Shipping
GM6250-3.2T92B	3.2V		TO-92	1,000 Units/Bag
GM6250-3.2T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-3.2ST23R		U	SOT-23	3,000 Units/Tape and Reel
GM6250-3.2ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-3.3T92B	3.3V		TO-92	1,000 Units/Bag
GM6250-3.3T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-3.3ST23R		K	SOT-23	3,000 Units/Tape and Reel
GM6250-3.3ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-3.5T92B	3.5V		TO-92	1,000 Units/Bag
GM6250-3.5T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-3.5ST23R		V	SOT-23	3,000 Units/Tape and Reel
GM6250-3.5ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-3.6T92B	3.6V		TO-92	1,000 Units/Bag
GM6250-3.6T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-3.6ST23R		L	SOT-23	3,000 Units/Tape and Reel
GM6250-3.6ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-4.0T92B	4.0V		TO-92	1,000 Units/Bag
GM6250-4.0T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-4.0ST23R		M	SOT-23	3,000 Units/Tape and Reel
GM6250-4.0ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-4.4T92B	4.4V		TO-92	1,000 Units/Bag
GM6250-4.4T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-4.4ST23R		W	SOT-23	3,000 Units/Tape and Reel
GM6250-4.4ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-4.5T92B	4.5V		TO-92	1,000 Units/Bag
GM6250-4.5T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-4.5ST23R		N	SOT-23	3,000 Units/Tape and Reel
GM6250-4.5ST89R			SOT-89	1,000 Units/Tape and Reel
GM6250-5.0T92B	5.0V		TO-92	1,000 Units/Bag
GM6250-5.0T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-5.0ST23R		Q	SOT-23	3,000 Units/Tape and Reel
GM6250-5.0ST89R			SOT-89	1,000 Units/Tape and Reel

Ordering Information – Green Product

Ordering Number	Output Voltage	Voltage Code	Package	Shipping
GM6250-1.5T92BG	1.5V		TO-92	1,000 Units/Bag
GM6250-1.5T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-1.5ST23RG		C	SOT-23	3,000 Units/Tape and Reel
GM6250-1.5ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-1.8T92BG	1.8V		TO-92	1,000 Units/Bag
GM6250-1.8T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-1.8ST23RG		E	SOT-23	3,000 Units/Tape and Reel
GM6250-1.8ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-2.2T92BG	2.2V		TO-92	1,000 Units/Bag
GM6250-2.2T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-2.2ST23RG		D	SOT-23	3,000 Units/Tape and Reel
GM6250-2.2ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-2.5T92BG	2.5V		TO-92	1,000 Units/Bag
GM6250-2.5T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-2.5ST23RG		G	SOT-23	3,000 Units/Tape and Reel
GM6250-2.5ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-2.7T92BG	2.7V		TO-92	1,000 Units/Bag
GM6250-2.7T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-2.7ST23RG		T	SOT-23	3,000 Units/Tape and Reel
GM6250-2.7ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-2.8T92BG	2.8V		TO-92	1,000 Units/Bag
GM6250-2.8T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-2.8ST23RG		H	SOT-23	3,000 Units/Tape and Reel
GM6250-2.8ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-2.85T92BG	2.85V		TO-92	1,000 Units/Bag
GM6250-2.85T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-2.85ST23RG		I	SOT-23	3,000 Units/Tape and Reel
GM6250-2.85ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-3.0T92BG	3.0V		TO-92	1,000 Units/Bag
GM6250-3.0T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-3.0ST23RG		J	SOT-23	3,000 Units/Tape and Reel
GM6250-3.0ST89RG			SOT-89	1,000 Units/Tape and Reel

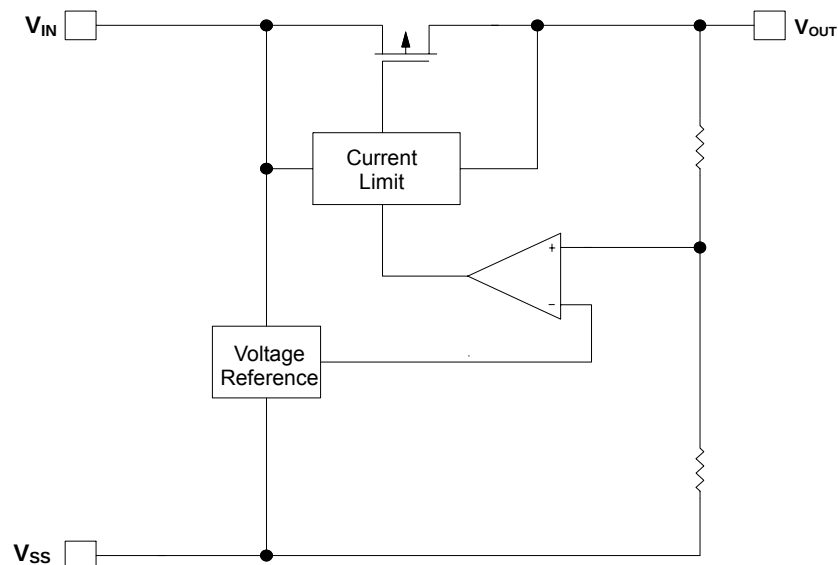
Ordering Information – Green Product (Continued)

Ordering Number	Output Voltage	Voltage Code	Package	Shipping
GM6250-3.2T92BG	3.2V		TO-92	1,000 Units/Bag
GM6250-3.2T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-3.2ST23RG		U	SOT-23	3,000 Units/Tape and Reel
GM6250-3.2ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-3.3T92BG	3.3V		TO-92	1,000 Units/Bag
GM6250-3.3T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-3.3ST23RG		K	SOT-23	3,000 Units/Tape and Reel
GM6250-3.3ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-3.5T92BG	3.5V		TO-92	1,000 Units/Bag
GM6250-3.5T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-3.5ST23RG		V	SOT-23	3,000 Units/Tape and Reel
GM6250-3.5ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-3.6T92BG	3.6V		TO-92	1,000 Units/Bag
GM6250-3.6T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-3.6ST23RG		L	SOT-23	3,000 Units/Tape and Reel
GM6250-3.6ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-4.0T92BG	4.0V		TO-92	1,000 Units/Bag
GM6250-4.0T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-4.0ST23RG		M	SOT-23	3,000 Units/Tape and Reel
GM6250-4.0ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-4.4T92BG	4.4V		TO-92	1,000 Units/Bag
GM6250-4.4T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-4.4ST23RG		W	SOT-23	3,000 Units/Tape and Reel
GM6250-4.4ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-4.5T92BG	4.5V		TO-92	1,000 Units/Bag
GM6250-4.5T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-4.5ST23RG		N	SOT-23	3,000 Units/Tape and Reel
GM6250-4.5ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6250-5.0T92BG	5.0V		TO-92	1,000 Units/Bag
GM6250-5.0T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6250-5.0ST23RG		Q	SOT-23	3,000 Units/Tape and Reel
GM6250-5.0ST89RG			SOT-89	1,000 Units/Tape and Reel

Absolute Maximum Ratings

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V_{IN}	12	V
Output Current		I_{OUT}	500	mA
Output Voltage		V_{OUT}	$V_{SS} - 0.3$ to $V_{IN} + 0.3$	V
Continuous Total Power Dissipation	SOT-23	P_D	150	mW
	SOT-89		500	
	TO-92		300	
Operating Ambient Temperature		T_A	- 40 to 125	°C
Storage Temperature		T_{stg}	- 65 to 150	°C
Lead Temperature (Soldering, 10 sec)			+ 260	°C

Block Diagram



Electrical Characteristics ($T_A = 25^\circ\text{C}$, $V_{IN} = V_{OUT} + 1\text{V}$ unless otherwise noted)

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Output Voltage	GM6250-1.5	V_{OUT}	$I_{OUT} = 40\text{mA}$, $V_{IN} = V_{OUT} + 1\text{V}$	1.470	1.500	1.530	V
	GM6250-2.2			2.156	2.200	2.244	
	GM6250-2.5			2.450	2.500	2.550	
	GM6250-2.7			2.646	2.700	2.754	
	GM6250-2.8			2.744	2.800	2.856	
	GM6250-3.0			2.940	3.000	3.060	
	GM6250-3.2			3.136	3.200	3.264	
	GM6250-3.3			3.234	3.300	3.366	
	GM6250-3.5			3.430	3.500	3.570	
	GM6250-3.6			3.528	3.600	3.672	
	GM6250-4.0			3.920	4.000	4.080	
	GM6250-4.4			4.312	4.400	4.488	
	GM6250-4.5			4.410	4.500	4.590	
	GM6250-5.0			4.900	5.000	5.100	
Line Regulation		ΔV_{OI}	$I_{OUT} = 40\text{mA}$, $V_{OUT} + 1\text{V} < V_{IN} < 10\text{V}$		0.2	0.3	%/V
Load Regulation		ΔV_{OL}	$1\text{mA} < I_{OUT} < 80\text{mA}$		0.02	0.03	%/mA
Dropout Voltage	$V_{OUT} > 2.7\text{V}$	ΔV	$I_{OUT} = 160\text{mA}$		0.4	0.7	V
	$2.0\text{V} < V_{OUT} < 2.7\text{V}$				0.55	0.85	
	$V_{OUT} < 2.0\text{V}$				0.9	1.3	
Current Consumption		I_Q			1.0	2.9	μA
Output Current Limit		I_{CL}		500			mA
Power Supply Rejection Ration		PSRR	10kHz		10		dB

Application Note

Notes on Usage

1. It is recommended to operate the GM6250 series within the stipulated absolute maximum ratings as the IC is liable to malfunction if it is operated outside the ratings.
2. There is a possibility of heat or oscillation as a result of the impedance present between the power supply and the IC's input. Where impedance is greater than 10Ω , it is recommended to use a capacitor (C_{IN}) of at least $1\mu F$ at the input terminal.
3. With a large output current, operations can be stabilized by increasing capacitor size (C_{IN}). If C_{IN} is too small and capacitance of (C_L) is increased, there is a possibility of oscillation due to input impedance. In such case, operation can be stabilized by either increasing the size of C_{IN} or decreasing the size of C_L .
4. Please ensure the output current (I_{OUT}) is less than $P_d \div (V_{IN} - V_{OUT})$ and does not exceed the stipulated continuous for total power dissipation value (P_d) for the package.

CALCULATING POWER DISSIPATION

The GM6250 series precision linear regulators include thermal shutdown and current limit circuitry to protect the devices. However, high power regulators normally operate at high junction temperatures so it is important to calculate the power dissipation and junction temperatures accurately to be sure that you use an adequate heat sink.

The thermal characteristics of an IC depend on four factors:

1. Maximum Ambient Temperature T_A ($^{\circ}C$)
2. Power Dissipation P_D (Watts)
3. Maximum Junction Temperature T_J ($^{\circ}C$)
4. Thermal Resistance Junction to ambient R_{JA} ($^{\circ}C/W$)

These relationships of these four factors is expressed by equation : $T_J = T_A + P_D \times R_{JA}$

Maximum ambient temperature and power dissipation are determined by the design while the maximum junction temperature and thermal resistance depend on the manufacturer and the package type.

Typical Performance Characteristics (for GM6250-3.0)

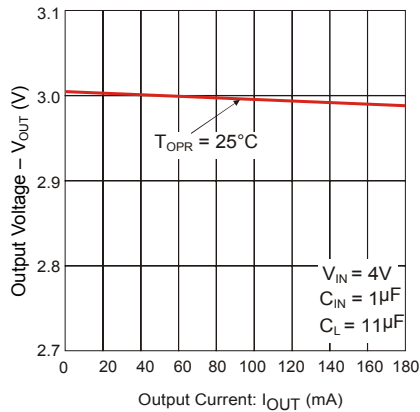


Figure 1: Output Voltage vs. Output Current

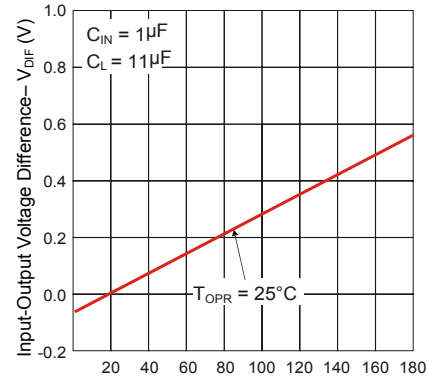


Figure 2: Input/ Output Voltage differential vs. Output Current

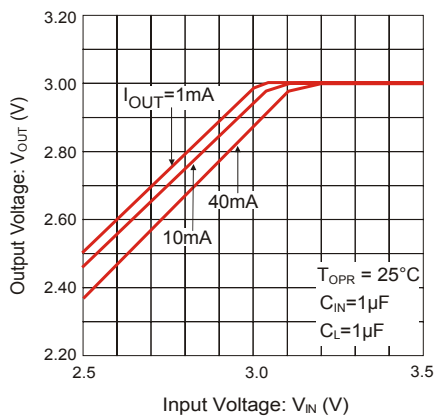


Figure 3: Output Voltage vs. Input voltage

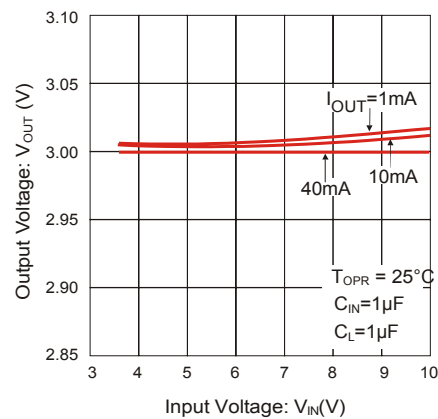


Figure 4: Output Voltage vs. Input voltage

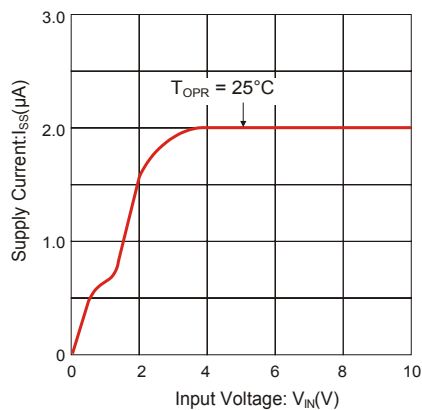


Figure 5: Supply Current vs. Input Voltage

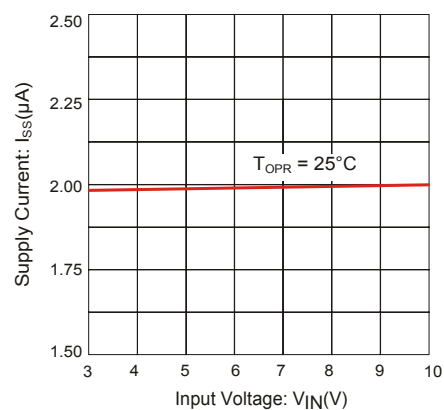


Figure 6: Supply Current vs. Input Voltage

Typical Performance Characteristics (for GM6250-3.0, continued)

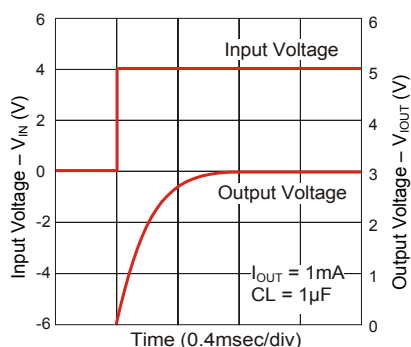


Figure 7: Input Transient Response 1

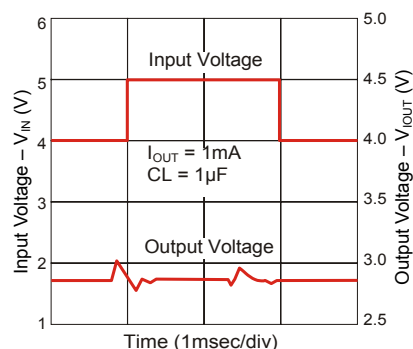


Figure 8: Input Transient Response 2

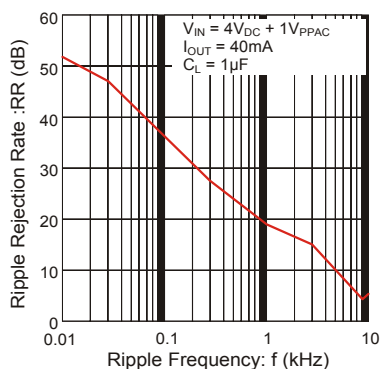
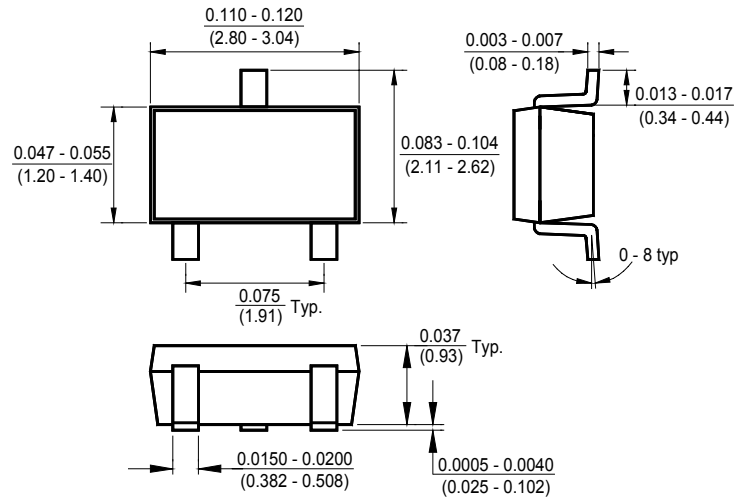
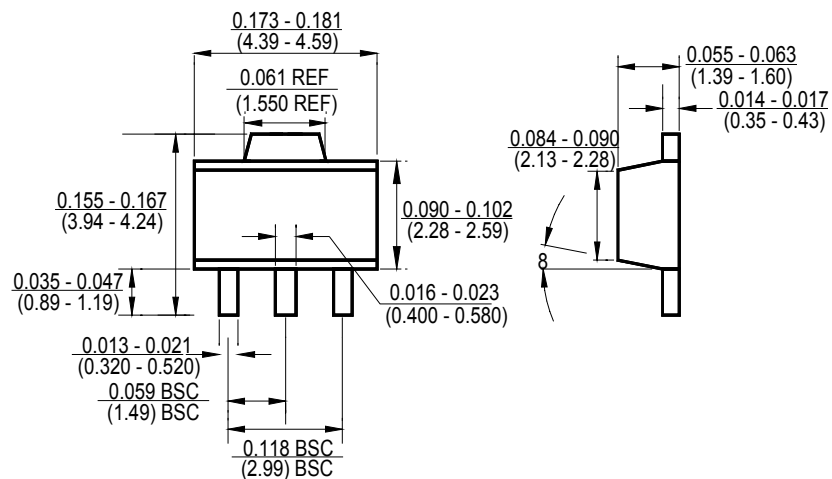


Figure 9: Ripple Rejection Rate

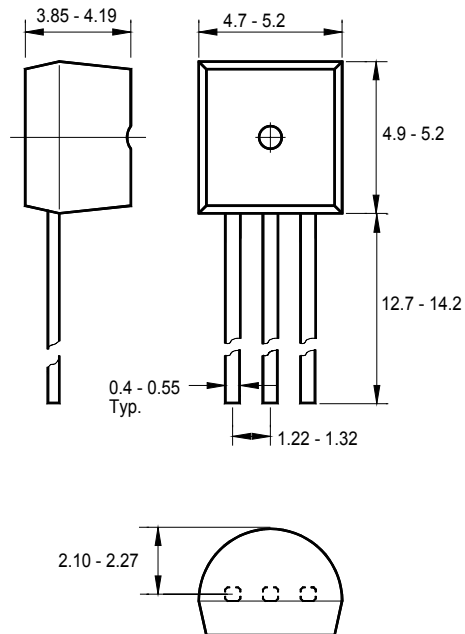
Package Outline Dimensions – SOT 23



Package Outline Dimensions – SOT 89



Package Outline Dimensions – TO 92



Dimensions are in millimeters

Ordering Number

GM 6250 - 2.2 T92 B G

APM Gamma Micro	Circuit Type	Output Voltage	Package Type	Shipping Type	
		2.2 = 2.2V	T92: TO 92	B: Bag	Blank: Pb-free
		2.5 = 2.5V	ST89: SOT 89	RL: Ammo Pack	G: Green
		3.3 = 3.3V	ST23: SOT 23	(Tape)	
		5.0 = 5.0V		T: Tube	
				R: Tape & Reel	

Note:

Pb-free products:

- ◆ RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- ◆ Suitable for use in SnPb or 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)

Description

GM6251 combines high accuracy with very low power consumption, and provides high output current even when the application requires extremely low input-output voltage dropout.

GM6251 includes a precision voltage reference, an error correction circuit, over-temperature protection, and a current limited output driver. Fast transient response to load variations provides excellent stability under dynamic loads.

GM6251 comes in SOT-25 (150mW), TO92 and SOT-89 (500mW).

Features

- ◆ Maximum output current up 300mA
- ◆ Output voltage from 1.5V to 5.0V in 0.1V increments
- ◆ Output voltage accuracy : $\pm 2\%$
- ◆ CMOS low power consumption, typically 1.0 μ A at $V_{OUT} = 5.0V$
- ◆ Input stability: typically 0.2%/V
- ◆ Ultra low dropout voltage: 0.38V @ $I_{OUT} = 200mA$ at $V_{OUT} = 5.0V$
- ◆ SOT-25 (150mW), SOT-89 (500mW) and TO-92 packages

Application

Palmtops

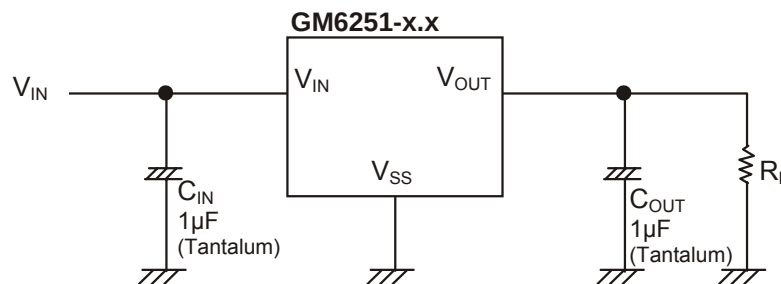
Portable Cameras

Video Recorders

Battery Powered Equipment

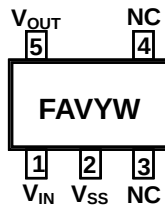
Reference Voltage Sources

Typical Application Circuits

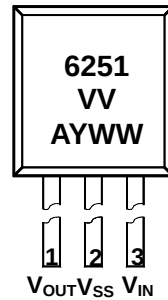


Marking Information and Pin Configurations (Top View)

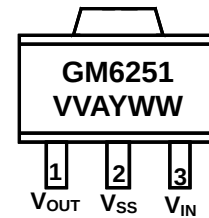
SOT25



TO92



SOT89



V: Voltage Code (see next page)
 VV: Voltage suffix (18 = 1.8V, 50 = 5.0V...)
 Y: Year
 W: Week code
 WW: Week

Ordering Information

Ordering Number	Output Voltage	Voltage Code	Package	Shipping
GM6251-1.8T92B	1.8V		TO-92	1,000 Units/Bag
GM6251-1.8T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-1.8ST25R		E	SOT-25	3,000 Units/Tape and Reel
GM6251-1.8ST89R			SOT-89	1,000 Units/Tape and Reel
GM6251-2.5T92B	2.5V		TO-92	1,000 Units/Bag
GM6251-2.5T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-2.5ST25R		G	SOT-25	3,000 Units/Tape and Reel
GM6251-2.5ST89R			SOT-89	1,000 Units/Tape and Reel
GM6251-2.7T92B	2.7V		TO-92	1,000 Units/Bag
GM6251-2.7T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-2.7ST25R		T	SOT-25	3,000 Units/Tape and Reel
GM6251-2.7ST89R			SOT-89	1,000 Units/Tape and Reel
GM6251-2.8T92B	2.8V		TO-92	1,000 Units/Bag
GM6251-2.8T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-2.8ST25R		H	SOT-25	3,000 Units/Tape and Reel
GM6251-2.8ST89R			SOT-89	1,000 Units/Tape and Reel
GM6251-3.0T92B	3.0V		TO-92	1,000 Units/Bag
GM6251-3.0T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-3.0ST25R		J	SOT-25	3,000 Units/Tape and Reel
GM6251-3.0ST89R			SOT-89	1,000 Units/Tape and Reel



GM6251

300mA ULTR LOW DROPOUT
POSITIVE VOLTAGE REGULATOR

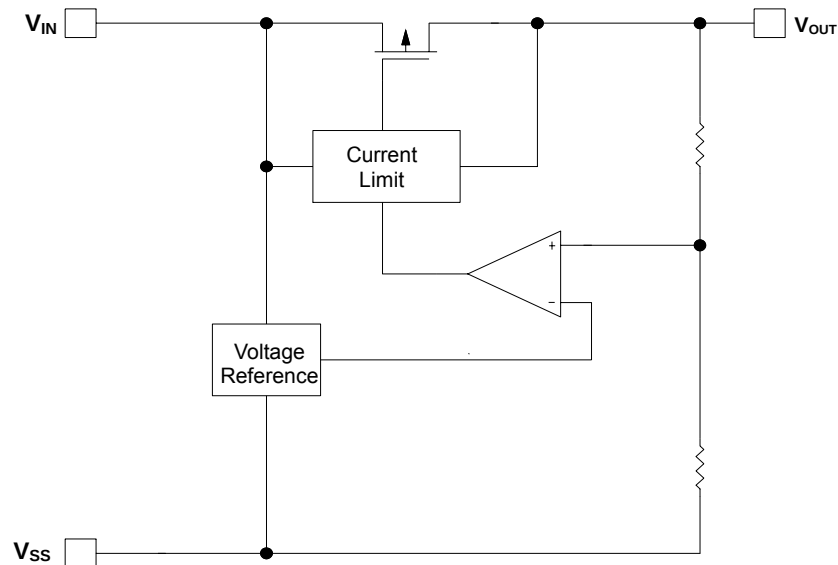
Ordering Information (Continued)

Ordering Number	Output Voltage	Voltage Code	Package	Shipping
GM6251-3.2T92B	3.2V		TO-92	1,000 Units/Bag
GM6251-3.2T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-3.2ST25R		U	SOT-25	3,000 Units/Tape and Reel
GM6251-3.2ST89R			SOT-89	1,000 Units/Tape and Reel
GM6251-3.3T92B	3.3V		TO-92	1,000 Units/Bag
GM6251-3.3T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-3.3ST25R		K	SOT-25	3,000 Units/Tape and Reel
GM6251-3.3ST89R			SOT-89	1,000 Units/Tape and Reel
GM6251-3.5T92B	3.5V		TO-92	1,000 Units/Bag
GM6251-3.5T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-3.5ST25R		V	SOT-25	3,000 Units/Tape and Reel
GM6251-3.5ST89R			SOT-89	1,000 Units/Tape and Reel
GM6251-3.6T92B	3.6V		TO-92	1,000 Units/Bag
GM6251-3.6T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-3.6ST25R		L	SOT-25	3,000 Units/Tape and Reel
GM6251-3.6ST89R			SOT-89	1,000 Units/Tape and Reel
GM6251-4.0T92B	4.0V		TO-92	1,000 Units/Bag
GM6251-4.0T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-4.0ST25R		M	SOT-25	3,000 Units/Tape and Reel
GM6251-4.0ST89R			SOT-89	1,000 Units/Tape and Reel
GM6251-4.4T92B	4.4V		TO-92	1,000 Units/Bag
GM6251-4.4T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-4.4ST25R		W	SOT-25	3,000 Units/Tape and Reel
GM6251-4.4ST89R			SOT-89	1,000 Units/Tape and Reel
GM6251-4.5T92B	4.5V		TO-92	1,000 Units/Bag
GM6251-4.5T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-4.5ST25R		N	SOT-25	3,000 Units/Tape and Reel
GM6251-4.5ST89R			SOT-89	1,000 Units/Tape and Reel
GM6251-5.0T92B	5.0V		TO-92	1,000 Units/Bag
GM6251-5.0T92RL			TO-92	2,000 Units/Ammo Pack (Tape)
GM6251-5.0ST25R		Q	SOT-25	3,000 Units/Tape and Reel
GM6251-5.0ST89R			SOT-89	1,000 Units/Tape and Reel

Absolute Maximum Ratings

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V_{IN}	12	V
Output Current		I_{OUT}	500	mA
Output Voltage		V_{OUT}	$V_{SS} - 0.3$ to $V_{IN} + 0.3$	V
Continuous Total Power Dissipation	SOT-25	P_D	150	mW
	SOT-89		500	
	TO-92		300	
Operating Ambient Temperature		T_A	- 40 to 125	°C
Storage Temperature		T_{stg}	- 65 to 150	°C

Block Diagram



Electrical Characteristics ($T_A = 25^\circ\text{C}$, $V_{IN} = V_{OUT} + 1\text{V}$ unless otherwise noted)

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Output Voltage	GM6251-1.8	V_{OUT}	$I_{OUT} = 40\text{mA}$, $V_{IN} = V_{OUT} + 1\text{V}$	1.764	1.800	1.836	V
	GM6251-2.5			2.450	2.500	2.550	
	GM6251-2.7			2.646	2.700	2.754	
	GM6251-2.8			2.744	2.800	2.856	
	GM6251-3.0			2.940	3.000	3.060	
	GM6251-3.2			3.136	3.200	3.264	
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	GM6251-3.5			3.430	3.500	3.570	
	GM6251-3.6			3.528	3.600	3.672	
	GM6251-4.0			3.920	4.000	4.080	
	GM6251-4.4			4.312	4.400	4.488	
	GM6251-4.5			4.410	4.500	4.590	
	GM6251-5.0			4.900	5.000	5.100	
Line Regulation		ΔV_{OI}	$I_{OUT} = 40\text{mA}$, $V_{OUT} + 1\text{V} < V_{IN} < 10\text{V}$		0.2	0.3	%/V
Load Regulation		ΔV_{OL}	$1\text{mA} < I_{OUT} < 80\text{mA}$		0.02	0.03	%/mA
Dropout Voltage	$V_{OUT} > 2.5\text{V}$	ΔV	$I_{OUT} = 180\text{mA}$		0.4	0.7	V
	$2.0\text{V} < V_{OUT} < 2.5\text{V}$				0.55	0.85	
	$V_{OUT} < 2.0\text{V}$				0.9	1.3	
Current Consumption		I_Q			1.0	2.9	μA
Output Current Limit		I_{CL}		500			mA

Application Note

Notes on Usage

1. It is recommended to operate the GM6251 series within the stipulated absolute maximum ratings as the IC is liable to malfunction if it is operated outside the ratings.
2. There is a possibility of heat or oscillation as a result of the impedance present between the power supply and the IC's input. Where impedance is greater than 10Ω , it is recommended to use a capacitor (C_{IN}) of at least $1\mu F$ at the input terminal.
3. With a large output current, operations can be stabilized by increasing capacitor size (C_{IN}). If C_{IN} is too small and capacitance of (C_L) is increased, there is a possibility of oscillation due to input impedance. In such case, operation can be stabilized by either increasing the size of C_{IN} or decreasing the size of C_L .
4. Please ensure the output current (I_{OUT}) is less than $P_d \div (V_{IN} - V_{OUT})$ and does not exceed the stipulated continuous for total power dissipation value (P_d) for the package.

CALCULATING POWER DISSIPATION

The GM6251 series precision linear regulators include thermal shutdown and current limit circuitry to protect the devices. However, high power regulators normally operate at high junction temperatures so it is important to calculate the power dissipation and junction temperatures accurately to be sure that you use an adequate heat sink.

The thermal characteristics of an IC depend on four factors:

1. Maximum Ambient Temperature T_A ($^{\circ}C$)
2. Power Dissipation P_D (Watts)
3. Maximum Junction Temperature T_J ($^{\circ}C$)
4. Thermal Resistance Junction to ambient R_{JA} ($^{\circ}C/W$)

These relationships of these four factors is expressed by equation : $T_J = T_A + P_D \times R_{JA}$

Maximum ambient temperature and power dissipation are determined by the design while the maximum junction temperature and thermal resistance depend on the manufacturer and the package type.

Typical Performance Characteristics (for GM6251-3.0)

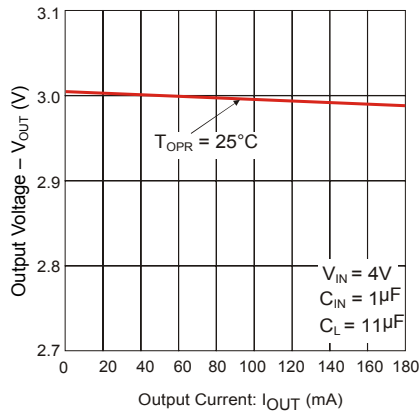


Figure 1: Output Voltage vs. Output Current

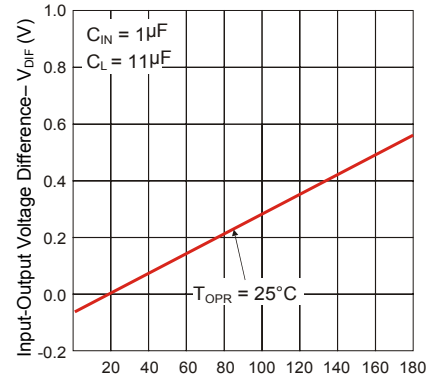


Figure 2: Input/ Output Voltage differential vs. Output Current

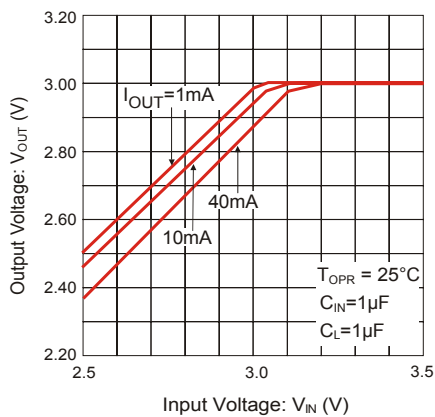


Figure 3: Output Voltage vs. Input voltage

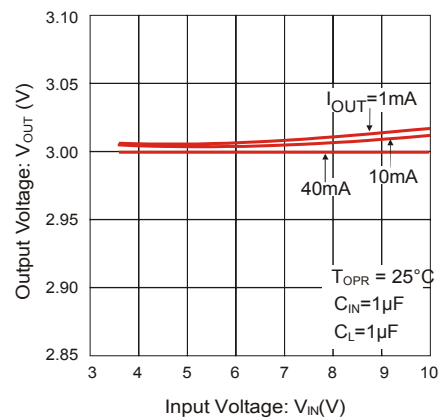


Figure 4: Output Voltage vs. Input voltage

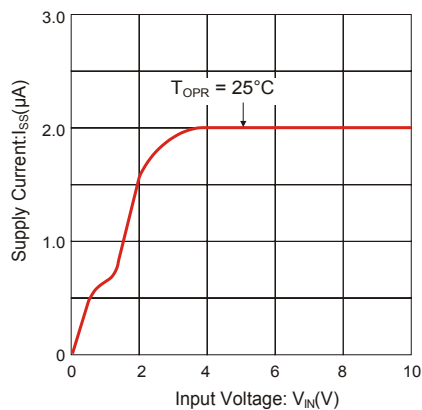


Figure 5: Supply Current vs. Input Voltage

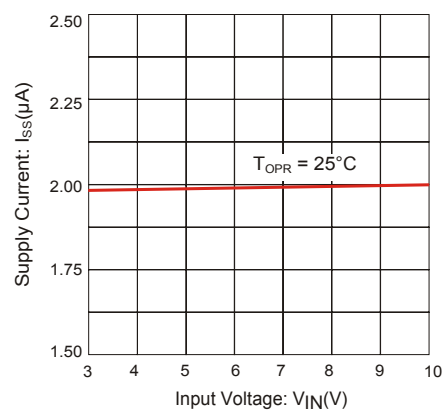


Figure 6: Supply Current vs. Input Voltage

Typical Performance Characteristics (for GM6251-3.0, continued)

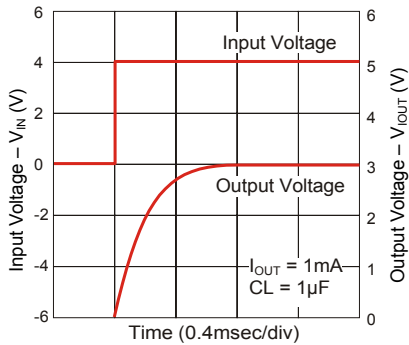


Figure 7: Input Transient Response 1

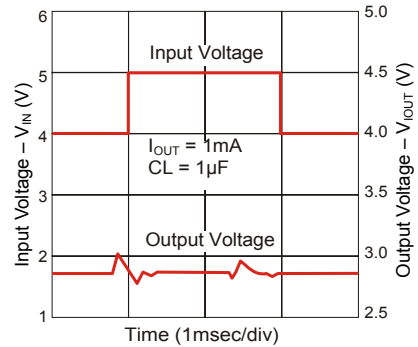


Figure 8: Input Transient Response 2

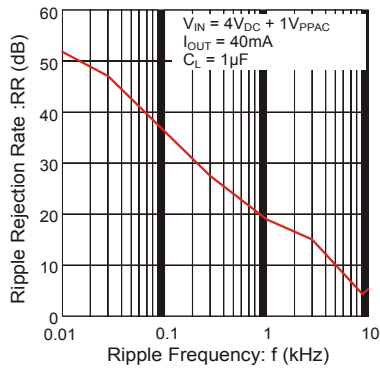
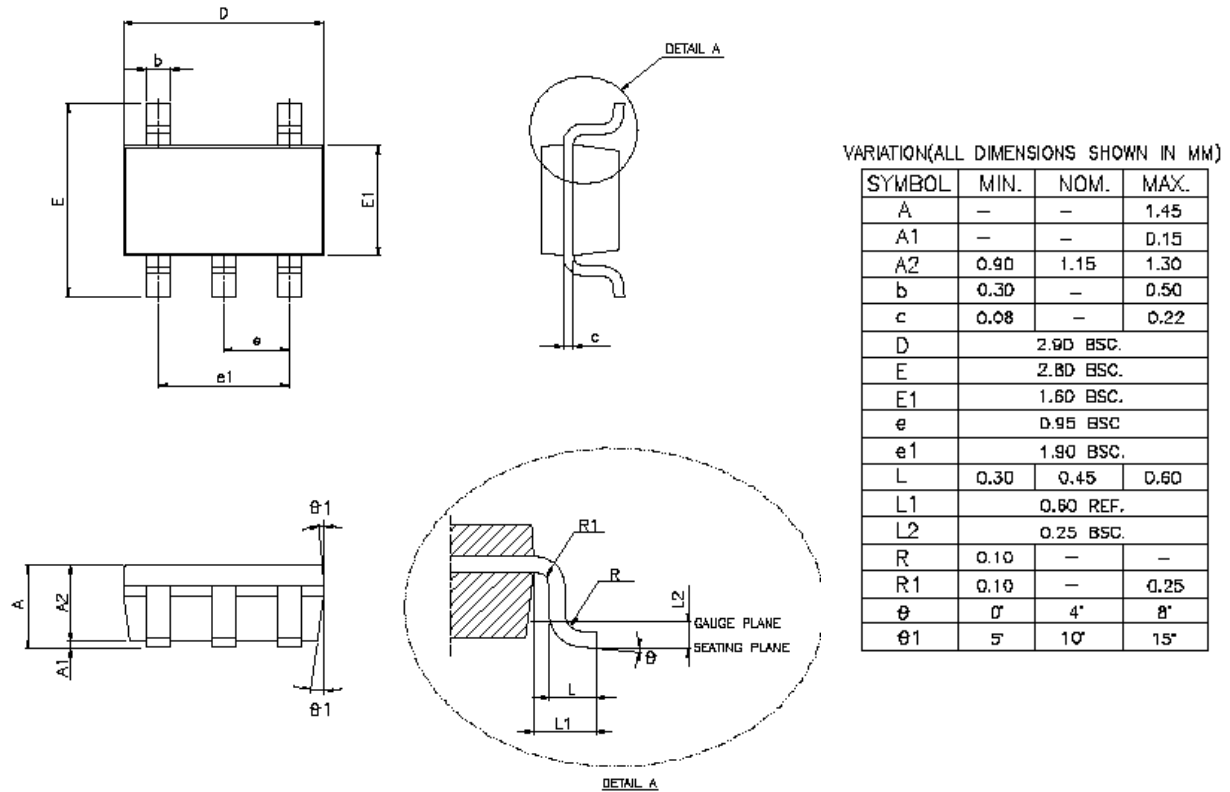
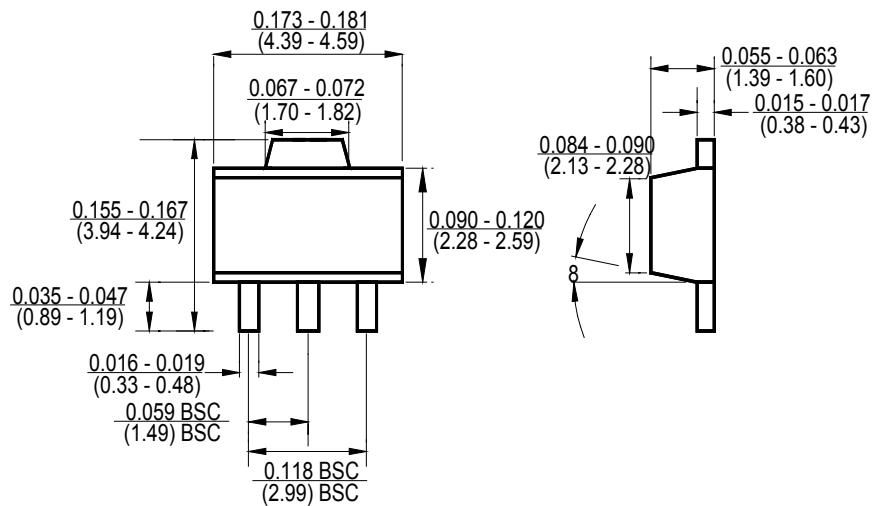


Figure 9: Ripple Rejection Rate

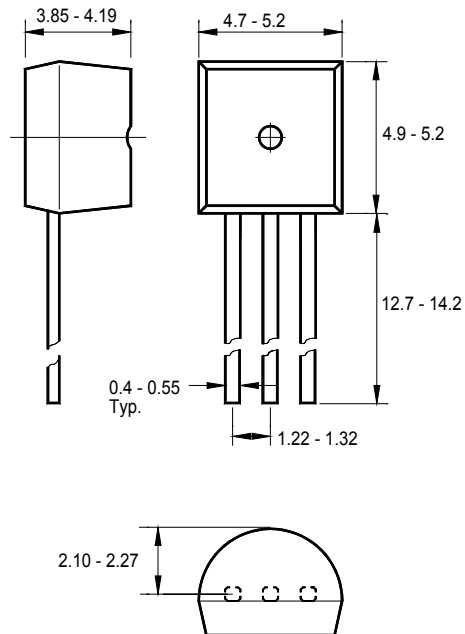
Package Outline Dimensions – SOT 25



Package Outline Dimensions – SOT 89



Package Outline Dimensions – TO 92



Dimensions are in millimeters

Ordering Number

GM 6251 - 1.8 T92 B

APM Gamma Micro	Circuit Type	Output Voltage	Package Type	Shipping Type
		1.8 = 1.8V	T92: TO 92	B: Bag
		2.5 = 2.5V	ST89: SOT 89	RL: Ammo Pack (Tape)
		3.3 = 3.3V	ST25: SOT 25	T: Tube
		5.0 = 5.0V		R: Tape & Reel

Description

GM6350 series is a group of positive voltage output, three-pin regulators, that provide a high current even when the input/output voltage differential is small. Low power consumption and high accuracy is achieved through CMOS and programmable fuse technologies, with the output voltage range from 1.5V to 6.0V

GM6350 consists of a high precision voltage reference, an error correction circuit, and a current limited output driver. Transient response to load variations has been improved in comparison to the existing series. The GM6350 incorporates both over temperature and over current protection.

Features

- ◆ Maximum output current up 450mA
- ◆ Output voltage from 1.5V to 6.0V in 0.1V increments
- ◆ Output voltage accuracy : $\pm 2\%$
- ◆ CMOS low power consumption, typically 15 μ A at $V_{OUT} = 5.0V$
- ◆ Input stability: typically 0.2%/V
- ◆ Ultra low dropout voltage: 0.3V @ $I_{OUT} = 300mA$ at $V_{OUT} = 5.0V$
- ◆ SOT-23 (150mW), SOT-89 (500mW) and TO-92 packages

Application

Palmtops

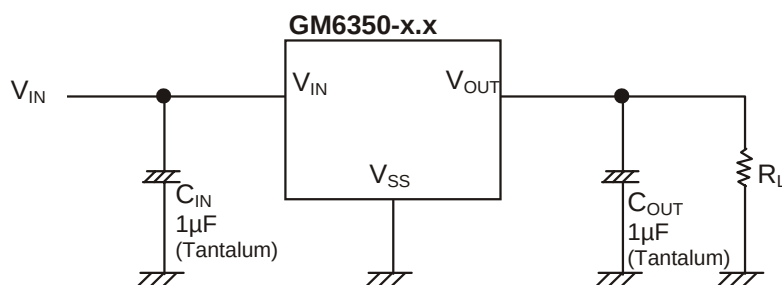
Portable Cameras

Video Recorders

Battery Powered Equipment

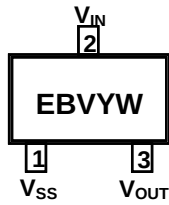
Reference Voltage Sources

Typical Application Circuits

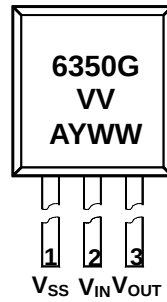


Marking Information and Pin Configurations (Top View)

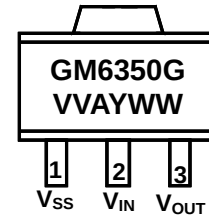
SOT23



TO92



SOT89



EB: Product Code
G: Green Product
V: Voltage Code (see next page)
VV: Voltage suffix (18 = 1.8V, 50 = 5.0V...)
Y: Year
W: Week code
WW: Week

Ordering Information

Ordering Number	Output Voltage	Voltage Code	Package	Shipping
GM6350-1.5T92BG	1.5V		TO-92	1,000 Units/Bag
GM6350-1.5T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-1.5ST23RG		C	SOT-23	3,000 Units/Tape and Reel
GM6350-1.5ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-1.8T92BG	1.8V		TO-92	1,000 Units/Bag
GM6350-1.8T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-1.8ST23RG		E	SOT-23	3,000 Units/Tape and Reel
GM6350-1.8ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-2.2T92BG	2.2V		TO-92	1,000 Units/Bag
GM6350-2.2T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-2.2ST23RG		D	SOT-23	3,000 Units/Tape and Reel
GM6350-2.2ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-2.5T92BG	2.5V		TO-92	1,000 Units/Bag
GM6350-2.5T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-2.5ST23RG		G	SOT-23	3,000 Units/Tape and Reel
GM6350-2.5ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-2.7T92BG	2.7V		TO-92	1,000 Units/Bag
GM6350-2.7T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-2.7ST23RG		T	SOT-23	3,000 Units/Tape and Reel
GM6350-2.7ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-2.8T92BG	2.8V		TO-92	1,000 Units/Bag
GM6350-2.8T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-2.8ST23RG		H	SOT-23	3,000 Units/Tape and Reel
GM6350-2.8ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-2.85T92BG	2.85V		TO-92	1,000 Units/Bag
GM6350-2.85T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-2.85ST23RG		I	SOT-23	3,000 Units/Tape and Reel
GM6350-2.85ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-3.0T92BG	3.0V		TO-92	1,000 Units/Bag
GM6350-3.0T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-3.0ST23RG		J	SOT-23	3,000 Units/Tape and Reel
GM6350-3.0ST89RG			SOT-89	1,000 Units/Tape and Reel

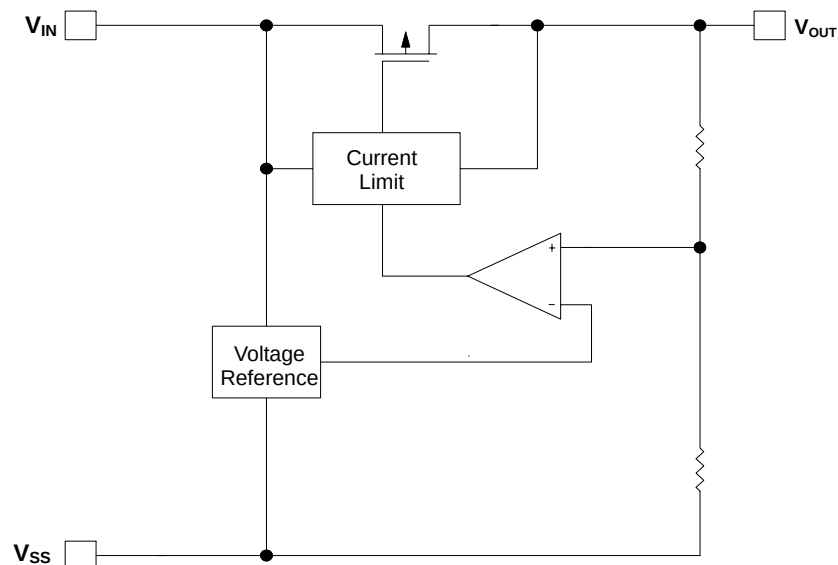
Ordering Information (Continued)

Ordering Number	Output Voltage	Voltage Code	Package	Shipping
GM6350-3.2T92BG	3.2V		TO-92	1,000 Units/Bag
GM6350-3.2T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-3.2ST23RG		U	SOT-23	3,000 Units/Tape and Reel
GM6350-3.2ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-3.3T92BG	3.3V		TO-92	1,000 Units/Bag
GM6350-3.3T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-3.3ST23RG		K	SOT-23	3,000 Units/Tape and Reel
GM6350-3.3ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-3.5T92BG	3.5V		TO-92	1,000 Units/Bag
GM6350-3.5T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-3.5ST23RG		V	SOT-23	3,000 Units/Tape and Reel
GM6350-3.5ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-3.6T92BG	3.6V		TO-92	1,000 Units/Bag
GM6350-3.6T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-3.6ST23RG		L	SOT-23	3,000 Units/Tape and Reel
GM6350-3.6ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-4.0T92BG	4.0V		TO-92	1,000 Units/Bag
GM6350-4.0T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-4.0ST23RG		M	SOT-23	3,000 Units/Tape and Reel
GM6350-4.0ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-4.4T92BG	4.4V		TO-92	1,000 Units/Bag
GM6350-4.4T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-4.4ST23RG		W	SOT-23	3,000 Units/Tape and Reel
GM6350-4.4ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-4.5T92BG	4.5V		TO-92	1,000 Units/Bag
GM6350-4.5T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-4.5ST23RG		N	SOT-23	3,000 Units/Tape and Reel
GM6350-4.5ST89RG			SOT-89	1,000 Units/Tape and Reel
GM6350-5.0T92BG	5.0V		TO-92	1,000 Units/Bag
GM6350-5.0T92RLG			TO-92	2,000 Units/Ammo Pack (Tape)
GM6350-5.0ST23RG		Q	SOT-23	3,000 Units/Tape and Reel
GM6350-5.0ST89RG			SOT-89	1,000 Units/Tape and Reel

Absolute Maximum Ratings

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V_{IN}	6.5	V
Output Current		I_{OUT}	450	mA
Output Voltage		V_{OUT}	$V_{SS} - 0.3$ to $V_{IN} + 0.3$	V
Continuous Total Power Dissipation	SOT-23	P_D	150	mW
	SOT-89		500	
	TO-92		300	
Operating Ambient Temperature		T_A	- 40 to 125	°C
Storage Temperature		T_{stg}	- 65 to 150	°C
Lead Temperature (Soldering, 10 sec)			+ 260	°C

Block Diagram



Electrical Characteristics ($T_A = 25^\circ\text{C}$, $V_{IN} = V_{OUT} + 0.5\text{V}$ unless otherwise noted)

Parameter		Symbol	Conditions	Min	Typ	Max	Unit	
Output Voltage Accuracy		V _{OUT}	I _{OUT} = 1mA	-1.4		+1.4	%	
			I _{OUT} = 0.1mA to 300mA	-3.0		+2.0		
Line Regulation		ΔV _{OI}	I _{OUT} = 1mA, V _{OUT} + 0.1V < V _{IN} < 6.5V, Fig. 1		0.1	0.3	%/V	
Load Regulation		ΔV _{OL}	V _{IN} = 6V, 0.1mA < I _{OUT} < 300mA C _{OUT} = 1μF, Fig. 2		0.005	0.04	%/mA	
Maximum Output Current			V _{IN} = 5V, V _{OUT} > 0.96 X V _{RATING}	300	500		mA	
Output Current Limit		I _{CL}		400			mA	
Ground Pin Current		I _{GND}	I _{OUT} = 0.1mA to 300mA, Fig. 3		15	30	μA	
Dropout Voltage	V _{OUT} > 2.5V	ΔV	I _{OUT} = 100mA		100	180	mV	
	I _{OUT} = 300mA			300	550			
	2.0V < V _{OUT} ≤ 2.5V		I _{OUT} = 100mA		150	300		
			I _{OUT} = 300mA		450	800		
	V _{OUT} ≤ 2.0V		I _{OUT} = 100mA		200	400		
			I _{OUT} = 300mA		600	1100		
Power Supply Rejection Ration		PSRR	10kHz		60		dB	

Note: Load Regulation is measured using pulse techniques with duty cycle < 5%

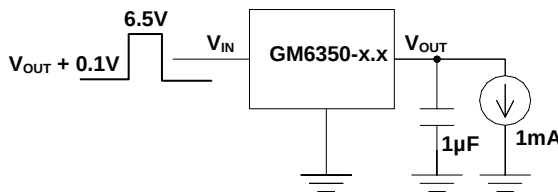


Figure 1. Line Regulation Test Circuit

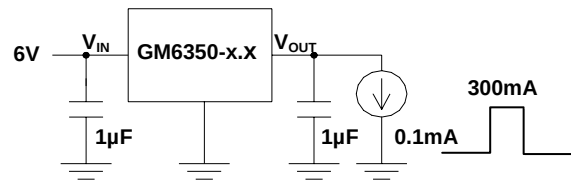


Figure 2. Load Regulation Test Circuit

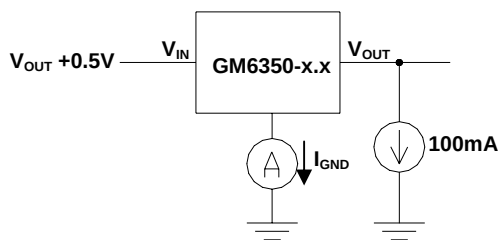
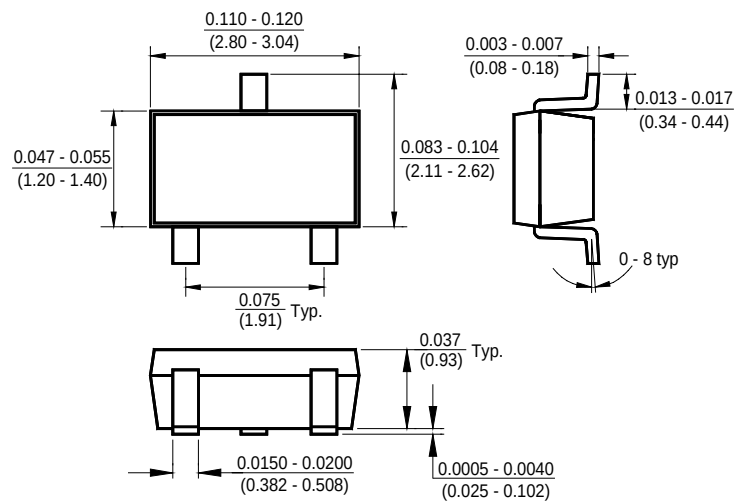
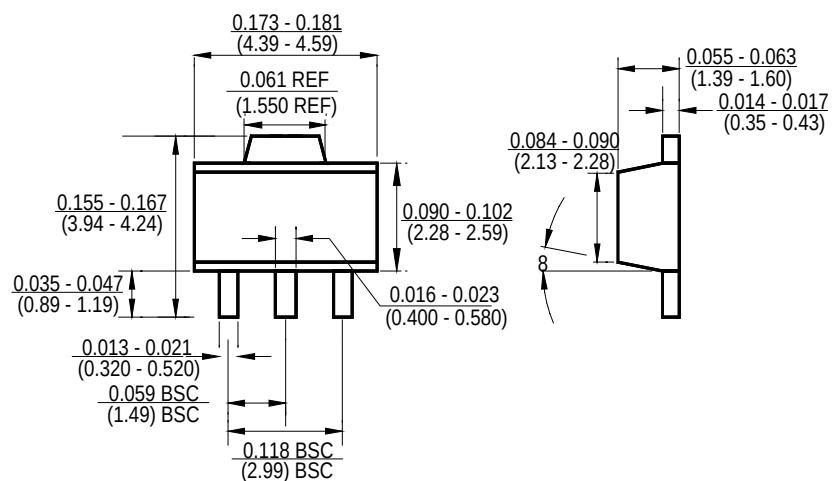


Figure 3. Ground Current Test Circuit

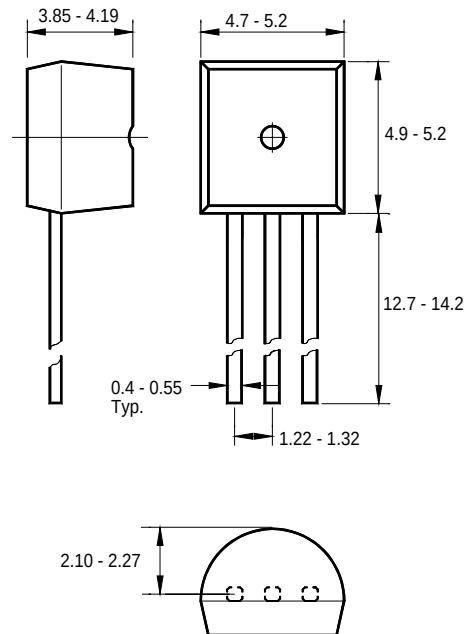
Package Outline Dimensions – SOT 23



Package Outline Dimensions – SOT 89



Package Outline Dimensions – TO 92



Dimensions are in millimeters

Ordering Number

GM 6350 - 1.5 ST23 R G

APM Gamma Micro	Circuit Type	Output Voltage	Package Type	Shipping Type	
		1.5 = 1.5V 2.5 = 2.5V 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	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 SnPb or 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)