1A Low Dropout Linear Regulator

Description

The FR1117 series are low dropout positive voltage regulators that are capable of providing an output current that is in excess of 1.0 A with a dropout of 1.15V at 800mA output current. On-chip thermal shutdown feature provides protection against overload or any condition when the ambient temperature exceeds the junction temperature.
The FR1117 series are available in adjustable version and fixed output voltage versions: 1.5V, 1.8V, 2.5V, 2.85V, 3.0V, 3.3V, and 5.0V.
The FR1117 series are available in the industry standard SOT-223 and TO-252 power package.

Features

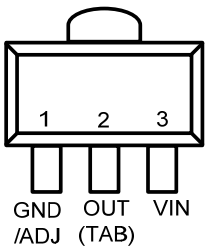
- Output Current in Excess of 1A
- Current Limiting and Thermal Protection
- Excellent Line and Load Regulation
- Fast Transient Response
- Standard 3 Pin Power Package

Applications

- LCD Monitors
- PC Motherboard
- Graphic Cards
- DVD-Video Players
- ADSL Modem
- Printer and other Peripheral Equipments

Pin Assignments

Package (SOT-223)



Package (TO-252)

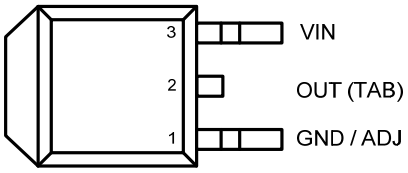


Figure 1. Pin Assignment of FR1117

Ordering Information

FR1117-□□□□

- TR: Tape / Reel
- P: Green
  G: Green
- Package Type
  R3: SOT-223
  T3: TO-252
- Output Voltage
  Blank: Adjustable
  15: 1.5V
  18: 1.8V
  25: 2.5V
  2J: 2.85V
  30: 3.0V
  33: 3.3V
  50: 5.0V

Typical Application Circuit

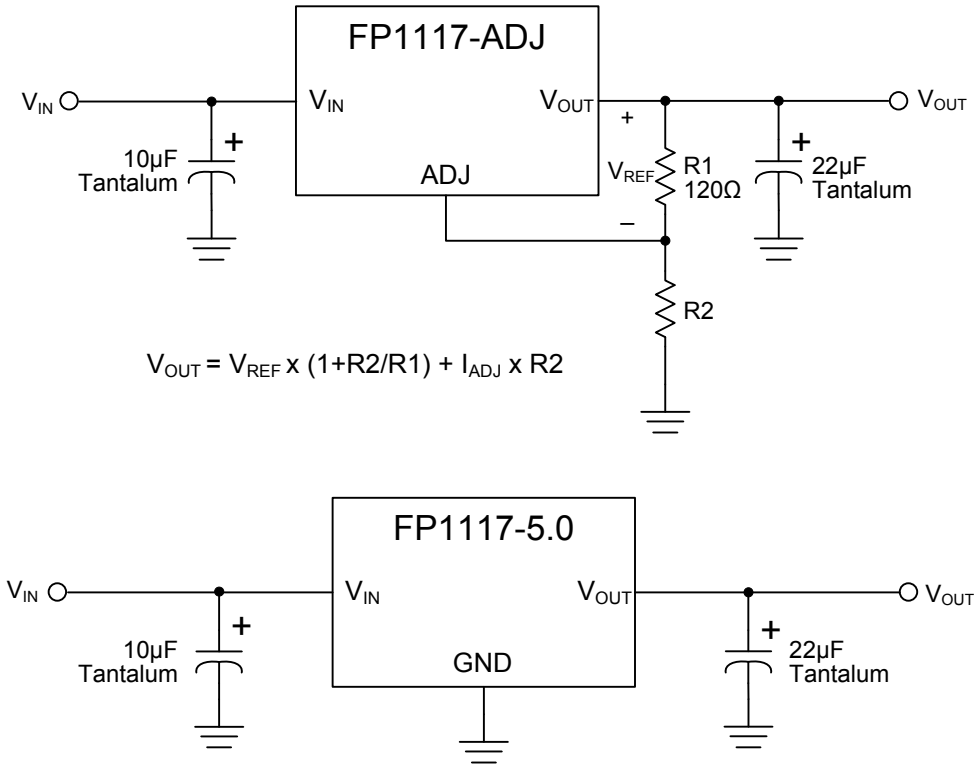


Figure 2. Typical Application Circuit of FR1117

Functional Pin Description

Pin Name	Pin Function
ADJ (GND)	A resistor divider from this pin to the VOUT pin and ground sets the output voltage. (Ground only for Fixed version)
VOUT	The output of the regulator. A minimum of 10uF capacitor (0.15Ω≤ ESR ≤ 20Ω) must be connected from this pin to ground to insure stability.
VIN	The input pin of regulator. Typically a large storage capacitor(0.15Ω ≤ ESR ≤ 20Ω) is connected from this pin to ground to insure that the input voltage does not droop below the minimum dropout voltage during the load transient response.

Block Diagram

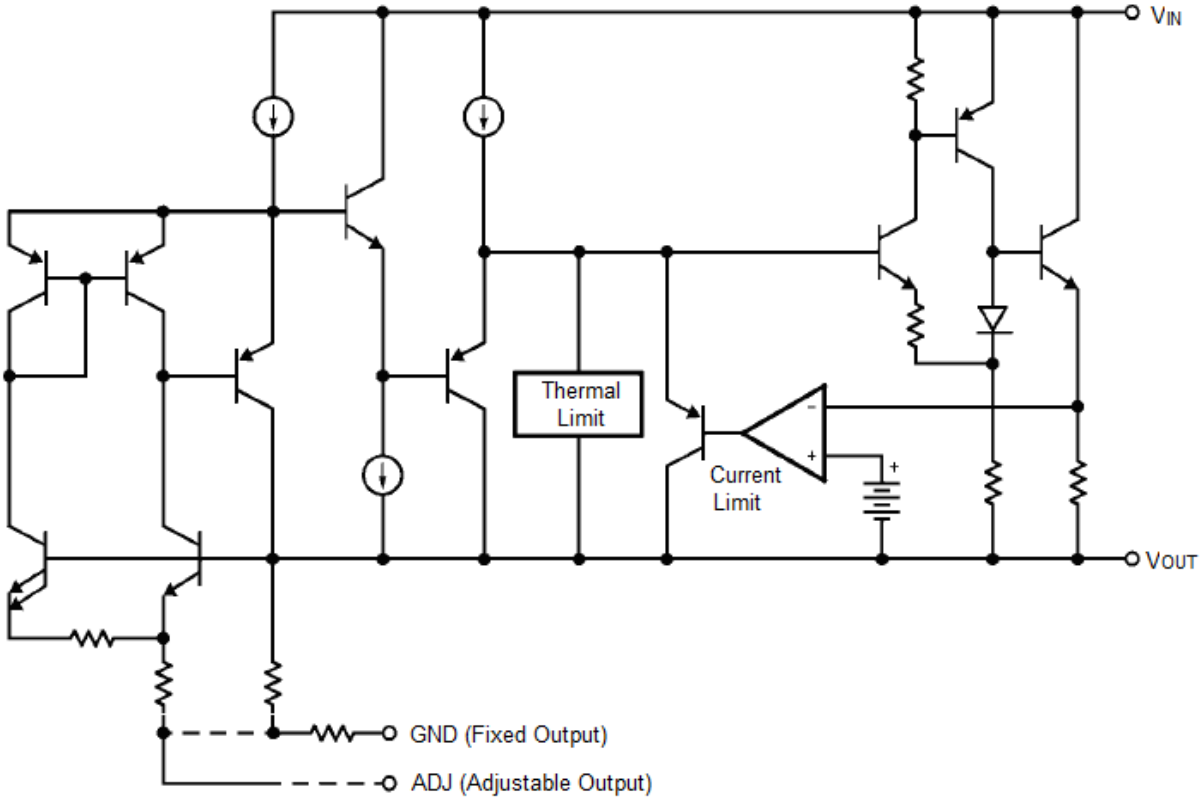


Figure 3. Block Diagram of FR1117

Absolute Maximum Ratings

- Supply Input Voltage (VIN)---------- +20V
- Supply Current---------- +1A
- Power Dissipation @25℃ (P_D) :
  - SOT-223 ---------- +0.74W
  - TO-252 ---------- +1.33W
- Package Thermal Resistance (θ_{JA})
  - SOT-223 ---------- +135℃/W
  - TO-252 ---------- +75℃/W
- Maximum Junction Temperature (T_J)---------- +150℃
- Storage Temperature Range (T_{STG}) ---------- -65℃ to +150℃
- Lead Temperature (Soldering, 10 sec.) (T_{LEAD})---------- +260℃

Note1：Stresses beyond those listed under “Absolute Maximum Ratings" may cause permanent damage to the device.

Recommended Operating Conditions

- Input Voltage (V_{IN})---------- +3.0V to +15.0V
- Operating Temperature Range (T_{OPR})---------- -40℃ to +85℃

Electrical Characteristics

V_{IN}≤15V, T_A = 25°C unless otherwise specified.

Parameter	Device	Conditions	Min	Typ	Max	Unit
Reference Voltage	FR1117	V_{IN} - V_{OUT} =2.0V, I_{OUT} =10mA 1.5V≤ V_{IN} - V_{OUT}≤8V, 10mA ≤I_{OUT}≤ 0.8A,	1.238 1.225	1.250 1.250	1.262 1.270	V
Output Voltage	FR1117-1.5	V_{IN} =3.5V, I_{OUT} =10mA 10mA≤I_{OUT}≤ 0.8A, 3.0V≤V_{IN}≤12V	1.485 1.470	1.500 1.500	1.515 1.530	V
	FR1117-1.8	V_{IN} =3.8V, I_{OUT} =10mA 10mA ≤I_{OUT}≤0.8A, 3.3V≤V_{IN}≤12V	1.782 1.746	1.800 1.800	1.818 1.854	V
	FR1117-2.5	V_{IN} =4.5V, I_{OUT} =10mA 10mA ≤I_{OUT}≤0.8A, 4.0V≤V_{IN}≤12V	2.475 2.450	2.500 2.500	2.525 2.550	V
	FR1117-2.85	V_{IN} =4.85V, I_{OUT} =10mA 10mA ≤I_{OUT}≤0.8A, 4.35V≤V_{IN}≤12V	2.82 2.79	2.850 2.850	2.88 2.91	V
	FR1117-3.0	V_{IN} =5V, I_{OUT} =10mA 10mA ≤I_{OUT}≤0.8A, 4.5V ≤V_{IN}≤12V	2.970 2.940	3.000 3.000	3.300 3.360	V
	FR1117-3.3	V_{IN} =5.3V, I_{OU}T =10mA 10mA≤I_{OUT}≤0.8A, 4.8V≤V_{IN}≤12V	3.267 3.235	3.300 3.300	3.333 3.365	V
	FR1117-5.0	V_{IN} =7V, I_{OUT} =10mA 10mA≤I_{OUT}≤0.8A, 6.5V ≤V_{IN}≤15V	4.950 4.900	5.000 5.000	5.050 5.100	V
Line Regulation	FR1117	I_{OUT} = 10mA, 1.5V≤V_{IN} - V_{OUT}≤10V		0.035	0.2	%
	FR1117-1.5	3.0V≤V_{IN}≤12V		1	5	mV
	FR1117-1.8	3.3V≤V_{IN}≤12V		1	6	mV
	FR1117-2.5	4.0V≤V_{IN}≤12V		1	6	mV
	FR1117-2.85	4.35V≤V_{IN}≤12V		1	6	mV
	FR1117-3.0	4.5V≤V_{IN}≤12V		1	10	mV
	FR1117-3.3	4.8V≤V_{IN}≤12V		1	10	mV
	FR1117-5.0	6.5V≤V_{IN}≤15V		1	10	mV
Load Regulation (Note3)	FR1117	V_{IN} - V_{OUT} =1.5V, 10mA≤I_{OUT}≤0.8A		0.2	0.4	%
	FR1117-1.5	V_{IN} =3.0V, 0 ≤I_{OUT}≤0.8A		3	10	mV
	FR1117-1.8	V_{IN} =3.3V, 0 ≤I_{OUT}≤0.8A		3	10	mV
	FR1117-2.5	V_{IN} =4.0V, 0 ≤I_{OUT}≤0.8A		3	12	mV
	FR1117-2.85	V_{IN} =4.35V, 0 ≤I_{OUT}≤0.8A		3	12	mV
	FR1117-3.0	V_{IN} =4.5V, 0 ≤I_{OUT}≤0.8A		3	15	mV
	FR1117-3.3	V_{IN} =4.8V, 0 ≤I_{OUT}≤0.8A		3	15	mV
	FR1117-5.0	V_{IN} =6.5V, 0 ≤I_{OUT}≤0.8A		5	20	mV

Electrical Characteristics (Continued)

V_{IN}≤15V, T_A = 25°C unless otherwise specified.

Parameter	Device	Conditions	Min	Typ	Max	Unit
Dropout Voltage (Note2)	FR1117/1.5/1.8/2.5 /2.85/3.0/3.3/5.0	I_{OUT} = 100mA		0.95	1.2	V
		I_{OUT} = 500mA		0.98	1.25	V
		I_{OUT} = 800mA		1.15	1.3	V
Current Limit	FR1117/1.5/1.8/2.5 /2.85/3.0/3.3/5.0	V_{IN} = V_{OUT} +2V	1100	1500	2200	mA
Minimum Load Current	FR1117	1.5V≤V_{IN} - V_{OUT}≤10V		5	10	mA
Quiescent Current	FR1117/1.5/1.8/2.5 /2.85/3.0/3.3/5.0	V_{IN} = V_{OUT} +2V		5	10	mA
Adjust Pin Current	FR1117			60	120	uA
Adjust Pin Current Change	FR1117	10mA ≤I_{OUT}≤ 0.8A , 1.5V≤ V_{IN} - V_{OUT}≤10V		0.2	5	uA
Ripple Rejection (Note4)	FR1117	f =120Hz , C_{OUT} = 22uF Tantalum, I_{OUT} =0.8A, V_{IN} - V_{OUT} = 3V V_{IN} - V_{OUT} = 3V, C_{ADJ} =10uF	60	75		dB
	FR1117-1.5/1.8/2.5 /2.85/3.0	f =120Hz , C_{OUT} = 22uF Tantalum, I_{OUT} = 0.8A, V_{IN} = 6V	60	72		dB
	FR1117-3.3	f =120Hz , C_{OUT} = 22uF Tantalum, I_{OUT} = 0.8A, V_{IN} = 6.3V	60	72		dB
	FR1117-5.0	f =120Hz , C_{OUT} = 22uF Tantalum, I_{OUT} = 0.8A, V_{IN} = 8V	60	68		dB
Thermal Regulation	FR1117	T_A = 25°C, 30ms pulse		0.004	0.04	%/W
RMS Output Noise (Note4)		10Hz≤ f ≤10kHz (% of V_{OUT})		0.003		%

Note2：The dropout voltage is defined as V_{IN}-V_{OUT}, which is measured when V_{OUT} drops 2% of its normal value with the specified output current.

Note3：Load regulation and dropout voltage are measured at a constant junction temperature by using a 20ms low duty cycle current pulse.

Note4：Guarantee by design.

Typical Performance Curves

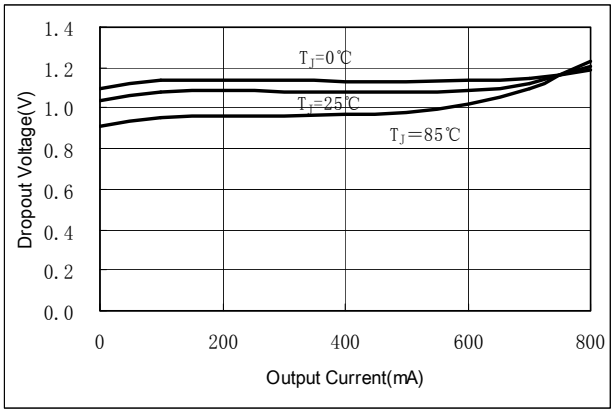


Figure 4.Dropout Voltage vs. Output Current

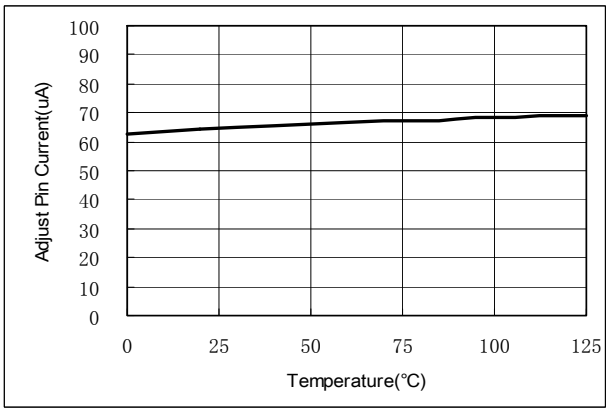


Figure 5.Adjust Pin Current vs. Temperature

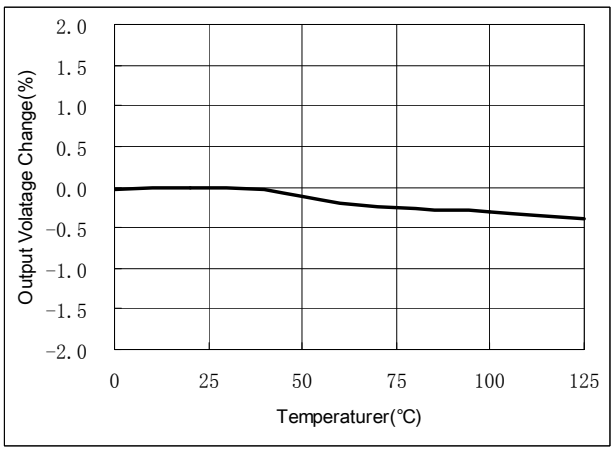


Figure 6.Outpout Voltage Change vs. Temperature

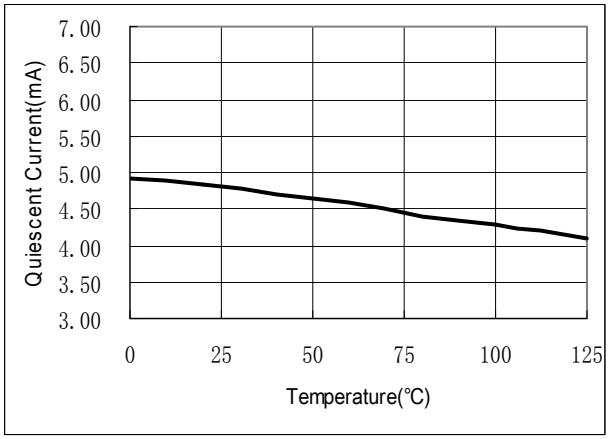


Figure 7.Quiescent Current vs. Temperature

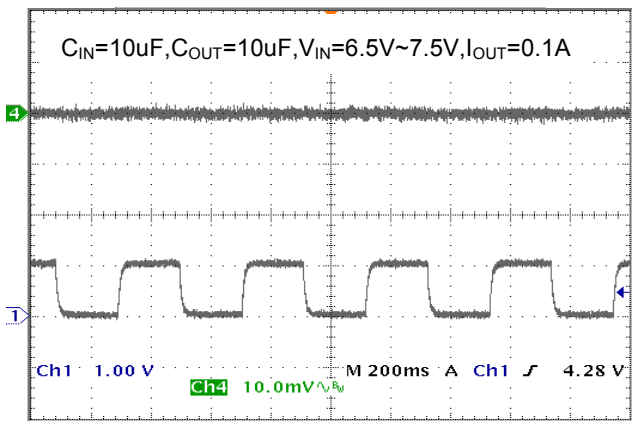


Figure 8.Line Transient Response

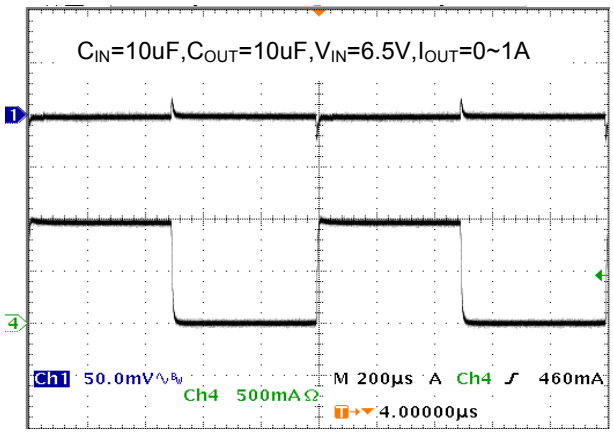


Figure 9.Load Transient Response

Application Information

Output Voltage

The FR1117 adjustable version develops a 1.25V reference voltage, V_{REF}, between the output and the adjust terminal. As shown in Figure 2, this voltage is applied across resistor R1 to generate a constant current I1. The current I_{ADJ} from the adjust terminal could introduce error to the output. But since it is very small (60μA) compared with the I1 and very constant with line and load changes, the error can be ignored. The constant current I1 then flows through the output set resistor R2 and sets the output voltage to the desired level.

For fixed voltage devices, R1 and R2 are integrated inside the devices.

Capacitor Selection

An input capacitor is recommended. A 10μF tantalum on the input is a suitable input bypassing for almost all applications.

An output capacitor is used as part of the device frequency compensation. The addition of 22μF tantalum on the output will ensure stability for all operating conditions.

When the adjustment terminal is bypassed with a capacitor to improve the ripple rejection, the requirement for an output capacitor increases. The value of 22μF tantalum covers all cases of bypassing the adjustment terminal. Without bypassing the adjustment terminal smaller capacitors can be used with equally good results.

To further improve stability and transient response of these devices larger values of output capacitor can be used.

Load Regulation

The FR1117 series is capable of providing excellent load regulation; but since these are three terminal devices, only partial remote load sensing is possible. There are two conditions that must be met to achieve the maximum available load regulation performance. As shown in Figure10, The first is that the top side of programming resistor R1 should be connected as close to the regulator case as practicable. This will minimize the voltage drop caused by wiring resistance Rp1 from appearing in series with reference voltage that is across R1.The second condition is that the ground end of R2 should be connected directly to the load.

This allows true Kelvin sensing where the regulator compensates for the voltage drop caused by wiring resistance Rp2.

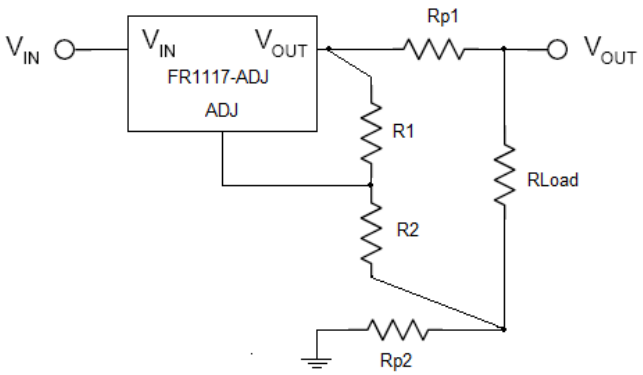


Figure 10.Load Sensing

Thermal Considerations

The FR1117 regulators have internal thermal shutdown to protect the device from over-heating. 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:

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

The next parameter which must be calculated is the maximum allowable temperature rise, $T_R(max)$:

$T_R(max) = T_J(max)-T_A(max)$

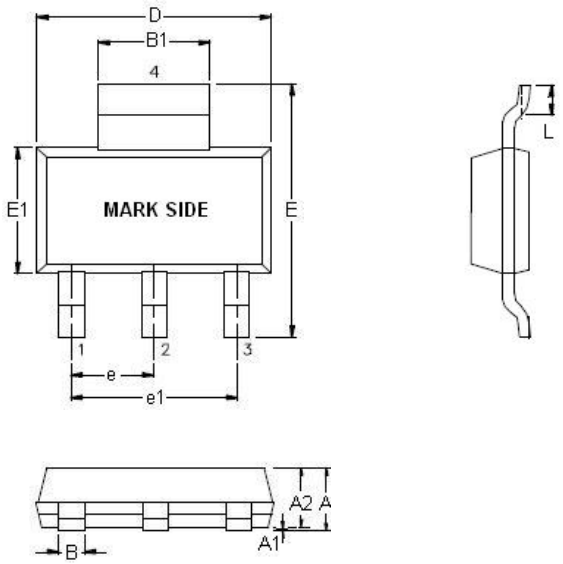
Where $T_J(max)$ is the maximum allowable junction temperature (125°C), and T_A (max) is the maximum ambient temperature which will be encountered in the application. Using the calculated values for $T_R(max)$ and P_D, the maximum allowable value for the junction-to-ambient thermal resistance (θ_{JA}) can be calculated:

$\theta_{JA} = T_R(max)/P_D$

If the maximum allowable value for θ_{JA} is found to be smaller than 135°C/W for SOT-223 package or 75°C/W for TO-252 package, no heatsink is needed since the package alone will dissipate enough heat to satisfy these requirements. If the calculated value for θ_{JA} falls below these limits, a heatsink is required.

Outline Information

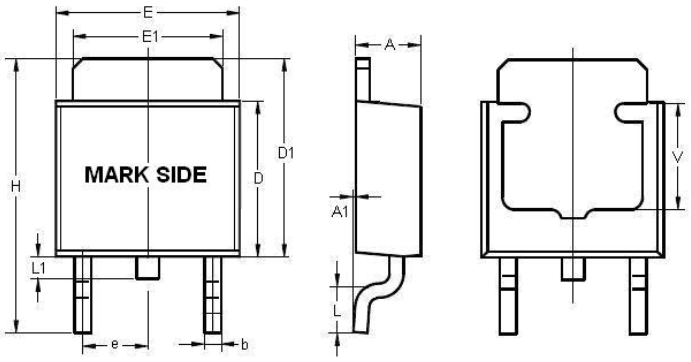
SOT-223 Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	1.55	1.80
A1	0.05	0.10
A2	1.50	1.70
B	0.60	0.84
B1	2.85	3.10
D	6.30	6.70
E1	3.30	3.70
E	6.70	7.30
e	2.20	2.40
e1	4.50	4.70
L	0.75	0.85

Note: Followed From JEDEC TO-261-C.

TO-252-3 Package (Unit: mm)



SYMBOLS UNIT	DIMENSION IN MILLIMETER	
	MIN	MAX
A	2.22	2.40
A1	0.01	0.15
b	0.75	0.10
D	6.00	6.20
D1	7.05	7.35
E	6.40	6.60
E1	5.20	5.45
e	2.20	2.40
L	1.40	1.70
L1	0.65	0.95
H	9.60	10.20
V	3.60	4.00

Note：Followed From JEDEC TO-252-E.