

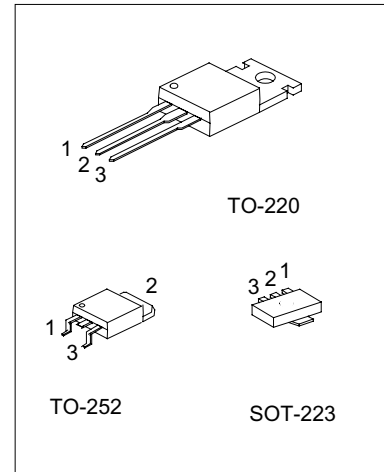
LOW DROP FIXED AND ADJUSTABLE POSITIVE VOLTAGE REGULATORS

DESCRIPTION

The LRC LR1117/A is a LOW DROP Voltage Regulator able to provide up to 0.8/1.0A of Output Current, available even in adjustable version ($V_{ref}=1.25V$). Concerning fixed versions, are offered the following Output Voltages: 1.5V, 1.8V, 2.5V, 2.85V, 3.0V, 3.3V, 3.6V and 5.0V. The 2.85V type is ideal for SCSI-2 lines active termination. High efficiency is assured by NPN pass transistor. In fact in the case, unlike than PNP one, the Quiescent Current flows mostly into the for stability. On chip trimming allows the regulator to reach a very tight output voltage tolerance, within $\pm 1\%$ at $25^{\circ}C$. The ADJUSTABLE LR1117/A is pin to pin compatible with the other standard Adjustable voltage regulators maintaining the better performances in terms of Drop and Tolerance.

FEATURES

- *Low dropout voltage (1V Typ.)
- *2.85V device performances are suitable for SCSI-2 active termination
- *Output current up to 0.8/1.0A
- *Fixed output voltage of: 1.5V, 1.8V, 2.5V, 2.85V, 3.0V, 3.3V, 3.6V, 5.0V
- *Adjustable version availability ($V_{ref}=1.25V$)
- *Internal current and thermal limit
- *Available in $\pm 1\%$ (at $25^{\circ}C$) and 2% in all temperature range
- *Supply voltage rejection: 75dB (TYP)
- *Temperature range: $0^{\circ}C$ to $125^{\circ}C$



1: GND 2: Output 3: Input

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
DC Input Voltage	V_{IN}	15	V
Power Dissipation	P_{tot}	12	W
Storage temperature	T_{stg}	-65 ~ +150	$^{\circ}C$
Operating Junction Temperature	T_{op}	0 ~ +125	$^{\circ}C$
Thermal Resistance Junction ambien	$R_{thj-amb}$	50	$^{\circ}C/W$

Note: Absolute Maximum Ratings are those value beyond which damage to the device may occur. Functional operation under there condition is not implied. Over the above suggested Max Power Dissipation a Short Circuit could definitively damage the device.

LR1117/A-1.5 ELECTRICAL CHARACTERISTICS

 (refer to the test circuits, $T_j=0$ to 125°C , $C_o=10\mu\text{F}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Output Voltage	V_o	$V_{in}=3.5\text{V}$, $I_o=10\text{mA}$, $T_j=25^\circ\text{C}$	1.485	1.500	1.515	VV
Output Voltage	V_o	$I_o=0$ to $800/1000\text{mA}$, $V_{in}=3$ to 8V	1.470	1.500	1.530	V
Line Regulation	ΔV_o	$V_{in}=3$ to 8V , $I_o=0\text{mA}$		1	6	mV
Load Regulation	ΔV_o	$V_{in}=3\text{V}$, $I_o=0$ to $800/1000\text{mA}$		1	10	mV
Temperature stability	ΔV_o			0.5		%
Long Term Stability	ΔV_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	$V_{in}\leq 10\text{V}$		5	10	mA
Output Current	I_o	$V_{in}=6.5\text{V}$, $T_j=25^\circ\text{C}$	800	950	1200	mA
Output Noise Voltage	eN	$B=10\text{Hz}$ to 10KHz , $T_j=25^\circ\text{C}$		100		μV
Supply Voltage Rejection	SVR	$I_o=40\text{mA}$, $f=120\text{Hz}$, $T_j=25^\circ\text{C}$, $V_{in}=4.5\text{V}$, $V_{ripple}=1\text{Vpp}$	60	75		dB
Dropout Voltage	V_d	$I_o=100\text{mA}$		1.00	1.10	V
		$I_o=500\text{mA}$		1.05	1.15	V
		$I_o=800\text{mA}$		1.10	1.20	V
		$I_o=1000\text{mA}$		1.15	1.25	V
Thermal Regulation		$T_a=25^\circ\text{C}$, 30ms Pulse		0.01	0.10	%/W

LR1117/A-1.8 ELECTRICAL CHARACTERISTICS

 (refer to the test circuits, $T_j=0$ to 125°C , $C_o=10\mu\text{F}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Output Voltage	V_o	$V_{in}=3.8\text{V}$, $I_o=10\text{mA}$, $T_j=25^\circ\text{C}$	1.780	1.800	1.820	V
Output Voltage	V_o	$I_o=0$ to $800/1000\text{mA}$, $V_{in}=3.3$ to 8V	1.760		1.840	V
Line Regulation	ΔV_o	$V_{in}=3.3$ to 8V , $I_o=0\text{mA}$		1	6	mV
Load Regulation	ΔV_o	$V_{in}=3.3\text{V}$, $I_o=0$ to $800/1000\text{mA}$		1	10	mV
Temperature stability	ΔV_o			0.5		%
Long Term Stability	ΔV_o	1000 hrs, $T_j=125^\circ\text{C}$		0.3		%
Operating Input Voltage	V_{in}	$I_o=100\text{mA}$			10	V
Quiescent Current	I_d	$V_{in}\leq 8\text{V}$		5	10	mA
Output Current	I_o	$V_{in}=6.8\text{V}$, $T_j=25^\circ\text{C}$	800	950	1200	mA
Output Noise Voltage	eN	$B=10\text{Hz}$ to 10KHz , $T_j=25^\circ\text{C}$		100		μV
Supply Voltage Rejection	SVR	$I_o=40\text{mA}$, $f=120\text{Hz}$, $T_j=25^\circ\text{C}$, $V_{in}=5.5\text{V}$, $V_{ripple}=1\text{Vpp}$	60	75		dB
Dropout Voltage	V_d	$I_o=100\text{mA}$		1.00	1.10	V
		$I_o=500\text{mA}$		1.05	1.15	V
		$I_o=800\text{mA}$		1.10	1.20	V
		$I_o=1000\text{mA}$		1.15	1.25	V
Thermal Regulation		$T_a=25^\circ\text{C}$, 30ms Pulse		0.01	0.10	%/W

LR1117/A-2.5 ELECTRICAL CHARACTERISTICS

(refer to the test circuits, Tj=0 to 125°C, Co=10μF unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT	
Output Voltage	Vo	Vin=4.5V, Io=10mA, Tj=25°C	±1%	2.475	2.500	2.525	V
			±2%	2.450	2.500	2.550	V
Output Voltage	Vo	Io=0 to 800/1000mA, Vin=3.9 to 10V	±2%	2.450		2.550	V
			±4%	2.400		2.600	V
Line Regulation	ΔVo	Vin=3.9 to 10V, Io=0mA		1	6	mV	
Load Regulation	ΔVo	Vin=3.9V, Io=0 to 800/1000mA		1	10	mV	
Temperature stability	ΔVo			0.5		%	
Long Term Stability	ΔVo	1000 hrs, Tj=125°C		0.3		%	
Operating Input Voltage	Vin	Io=100mA			15	V	
Quiescent Current	Id	Vin≤10V		5	10	mA	
Output Current	Io	Vin=7.5V, Tj=25°C	800	950	1200	mA	
Output Noise Voltage	eN	B=10Hz to 10KHz, Tj=25°C		100		μV	
Supply Voltage Rejection	SVR	Io=40mA, f=120Hz, Tj=25°C, Vin=5.5V, Vripple=1Vpp	60	75		dB	
Dropout Voltage	Vd	Io=100mA Io=500mA Io=800mA Io=1000mA		1.00	1.10	V	
				1.05	1.15	V	
				1.10	1.20	V	
				1.15	1.25	V	
Thermal Regulation		Ta=25°C, 30ms Pulse		0.01	0.10	%/W	

LR1117/A-2.85 ELECTRICAL CHARACTERISTICS

(refer to the test circuits, Tj=0 to 125°C, Co=10μF unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Output Voltage	Vo	Vin=4.85V, Io=10mA, Tj=25°C	2.82	2.85	2.88	V
Output Voltage	Vo	Io=0 to 800/1000mA, Vin=4.25 to 10V	2.79		2.91	V
Line Regulation	ΔVo	Vin=4.25 to 10V, Io=0mA		1	6	mV
Load Regulation	ΔVo	Vin=4.25V, Io=0 to 800/1000mA		1	10	mV
Temperature stability	ΔVo			0.5		%
Long Term Stability	ΔVo	1000 hrs, Tj=125°C		0.3		%
Operating Input Voltage	Vin	Io=100mA			15	V
Quiescent Current	Id	Vin≤10V		5	10	mA
Output Current	Io	Vin=7.85V, Tj=25°C	800	950	1200	mA
Output Noise Voltage	eN	B=10Hz to 10KHz, Tj=25°C		100		μV
Supply Voltage Rejection	SVR	Io=40mA, f=120Hz, Tj=25°C, Vin=5.85V, Vripple=1Vpp	60	75		DB
Dropout Voltage	Vd	Io=100mA Io=500mA Io=800mA Io=1000mA		1.00	1.10	V
				1.05	1.15	V
				1.10	1.20	V
				1.15	1.25	V
Thermal Regulation		Ta=25°C, 30ms Pulse		0.01	0.10	%/W

LR1117/A-3.0 ELECTRICAL CHARACTERISTICS

 (refer to the test circuits, T_j=0 to 125°C, C_o=10μF unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT	
Output Voltage	V _o	Vin=5V, I _o =10mA, T _j =25°C	±1%	2.97	3.00	3.03	V
			±2%	2.94	3.00	3.06	V
Output Voltage	V _o	I _o =0 to 800/1000mA, Vin=4.5 to 10V	±2%	2.94		3.06	V
			±4%	2.88		3.12	V
Line Regulation	ΔV _o	Vin=4.5 to 12V, I _o =0mA		1	6	mV	
Load Regulation	ΔV _o	Vin=4.5V, I _o =0 to 800/1000mA		1	10	mV	
Temperature stability	ΔV _o			0.5		%	
Long Term Stability	ΔV _o	1000 hrs, T _j =125°C		0.3		%	
Operating Input Voltage	V _{in}	I _o =100mA			15	V	
Quiescent Current	I _d	Vin≤12V		5	10	mA	
Output Current	I _o	Vin=8V, T _j =25°C	800	950	1200	mA	
Output Noise Voltage	e _N	B=10Hz to 10KHz, T _j =25°C		100		μV	
Supply Voltage Rejection	SVR	I _o =40mA, f=120Hz, T _j =25°C, Vin=6V, V _{ripple} =1V _{pp}	60	75		dB	
Dropout Voltage	V _d	I _o =100mA I _o =500mA I _o =800mA I _o =1000mA		1.00	1.10	V	
				1.05	1.15	V	
				1.10	1.20	V	
				1.15	1.25	V	
Thermal Regulation		T _a =25°C, 30ms Pulse		0.01	0.10	%/W	

LR1117/A-3.3 ELECTRICAL CHARACTERISTICS

 (refer to the test circuits, T_j=0 to 125°C, C_o=10μF unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT	
Output Voltage	V _o	Vin=5.3V, I _o =10mA, T _j =25°C	±1%	3.267	3.300	3.333	V
			±2%	3.235	3.300	3.365	V
Output Voltage	V _o	I _o =0 to 800/1000mA, Vin=4.75 to 10V	±2%	3.235		3.365	V
			±4%	3.160		3.440	V
Line Regulation	ΔV _o	Vin=4.75 to 15V, I _o =0mA		1	6	mV	
Load Regulation	ΔV _o	Vin=4.75V, I _o =0 to 800/1000mA		1	10	mV	
Temperature stability	ΔV _o			0.5		%	
Long Term Stability	ΔV _o	1000 hrs, T _j =125°C		0.3		%	
Operating Input Voltage	V _{in}	I _o =100mA			15	V	
Quiescent Current	I _d	Vin≤15V		5	10	mA	
Output Current	I _o	Vin=8.3V, T _j =25°C	800	950	1200	mA	
Output Noise Voltage	e _N	B=10Hz to 10KHz, T _j =25°C		100		μV	
Supply Voltage Rejection	SVR	I _o =40mA, f=120Hz, T _j =25°C, Vin=6.3V, V _{ripple} =1V _{pp}	60	75		DB	
Dropout Voltage	V _d	I _o =100mA I _o =500mA I _o =800mA I _o =1000mA		1.00	1.10	V	
				1.05	1.15	V	
				1.10	1.20	V	
				1.15	1.25	V	
Thermal Regulation		T _a =25°C, 30ms Pulse		0.01	0.10	%/W	

LR1117/A-3.6 ELECTRICAL CHARACTERISTICS

 (refer to the test circuits, $T_j=0$ to 125°C , $C_o=10\mu\text{F}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Output Voltage	V_o	$V_{in}=5.6\text{V}$, $I_o=10\text{mA}$, $T_j=25^\circ\text{C}$	3.564	3.600	3.636	V
Output Voltage	V_o	$I_o=0$ to $800/1000\text{mA}$, $V_{in}=5$ to 10V	3.528	3.600	3.672	V
Line Regulation	ΔV_o	$V_{in}=5$ to 15V , $I_o=0\text{mA}$		1	6	mV
Load Regulation	ΔV_o	$V_{in}=5\text{V}$, $I_o=0$ to $800/1000\text{mA}$		1	10	mV
Temperature stability	ΔV_o			0.5		%
Long Term Stability	ΔV_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	$V_{in}\leq 15\text{V}$		5	10	mA
Output Current	I_o	$V_{in}=8.6\text{V}$, $T_j=25^\circ\text{C}$	800	950	1200	mA
Output Noise Voltage	eN	$B=10\text{Hz}$ to 10KHz , $T_j=25^\circ\text{C}$		100		μV
Supply Voltage Rejection	SVR	$I_o=40\text{mA}$, $f=120\text{Hz}$, $T_j=25^\circ\text{C}$, $V_{in}=6.6\text{V}$, $V_{ripple}=1\text{Vpp}$	60	75		DB
Dropout Voltage	V_d	$I_o=100\text{mA}$		1.00	1.10	V
		$I_o=500\text{mA}$		1.05	1.15	V
		$I_o=800\text{mA}$		1.10	1.20	V
		$I_o=1000\text{mA}$		1.15	1.25	V
Thermal Regulation		$T_a=25^\circ\text{C}$, 30ms Pulse		0.01	0.10	%/W

LR1117/A-5.0 ELECTRICAL CHARACTERISTICS

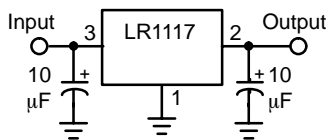
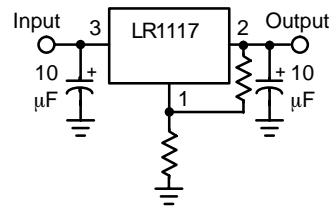
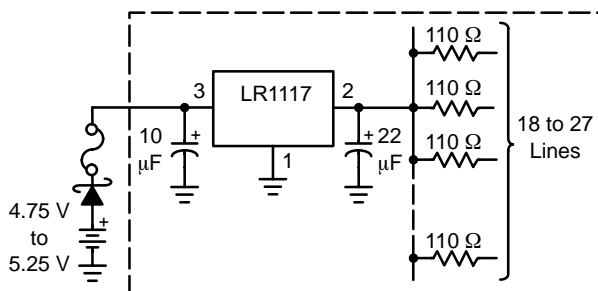
 (refer to the test circuits, $T_j=0$ to 125°C , $C_o=10\mu\text{F}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT	
Output Voltage	V_o	$V_{in}=7\text{V}$, $I_o=10\text{mA}$, $T_j=25^\circ\text{C}$	$\pm 1\%$	4.95	5.00	5.05	V
			$\pm 2\%$	4.90	5.00	5.10	V
Output Voltage	V_o	$I_o=0$ to $800/1000\text{mA}$, $V_{in}=6.5$ to 15V	$\pm 2\%$ $\pm 4\%$	4.90 4.80	5.10 5.20	V	
Line Regulation	ΔV_o	$V_{in}=6.5$ to 15V , $I_o=0\text{mA}$		1	10	mV	
Load Regulation	ΔV_o	$V_{in}=6.5\text{V}$, $I_o=0$ to $800/1000\text{mA}$		1	15	mV	
Temperature stability	ΔV_o			0.5		%	
Long Term Stability	ΔV_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	$V_{in}\leq 15\text{V}$		5	10	mA	
Output Current	I_o	$V_{in}=10\text{V}$, $T_j=25^\circ\text{C}$	800	950	1200	mA	
Output Noise Voltage	eN	$B=10\text{Hz}$ to 10KHz , $T_j=25^\circ\text{C}$		100		μV	
Supply Voltage Rejection	SVR	$I_o=40\text{mA}$, $f=120\text{Hz}$, $T_j=25^\circ\text{C}$, $V_{in}=8\text{V}$, $V_{ripple}=1\text{Vpp}$	60	75		dB	
Dropout Voltage	V_d	$I_o=100\text{mA}$		1.00	1.10	V	
		$I_o=500\text{mA}$		1.05	1.15	V	
		$I_o=800\text{mA}$		1.10	1.20	V	
		$I_o=1000\text{mA}$		1.15	1.25	V	
Thermal Regulation		$T_a=25^\circ\text{C}$, 30ms Pulse		0.01	0.10	%/W	

LR1117/A-ADJUSTABLE ELECTRICAL CHARACTERISTICS

 (refer to the test circuits, $T_j=0$ to 125°C , $C_o=10\mu\text{F}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Reference Voltage	V_{ref}	$V_{in}-V_o=2\text{V}$, $I_o=10\text{mA}$, $T_j=25^\circ\text{C}$	1.238	1.25	1.262	V
Reference Voltage	V_{ref}	$I_o=10$ to $800/1000\text{mA}$, $V_{in}-V_o=1.4$ to 10V	1.225		1.275	V
Line Regulation	ΔV_o	$V_{in}-V_o=1.5$ to 13.75V , $I_o=10\text{mA}$		0.035	0.200	%
Load Regulation	ΔV_o	$V_{in}-V_o=3\text{V}$, $I_o=10$ to $800/1000\text{mA}$		0.10	0.400	%
Temperature stability	ΔV_o			0.50		%
Long Term Stability	ΔV_o	1000 hrs, $T_j=125^\circ\text{C}$		0.3		%
Operating Input Voltage	V_{in}				15	V
Adjustment Pin Current	I_{adj}	$V_{in}\leq 15\text{V}$		60	120	μA
Adjustment Pin Current Change	ΔI_{adj}	$V_{in}-V_o=1.4$ to 10V , $I_o=10$ to $800/1000\text{mA}$		1	5	μA
Minimum Load Current	$I_o(\text{min})$	$V_{in}=15\text{V}$		2	5	mA
Output Current	I_o	$V_{in}-V_o=5\text{V}$, $T_j=25^\circ\text{C}$	800	950	1200	mA
Output Noise (%Vo)	eN	$B=10\text{Hz}$ to 10KHz , $T_j=25^\circ\text{C}$		0.003		%
Supply Voltage Rejection	SVR	$I_o=40\text{mA}$, $f=120\text{Hz}$, $T_j=25^\circ\text{C}$, $V_{in}-V_o=3\text{V}$, $V_{ripple}=1\text{Vpp}$	60	75		dB
Dropout Voltage	V_d	$I_o=100\text{mA}$		1.00	1.10	V
		$I_o=500\text{mA}$		1.05	1.15	V
		$I_o=800\text{mA}$		1.10	1.20	V
		$I_o=1000\text{mA}$		1.15	1.25	V
Thermal Regulation		$T_a=25^\circ\text{C}$, 30ms Pulse		0.01	0.10	%/W

TYPICAL APPLICATIONS

Fig 1. Fixed Output Regulator

Fig 2. Adjustable Output Regulator

Fig 3. Active SCSI Bus Terminator

LR1117/A ADJUSTABLE APPLICATION NOTE

The LR1117/A ADJUSTABLE has a thermal stabilized $1.25 \pm 0.012V$ reference voltage between the OUT and ADJ pins. I_{ADJ} is $60\mu A$ typ. ($120\mu A$ max.) and ΔI_{ADJ} is $1\mu A$ typ. ($5\mu A$ max.).

$R1$ is normally fixed to 120Ω . From figure 7 we obtain:

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

In normal application $R2$ value is in the range of few Kohm., so the $R2 \times I_{ADJ}$ product could not be considered in the V_{OUT} calculation; then the above expression becomes: $V_{OUT} = V_{REF}(1 + R2/R1)$

In order to have the better load regulation it is important to realize a good Kelvin connection of $R1$ and $R2$ resistors.

In particular $R1$ connection must be realized very close to OUT and ADJ pin, while $R2$ ground connection must be placed as near as possible to the negative Load pin. Ripple rejection can be improved by introducing a $10\mu F$ electrolytic capacitor placed in parallel to the $R2$ resistor (See Fig. 6)

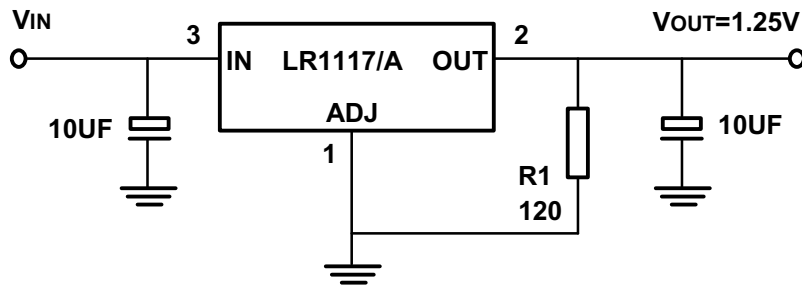


FIG.4 Adjustable Output 1.25 Voltage Application Circuit

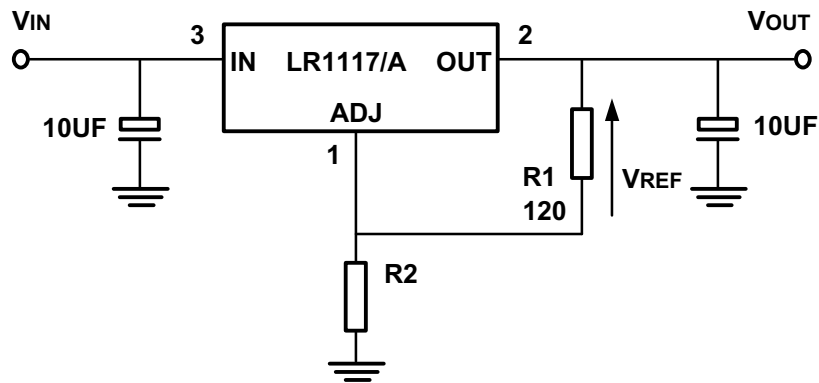


FIG.5 Adjustable Output Voltage Application Circuit

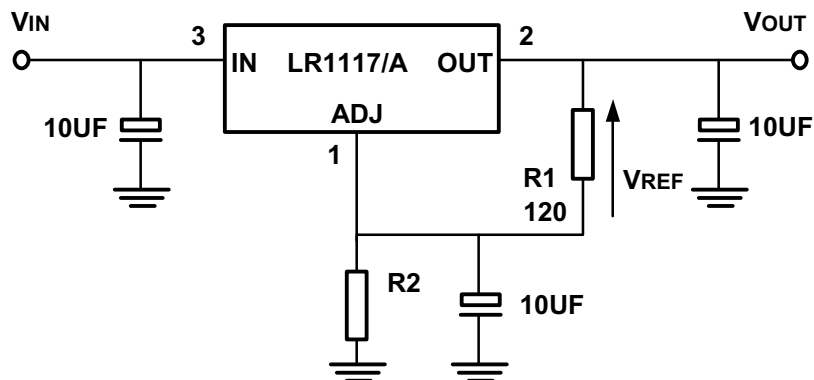
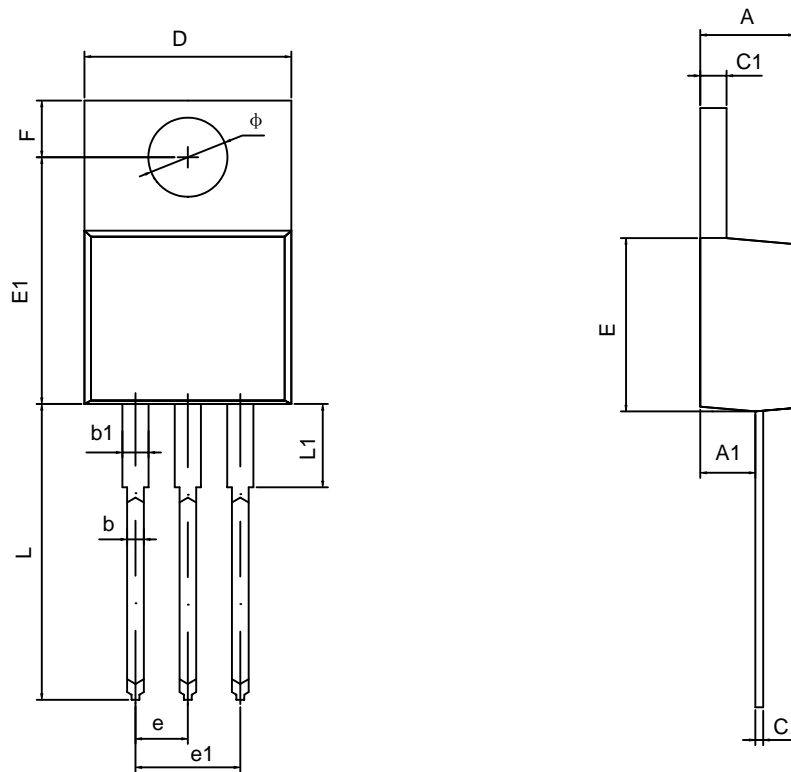
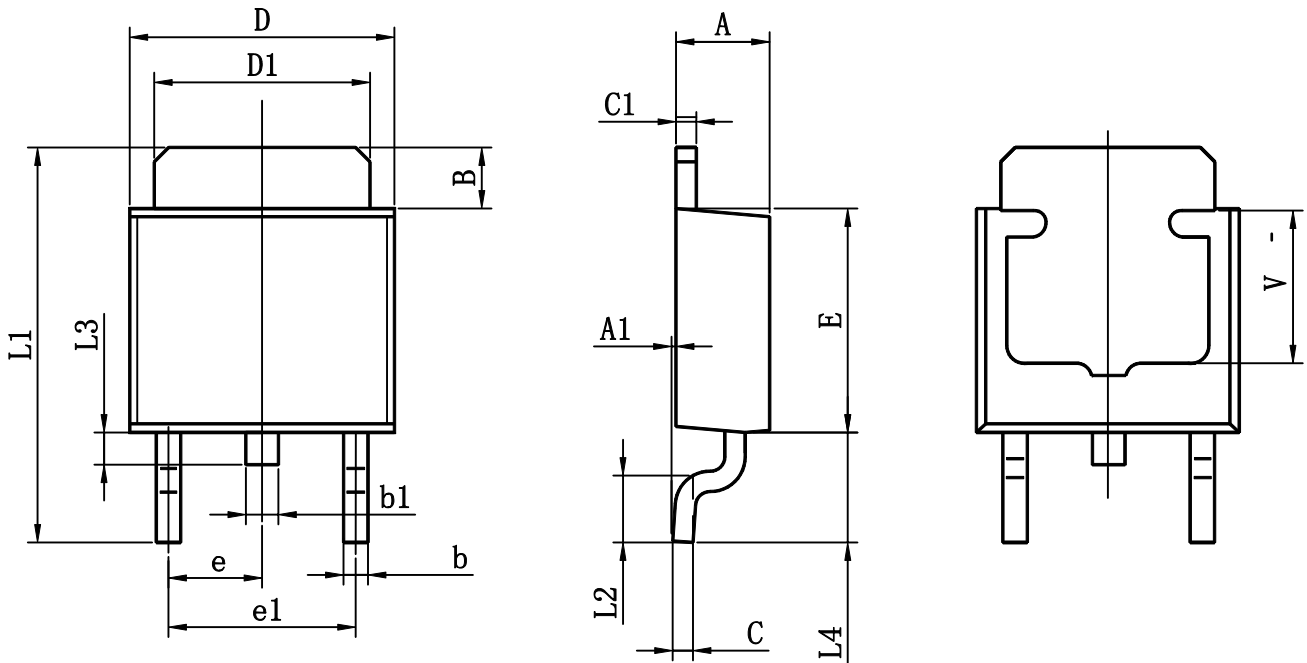


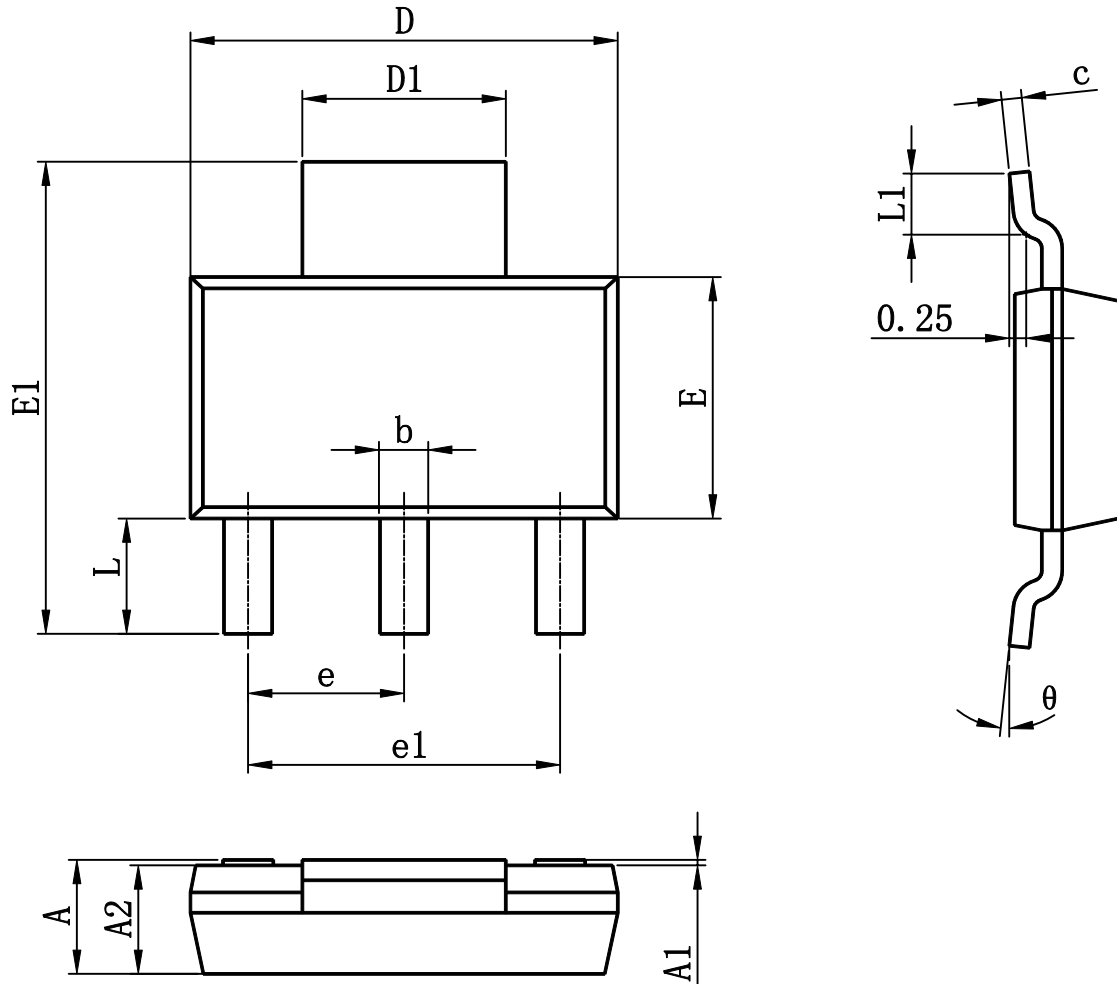
FIG.6 Adjustable Output Voltage Application with improved Ripple Rejection.

TO-220-3L PACKAGE OUTLINE DIMENSIONS


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.470	4.670	1.176	0.184
A1	2.520	2.820	0.099	0.111
b	0.710	0.910	0.028	0.036
b1	1.170	1.370	0.046	0.054
c	0.310	0.530	0.012	0.021
c1	1.710	1.370	0.046	0.054
D	10.010	10.310	0.394	0.406
E	8.500	8.900	0.335	0.350
E1	12.060	12.460	0.475	0.491
e	2.540TYP		0.100TYP	
e1	4.980	5.180	0.196	0.204
F	2.590	2.890	0.102	0.114
L	13.400	13.800	0.528	0.543
L1	3.560	3.960	0.140	0.156
ϕ	3.790	3.890	0.149	0.153

TO-252-2 PACKAGE OUTLINE DIMENSIONS


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	2.200	2.400	0.087	0.094
A1	0.000	0.127	0.000	0.005
B	1.350	1.650	0.053	0.065
b	0.500	0.700	0.020	0.028
b1	0.700	0.900	0.028	0.035
c	0.430	0.580	0.017	0.023
c1	0.430	0.580	0.017	0.023
D	6.350	6.650	0.250	0.262
D1	5.200	5.400	0.205	0.213
E	5.400	5.700	0.213	0.224
e	2.300TYP		0.091TYP	
e1	4.500	4.700	0.177	0.185
L1	9.500	9.900	0.374	0.390
L2	1.400	1.780	0.055	0.070
L3	0.650	0.950	0.026	0.037
L4	2.550	2.900	0.100	0.114
V	3.80REF		0.150REF	

SOT-223 PACKAGE OUTLINE DIMENSIONS


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.520	1.800	0.060	0.071
A1	0.020	0.100	0.001	0.004
A2	1.500	1.700	0.059	0.067
b	0.610	0.810	0.024	0.032
c	0.250	0.350	0.010	0.014
D	6.300	6.700	0.248	0.264
D1	2.900	3.100	0.114	0.122
E	3.300	3.700	0.130	0.146
E1	6.700	7.300	0.264	0.287
e	2.300TYP		0.091TYP	
e1	4.500	4.700	0.177	0.185
L	1.750TYP		0.069TYP	
L1	0.900		0.035	
θ	0°	10°	0°	10°