

Description

The GM1117S is a positive low dropout regulator and is available in an adjustable version and fixed output voltage from 1.5V to 5.0V. All internal circuitry is designed to operate down to 800mV input to output differential and the dropout voltage is fully specified as a function of load current. On chip trimming adjusts the reference/output voltage to within $\pm 1\%$. Current limit is also trimmed in order to minimize the stress on both the regulator and the power source circuitry under overloaded conditions.

Features

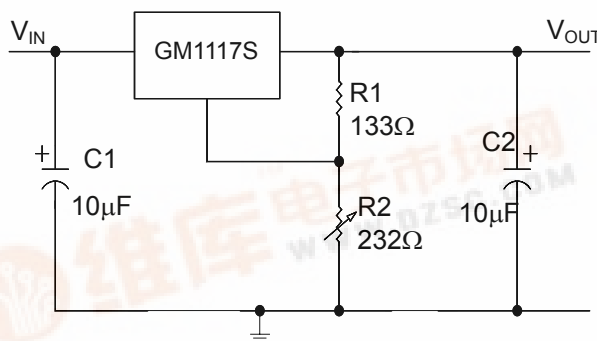
- ◆ Adjustable or Fixed Output
- ◆ Output Current of 1.0A
- ◆ Dropout Voltage 1.5V max @ 1.0A
- ◆ Line Regulation 0.2% max.
- ◆ Load Regulation 0.4% max.
- ◆ Fast Transient Response
- ◆ Current Limit Protection
- ◆ Thermal Shutdown Protection

Application

High Efficiency Linear Regulators
 Post Regulators for Switching Supplies
 Microprocessor Supply

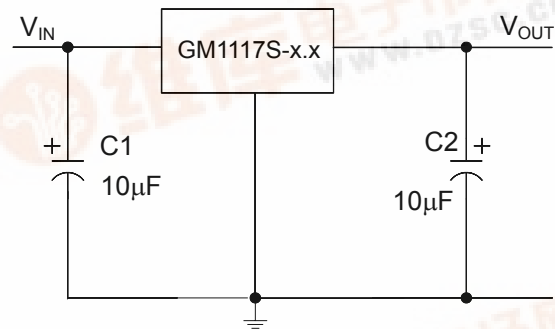
Battery Powered Equipment
 Reference Voltage Sources
 Hard Drive Controllers
 Battery Chargers
 Adjustable Power Supply

Typical Application Circuits



Adjustable Regulator

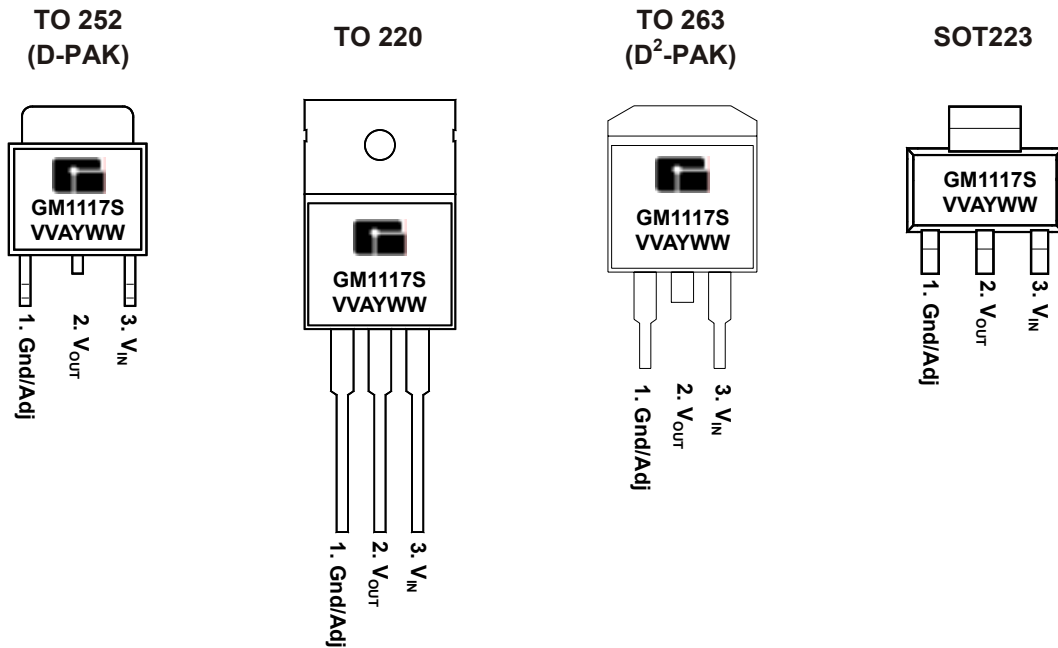
$$V_{OUT} = 1.25V \left(1 + \frac{R2}{R1} \right)$$



Fixed Output Voltage Regulator

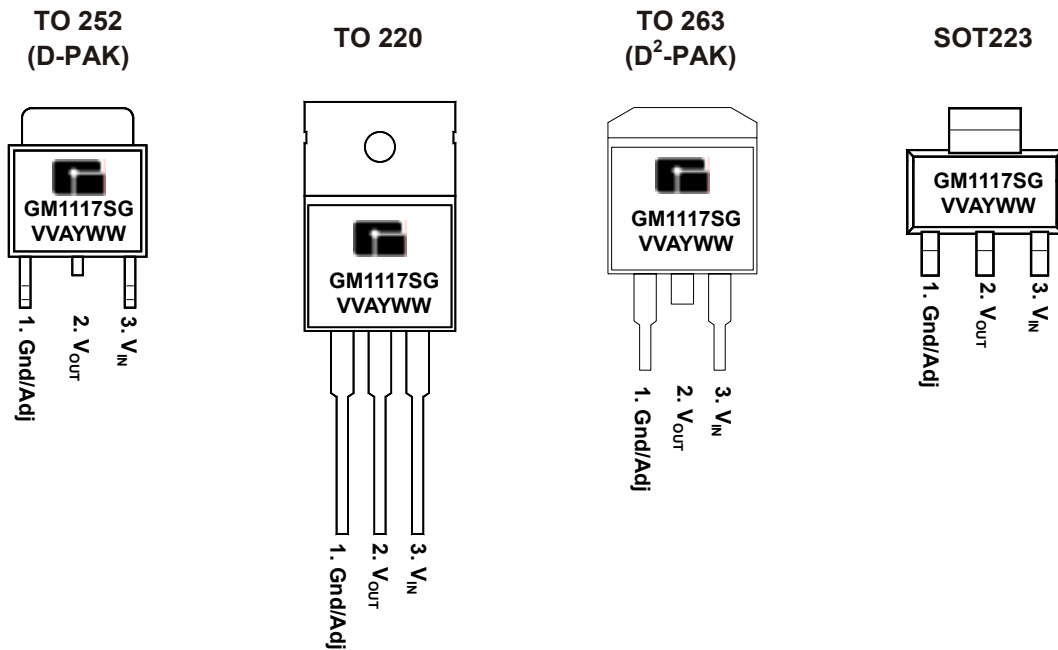


Marking Information and Pin Configurations (Top View) – Pb Free



VV: Voltage suffix (15 = 1.5V, 50 = 5.0V...A = Adj)
 A: Assembly / Test site code
 Y: Year
 WW: Week

Marking Information and Pin Configurations (Top View) – Green



G: Green Product
 VV: Voltage suffix (15 = 1.5V, 50 = 5.0V...A = Adj)
 A: Assembly / Test site code
 Y: Year
 WW: Week

Ordering Information – Pb Free Products

Ordering Number	Output Voltage	Package	Shipping
GM1117S-AST3T	Adj	SOT-223	80 Units/Tube
GM1117S-AST3R		SOT-223	2,500 Units / Tape & Reel
GM1117S-ATC3T		TO-252	80 Units/Tube
GM1117S-ATC3R		TO-252	2,500 Units / Tape & Reel
GM1117S-ATB3T		TO-220	50 Units/Tube
GM1117S-ATA3T		TO-263	50 Units/Tube
GM1117S-ATA3R		TO-263	800 Units / Tape & Reel
GM1117S-1.5ST3T	1.5V	SOT-223	80 Units/Tube
GM1117S-1.5ST3R		SOT-223	2,500 Units / Tape & Reel
GM1117S-1.5TC3T		TO-252	80 Units/Tube
GM1117S-1.5TC3R		TO-252	2,500 Units / Tape & Reel
GM1117S-1.5TB3T		TO-220	50 Units/Tube
GM1117S-1.5TA3T		TO-263	50 Units/Tube
GM1117S-1.5TA3R		TO-263	800 Units / Tape & Reel
GM1117S-1.8ST3T	1.8V	SOT-223	80 Units/Tube
GM1117S-1.8ST3R		SOT-223	2,500 Units / Tape & Reel
GM1117S-1.8TC3T		TO-252	80 Units/Tube
GM1117S-1.8TC3R		TO-252	2,500 Units / Tape & Reel
GM1117S-1.8TB3T		TO-220	50 Units/Tube
GM1117S-1.8TA3T		TO-263	50 Units/Tube
GM1117S-1.8TA3R		TO-263	800 Units / Tape & Reel
GM1117S-2.5ST3T	2.5V	SOT-223	80 Units/Tube
GM1117S-2.5ST3R		SOT-223	2,500 Units / Tape & Reel
GM1117S-2.5TC3T		TO-252	80 Units/Tube
GM1117S-2.5TC3R		TO-252	2,500 Units / Tape & Reel
GM1117S-2.5TB3T		TO-220	50 Units/Tube
GM1117S-2.5TA3T		TO-263	50 Units/Tube
GM1117S-2.5TA3R		TO-263	800 Units / Tape & Reel

Ordering Information – Pb Free Products (Continued)

Ordering Number	Output Voltage	Package	Shipping
GM1117S-2.85ST3T	2.85V	SOT-223	80 Units/Tube
GM1117S-2.85ST3R		SOT-223	2,500 Units / Tape & Reel
GM1117S-2.85TC3T		TO-252	80 Units/Tube
GM1117S-2.85TC3R		TO-252	2,500 Units / Tape & Reel
GM1117S-2.85TB3T		TO-220	50 Units/Tube
GM1117S-2.85TA3T		TO-263	50 Units/Tube
GM1117S-2.85TA3R		TO-263	800 Units / Tape & Reel
GM1117S-3.0ST3T	3.0V	SOT-223	80 Units/Tube
GM1117S-3.0ST3R		SOT-223	2,500 Units / Tape & Reel
GM1117S-3.0TC3T		TO-252	80 Units/Tube
GM1117S-3.0TC3R		TO-252	2,500 Units / Tape & Reel
GM1117S-3.0TB3T		TO-220	50 Units/Tube
GM1117S-3.0TA3T		TO-263	50 Units/Tube
GM1117S-3.0TA3R		TO-263	800 Units / Tape & Reel
GM1117S-3.3ST3T	3.3V	SOT-223	80 Units/Tube
GM1117S-3.3ST3R		SOT-223	2,500 Units / Tape & Reel
GM1117S-3.3TC3T		TO-252	80 Units/Tube
GM1117S-3.3TC3R		TO-252	2,500 Units / Tape & Reel
GM1117S-3.3TB3T		TO-220	50 Units/Tube
GM1117S-3.3TA3T		TO-263	50 Units/Tube
GM1117S-3.3TA3R		TO-263	800 Units / Tape & Reel
GM1117S-5.0ST3T	5.0V	SOT-223	80 Units/Tube
GM1117S-5.0ST3R		SOT-223	2,500 Units / Tape & Reel
GM1117S-5.0TC3T		TO-252	80 Units/Tube
GM1117S-5.0TC3R		TO-252	2,500 Units / Tape & Reel
GM1117S-5.0TB3T		TO-220	50 Units/Tube
GM1117S-5.0TA3T		TO-263	50 Units/Tube
GM1117S-5.0TA3R		TO-263	800 Units / Tape & Reel

Ordering Information – Green Products

Ordering Number	Output Voltage	Package	Shipping
GM1117S-AST3TG	Adj	SOT-223	80 Units/Tube
GM1117S-AST3RG		SOT-223	2,500 Units / Tape & Reel
GM1117S-ATC3TG		TO-252	80 Units/Tube
GM1117S-ATC3RG		TO-252	2,500 Units / Tape & Reel
GM1117S-ATB3TG		TO-220	50 Units/Tube
GM1117S-ATA3TG		TO-263	50 Units/Tube
GM1117S-ATA3RG		TO-263	800 Units / Tape & Reel
GM1117S-1.5ST3TG	1.5V	SOT-223	80 Units/Tube
GM1117S-1.5ST3RG		SOT-223	2,500 Units / Tape & Reel
GM1117S-1.5TC3TG		TO-252	80 Units/Tube
GM1117S-1.5TC3RG		TO-252	2,500 Units / Tape & Reel
GM1117S-1.5TB3TG		TO-220	50 Units/Tube
GM1117S-1.5TA3TG		TO-263	50 Units/Tube
GM1117S-1.5TA3RG		TO-263	800 Units / Tape & Reel
GM1117S-1.8ST3TG	1.8V	SOT-223	80 Units/Tube
GM1117S-1.8ST3RG		SOT-223	2,500 Units / Tape & Reel
GM1117S-1.8TC3TG		TO-252	80 Units/Tube
GM1117S-1.8TC3RG		TO-252	2,500 Units / Tape & Reel
GM1117S-1.8TB3TG		TO-220	50 Units/Tube
GM1117S-1.8TA3TG		TO-263	50 Units/Tube
GM1117S-1.8TA3RG		TO-263	800 Units / Tape & Reel
GM1117S-2.5ST3TG	2.5V	SOT-223	80 Units/Tube
GM1117S-2.5ST3RG		SOT-223	2,500 Units / Tape & Reel
GM1117S-2.5TC3TG		TO-252	80 Units/Tube
GM1117S-2.5TC3RG		TO-252	2,500 Units / Tape & Reel
GM1117S-2.5TB3TG		TO-220	50 Units/Tube
GM1117S-2.5TA3TG		TO-263	50 Units/Tube
GM1117S-2.5TA3RG		TO-263	800 Units / Tape & Reel

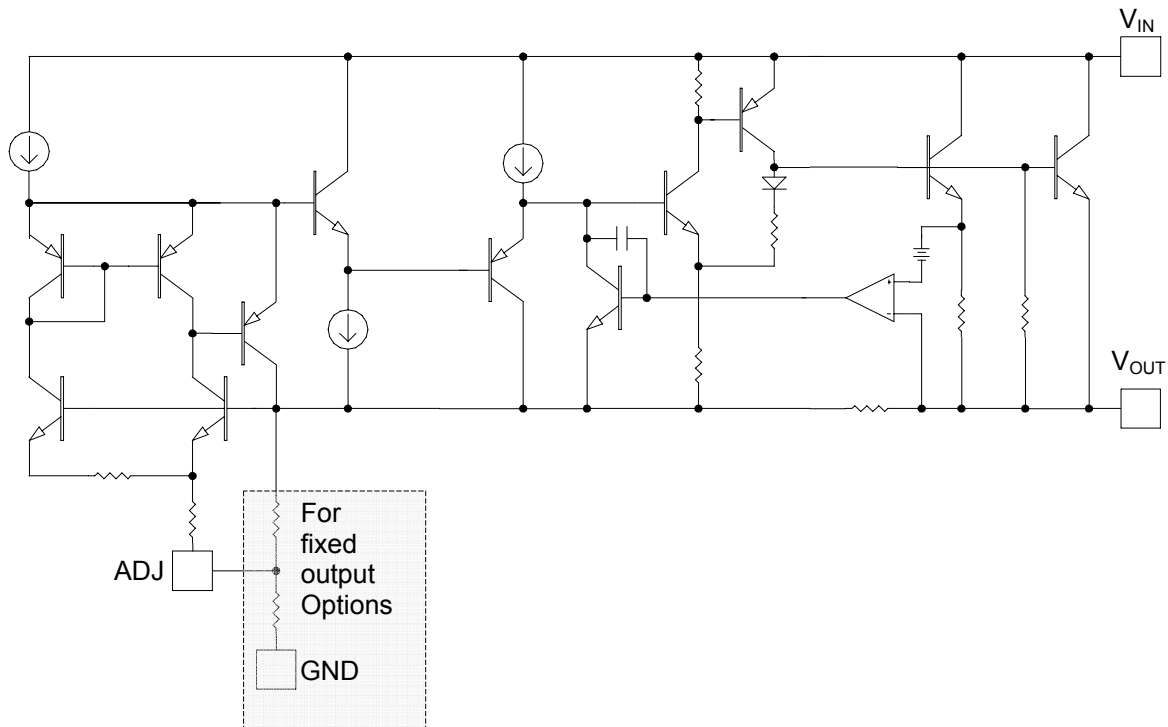
Ordering Information – Green Products (Continued)

Ordering Number	Output Voltage	Package	Shipping
GM1117S-2.85ST3TG	2.85V	SOT-223	80 Units/Tube
GM1117S-2.85ST3RG		SOT-223	2,500 Units / Tape & Reel
GM1117S-2.85TC3TG		TO-252	80 Units/Tube
GM1117S-2.85TC3RG		TO-252	2,500 Units / Tape & Reel
GM1117S-2.85TB3TG		TO-220	50 Units/Tube
GM1117S-2.85TA3TG		TO-263	50 Units/Tube
GM1117S-2.85TA3RG		TO-263	800 Units / Tape & Reel
GM1117S-3.0ST3TG	3.0V	SOT-223	80 Units/Tube
GM1117S-3.0ST3RG		SOT-223	2,500 Units / Tape & Reel
GM1117S-3.0TC3TG		TO-252	80 Units/Tube
GM1117S-3.0TC3RG		TO-252	2,500 Units / Tape & Reel
GM1117S-3.0TB3TG		TO-220	50 Units/Tube
GM1117S-3.0TA3TG		TO-263	50 Units/Tube
GM1117S-3.0TA3RG		TO-263	800 Units / Tape & Reel
GM1117S-3.3ST3TG	3.3V	SOT-223	80 Units/Tube
GM1117S-3.3ST3RG		SOT-223	2,500 Units / Tape & Reel
GM1117S-3.3TC3TG		TO-252	80 Units/Tube
GM1117S-3.3TC3RG		TO-252	2,500 Units / Tape & Reel
GM1117S-3.3TB3TG		TO-220	50 Units/Tube
GM1117S-3.3TA3TG		TO-263	50 Units/Tube
GM1117S-3.3TA3R		TO-263	800 Units / Tape & Reel
GM1117S-5.0ST3TG	5.0V	SOT-223	80 Units/Tube
GM1117S-5.0ST3RG		SOT-223	2,500 Units / Tape & Reel
GM1117S-5.0TC3TG		TO-252	80 Units/Tube
GM1117S-5.0TC3RG		TO-252	2,500 Units / Tape & Reel
GM1117S-5.0TB3TG		TO-220	50 Units/Tube
GM1117S-5.0TA3TG		TO-263	50 Units/Tube
GM1117S-5.0TA3RG		TO-263	800 Units / Tape & Reel

Absolute Maximum Ratings

PARAMETER	SYMBOL	RATINGS	UNITS
Input Voltage	V_{IN}	15	V
Thermal Resistance, Junction to Case	SOT-223	15.0	°C/W
	TO-252 (D PAK)	6.0	
	TO-263 (D ² PAK)	3.0	
Operating Junction Temperature	T_J	0 to 125	°C
Storage Temperature	T_{stg}	- 40 to 125	°C

Block Diagram



Electrical Characteristics ($T_A = 25^\circ\text{C}$, unless otherwise noted)

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Reference Voltage	GM1117S-Adj	V_{REF}	$I_{OUT} = 10\text{mA}$, $V_{IN} = 5\text{V}$	1.238	1.250	1.262	V
			$10\text{mA} \leq I_{OUT} \leq 1.0\text{A}$, $2.65\text{V} \leq V_{IN} \leq 10\text{V}$	1.225	1.250	1.275	
Output Voltage	GM1117S-1.8	V_{OUT}	$I_{OUT} = 10\text{mA}$, $V_{IN} = 3.3\text{V}$	1.782	1.800	1.818	V
			$10\text{mA} \leq I_{OUT} \leq 1.0\text{A}$, $3.3\text{V} \leq V_{IN} \leq 10\text{V}$	1.764	1.800	1.836	
	GM1117S-2.5		$I_{OUT} = 10\text{mA}$, $V_{IN} = 4\text{V}$	2.475	2.500	2.525	
			$10\text{mA} \leq I_{OUT} \leq 1.0\text{A}$, $4\text{V} \leq V_{IN} \leq 10\text{V}$	2.450	2.500	2.550	
	GM1117S-3.3		$I_{OUT} = 10\text{mA}$, $V_{IN} = 4.8\text{V}$	3.267	3.300	3.333	
			$10\text{mA} \leq I_{OUT} \leq 1.0\text{A}$, $4.8\text{V} \leq V_{IN} \leq 10\text{V}$	3.234	3.300	3.366	
	GM1117S-5.0		$I_{OUT} = 10\text{mA}$, $V_{IN} = 6.5\text{V}$	4.950	5.000	5.050	
	$10\text{mA} \leq I_{OUT} \leq 1.0\text{A}$, $6.5\text{V} \leq V_{IN} \leq 10\text{V}$	4.900	5.000	5.100			
Line Regulation		ΔV_{OI}	$I_{OUT} = 10\text{mA}$, $1.5\text{V} \leq V_{IN} - V_{out} \leq 10\text{V}$		0.04	0.2	%
Load Regulation		ΔV_{OL}	$V_{IN} = V_{OUT} + 1.5\text{V}$ $10\text{mA} \leq I_{OUT} \leq 1.0\text{A}$		0.2	0.4	%
Dropout Voltage		ΔV	$I_{OUT} = 1\text{A}$		1.3	1.5	V
Current Limit		I_{CL}	$V_{IN} = V_{OUT} + 1.5\text{V}$	1.0	1.5	2.0	A
Quiescent Current (Fixed Output Voltage Versions)		I_Q	$V_{IN} = V_{OUT} + 1.5\text{V}$ $10\text{mA} \leq I_{OUT} \leq 1.0\text{A}$		3.5	10	mA
Adjust Pin Current	GM1117S-Adj	I_{Adj}	$I_{OUT} = 10\text{mA}$, $2.75\text{V} \leq V_{IN} \leq 7\text{V}$		40	90	μA
Temperature Coefficient			$V_{IN} = V_{OUT} + 1.5\text{V}$ $I_{OUT} = 10\text{mA}$		0.005		%/
Thermal Regulation		T_C	$T_A = 25^\circ\text{C}$, 30ms pulse		0.003		%/W
Ripple Rejection		R_A	$V_{IN} = V_{OUT} + 1.5\text{V}$ $I_{OUT} = 1\text{A}$	60	65		dB

Typical Performance Characteristics

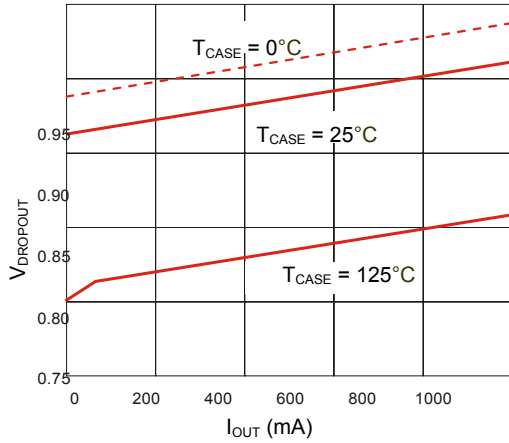


Figure 1. Dropout Voltage vs. Output Current

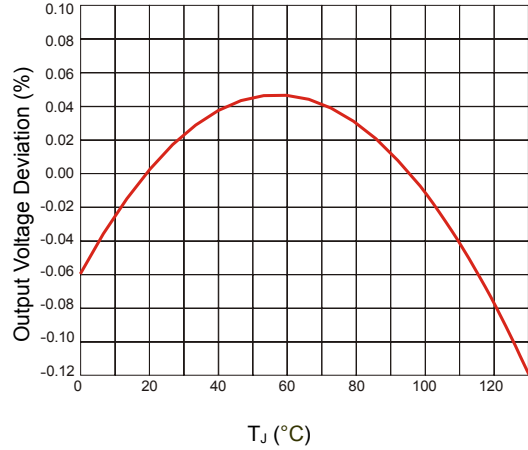


Figure 2. Reference Voltage vs. Temperature

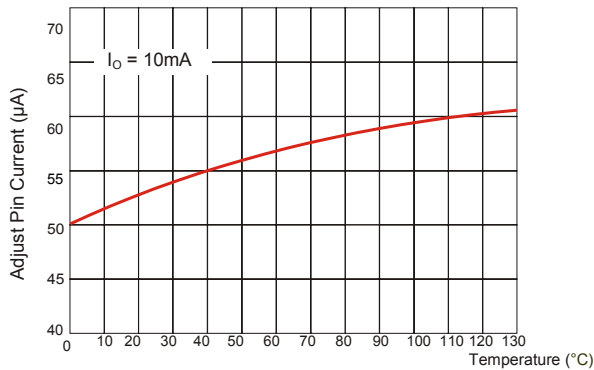


Figure 3. Adjust Pin Current vs. Temperature

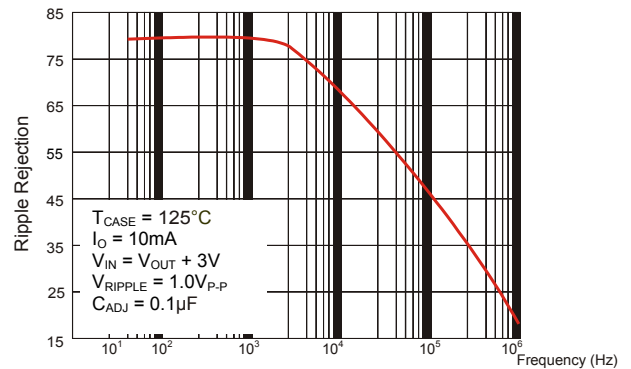


Figure 4. Ripple Rejection vs. Frequency

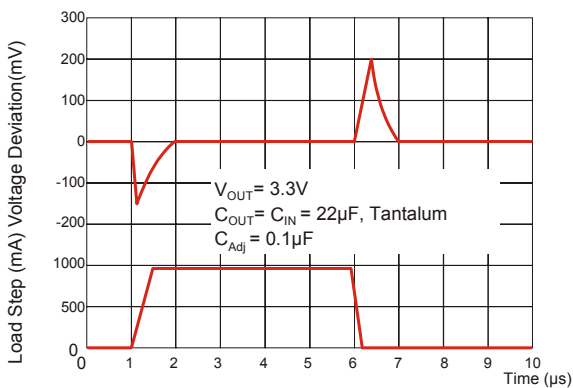


Figure 5. Transient Response

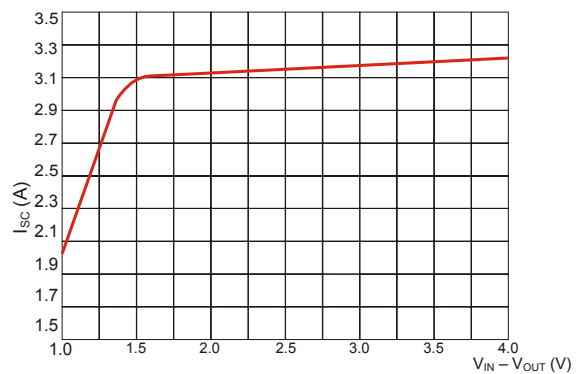


Figure 6. Short Circuit Current vs. $V_{IN} - V_{OUT}$

Application Notes

GM1117S linear regulators provide fixed and adjustable output voltage at current up to 1.0A. These regulators are protected against over current conditions and include thermal shutdown protection. The GM1117S has a composite PNP-NPN output transistor and require an output capacitor for stability. A detailed procedure for selecting this capacitor follows.

Adjustable Operation

The GM1117S has an output voltage range for 1.25V to 5.5V. An external resistor divider sets the output voltage as show in Figure 1. The regulator maintains a fixed 1.25V (typical) reference between the output pin and the adjust pin. A resistor divider network R1 and R1 causes a fixed current to follow to ground. This current creates a voltage across R2 that adds to the 1.25V across R1 and sets the overall output voltage. The adjust pin current (typically 50µA) also flows through R2 and adds a small error that should be taken into account if precise adjustment of V_{OUT} is necessary.

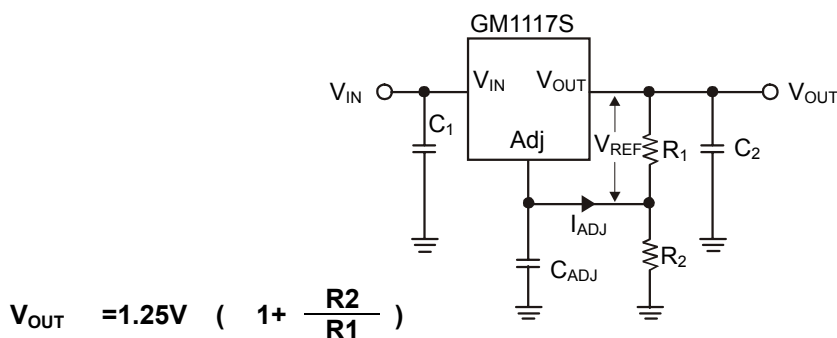


Figure 1. Resistor Divider Scheme

The term I_{ADJ} X R2 represents the error added by the adjust pin current. R1 is chosen such that the minimum load current is at least 2mA. R1 and R2 should be the same type, e.g., metal film for best tracking over temperature. While not require, a bypass capacitor from the adjust pin to ground will improve ripple rejection and transient response. A 0.1µF tantalum capacitor is recommended.

Stability Considerations

The output compensation capacitor helps to determine three feature characteristics of a linear regulator's performance: start-up delay, load transient response, and loop stability. The capacitance and type is based on cost, availability, size and temperature constraints. A tantalum or aluminum electrolytic capacitor is preferred, as a film or ceramic capacitor with almost zero ESR can cause instability. An aluminum electrolytic capacitor is the least expensive type, but when the circuit operates at low temperatures, both the capacitance and ESR will vary widely. For optimum performance over the full operating temperature range, a tantalum capacitor is best. A 22µF tantalum capacitor will work fine in most applications, but with high current regulators such as the GM1117S higher capacitance values will improve the transient response and stability. Most applications for the GM1117S involve large changes in load current, so the output capacitor must supply instantaneous load current. The ESR of the output capacitor causes an immediate drop in output voltage given by:

$$V = I \times ESR$$

In microprocessor applications, an output capacitor network of several tantalum and ceramic capacitors in parallel is commonly used. This reduces overall ESR and minimizes the instantaneous output voltage drop under transient load conditions. The output capacitor network should be placed as close to the load as possible.

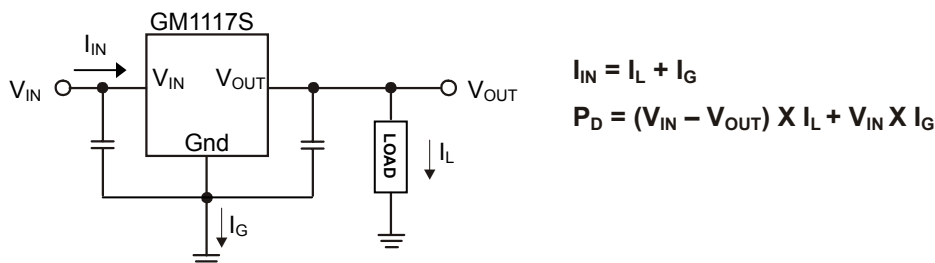
Heatsink Requirements

When an integrated circuit operates with an appreciable current, its junction temperature is elevated. It is important to consider its thermal limits in order to achieve acceptable performance and reliability. This limit is determined by summing the individual parts consisting of a series of temperature rises from the semiconductor junction to the operating environment.

The heat generated at the device junction flows through the die to the die attach pad, through the lead frame to the surrounding case material, to the printed circuit board, and eventually to the ambient environment. Below is a list of variables that may affect the thermal resistance and in turn the need to a heatsink.

Θ_{JC} , Junction to Case Thermal Resistance	Θ_{CA} , Case to Ambient Thermal Resistance
1. Lead Frame Size & Material	1. Mounting Pad Size, Material & Location
2. Number of conducting Pins	2. Placement of Mounting Pad
3. Die Size	3. PCB Size & Material
4. Die Attach Material	4. Traces Length & Width
5. Molding Compound Size & Material	5. Adjacent Heat Source
	6. Volume of Air
	7. Ambient Temperature
	8. Shape of Mounting Pad

The GM1117S regulators have internal thermal shutdown to protect the device from over heating. Under all possible operating conditions, the junction temperature of the GM1117S must be within in the range of 0°C to 125°C. A heatsink may be required depending on the maximum power dissipation and maximum ambient temperature of the application. To determine if a heatsink is needed, the power dissipated by the regulator, P_D , must be calculated according to the circuit below:



The next parameter which must be calculated is the maximum allowable temperature rise, $T_R(\max)$:

$$T_R(\max) = T_J(\max) - T_A(\max)$$

Where $T_J(\max)$ is the maximum allowable junction temperature (125°C) and $T_A(\max)$ is the maximum ambient temperature which will be encountered in the application.

Using the calculated values for $T_R(\max)$ and P_D the maximum allowable value for the junction-to-ambient thermal resistance (Θ_{JA}) can be calculated:

$$\Theta_{JA}(\max) = T_R(\max) \times P_D$$

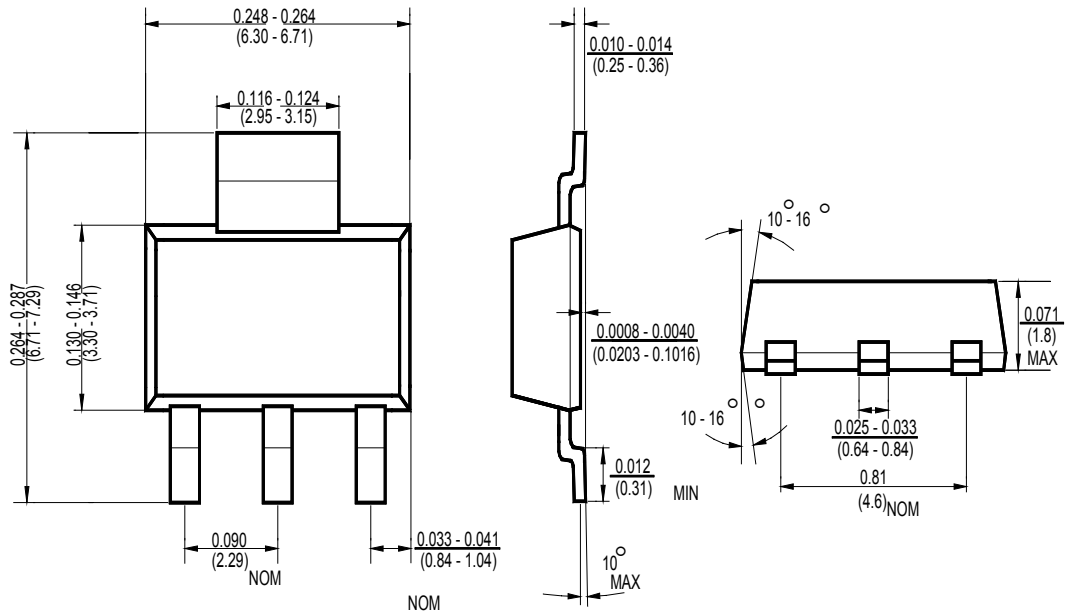
If the maximum allowable value for Θ_{JA} is found to be $\geq 136^\circ\text{C/W}$ for SOT223 packages or $\geq 79^\circ\text{C/W}$ for TO220 package or $\geq 92^\circ\text{C/W}$ for TO252 package, no heat sink is needed since the package alone will dissipate enough heat to satisfy these requirements. If the calculated value for Θ_{JA} falls below these limits, a heat sink is required.

As a design aid, the table below shows the value of the Θ_{JA} of SOT-223 and TO-252 for different heat sink area.

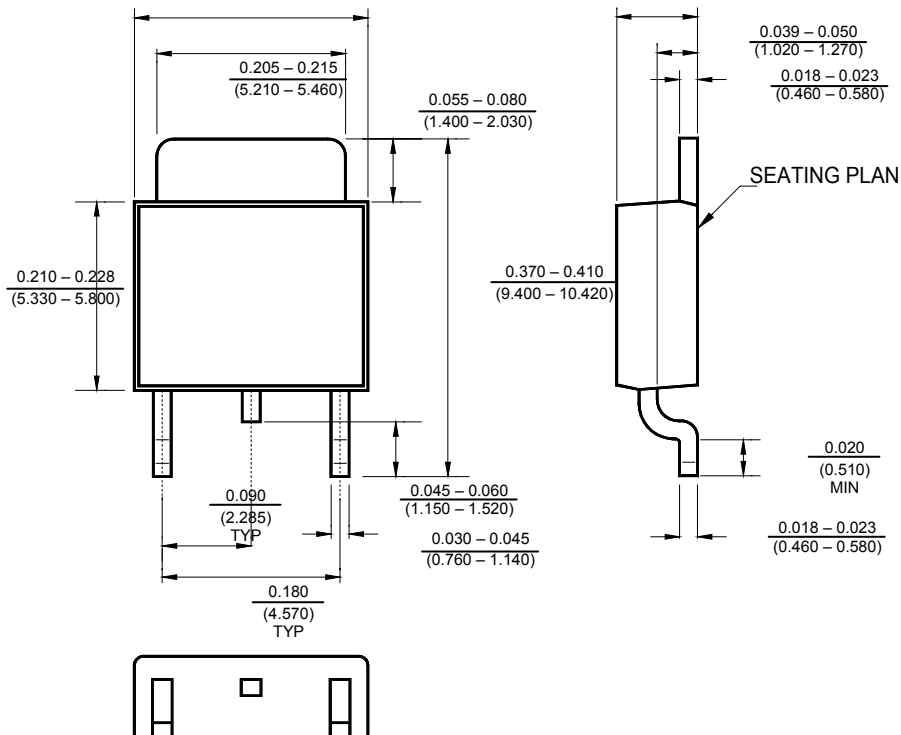
Layout	Copper Area		Thermal Resistance	
	* Top Side (in ²)	Bottom Side (in ²)	(Θ_{JA} , °C/W) SOT-223	(Θ_{JA} , °C/W) TO-252
1	0.0123	0	136	103
2	0.066	0	123	87
3	0.3	0	84	60
4	0.53	0	75	54
5	0.76	0	69	52
6	1	0	66	47
7	0	0.2	115	84
8	0	0.4	98	70
9	0	0.6	89	63
10	0	0.8	82	57
11	0	1	79	57
12	0.066	0.066	125	89
13	0.175	0.175	93	72
14	0.284	0.284	83	61
15	0.392	0.392	75	55
16	0.5	0.5	70	53

* Tab of device attached to top side copper.

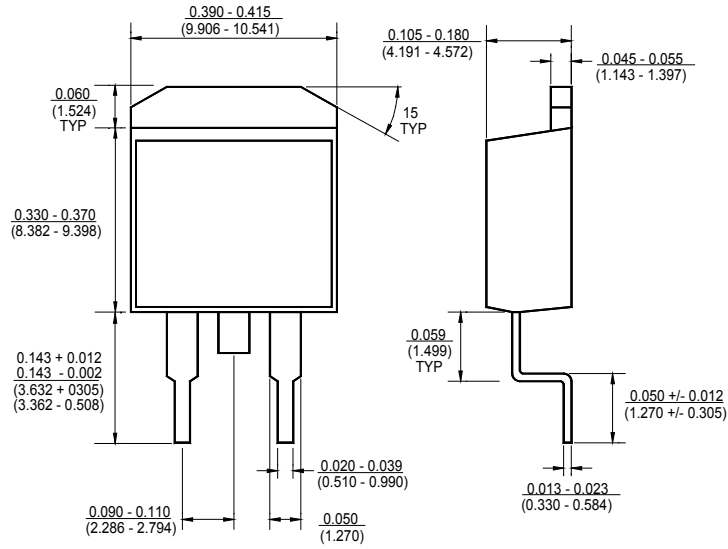
Package Outline Dimensions – SOT223



Package Outline Dimensions – TO252



Package Outline Dimensions – TO263



Ordering Number

<u>GM</u>	<u>1117S</u>	<u>A</u>	<u>ST3</u>	<u>R</u>	<u>G</u>
APM Gamma Micro	Circuit Type	Output Voltage	Package Type	Shipping Type	Blank: Pb-free G:Green
		A: Adj 1.8 =1.8V 2.5 =2.5V 3.3 = 3.3V 5.0 =5.0V	ST3: SOT223 TA3: TO263 TB3: TO220 TC3: TO252	R: Taping & Reel T: Tube	

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)

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