

## LM1117 1A L.D.O VOLTAGE REGULATOR

### FEATURES

- Output Current up to 1 A
- Low Dropout Voltage (1.2V at 1A Output current)
- Three Terminal Adjustable(ADJ) or Fixed 1.2V, 1.5V, 1.8V, 2.5V, 2.85V, 3.3V, 5.0V
- Line Regulation typically at 0.1% max.
- Load Regulation typically at 0.2% max.
- Internal Current and Terminal Protection
- Maximum Input Voltage 20V
- Surface Mount Package SOT-223, TO-252, SOT-89
- 100% Thermal Limit Burn-In
- Moisture Sensitivity Level 3

### APPLICATION

- Active SCSI Terminators
- Portable/ Plan Top/ Notebook Computers
- High Efficiency Linear Regulators
- SMPS Post Regulators
- Mother B/D Clock Supplies
- Disk Drives
- Battery Chargers

### DESCRIPTION

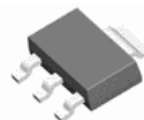
The LM1117 is a low power positive-voltage regulator designed to meet 1A output current and comply with SCSI-II specifications with a fixed output voltage of 2.85V. This device is an excellent choice for use in battery-powered applications, as active terminators for the SCSI bus, and portable computers. The LM1117 features very low quiescent current and very low dropout voltage of 1V at a full load and lower as output current decreases. LM1117 is available as an adjustable or fixed 1.2V, 1.5V, 1.8V, 2.5V, 2.85, 3.3V, and 5.0V output voltages. The LM1117 is offered in a 3-pin surface mount package SOT-223, TO-252 & SOT-89. The output capacitor of 10 $\mu$ F or larger is needed for output stability of LM1117 as required by most of the other regulator circuits.

### Absolute Maximum Ratings

(T<sub>A</sub> = 25°C, unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
DC Input Voltage	V <sub>IN</sub>	-	20	V
Lead Temperature (Soldering, 5 seconds)	T <sub>SOL</sub>	-	260	°C
Operating Junction Temperature Range	T <sub>OPR</sub>	-40	125	°C
Storage Temperature Range	T <sub>STG</sub>	-65	150	°C

SOT-223 PKG



TO-252 PKG



SOT-89 PKG



### ORDERING INFORMATION

Device	Package
LM1117MPX-ADJ	SOT-223 3L
LM1117MPX-X.X	
LM1117IMPX-ADJ	
LM1117IMPX-X.X	
LM1117DTX-ADJ	TO-252 3L
LM1117DTX-X.X	
LM1117IDTX-ADJ	
LM1117IDTX-X.X	
LM1117ML-ADJ	SOT-89 3L
LM1117ML-X.X	
LM1117IML-ADJ	
LM1117IML-X.X	

X.X = Output Voltage = 1.2V, 1.5V, 1.8V, 2.5V, 2.85V, 3.3V, 5.0V

**Ordering Information**

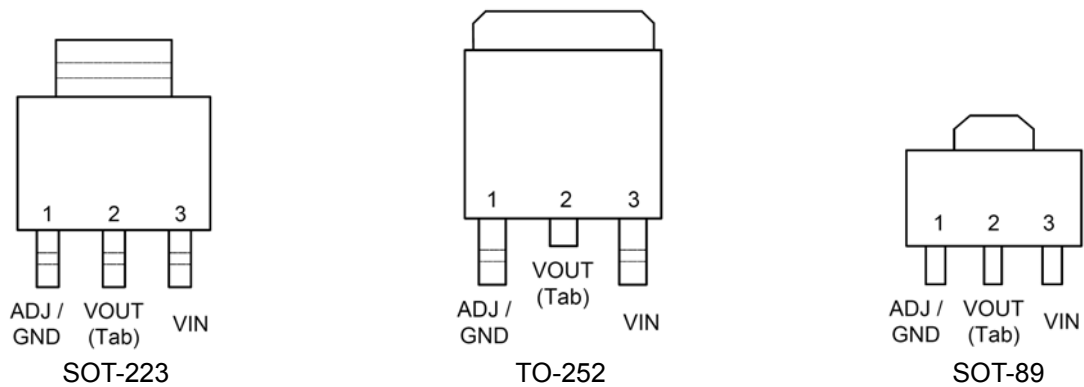
V <sub>OUT</sub>	Package	Order No.	Package Marking	Supplied As	Status
ADJ	SOT-223	LM1117MPX-ADJ	N03A	Reel	Active
	SOT-223	LM1117IMPX-ADJ	N03B	Reel	Contact us
	TO-252	LM1117DTX-ADJ	LM1117DT-ADJ	Reel	Active
	TO-252	LM1117IDTX-ADJ	LM1117IDT-ADJ	Reel	Contact us
	SOT-89	LM1117ML-ADJ	M03A	Reel	Active
	SOT-89	LM1117IML-ADJ	M03B	Reel	Active
1.2V	SOT-223	LM1117MPX-1.2V	N04A	Reel	Active
	SOT-223	LM1117IMPX-1.2V	N04B	Reel	Contact us
	TO-252	LM1117DTX-1.2V	LM1117DT-1.2	Reel	Active
	TO-252	LM1117IDTX-1.2V	LM1117IDT-1.2	Reel	Contact us
	SOT-89	LM1117ML-1.2V	M04A	Reel	Active
	SOT-89	LM1117IML-1.2V	M04B	Reel	Active
1.5V	SOT-223	LM1117MPX-1.5V	N10A	Reel	Active
	SOT-223	LM1117IMPX-1.5V	N10B	Reel	Contact us
	TO-252	LM1117DTX-1.5V	LM1117DT-1.5	Reel	Active
	TO-252	LM1117IDTX-1.5V	LM1117IDT-1.5	Reel	Contact us
	SOT-89	LM1117ML-1.5V	M10A	Reel	Active
	SOT-89	LM1117IML-1.5V	M10B	Reel	Active
1.8V	SOT-223	LM1117MPX-1.8V	N12A	Reel	Active
	SOT-223	LM1117IMPX-1.8V	N12B	Reel	Contact us
	TO-252	LM1117DTX-1.8V	LM1117DT-1.8	Reel	Active
	TO-252	LM1117IDTX-1.8V	LM1117IDT-1.8	Reel	Contact us
	SOT-89	LM1117ML-1.8V	M12A	Reel	Active
	SOT-89	LM1117IML-1.8V	M12B	Reel	Active
2.5V	SOT-223	LM1117MPX-2.5V	N13A	Reel	Active
	SOT-223	LM1117IMPX-2.5V	N13B	Reel	Contact us
	TO-252	LM1117DTX-2.5V	LM1117DT-2.5	Reel	Active
	TO-252	LM1117IDTX-2.5V	LM1117IDT-2.5	Reel	Contact us
	SOT-89	LM1117ML-2.5V	M13A	Reel	Active
	SOT-89	LM1117IML-2.5V	M13B	Reel	Active
2.85V	SOT-223	LM1117MPX-2.85V	N11A	Reel	Active
	SOT-223	LM1117IMPX-2.85V	N11B	Reel	Contact us
	TO-252	LM1117DTX-2.85V	LM1117DT-2.85	Reel	Active
	TO-252	LM1117IDTX-2.85V	LM1117IDT-2.85	Reel	Contact us
	SOT-89	LM1117ML-2.85V	M11A	Reel	Active
	SOT-89	LM1117IML-2.85V	M11B	Reel	Active

## Ordering Information

(Continued)

VOUT	Package	Order No.	Package Marking	Supplied As	Status
3.3V	SOT-223	LM1117MPX-3.3V	N05A	Reel	Active
	SOT-223	LM1117IMPX-3.3V	N05B	Reel	Contact us
	TO-252	LM1117DTX-3.3V	LM1117DT-3.3	Reel	Active
	TO-252	LM1117IDTX-3.3V	LM1117IDT-3.3	Reel	Contact us
	SOT-89	LM1117ML-3.3V	M05A	Reel	Active
	SOT-89	LM1117IML-3.3V	M05B	Reel	Active
5.0V	SOT-223	LM1117MPX-5.0V	N06A	Reel	Active
	SOT-223	LM1117IMPX-5.0V	N06B	Reel	Contact us
	TO-252	LM1117DTX-5.0V	LM1117DT-5.0	Reel	Active
	TO-252	LM1117IDTX-5.0V	LM1117IDT-5.0	Reel	Contact us
	SOT-89	LM1117ML-5.0V	M06A	Reel	Active
	SOT-89	LM1117IML-5.0V	M06B	Reel	Active

## PIN CONFIGURATION



## PIN DESCRIPTION

Pin No.	SOT-223 / TO-252 / SOT-89	
	Name	Function
1	ADJ/GND	Adjustable / Ground
2	V <sub>OUT</sub>	Output Voltage
3	V <sub>IN</sub>	Input Voltage

**ELECTRICAL CHARACTERISTICS**
**For ADJ Output Voltage**

 (T<sub>A</sub>=25°C, C<sub>O</sub> = 10uF unless otherwise specified)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V <sub>REF</sub>	Reference Voltage	V <sub>IN</sub> =5V, I <sub>O</sub> =10mA	1.238	1.250	1.262	V
V <sub>REF</sub>	Reference Voltage	I <sub>O</sub> = 10mA to 1A, V <sub>IN</sub> - V <sub>REF</sub> = 1.5V to 13.75V (T <sub>J</sub> = 0 ~ 125°C)	1.219		1.281	V
ΔV <sub>LINE</sub>	Line Regulation	I <sub>O</sub> = 10mA, V <sub>IN</sub> - V <sub>REF</sub> = 1.5V to 12V		0.1	0.2	%
ΔV <sub>LOAD</sub>	Load Regulation	I <sub>O</sub> = 10mA to 1A, V <sub>IN</sub> - V <sub>REF</sub> = 2 V		0.2	0.4	%
V <sub>IN</sub>	Operating Input Voltage				12	V
I <sub>ADJ</sub>	Adjustment pin Current	V <sub>IN</sub> - V <sub>REF</sub> = 1.5V to 12V, I <sub>O</sub> = 100mA		50	120	uA
ΔI <sub>ADJ</sub>	Adjustment Pin Current Change	V <sub>IN</sub> - V <sub>REF</sub> = 1.5V to 12V, I <sub>O</sub> = 100mA to 1A		0.5	5	uA
I <sub>O(MIN)</sub>	Minimum Load Current	V <sub>IN</sub> =5V, V <sub>REF</sub> =0V		5	10	mA
I <sub>O</sub>	Current Limit	V <sub>IN</sub> - V <sub>REF</sub> = 5V	1000	1250	1600	mA
e <sub>N</sub>	Output Noise(%V <sub>O</sub> )	B = 10Hz to 10kHz, T <sub>J</sub> = 25°C		0.003		%
SVR	Supply Voltage Rejection	I <sub>O</sub> = 1A, f = 120Hz, V <sub>IN</sub> - V <sub>REF</sub> = 3V, V <sub>RIPPLE</sub> = 1V <sub>PP</sub>	60	75		dB

**For 1.2V Output Voltage**

 (T<sub>A</sub>=25°C, C<sub>O</sub> = 10uF unless otherwise specified)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 2.7V, I <sub>O</sub> = 10mA	1.176	1.200	1.224	V
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 2.7V to 12V, I <sub>O</sub> = 0mA to 1A (T <sub>J</sub> = 0 ~ 125°C)	1.152		1.248	V
ΔV <sub>LINE</sub>	Line Regulation	I <sub>O</sub> = 0mA, V <sub>IN</sub> = 2.7V to 12V		0.1	0.2	%
ΔV <sub>LOAD</sub>	Load Regulation	I <sub>O</sub> = 10mA to 1A, V <sub>IN</sub> = 3.2V		0.2	0.4	%
V <sub>IN</sub>	Operating Input Voltage				12	V
I <sub>D</sub>	Quiescent Current	V <sub>IN</sub> - V <sub>O</sub> = 5V		5	10	mA
I <sub>O</sub>	Current Limit	V <sub>IN</sub> - V <sub>O</sub> = 5V	1000	1250	1600	mA
e <sub>N</sub>	Output Noise(%V <sub>O</sub> )	B = 10Hz to 10kHz, T <sub>J</sub> = 25°C		0.003		%
SVR	Supply Voltage Rejection	I <sub>O</sub> = 1A, f = 120Hz, V <sub>IN</sub> - V <sub>O</sub> = 1.5V, V <sub>RIPPLE</sub> = 1V <sub>PP</sub>	60	75		dB

**For 1.5V Output Voltage**

 (T<sub>A</sub>=25°C, C<sub>O</sub> = 10uF unless otherwise specified)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 3.0V, I <sub>O</sub> = 10mA	1.485	1.5	1.515	V
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 3.0V to 12V, I <sub>O</sub> = 0mA to 1A (T <sub>J</sub> = 0 ~ 125°C)	1.470		1.530	V
ΔV <sub>LINE</sub>	Line Regulation	I <sub>O</sub> = 0mA, V <sub>IN</sub> = 3.0V to 12V		0.1	0.2	%
ΔV <sub>LOAD</sub>	Load Regulation	I <sub>O</sub> = 0mA to 1A, V <sub>IN</sub> = 3.5 V		0.2	0.4	%
V <sub>IN</sub>	Operating Input Voltage	I <sub>O</sub> = 100mA			12	V
I <sub>D</sub>	Quiescent Current	V <sub>IN</sub> - V <sub>O</sub> = 5V		5	10	mA
I <sub>O</sub>	Current Limit	V <sub>IN</sub> - V <sub>O</sub> = 5V	1000	1250	1600	mA
εN	Output Noise(%V <sub>O</sub> )	B = 10Hz to 10kHz, T <sub>J</sub> = 25°C		100		uV
SVR	Supply Voltage Rejection	I <sub>O</sub> = 1A, f = 120Hz, V <sub>IN</sub> - V <sub>O</sub> = 3V, V <sub>RIPPLE</sub> = 1V <sub>PP</sub>	60	75		dB

**For 1.8V Output Voltage**

 (T<sub>A</sub>=25°C, C<sub>O</sub> = 10uF unless otherwise specified)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 3.3V, I <sub>O</sub> = 10mA	1.782	1.8	1.818	V
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 3.3V to 12V, I <sub>O</sub> = 0mA to 1A (T <sub>J</sub> = 0 ~ 125°C)	1.764		1.836	V
ΔV <sub>LINE</sub>	Line Regulation	I <sub>O</sub> = 0mA, V <sub>IN</sub> = 3.3V to 12V		0.1	0.2	%
ΔV <sub>LOAD</sub>	Load Regulation	I <sub>O</sub> = 0mA to 1A, V <sub>IN</sub> = 3.8 V		0.2	0.4	%
V <sub>IN</sub>	Operating Input Voltage	I <sub>O</sub> = 100mA			12	V
I <sub>D</sub>	Quiescent Current	V <sub>IN</sub> - V <sub>O</sub> = 5V		5	10	mA
I <sub>O</sub>	Current Limit	V <sub>IN</sub> - V <sub>O</sub> = 5V	1000	1250	1600	mA
εN	Output Noise(%V <sub>O</sub> )	B = 10Hz to 10kHz, T <sub>J</sub> = 25°C		100		uV
SVR	Supply Voltage Rejection	I <sub>O</sub> = 1A, f = 120Hz, V <sub>IN</sub> - V <sub>O</sub> = 3V, V <sub>RIPPLE</sub> = 1V <sub>PP</sub>	60	75		dB

**For 2.5V Output Voltage**

 (T<sub>A</sub>=25°C, C<sub>O</sub> = 10uF unless otherwise specified)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 4.0V, I <sub>O</sub> = 10mA	2.475	2.5	2.525	V
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 4.0V to 12V, I <sub>O</sub> = 0mA to 1A (T <sub>J</sub> = 0 ~ 125°C)	2.450		2.550	V
ΔV <sub>LINE</sub>	Line Regulation	I <sub>O</sub> = 0mA, V <sub>IN</sub> = 4.0V to 12V		0.1	0.2	%
ΔV <sub>LOAD</sub>	Load Regulation	I <sub>O</sub> = 0mA to 1A, V <sub>IN</sub> = 4.5 V		0.2	0.4	%
V <sub>IN</sub>	Operating Input Voltage	I <sub>O</sub> = 100mA			12	V
I <sub>D</sub>	Quiescent Current	V <sub>IN</sub> - V <sub>O</sub> = 5V		5	10	mA
I <sub>O</sub>	Current Limit	V <sub>IN</sub> - V <sub>O</sub> = 5V	1000	1250	1600	mA
e <sub>N</sub>	Output Noise(%V <sub>O</sub> )	B = 10Hz to 10kHz, T <sub>J</sub> = 25°C		100		uV
SVR	Supply Voltage Rejection	I <sub>O</sub> = 1A, f = 120Hz, V <sub>IN</sub> - V <sub>O</sub> = 3V, V <sub>RIPPLE</sub> = 1V <sub>PP</sub>	60	75		dB

**For 2.85V Output Voltage**

 (T<sub>A</sub>=25°C, C<sub>O</sub> = 10uF unless otherwise specified)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 4.4V, I <sub>O</sub> = 10mA	2.821	2.85	2.878	V
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 4.4V to 12V, I <sub>O</sub> = 0mA to 1A (T <sub>J</sub> = 0 ~ 125°C)	2.793		2.907	V
ΔV <sub>LINE</sub>	Line Regulation	I <sub>O</sub> = 0mA, V <sub>IN</sub> = 4.4 to 12V		0.1	0.2	%
ΔV <sub>LOAD</sub>	Load Regulation	I <sub>O</sub> = 0mA to 1A, V <sub>IN</sub> = 4.85 V		0.2	0.4	%
V <sub>IN</sub>	Operating Input Voltage	I <sub>O</sub> = 100mA			12	V
I <sub>D</sub>	Quiescent Current	V <sub>IN</sub> - V <sub>O</sub> = 5V		5	10	mA
I <sub>O</sub>	Current Limit	V <sub>IN</sub> - V <sub>O</sub> = 5V	1000	1250	1600	mA
e <sub>N</sub>	Output Noise(%V <sub>O</sub> )	B = 10Hz to 10kHz, T <sub>J</sub> = 25°C		100		uV
SVR	Supply Voltage Rejection	I <sub>O</sub> = 1A, f = 120Hz, V <sub>IN</sub> - V <sub>O</sub> = 3V, V <sub>RIPPLE</sub> = 1V <sub>PP</sub>	60	75		dB

**For 3.3V Output Voltage**

 (T<sub>A</sub>=25°C, C<sub>O</sub> = 10uF unless otherwise specified)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 4.8V, I <sub>O</sub> = 10mA	3.267	3.3	3.333	V
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 4.8V to 12V, I <sub>O</sub> = 0mA to 1A (T <sub>J</sub> = 0 ~ 125°C)	3.234		3.366	V
ΔV <sub>LINE</sub>	Line Regulation	I <sub>O</sub> = 0mA, V <sub>IN</sub> = 4.8V to 12V		0.1	0.2	%
ΔV <sub>LOAD</sub>	Load Regulation	I <sub>O</sub> = 0mA to 1A, V <sub>IN</sub> = 5.3 V		0.2	0.4	%
V <sub>IN</sub>	Operating Input Voltage	I <sub>O</sub> = 100mA			12	V
I <sub>D</sub>	Quiescent Current	V <sub>IN</sub> - V <sub>O</sub> = 5V		5	10	mA
I <sub>O</sub>	Current Limit	V <sub>IN</sub> - V <sub>O</sub> = 5V	1000	1250	1600	mA
e <sub>N</sub>	Output Noise(%V <sub>O</sub> )	B = 10Hz to 10kHz, T <sub>J</sub> = 25°C		100		uV
SVR	Supply Voltage Rejection	I <sub>O</sub> = 1A, f = 120Hz, V <sub>IN</sub> - V <sub>O</sub> = 3V, V <sub>RIPPLE</sub> = 1V <sub>PP</sub>	60	75		dB

**For 5.0V Output Voltage**

 (T<sub>A</sub>=25°C, C<sub>O</sub> = 10uF unless otherwise specified)

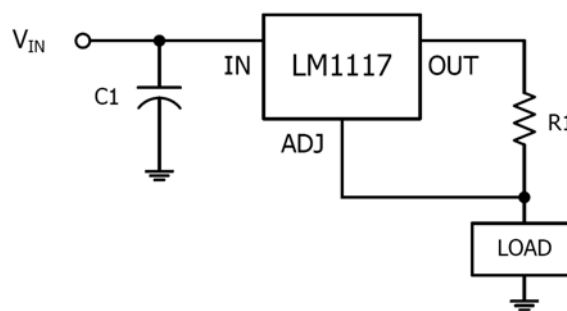
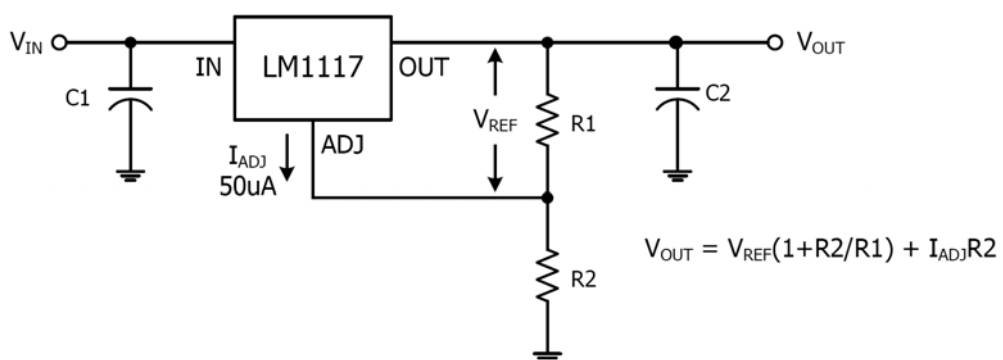
Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 6.5V, I <sub>O</sub> = 10mA	4.950	5.0	5.050	V
V <sub>O</sub>	Output Voltage	V <sub>IN</sub> = 6.5V to 15V, I <sub>O</sub> = 0mA to 1A (T <sub>J</sub> = 0 ~ 125°C)	4.900		5.100	V
ΔV <sub>LINE</sub>	Line Regulation	I <sub>O</sub> = 0mA, V <sub>IN</sub> = 6.5V to 15V		0.1	0.2	%
ΔV <sub>LOAD</sub>	Load Regulation	I <sub>O</sub> = 0mA to 1A, V <sub>IN</sub> = 7.0 V		0.2	0.4	%
V <sub>IN</sub>	Operating Input Voltage	I <sub>O</sub> = 100mA			12	V
I <sub>D</sub>	Quiescent Current	V <sub>IN</sub> - V <sub>O</sub> = 5V		5	10	mA
I <sub>O</sub>	Current Limit	V <sub>IN</sub> - V <sub>O</sub> = 5V	1000	1250	1600	mA
e <sub>N</sub>	Output Noise(%V <sub>O</sub> )	B = 10Hz to 10kHz, T <sub>J</sub> = 25°C		100		uV
SVR	Supply Voltage Rejection	I <sub>O</sub> = 1A, f = 120Hz, V <sub>IN</sub> - V <sub>O</sub> = 3V, V <sub>RIPPLE</sub> = 1V <sub>PP</sub>	60	75		dB

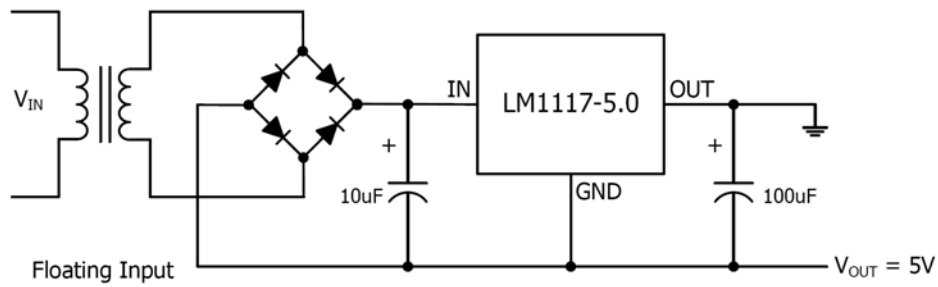


**For All Output Voltage**

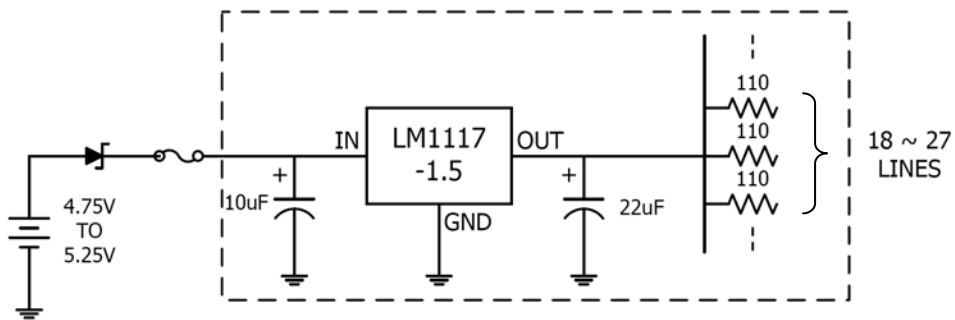
 (T<sub>A</sub>=25°C, C<sub>O</sub> = 10uF unless otherwise specified)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
V <sub>D</sub>	Dropout Voltage	I <sub>O</sub> = 100mA		1.0	1.1	V
		I <sub>O</sub> = 500mA		1.1	1.2	V
		I <sub>O</sub> = 1A		1.2	1.3	V
	Temperature Stability			0.5		%
	Long Term Stability	1000 hrs, T <sub>J</sub> = 125°C		0.3		%
	Thermal Regulation	T <sub>A</sub> = 25°C 30ms Pulse		0.003		%/W

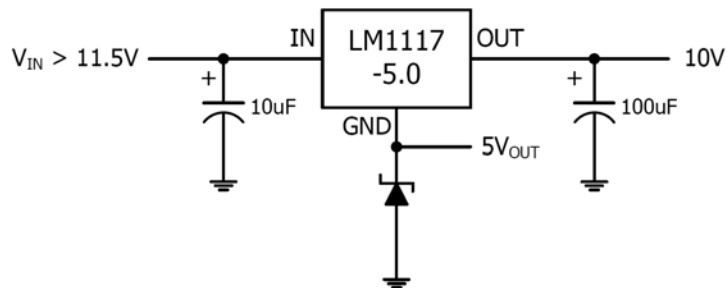
**TYPICAL APPLICATION CIRCUIT**

**Fig.1 1A Current Output**

**Fig.2 Typical Adjustable Regulator**



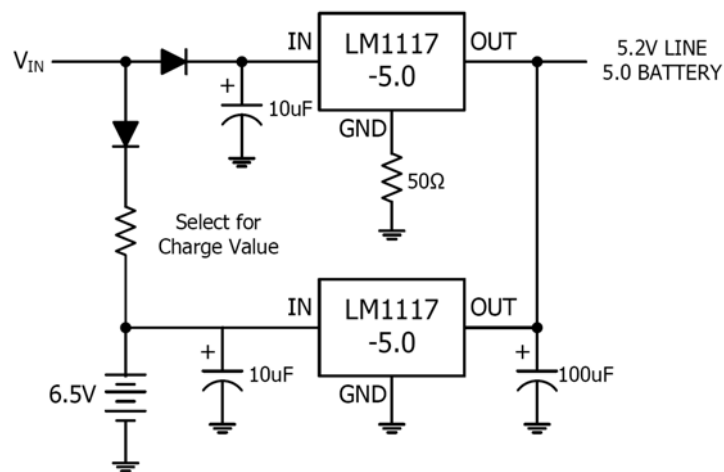
**Fig.3 Negative Supply**



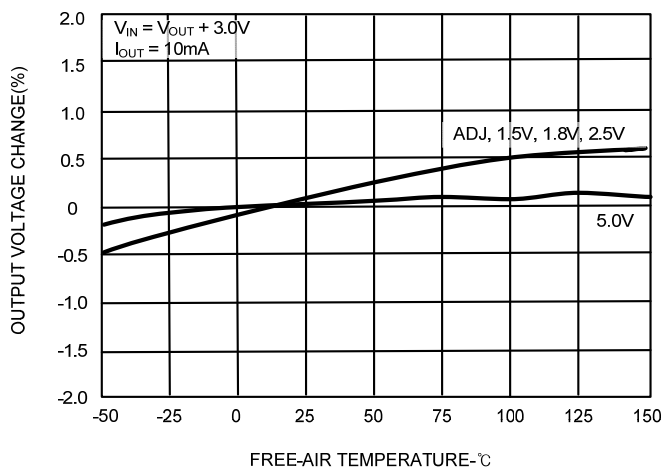
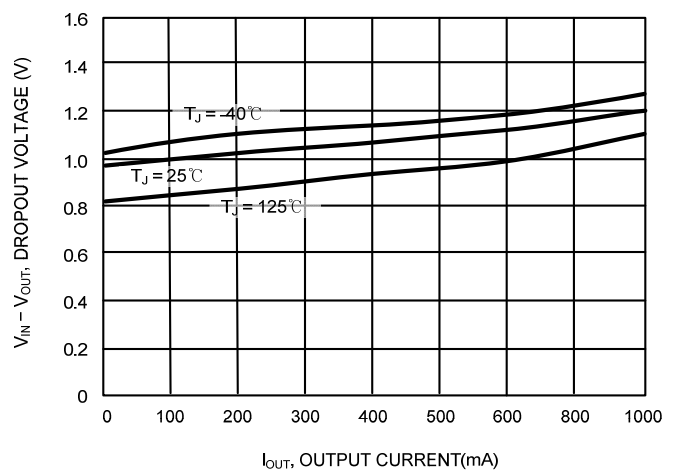
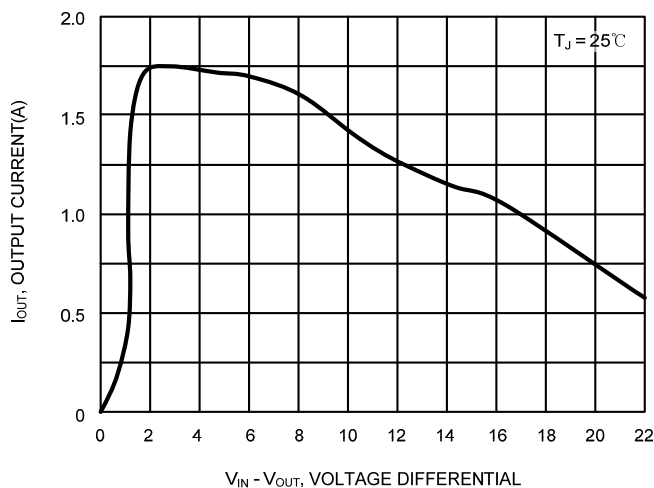
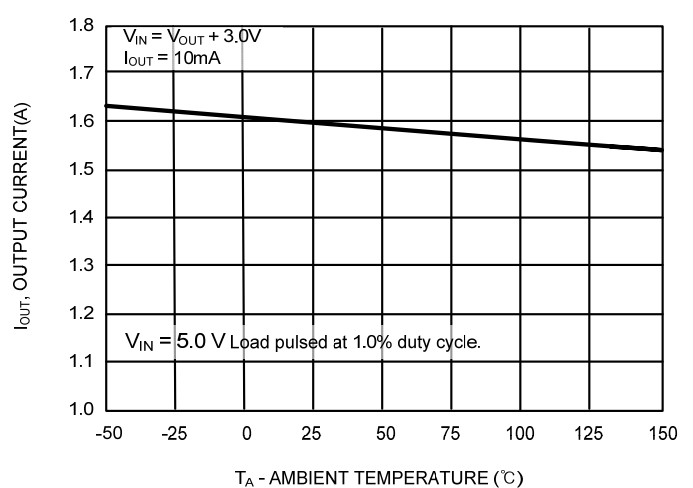
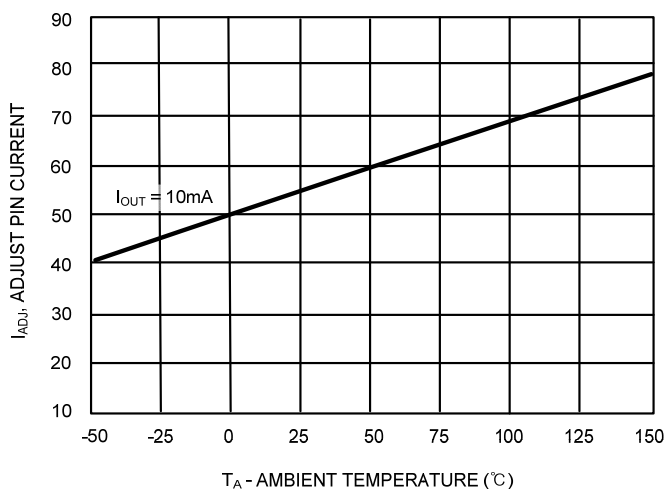
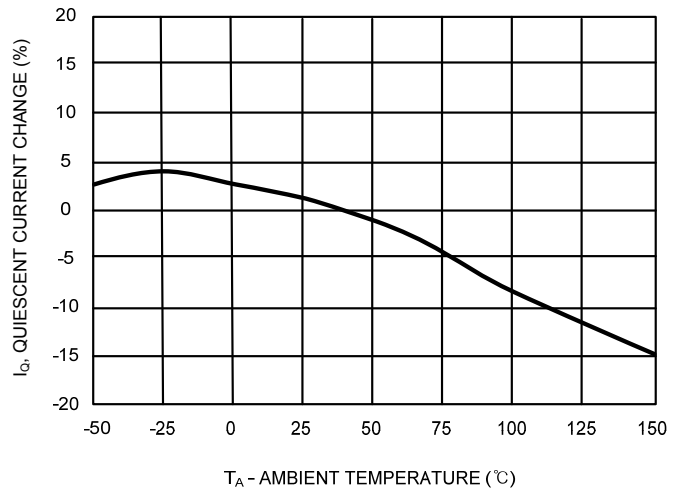
**Fig.4 Active Terminator for SCSI-2BUS**



**Fig.5 Voltage Regulator with Reference**



**Fig.6 Battery Backed-up Regulated Supply**

**TYPICAL OPERATING CHARACTERISTICS**

**Fig.7 OUTPUT VOLTAGE CHANGE VS TEMPERATURE**

**Fig.8 DROPOUT VOLTAGE VS OUTPUT CURRENT**

**Fig.9 OUTPUT SHORT CIRCUIT CURRENT VS DIFFERENTIAL VOLTAGE**

**Fig.10 OUTPUT SHORT CIRCUIT CURRENT VS TEMPERATURE**

**Fig.11 ADJ PIN CURRENT VS TEMPERATURE**

**Fig.12 QUIESCENT CURRENT CHANGE VS TEMPERATURE**

## APPLICATION INFORMATION

### Maximum Output Current Capability

The LM1117 can deliver a continuous current of 1A over the full operating junction temperature range. However, the output current is limited by the restriction of power dissipation which differs from packages. A heat sink may be required depending on the maximum power dissipation and maximum ambient temperature of application. With respect to the applied package, the maximum output current of 1A may be still undeliverable due to the restriction of the power dissipation of LM1117. Under all possible conditions, the junction temperature must be within the range specified under operating conditions. The temperatures over the device are given by:

$$T_C = T_A + P_D \times \theta_{CA} / \quad T_J = T_C + P_D \times \theta_{JC} / \quad T_J = T_A + P_D \times \theta_{JA}$$

where  $T_J$  is the junction temperature,  $T_C$  is the case temperature,  $T_A$  is the ambient temperature,  $P_D$  is the total power dissipation of the device,  $\theta_{CA}$  is the thermal resistance of case-to-ambient,  $\theta_{JC}$  is the thermal resistance of junction-to-case, and  $\theta_{JA}$  is the thermal resistance of junction to ambient. The total power dissipation of the device is given by:

$$P_D = P_{IN} - P_{OUT} = (V_{IN} \times I_{IN}) - (V_{OUT} \times I_{OUT}) \\ = (V_{IN} \times (I_{OUT} + I_{GND})) - (V_{OUT} \times I_{OUT}) = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND}$$

where  $I_{GND}$  is the operating ground current of the device which is specified at the Electrical Characteristics. The maximum allowable temperature rise ( $T_{Rmax}$ ) depends on the maximum ambient temperature ( $T_{Amax}$ ) of the application, and the maximum allowable junction temperature ( $T_{Jmax}$ ):

$$T_{Rmax} = T_{Jmax} - T_{Amax}$$

The maximum allowable value for junction-to-ambient thermal resistance,  $\theta_{JA}$ , can be calculated using the formula:

$$\theta_{JA} = T_{Rmax} / P_D = (T_{Jmax} - T_{Amax}) / P_D$$

LM1117 is available in SOT223, TO252 and SOT89 packages. The thermal resistance depends on amount of copper area or heat sink, and on air flow. If the maximum allowable value of  $\theta_{JA}$  calculated above is over 137°C/W for SOT-223 package, over 105 °C/W for TO252 package, over 315 °C/W for SOT-89 package, no heat sink is needed since the package can dissipate enough heat to satisfy these requirements. If the value for allowable  $\theta_{JA}$  falls near or below these limits, a heat sink or proper area of copper plane is required. In summary, the absolute maximum ratings of thermal resistances are as follow:

### Absolute Maximum Ratings of Thermal Resistance

Characteristic	Symbol	Rating	Unit
Thermal Resistance Junction-To-Ambient / SOT-223	$\theta_{JA-SOT-223}$	137	°C/W
Thermal Resistance Junction-To-Ambient / TO-252	$\theta_{JA-TO-252}$	105	°C/W
Thermal Resistance Junction-To-Ambient / SOT-89	$\theta_{JA-SOT-89}$	315	°C/W

No heat sink / No air flow / No adjacent heat source / 0.066 inch<sup>2</sup> copper area. ( $T_A=25^\circ\text{C}$ )