HG1117 800mA LOW DROPOUT VOLTAGE REGULATOR

FEATURES

- **Three Terminal Adjustable or Fixed Voltages***
  1.5V, 1.8V, 2.5V, 2.85V, 3.3V and 5.0V
- **Output Current of 800mA**
- **Operates Down to 1V Dropout**
- **Line Regulation: 0.2% Max.**
- **Load Regulation: 0.4% Max.**

APPLICATIONS

- **High Efficiency Linear Regulators**
- **Post Regulators for Switching Supplies**
- **5V to 3.3V Linear Regulator**
- **Battery Chargers**
- **Active SCSI Terminators**
- **Power Management for Notebook**
- **Battery Powered Instrumentation**

GENERAL DESCRIPTION

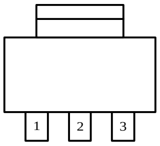
The HG1117 series of adjustable and fixed voltage regulators are designed to provide 800mA output current and to operate down to 1V input-to-output differential. The dropout voltage of the device is guaranteed maximum 1.3V at maximum output current, decreasing at lower load currents.

On-chip trimming adjusts the reference voltage to 1%. Current limit is also trimmed, minimizing the stress under overload conditions on both the regulator and power source circuitry.

The HG1117 devices are pin compatible with other three-terminal SCSI regulators and are offered in the low profile surface mount SOT-223 package.

ORDERING INFORMATION:

SOT-223 Top View



PIN CONNECTIONS

FIXED VERSION	ADJUSTABLE VERSION
1- Ground	1- Adjust
2- V_{OUT}	2- V_{OUT}
3- V_{IN}	3- V_{IN}

ABSOLUTE MAXIMUM RATINGS (Note 1)

Power Dissipation	Internally limited
Input Voltage	15V
Operating Junction Temperature	
Control Section	0°C to 125°C
Power Transistor	0°C to 150°C
Storage temperature	- 65°C to +150°C

Soldering information	
Lead Temperature (10 sec)	300°C
Thermal Resistance	
SOT-223 package	φ_{JA}= 90°C/W*

* With package soldering to copper area over backside ground plane or internal power plane φ_{JA} can vary from 46°C/W to >90°C/W depending on mounting technique and the size of the copper area.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics at I_{OUT} = 0 mA, and T_J = +25°C unless otherwise specified.

Parameter	Device	Conditions	Min	Typ	Max	Units
Reference Voltage (Note 2)	HG1117	I_{OUT} = 10 mA 10mA ≤ I_{OUT} ≤ 800mA, 1.5V≤ (V_{IN} - V_{OUT}) ≤ 12V	1.238 **1.225**	1.250 **1.250**	1.262 **1.270**	V V
Output Voltage (Note 2)	HG1117-1.5	0 ≤ I_{OUT} ≤ 800mA , 3.0V≤ V_{IN} ≤ 12V	1.485 **1.476**	1.500 **1.500**	1.515 **1.524**	V V
	HG1117-1.8	0 ≤ I_{OUT} ≤ 800mA , 3.3V≤ V_{IN} ≤ 12V	1.782 **1.773**	1.800 **1.800**	1.818 **1.827**	V V
	HG1117-2.5	0 ≤ I_{OUT} ≤ 800mA , 4.0V≤ V_{IN} ≤ 12V	2.475 **2.460**	2.500 **2.500**	2.525 **2.560**	V V
	HG1117-2.85	0 ≤ I_{OUT} ≤ 800mA , 4.35V≤ V_{IN} ≤ 12V	2.82 **2.79**	2.850 **2.850**	2.88 **2.91**	V V
	HG1117-3.3	0 ≤ I_{OUT} ≤ 800mA , 4.75V ≤ V_{IN} ≤ 12V	3.267 **3.235**	3.300 **3.300**	3.333 **3.365**	V V
	HG1117-5.0	0 ≤ I_{OUT} ≤ 800mA , 6.5V ≤ V_{IN} ≤ 12V	4.950 **4.900**	5.000 **5.000**	5.050 **5.100**	V V
Line Regulation	HG1117	I_{LOAD} = 10 mA , 1.5V≤ (V_{IN} - V_{OUT}) ≤ 12V		0.015 **0.035**	0.2 **0.2**	% %
	HG1117-1.5	3.0V≤ V_{IN} ≤ 12V		0.3 **0.6**	5 **6**	mV mV
	HG1117-1.8	3.3V≤ V_{IN} ≤ 12V		0.3 **0.6**	5 **6**	mV mV
	HG1117-2.5	4.0V≤ V_{IN} ≤ 12V		0.3 **0.6**	6 **6**	mV mV
	HG1117-2.85	4.35V≤ V_{IN} ≤ 12V		0.3 **0.6**	6 **6**	mV mV
	HG1117-3.3	4.75V≤ V_{IN} ≤ 12V		0.5 **1.0**	10 **10**	mV mV
	HG1117-5.0	6.5V≤ V_{IN} ≤ 12V		0.5 **1.0**	10 **10**	mV mV
Load Regulation (Notes 2, 3)	HG1117	(V_{IN} - V_{OUT}) =3V, 10mA ≤ I_{OUT} ≤ 800mA		0.1 **0.2**	0.3 **0.4**	% %
	HG1117-1.5	V_{IN} = 5V, 0 ≤ I_{OUT} ≤ 800mA		3 **6**	10 **20**	mV mV
	HG1117-1.8	V_{IN} = 5V, 0 ≤ I_{OUT} ≤ 800mA		3 **6**	10 **20**	mV mV
	HG1117-2.5	V_{IN} = 5V, 0 ≤ I_{OUT} ≤ 800mA		3 **6**	12 **20**	mV mV

ELECTRICAL CHARACTERISTICS

Electrical Characteristics at I_{OUT} = 0 mA, and T_J = +25°C unless otherwise specified.

Parameter	Device	Conditions	Min	Typ	Max	Units
Load Regulation (Notes 2, 3)	HG1117-2.85	V_{IN} = 5V, $0 \le I_{OUT} \le 800mA$		3 **6**	12 **20**	mV mV
	HG1117-3.3	V_{IN} = 5V, $0 \le I_{OUT} \le 800mA$		3 **7**	15 **25**	mV mV
	HG1117-5.0	V_{IN} = 8V, $0 \le I_{OUT} \le 800mA$		5 **10**	20 **35**	mV mV
Dropout Voltage (V_{IN} - V_{OUT})	HG1117-1.5/-1.8/-2.5/-2.85/-3.3/-5.0	ΔV_{OUT}, ΔV_{REF} = 1%, I_{OUT} = 800mA (Note 4)		**1.1**	**1.3**	V
Current Limit	HG1117-1.5/-1.8/-2.5/-2.85/-3.3/-5.0	(V_{IN} - V_{OUT}) = 5V TJ = 25°C	**900**	**1,100**	**1,500**	mA
Minimum Load Current	HG1117	(V_{IN} - V_{OUT}) = 12V (Note 5)		**5**	**10**	mA
Quiescent Current	HG1117-1.5/-1.8/-2.5/-2.85/-3.3/-5.0	$V_{IN} \le 12V$		**5**	**10**	mA
Ripple Rejection	HG1117	f =120Hz , C_{OUT} = 22µF Tantalum, I_{OUT} = 800mA, (V_{IN}-V_{OUT}) = 3V, C_{ADJ} =10µF	**60**	**75**		dB
	HG1117-1.5/-1.8/-2.5/-2.85	f =120Hz , C_{OUT} = 22µF Tantalum, I_{OUT} = 800mA, V_{IN} = 6V	**60**	**72**		dB
	HG1117-3.3	f =120Hz , C_{OUT} = 22µF Tantalum, I_{OUT} = 800mA V_{IN} = 6.3V	**60**	**72**		dB
	HG1117-5.0	f =120Hz , C_{OUT} = 22µF Tantalum, I_{OUT} = 800mA V_{IN} = 8V	**60**	**68**		dB
Thermal Regulation	HG1117	T_A = 25°C, 30ms pulse		0.008	0.04	%W
Adjust Pin Current	HG1117	$10mA \le I_{OUT} \le 800mA$, $1.5V \le (V_{IN} - V_{OUT}) \le 12V$		55	**120**	µA µA
Adjust Pin Current Change	HG1117	$10mA \le I_{OUT} \le 800mA$, $1.5V \le (V_{IN} - V_{OUT}) \le 12V$		**0.2**	**5**	µA
Temperature Stability				**0.5**		%
Long Term Stability		T_A =125°C, 1000Hrs		0.3	1	%
RMS Output Noise (% of V_{OUT})		T_A = 25°C , $10Hz \le f \le 10kHz$		0.003		%
Thermal Resistance Junction-to-Case					15	°C/W

APPLICATION HINTS

The HG1117 series of adjustable and fixed regulators are easy to use and are protected against short circuit and thermal overloads. Thermal protection circuitry will shut-down the regulator should the junction temperature exceed 165°C at the sense point.
Pin compatible with older three terminal adjustable regulators, these devices offer the advantage of a lower dropout voltage, more precise reference tolerance and improved reference stability with temperature.

Stability

The circuit design used in the HG1117 series requires the use of an output capacitor as part of the device frequency compensation. The addition of 22µF solid tantalum on the output will ensure stability for all operating conditions.
When the adjustment terminal is bypassed with a capacitor to improve the ripple rejection, the requirement for an output capacitor increases. The value of 22µF tantalum covers all cases of bypassing the adjustment terminal. Without bypassing the adjustment terminal smaller capacitors can be used with equally good results.
To ensure good transient response with heavy load current changes capacitor values on the order of 100µF are used in the output of many regulators. To further improve stability and transient response of these devices larger values of output capacitor can be used.

Protection Diodes

Unlike older regulators, the HG1117 family does not need any protection diodes between the adjustment pin and the output and from the output to the input to prevent over-stressing the die. Internal resistors are limiting the internal current paths on the HG1117 adjustment pin, therefore even with capacitors on the adjustment pin no protection diode is needed to ensure device safety under short-circuit conditions.
Diodes between the input and output are not usually needed. Microsecond surge currents of 50A to 100A can be handled by the internal diode between the input and output pins of the device. In normal operations it is difficult to get those values of surge currents even with the use of large output capacitances. If high value output capacitors are used, such as 1000µF to 5000µF and the input pin is instantaneously shorted to ground, damage can occur. A diode from output to input is recommended, when a crowbar circuit at the input of the HG1117 is used (Figure 1).

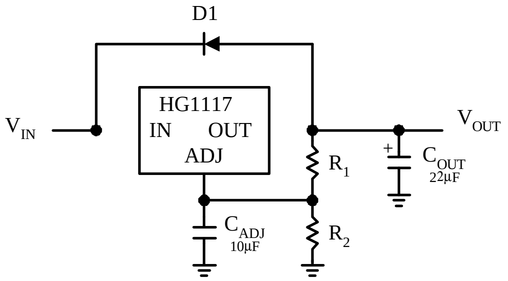
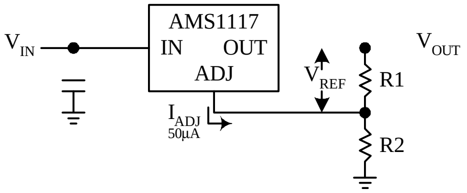


Figure 1.

Output Voltage

The HG1117 series develops a 1.25V reference voltage between the output and the adjust terminal. Placing a resistor between these two terminals causes a constant current to flow through R1 and down through R2 to set the overall output voltage. This current is normally the specified minimum load current of 10mA. Because I_{ADJ} is very small and constant it represents a small error and it can usually be ignored.



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

Figure 2. Basic Adjustable Regulator

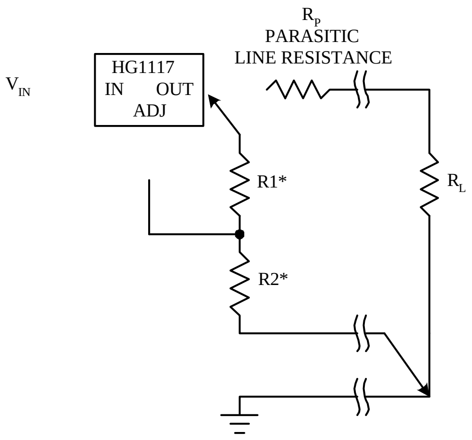
Load Regulation

True remote load sensing it is not possible to provide, because the HG1117 is a three terminal device. The resistance of the wire connecting the regulator to the load will limit the load regulation. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load.
The best load regulation is obtained when the top of the resistor divider R1 is connected directly to the case not to the load. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_P \text{ x } \left(\frac{R2+R1}{R1}\right), \quad R_P = \text{Parasitic Line Resistance}$$

APPLICATION HINTS

Connected as shown , R_P is not multiplied by the divider ratio



*CONNECT R1 TO CASE
CONNECT R2 TO LOAD

Figure 3. Connections for Best Load Regulation

In the case of fixed voltage devices the top of R1 is connected Kelvin internally, and the ground pin can be used for negative side sensing.

Thermal Considerations

The HG1117 series have internal power and thermal limiting circuitry designed to protect the device under overload conditions. However maximum junction temperature ratings of 125°C should not be exceeded under continuous normal load conditions.

Careful consideration must be given to all sources of thermal resistance from junction to ambient. For the surface mount package SOT-223 additional heat sources mounted near the device must be considered. The heat dissipation capability of the PC board and its copper traces is used as a heat sink for the device. The thermal resistance from the junction to the tab for the AMS1117 is 15°C/W. Thermal resistance from tab to ambient can be as low as 30°C/W.

The total thermal resistance from junction to ambient can be as low as 45°C/W. This requires a reasonable sized PC board with at least on layer of copper to spread the heat across the board and couple it into the surrounding air.

Experiments have shown that the heat spreading copper layer does not need to be electrically connected to the tab of the device. The PC material can be very effective at transmitting heat between the pad area, attached to the pad of the device, and a ground plane layer either inside or on the opposite side of the board. Although the actual thermal resistance of the PC material is high, the Length/Area ratio of the thermal resistance between layers is small. The data in Table 1, was taken using 1/16" FR-4 board with 1 oz. copper foil, and it can be used as a rough guideline for estimating thermal resistance.

For each application the thermal resistance will be affected by thermal interactions with other components on the board. To determine the actual value some experimentation will be necessary.

The power dissipation of the HG1117 is equal to:

$P_D = (V_{IN} - V_{OUT})(I_{OUT})$

Maximum junction temperature will be equal to:

$T_J = T_{A(MAX)} + P_D$(Thermal Resistance (junction-to-ambient))

Maximum junction temperature must not exceed 125°C.

Ripple Rejection

The ripple rejection values are measured with the adjustment pin bypassed. The impedance of the adjust pin capacitor at the ripple frequency should be less than the value of R1 (normally 100Ω to 200Ω) for a proper bypassing and ripple rejection approaching the values shown. The size of the required adjust pin capacitor is a function of the input ripple frequency. If R1=100Ω at 120Hz the adjust pin capacitor should be >13µF. At 10kHz only 0.16µF is needed.

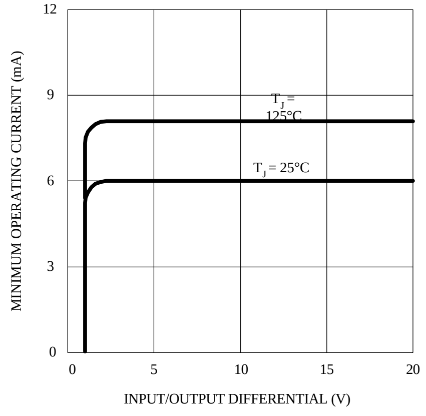
The ripple rejection will be a function of output voltage, in circuits without an adjust pin bypass capacitor. The output ripple will increase directly as a ratio of the output voltage to the reference voltage (V_{OUT} / V_{REF}).

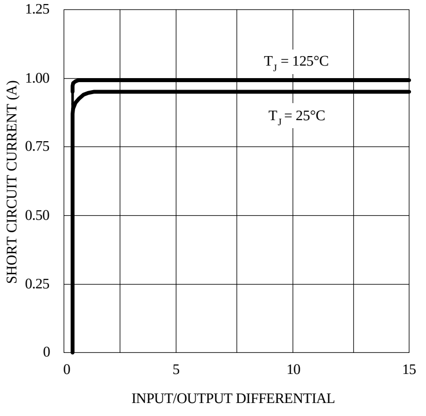
Table 1.

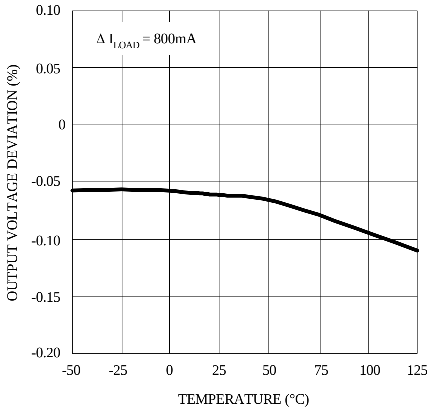
COPPER AREA		BOARD AREA	THERMAL RESISTANCE (JUNCTION-TO-AMBIENT)
TOP SIDE*	BACK SIDE		
2500 Sq. mm	2500 Sq. mm	2500 Sq. mm	45°C/W
1000 Sq. mm	2500 Sq. mm	2500 Sq. mm	45°C/W
225 Sq. mm	2500 Sq. mm	2500 Sq. mm	53°C/W
100 Sq. mm	2500 Sq. mm	2500 Sq. mm	59°C/W
1000 Sq. mm	1000 Sq. mm	1000 Sq. mm	52°C/W
1000 Sq. mm	0	1000 Sq. mm	55°C/W

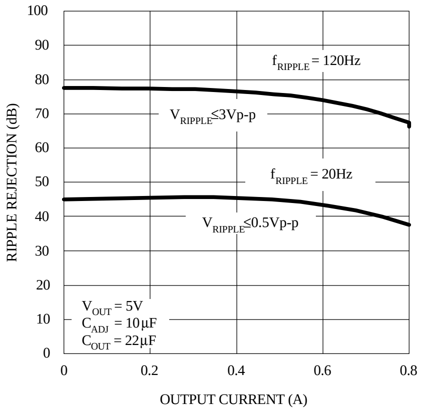
* Tab of device attached to topside copper.

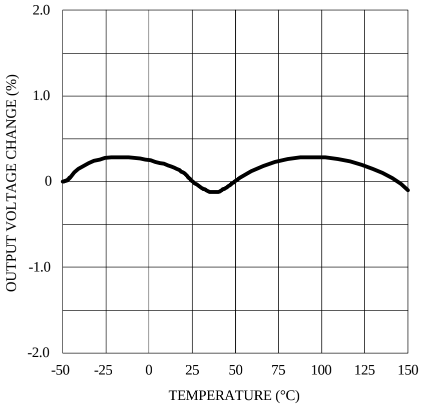
TYPICAL PERFORMANCE CHARACTERISTICS

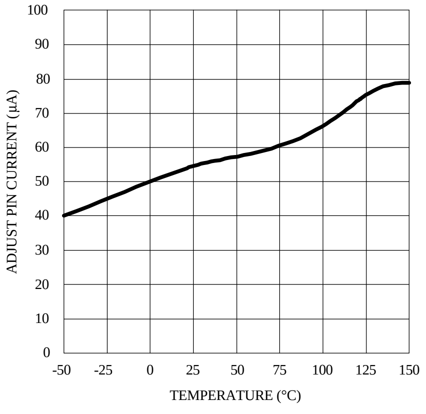

Minimum Operating Current (Adjustable Device)


Short-Circuit Current


Load Regulation


Ripple Rejection vs. Current


Temperature Stability


Adjust Pin Current