

# 1A L.D.O. VOLTAGE REGULATOR

# LM1117S/RS/F

## 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 Regulaion typically at 0.1% max
- Load Regulaion typically at 0.2% max
- Internal Current and Terminal Protection
- Maximum Input Voltage – 15V
- Surface Mount Package SOT–223, TO–252, SOT–89
- 100% Thermal Limit Burn-In

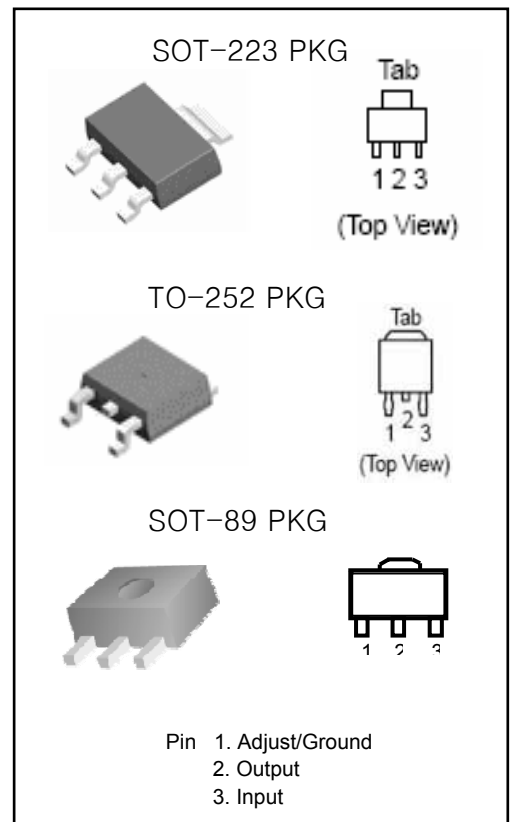
## APPLICATION

- 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 1.5V, 1.8V, 2.5V, 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.



## ORDERING INFORMATION

Device (Marking)	Package
LM1117S-ADJ	SOT-223
LM1117S-XX	
LM1117RS-ADJ	TO-252
LM1117RS-XX	
LM1117F-ADJ	SOT-89
LM1117F-XX	

( X.X=Output Voltage=1.2V,1.5V, 1.8V, 2.5V, '3.3V, 5.0V, Adjustable=ADJ)

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## ABSOLUTE MAXIMUM RATINGS

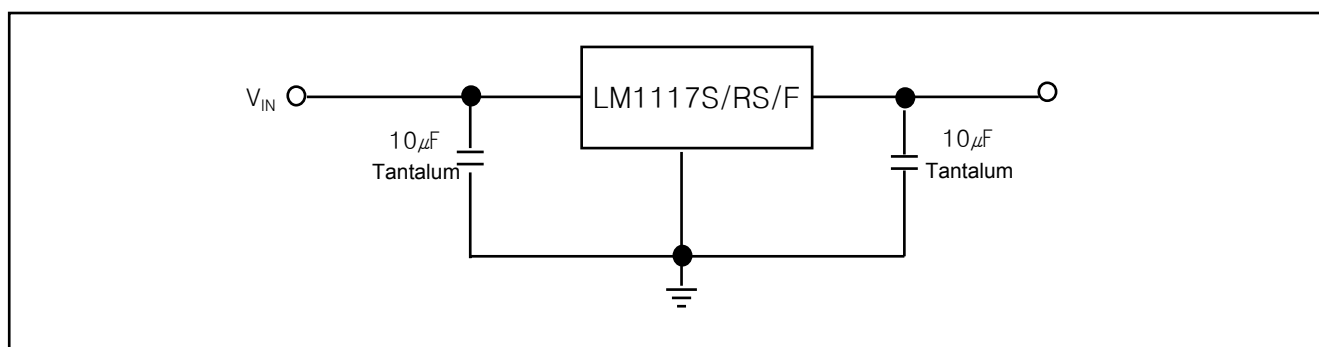
CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
DC Input Voltage	$V_{IN}$		15	V
Lead Temperature (Soldering, 5 Seconds)	$T_{SOL}$		260	°C
Storage Temperature Range	$T_{STG}$	-65	150	°C
Operating Junction Temperature Range	$T_{OPR}$	-40	125	°C

## THERMAL DATA

PARAMETER	SYMBOL	SOT-223	TO-252	SOT-89	UNIT
Thermal Resistance Junction-Ambient	$R_{\theta JA}$	130	93	315	°C/W

## TYPICAL APPLICATION

### FIXED OUTPUT VOLTAGE



# 1A L.D.O. VOLTAGE REGULATOR

# LM1117S/RS/F

## ELECTRICAL CHARACTERISTICS FOR LM1117S/RS/F-ADJ(ADJUSTABLE)

(Refer to the test circuits,  $T_J=25^\circ\text{C}$   $C_O=10\mu\text{F}$  unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Reference Voltage	$V_{REF}$	$I_O = 10\text{mA}$ to 1A, $V_{IN} - V_O = 1.5$ to 13.75V	1.238	1.25	1.262	V
Reference Voltage ( $T_J=0\sim 125^\circ\text{C}$ )	$V_{REF}$	$I_O = 10\text{mA}$ to 1A, $V_{IN} - V_O = 1.5$ to 13.75V	1.219		1.281	V
Line Regulation	$\Delta V_O$	$I_O = 10\text{mA}$ , $V_{IN} - V_O = 1.5$ to 13.75V		0.1	0.2	%
Load Regulation	$\Delta V_O$	$I_O = 10\text{mA}$ to 1A, $V_{IN} - V_O = 2\text{V}$		0.2	0.4	%
Temperature Stability	$\Delta V_O$			0.5		%
Long Term Stability	$\Delta V_O$	1000 hrs, $T_J = 125^\circ\text{C}$		0.3		%
Operating Input Voltage	$V_{IN}$				15	V
Adjustment Pin Current	$I_{ADJ}$	$V_{IN} - V_O = 1.5$ to 12V $I_O = 100\text{mA}$		50	120	$\mu\text{A}$
Adjustment Pin Current Change	$\Delta I_{ADJ}$	$V_{IN} - V_O = 1.5$ to 12V, $I_O = 10\text{mA}$ to 1A		0.5	5	$\mu\text{A}$
Minimum Load Current	$I_{O(MIN)}$	$V_{IN} - V_O = 12\text{V}$		5	10	mA
Current Limit	$I_O$	$V_{IN} - V_O = 5\text{V}$	1000	1250	1600	mA
Output Noise (% $V_O$ )	$\epsilon_N$	$B = 10\text{Hz}$ to 10kHz, $T_J = 25^\circ\text{C}$		0.003		%
Supply Voltage Rejection	SVR	$I_O = 40\text{mA}$ , $f = 120\text{Hz}$ , $T_J = 25^\circ\text{C}$ $V_{IN} - V_O = 3\text{V}$ , $V_{NIPPLE} = 1V_{PP}$	60	75		dB
Dropout Voltage	$V_D$	$I_O = 100\text{mA}$		1.0	1.1	V
		$I_O = 500\text{mA}$		1.1	1.2	V
		$I_O = 1\text{A}$		1.2	1.3	V
Thermal Regulation		$T_A = 25^\circ\text{C}$ 30ms Pulse		0.003		%/W

## ELECTRICAL CHARACTERISTICS FOR LM1117S/RS/F-1.2V

(Refer to the test circuits,  $T_J=25^\circ\text{C}$   $C_O=10\mu\text{F}$  unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	$V_O$	$V_{IN} = 3.2$ $I_O = 0\text{mA}$ to 1A	1.176	1.20	1.224	V
Output Voltage	$V_O$	$V_{IN}=2.5$ to 12V, $I_O=0\text{mA}$ to 1A ( $T_J = 0\sim 125^\circ\text{C}$ )	1.152		1.248	V
Line Regulation	$\Delta V_O$	$I_O = 10\text{mA}$ , $V_{IN} - V_O = 1.5$ to 13.75V		0.1	0.2	%
Load Regulation	$\Delta V_O$	$I_O = 10\text{mA}$ to 1A, $V_{IN} - V_O = 2\text{V}$		0.2	0.4	%
Temperature Stability	$\Delta V_O$			0.5		%
Long Term Stability	$\Delta V_O$	1000 hrs, $T_J = 125^\circ\text{C}$		0.3		%
Operating Input Voltage	$V_{IN}$				15	V
Quiescent Current	$I_D$	$V_{IN} - V_O = 5\text{V}$		5	10	mA
Current Limit	$I_O$	$V_{IN} - V_O = 5\text{V}$	1000	1250	1600	mA
Output Noise (% $V_O$ )	$\epsilon_N$	$B = 10\text{Hz}$ to 10kHz, $T_J = 25^\circ\text{C}$		0.003		%
Supply Voltage Rejection	SVR	$I_O = 40\text{mA}$ , $f = 120\text{Hz}$ , $T_J = 25^\circ\text{C}$ $V_{IN} - V_O = 3\text{V}$ , $V_{NIPPLE} = 1V_{PP}$	60	75		dB
Dropout Voltage	$V_D$	$I_O = 100\text{mA}$		1.0	1.1	V
		$I_O = 500\text{mA}$		1.1	1.2	V
		$I_O = 1\text{A}$		1.2	1.3	V
Thermal Regulation		$T_A = 25^\circ\text{C}$ 30ms Pulse		0.003		%/W

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## ELECTRICAL CHARACTERISTICS FOR LM1117 S/RS/F-1.5

(Refer to the test circuits,  $T_J=25^\circ\text{C}$   $C_O=10\mu\text{F}$  unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	$V_O$	$V_{IN} = 3.0$ to $12\text{V}$ , $I_O = 0\text{mA}$ to $1\text{A}$	1.485	1.5	1.515	V
Output Voltage	$V_O$	$V_{IN}=3.0$ to $12\text{V}$ , $I_O=0\text{mA}$ to $1\text{A}$ ( $T_J = 0\sim 125^\circ\text{C}$ )	1.470		1.530	V
Line Regulation	$\Delta V_O$	$V_{IN} = 3.0$ to $12\text{V}$ , $I_O = 0\text{mA}$		0.1	0.2	%
Load Regulation	$\Delta V_O$	$V_{IN} = 3.5\text{V}$ , $I_O = 0$ to $1\text{A}$		0.2	0.4	%
Temperature Stability	$\Delta V_O$			0.5		%
Long Term Stability	$\Delta V_O$	1000 hrs, $T_J = 125^\circ\text{C}$		0.3		%
Operating Input Voltage	$V_{IN}$	$I_O = 100\text{mA}$			12	V
Quiescent Current	$I_D$	$V_{IN}-V_O = 5\text{V}$		5	10	mA
Current Limit	$I_O$	$V_{IN}-V_O = 5\text{V}$	1000	1250	1600	mA
Output Noise Voltage	$e_N$	$B = 10\text{Hz}$ to $10\text{kHz}$ , $T_J = 25^\circ\text{C}$		100		$\mu\text{V}$
Supply Voltage Rejection	SVR	$I_O = 40\text{mA}$ , $f = 120\text{Hz}$ , $T_J = 25^\circ\text{C}$ $V_{IN} = 5.5\text{V}$ , $V_{NIPPLE} = 1V_{PP}$	60	75		dB
Dropout Voltage	$V_D$	$I_O = 100\text{mA}$		1.0	1.1	V
		$I_O = 500\text{mA}$		1.1	1.2	V
		$I_O = 1\text{A}$		1.2	1.3	V
Thermal Regulation		$T_A = 25^\circ\text{C}$ 30ms Pulse		0.003		%/W

## ELECTRICAL CHARACTERISTICS FOR LM1117 S/RS/F-1.8

(Refer to the test circuits,  $T_J=25^\circ\text{C}$   $C_O=10\mu\text{F}$  unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	$V_O$	$V_{IN} = 3.3$ to $12\text{V}$ , $I_O = 0\text{mA}$ to $1\text{A}$	1.782	1.8	1.818	V
Output Voltage	$V_O$	$V_{IN}=3.3$ to $12\text{V}$ , $I_O=0\text{mA}$ to $1\text{A}$ ( $T_J = 0\sim 125^\circ\text{C}$ )	1.764		1.836	V
Line Regulation	$\Delta V_O$	$V_{IN} = 3.3$ to $12\text{V}$ , $I_O = 10\text{mA}$		0.1	0.2	mV
Load Regulation	$\Delta V_O$	$V_{IN} = 3.8\text{V}$ , $I_O = 0$ to $1\text{A}$		0.2	0.4	mV
Temperature Stability	$\Delta V_O$			0.5		%
Long Term Stability	$\Delta V_O$	1000 hrs, $T_J = 125^\circ\text{C}$		0.3		%
Operating Input Voltage	$V_{IN}$	$I_O = 100\text{mA}$			12	V
Quiescent Current	$I_D$	$V_{IN}-V_O = 5\text{V}$		5	10	mA
Current Limit	$I_O$	$V_{IN}-V_O = 5\text{V}$	1000	1250	1600	mA
Output Noise Voltage	$e_N$	$B = 10\text{Hz}$ to $10\text{kHz}$ , $T_J = 25^\circ\text{C}$		100		$\mu\text{V}$
Supply Voltage Rejection	SVR	$I_O = 40\text{mA}$ , $f = 120\text{Hz}$ , $T_J = 25^\circ\text{C}$ $V_{IN} = 5.5\text{V}$ , $V_{NIPPLE} = 1V_{PP}$	60	75		dB
Dropout Voltage	$V_D$	$I_O = 100\text{mA}$		1.0	1.1	V
		$I_O = 500\text{mA}$		1.1	1.2	V
		$I_O = 1\text{A}$		1.2	1.3	V
Thermal Regulation		$T_A = 25^\circ\text{C}$ 30ms Pulse		0.003		%/W

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## ELECTRICAL CHARACTERISTICS FOR LM1117 S/RS/F-2.5

(Refer to the test circuits,  $T_J=25^\circ\text{C}$   $C_O=10\mu\text{F}$  unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	$V_O$	$V_{IN} = 4.0$ to $12\text{V}$ , $I_O = 0\text{mA}$ to $1\text{A}$	2.475	2.5	2.525	V
Output Voltage	$V_O$	$V_{IN}=4.0$ to $12\text{V}$ , $I_O=0\text{mA}$ to $1\text{A}$ ( $T_J = 0\sim 125^\circ\text{C}$ )	2.450		2.550	V
Line Regulation	$\Delta V_O$	$V_{IN} = 4.0$ to $12\text{V}$ , $I_O = 10\text{mA}$		0.1	0.2	%
Load Regulation	$\Delta V_O$	$V_{IN} = 4.5\text{V}$ , $I_O = 0$ to $1\text{A}$		0.2	0.4	%
Temperature Stability	$\Delta V_O$			0.5		%
Long Term Stability	$\Delta V_O$	1000 hrs, $T_J = 125^\circ\text{C}$		0.3		%
Operating Input Voltage	$V_{IN}$	$I_O = 100\text{mA}$			12	V
Quiescent Current	$I_D$	$V_{IN}-V_O = 5\text{V}$		5	10	mA
Current Limit	$I_O$	$V_{IN}-V_O = 5\text{V}$	1000	1250	1600	mA
Output Noise Voltage	$e_N$	$B = 10\text{Hz}$ to $10\text{kHz}$ , $T_J = 25^\circ\text{C}$		100		$\mu\text{V}$
Supply Voltage Rejection	SVR	$I_O = 40\text{mA}$ , $f = 120\text{Hz}$ , $T_J = 25^\circ\text{C}$ $V_{IN} = 5.5\text{V}$ , $V_{NIPPLE} = 1\text{V}_{PP}$	60	75		dB
Dropout Voltage	$V_D$	$I_O = 100\text{mA}$		1.0	1.1	V
		$I_O = 500\text{mA}$		1.1	1.2	V
		$I_O = 1\text{A}$		1.2	1.3	V
Thermal Regulation		$T_A = 25^\circ\text{C}$ 30ms Pulse		0.01	0.1	%/W

## ELECTRICAL CHARACTERISTICS FOR LM1117 S/RS/F-2.85

(Refer to the test circuits,  $T_J=25^\circ\text{C}$   $C_O=10\mu\text{F}$  unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	$V_O$	$V_{IN} = 4.4$ to $12\text{V}$ , $I_O = 0\text{mA}$ to $1\text{A}$	2.821	2.85	2.878	V
Output Voltage	$V_O$	$V_{IN}=4.4$ to $12\text{V}$ , $I_O=0\text{mA}$ to $1\text{A}$ ( $T_J = 0\sim 125^\circ\text{C}$ )	2.793		2.907	V
Line Regulation	$\Delta V_O$	$V_{IN} = 4.4$ to $12\text{V}$ , $I_O = 10\text{mA}$		0.1	0.2	%
Load Regulation	$\Delta V_O$	$V_{IN} = 4.85\text{V}$ , $I_O = 0$ to $1\text{A}$		0.2	0.4	%
Temperature Stability	$\Delta V_O$			0.5		%
Long Term Stability	$\Delta V_O$	1000 hrs, $T_J = 125^\circ\text{C}$		0.3		%
Operating Input Voltage	$V_{IN}$	$I_O = 100\text{mA}$			12	V
Quiescent Current	$I_D$	$V_{IN}-V_O = 5\text{V}$		5	10	mA
Current Limit	$I_O$	$V_{IN}-V_O = 5\text{V}$	1000	1250	1600	mA
Output Noise Voltage	$e_N$	$B = 10\text{Hz}$ to $10\text{kHz}$ , $T_J = 25^\circ\text{C}$		100		$\mu\text{V}$
Supply Voltage Rejection	SVR	$I_O = 40\text{mA}$ , $f = 120\text{Hz}$ , $T_J = 25^\circ\text{C}$ $V_{IN} = 5.85\text{V}$ , $V_{NIPPLE} = 1\text{V}_{PP}$	60	75		dB
Dropout Voltage	$V_D$	$I_O = 100\text{mA}$		1.0	1.1	V
		$I_O = 500\text{mA}$		1.1	1.2	V
		$I_O = 1\text{A}$		1.2	1.3	V
Thermal Regulation		$T_A = 25^\circ\text{C}$ 30ms Pulse		0.003		%/W

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# LM1117S/RS/F

## ELECTRICAL CHARACTERISTICS FOR LM1117 S/RS/F-3.3

(Refer to the test circuits,  $T_J=25^\circ\text{C}$   $C_O=10\mu\text{F}$  unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	$V_O$	$V_{IN} = 4.8$ to $12\text{V}$ , $I_O = 0\text{mA}$ to $1\text{A}$	3.267	3.3	3.333	V
Output Voltage	$V_O$	$V_{IN}=4.8$ to $12\text{V}$ , $I_O=0\text{mA}$ to $1\text{A}$ ( $T_J = 0\sim 125^\circ\text{C}$ )	3.234		3.366	V
Line Regulation	$\Delta V_O$	$V_{IN} = 4.8$ to $12\text{V}$ , $I_O = 10\text{mA}$		0.1	0.2	%
Load Regulation	$\Delta V_O$	$V_{IN} = 5.3\text{V}$ , $I_O = 0$ to $1\text{A}$		0.2	0.4	%
Temperature Stability	$\Delta V_O$			0.5		%
Long Term Stability	$\Delta V_O$	1000 hrs, $T_J = 125^\circ\text{C}$		0.3		%
Operating Input Voltage	$V_{IN}$	$I_O = 100\text{mA}$			12	V
Quiescent Current	$I_D$	$V_{IN} - V_O = 5\text{V}$		5	10	mA
Current Limit	$I_O$	$V_{IN} - V_O = 5\text{V}$	1000	1250	1600	mA
Output Noise Voltage	$e_N$	$B = 10\text{Hz}$ to $10\text{kHz}$ , $T_J = 25^\circ\text{C}$		100		$\mu\text{V}$
Supply Voltage Rejection	SVR	$I_O = 40\text{mA}$ , $f = 120\text{Hz}$ , $T_J = 25^\circ\text{C}$ $V_{IN} = 6.3\text{V}$ , $V_{NIPPLE} = 1\text{V}_{PP}$	60	75		dB
Dropout Voltage	$V_D$	$I_O = 100\text{mA}$		1.0	1.1	V
		$I_O = 500\text{mA}$		1.1	1.2	V
		$I_O = 1\text{A}$		1.2	1.3	V
Thermal Regulation		$T_A = 25^\circ\text{C}$ 30ms Pulse		0.003		%/W

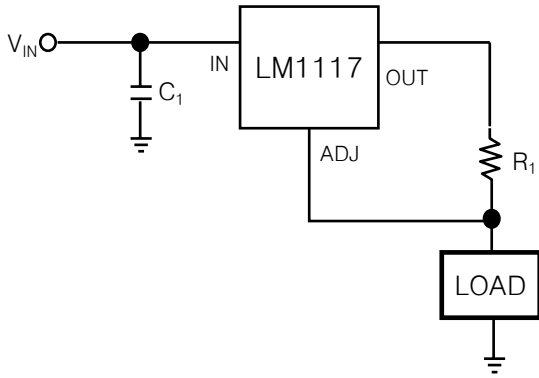
## ELECTRICAL CHARACTERISTICS FOR LM1117 S/RS/F-5.0

(Refer to the test circuits,  $T_J=25^\circ\text{C}$   $C_O=10\mu\text{F}$  unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	$V_O$	$V_{IN} = 6.5$ to $15\text{V}$ , $I_O = 0\text{mA}$ to $1\text{A}$	4.950	5.0	5.050	V
Output Voltage	$V_O$	$V_{IN}=6.5$ to $15\text{V}$ , $I_O=0\text{mA}$ to $1\text{A}$ ( $T_J = 0\sim 125^\circ\text{C}$ )	4.900		5.100	V
Line Regulation	$\Delta V_O$	$V_{IN} = 6.5$ to $15\text{V}$ , $I_O = 10\text{mA}$		0.1	0.2	%
Load Regulation	$\Delta V_O$	$V_{IN} = 7.0\text{V}$ , $I_O = 0$ to $1\text{A}$		0.2	0.4	%
Temperature Stability	$\Delta V_O$			0.5		%
Long Term Stability	$\Delta V_O$	1000 hrs, $T_J = 125^\circ\text{C}$		0.3		%
Operating Input Voltage	$V_{IN}$	$I_O = 100\text{mA}$			15	V
Quiescent Current	$I_D$	$V_{IN} - V_O = 5\text{V}$		5	10	mA
Current Limit	$I_O$	$V_{IN} - V_O = 5\text{V}$	1000	1250	1600	mA
Output Noise Voltage	$e_N$	$B = 10\text{Hz}$ to $10\text{kHz}$ , $T_J = 25^\circ\text{C}$		100		$\mu\text{V}$
Supply Voltage Rejection	SVR	$I_O = 40\text{mA}$ , $f = 120\text{Hz}$ , $T_J = 25^\circ\text{C}$ $V_{IN} = 6.3\text{V}$ , $V_{NIPPLE} = 1\text{V}_{PP}$	60	75		dB
Dropout Voltage	$V_D$	$I_O = 100\text{mA}$		1.0	1.1	V
		$I_O = 500\text{mA}$		1.1	1.2	V
		$I_O = 1\text{A}$		1.2	1.3	V
Thermal Regulation		$T_A = 25^\circ\text{C}$ 30ms Pulse		0.003		%/W

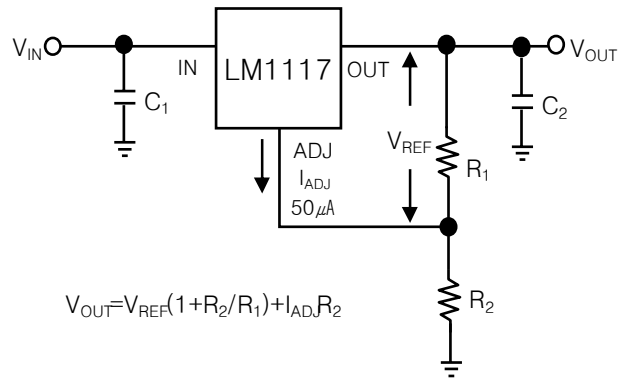
APPLICATION CIRCUITS

Figure 1.



1A Current Output

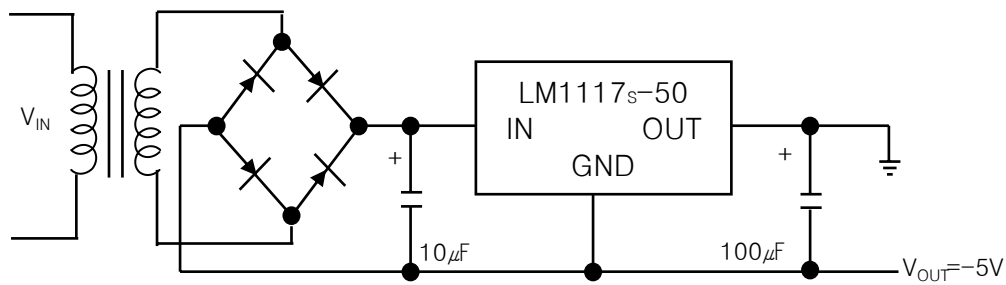
Figure 2.



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

Typical Adjustable Regulator

Figure 3. Negative Supply



FLOATING INPUT

Figure 4. Active Terminator for SCSI-2 BUS

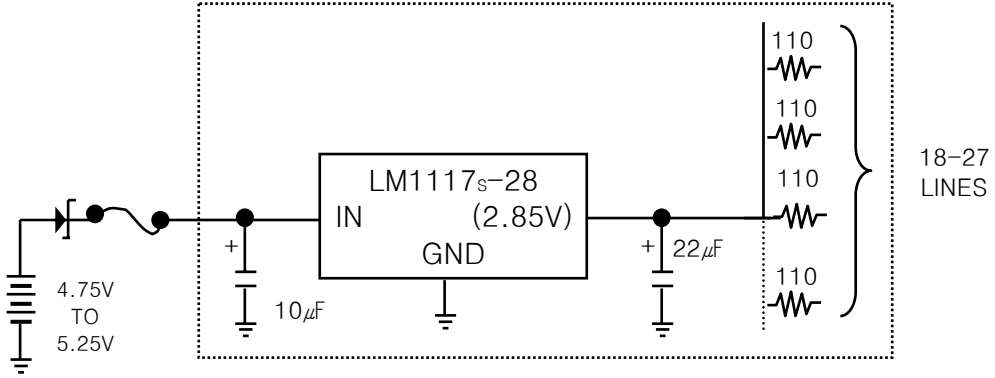


Figure 5. Voltage Regulator With Reference

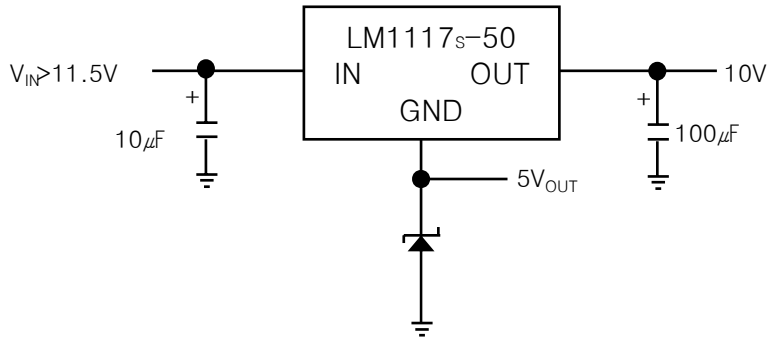
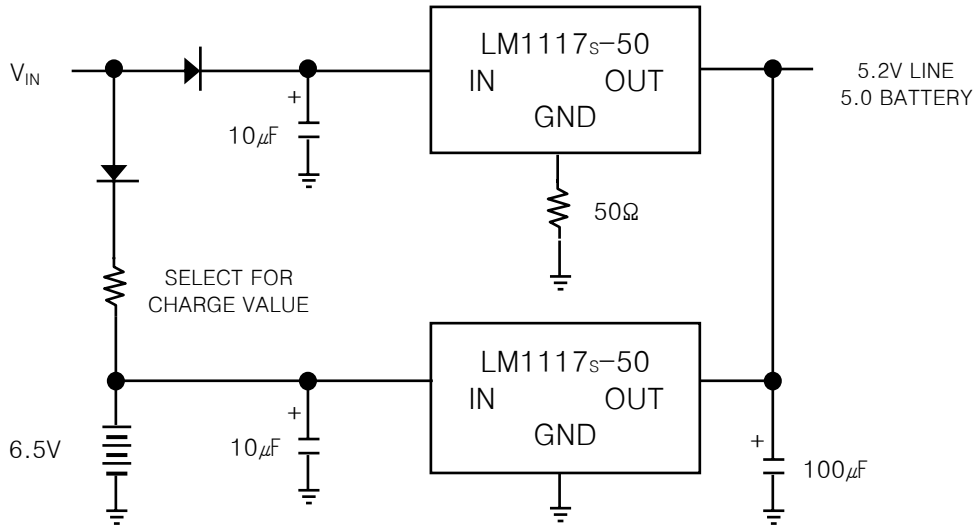




Figure 6. Battery Backed-up Regulated Supply



\* NOTES : IF ANYTHING WILL BE CHANGED FOR THIS SPECIFICATION,  
TAEJIN TECHNOLOGY MUST INFORM PCC BEFORE THE CHANGE

## Typical Performance Characteristics

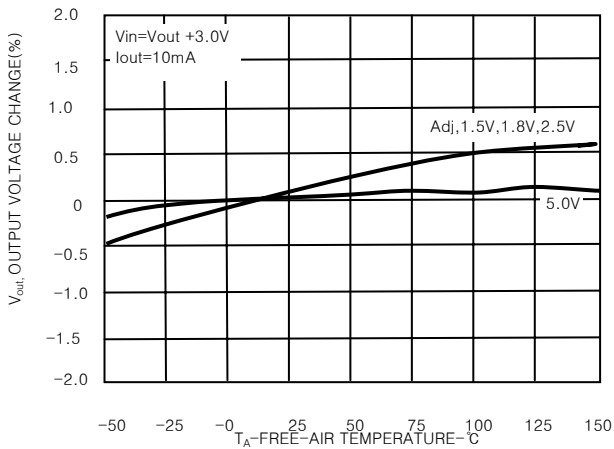


FIG 1. OUTPUT VOLTAGE CHANGE vs TEMPERATURE (°C)

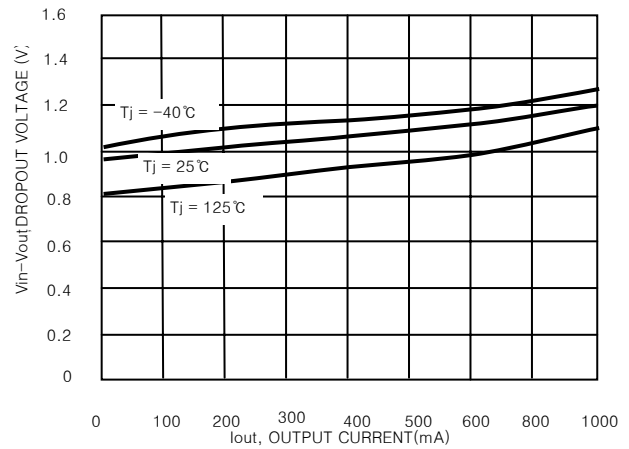


FIG 2. DROPOUT VOLTAGE vs OUTPUT CURRENT

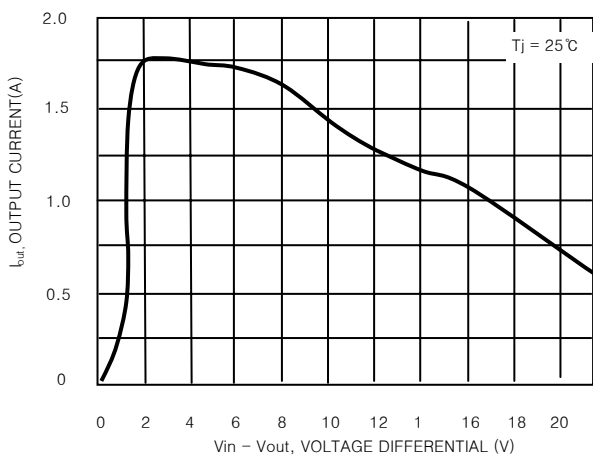


FIG 3. OUTPUT SHORT CIRCUIT CURRENT vs DIFFERENTIAL VOLTAGE

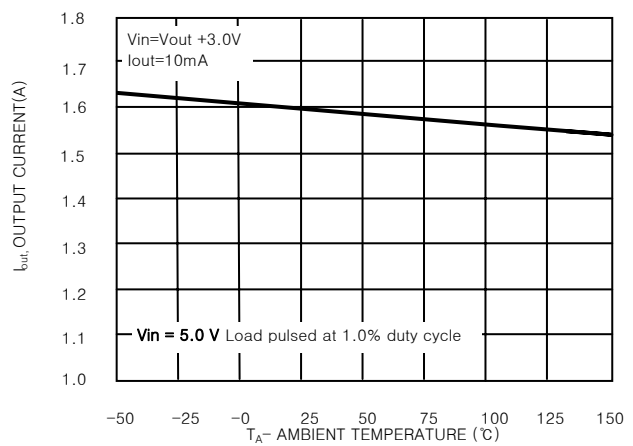


FIG 4. OUTPUT SHORT CIRCUIT CURRENT vs TEMPERATURE

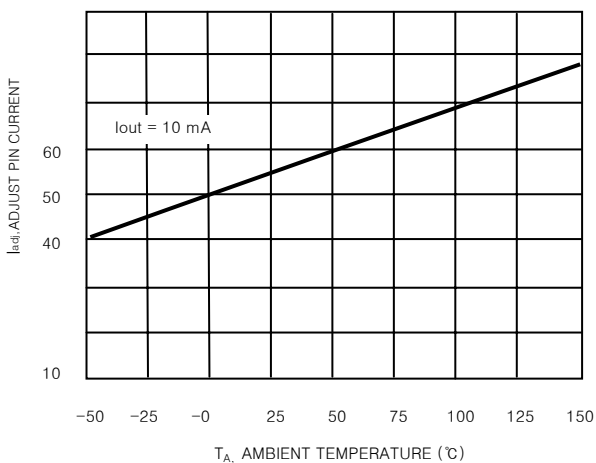


FIG 5. ADJ PIN CURRENT vs TEMPERATURE (°C)

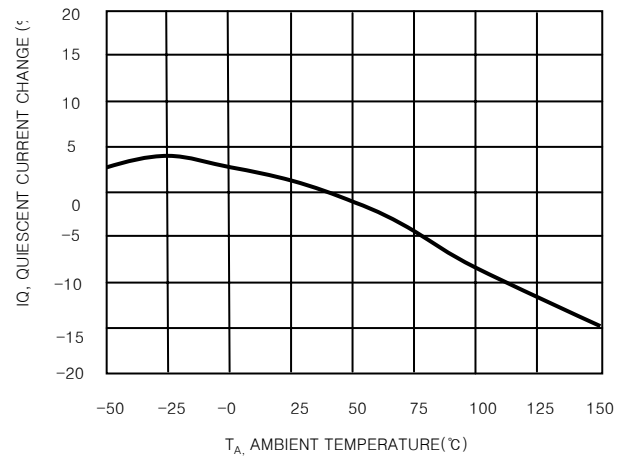


FIG 6. QUIESCENT CURRENT CHANGE vs TEMPERATURE (°C)

## Maximum Output Current Capability

The LM1117 can deliver a continuous current of 1A over the full operating junction temperature range. However, the 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:

$$T_C = T_A + P_D \times \theta_{CA}$$

$$T_J = T_C + P_D \times \theta_{JC}$$

$$T_J = T_A + P_D \times \theta_{JA}$$

$T_J$  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:

$$\theta_{JA} = T_{Rmax} / P_D$$

LM1117 is available in SOT223, TO252 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 130°C/W for SO-223 package, over 93°C/W for TO252 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 follows:

### Absolute Maximum Ratings of Thermal Resistance

Characteristic	Symbol	Max. Rating	Unit
Thermal Resistance Junction-To-Ambient / SOT223	$\theta_{JA-SOT223}$	130	°C/W
Thermal Resistance Junction-To-Ambient / TO252	$\theta_{JA-TO252}$	93	°C/W
Thermal Resistance Junction-To-Ambient / SOT89	$\theta_{JA-SOT89}$	315	°C/W

No heat sink / No air flow / No adjacent heat source / 0.066 inch<sup>2</sup> copper area