

## 1A Low Dropout Fast Response Positive Adjustable Regulator and Fixed 1.8V, 2.5V, 2.85V, 3.3V and 5V

### Features

- Guaranteed Output Voltage Accuracy within 2%
- Fast Transient Response
- Guaranteed Dropout Voltage at Multiple Currents
- Load Regulation : 0.1% Typ.
- Line Regulation : 0.03% Typ.
- Low Dropout Voltage : 1.1V Typ. at  $I_{OUT} = 1A$
- Current Limit : 1A Typ. at  $T_J = 25^{\circ}C$
- On-Chip Thermal Limiting :  $150^{\circ}C$  Typ.
- Adjustable Output : 1.25~10.7V
- Standard 3-pin TO-220, TO-252, TO-263 and SOT-223 Power Packages

### General Description

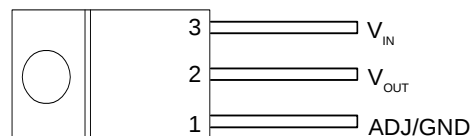
The HPL1117 is a low dropout three-terminal adjustable regulators with 1A output current capability. In order to obtain lower dropout voltage and faster transient response, which is critical for low voltage applications, the HPL1117 has been optimized. The device is available in an adjustable version and fixed output voltages of 1.8V, 2.5V, 2.85V, 3.3V and 5V. The output available voltage range of an adjustable version is from 1.25~10.7V with an input supply below 12V. Dropout voltage is guaranteed at a maximum of 1.3V at 1A. Current limit is trimmed to ensure specified output current and controlled short-circuit current. On-chip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures. The HPL1117 is available in the industry standard 3-pin TO-220, TO-252, TO-263, and the low profile surface mount SOT-223 power packages which can be used in applications where space is limited.

### Applications

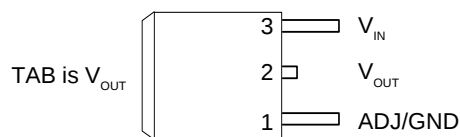
- Active SCSI Terminators
- Low Voltage Logic Supplies
- Post Regulator for Switching Power Supply

### Pin Description

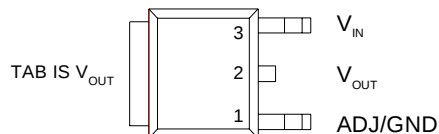
Front View for TO-220



Front View for TO-263

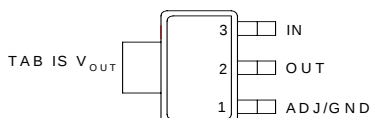


Front View for TO-252



## Pin Description (Cont.)

Front View for SOT-223



## Ordering and Marking Information

|                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>HPL1117-□□□□-□□□</p> <p>Lead Free Code<br/>Handling Code<br/>Temp. Range<br/>Package Code<br/>Voltage Code</p>                | <p>Package Code<br/>F : TO-220 G : TO-263 U : TO-252 V : SOT-223<br/>Temp. Range<br/>C : 0 to 70°C<br/>Handling Code<br/>TU : Tube TR : Tape &amp; Reel<br/>Voltage Code<br/>18 : 1.8V 25 : 2.5V 28 : 2.85V 33 : 3.3V<br/>50 : 5V<br/>Blank : Adjustable Version<br/>Lead Free Code<br/>L : Lead Free Device Blank : Original Device</p> |
| <p>HPL1117 F/G/U : <span style="border: 1px solid black; padding: 2px;">HPL1117<br/>XXXXX</span> XXXXX - Date Code</p>           | <p>HPL1117 V : <span style="border: 1px solid black; padding: 2px;">HPL1117<br/>XXXXX</span> XXXXX - Date Code</p>                                                                                                                                                                                                                       |
| <p>HPL1117-18F/G/U : <span style="border: 1px solid black; padding: 2px;">18<br/>HPL1117<br/>XXXXX</span> XXXXX - Date Code</p>  | <p>HPL1117-18V : <span style="border: 1px solid black; padding: 2px;">HPL1117<br/>XXXXX18</span> XXXXX - Date Code</p>                                                                                                                                                                                                                   |
| <p>HPL1117-25F/G/U : <span style="border: 1px solid black; padding: 2px;">25<br/>HPL1117<br/>XXXXX</span> XXXXX - Date Code</p>  | <p>HPL1117-25V : <span style="border: 1px solid black; padding: 2px;">HPL1117<br/>XXXXX25</span> XXXXX - Date Code</p>                                                                                                                                                                                                                   |
| <p>HPL1117-28F/G/U : <span style="border: 1px solid black; padding: 2px;">28<br/>HPL1117<br/>XXXXX</span> XXXXX - Date Code</p>  | <p>HPL1117-28V : <span style="border: 1px solid black; padding: 2px;">HPL1117<br/>XXXXX28</span> XXXXX - Date Code</p>                                                                                                                                                                                                                   |
| <p>HPL1117 -33F/G/U : <span style="border: 1px solid black; padding: 2px;">33<br/>HPL1117<br/>XXXXX</span> XXXXX - Date Code</p> | <p>HPL1117-33V : <span style="border: 1px solid black; padding: 2px;">HPL1117<br/>XXXXX33</span> XXXXX - Date Code</p>                                                                                                                                                                                                                   |
| <p>HPL1117 -50F/G/U : <span style="border: 1px solid black; padding: 2px;">50<br/>HPL1117<br/>XXXXX</span> XXXXX - Date Code</p> | <p>HPL1117-50V : <span style="border: 1px solid black; padding: 2px;">HPL1117<br/>XXXXX50</span> XXXXX - Date Code</p>                                                                                                                                                                                                                   |

## Absolute Maximum Ratings

| Symbol    | Parameter                                                                              | Rating <sup>(Note)</sup> | Unit |
|-----------|----------------------------------------------------------------------------------------|--------------------------|------|
| $V_I$     | Input Voltage<br>HPL1117, HPL1117-50, HPL1117-33<br>HPL1117-25, HPL1117-18, HPL1117-28 | 15<br>9                  | V    |
| $T_J$     | Operating Junction Temperature Range<br>Control Section<br>Power Transistor            | 0 to 125<br>0 to 150     | °C   |
| $T_{STG}$ | Storage Temperature Range                                                              | -65 to +150              | °C   |
| $T_L$     | Lead Temperature (Soldering, 10 second)                                                | 260                      | °C   |

Note : The values here show the absolute maximum rating, and for normal usage please refer the test condition in Electrical Characteristics Table.

## Electrical Characteristics

Unless otherwise noted , these specifications apply over  $C_{IN}=10\mu F$  ,  $C_{OUT}=10\mu F$  , and  $T_J=0$  to  $125^\circ C$ . Typical values refer to  $T_J=25^\circ C$ .

| Symbol       | Parameter                                                                                        | Test Conditions                                                                                                                                                                                                                                                                                                                                                                                                                                                         | HPL1117                                   |                                           |                                           | Unit |
|--------------|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|-------------------------------------------|-------------------------------------------|------|
|              |                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Min.                                      | Typ.                                      | Max.                                      |      |
| $V_{REF}$    | Reference Voltage                                                                                | $10mA \leq I_{OUT} \leq 1A$ , $1.4V \leq (V_{IN} - V_{OUT}) \leq 10.75V$ ,<br>$T_J = 0 \sim 125^\circ C$                                                                                                                                                                                                                                                                                                                                                                | 1.225                                     | 1.250                                     | 1.275                                     | V    |
| $V_{OUT}$    | Output Voltage<br>HPL1117-18<br>HPL1117-25<br>HPL1117-28<br>HPL1117-33<br>HPL1117-50             | $T_J = 0 \sim 125^\circ C$ ,<br>$0 \leq I_{OUT} \leq 1A$ , $3.1V \leq V_{IN} \leq 9V$ ,<br>$T_J = 0 \sim 125^\circ C$ ,<br>$0 \leq I_{OUT} \leq 1A$ , $3.8V \leq V_{IN} \leq 9V$ ,<br>$T_J = 0 \sim 125^\circ C$ ,<br>$0 \leq I_{OUT} \leq 1A$ , $4.25V \leq V_{IN} \leq 9V$ ,<br>$T_J = 0 \sim 125^\circ C$ ,<br>$0 \leq I_{OUT} \leq 1A$ , $4.6V \leq V_{IN} \leq 12V$ ,<br>$T_J = 0 \sim 125^\circ C$ ,<br>$0 \leq I_{OUT} \leq 1A$ , $6.45V \leq V_{IN} \leq 12V$ , | 1.764<br>2.450<br>2.790<br>3.235<br>4.900 | 1.800<br>2.500<br>2.850<br>3.300<br>5.000 | 1.836<br>2.550<br>2.910<br>3.365<br>5.100 | V    |
| $REG_{LINE}$ | Line Regulation<br>HPL1117<br>HPL1117-18<br>HPL1117-25<br>HPL1117-28<br>HPL1117-33<br>HPL1117-50 | $I_{OUT}=10mA$ , $1.5V \leq (V_{IN} - V_{OUT}) \leq 10.75V$ (Note1)<br>$I_{OUT}=0A$ , $3.5V \leq V_{IN} \leq 9V$ (Note1)<br>$I_{OUT}=0A$ , $4V \leq V_{IN} \leq 9V$ (Note1)<br>$I_{OUT}=0A$ , $4.25V \leq V_{IN} \leq 9V$ (Note1)<br>$I_{OUT}=0A$ , $4.75V \leq V_{IN} \leq 12V$ (Note1)<br>$I_{OUT}=0A$ , $6.45V \leq V_{IN} \leq 12V$ (Note1)                                                                                                                         |                                           | 0.03<br>1<br>1<br>1<br>1<br>1             | 0.2<br>6<br>6<br>6<br>6<br>6              | %mV  |
| $REG_{LOAD}$ | Load Regulation<br>HPL1117<br>HPL1117-18<br>HPL1117-25<br>HPL1117-28<br>HPL1117-33<br>HPL1117-50 | $(V_{IN} - V_{OUT})=3V$ , $0 \leq I_{OUT} \leq 1A$ (Note1)<br>$V_{IN}=3.5V$ , $0 \leq I_{OUT} \leq 1A$ (Note1)<br>$V_{IN}=4V$ , $0 \leq I_{OUT} \leq 1A$ (Note1)<br>$V_{IN}=4.25V$ , $0 \leq I_{OUT} \leq 1A$ (Note1)<br>$V_{IN}=4.75V$ , $0 \leq I_{OUT} \leq 1A$ (Note1)<br>$V_{IN}=6.45V$ , $0 \leq I_{OUT} \leq 1A$ (Note1)                                                                                                                                         |                                           | 0.1<br>1<br>1<br>1<br>1<br>1              | 0.4<br>10<br>10<br>10<br>10<br>10         | %mV  |

## Electrical Characteristics (Cont.)

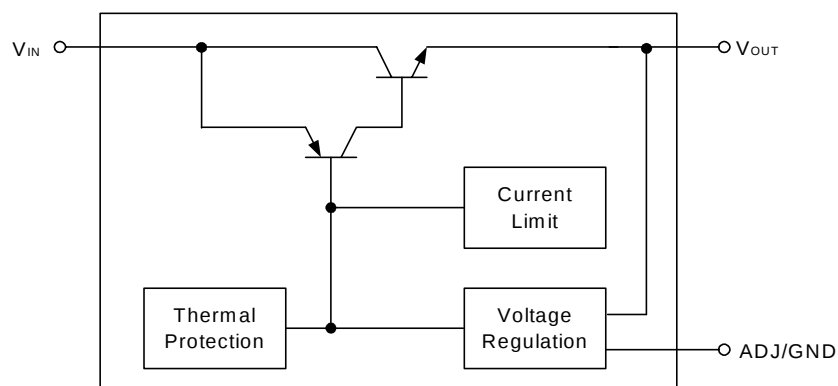
| Symbol           | Parameter                            | Test Conditions                                                                                             | HPL1117 |                  |                   | Unit          |
|------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------|---------|------------------|-------------------|---------------|
|                  |                                      |                                                                                                             | Min.    | Typ.             | Max.              |               |
| $V_D$            | Dropout Voltage                      | $I_{OUT}=100mA$ <sup>(Note2)</sup><br>$I_{OUT}=500mA$ <sup>(Note2)</sup><br>$I_{OUT}=1A$ <sup>(Note2)</sup> |         | 1<br>1.05<br>1.1 | 1.1<br>1.2<br>1.3 | V             |
| $I_{LIMIT}$      | Current Limit                        | $(V_{IN}-V_{OUT})=5V$ , $T_J=25^{\circ}C$                                                                   | 1000    |                  |                   | mA            |
| $I_{ADJ}$        | Adjust Pin Current<br>HPL1117        | $(V_{IN}-V_{OUT})=3V$ , $I_{OUT}=10mA$                                                                      |         | 60               | 120               | $\mu A$       |
| $\Delta I_{ADJ}$ | Adjust Pin Current<br>Change HPL1117 | $10mA \leq I_{OUT} \leq 1A$ ,<br>$1.4V \leq (V_{IN}-V_{OUT}) \leq 10.75V$                                   |         | 0.2              | 5                 | $\mu A$       |
| $I_O$            | Minimum Load<br>Current HPL1117      | $(V_{IN}-V_{OUT})=10.75V$ <sup>(Note3)</sup>                                                                |         | 1.7              |                   | mA            |
| PSRR             | Ripple Rejection                     | $f_{RIPPLE}=120Hz$ , $V_{RIPPLE}=1V_{P-P}$ ,<br>$(V_{IN}-V_{OUT})=3V$                                       | 60      | 75               |                   | dB            |
| $T_R$            | Thermal Regulation                   | $T_J=25^{\circ}C$ , 30ms Pulse                                                                              |         | 0.01             | 0.02              | %/W           |
| $T_S$            | Temperature<br>Stability             |                                                                                                             |         | 0.5              |                   | %             |
| $L_S$            | Long -Term Stability                 | $T_J=125^{\circ}C$ , 1000Hrs.                                                                               |         | 0.3              |                   | %             |
| $V_N$            | RMS Output Noise                     | $T_J=25^{\circ}C$ , $10Hz \leq F \leq 10kHz$ , (% of $V_{OUT}$ )                                            |         | 0.003            |                   | %             |
| $\theta_{th}$    | Thermal Resistance                   | Junction to Case, at Tab<br>Junction to Ambient                                                             |         | 15<br>50         |                   | $^{\circ}C/W$ |
| OT               | Over Temperature<br>Point            |                                                                                                             |         | 150              |                   | $^{\circ}C$   |
| $I_Q$            | Quiescent Current                    |                                                                                                             |         |                  |                   |               |
|                  | HPL1117-18                           | $V_{IN} \leq 9V$                                                                                            |         | 5.5              | 10                | mA            |
|                  | HPL1117-25                           | $V_{IN} \leq 9V$                                                                                            |         | 5.5              | 10                |               |
|                  | HPL1117-28                           | $V_{IN} \leq 9V$                                                                                            |         | 5.5              | 10                |               |
|                  | HPL1117-33                           | $V_{IN} \leq 12V$                                                                                           |         | 5.5              | 10                |               |
|                  | HPL1117-50                           | $V_{IN} \leq 12V$                                                                                           |         | 5.5              | 10                |               |

Note 1 : See thermal regulation specifications for changes in output voltage due to heating effects. Load line regulations are measured at a constant junction temperature by low duty cycle pulse testing.

Note 2 : Dropout voltage is specified over the full output current range of the device. Dropout voltage is defined as the minimum input/output differential measured at the specified output current. Test points and limits are also shown on the Dropout Voltage curve.

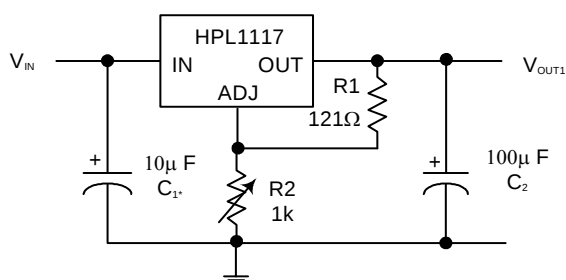
Note 3 : Minimum load current is defined as the minimum output current required to maintain regulation.

## Block Diagram



## Application Circuits

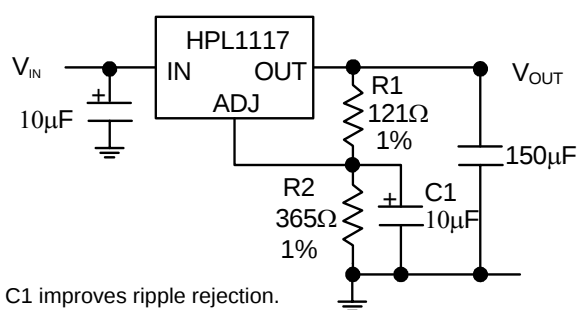
1.25V to 10.7V Adjustable Regulator



\* Needed if device is far from filter capacitors

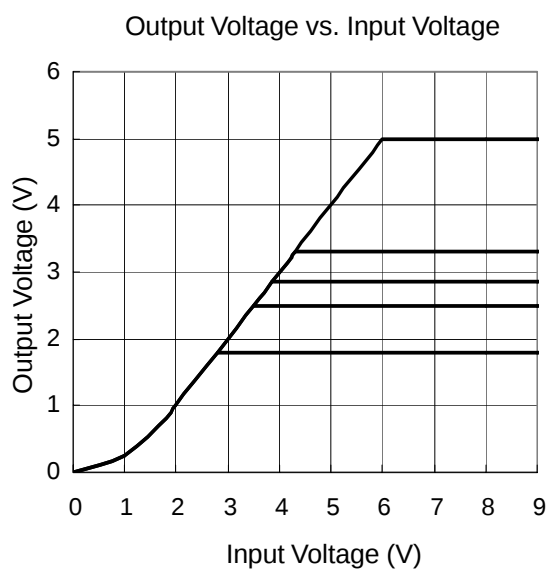
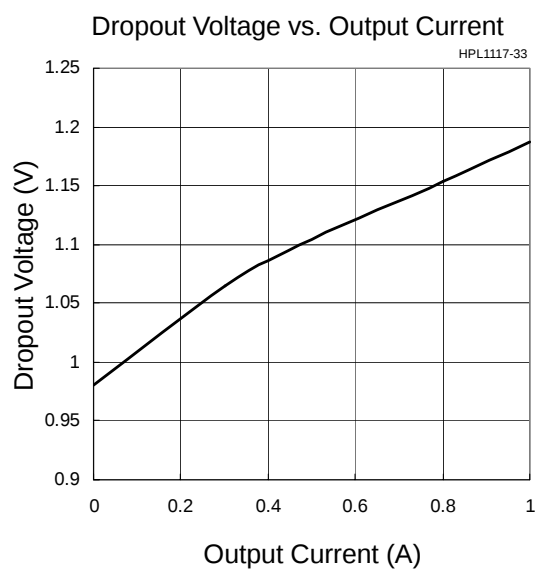
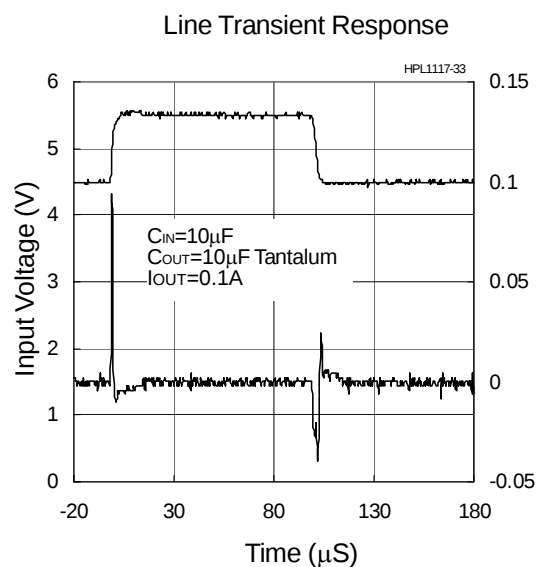
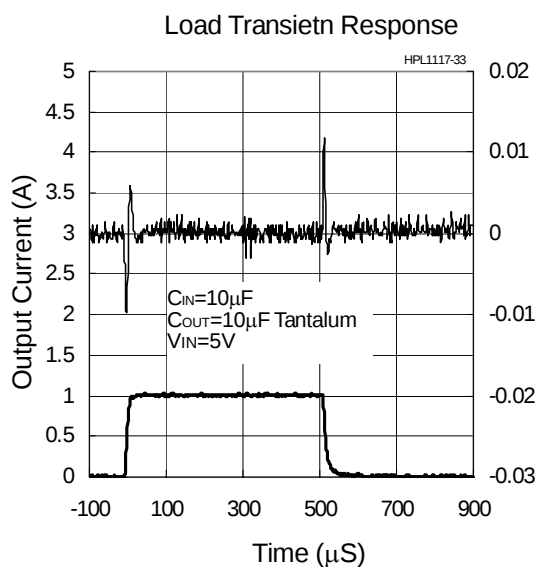
$$V_{OUT} = 1.250V \times \frac{R1 + R2}{R1}$$

Improving Ripple Rejection



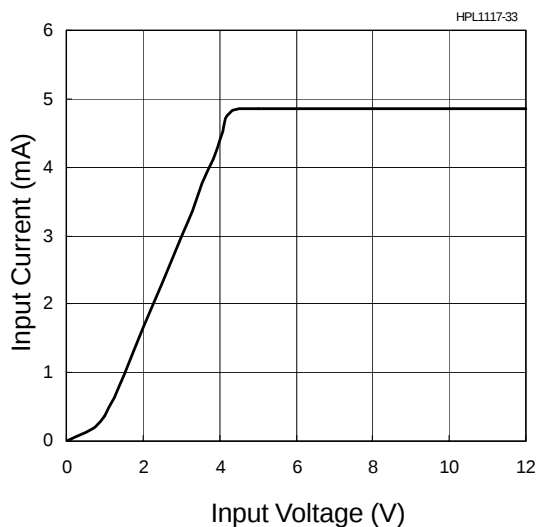
\* C1 improves ripple rejection.  
X<sub>C</sub> should be approximately  
equal to R1 at ripple frequency

## Typical Characteristics

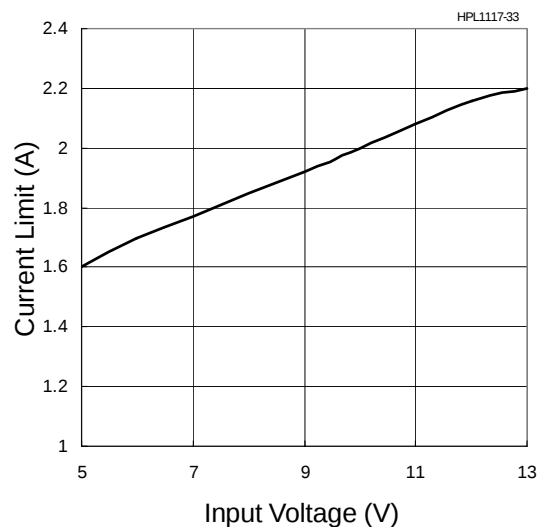


## Typical Characteristics Cont.

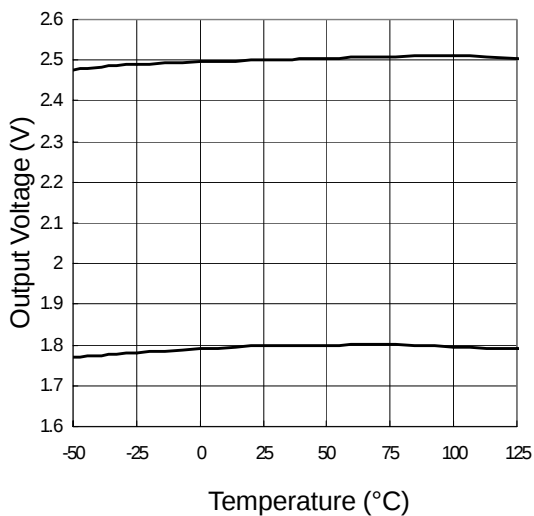
Input Current vs. Input Voltage



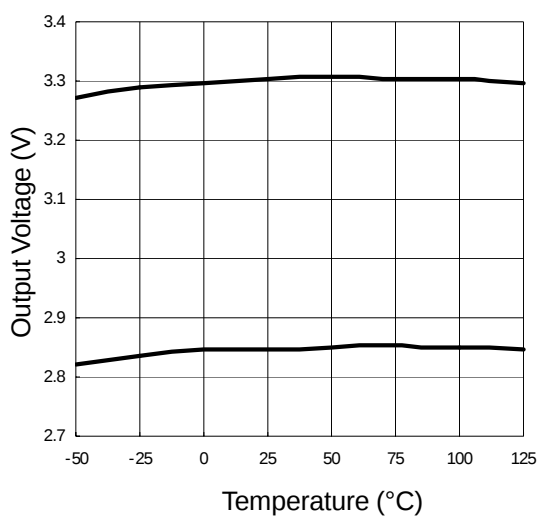
Current Limit vs. Input Voltage



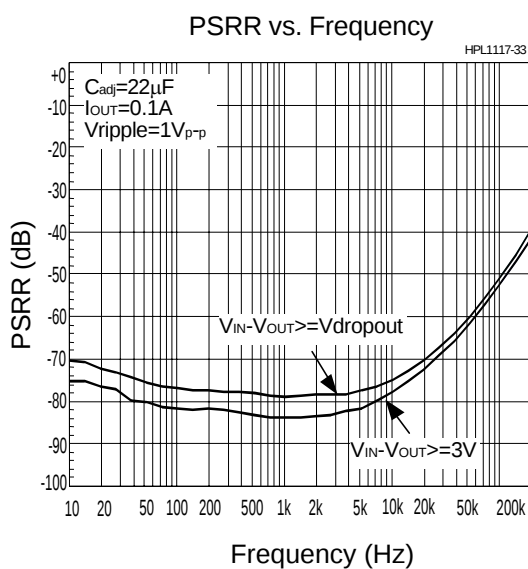
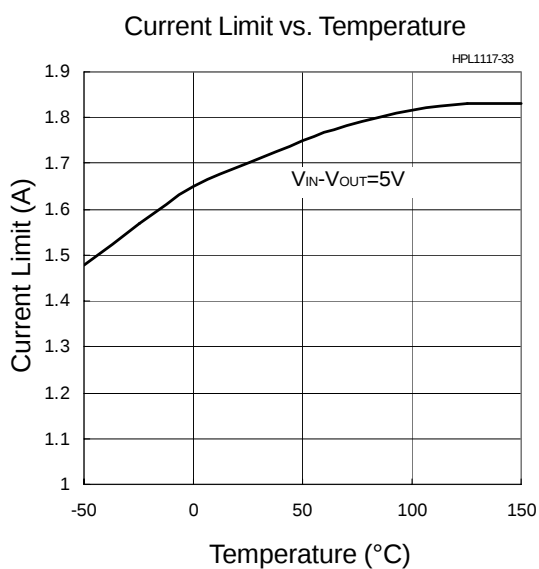
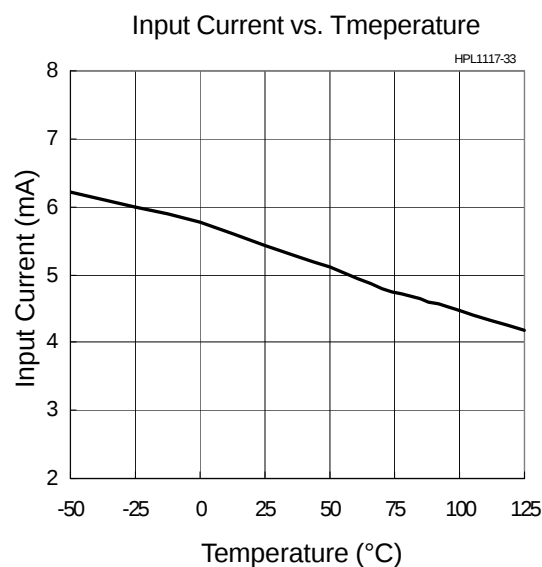
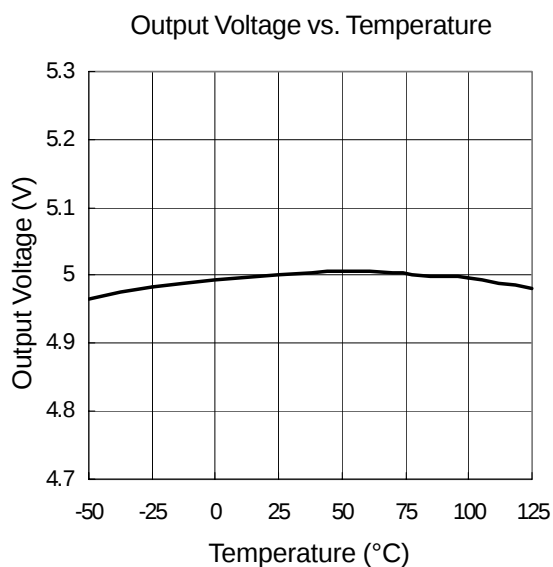
Output Voltage vs. Temperature

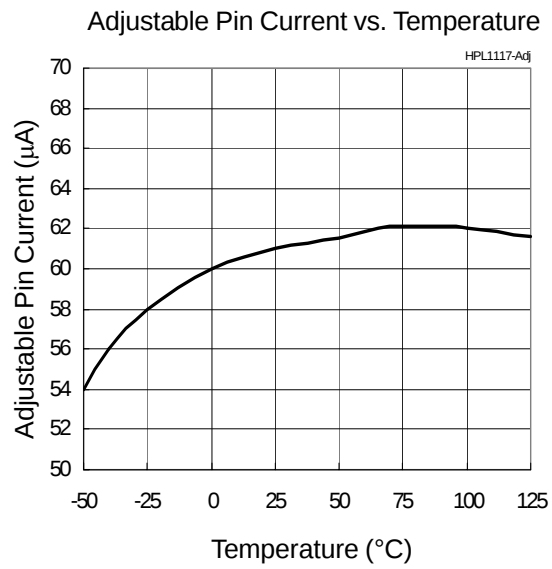


Output Voltage vs. Temperature



## Typical Characteristics Cont.



**Typical Characteristics Cont.**

## Application Information

### Output Voltage

The HPL1117 develops a 1.25V reference voltage between the output and the adjust terminal. By placing a resistor between these two terminals, a constant Current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is chosen to be the specified minimum load current of 10mA. For fixed voltage devices R1 and R2 are included in the device.

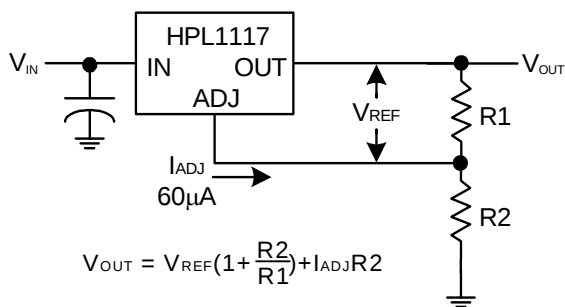


Figure 1. Basic Adjustable Regulator

### Load Regulation

When the adjustable regulator is used. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the output pin of the device. Best load regulation is obtained when the top of the resistor divider (R1) is tied directly to the output pin of the device, not to the load. For fixed voltage devices the top of R1 is internally connected to the output, and the ground pin can be connected to low side of the load. If R1 were connected to the load,  $R_p$  is multiplied by the divider ratio, the effective resistance between the regulator and the load would be:

$$R_p \times \left(1 + \frac{R_2}{R_1}\right), R_p = \text{Parasitic Line Resistance}$$

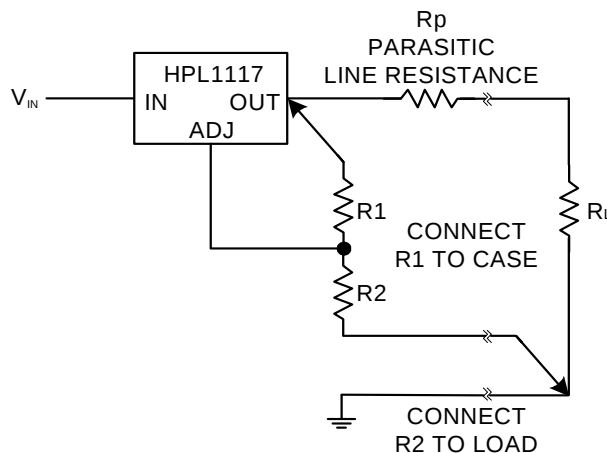


Figure 2. Connections for Best Load Regulation

### Input Capacitor

An input capacitor of 10µF or greater is recommended. Tantalum, or aluminum electrolytic capacitors can be used for bypassing. Larger values will improve ripple rejection by bypassing the input to the regulator.

### Output Capacitor

The HPL1117 requires an output capacitor to maintain stability and improve transient response. Proper capacitor selection is important to ensure proper operation. The HPL1117 output capacitor selection is dependent upon the ESR (equivalent series resistance) of the output capacitor to maintain stability. When the output capacitor is 10µF or greater, the output capacitor should have an ESR less than 1Ω. This will improve transient response as well as promote stability. A low-ESR solid tantalum capacitor works extremely well and provides good transient response and stability over temperature.

## Application Information (Cont.)

### Output Capacitor (Cont.)

Aluminum electrolytics can also be used, as long as the ESR of the capacitor is  $<1\Omega$ . The value of the output capacitor can be increased without limit. Higher capacitance values help to improve transient response and ripple rejection and reduce output noise.

### Ripple Rejection

The curves for Ripple Rejection were generated using an adjustable device with the adjust pin bypassed. With a  $22\mu\text{F}$  bypassing capacitor 75dB ripple rejection is obtainable at any output level. The impedance of the adjust pin capacitor, at the ripple frequency, should be  $< R1$ .  $R1$  is normally in the range of  $100\Omega$ - $200\Omega$ . The size of the required adjust pin capacitor is a function of the input ripple frequency. At 120Hz, with  $R1=100\Omega$ , the adjust pin capacitor should be  $13\mu\text{F}$ . For fixed voltage devices, and adjustable devices without an adjust pin capacitor, the output ripple will increase as the ratio of the output voltage to the reference voltage ( $V_{\text{OUT}}/V_{\text{REF}}$ ).

### Thermal Considerations

HPL1117 has thermal protection which limits junction temperature to  $150^\circ\text{C}$ . However, device functionality is only guaranteed to a maximum junction temperature of  $+125^\circ\text{C}$ .

Both the TO-220, TO-252, TO-263 and SOT-223 packages use a copper plane on the PCB and the PCB itself as a heatsink. To optimize the heat sinking ability of the plane and PCB, solder the tab of the package to the plane.

Figure 3&4 shows for the TO-252 and SOT-223 the measured values of  $\theta(\text{J-A})$  for different copper area sizes using a 2 layers, 1.6mm, and 6Sq. cm FR-4 PCB with 2oz. copper and a ground plane layer on the backside area used for heatsinking. It can be used as a rough guideline in estimating thermal resistance.

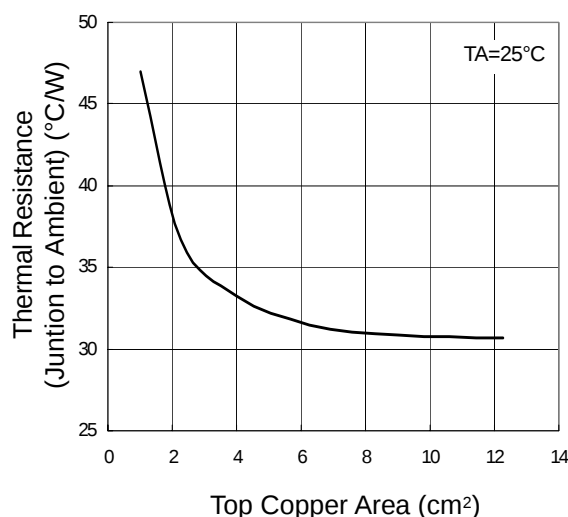


Figure 3.

$\theta(\text{J-A})$  vs. copper area for the TO-252 package

## Application Information (Cont.)

### Thermal Considerations (Cont.)

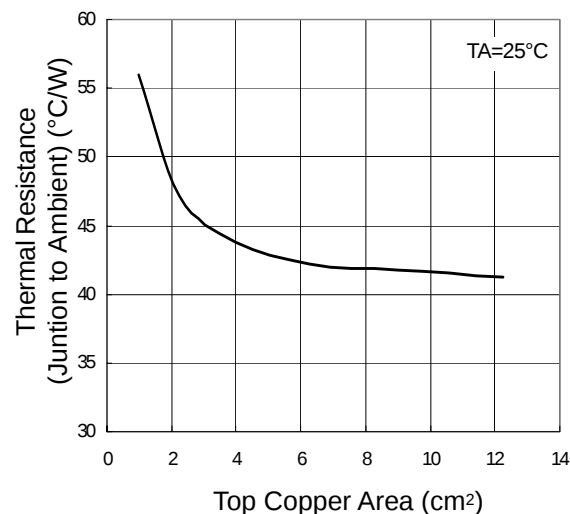


Figure 4.

$\theta(J-A)$  vs. copper area for the SOT-223 package

The thermal resistance for each application will be affected by thermal interactions with other components on the board. Some experimentation will be necessary to determine the actual value.

The power dissipation of HPL1117 is equal to :

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

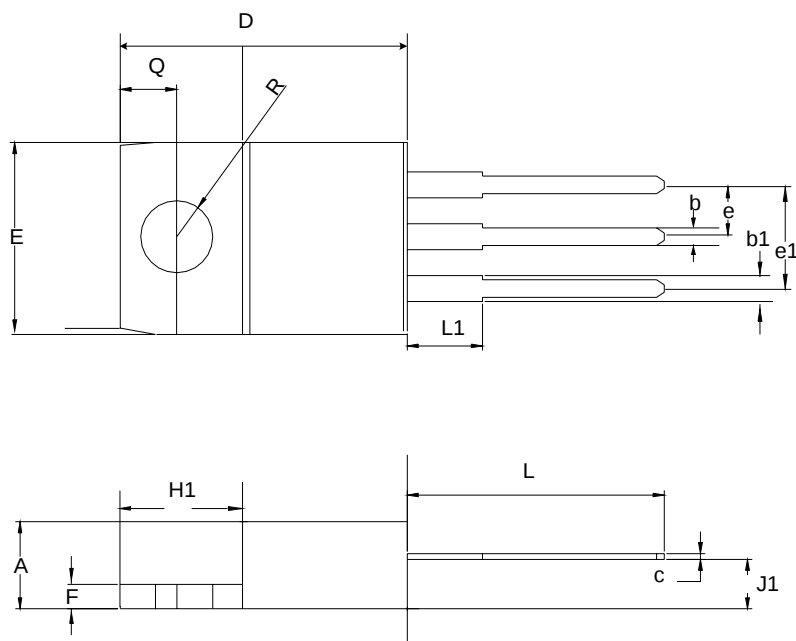
Maximum junction temperature is equal to :

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

Note:  $T_{JUNCTION}$  must not exceed 125°C

## Package Information

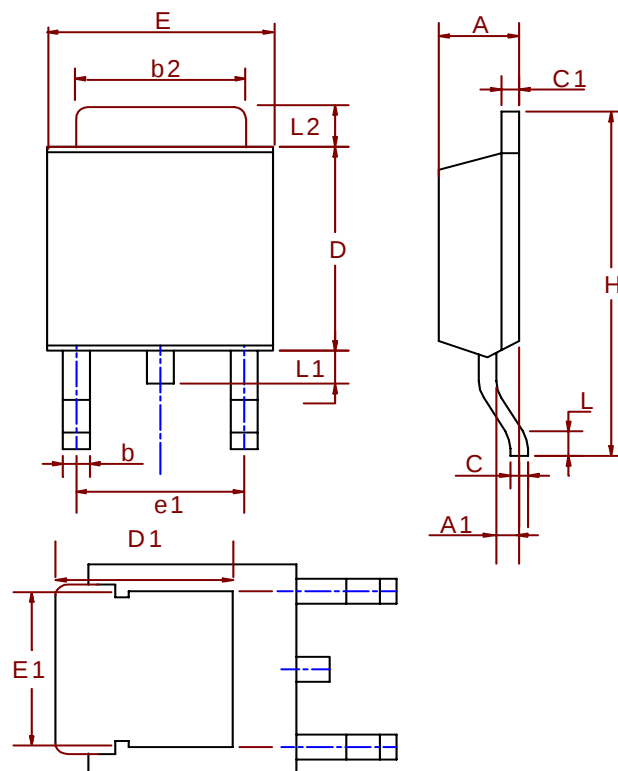
TO-220 ( Reference JEDEC Registration TO-220)



| Dim | Millimeters |       | Inches |       |
|-----|-------------|-------|--------|-------|
|     | Min.        | Max.  | Min.   | Max.  |
| A   | 3.56        | 4.83  | 0.140  | 0.190 |
| b1  | 1.14        | 1.78  | 0.045  | 0.070 |
| b   | 0.51        | 1.14  | 0.020  | 0.045 |
| c   | 0.31        | 1.14  | 0.012  | 0.045 |
| D   | 14.23       | 16.51 | 0.560  | 0.650 |
| e   | 2.29        | 2.79  | 0.090  | 0.110 |
| e1  | 4.83        | 5.33  | 0.190  | 0.210 |
| E   | 9.65        | 10.67 | 0.380  | 0.420 |
| F   | 0.51        | 1.40  | 0.020  | 0.055 |
| H1  | 5.84        | 6.86  | 0.230  | 0.270 |
| J1  | 2.03        | 2.92  | 0.080  | 0.115 |
| L   | 12.7        | 14.73 | 0.500  | 0.580 |
| L1  | 3.65        | 6.35  | 0.143  | 0.250 |
| R   | 3.53        | 4.09  | 0.139  | 0.161 |
| Q   | 2.54        | 3.43  | 0.100  | 0.135 |

## Package Informaion

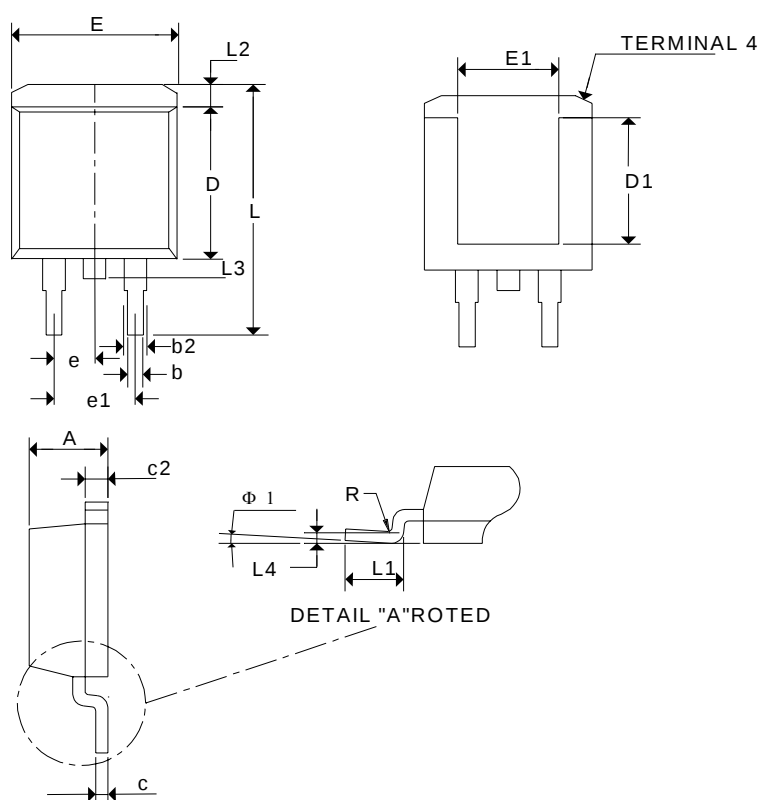
TO-252( Reference JEDEC Registration TO-252)



| Dim | Millimeters |       | Inches    |       |
|-----|-------------|-------|-----------|-------|
|     | Min.        | Max.  | Min.      | Max.  |
| A   | 2.18        | 2.39  | 0.086     | 0.094 |
| A1  | 0.89        | 1.27  | 0.035     | 0.050 |
| b   | 0.508       | 0.89  | 0.020     | 0.035 |
| b2  | 5.207       | 5.461 | 0.205     | 0.215 |
| C   | 0.46        | 0.58  | 0.018     | 0.023 |
| C1  | 0.46        | 0.58  | 0.018     | 0.023 |
| D   | 5.334       | 6.22  | 0.210     | 0.245 |
| D1  | 5.2 REF     |       | 0.205 REF |       |
| E   | 6.35        | 6.73  | 0.250     | 0.265 |
| E1  | 5.3 REF     |       | 0.209 REF |       |
| e1  | 3.96        | 5.18  | 0.156     | 0.204 |
| H   | 9.398       | 10.41 | 0.370     | 0.410 |
| L   | 0.51        |       | 0.020     |       |
| L1  | 0.64        | 1.02  | 0.025     | 0.040 |
| L2  | 0.89        | 2.032 | 0.035     | 0.080 |

## Package Information

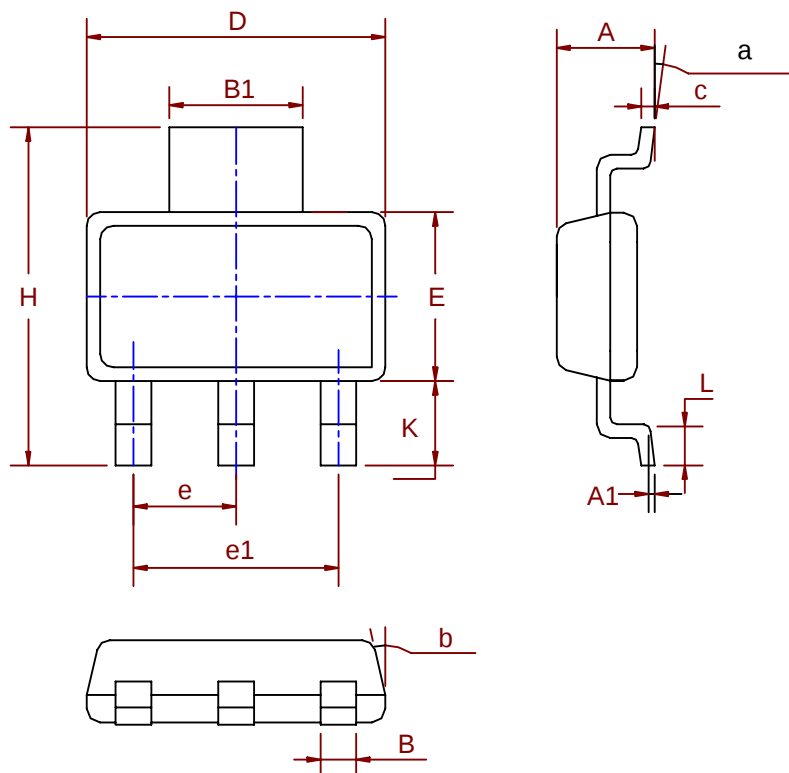
TO-263 ( Reference JEDEC Registration TO-263)



| Dim | Millimeters |       | Inches     |       |
|-----|-------------|-------|------------|-------|
|     | Min.        | Max.  | Min.       | Max.  |
| A   | 4.06        | 4.83  | 0.160      | 0.190 |
| b   | 0.51        | 1.016 | 0.02       | 0.040 |
| b2  | 1.14        | 1.651 | 0.045      | 0.065 |
| c   | 0.38 TYP.   |       | 0.015 TYP. |       |
| c2  | 1.14        | 1.40  | 0.045      | 0.055 |
| D   | 8.64        | 9.65  | 0.340      | 0.380 |
| e   | 9.65        | 10.54 | 0.380      | 0.415 |
| e1  | 2.54 TYP    |       | 0.100 TYP  |       |
| L   | 14.60       | 15.88 | 0.575      | 0.625 |
| L1  | 2.24        | 2.84  | 0.090      | 0.110 |
| L2  | 1.02        | 2.92  | 0.040      | 0.112 |
| L3  | 1.20        | 1.78  | 0.050      | 0.070 |

## Package Information

SOT-223( Reference JEDEC Registration SOT-223)

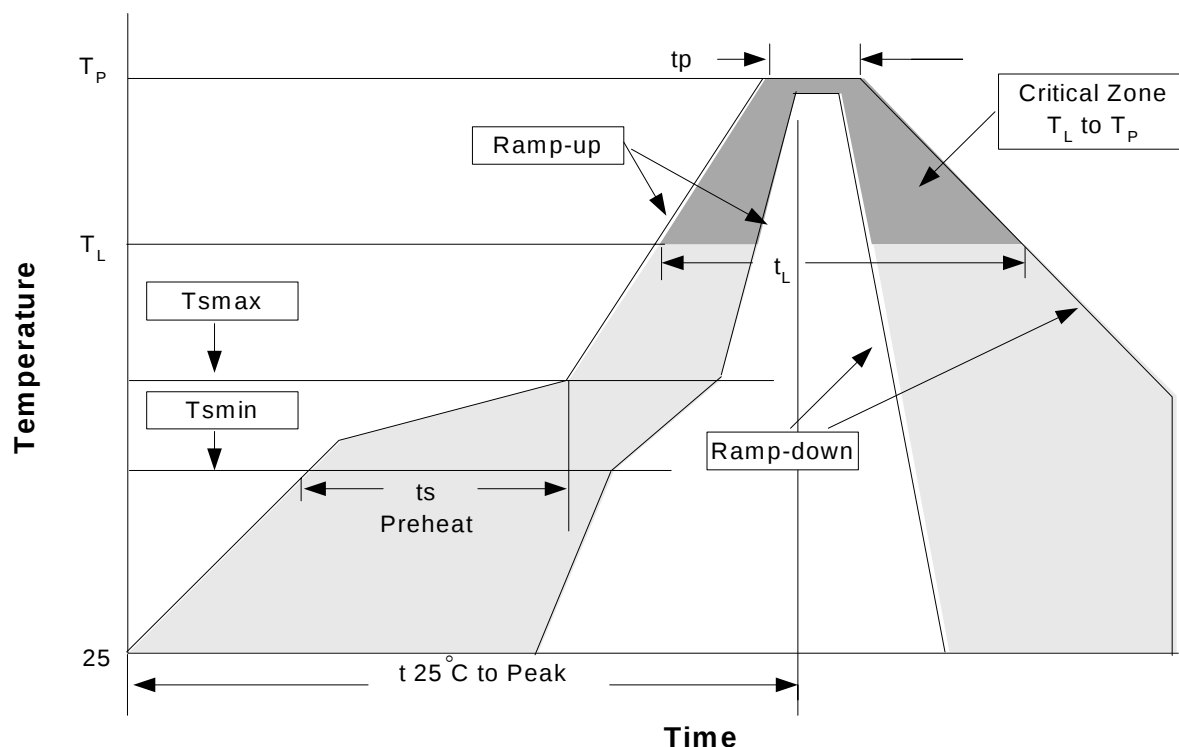


| Dim      | Millimeters |      | Inches   |      |
|----------|-------------|------|----------|------|
|          | Min.        | Max. | Min.     | Max. |
| A        | 1.50        | 1.80 | 0.06     | 0.07 |
| A1       | 0.02        | 0.08 |          |      |
| B        | 0.60        | 0.80 | 0.02     | 0.03 |
| B1       | 2.90        | 3.10 | 0.11     | 0.12 |
| c        | 0.28        | 0.32 | 0.01     | 0.01 |
| D        | 6.30        | 6.70 | 0.25     | 0.26 |
| E        | 3.30        | 3.70 | 0.13     | 0.15 |
| e        | 2.3 BSC     |      | 0.09 BSC |      |
| e1       | 4.6 BSC     |      | 0.18 BSC |      |
| H        | 6.70        | 7.30 | 0.26     | 0.29 |
| L        | 0.91        | 1.10 | 0.04     | 0.04 |
| K        | 1.50        | 2.00 | 0.06     | 0.08 |
| $\alpha$ | 0°          | 10°  | 0°       | 10°  |
| $\beta$  | 13°         |      | 13°      |      |

## Physical Specifications

|                    |                                                              |
|--------------------|--------------------------------------------------------------|
| Terminal Material  | Solder-Plated Copper (Solder Material : 90/10 or 63/37 SnPb) |
| Lead Solderability | Meets EIA Specification RSI86-91, ANSI/J-STD-002 Category 3. |
| Packaging          | 2500 devices per reel                                        |

### Reflow Condition (IR/Convection or VPR Reflow)



### Classification Reflow Profiles

| Profile Feature                                     | Sn-Pb Eutectic Assembly |               | Pb-Free Assembly |               |
|-----------------------------------------------------|-------------------------|---------------|------------------|---------------|
|                                                     | Large Body              | Small Body    | Large Body       | Small Body    |
| Average ramp-up rate ( $T_L$ to $T_P$ )             | 3°C/second max.         |               | 3°C/second max.  |               |
| Preheat                                             | 100°C                   |               | 150°C            |               |
| - Temperature Min ( $T_{min}$ )                     | 150°C                   |               | 200°C            |               |
| - Temperature Mix ( $T_{max}$ )                     | 60-120 seconds          |               | 60-180 seconds   |               |
| - Time (min to max)( $t_s$ )                        |                         |               |                  |               |
| $T_{max}$ to $T_L$                                  |                         |               | 3°C/second max   |               |
| - Temperature( $T_L$ )                              |                         |               |                  |               |
| - Time ( $t_L$ )                                    |                         |               |                  |               |
| Peak Temperature( $T_p$ )                           | 183°C                   |               | 217°C            |               |
|                                                     | 60-150 seconds          |               | 60-150 seconds   |               |
| Time within 5°C of actual Peak Temperature( $t_p$ ) | 225 +0/-5°C             | 240 +0/-5°C   | 245 +0/-5°C      | 250 +0/-5°C   |
| Ramp-down Rate                                      | 10-30 seconds           | 10-30 seconds | 10-30 seconds    | 20-40 seconds |
| Time 25°C to Peak Temperature                       | 6°C/second max.         |               | 6°C/second max.  |               |
|                                                     | 6 minutes max.          |               | 8 minutes max.   |               |

Note: All temperatures refer to topside of the package. Measured on the body surface.

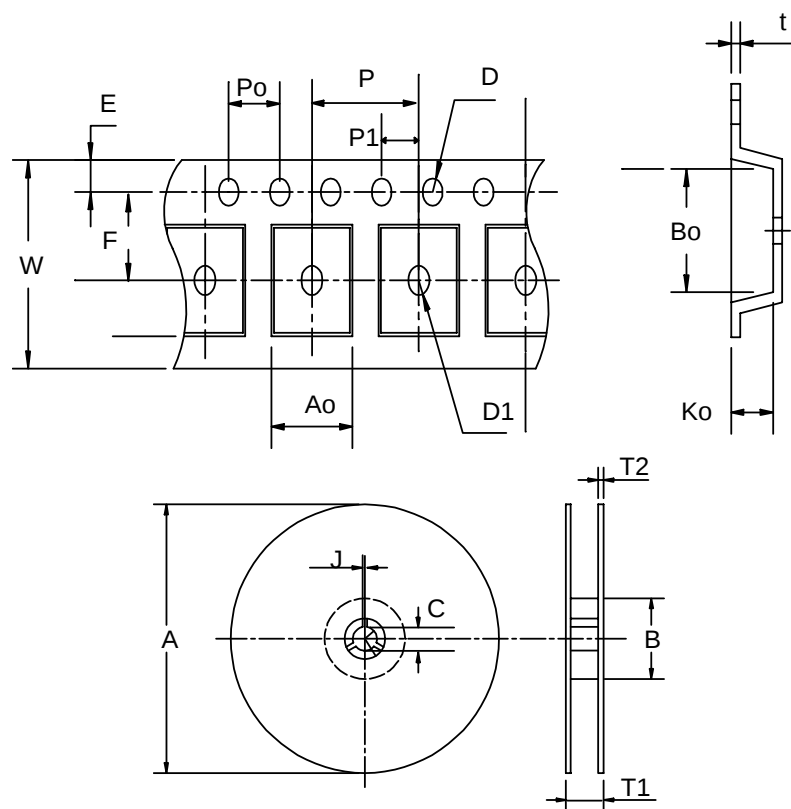
## Package Reflow Conditions

| pkg. thickness $\geq 2.5\text{mm}$<br>and all bgas | pkg. thickness $< 2.5\text{mm}$<br>and pkg. volume $\geq 350\text{mm}^3$ | pkg. thickness $< 2.5\text{mm}$ and pkg.<br>volume $< 350\text{mm}^3$ |
|----------------------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------|
| Convection 220 $\pm 5/-0^\circ\text{C}$            |                                                                          | Convection 235 $\pm 5/-0^\circ\text{C}$                               |
| VPR 215-219 $^\circ\text{C}$                       |                                                                          | VPR 235 $\pm 5/-0^\circ\text{C}$                                      |
| IR/Convection 220 $\pm 5/-0^\circ\text{C}$         |                                                                          | IR/Convection 235 $\pm 5/-0^\circ\text{C}$                            |

## Reliability test program

| Test item     | Method              | Description                                              |
|---------------|---------------------|----------------------------------------------------------|
| SOLDERABILITY | MIL-STD-883D-2003   | 245 $^\circ\text{C}$ , 5 SEC                             |
| HOLT          | MIL-STD-883D-1005.7 | 1000 Hrs Bias @ 125 $^\circ\text{C}$                     |
| PCT           | JESD-22-B, A102     | 168 Hrs, 100 % RH , 121 $^\circ\text{C}$                 |
| TST           | MIL-STD-883D-1011.9 | -65 $^\circ\text{C}$ ~ 150 $^\circ\text{C}$ , 200 Cycles |
| ESD           | MIL-STD-883D-3015.7 | VHBM $> 2\text{KV}$ , VMM $> 200\text{V}$                |
| Latch-Up      | JESD 78             | 10ms , $I_{tr} > 100\text{mA}$                           |

## Carrier Tape & Reel Dimension



## Carrier Tape & Reel Dimension

| Application | A          | B         | C            | J         | T1                  | T2         | W                 | P         | E                |
|-------------|------------|-----------|--------------|-----------|---------------------|------------|-------------------|-----------|------------------|
| TO-252      | 330 ± 3    | 100 ± 2   | 13 ± 0.5     | 2 ± 0.5   | 16.4 + 0.3<br>- 0.2 | 2.5 ± 0.5  | 16 + 0.3<br>- 0.1 | 8 ± 0.1   | 1.75 ± 0.1       |
|             | F          | D         | D1           | Po        | P1                  | Ao         | Bo                | Ko        | t                |
|             | 7.5 ± 0.1  | 1.5 ± 0.1 | 1.5 ± 0.25   | 4.0 ± 0.1 | 2.0 ± 0.1           | 6.8 ± 0.1  | 10.4 ± 0.1        | 2.5 ± 0.1 | 0.3 ± 0.05       |
| Application | A          | B         | C            | J         | T1                  | T2         | W                 | P         | E                |
| TO-263      | 380 ± 3    | 80 ± 2    | 13 ± 0.5     | 2 ± 0.5   | 24 ± 4              | 2 ± 0.3    | 24 + 0.3<br>- 0.1 | 16 ± 0.1  | 1.75 ± 0.1       |
|             | F          | D         | D1           | Po        | P1                  | Ao         | Bo                | Ko        | t                |
|             | 11.5 ± 0.1 | 1.5 ± 0.1 | 1.5 ± 0.25   | 4.0 ± 0.1 | 2.0 ± 0.1           | 10.8 ± 0.1 | 16.1 ± 0.1        | 5.2 ± 0.1 | 0.35 ± 0.01<br>3 |
| Application | A          | B         | C            | J         | T1                  | T2         | W                 | P         | E                |
| SOT-223     | 330 ± 1    | 62 ± 1.5  | 12.75 ± 0.15 | 2 ± 0.6   | 12.4 ± 0.2          | 2 ± 0.2    | 12 ± 0.3          | 8 ± 0.1   | 1.75 ± 0.1       |
|             | F          | D         | D1           | Po        | P1                  | Ao         | Bo                | Ko        | t                |
|             | 5.5 ± 0.05 | 1.5 ± 0.1 | 1.5 ± 0.1    | 4.0 ± 0.1 | 2.0 ± 0.05          | 6.9 ± 0.1  | 7.5 ± 0.1         | 2.1 ± 0.1 | 0.3 ± 0.05       |

## Cover Tape Dimensions

| Application | Carrier Width | Cover Tape Width | Devices Per Reel |
|-------------|---------------|------------------|------------------|
| TO- 252     | 16            | 13.3             | 2500             |
| TO- 263     | 24            | 21.3             | 1000             |
| SOT- 223    | 12            | 9.3              | 2500             |

## CONTACT

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