Low Dropout Positive Voltage Regulator

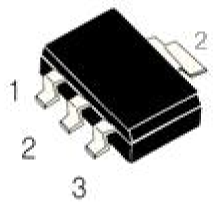
Description

The IL1117C is a series of low dropout voltage regulators which can provide up to 1A of output current. The IL1117C is available in eight fixed voltage, 1.5, 1.8, 2.5, 2.85, 3.0, 3.3, 3.5 and 5.0V. Additionally it is also available in adjustable version. On chip precision trimming adjusts the reference/ output voltage to within ± 2%. Current limit is also trimmed to ensure specified output current and controlled short-circuit current.

The IL1117C series is available in SOT-223, TO-252, SOT-89 packages.

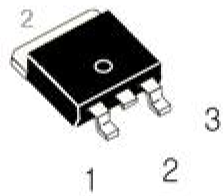
A minimum of 10uF tantalum capacitor is required at the output to improve the transient response and Stability.

SOT−223



IL1117C-xx

TO−252



IL1117C-xxD0T

SOT−89

IL1117C-xxPT

1. ADJ/GND
2. Output
3. Input

Pin#2 connected with heat sink

Features

- Dropout Voltage – 1.2V (Typical)
- Reference/Output Voltage Trimmed to ± 2%
- Maximum Input Voltage – 15V
- Adjustable Output Voltage or Fixed 1.2V, 1.25V, 1.5V, 1.8V, 2.5V, 2.85V, 3.3V, 5V
- Line Regulation typically at 0.2% max
- Load Regulation typically at 0.4% max
- Current Limiting and Thermal Protection
- Standard 3-Pin Power Packages
- Operating Junction Temperature Range -40 to +125°C
- MSL (Moisture Sensitive Level) 3
- RoHS Compliant

Applications

- Post Regulator for switching DC/DC Converter
- High Efficiency Linear Regulator
- Battery Chargers
- PC Add on Card
- Motherboard clock supplies
- LCD Monitor
- Set-top Box

ORDERING INFORMATION

Device	Package	Packing
IL1117C-xx	SOT-223	Tape & Reel
IL1117C-xxD0T	TO-252	Tape & Reel
IL1117C-xxPT	SOT-89	Tape & Reel

Absolute Maximum Ratings

Symbol	Description	Max	Units
VIN	Input Voltage	15	V
PD	Internally Limited (Note 1)		W
T_J	Operating Junction Temperature Range (* in case of IL1117C-1.2ET)	-40 to 125 (* 0 to 150)	°C
T_S	Storage Temperature Range	-50 to 150	°C
Θ_{JA}	Thermal Resistance Junction-to-Ambient (SOT-223)	170	°C/W
Θ_{JA}	Thermal Resistance Junction-to-Ambient (TO-252)	115	°C/W
Θ_{JA}	Thermal Resistance Junction-to-Ambient (SOT-89)	250	°C/W
Θ_{JC}	Thermal Resistance Junction-to-Case (SOT-223)	40	°C/W
Θ_{JC}	Thermal Resistance Junction-to-Case (TO-252)	25	°C/W
Θ_{JC}	Thermal Resistance Junction-to-Case (SOT-89)	65	°C/W
ESD	ESD HBM Protection max level (Note 2)	±2000	V

* Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device.
These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied.
Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Note 1: The maximum power dissipation is a function of $T_{J(MAX)}$, Θ_{JA} and T_A. The maximum allowable power dissipation at ambient temperature is $P_D = (T_{J(MAX)} - T_A)/\Theta_{JA}$.

Note 2: For testing purposes, ESD was applied using human body model, 1.5kΩ in series with 100pF.

Electrical Characteristics

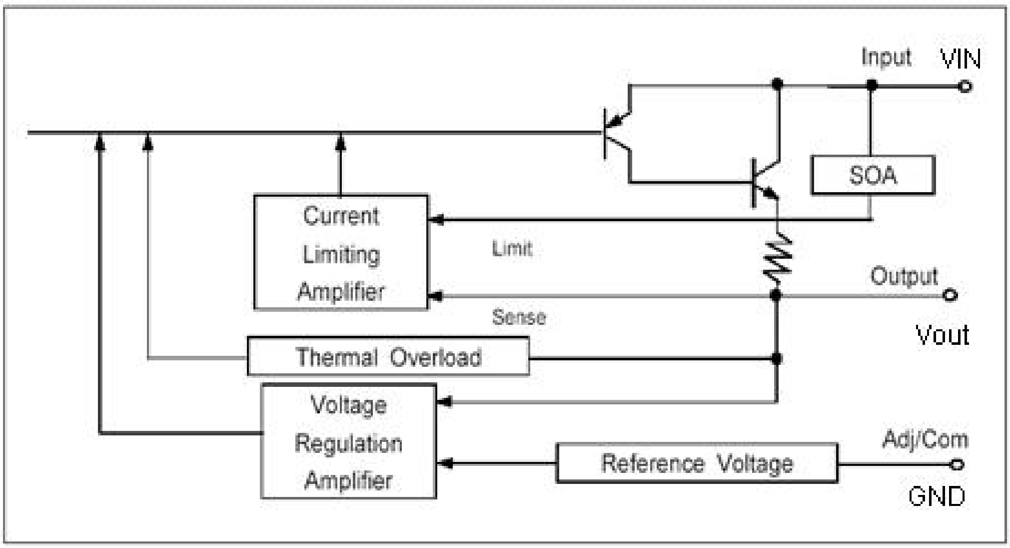
T_J = -40°C to +125°C unless otherwise specified

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
OUTPUT VOLTAGE					
IL1117C-1.25 (Adjustable)	Io = 10mA to $I_{FULLLOAD}$[1)] Vin = 2.75 to 12.0V	1.225	1.250	1.275	V
IL1117C-1.5	Io = 10mA to $I_{FULLLOAD}$, Vin = 3.0 to 12.0V	1.470	1.500	1.530	V
IL1117C-1.8	Io = 10mA to $I_{FULLLOAD}$, Vin = 3.3 to 12.0V	1.764	1.800	1.836	V
IL111C-2.5	Io = 10mA to $I_{FULLLOAD}$, Vin = 4.0 to 12.0V	2.450	2.500	2.550	V
IL1117C-2.85	Io = 10mA to $I_{FULLLOAD}$, Vin = 4.35 to 12.0V	2.793	2.850	2.907	V
IL1117C-3.0	Io = 10mA to $I_{FULLLOAD}$, Vin = 4.5 to 12.0V	2.940	2.850	3.060	V
IL1117C-3.3	Io = 10mA to $I_{FULLLOAD}$, Vin = 4.8 to 12.0V	3.234	3.300	3.366	V
IL1117C-3.5	Io = 10mA to $I_{FULLLOAD}$, Vin = 5.5 to 12.0V	3.430	3.500	3.570	V
L1117C-5.0	Io = 10mA to $I_{FULLLOAD}$, Vin = 6.5 to 15.0V	4.900	5.000	5.100	V
LINE REGULATION					
IL1117C-1.25 (Adjustable)	Io =10mA, Vin = 2.75 to 12.0V		0.1	0.3	%
IL1117C-1.5	Io =10mA, Vin = 3.0 to 12.0V		1.0	10.0	mV
IL1117C-1.8	Io =10mA, Vin = 3.3 to 12.0V		1.2	10.0	mV
IL111C-2.5	Io =10mA, Vin = 4.0 to 12.0V		1.0	10.0	mV
IL1117C-2.85	Io =10mA, Vin = 4.35 to 12.0V		2.0	10.0	mV
IL1117C-3.0	Io =10mA, Vin = 4.5 to 12.0V		2.0	10.0	mV
IL1117C-3.3	Io =10mA, Vin = 4.8 to 12.0V		3.0	10.0	mV
IL1117C-3.5	Io =10mA, Vin = 5.0 to 12.0V		3.0	10.0	mV
L1117C-5.0	Io =10mA, Vin = 6.5 to 15.0V		7.0	15.0	mV
LOAD REGULATION					
IL1117C-1.25 (Adjustable)	Io = 10mA to 1.0A, Vin = 3.25V		0.2	0.5	%
IL1117C-1.5	Io = 10mA to 1.0A, Vin = 3.5V		0.2	12.0	mV
IL1117C-1.8	Io = 10mA to 1.0A, Vin = 3.8V		2.0	12.0	mV
IL111C-2.5	Io = 10mA to 1.0A, Vin = 4.5V		2.0	12.0	mV
IL1117C-2.85	Io = 10mA to 1.0A, Vin = 4.85V		2.0	12.0	mV
IL1117C-3.0	Io = 10mA to 1.0A, Vin = 5.0V		2.0	12.0	mV
IL1117C-3.3	Io = 10mA to 1.0A, Vin = 5.3V		2.0	12.0	mV
IL1117C-3.5	Io = 10mA to 1.0A, Vin = 5.5V		2.0	15.0	mV
L1117C-5.0	Io = 10mA to 1.0A, Vin = 7.0V		14.0	20.0	mV
DROPOUT VOLTAGE [2)] All Models	Io =1A (T_J = 25°C)		1.20	1.40	V
	Io =1A (T_J = -40°C to +125°C)		1.20	1.55	V
Current Limit	Vin - Vo = 5V (TJ = 25°C)	1000	1500		mA
Minimum Load Current Adjustable Models	Vin = 13.75V		2	7	mA
Quiescent Current	Vin - Vo = 1.5V		5.2	10	mA
Adjust Pin Current	Io = 10mA, Vin - Vo = 1.4 to 10V		56	80	uA
Adjust Pin Current Change	Io = 10mA to 1A, Vin - Vo = 1.4 to 10V		0.5	5	uA
Temperature Drift	T_J = -40°C to +125°C		0.5		%
RMS Output Noise	Bandwidth of 10Hz to 10kHz at 25°C		0.003		%Vo
Ripple Rejection Ratio	120Hz input Ripple(C_{ADJ} for ADJ) = 25uF Vin -Vo = 5V, Io = 1.0A T_J = -40°C to +125°C	60	72		dB

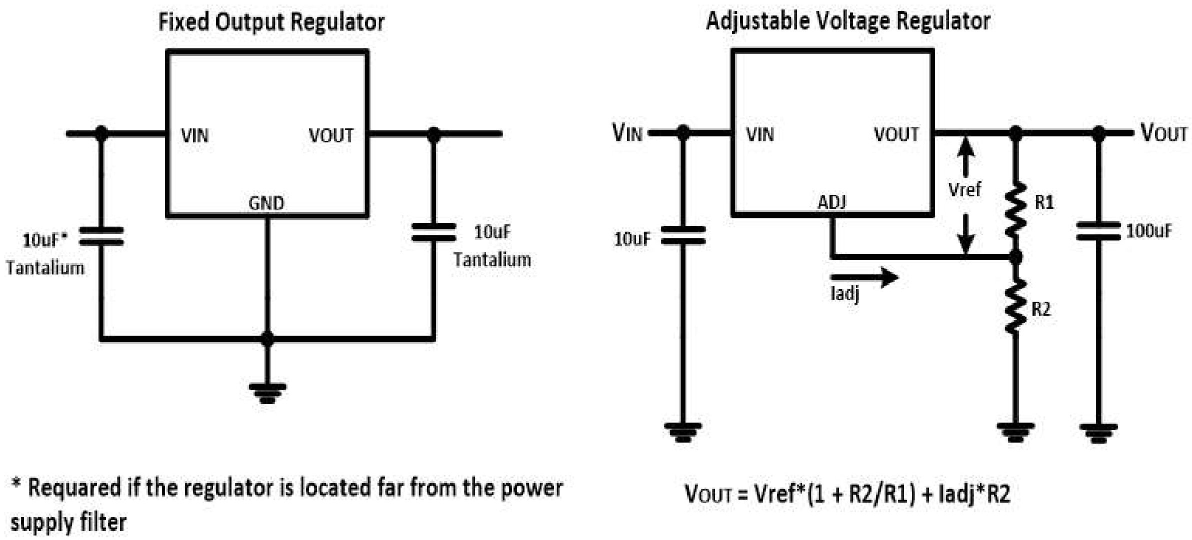
NOTES:

1) $I_{FULL\ LOAD}$, A, - current limit is a function of input-to-output (max 1A),
Defines as: $I_{FULL\ LOAD} = P_{DMAX}/(Vin - Vo)$, where
PD max – maximum operation power dissipation defines as $P_{DMAX} = (T_J - T_A)/\Theta_{J-A}$,
T_J – maximum operation junction temperature, 125°C;
T_A – maximum operation ambient temperature, °C;
Θ_{J-A} – thermal resistance junction- to-ambient, °C/W.

2) 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 at 100mV from the nominal value obtained at $V_{IN}=V_{OUT}+1.5V$.

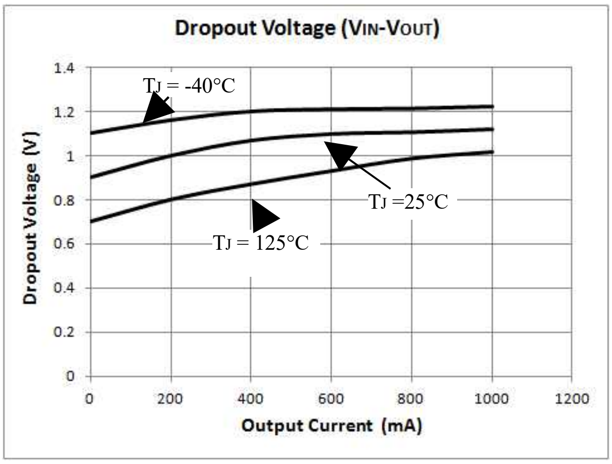


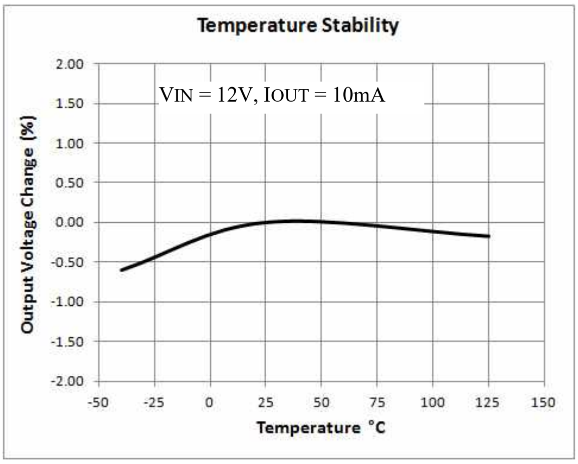
Block Diagram

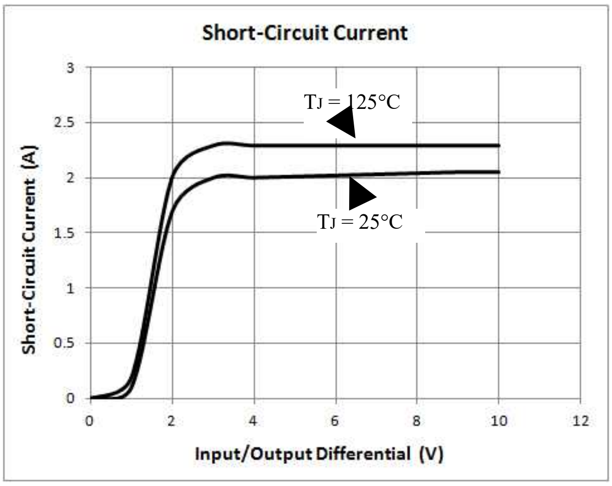


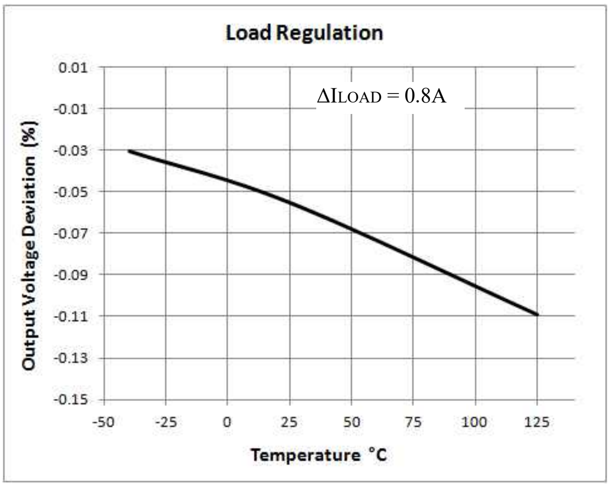
Application Schematic

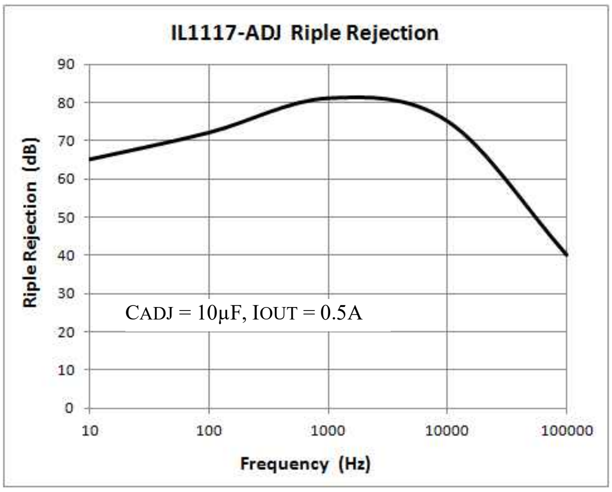
Typical Performances Characteristics

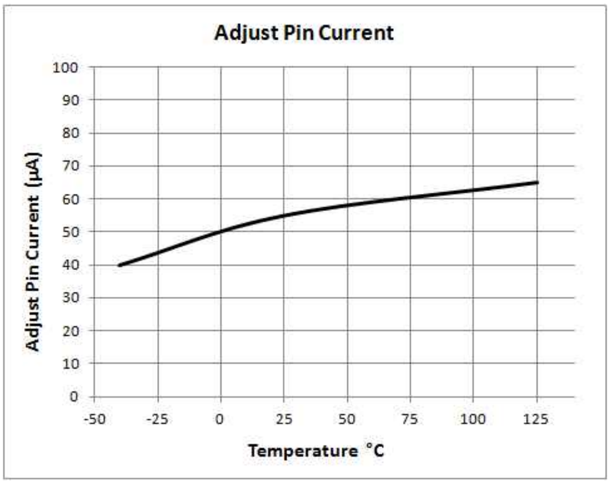




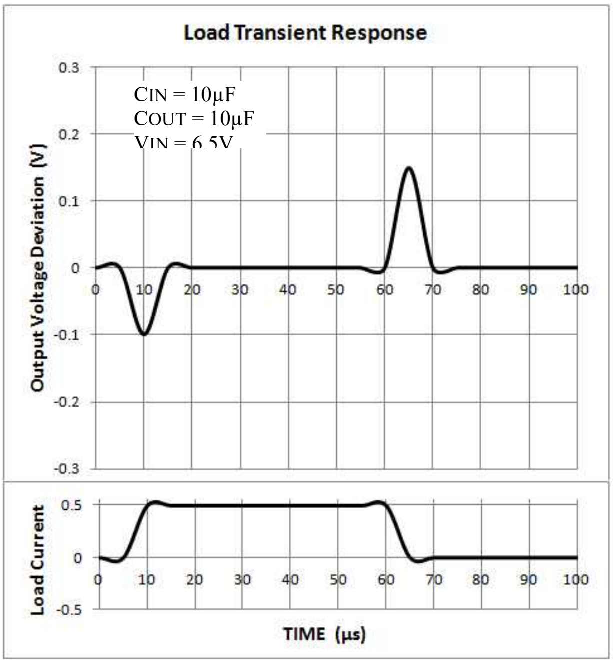


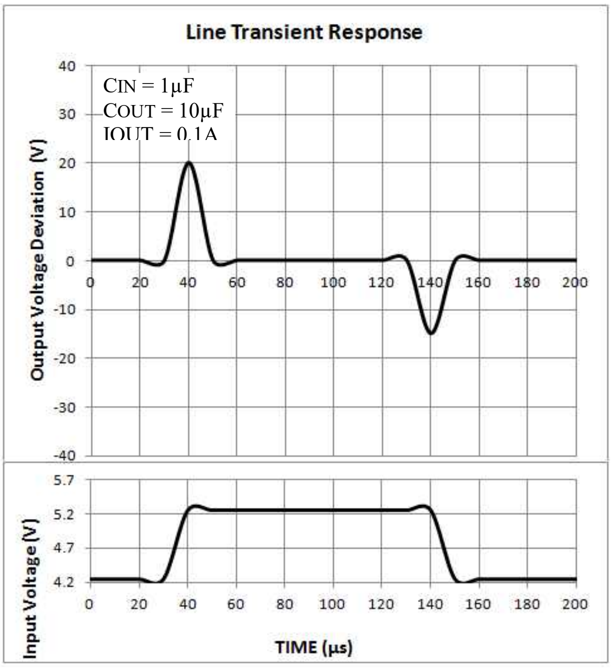






Typical Performance Characteristics (continue)





Application Information

Output voltage adjustment

Like most regulators, the IL1117C regulates the output by comparing the output voltage to an internally generated reference voltage. On the adjustable version as shown in Fig.4, the V_{REF} is available externally as 1.25V between V_{OUT} and ADJ. The voltage ratio formed by R1 and R2 should be set to conduct 10mA (minimum output load).
The output voltage is given by the following equation:
$V_{OUT} = V_{REF}*(1+R2/R1) + I_{ADJ}*R2$
On fixed versions of IL1117C, the voltage divider is provided internally.

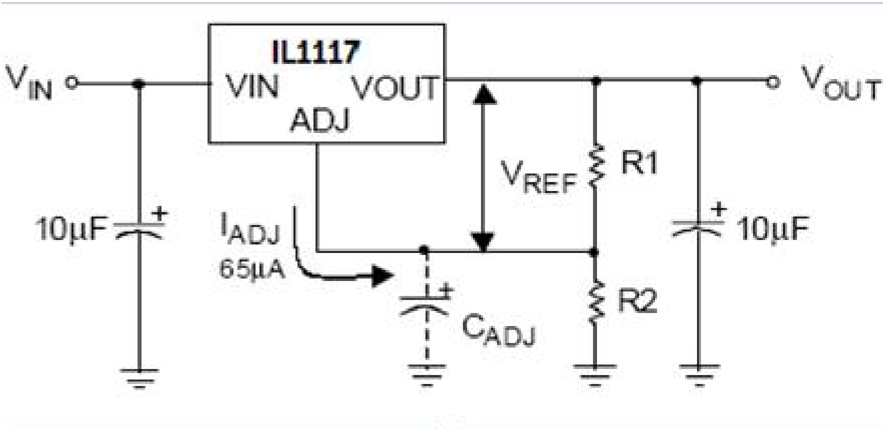


Fig.4. Basic Adjustable Regulator

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

IL1117C requires a capacitor from V_{OUT} to GND to provide compensation feedback to the internal gain stage. This is to ensure stability at the output terminal. Typically, 10μF tantalum or 50μF aluminum electrolytic is sufficient.

Note: The ESR is typically 1.0 Ω.

The output capacitor does not have a theoretical upper limit and increasing its value will increase stability. C_{OUT} = 100μF or more is typical for high current regulator design.

Load Regulation

When the adjustable regulator is used (Fig.5), the best load regulation is accomplished when the top of the resistor divider (R1) is connected directly to the output pin of the IL1117S. When so connected, R_P is not multiplied by the divider ratio. For Fixed output version, the top of R1 is internally connected to the output and ground pins can be connected to low side of the load.

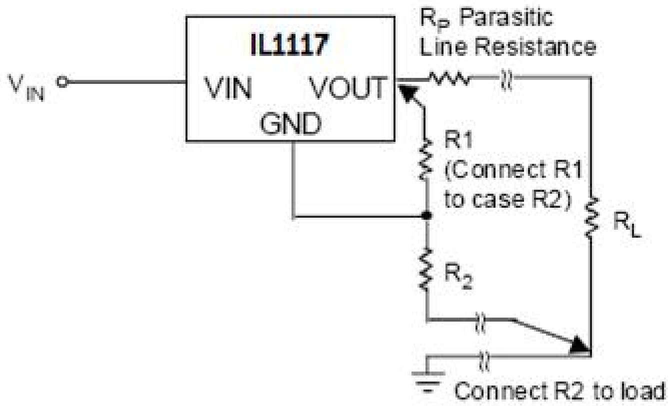


Fig.5. Best Load Regulation Using Adjustable Output Regulator

Thermal Protection

IL1117C has thermal protection which limits junction temperature to 150°C. However, device functionality is only guaranteed to a maximum junction temperature of +125°C. The power dissipation and junction temperature for IL1117S in package are given by

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

$T_{JUNCTION} = T_{AMBIENT} + (P_D \times \theta_{JA})$

Note: T_J must not exceed 125°C

Current Limit Protection

IL1117C is protected against overload conditions. Current protection is triggered at typically 1.8A.

Thermal Consideration

The IL1117C series contain thermal limiting circuitry designed to protect itself from over-temperature conditions. Even for normal load conditions, maximum junction temperature ratings must not be exceeded. As mention in thermal protection section, we need to consider all sources of thermal resistance between junction and ambient. It includes junction-to-case, case-to-heat-sink interface, and heat sink thermal resistance itself.

Junction-to-case thermal resistance is specified from the IC junction to the bottom of the case directly below the die. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. The case of all devices in this series is electrically connected to the output. Therefore, if the case of the device must be electrically isolated, a thermally conductive spacer is recommended.

Heatsink Requirements

The IL1117C series have internal thermal shutdown to protect the device from over-heat. Under all possible operating conditions, the junction temperature 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:

$I_{IN} = I_L + I_G$

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

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:

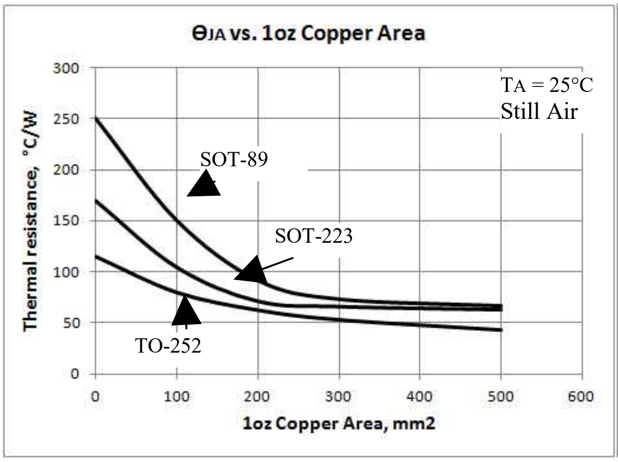
$\Theta_{JA} = T_{R(MAX)} / P_D$

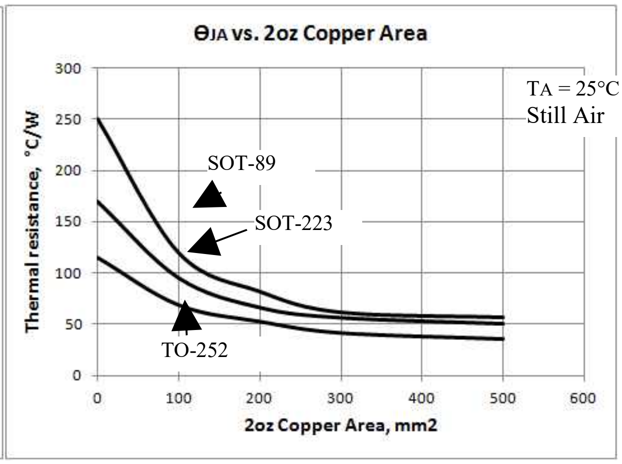
If the maximum allowable value for ΘJA is found to be ≥ 170°C/W for SOT-223 package or ≥ 115°C/W for TO-252 package or ≥ 250°C/W for SO-89 package , no heat sink is needed since the package alone will dissipate enough heat to satisfy these requirements. If the calculated value for ΘJA falls below these limits, a heatsink is required.

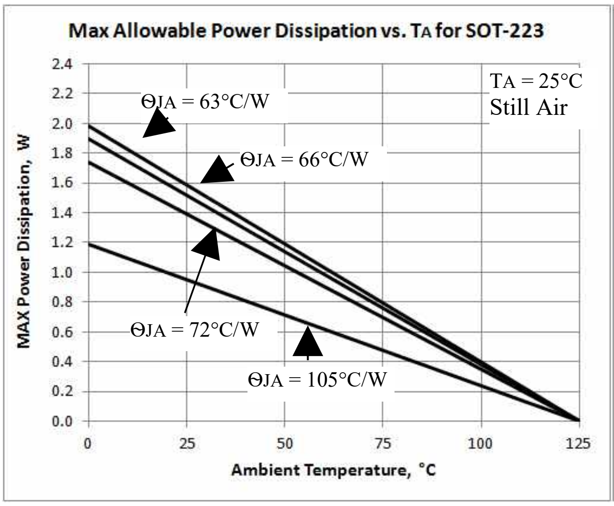
As design aid, Table 1 shows the value of the ΘJA of SOT-223, TO-252 and SOT-89 for different heatsink area. The copper patterns that used to measure these ΘJA are shown on the Figure 6.

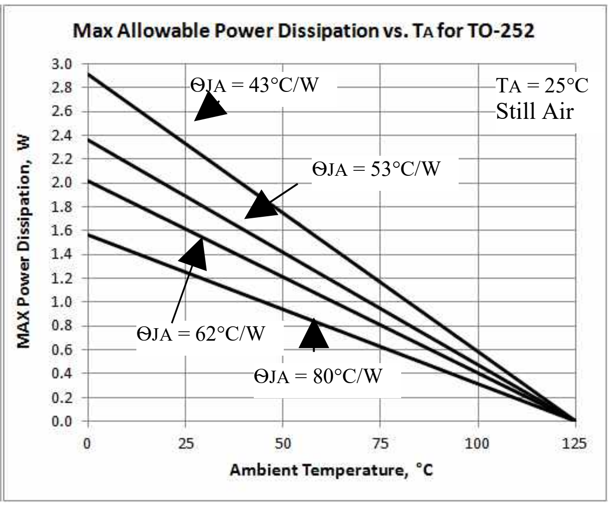
TABLE1. Thermal Resistance values for different packages and Copper Areas.

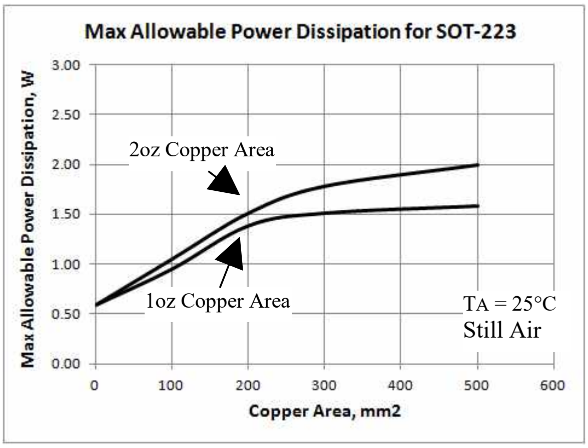
PKG	OZ	Thermal Resistance	Copper Area, mm^2			
			$100mm^2$	$200mm^2$	$300mm^2$	$500mm^2$
SOT-223	1OZ	ΘJ-A, °C/W	105	72	66	63
	2OZ	ΘJ-A, °C/W	95	66	56	50
SOT-89	1OZ	ΘJ-A, °C/W	150	92	73	66
	2OZ	ΘJ-A, °C/W	120	82	62	57
TO-252	1OZ	ΘJ-A, °C/W	80	62	53	43
	2OZ	ΘJ-A, °C/W	69	53	42	36

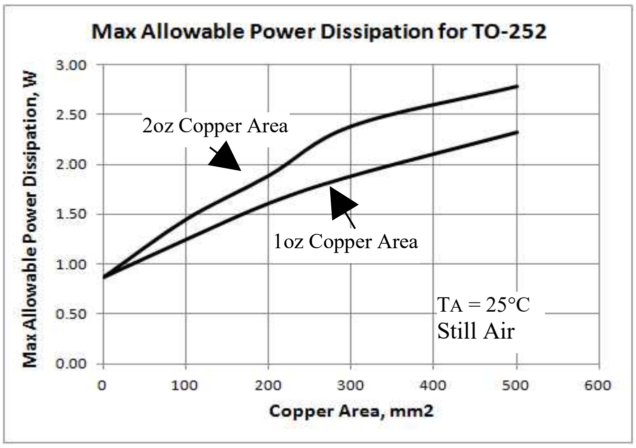


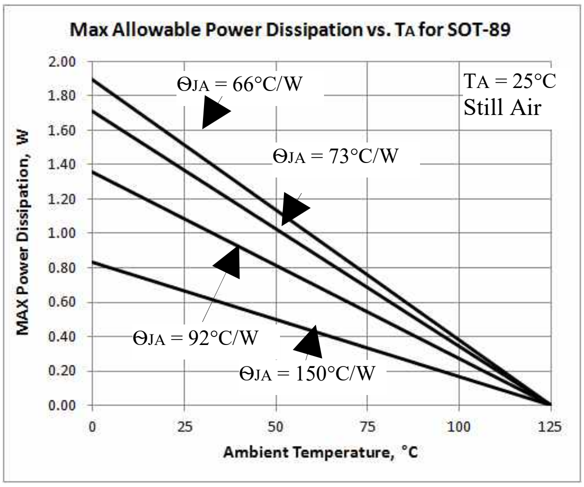


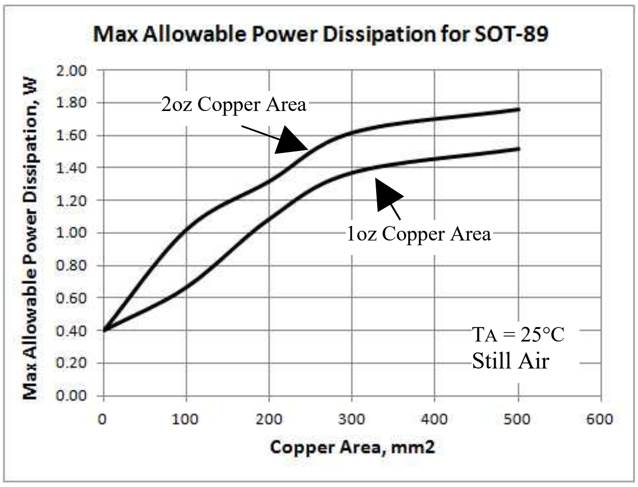





Max Allowable Power Dissipation for SOT-223
Max Allowable Power Dissipation, W
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
100
200
300
400
500
600
Copper Area, mm2
2oz Copper Area
1oz Copper Area
TA = 25°C
Still Air


Max Allowable Power Dissipation for TO-252
Max Allowable Power Dissipation, W
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
100
200
300
400
500
600
Copper Area, mm2
2oz Copper Area
1oz Copper Area
TA = 25°C
Still Air


Max Allowable Power Dissipation vs. TA for SOT-89
MAX Power Dissipation, W
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
25
50
75
100
125
Ambient Temperature, °C
ΘJA = 66°C/W
ΘJA = 73°C/W
ΘJA = 92°C/W
ΘJA = 150°C/W
TA = 25°C
Still Air


Max Allowable Power Dissipation for SOT-89
Max Allowable Power Dissipation, W
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
100
200
300
400
500
600
Copper Area, mm2
2oz Copper Area
1oz Copper Area
TA = 25°C
Still Air

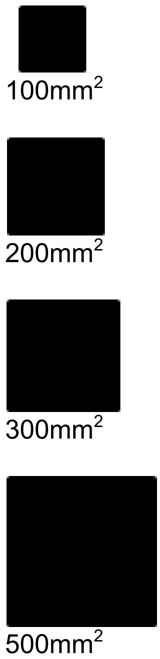
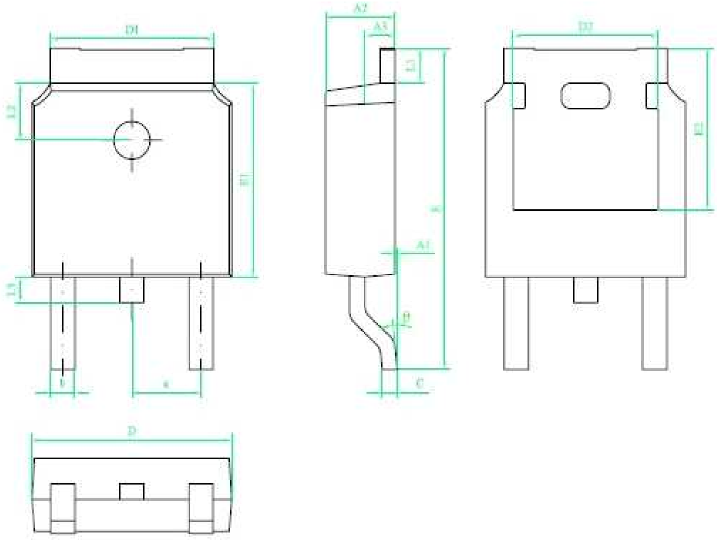


Fig.6. Top View of the Thermal Test Pattern in Actual Scale

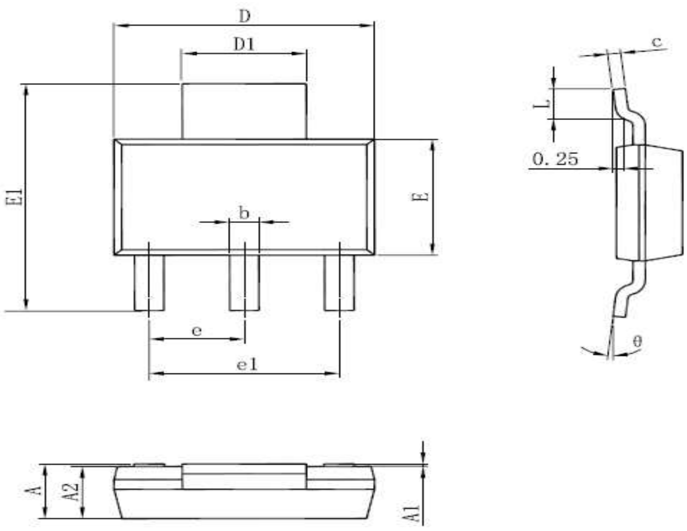
Package Dimensions

TO-252-3L Package



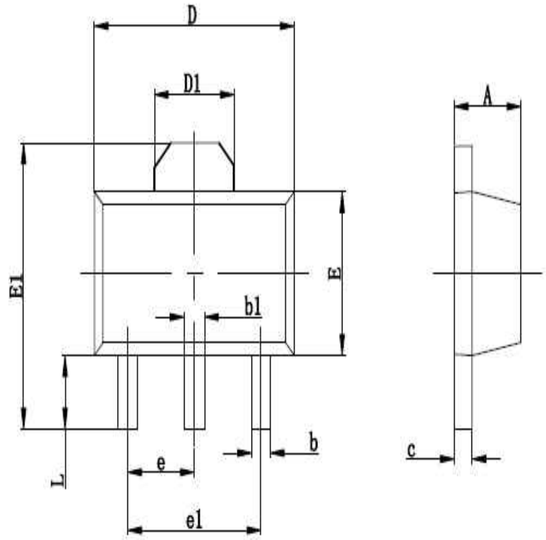
Symbol	Dimension in Millimeters		
	Min	Typ	Max
A1	0.00		0.10
A2	2.20	2.30	2.40
A3	0.90	1.00	1.10
b	0.75		0.85
c	0.50		0.60
D	6.50	6.60	6.70
D1	5.30	5.40	5.50
D2	4.70	4.80	4.90
E	9.90	10.10	10.30
E1	6.00	6.10	6.20
E2	5.20	5.30	5.40
e	2.20	2.29	2.40
Ll	0.90		1.25
L2	1.70	1.80	1.90
L3	0.60	0.80	1.00
⊙	0.00		8.00

SOT-223-3L Package



Symbol	Dimension in Millimeters		
	Min	Typ	Max
A	1.52		1.80
A1	0.02		0.10
A2	1.50		1.70
b	0.66		0.81
c	0.24		0.32
D	6.30		6.50
D1	2.90		3.10
E	3.30		3.70
E1	6.83		7.07
e	2.300 (BSC)		
e1	4.50		4.70
L	0.90		1.15
⊙	0.00		10.00

SOT-89-3L Package



Symbol	Dimension in Millimeters		
	Min	Typ	Max
A	1.40		1.60
b	0.35		0.52
b1	0.40		0.58
c	0.35		0.44
D	4.40		4.60
D1	1.550REF		
E	2.35		2.55
E1	3.94		4.25
e	1.500 (BSC)		
e1	3.000 (BSC)		
⊙	0.90		1.10