800 mA Low Dropout Regulator

General Description

The LM1117 is a series of low dropout voltage regulators with a dropout of 1.2V at 800mA load current. The LM1117 is available in an adjustable version, which can set the output voltage from 1.25V to 18.8V with only two external resistors. In addition, it is also available in fixed voltages 1.5V, 1.8V, 2.5V, 2.85V, 3.0V, 3.3V and 5V.

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

The LM1117 series is available in TO-263, SOT-223, TO-220, and TO-252 packages.

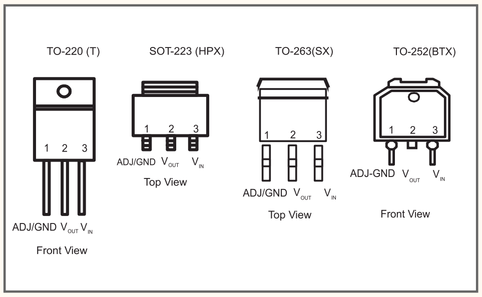
Features

- Space Saving SOT-223 Package
- 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
- Low Quiescent Current
- Low Dropout voltage of 1.2V at 0.8A
- Three terminal adjustable or fixed 1.5V, 1.8V, 2.5V, 2.85V, 3.0V, 3.3V and 5V

Applications

- Notebook Computers
- Battery Chargers
- Disk Drives
- PDA
- SMPS Post-Regulator
- Active SCSI Terminators
- Post Regulator for Switching Supplies
- 5V to 3.3V Linear Regulators

Pin Connections



Ordering Information

T_A	Voltage	Package	Ordering Part Number	Top Side Marking	T_A	Voltage	Package	Ordering Part Number	Top Side Marking
0°C to 125°C	ADJ	SOT-223-3	LM1117MPX-ADJ/TR	N03A	-40°C to 125°C	ADJ	SOT-223-3	LM1117IMPX-ADJ/TR	N03B
	1.5V	SOT223-3	LM1117MPX-1.5/TR	N11A		1.5V	SOT223-3	LM1117IMPX-1.5/TR	N11B
	1.8V	SOT223-3	LM1117MPX-1.8/TR	N12A		1.8V	SOT223-3	LM1117IMPX-1.8/TR	N12B
	2.5V	SOT223-3	LM1117MPX-2.5/TR	N13A		2.5V	SOT223-3	LM1117IMPX-2.5/TR	N13B
	2.85V	SOT223-3	LM1117MPX-2.85/TR	N04A		2.85V	SOT223-3	LM1117IMPX-2.85/TR	N04B
	3.0V	SOT223-3	LM1117MPX-3.0/TR	N14A		3.0V	SOT223-3	LM1117IMPX-3.0/TR	N14B
	3.3V	SOT223-3	LM1117MPX-3.3/TR	N05A		3.3V	SOT223-3	LM1117IMPX-3.3/TR	N05B
	5.0V	SOT223-3	LM1117MPX-5.0/TR	N06A		5.0V	SOT223-3	LM1117IMPX-5.0/TR	N06B
	ADJ	TO-220-3	LM1117T-ADJ	LM1117T-ADJ		ADJ	TO-220-3	LM1117IT-ADJ	LM1117IT-ADJ
	1.5V	TO-220-3	LM1117T-1.5	LM1117T-1.5		1.5V	TO-220-3	LM1117IT-1.5	LM1117IT-1.5
	1.8V	TO-220-3	LM1117T-1.8	LM1117T-1.8		1.8V	TO-220-3	LM1117IT-1.8	LM1117IT-1.8
	2.5V	TO-220-3	LM1117T-2.5	LM1117T-2.5		2.5V	TO-220-3	LM1117IT-2.5	LM1117IT-2.5
	2.85V	TO-220-3	LM1117T-2.85	LM1117T-2.85		2.85V	TO-220-3	LM1117IT-2.85	LM1117IT-2.85
	3.0V	TO-220-3	LM1117T-3.0	LM1117T-3.0		3.0V	TO-220-3	LM1117IT-3.0	LM1117IT-3.0
	3.3V	TO-220-3	LM1117T-3.3	LM1117T-3.3		3.3V	TO-220-3	LM1117IT-3.3	LM1117IT-3.3
	5.0V	TO-220-3	LM1117T-5.0	LM1117T-5.0		5.0V	TO-220-3	LM1117IT-5.0	LM1117IT-5.0
	ADJ	TO-263-3	LM1117SX-ADJ	LM1117SADJ		ADJ	TO-263-3	LM1117ISX-ADJ	LM1117ISADJ
	1.5V	TO-263-3	LM1117SX-1.5	LM1117S1.8		1.5V	TO-263-3	LM1117ISX-1.5	LM1117IS1.8
	1.8V	TO-263-3	LM1117SX-1.8	LM1117S1.5		1.8V	TO-263-3	LM1117ISX-1.8	LM111I7S1.5
	2.5V	TO-263-3	LM1117SX2.5	LM1117S2.5		2.5V	TO-263-3	LM1117ISX2.5	LM1117IS2.5
	2.85V	TO-263-3	LM1117SX2.85	LM1117S2.85		2.85V	TO-263-3	LM1117ISX2.85	LM1117IS2.85
	3.0V	TO-263-3	LM1117SX3.0	LM1117S3.0		3.0V	TO-263-3	LM1117ISX3.0	LM1117IS3.0
	3.3V	TO-263-3	LM1117SX3.3	LM1117S3.3		3.3V	TO-263-3	LM1117ISX3.3	LM1117IS3.3
	5.0V	TO-263-3	LM1117SX5.0	LM1117S5.0		5.0V	TO-263-3	LM1117ISX5.0	LM1117IS5.0
	ADJ	TO-252-3	LM1117DTX-ADJ	LM1117DT-ADJ		ADJ	TO-252-3	LM1117IDTX-ADJ	LM1117IDT-ADJ
	1.5V	TO-252-3	LM1117DTX-1.5	LM1117DT-1.5		1.5V	TO-252-3	LM1117IDTX-1.5	LM1117IDT-1.5
	1.8V	TO-252-3	LM1117DTX-1.8	LM1117DT-1.8		1.8V	TO-252-3	LM1117IDTX-1.8	LM1117IIDT-1.8
	2.5V	TO-252-3	LM1117DTX-2.5	LM1117DT-2.5		2.5V	TO-252-3	LM1117IDTX-2.5	LM1117IDT-2.5
	2.85V	TO-252-3	LM1117DTX-2.85	LM1117DT-2.85		2.85V	TO-252-3	LM1117IDTX-2.85	LM1117IDT-2.85
	3.0V	TO-252-3	LM1117DTX-3.0	LM1117DT-3.0		3.0V	TO-252-3	LM1117IDTX-3.0	LM1117IDT-3.0
	3.3V	TO-252-3	LM1117DTX-3.3	LM1117DT-3.3		3.3V	TO-252-3	LM1117IDTX-3.3	LM1117IDT-3.3
	5.0V	TO-252-3	LM1117DTX-5.0	LM1117DT-5.0		5.0V	TO-252-3	LM1117IDTX-5.0	LM1117IDT-5.0

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Absolute Maximum Ratings

Minimum Input Voltage (V_{IN} to GND) .... 20 V
Power Dissipation (Note 2) .... Internally Limited
Junction Temperature (T_J) (Note 2) .... 150 °C
Storage Temperature Range .... +65°C to 150°C
ESD Tolerance (Note 3) 2000V

Load Temperature
TO-220 Package .... 260°C, 10 sec
SOT-223 Package .... 260°C, 4 sec

Operating Conditions	Min	Max
Input Voltage (V_{IN} to GND)		15V
Junction Temperature Range LM1117	0°C	125°C
Junction Temperature Range LM1117I	-40°C	125°C

LM1117 Electrical Characterstics

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 (Note 5)	Typ (Note 4)	Max (Note 5)	Units
V_{REF}	Reference Voltage	LM1117-ADJ I_{OUT} = 10mA, V_{IN}-V_{OUT} = 2V, T_J = 25°C 10 mA≤I_{OUT}≤800 mA, 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	LM1117-1.5 I_{OUT} = 10mA, V_{IN} = 3.5V, T_J = 25°C 0 ≤I_{OUT}≤800 mA, 3.2V≤V_{IN} ≤10V	 1.782 1.746	 1.800 1.800	 1.818 1.854	 V V
		LM1117-1.8 I_{OUT} = 10mA, V_{IN} = 3.8V, T_J = 25°C 0 ≤I_{OUT}≤800 mA, 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}≤800 mA, 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}≤800 mA, 4.25V≤V_{IN} ≤10V 0 ≤I_{OUT}≤500 mA, 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
		LM1117-3.0 I_{OUT} = 10mA, V_{IN} = 4.5V, T_J = 25°C 0 ≤I_{OUT}≤800 mA, 4.75V≤V_{IN} ≤10V	 3.267 3.235	 3.300 3.300	 3.333 3.365	 V V
		LM1117-3.3 I_{OUT} = 10mA, V_{IN} = 5V, T_J = 25°C 0 ≤I_{OUT}≤800 mA, 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}≤800 mA, 6.5V≤V_{IN} ≤12V	 4.950 4.900	 5.000 5.000	 5.050 5.100	 V V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation (Note 6)	LM1117-ADJ I_{OUT} = 10mA, 1.5V ≤ V_{IN}-V_{OUT} ≤ 13.75V		0.035	0.2	%
		LM1117-1.5 I_{OUT} = 0mA, 3.2V ≤ V_{IN} ≤ 10V		1	6	mV
		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
		LM1117-3.0 I_{OUT} = 0mA, 4.5V ≤ V_{IN} ≤ 15V		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

Electrical Characteristics (Contd...)

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

Symbol	Parameter	Conditions	Min (Note 5)	Typ (Note 4)	Max (Note 5)	Units
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Line Regulation (Note 6)	LM1117-ADJ V_{IN}-V_{OUT} =3V, 10 $\le I_{OUT} \le$ 800mA		0.2	0.4	%
		LM1117-1.5 V_{IN} =3.2V, 0 $\le I_{OUT} \le$ 800mA		1	10	mV
		LM1117-1.8 V_{IN} =3.2V, 0 $\le I_{OUT} \le$ 800mA		1	10	mV
		LM1117-2.5 V_{IN} =3.9V, 0 $\le I_{OUT} \le$ 800mA		1	10	mV
		LM1117-2.85 V_{IN} =4.25V, 0 $\le I_{OUT} \le$ 800mA		1	10	mV
		LM1117-3.0 V_{IN} =4.5V, 0 $\le I_{OUT} \le$ 800mA		1	10	mV
		LM1117-3.3 V_{IN} =4.75V, 0 $\le I_{OUT} \le$ 800mA		1	10	mV
		LM1117-5.0 V_{IN} =6.5V, 0 $\le I_{OUT} \le$ 800mA		1	15	mV
V_{IN}-V_{OUT}	Dropout Voltage (Note 7)	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, $T_J = 25^{\circ}C$	800	1200	1500	mA
	Minimum Load Current (Note 8)	LM1117-ADJ V_{IN} =15V		1.7	5	mA
	Quiescent Current	LM1117-1.5 $V_{IN} \le$15V		5	10	mA
		LM1117-1.8 $V_{IN} \le$15V		5	10	mA
		LM1117-2.5 $V_{IN} \le$15V		5	10	mA
		LM1117-2.85 $V_{IN} \le$15V		5	10	mA
		LM1117-3.0 $V_{IN} \le$15V		5	10	mA
		LM1117-3.3 $V_{IN} \le$15V		5	10	mA
		LM1117-5.0 $V_{IN} \le$15V		5	10	mA
	Thermal Regulation	$T_A = 25^{\circ}C$, 30 ms Pulse		0.01	0.1	%W
	Ripple Regulation	$f_{RIPPLE} \le$ 1.20 Hz, V_{IN}-V_{OUT}=3V V_{RIPPLE} = 1 V_{PP}	60	75		dB
	Adjust Pin Current			60	120	µA
	Adjust Pin Current Change	10 $\le I_{OUT} \le$ 800mA, 1.4V $\le V_{IN}$-$V_{OUT} \le$ 10V		0.2	5	µA
	Temp. Stability			0.5		%
	Long Term Stability	$T_A = 125^{\circ}C$, 1000 Hrs		0.3		%
	RMS Output Noise	(% of V_{OUT}), 10Hz $\le f \le$ 10 kHz		0.003		%
	Thermal Resistance Junction-to-case	3-Lead SOT-223		15.0		°C/W
		3-Lead SOT-220		3.0		°C/W
		3-Lead SOT-252		10		°C/W
	Thermal Resistance Junction-to-Ambient (No air flow)	3-Lead SOT-223 (No heat sink)		135		°C/W
		3-Lead SOT-220 (No heat sink)		79		°C/W
		3-Lead SOT-252 (Note 9) (No heat sink)		92		°C/W
		3-Lead SOT-263		55		°C/W
	Thermal Resistance Junction-to-case	3-Lead SOT-223		15.0		°C/W
		3-Lead SOT-220		10		°C/W
	Thermal Resistance Junction-to-Ambient (No air flow)	3-Lead SOT-223 (No heat sink)		135		°C/W
		3-Lead SOT-220 (No heat sink) (Note 9)		92		°C/W

LM1117I Electrical Characterstics

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

Symbol	Parameter	Conditions	Min (Note 5)	Typ (Note 4)	Max (Note 5)	Units
V_{REf}	Reference Voltage	LM1117-ADJ I_{OUT} = 10mA, V_{IN}-V_{OUT} = 2V, T_J = 25°C 10 mA≤I_{OUT}≤800 mA, 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	LM1117-3.3 I_{OUT} = 10mA, V_{IN}-V_{OUT} = 2V, T_J = 25°C 0 ≤I_{OUT}≤800 mA, 4.75V ≤ V_{IN} ≤ 10V	3.267 **3.168**	3.300 3.300	3.333 **3.432**	V V
		LM1117-5.0 I_{OUT} = 10mA, V_{IN}-V_{OUT} = 2V, T_J = 25°C 0 ≤I_{OUT}≤800 mA, 4.75V ≤ V_{IN} ≤ 10V	4.950 **4.800**	5.000 5.000	5.050 **5.200**	V V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	LM1117- ADJ I_{OUT} = 10mA, 1.5V ≤ V_{IN}-V_{OUT} ≤ 13.75V		0.035	**0.3**	%
		LM1117-3.3 I_{OUT} = 0mA, 4.75V ≤ V_{IN} ≤ 15V		1	**10**	mV
		LM1117-5.0 I_{OUT} = 00mA, 6.5V ≤ V_{IN} ≤ 15V		1	**15**	mV
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	LM1117- ADJ V_{IN}-V_{OUT} ≤ 3V, 10 ≤ I_{OUT} ≤ 800mA		0.2	**0.5**	%
		LM1117- 3.3 V_{IN} = 4.75V, 0 ≤ I_{OUT} ≤ 800mA		1	**15**	mV
		LM1117- 5.0 V_{IN} = 6.5V, 0 ≤ I_{OUT} ≤ 800mA		1	**20**	mV
V_{IN}-V_{OUT}	Dropout Voltage (Note 7)	I_{OUT} = 100 mA		1.10	**1.30**	V
		I_{OUT} = 500 mA		1.15	**1.35**	V
		I_{OUT} = 800 mA		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 (Note 8)	LM1117-ADJ V_{IN} =15V		1.7	5	mA
	Quiescent Current	LM1117-3.3 V_{IN} ≤15V		5	15	mA
		LM1117-5.0 V_{IN} ≤15V		5	15	mA
	Thermal Regulation	T_A = 25°C, 30 ms Pulse		0.01	0.1	%W
	Ripple Regulation	f_{RIPPLE} ≤ 1.20 Hz, V_{IN}-V_{OUT}=3V V_{RIPPLE} = 1 V_{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
	Temp. Stability			0.5		%
	Long Term Stability	T_A = 125°C, 1000 Hrs		0.3		%
	RMS Output Noise	(% of V_{OUT}), 10Hz ≤ f ≤ 10 kHz		0.003		%

Electrical Characterstics

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

Symbol	Parameter	Conditions	Min (Note 5)	Typ (Note 4)	Max (Note 5)	Units
	Thermal Resistance Junction-to-case	3-Lead SOT-223		15.0		°C/W
		3-Lead SOT-220		10		°C/W
	Thermal Resistance Junction-to-Ambient (No air flow)	3-Lead SOT-223 (No heat sink)		135		°C/W
		3-Lead SOT-220 (No heat sink) (Note 9)		92		°C/W

Note 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.

Note 2: The maximum power dissipation is a function of $T_{J(MAX)}$ - $T_A).\theta_{JA}$, and T_A. The maximum available 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.

Note 3: For testing purposes. ESD was applied using human body model, 1.5kΩ in series with 100pF.

Note 4: Typical values represent the most likely parametric form.

Note 5: Load and line regulation are measured at constant junction room temperature.

Note 6: Load and line regulation are measured at constant junction room temperature.

Note 7: The dropout voltage is the input/output differential at which the circuit ceases to regulate under further reduction in input voltage. It is measured when the output voltage has dropped 100mV from the nominal value obtained at $V_{IN} = V_{OUT} + 1.5V$

Note 8: The minimum output current required to maintain regulation.

Note 9: Minimum pad size of $0.038in^2$.

Typical Performance Characteristics

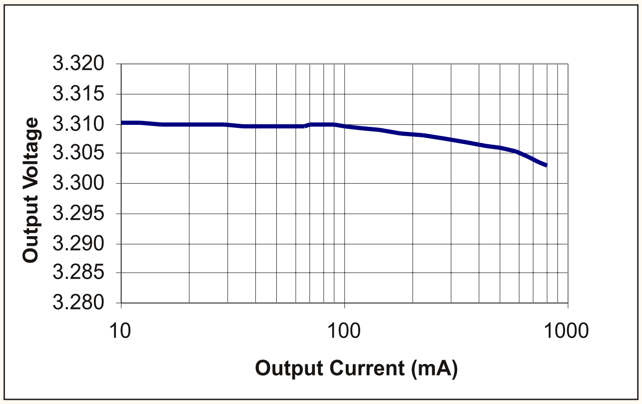


Figure 1. Load Regulation for LM1117-3.3 V_{IN}=4.8V

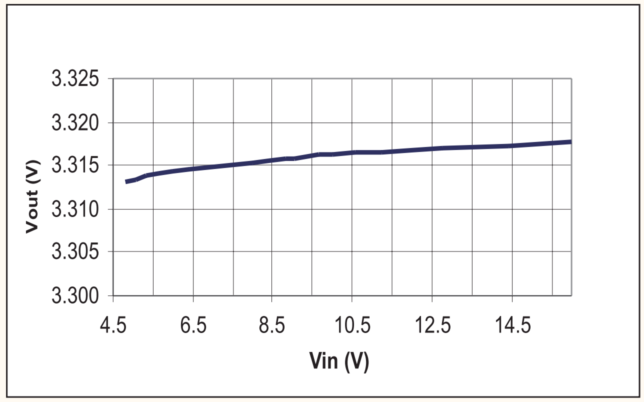


Figure 2. Line Regulation for LM1117-3.3; I_{OUT}=10mA

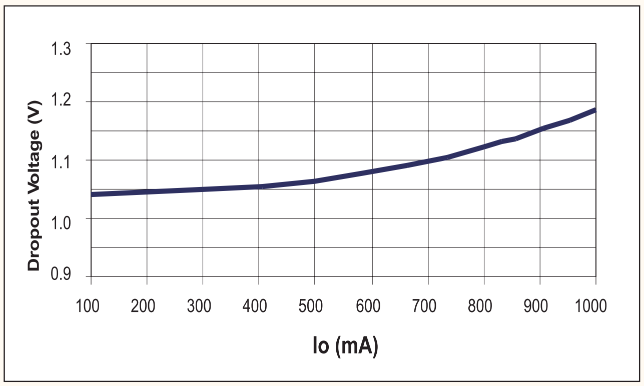


Figure 3. Dropout Voltage vs Output Current for LM11173-3.3; V_{IN}=4.8V, C_{OUT}=2.2µF

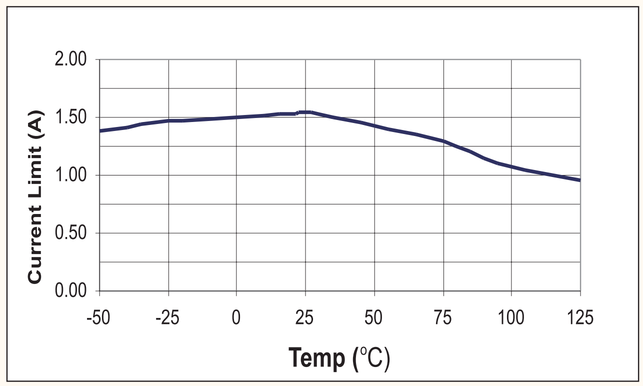


Figure 4. Current Limit for LM1117-3.3; V_{IN}=4.8V, C_{IN}=C_{OUT}=1µF, I_{OUT} pulsed from 10mA to Current Limit

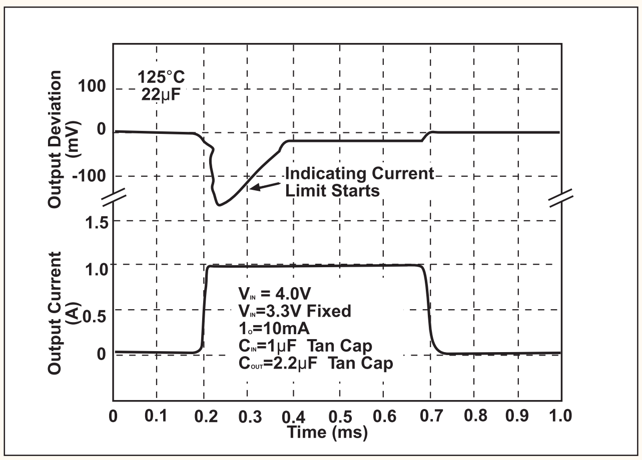


Figure 5. Current Limit for LM1117-3.3, Output Voltage Deviation with I_{OUT}=10mA to 1A Step

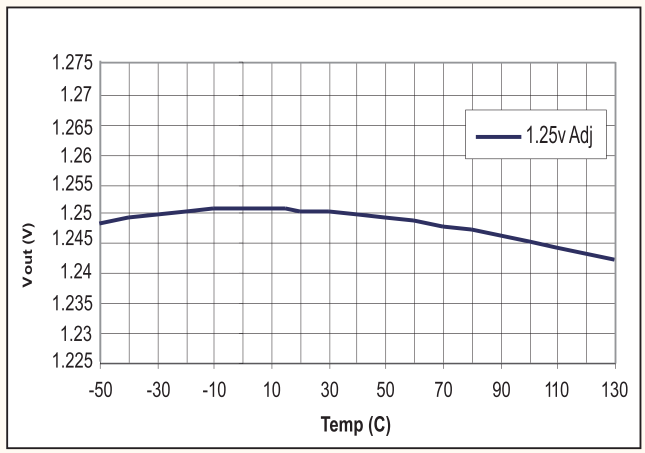


Figure 6. V_{OUT} vs Temperature, V_{IN}=2.5V, I_{OUT}=10mA

Typical Performance Characteristics

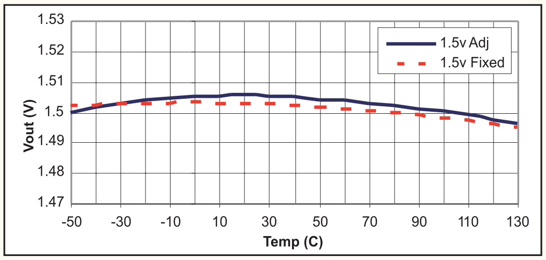


Figure 7. V_{IN}=3.0V, I_{OUT}=10mA

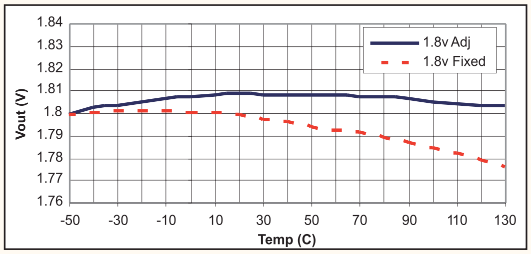


Figure 8. V_{IN}=3.3V, I_{OUT}=10mA

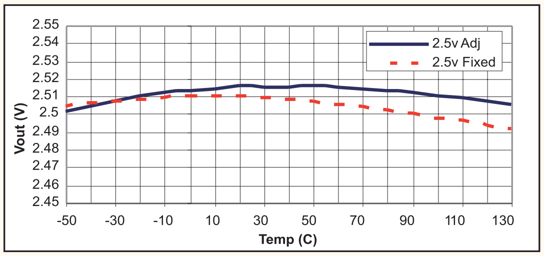


Figure 9. V_{IN}=4.0V, I_{OUT}=10mA

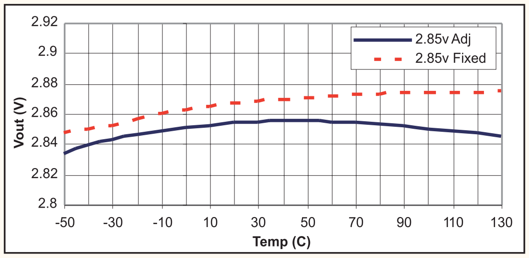


Figure 10. V_{IN}=4.85V, I_{OUT}=10mA

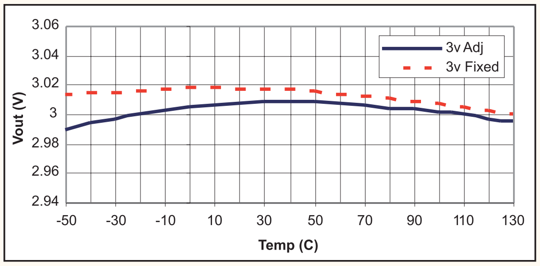


Figure 11. V_{IN}=4.85V, I_{OUT}=10mA

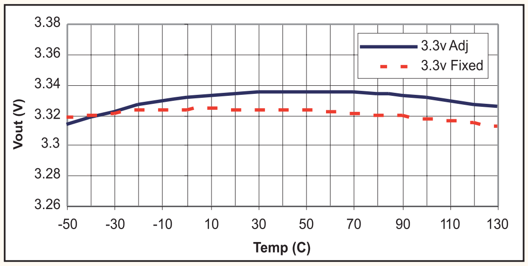


Figure 12. V_{IN}=5.0V, I_{OUT}=10mA

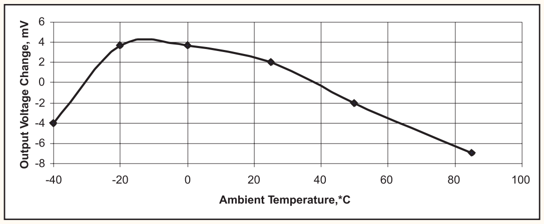


Figure 13. Line Regulation vs Temperature. V_{OUT}=1.8V (adjustable), V_{IN}= 3.3V

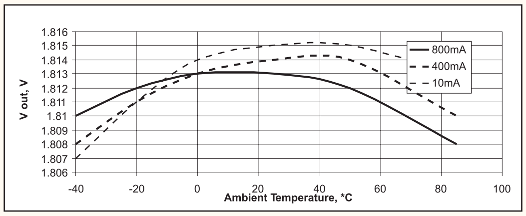


Figure 14. Output Voltage vs Temperature at different Current Loads, V_{IN}=3.3V, V_{OUT} = 1.8V Adjustable

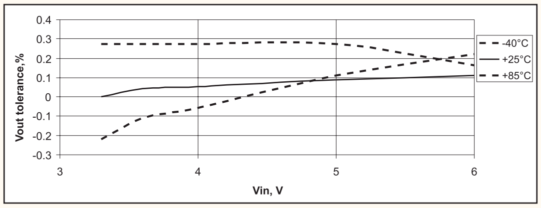


Figure 15. Line Regulation at I_{LOAD}=800mA over Temperature, V_{OUT}=1.8V adjustable

Application Information

To ensure the stability of the LM1117, an output capacitor of at least 2.2µF (tantalum or ceramic) or 10µF (aluminum) is required. The value may change based on the application requirements of the output load or temperature range. The value of ESR can vary based on the type of capacitor used in the applications to guarantee stability. The recommended value for ESR is 0.5Ω or less. A larger value of output capacitance (up to 100µF) can improve the load transient response.

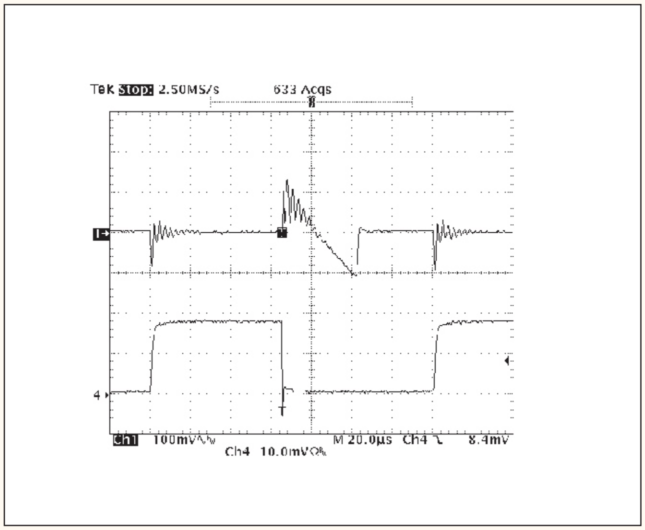


Figure 16. Load Step Response (0 to 800mA), V_{in}=3.3V, V_{out}=1.8V, C_{in}=10µF, C_{out}=2.2µF, Ceramic; 1 = V_{out} 4= I_{load}

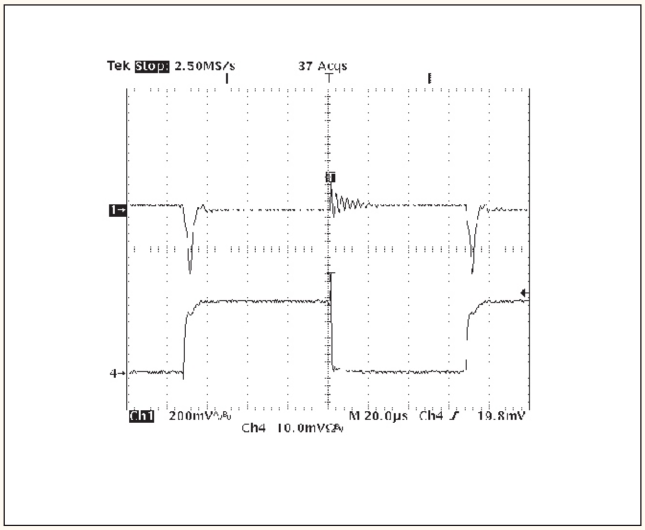
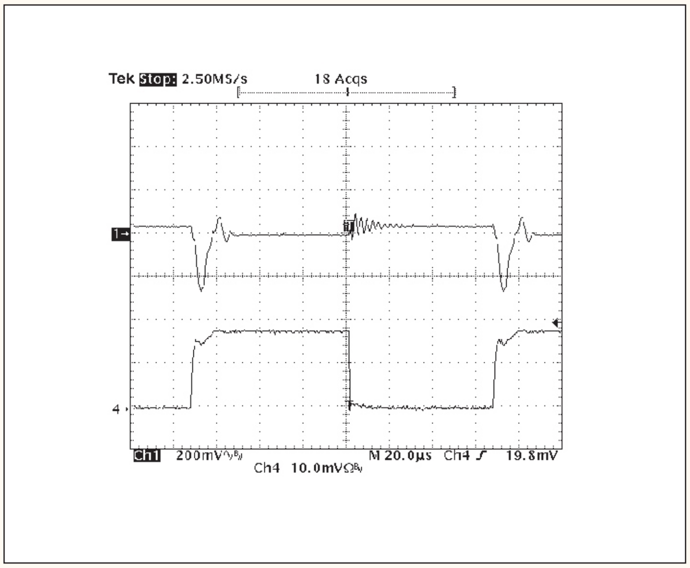


Figure 17. Load Step Response (0 to 800mA), V_{in}=3.3V, V_{out}=1.8V, C_{in}=10µF, C_{out}=2.2µF, OSCON; 1 = V_{out} 4= I_{load}



The LM1117 SOT-223 package is designed to be compatible with infrared reflow or vapor-phase reflow soldering techniques. During soldering, the non-active or mildly active fluxes may be used. The SPX1117 die is attached to the heatsink lead which exits opposite the input, output, and ground pins.

Hand soldering and wave soldering should be avoided since these methods can cause damage to the device with excessive thermal gradients on the package. The SOT-223 recommended soldering method are as follows: vapor phase reflow and infrared reflow with the component preheated to within 65°C of the soldering temperature range.

Application Information

Thermal Characteristics

The thermal resistance of LM1117 (SOT-223 Package) is 15°C/W from junction to tab and 31 °C/W from tab to ambient for a total of 46 °C/W from junction to ambient (Table 1). The LM1117 features the internal thermal limiting to protect the device during overload conditions. Special care needs to be taken during continuous load conditions such that the maximum junction temperature does not exceed 125 °C. Thermal protection is activated at >155°C and deactivated at <140°C.

Taking the FR-4 printed circuit board and 1/16 thick with 1 ounce copper foil as an experiment (fig.13), the PCB material is effective at transmitting heat with the tab attached to the pad area and a ground plane layer on the backside of the substrate. Refer to table 1 for the results of the experiment.

The thermal interaction from other components in the application can effect the thermal resistance of the LM1117. The actual thermal resistance can be determined with experimentation. LM1117 power dissipation is calculated as follows:

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

Maximum Junction Temperature range:

$T_J = T_{A(max)} + P_D$ x thermal resistance (junction-to-ambient)

Maximum junction temperature must not exceed the 125°C.

Ripple Rejection

Ripple rejection can be improved by adding a capacitor between the ADJ pin and ground as shown in Figure 23. When ADJ pin bypassing is used, the value of the output capacitor required increases to its maximum. If the ADJ pin is not bypassed, the value of the output capacitor can be lowered to 10µF for an electrolytic aluminum capacitor or 2.2µF for a ceramic or solid tantalum capacitor (Fig 22). However the value of the ADJ-bypass capacitor should be chosen with respect to the following equation:

$$C = 1 / (6.28 \times FR \times R_1)$$

Where
C = value of the capacitor in Farads (select an equal or larger standard value),
F_R = ripple frequency in Hz,
R_1 = value of resistor R_1 in Ohms.

If an ADJ-bypass capacitor is used, the amplitude of the output ripple will be independent of the output voltage. If an ADJ-bypass capacitor is not used, the output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$$M = V_{OUT} / V_{REF}$$

Where M = multiplier for the ripple seen when the ADJ pin is optimally bypassed.
V_{REF} = 1.25V
Ripple rejection for the adjustable version is shown in Figure 20.

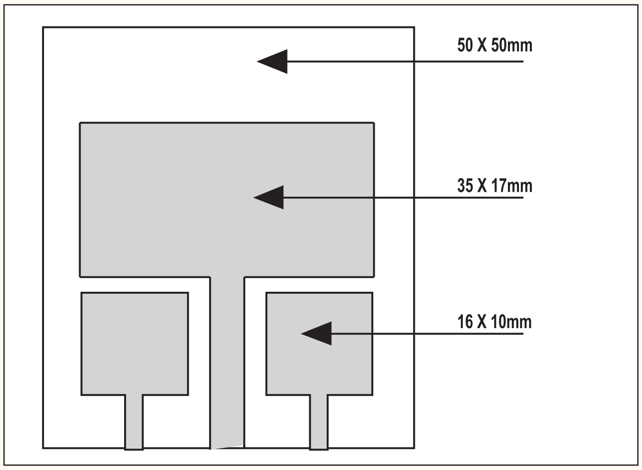


Figure 19. Substrate Layout for SOT-223

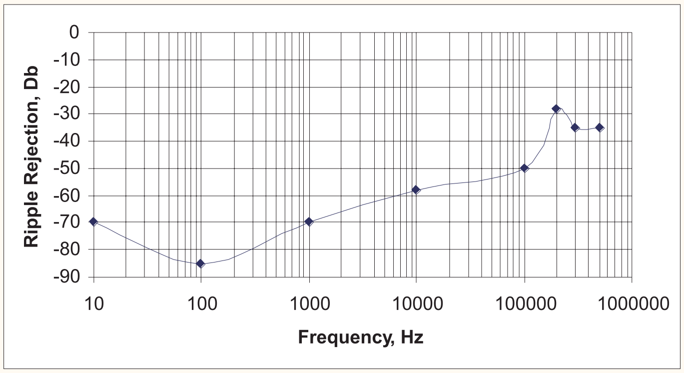


Figure 20. Ripple Rejection; Vin=3.3V, Vout=1.8V (adj.), Iload=200mA

Application Information

PC BOARD mm²	TOPSIDE COPPER mm²	BACKSIDE COPPER mm²	THERMAL RESISTANCE JUNC. TO AMB. °C/W
2500	2500	2500	46
2500	1250	2500	47
2500	950	2500	49
2500	2500	0	51
2500	1800	0	53
1600	600	1600	55
2500	1250	0	58
2500	915	0	59
1600	600	0	67
900	240	900	72
900	240	0	85

Output Voltage

The output of the adjustable regulator can be set to any voltage between 1.25V and 15V. The value of V_{OUT} can be quickly approximated using the formula

$$V_{OUT} = 1.25 \times (R_1 + R_2)/R_1.$$

A small correction to this formula is required depending on the values of resistors R_1 and R_2, since the adjustable pin current (approx 50μA) flows through R2. When I_{ADJ} is taken into account, the formula becomes

$$V_{OUT} = V_{REF}(1 + (R_2/R_1)) + I_{ADJ} \times R_2,$$

where
$V_{REF} = 1.25V$.

Layout Considerations

Parasitic line resistance can degrade load regulation. In order to avoid this, connect R_1 directly to V_{OUT} as illustrated in Figure 25. For the same reason, R_2 should be connected to the negative side of the load.

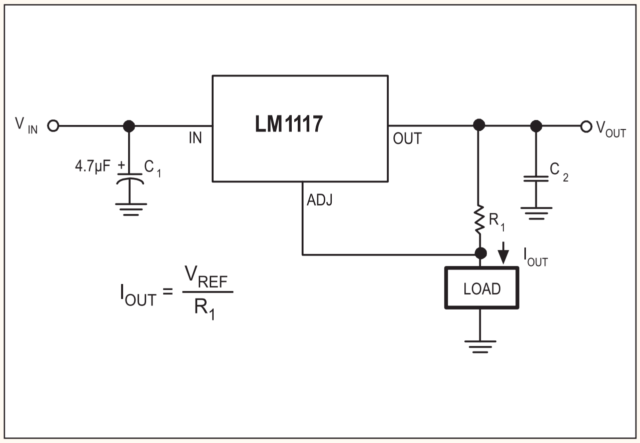


Figure 21. Current Source

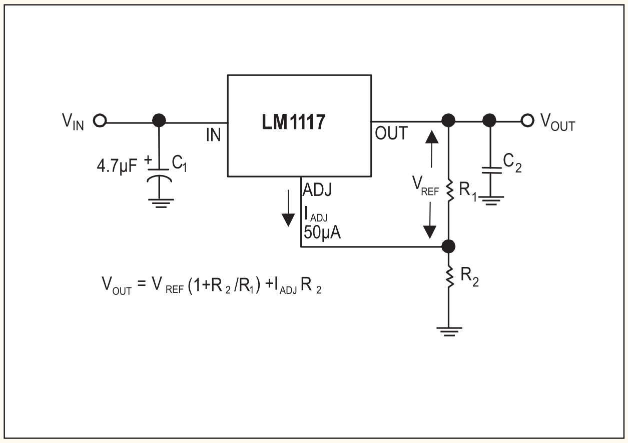


Figure 22. Typical Adjustable Regulator

Application Information

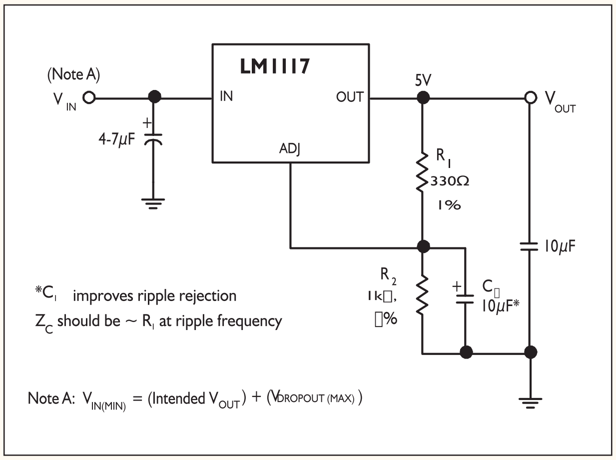


Figure 23. Improving Ripple Rejection

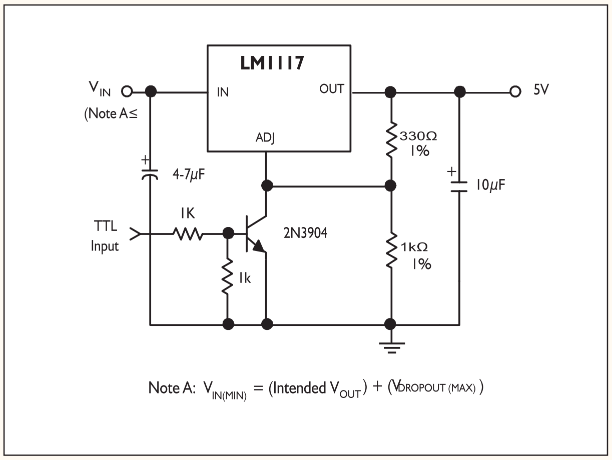


Figure 24. 5V Regulator with Shutdown

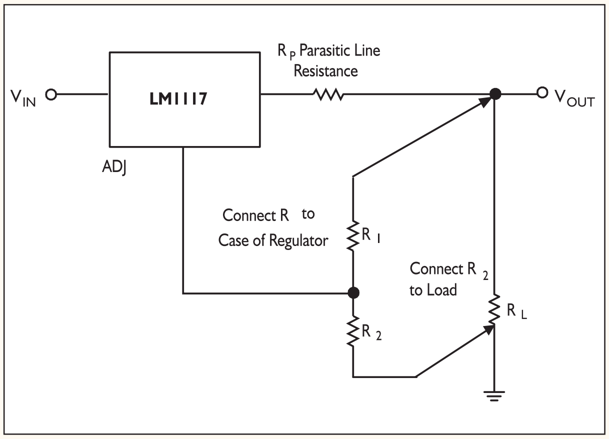


Figure 25. Recommended Connections for Best Results