

### 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 (600 $\mu$ A 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

GM6155 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

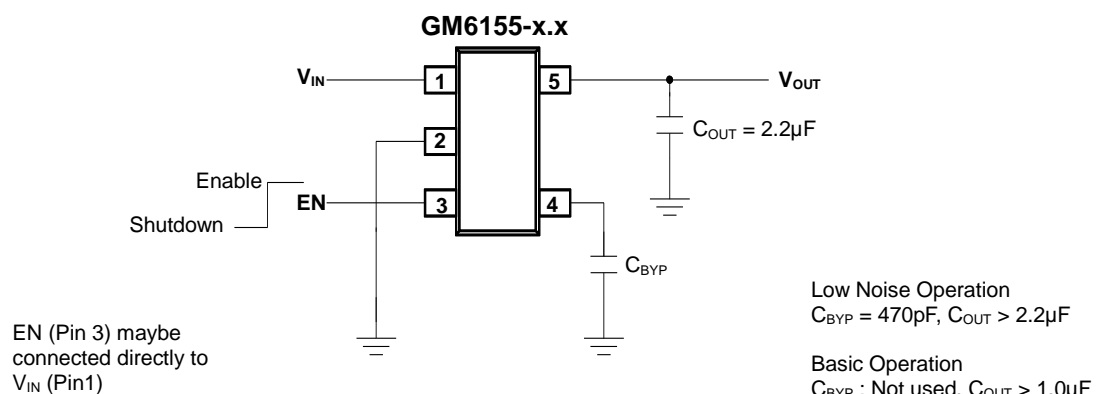
PCMCIA  $V_{CC}$  and  $V_{PP}$  regulation/switching

Consumer/personal electronics

SMPS post regulator/dc to dc modules

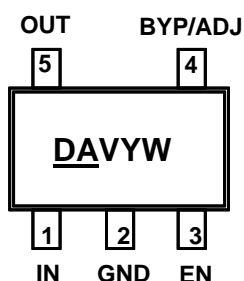
High efficiency linear power supplies

### Typical Application Circuits



## Marking Information and Pin Configurations (Top View)

SOT25



DA: Device Code, 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 – 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

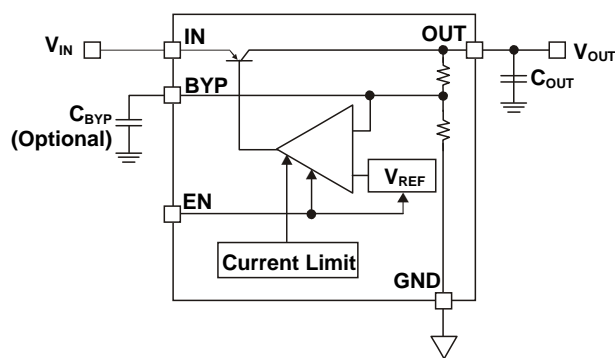
### Absolute Maximum Ratings (Note 1)

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

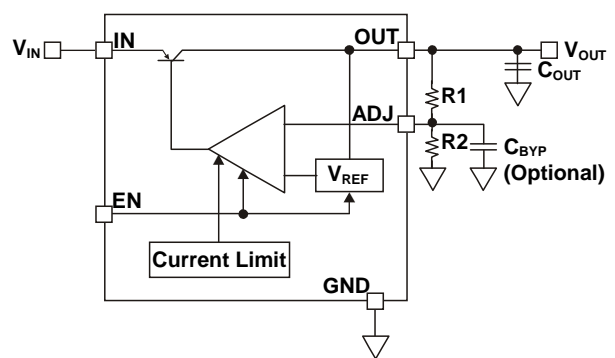
### Operating Ratings (Note 2)

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	$\theta_{JA}$	(Note 3)	°C/W

### Block Diagram



Ultra Low Noise Fixed Regulator



Ultra Low Noise Adjustable Regulator

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

$$V_{REF} = 1.242V$$

$$V_{OUT\ MIN} = 1.5V$$

**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		1	%
			-2		2	
Output Voltage Temperature Coefficient	$\Delta V_O / \Delta T$	(Note 5)		40		ppm/ $^\circ C$
Line Regulation	$\Delta V_O / V_O$	$V_{IN} = V_{OUT} + 1V$ to 16V		0.004	0.012	%/V
					<b>0.05</b>	
Load Regulation	$\Delta V_O / V_O$	$I_L = 0.1mA$ to 150mA, (Note 6)		0.02	0.2	%
					<b>0.5</b>	
Dropout Voltage (Note 7)	$V_{IN} - V_O$	$I_L = 100\mu A$		10	50	mV
					<b>70</b>	
		$I_L = 50mA$		110	150	
					<b>230</b>	
		$I_L = 100mA$		140	250	
					<b>300</b>	
		$I_L = 150mA$		165	275	
					<b>350</b>	
Quiescent Current	$I_Q$	$V_{EN} \leq 0.4V$ (Shutdown)		0.01	1	$\mu A$
		$V_{EN} \leq 0.18V$ (Shutdown)			<b>5</b>	
Ground Pin Current (Note 8)	$I_{GND}$	$I_L = 100\mu A$		80	160	$\mu A$
					<b>180</b>	
		$I_L = 50mA$		350	600	
					<b>800</b>	
		$I_L = 100mA$		600	1000	
					<b>1500</b>	
		$I_L = 150mA$		1300	1900	
					<b>2500</b>	
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
<b>ENABLE INPUT</b>						
Enable Input Logic Low Voltage	$V_{IL}$	Regulator shutdown			0.4	V
					<b>0.18</b>	
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	$\mu A$
		$V_{IL} \leq 0.18V$			<b>-2</b>	
	$I_{IH}$	$V_{IH} \leq 2.0V$	2	5	35	
					<b>40</b>	

- 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  $V_{OUTMIN} = 1.5V$ ,
- 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 the 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  $5\text{ m}\Omega$  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.  $\theta_{JA}$  is layout dependent; Table 1 shows examples of junction-to-ambient thermal resistance for the GM6155.

Parameter	$\theta_{JA}$ Recommended Minimum Foot print	$\theta_{JA}$ 1" Square Copper Clad	$\theta_{JC}$
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

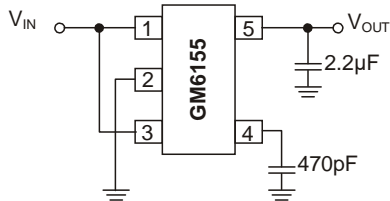


Figure 4. Low-Noise Fixed Voltage Application

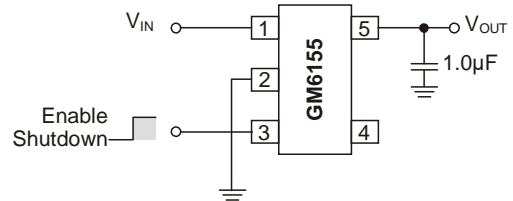


Figure 3 includes a 470pF low noise operation and shows EN (pin 3) connected to IN (pin 1) for an application where enable / shutdown is not required.

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, it is recommended to keep a minimum load current of 100µA. 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.

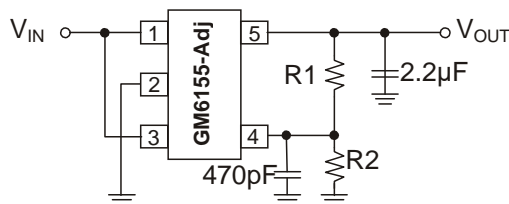


Figure 5. Ultra-Low- Noise Adjustable Voltage Application

### Typical Performance Characteristics

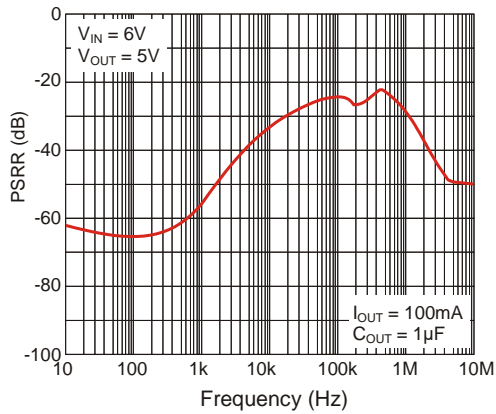


Figure 6. Power Supply Rejection Ratio

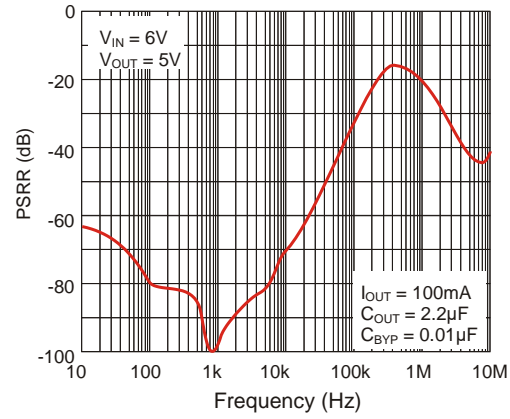


Figure 7. Power Supply Rejection Ratio

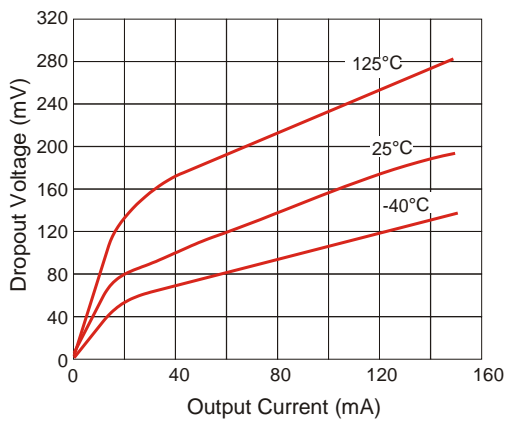


Figure 8. Dropout Voltage vs.  
Output Current

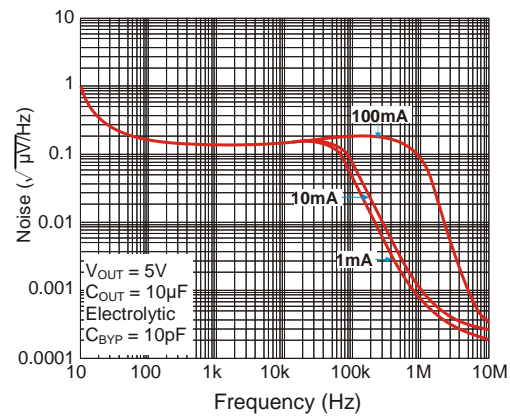
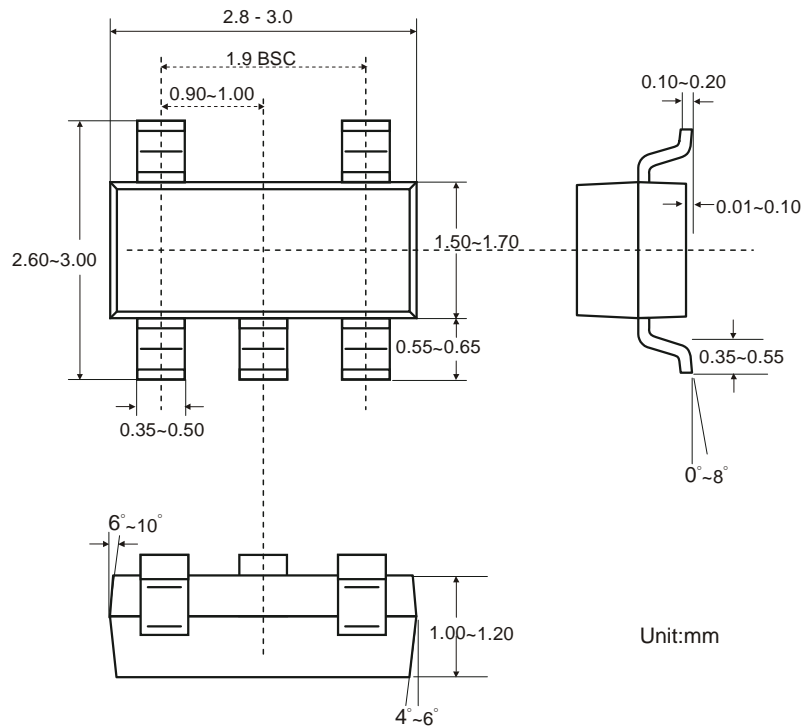


Figure 9. Noise Performance

## Package Outline Dimensions – SOT 25



Note: All dimensions are subject to change due to manufacturing concerns. However, they will be in full compliance with JEDEC MO-178C standard.



**GAMMA**  
MICROELECTRONICS

# GM6155

150mA LOW NOISE LDO  
WITH ENABLE FUNCTION

## 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    G:Green

Note:

### 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)