LM1117/LM1117I 800mA Low-Dropout Linear Regulator

Check for Samples: LM1117-N

FEATURES

- Available in 1.8V, 2.5V, 2.85V, 3.3V, 5V, and Adjustable Versions
- Space Saving SOT-223 and LLP Packages
- Current Limiting and Thermal Protection
- Output Current 800mA
- Line Regulation 0.2% (Max)
- Load Regulation 0.4% (Max)
- Temperature Range
  - LM1117: 0°C to 125°C
  - LM1117I: −40°C to 125°C

APPLICATIONS

- 2.85V Model for SCSI-2 Active Termination
- Post Regulator for Switching DC/DC Converter
- High Efficiency Linear Regulators
- Battery Charger
- Battery Powered Instrumentation

DESCRIPTION

The LM1117 is a series of low dropout voltage regulators with a dropout of 1.2V at 800mA of load current. It has the same pin-out as National Semiconductor's industry standard LM317.

The LM1117 is available in an adjustable version, which can set the output voltage from 1.25V to 13.8V with only two external resistors. In addition, it is also available in five fixed voltages, 1.8V, 2.5V, 2.85V, 3.3V, and 5V.

The LM1117 offers current limiting and thermal shutdown. Its circuit includes a zener trimmed bandgap reference to assure output voltage accuracy to within ±1%.

The LM1117 series is available in LLP, TO-263, SOT-223, TO-220, and TO-252 D-PAK packages. A minimum of 10µF tantalum capacitor is required at the output to improve the transient response and stability.

TYPICAL APPLICATION

Active Terminator for SCSI-2 Bus

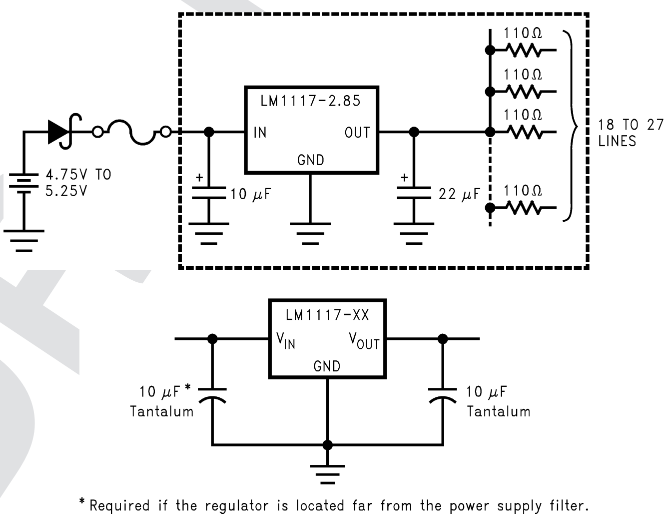
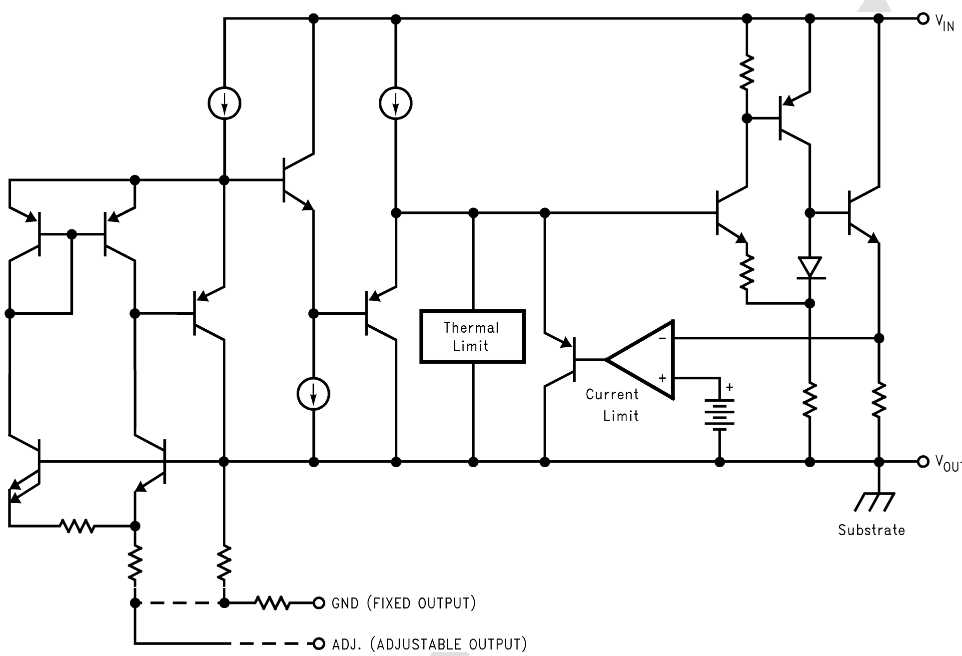


Figure 1. Fixed Output Regulator

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Block Diagram



Connection Diagrams

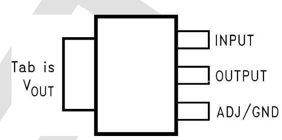


Figure 2. SOT-223 Top View

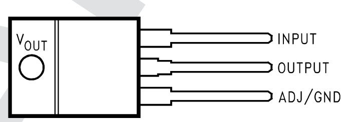


Figure 3. TO-220 Top View

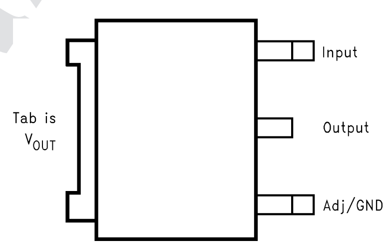


Figure 4. TO-252 Top View

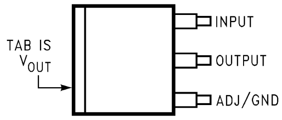
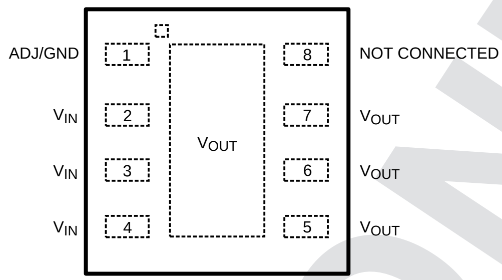


Figure 5. TO-263 Top View

Figure 6. Side View



When using the LLP package
Pins 2, 3 & 4 must be connected together and
Pins 5, 6 & 7 must be connected together

Figure 7. LLP Top View

ABSOLUTE MAXIMUM RATINGS(1)

Maximum Input Voltage (V_{IN} to GND)	20V
Power Dissipation(2)	Internally Limited
Junction Temperature (T_J)(2)	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature	
TO-220 (T) Package	260°C, 10 sec
SOT-223 (IMP) Package	260°C, 4 sec
ESD Tolerance(3)	2000V

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.
(2) The maximum power dissipation is a function of $T_{J(max)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(max)}–T_A)/\theta_{JA}$. All numbers apply for packages soldered directly into a PC board.
(3) For testing purposes, ESD was applied using human body model, 1.5kΩ in series with 100pF.

OPERATING RATINGS(1)

Input Voltage (V_{IN} to GND)	15V
Junction Temperature Range (T_J)(2)	
LM1117	0°C to 125°C
LM1117I	−40°C to 125°C

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.
(2) The maximum power dissipation is a function of $T_{J(max)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(max)}–T_A)/\theta_{JA}$. All numbers apply for packages soldered directly into a PC board.

LM1117 ELECTRICAL CHARACTERISTICS

Typicals and limits appearing in normal type apply for T_J = 25°C. Limits appearing in **Boldface** type apply over the entire junction temperature range for operation, 0°C to 125°C.

Symbol	Parameter	Conditions	Min(1)	Typ(2)	Max(1)	Units
V_{REF}	Reference Voltage	LM1117-ADJ I_{OUT} = 10mA, V_{IN}-V_{OUT} = 2V, T_J = 25°C 10mA ≤ I_{OUT} ≤ 800mA, 1.4V ≤ V_{IN}-V_{OUT} ≤ 10V	1.238 **1.225**	1.250 1.250	1.262 **1.270**	V V
V_{OUT}	Output Voltage	LM1117-1.8 I_{OUT} = 10mA, V_{IN} = 3.8V, T_J = 25°C 0 ≤ I_{OUT} ≤ 800mA, 3.2V ≤ V_{IN} ≤ 10V	1.782 **1.746**	1.800 1.800	1.818 **1.854**	V V
		LM1117-2.5 I_{OUT} = 10mA, V_{IN} = 4.5V, T_J = 25°C 0 ≤ I_{OUT} ≤ 800mA, 3.9V ≤ V_{IN} ≤ 10V	2.475 **2.450**	2.500 2.500	2.525 **2.550**	V V
		LM1117-2.85 I_{OUT} = 10mA, V_{IN} = 4.85V, T_J = 25°C 0 ≤ I_{OUT} ≤ 800mA, 4.25V ≤ V_{IN} ≤ 10V 0 ≤ I_{OUT} ≤ 500mA, V_{IN} = 4.10V	2.820 **2.790** **2.790**	2.850 2.850 2.850	2.880 **2.910** **2.910**	V V V
		LM1117-3.3 I_{OUT} = 10mA, V_{IN} = 5V T_J = 25°C 0 ≤ I_{OUT} ≤ 800mA, 4.75V≤ V_{IN} ≤ 10V	3.267 **3.235**	3.300 3.300	3.333 **3.365**	V V
		LM1117-5.0 I_{OUT} = 10mA, V_{IN} = 7V, T_J = 25°C 0 ≤ I_{OUT} ≤ 800mA, 6.5V ≤ V_{IN} ≤ 12V	4.950 **4.900**	5.000 5.000	5.050 **5.100**	V V
ΔV_{OUT}	Line Regulation(3)	LM1117-ADJ I_{OUT} = 10mA, 1.5V ≤ V_{IN}-V_{OUT} ≤ 13.75V		0.035	**0.2**	%
		LM1117-1.8 I_{OUT} = 0mA, 3.2V ≤ V_{IN} ≤ 10V		1	**6**	mV
		LM1117-2.5 I_{OUT} = 0mA, 3.9V ≤ V_{IN} ≤ 10V		1	**6**	mV
		LM1117-2.85 I_{OUT} = 0mA, 4.25V ≤ V_{IN} ≤ 10V		1	**6**	mV
		LM1117-3.3 I_{OUT} = 0mA, 4.75V ≤ V_{IN} ≤ 15V		1	**6**	mV
		LM1117-5.0 I_{OUT} = 0mA, 6.5V ≤ V_{IN} ≤ 15V		1	**10**	mV
ΔV_{OUT}	Load Regulation(3)	LM1117-ADJ V_{IN}-V_{OUT} = 3V, 10 ≤ I_{OUT} ≤ 800mA		0.2	**0.4**	%
		LM1117-1.8 V_{IN} = 3.2V, 0 ≤ I_{OUT} ≤ 800mA		1	**10**	mV
		LM1117-2.5 V_{IN} = 3.9V, 0 ≤ I_{OUT} ≤ 800mA		1	**10**	mV
		LM1117-2.85 V_{IN} = 4.25V, 0 ≤ I_{OUT} ≤ 800mA		1	**10**	mV
		LM1117-3.3 V_{IN} = 4.75V, 0 ≤ I_{OUT} ≤ 800mA		1	**10**	mV
		LM1117-5.0 V_{IN} = 6.5V, 0 ≤ I_{OUT} ≤ 800mA		1	**15**	mV
V_{IN}-V_{OUT}	Dropout Voltage(4)	I_{OUT} = 100mA		1.10	**1.20**	V
		I_{OUT} = 500mA		1.15	**1.25**	V
		I_{OUT} = 800mA		1.20	**1.30**	V
I_{LIMIT}	Current Limit	V_{IN}-V_{OUT} = 5V, T_J = 25°C	800	1200	1500	mA
	Minimum Load Current(5)	LM1117-ADJ V_{IN} = 15V		1.7	**5**	mA

(1) All limits are guaranteed by testing or statistical analysis.
(2) Typical Values represent the most likely parametric norm.
(3) Load and line regulation are measured at constant junction room temperature.
(4) The dropout voltage is the input/output differential at which the circuit ceases to regulate against further reduction in input voltage. It is measured when the output voltage has dropped 100mV from the nominal value obtained at V_{IN} = V_{OUT} +1.5V.
(5) The minimum output current required to maintain regulation.

LM1117 ELECTRICAL CHARACTERISTICS (continued)

Typicals and limits appearing in normal type apply for T_J = 25°C. Limits appearing in **Boldface** type apply over the entire junction temperature range for operation, 0°C to 125°C.

Symbol	Parameter	Conditions	Min (1)	Typ (2)	Max (1)	Units
	Quiescent Current	LM1117-1.8 V_{IN} ≤ 15V		5	**10**	mA
		LM1117-2.5 V_{IN} ≤ 15V		5	**10**	mA
		LM1117-2.85 V_{IN} ≤ 10V		5	**10**	mA
		LM1117-3.3 V_{IN} ≤ 15V		5	**10**	mA
		LM1117-5.0 V_{IN} ≤ 15V		5	**10**	mA
	Thermal Regulation	T_A = 25°C, 30ms Pulse		0.01	0.1	%/W
	Ripple Regulation	f_{RIPPLE} =1 20Hz, V_{IN}-V_{OUT} = 3V V_{RIPPLE} = 1V_{PP}	**60**	75		dB
	Adjust Pin Current			60	**120**	μA
	Adjust Pin Current Change	10 ≤ I_{OUT}≤ 800mA, 1.4V ≤ V_{IN}-V_{OUT} ≤ 10V		0.2	**5**	μA
	Temperature Stability			0.5		%
	Long Term Stability	T_A = 125°C, 1000Hrs		0.3		%
	RMS Output Noise	(% of V_{OUT}), 10Hz ≤ f ≤10kHz		0.003		%
	Thermal Resistance Junction-to-Case	3-Lead SOT-223		15.0		°C/W
		3-Lead TO-220		3.0		°C/W
		3-Lead TO-252		10		°C/W
	Thermal Resistance Junction-to-Ambient (No air flow)	3-Lead SOT-223 (No heat sink)		136		°C/W
		3-Lead TO-220 (No heat sink)		79		°C/W
		3-Lead TO-252 (6) (No heat sink)		92		°C/W
		3-Lead TO-263		55		°C/W
		8-Lead LLP (7)		40		°C/W

(6) Minimum pad size of 0.038in^2
(7) Thermal Performance for the LLP was obtained using JESD51-7 board with six vias and an ambient temperature of 22°C. For information about improved thermal performance and power dissipation for the LLP, refer to Application Note AN-1187.

LM1117I ELECTRICAL CHARACTERISTICS

Typicals and limits appearing in normal type apply for T_J = 25°C. Limits appearing in **Boldface** type apply over the entire junction temperature range for operation, −40°C to 125°C.

Symbol	Parameter	Conditions	Min[(1)]	Typ[(2)]	Max[(1)]	Units
V_{REF}	Reference Voltage	LM1117I-ADJ I_{OUT} = 10mA, V_{IN}-V_{OUT} = 2V, T_J = 25°C 10mA ≤ I_{OUT} ≤ 800mA, 1.4V ≤ V_{IN}-V_{OUT} ≤ 10V	1.238 **1.200**	1.250 1.250	1.262 **1.290**	V V
V_{OUT}	Output Voltage	LM1117I-3.3 I_{OUT} = 10mA, V_{IN} = 5V, T_J = 25°C 0 ≤ I_{OUT} ≤ 800mA, 4.75V ≤ V_{IN} ≤ 10V	3.267 **3.168**	3.300 3.300	3.333 **3.432**	V V
		LM1117I-5.0 I_{OUT} = 10mA, V_{IN} = 7V, T_J = 25°C 0 ≤ I_{OUT} ≤ 800mA, 6.5V ≤ V_{IN} ≤ 12V	4.950 **4.800**	5.000 5.000	5.050 **5.200**	V V
ΔV_{OUT}	Line Regulation[(3)]	LM1117I-ADJ I_{OUT} = 10mA, 1.5V ≤ V_{IN}-V_{OUT} ≤ 13.75V		0.035	**0.3**	%
		LM1117I-3.3 I_{OUT} = 0mA, 4.75V ≤ V_{IN} ≤ 15V		1	**10**	mV
		LM1117I-5.0 I_{OUT} = 0mA, 6.5V ≤ V_{IN} ≤ 15V		1	**15**	mV
ΔV_{OUT}	Load Regulation[(3)]	LM1117I-ADJ V_{IN}-V_{OUT} = 3V, 10 ≤ I_{OUT} ≤ 800mA		0.2	**0.5**	%
		LM1117I-3.3 V_{IN} = 4.75V, 0 ≤ I_{OUT} ≤ 800mA		1	**15**	mV
		LM1117I-5.0 V_{IN} = 6.5V, 0 ≤ I_{OUT} ≤ 800mA		1	**20**	mV
V_{IN}-V_{OUT}	Dropout Voltage[(4)]	I_{OUT} = 100mA		1.10	**1.30**	V
		I_{OUT} = 500mA		1.15	**1.35**	V
		I_{OUT} = 800mA		1.20	**1.40**	V
I_{LIMIT}	Current Limit	V_{IN}-V_{OUT} = 5V, T_J = 25°C	800	1200	1500	mA
	Minimum Load Current[(5)]	LM1117I-ADJ V_{IN} = 15V		1.7	**5**	mA
	Quiescent Current	LM1117I-3.3 V_{IN} ≤ 15V		5	**15**	mA
		LM1117I-5.0 V_{IN} ≤ 15V		5	**15**	mA
	Thermal Regulation	T_A = 25°C, 30ms Pulse		0.01	0.1	%/W
	Ripple Regulation	f_{RIPPLE} =1 20Hz, V_{IN}-V_{OUT} = 3V V_{RIPPLE} = 1V_{PP}	**60**	75		dB
	Adjust Pin Current			60	**120**	μA
	Adjust Pin Current Change	10 ≤ I_{OUT}≤ 800mA, 1.4V ≤ V_{IN}-V_{OUT} ≤ 10V		0.2	**10**	μA
	Temperature Stability			0.5		%
	Long Term Stability	T_A = 125°C, 1000Hrs		0.3		%
	RMS Output Noise	(% of V_{OUT}), 10Hz ≤ f ≤10kHz		0.003		%
	Thermal Resistance Junction-to-Case	3-Lead SOT-223		15.0		°C/W
		3-Lead TO-252		10		°C/W

(1) All limits are guaranteed by testing or statistical analysis.
(2) Typical Values represent the most likely parametric norm.
(3) Load and line regulation are measured at constant junction room temperature.
(4) The dropout voltage is the input/output differential at which the circuit ceases to regulate against further reduction in input voltage. It is measured when the output voltage has dropped 100mV from the nominal value obtained at V_{IN} = V_{OUT} +1.5V.
(5) The minimum output current required to maintain regulation.

LM1117I ELECTRICAL CHARACTERISTICS (continued)

Typicals and limits appearing in normal type apply for T_J = 25°C. Limits appearing in **Boldface** type apply over the entire junction temperature range for operation, −40°C to 125°C.

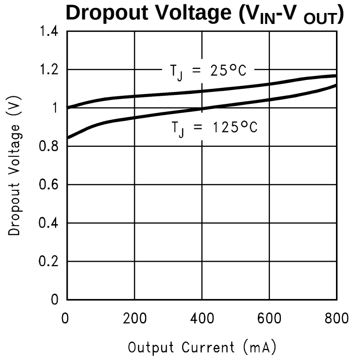
Symbol	Parameter	Conditions	Min (1)	Typ (2)	Max (1)	Units
	Thermal Resistance Junction-to-Ambient No air flow)	3-Lead SOT-223 (No heat sink)		136		°C/W
		3-Lead TO-252 (No heat sink) (6)		92		°C/W
		8-Lead LLP (7)		40		°C/W

(6) Minimum pad size of 0.038in^2

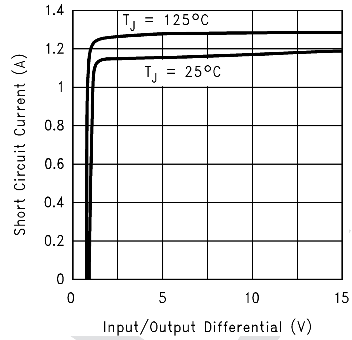
(7) Thermal Performance for the LLP was obtained using JESD51-7 board with six vias and an ambient temperature of 22°C. For information about improved thermal performance and power dissipation for the LLP, refer to Application Note AN-1187.

TYPICAL PERFORMANCE CHARACTERISTICS

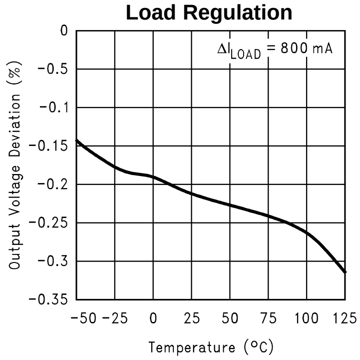
Dropout Voltage (V_{IN}-V_{OUT})



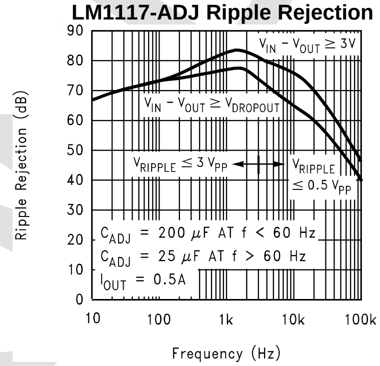
Short-Circuit Current



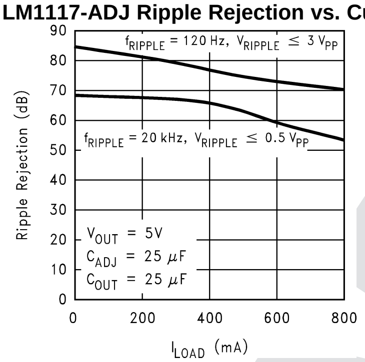
Load Regulation



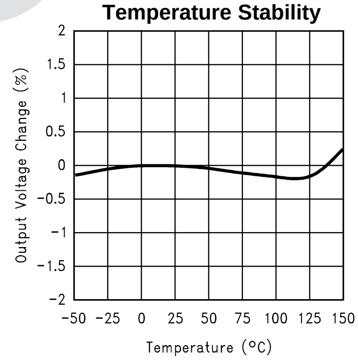
LM1117-ADJ Ripple Rejection



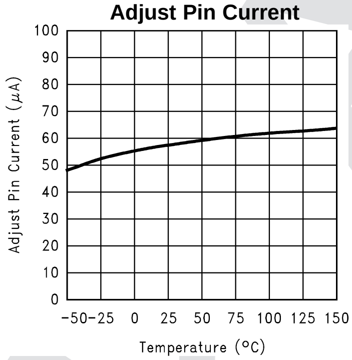
LM1117-ADJ Ripple Rejection vs. Current



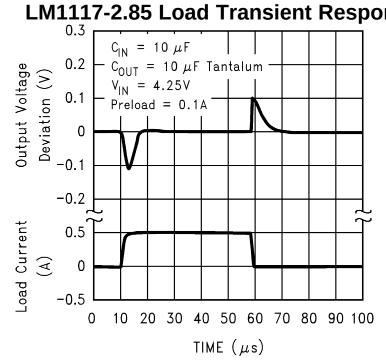
Temperature Stability



Adjust Pin Current

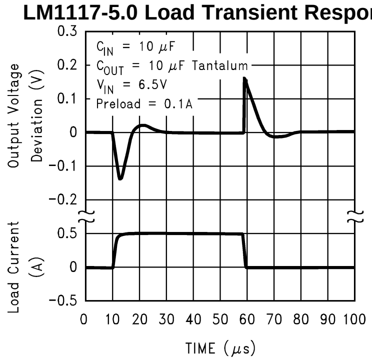


LM1117-2.85 Load Transient Response

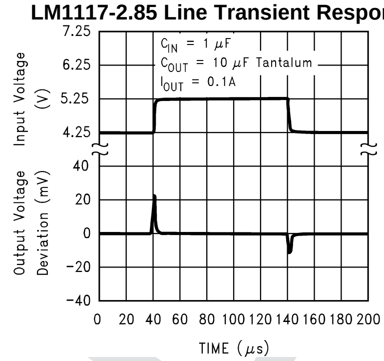


TYPICAL PERFORMANCE CHARACTERISTICS (continued)

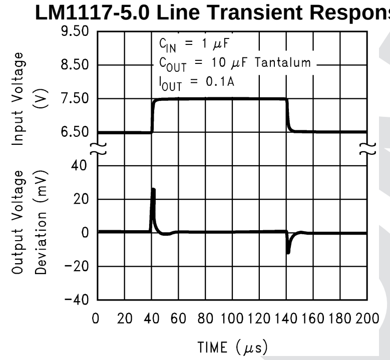
LM1117-5.0 Load Transient Response



LM1117-2.85 Line Transient Response



LM1117-5.0 Line Transient Response



APPLICATION INFORMATION

EXTERNAL CAPACITORS/STABILITY

Input Bypass Capacitor

An input capacitor is recommended. A 10µF tantalum on the input is a suitable input bypassing for almost all applications.

Adjust Terminal Bypass Capacitor

The adjust terminal can be bypassed to ground with a bypass capacitor (C_{ADJ}) to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. At any ripple frequency, the impedance of the C_{ADJ} should be less than R1 to prevent the ripple from being amplified:

$$1/(2\pi * f_{RIPPLE} * C_{ADJ}) < R1$$

The R1 is the resistor between the output and the adjust pin. Its value is normally in the range of 100-200Ω. For example, with R1 = 124Ω and f_{RIPPLE} = 120Hz, the C_{ADJ} should be > 11µF.

Output Capacitor

The output capacitor is critical in maintaining regulator stability, and must meet the required conditions for both minimum amount of capacitance and ESR (Equivalent Series Resistance). The minimum output capacitance required by the LM1117 is 10µF, if a tantalum capacitor is used. Any increase of the output capacitance will merely improve the loop stability and transient response. The ESR of the output capacitor should range between 0.3Ω - 22Ω. In the case of the adjustable regulator, when the C_{ADJ} is used, a larger output capacitance (22µf tantalum) is required.

OUTPUT VOLTAGE

The LM1117 adjustable version develops a 1.25V reference voltage, V_{REF}, between the output and the adjust terminal. As shown in Figure 8, this voltage is applied across resistor R1 to generate a constant current I1. The current I_{ADJ} from the adjust terminal could introduce error to the output. But since it is very small (60µA) compared with the I1 and very constant with line and load changes, the error can be ignored. The constant current I1 then flows through the output set resistor R2 and sets the output voltage to the desired level.

For fixed voltage devices, R1 and R2 are integrated inside the devices.

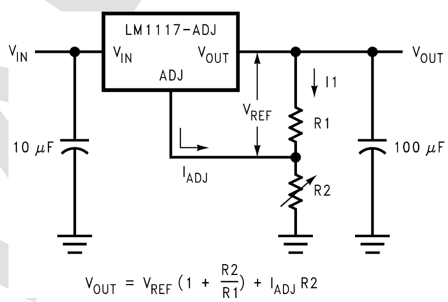


Figure 8. Basic Adjustable Regulator

LOAD REGULATION

The LM1117 regulates the voltage that appears between its output and ground pins, or between its output and adjust pins. In some cases, line resistances can introduce errors to the voltage across the load. To obtain the best load regulation, a few precautions are needed.

Figure 9, shows a typical application using a fixed output regulator. The Rt1 and Rt2 are the line resistances. It is obvious that the V_{LOAD} is less than the V_{OUT} by the sum of the voltage drops along the line resistances. In this case, the load regulation seen at the R_{LOAD} would be degraded from the data sheet specification. To improve this, the load should be tied directly to the output terminal on the positive side and directly tied to the ground terminal on the negative side.

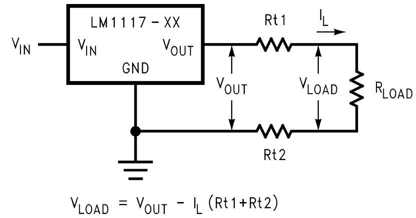


Figure 9. Typical Application using Fixed Output Regulator

When the adjustable regulator is used (Figure 10), the best performance is obtained with the positive side of the resistor R1 tied directly to the output terminal of the regulator rather than near the load. This eliminates line drops from appearing effectively in series with the reference and degrading regulation. For example, a 5V regulator with 0.05Ω resistance between the regulator and load will have a load regulation due to line resistance of 0.05Ω x I_L. If R1 (=125Ω) is connected near the load, the effective line resistance will be 0.05Ω (1+R2/R1) or in this case, it is 4 times worse. In addition, the ground side of the resistor R2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.

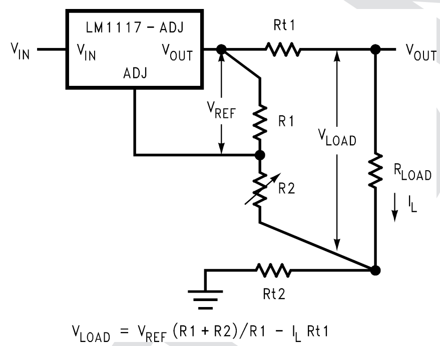


Figure 10. Best Load Regulation using Adjustable Output Regulator

PROTECTION DIODES

Under normal operation, the LM1117 regulators do not need any protection diode. With the adjustable device, the internal resistance between the adjust and output terminals limits the current. No diode is needed to divert the current around the regulator even with capacitor on the adjust terminal. The adjust pin can take a transient signal of ±25V with respect to the output voltage without damaging the device.

When a output capacitor is connected to a regulator and the input is shorted to ground, the output capacitor will discharge into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage of the regulator, and rate of decrease of V_{IN}. In the LM1117 regulators, the internal diode between the output and input pins can withstand microsecond surge currents of 10A to 20A. With an extremely large output capacitor (≥1000 µF), and with input instantaneously shorted to ground, the regulator could be damaged.

In this case, an external diode is recommended between the output and input pins to protect the regulator, as shown in Figure 11.

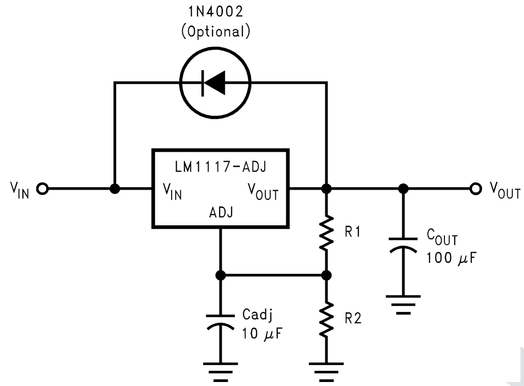
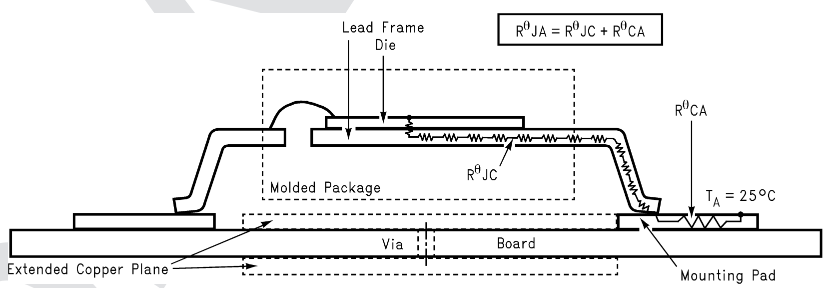


Figure 11. Regulator with Protection Diode

HEATSINK REQUIREMENTS

When an integrated circuit operates with an appreciable current, its junction temperature is elevated. It is important to quantify 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. A one-dimensional steady-state model of conduction heat transfer is demonstrated in Figure 12. 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 for a heatsink.

$R\theta_{JC}$ (Component Variables)	$R\theta_{CA}$ (Application Variables)
Leadframe Size & Material	Mounting Pad Size, Material, & Location
No. of Conduction Pins	Placement of Mounting Pad
Die Size	PCB Size & Material
Die Attach Material	Traces Length & Width
Molding Compound Size and Material	Adjacent Heat Sources
	Volume of Air
	Ambient Temperatue
	Shape of Mounting Pad



Note: The case temperature is measured at the point where the leads contact with the mounting pad surface

Figure 12. Cross-Sectional View of Integrated Circuit Mounted on a Printed Circuit Board

The LM1117 regulators have internal thermal shutdown to protect the device from over-heating. Under all possible operating conditions, the junction temperature of the LM1117 must be within 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:

$$I_{IN} = I_L + I_G$$

$P_D = (V_{IN}-V_{OUT})I_L + V_{IN}I_G$

Figure 13 shows the voltages and currents which are present in the circuit.

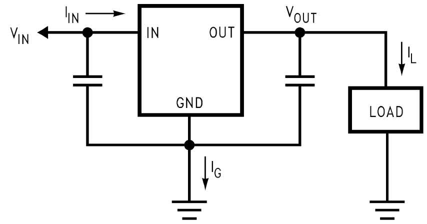


Figure 13. Power Dissipation Diagram

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:

$\theta_{JA} = T_R(max)/P_D$

If the maximum allowable value for θ_{JA} is found to be ≥136°C/W for SOT-223 package or ≥79°C/W for TO-220 package or ≥92°C/W for TO-252 package, no heatsink 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 heatsink is required.

As a design aid, Table 1 shows the value of the θ_{JA} of SOT-223 and TO-252 for different heatsink area. The copper patterns that we used to measure these θ_{JA}s are shown at the end of APPLICATION INFORMATION. Figure 14 and Figure 15 reflects the same test results as what are in the Table 1

Figure 16 and Figure 17 shows the maximum allowable power dissipation vs. ambient temperature for the SOT-223 and TO-252 device. Figure 18 and Figure 19 shows the maximum allowable power dissipation vs. copper area (in^2) for the SOT-223 and TO-252 devices. Please see AN1028 for power enhancement techniques to be used with SOT-223 and TO-252 packages.

Application Note AN-1187 discusses improved thermal performance and power dissipation for the LLP.

Table 1. θ_{JA} Different Heatsink Area

Layout	Copper Area		Thermal Resistance	
	Top Side (in^2)(1)	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

(1) Tab of device attached to topside copper

Table 1. θ_{JA} Different Heatsink Area (continued)

Layout	Copper Area		Thermal Resistance	
15	0.392	0.392	75	55
16	0.5	0.5	70	53

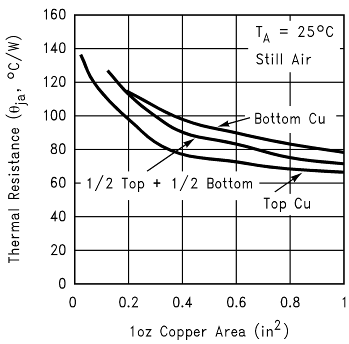


Figure 14. θ_{JA} vs. 1oz Copper Area for SOT-223

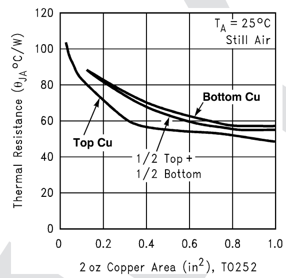


Figure 15. θ_{JA} vs. 2oz Copper Area for TO-252

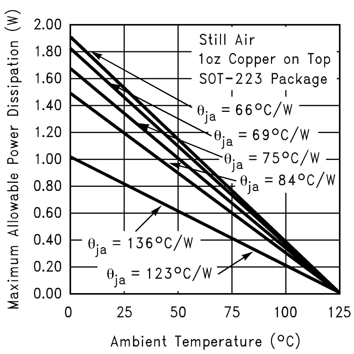


Figure 16. Maximum Allowable Power Dissipation vs. Ambient Temperature for SOT-223

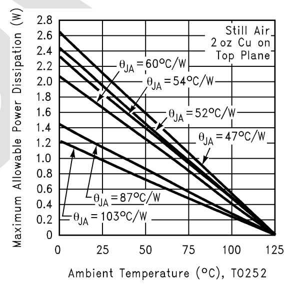


Figure 17. Maximum Allowable Power Dissipation vs. Ambient Temperature for TO-252

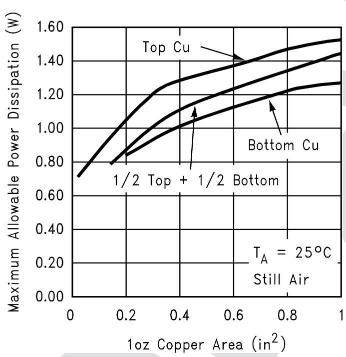


Figure 18. Maximum Allowable Power Dissipation vs. 1oz Copper Area for SOT-223

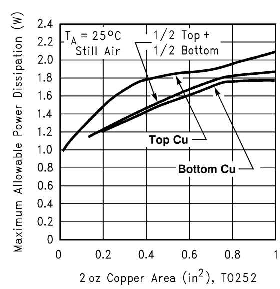


Figure 19. Maximum Allowable Power Dissipation vs. 2oz Copper Area for TO-252

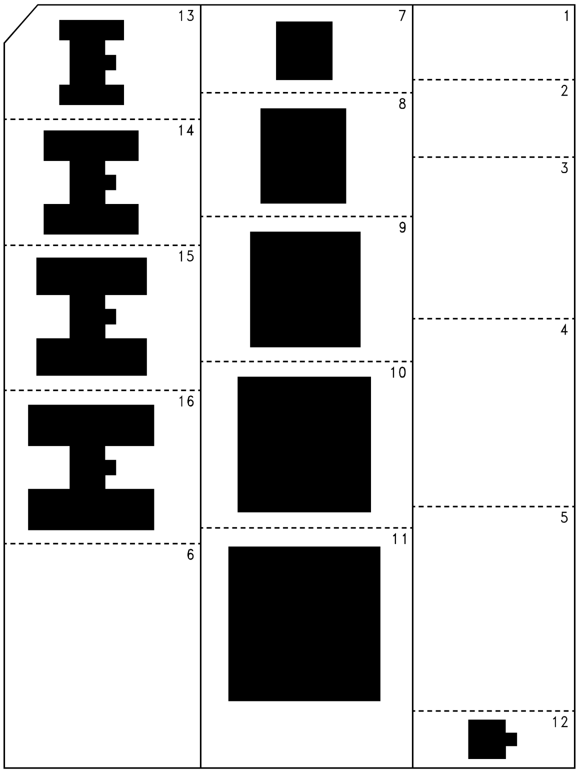


Figure 20. Top View of the Thermal Test Pattern in Actual Scale

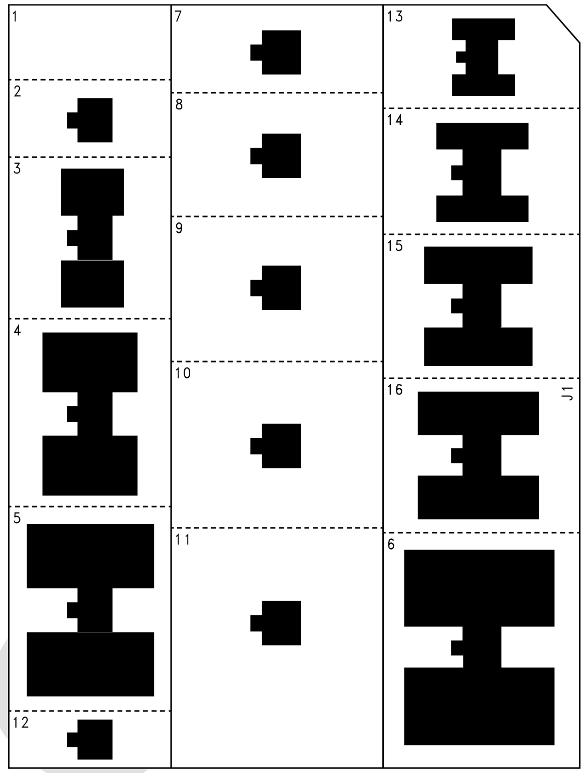


Figure 21. Bottom View of the Thermal Test Pattern in Actual Scale

TYPICAL APPLICATION CIRCUITS

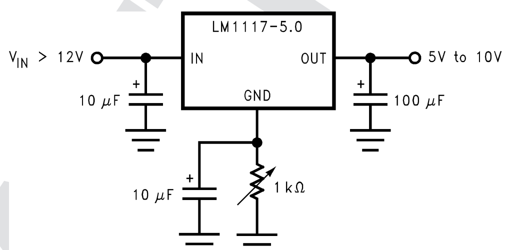


Figure 22. Adjusting Output of Fixed Regulators

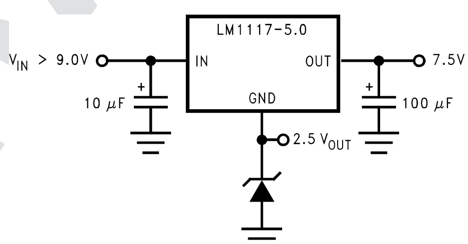


Figure 23. Regulator with Reference

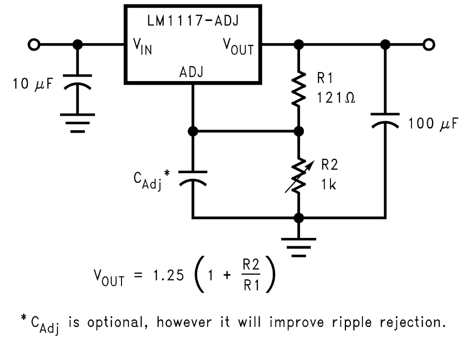


Figure 24. 1.25V to 10V Adjustable Regulator with Improved Ripple Rejection

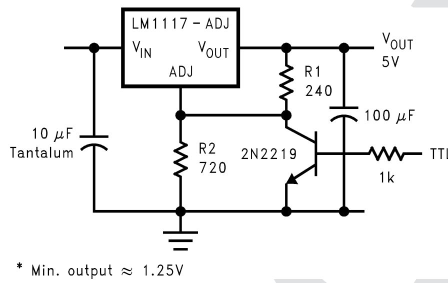


Figure 25. 5V Logic Regulator with Electronic Shutdown*

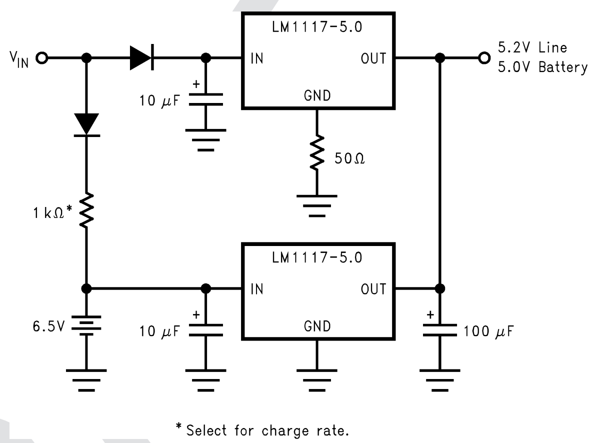


Figure 26. Battery Backed-Up Regulated Supply

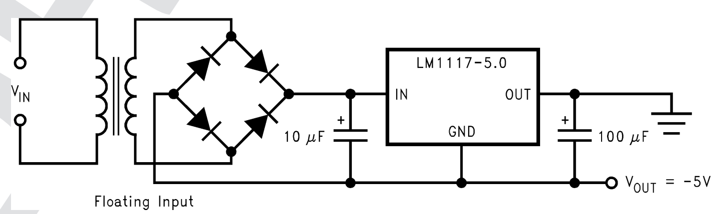
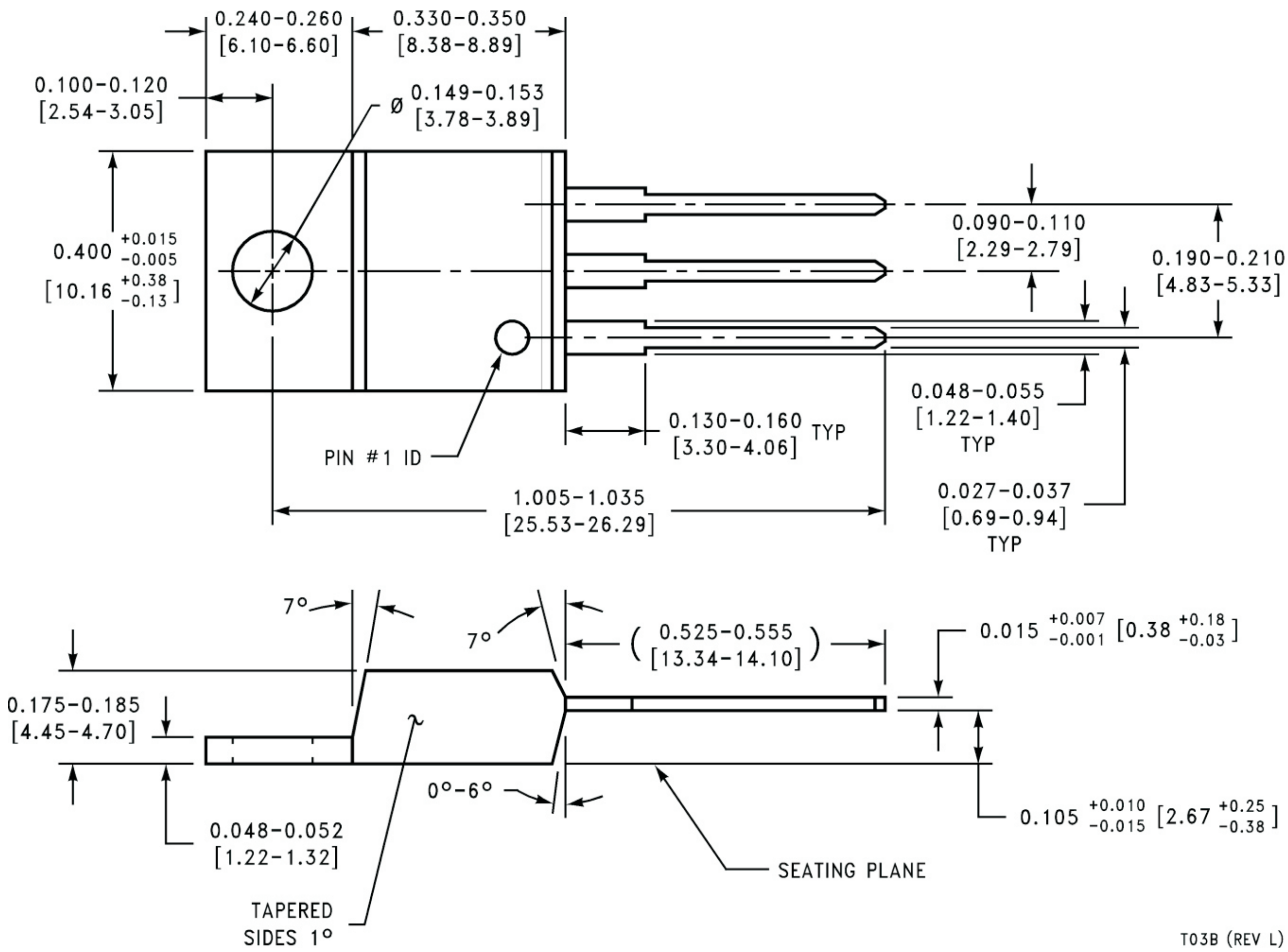
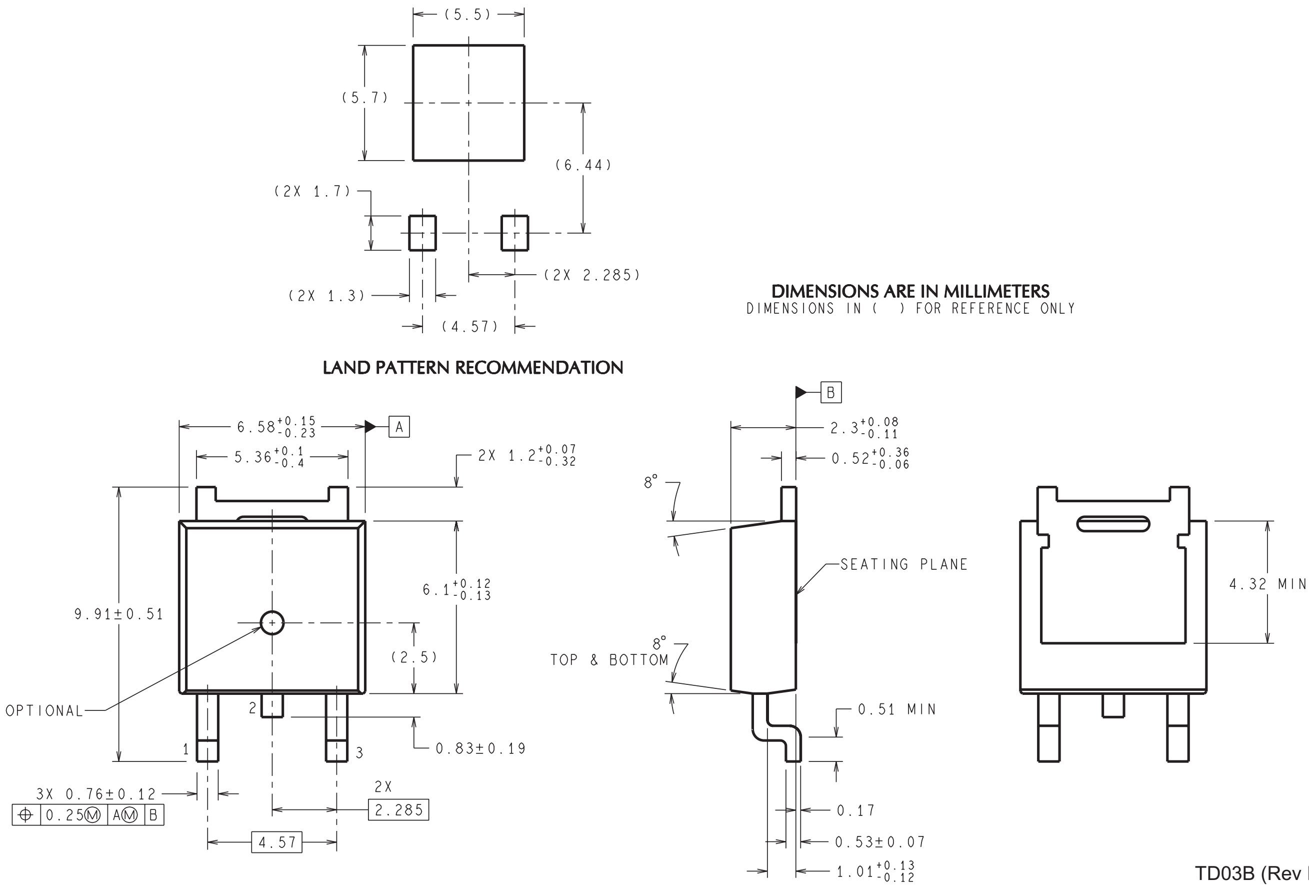


Figure 27. Low Dropout Negative Supply

NDE0003B

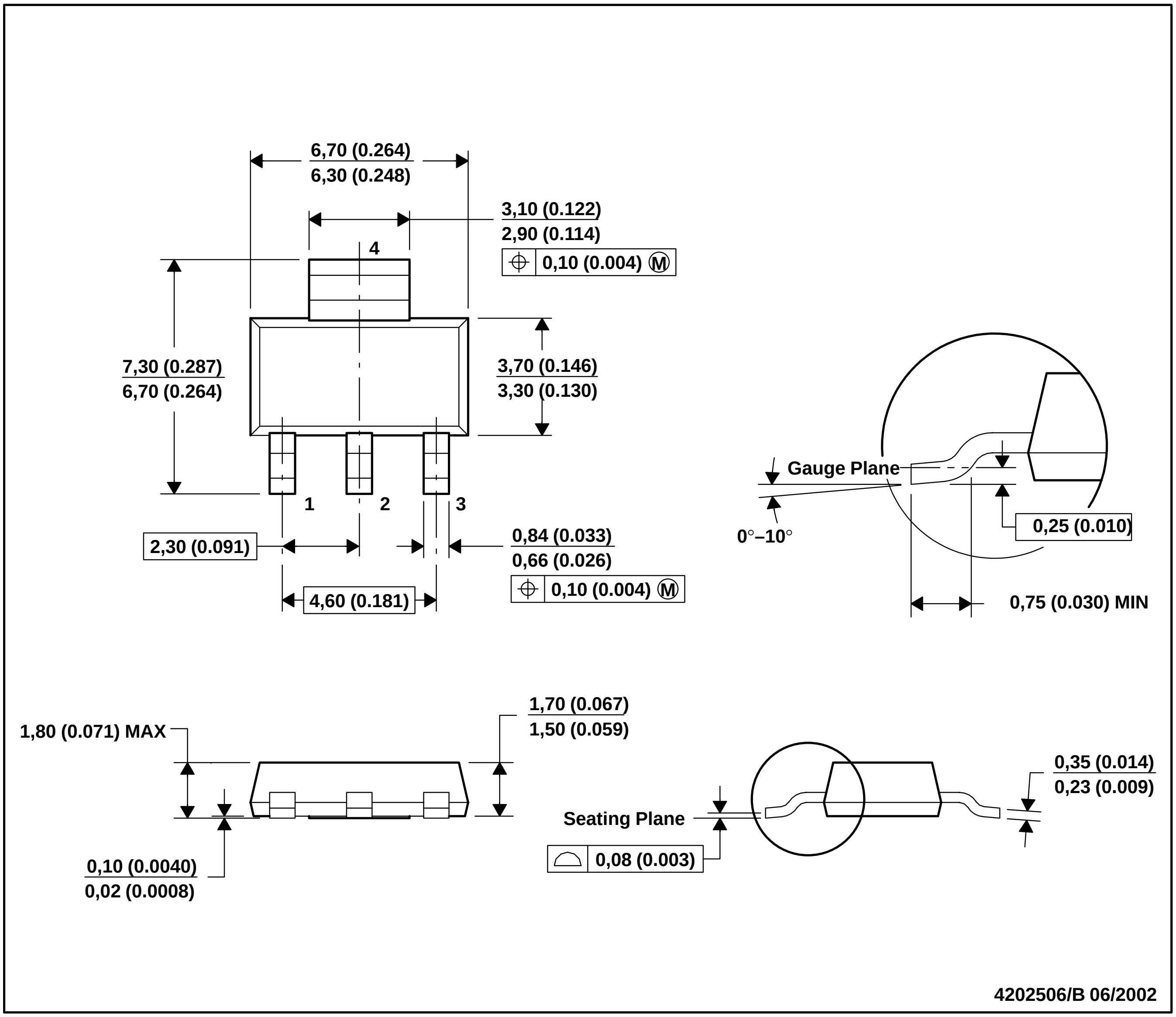


0.240–0.260
[6.10–6.60]
0.330–0.350
[8.38–8.89]
0.100–0.120
[2.54–3.05]
Ø 0.149–0.153
[3.78–3.89]
0.400 +0.015 −0.005
[10.16 +0.38 −0.13]
0.090–0.110
[2.29–2.79]
0.190–0.210
[4.83–5.33]
0.048–0.055
[1.22–1.40]
TYP
0.130–0.160 TYP
[3.30–4.06]
PIN #1 ID
1.005–1.035
[25.53–26.29]
0.027–0.037
[0.69–0.94]
TYP
7°
7°
(0.525–0.555)
[13.34–14.10]
0.015 +0.007 −0.001 [0.38 +0.18 −0.03]
0.175–0.185
[4.45–4.70]
0°–6°
0.105 +0.010 −0.015 [2.67 +0.25 −0.38]
0.048–0.052
[1.22–1.32]
SEATING PLANE
TAPERED
SIDES 1°
T03B (REV L)


(5.5)
(5.7)
(6.44)
(2X 1.7)
(2X 2.285)
(2X 1.3)
(4.57)
LAND PATTERN RECOMMENDATION
DIMENSIONS ARE IN MILLIMETERS
DIMENSIONS IN ( ) FOR REFERENCE ONLY
6.58 +0.15 -0.23
A
5.36 +0.1 -0.4
2X 1.2 +0.07 -0.32
9.91±0.51
6.1 +0.12 -0.13
(2.5)
OPTIONAL
2
1
3
0.83±0.19
3X 0.76±0.12
0.25 M A M B
2X
2.285
4.57
B
2.3 +0.08 -0.11
0.52 +0.36 -0.06
8°
SEATING PLANE
8°
TOP & BOTTOM
0.51 MIN
0.17
0.53±0.07
1.01 +0.13 -0.12
4.32 MIN

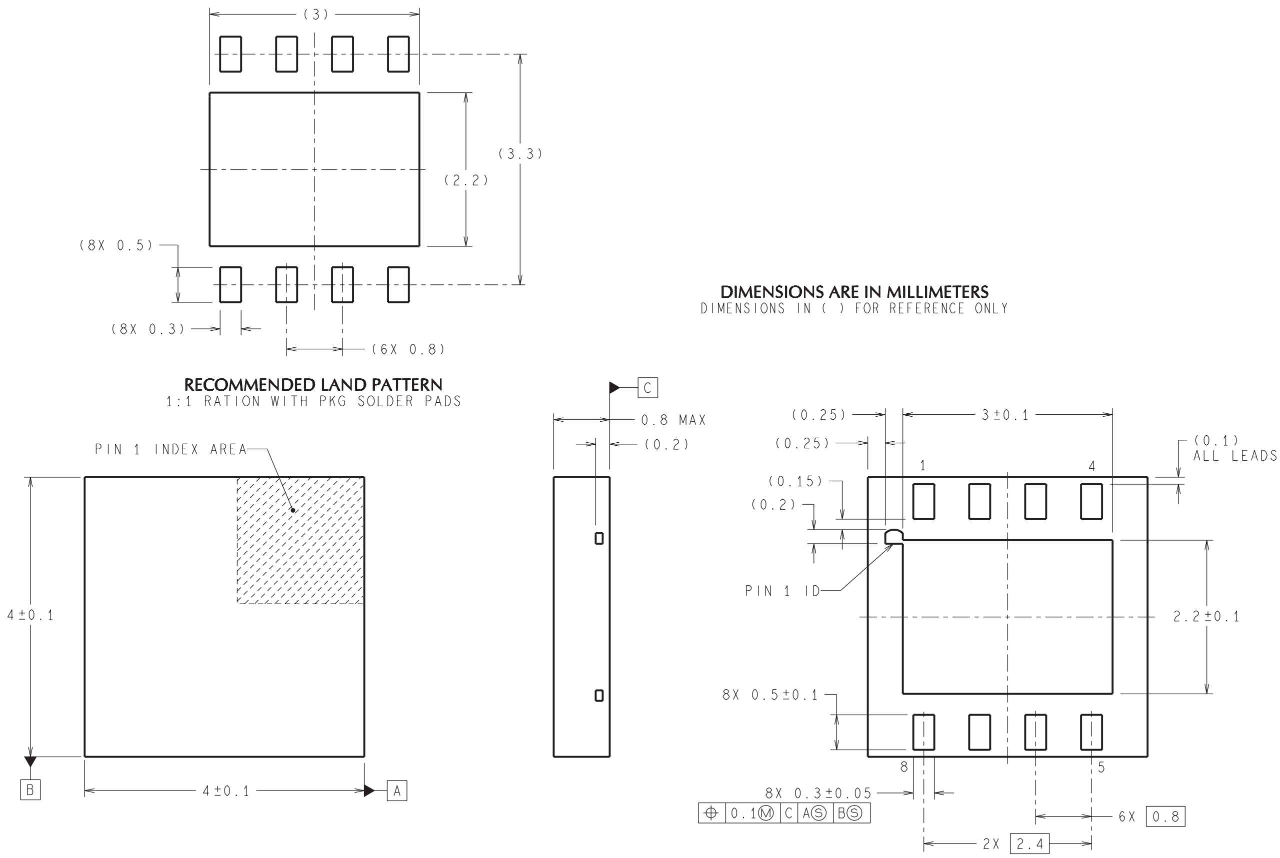
TD03B (Rev F)

DCY (R-PDSO-G4) **PLASTIC SMALL-OUTLINE**



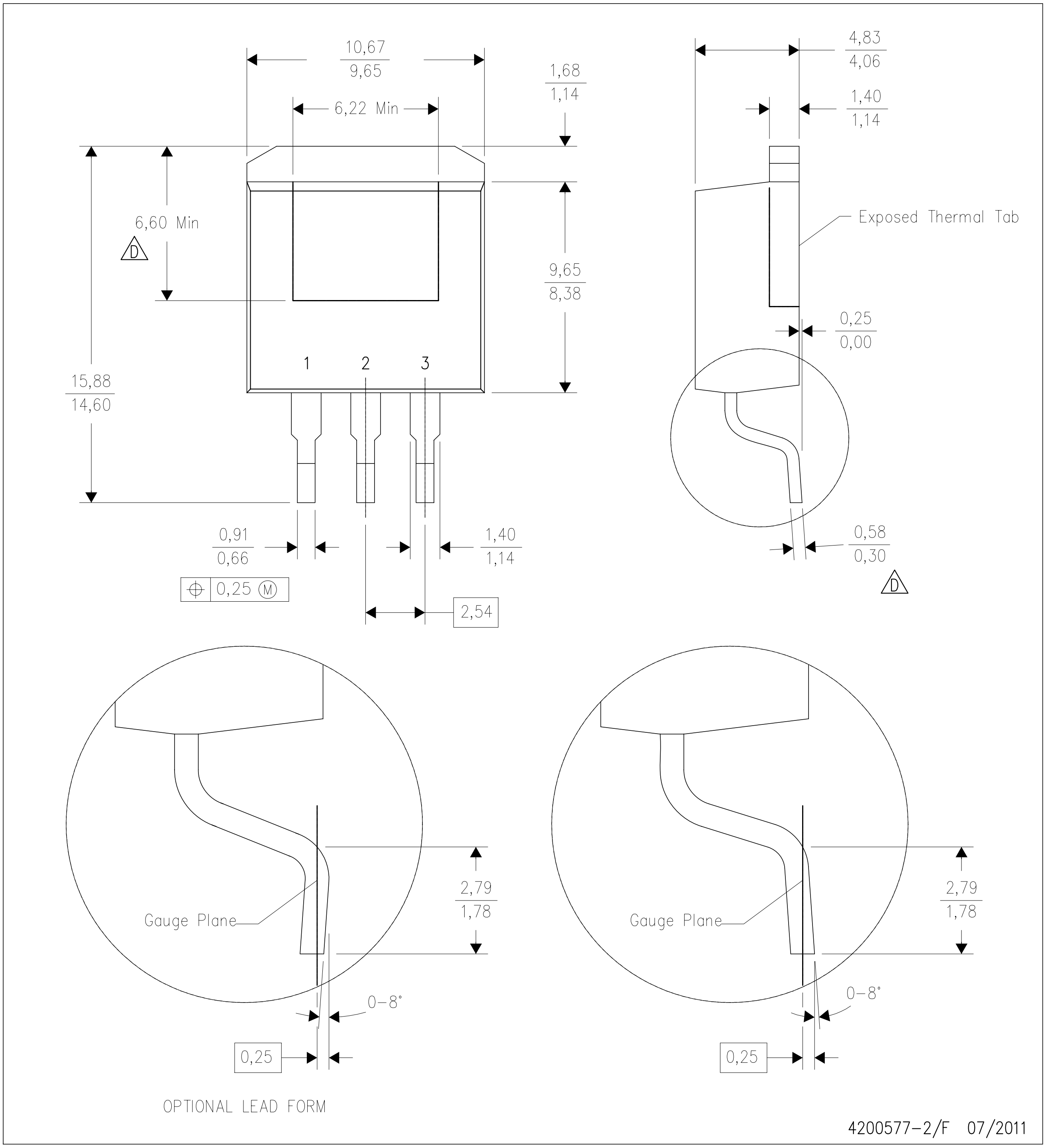
NOTES: A. All linear dimensions are in millimeters (inches).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.
D. Falls within JEDEC TO-261 Variation AA.

NGN0008A



LDC08A (Rev B)

KTT (R–PSFM–G3) PLASTIC FLANGE–MOUNT PACKAGE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash or protrusion not to exceed 0.005 (0,13) per side.
D (in triangle). Falls within JEDEC TO–263 variation AA, except minimum lead thickness and minimum exposed pad length.

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