GM6155

150mA LOW NOISE CMOS LDO WITH ENABLE FUNCTION

Description

GM6155 is a high efficient CMOS LDO with features as such ultra low noise output, ultra low dropout voltage (typically 17mV at light load and 165mV at 50mA 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

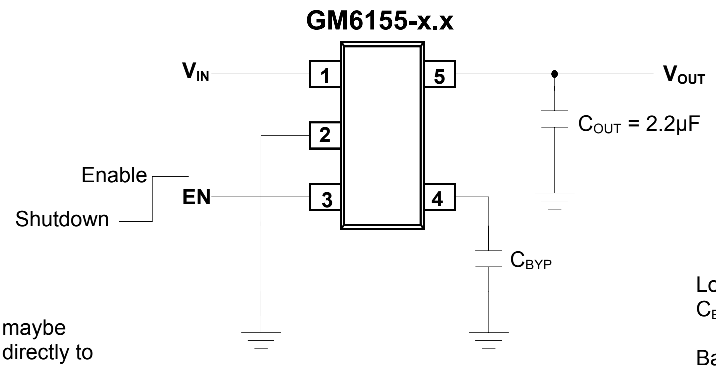
PCMCIA V_{CC} and V_{PP} regulation/switching

Consumer/personal electronics

SMPS post regulator/dc to dc modules

High efficiency linear power supplies

Typical Application Circuits



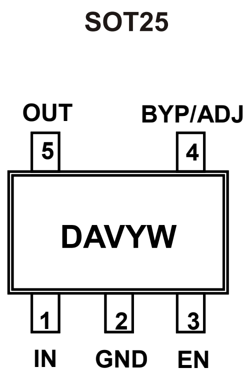
EN (Pin 3) maybe connected directly to V_{IN} (Pin1)

Low Noise Operation
C_{BYP} = 470pF, C_{OUT} > 2.2µF

Basic Operation
C_{BYP} : Not used, C_{OUT} > 1.0µF

GM6155V1.01

Marking Information and Pin Configurations (Top View)



DA: GM6155
V: Voltage Code (see next page)
Y: Year
W: Week code

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

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
GM6155-4.0ST25R	4.0V	M	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

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

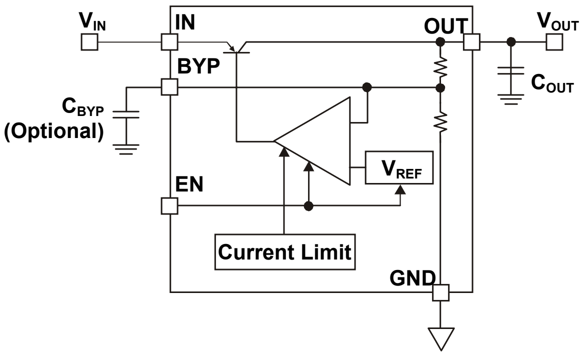
Note 1. Exceeding the absolute maximum rating may damage the device.

Operating Ratings (Note 2)

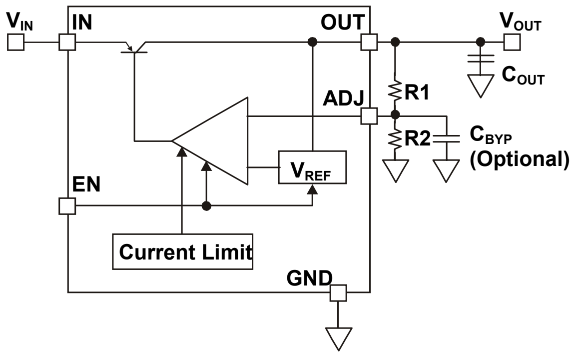
PARAMETER	SYMBOL	RATINGS	UNITS
Input Voltage	V_{IN}	2.5V to 16V	V
Enable Voltage	V_{EN}	0V to V_{IN}	V
Continuous Total Power Dissipation (Note 3)	P_D	Internally Limited	mW
Junction Temperature	T_J	- 40 to 125	°C
Thermal Resisitance	θ_{JA}	(Note 3)	°C/W

Note 2. The device is not guaranteed to function outside its operating rating.

Block Diagram



Ultra Low Noise Fixed Regulator



Ultra Low Noise Adjustable Regulator

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

Electrical Characteristics

($V_{IN} = V_{OUT}$ + 1V, I_L = 100µA, CL = 1.0µF, $V_{EN} \geq$ 2.0V, T_J = 25˚C, bold values indicate -40˚C ≤ T_J ≤ +125˚C unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Output Voltage Accuracy	V_O	Variation from specified V_{OUT}	-1		1	%
			-2		**2**	
Output Voltage Temperature Coefficient	$\Delta V_O/\Delta T$	(Note 4)		**40**		ppm/˚C
Line Regulation	$\Delta V_O/\Delta V_I$	$V_{IN} = V_{OUT}$ + 1V to 16V		0.004	0.012	%/V
					0.05	
Load Regulation	$\Delta V_O/\Delta I_L$	I_L = 0.1mA to 150mA, (Note 5)		0.02	0.2	%
					0.5	
Dropout Voltage (Note 6)	$V_{IN} - V_O$	I_L = 100µA		10	50	mV
					70	
		I_L = 50mA		110	150	
					230	
		I_L = 100mA		140	250	
					300	
		I_L = 150mA		165	275	
					350	
Quiescent Current	I_Q	V_{EN} ≤ 0.4V (Shutdown)		0.01	1	µA
		V_{EN} ≤ 0.18V (Shutdown)			**5**	
Ground Pin Current (Note 7)	I_{GND}	I_L = 100µA		80	125	µA
					150	
		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 = 100µA		75		dB
Current Limit	I_{LIMIT}	V_{OUT} = 0V		**320**	500	mA
Thermal Regulation	$\Delta V_O/\Delta P_D$	Note 8		0.05		%/W
Output Noise	e_{no}	I_L = 50mA, C_L = 2.2µF, 470pF from BYP to GND		260		nV/√HZ
Power Supply Rejection Ration	PSRR	f = 120Hz		60		dB
ENABLE INPUT						
Enable Input Logic Low Voltage	V_{IL}	Regulator shutdown			0.4	V
					0.18	
Enable Input Logic High Voltage	V_{IH}	Regulator Enabled	2.0			V
Enable Input Current	I_{IL}	V_{IL} ≤ 0.4V		0.01	-1	µA
		V_{IL} ≤ 0.18V			**-2**	
	I_{IH}	V_{IH} ≤ 2.0V	2	5	20	
					25	

Note 3: The maximum allowable power dissipation at any T_A (ambient temperature) is: $P_D(max) = (T_J(max) - T_A) - \theta_{JA.}$ Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.

Note 4: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 5: 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 6: 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 7: 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 8: 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 VIN = 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 1μF 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 2.2μF 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. 1.0μF minimum is recommended when C_{BYP} is not used (see Figure 2). 2.2μF 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 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˚C, solid tantalums are recommended for operation below -25˚C.

At lower values for output current, less output capacitance is required for output stability. The capacitor can be reduced to 0.47μF for current below 10mA or 0.33μF 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	Q_{JA} Recommended Minimum Foot print	Q_{JA} 1" Square Copper Clad	Q_{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:

$$P_{D(max)} = \frac{125°C \quad - 25°C}{220°C/W}$$

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

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 for150mA output current is 2500µA or 2.5mA.

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

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

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

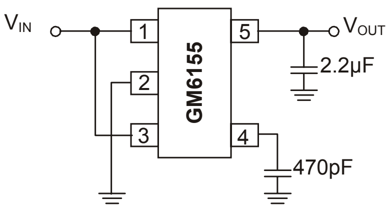


Figure 3. Ultra-Low-Noise Fixed Voltage Application

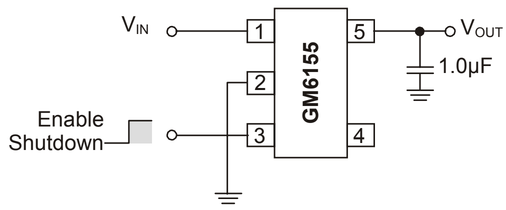


Figure 4. Low-Noise Fixed Voltage Application

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.

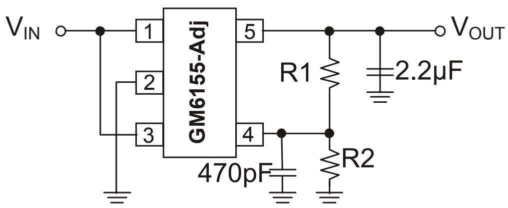


Figure 5. Ultra-Low- Noise Adjustable Voltage Application

Typical Performance Characteristics

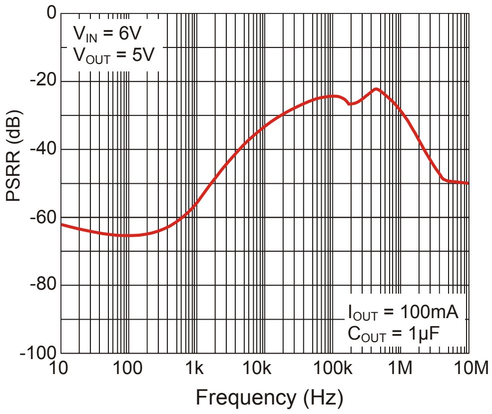


Figure 6. Power Supply Rejection Ratio

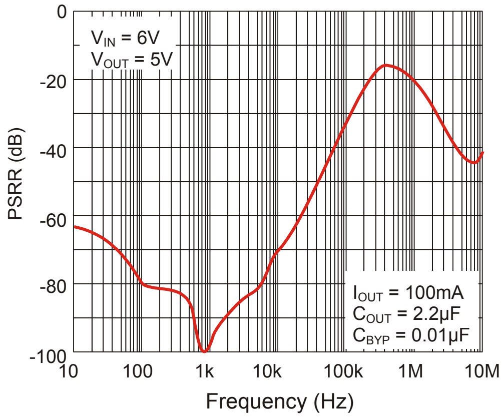


Figure 7. Power Supply Rejection Ratio

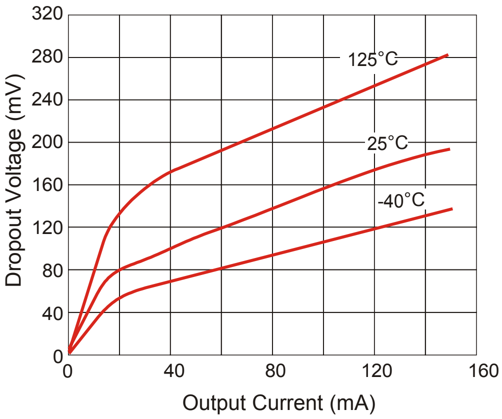


Figure 8. Dropout Voltage vs.

Output Current

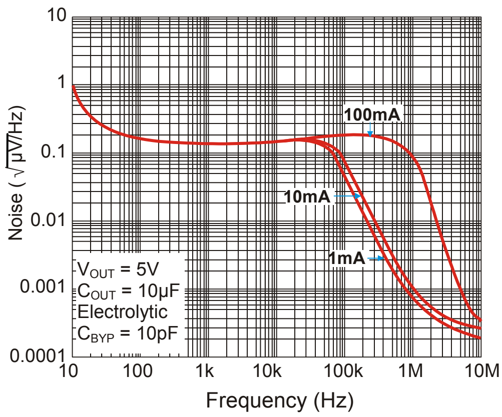
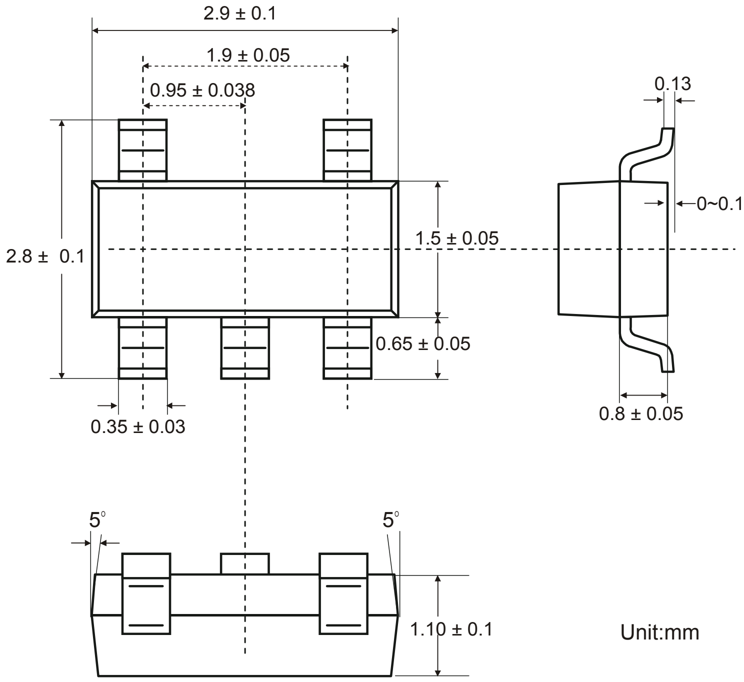
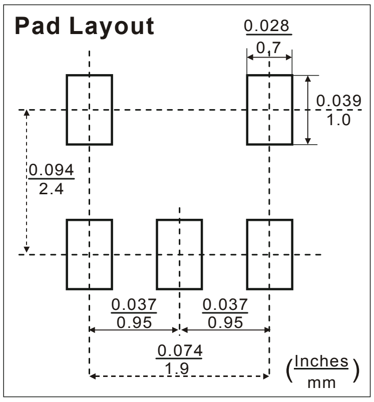


Figure 9. Noise Performance

Package Outline Dimensions – SOT 25



Unit:mm



Ordering Number

GM 6155 - 1.8 ST25 R

GM	6155	1.8	ST25	R
APM Gamma Micro	Circuit Type	Output Voltage	Package Type	Shipping Type
		1.8 = 1.8V 2.5 = 2.5V 3.3 = 3.3V 5.0 = 5.0V	ST25: SOT 25	R: Tape & Reel