

|                                                                                                      |
|------------------------------------------------------------------------------------------------------|
| 1.5A Low Dropout Fast Response Positive Adjustable Regulator and Fixed<br>1.8V, 2.5V, 2.85V and 3.3V |
|------------------------------------------------------------------------------------------------------|

## 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 : 1.3V Typ. at  $I_{OUT}=1.5A$
- Current Limit : 1.5A Min. at  $T_J=125^{\circ}C$
- On-Chip Thermal Limiting : 150  $^{\circ}C$  Typ.
- Adjustable Output : 1.25~10.7V
- Standard 3-pin SOT-223, TO-252 , TO-220 and TO-263 Power Packages.

## Applications

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

## General Description

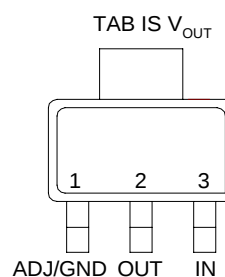
The APL1086 is a low dropout three-terminal adjustable regulators with 1.5A output current capability. In order to obtain lower dropout voltage and faster transient response, which is critical for low voltage applications , the APL1086 has been optimized.

The device is available in an adjustable version and fixed output voltages of 1.8V, 2.5V, 2.85V and 3.3V, the output available voltage range is from 1.25~10.7V with an input supply below 12V. Dropout voltage is guaranteed at a maximum of 1.45V at 1.5A.

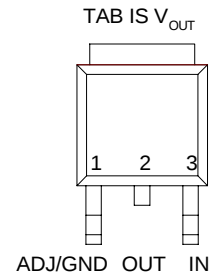
Current limit is trimmed to ensure specified output current and controlled short-circuit current. On-chip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The APL1086 is available in the industry standard 3-pin SOT-223, TO-252, TO-220 or TO-263 power packages.

## Pin Description

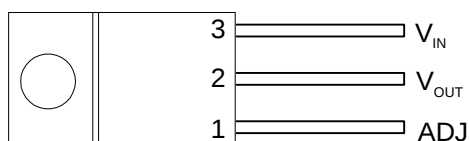


Front View for SOT-223

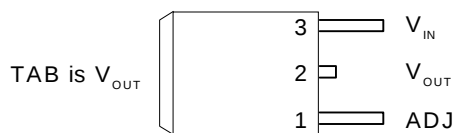


Front View for TO-252

## Pin Description

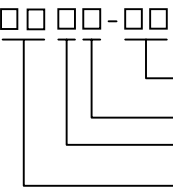
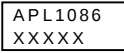
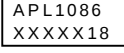
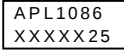
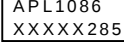
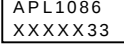


Front View for TO-220



Front View for TO-263

## Ordering and Marking Information

|                                                                                                                                 |                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>APL1086- </p>                               | <p>Package Code<br/> F : TO-220      G : TO-263<br/> 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      285 : 2.85V      33 : 3.3V<br/> Blank : Adjustable Version</p> |
| <p>APL1086 F/G/U :  XXXXX - Date Code</p>     | <p>APL1086 V :  XXXXX - Date Code</p>                                                                                                                                                                             |
| <p>APL1086 -18F/G/U:  XXXXX - Date Code</p>  | <p>APL1086- 18V :  XXXXX - Date Code</p>                                                                                                                                                                         |
| <p>APL1086 -25F/G/U:  XXXXX - Date Code</p>  | <p>APL1086- 25V :  XXXXX - Date Code</p>                                                                                                                                                                         |
| <p>APL1086 -285F/G/U:  XXXXX - Date Code</p> | <p>APL1086- 285V :  XXXXX - Date Code</p>                                                                                                                                                                        |
| <p>APL1086 -33F/G/U:  XXXXX - Date Code</p>  | <p>APL1086- 33V :  XXXXX - Date Code</p>                                                                                                                                                                         |

## Absolute Maximum Ratings

| Symbol    | Parameter                                                                   | Rating               | Unit |
|-----------|-----------------------------------------------------------------------------|----------------------|------|
| $V_I$     | Input Voltage                                                               | 12                   | 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   |

## Electrical Characteristics

| Symbol           | Parameter                    | Test Conditions                                                                                                                      | APL1086        |                |                | Unit    |
|------------------|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|----------------|---------|
|                  |                              |                                                                                                                                      | Min.           | Typ.           | Max.           |         |
| $V_{REF}$        | Reference Voltage            | $10mA \leq I_{OUT} \leq 1.5A$ , $1.4V \leq (V_{IN} - V_{OUT}) \leq 9.75V$ ,<br>$T_J = 0 \sim 125^\circ C$                            | 1.225          | 1.250          | 1.275          | V       |
| $V_{OUT}$        | Output Voltage<br>APL1086-18 | $T_J = 25^\circ C$ , $I_{OUT} = 0mA$ ,<br>$T_J = 0 \sim 125^\circ C$ ,<br>$0 \leq I_{OUT} \leq 1.5A$ , $3.5V \leq V_{IN} \leq 9V$ ,  | 1.782<br>1.764 | 1.800<br>1.800 | 1.818<br>1.836 | V       |
|                  | APL1086-25                   | $T_J = 25^\circ C$ , $I_{OUT} = 0mA$ ,<br>$T_J = 0 \sim 125^\circ C$ ,<br>$0 \leq I_{OUT} \leq 1.5A$ , $4V \leq V_{IN} \leq 9V$ ,    | 2.475<br>2.450 | 2.500<br>2.500 | 2.525<br>2.550 |         |
|                  | APL1086-28                   | $T_J = 25^\circ C$ , $I_{OUT} = 0mA$ ,<br>$T_J = 0 \sim 125^\circ C$ ,<br>$0 \leq I_{OUT} \leq 1.5A$ , $4.25V \leq V_{IN} \leq 9V$ , | 2.822<br>2.792 | 2.850<br>2.850 | 2.878<br>2.910 |         |
|                  | APL1086-33                   | $T_J = 25^\circ C$ , $I_{OUT} = 0mA$ ,<br>$T_J = 0 \sim 125^\circ C$ ,<br>$0 \leq I_{OUT} \leq 1.5A$ , $4.75V \leq V_{IN} \leq 9V$ , | 3.267<br>3.235 | 3.300<br>3.300 | 3.333<br>3.365 |         |
| $REG_{LINE}$     | Line Regulation<br>APL1086   | $T_J = 0 \sim 125^\circ C$<br>$I_{OUT} = 10mA$ , $1.5V \leq V_{IN} - V_{OUT} \leq 9V$ , (note1)                                      |                | 0.03           | 0.2            | %<br>mV |
|                  | APL1086-18                   | $I_{OUT} = 0mA$ , $3.5V \leq V_{IN} \leq 9V$ , (note1)                                                                               |                | 1              | 6              |         |
|                  | APL1086-25                   | $I_{OUT} = 0A$ , $4V \leq V_{IN} \leq 9V$ , (note 1)                                                                                 |                | 1              | 6              |         |
|                  | APL1086-28                   | $I_{OUT} = 0A$ , $4.25V \leq V_{IN} \leq 9V$ , (note 1)                                                                              |                | 1              | 6              |         |
|                  | APL1086-33                   | $I_{OUT} = 0A$ , $4.75V \leq V_{IN} \leq 9V$ , (note 1)                                                                              |                | 1              | 6              |         |
| $REG_{LOAD}$     | Load Regulation<br>APL1086   | $T_J = 0 \sim 125^\circ C$<br>$(V_{IN} - V_{OUT}) = 3V$ , $0 \leq I_{OUT} \leq 1.5A$ , (note 1)                                      |                | 0.1            | 0.4            | %<br>mV |
|                  | APL1086-18                   | $V_{IN} = 3.5V$ , $0 \leq I_{OUT} \leq 1.5A$ , (note 1)                                                                              |                | 1              | 10             |         |
|                  | APL1086-25                   | $V_{IN} = 4V$ , $0 \leq I_{OUT} \leq 1.5A$ , (note 1)                                                                                |                | 1              | 10             |         |
|                  | APL1086-28                   | $V_{IN} = 4.25V$ , $0 \leq I_{OUT} \leq 1.5A$ , (note 1)                                                                             |                | 1              | 10             |         |
|                  | APL1086-33                   | $V_{IN} = 4.75V$ , $0 \leq I_{OUT} \leq 1.5A$ , (note 1)                                                                             |                | 1              | 10             |         |
| $V_D$            | Dropout Voltage              | $I_{OUT} = 1.5A$ , $T_J = 0 \sim 125^\circ C$                                                                                        |                | 1.3            | 1.45           | V       |
| $I_{LIMIT}$      | Current Limit                | $(V_{IN} - V_{OUT}) = 5V$ , $T_J = 25^\circ C$                                                                                       | 1500           |                |                | mA      |
| $I_{ADJ}$        | Adjust Pin Current           | $(V_{IN} - V_{OUT}) = 3V$ , $I_{OUT} = 10mA$ , $T_J = 0 \sim 125^\circ C$                                                            |                | 60             | 120            | $\mu A$ |
| $\Delta I_{ADJ}$ | Adjust Pin Current Change    | $T_J = 0 \sim 125^\circ C$ , $10mA \leq I_{OUT} \leq 1.5A$ ,<br>$1.4V \leq (V_{IN} - V_{OUT}) \leq 7.75V$                            |                | 0.2            | 5              | $\mu A$ |
| $I_O$            | Minimum Load Current         | $T_J = 0 \sim 125^\circ C$ , $(V_{IN} - V_{OUT}) = 7.75V$ , (note 3)                                                                 |                | 1.7            |                | mA      |
| PSRR             | Ripple Rejection             | $F_{RIPPLE} = 120Hz$ , $V_{RIPPLE} = 1V_{P-P}$ ,<br>$(V_{IN} - V_{OUT}) = 3V$ , $T_J = 0 \sim 125^\circ C$                           | 60             | 75             |                | dB      |
| $T_R$            | Thermal Regulation           | $T_J = 25^\circ C$ , 30ms Pulse                                                                                                      |                | 0.01           | 0.02           | %/ W    |
| $T_S$            | Temperature Stability        |                                                                                                                                      |                | 0.5            |                | %       |
| $L_S$            | Long -Term Stability         | $T_J = 125^\circ C$ , 1000Hrs.                                                                                                       |                | 0.3            |                | %       |

## Electrical Characteristics (Cont.)

| Symbol               | Parameter              | Test Conditions                                                                                 | APL1086 |          |      | Unit                        |
|----------------------|------------------------|-------------------------------------------------------------------------------------------------|---------|----------|------|-----------------------------|
|                      |                        |                                                                                                 | Min.    | Typ.     | Max. |                             |
| $V_N$                | RMS Output Noise       | $T_J=25^{\circ}\text{C}, 10\text{Hz} \leq F \leq 10\text{kHz}, (\% \text{ of } V_{\text{OUT}})$ |         | 0.003    |      | %                           |
| $\theta_{\text{th}}$ | Thermal Resistance     | Junction to Case, at Tab<br>Junction to ambient                                                 |         | 15<br>50 |      | $^{\circ}\text{C}/\text{W}$ |
| OT                   | Over Temperature Point |                                                                                                 |         | 150      |      | $^{\circ}\text{C}$          |
|                      | Quiescent Current      | $T_J=0\sim 125^{\circ}\text{C},$<br>APL1086-18 $V_{\text{IN}} \leq 9\text{V}$                   |         | 5.5      | 10   | mA                          |
|                      |                        | APL1086-25 $V_{\text{IN}} \leq 9\text{V}$                                                       |         | 5.5      | 10   |                             |
|                      |                        | APL1086-28 $V_{\text{IN}} \leq 9\text{V}$                                                       |         | 5.5      | 10   |                             |
|                      |                        | APL1086-33 $V_{\text{IN}} \leq 9\text{V}$                                                       |         | 5.5      | 10   |                             |

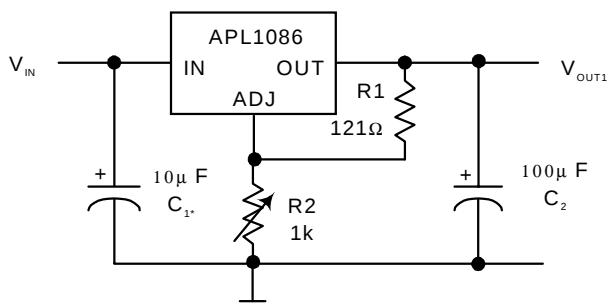
Note 1: See thermal regulation specifications for changes in output voltage due to heating effects. Load line regulations are measured at a constant junction temperature by low duty cycle pulse testing.

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.

## Application Circuits

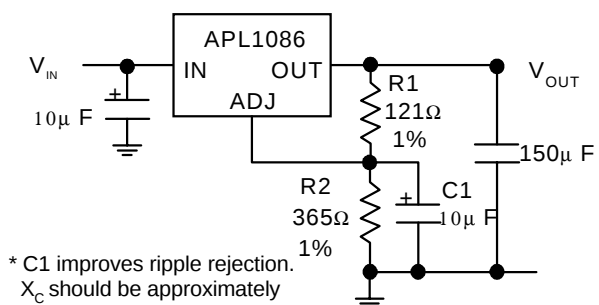
1.25V to 10.7V Adjustable Regulator



\* Needed if device is far from filter capacitors

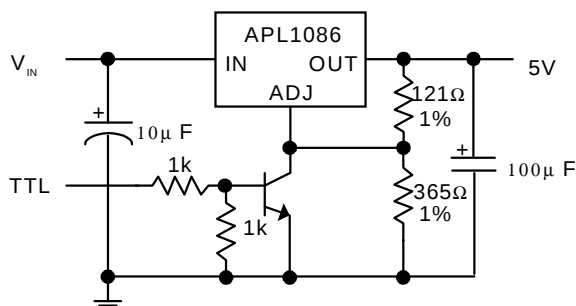
$$V_{\text{OUT}} = 1.250\text{V} \times \frac{R1 + R2}{R1}$$

Improving Ripple Rejection



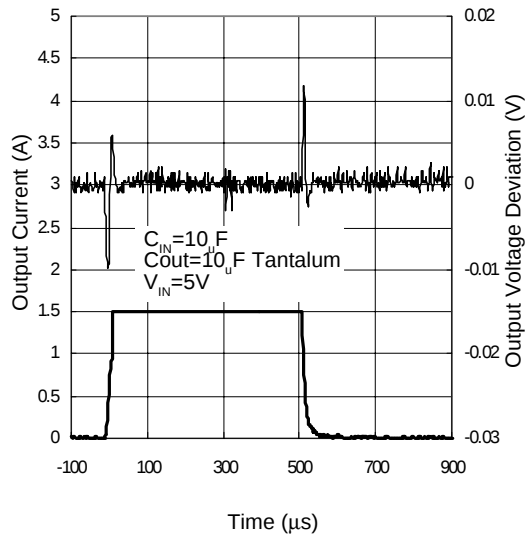
\* C1 improves ripple rejection.  
X<sub>C</sub> should be approximately equal to R1 at ripple frequency

5V Regulator with Shutdown

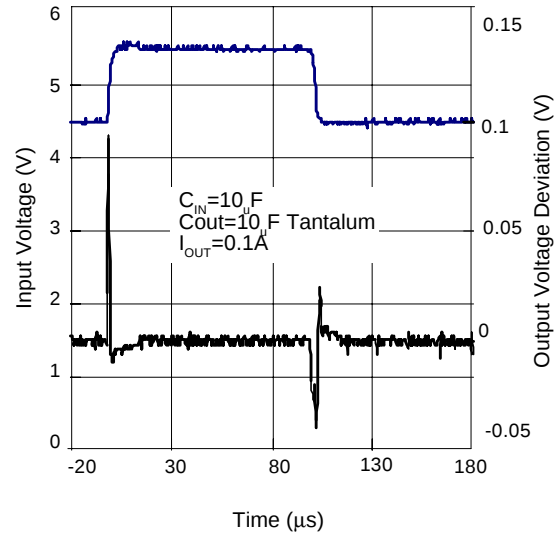


## Typical Characteristics

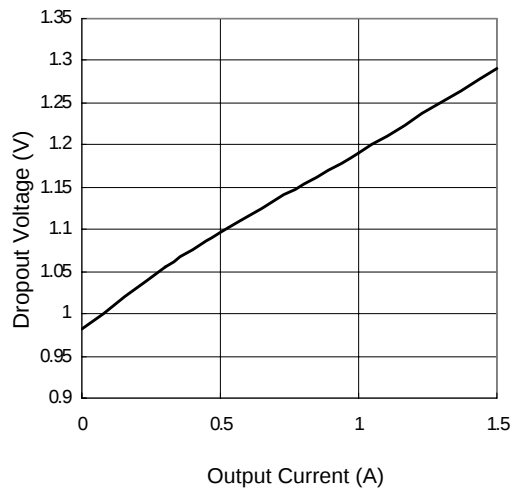
Load Transient Response



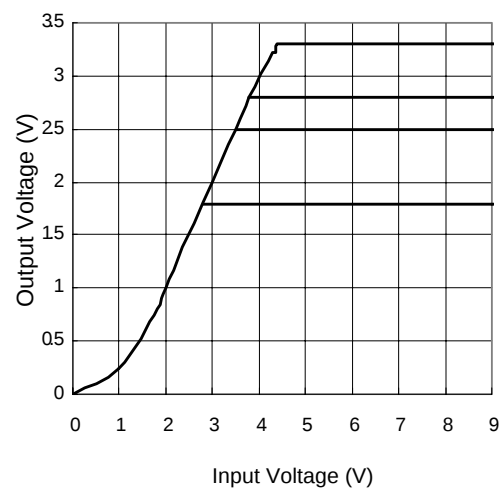
Line Transient Response



Dropout Voltage vs. Output Current

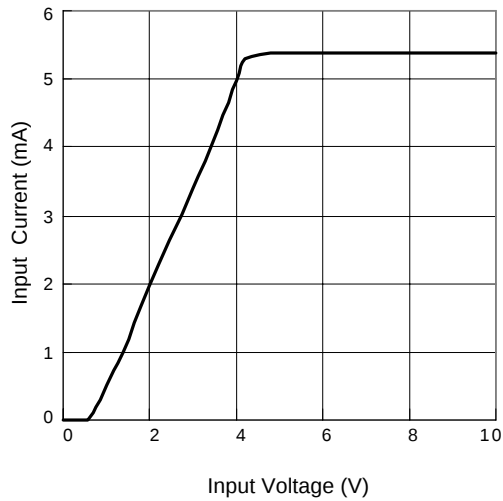


Output Voltage vs. Input Voltage

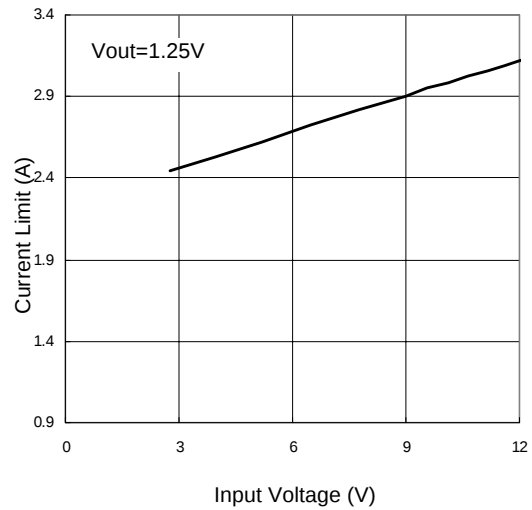


## Typical Characteristics Cont.

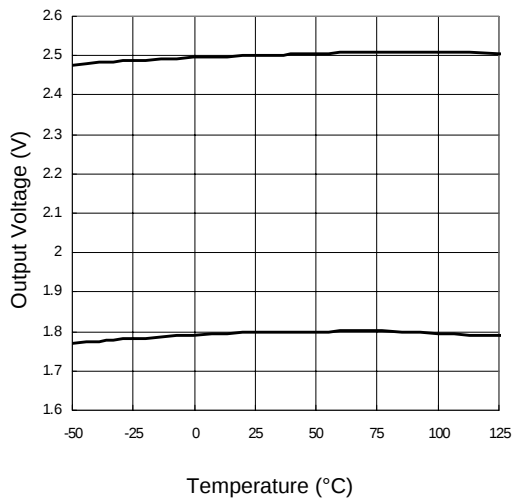
Input Current vs. Input Voltage



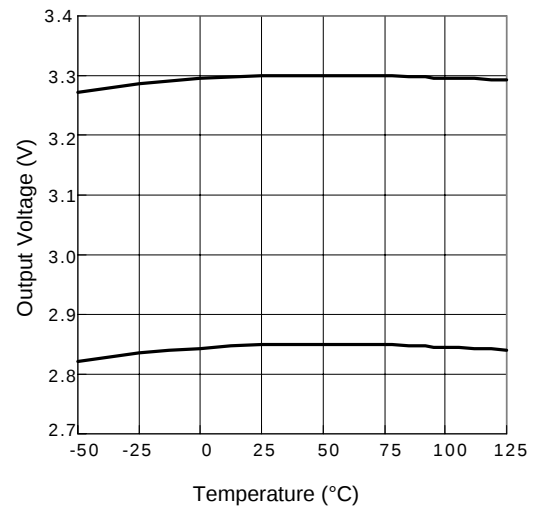
Current Limit vs. Input Voltage



Output Voltage vs. Temperature

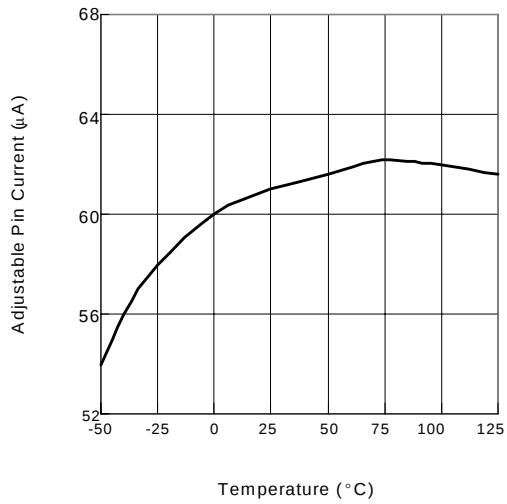


Output Voltage vs. Temperature

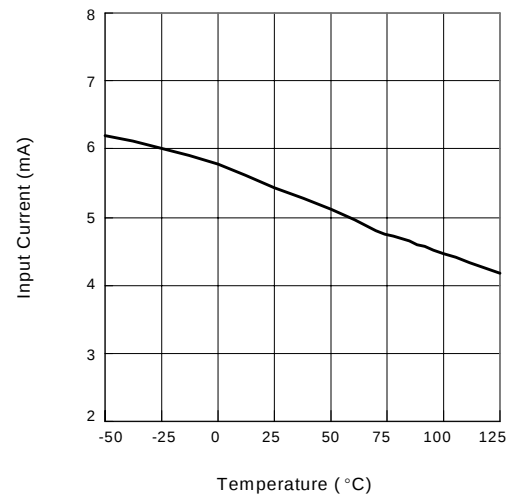


## Typical Characteristics Cont.

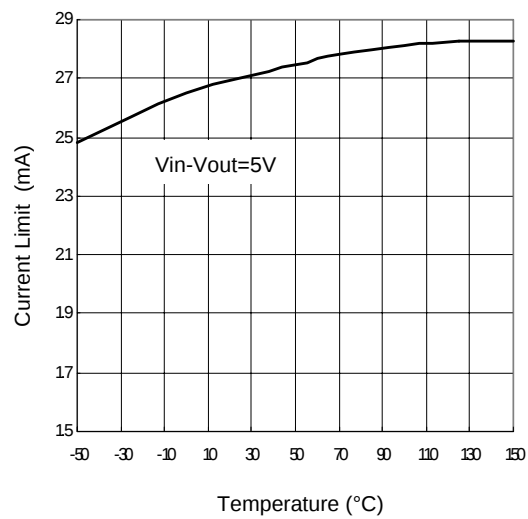
Adjustable Pin Current vs. Temperature



Input Current vs. Temperature

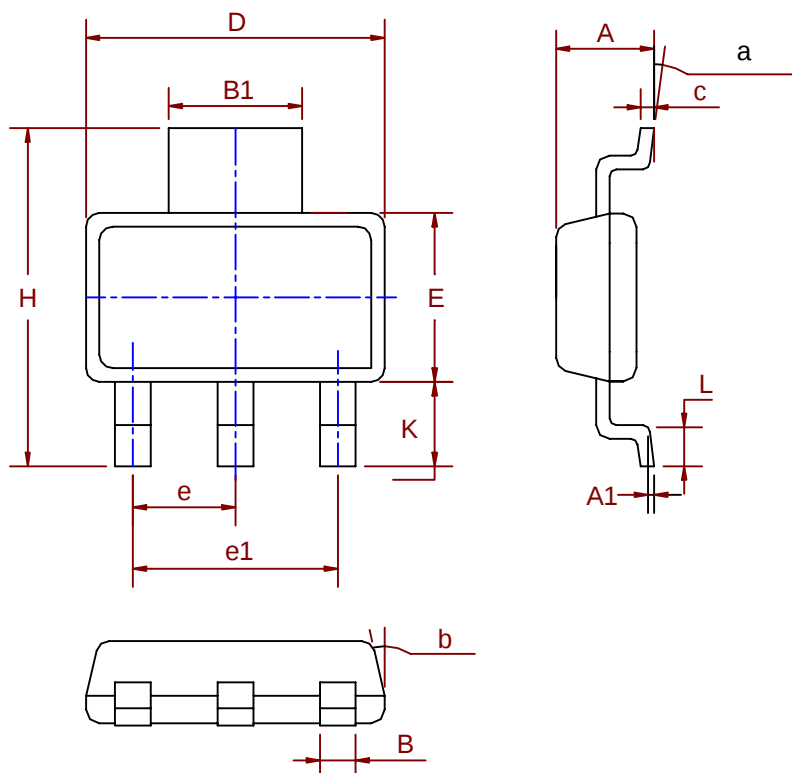


Current Limit vs. Temperature



## Package Information

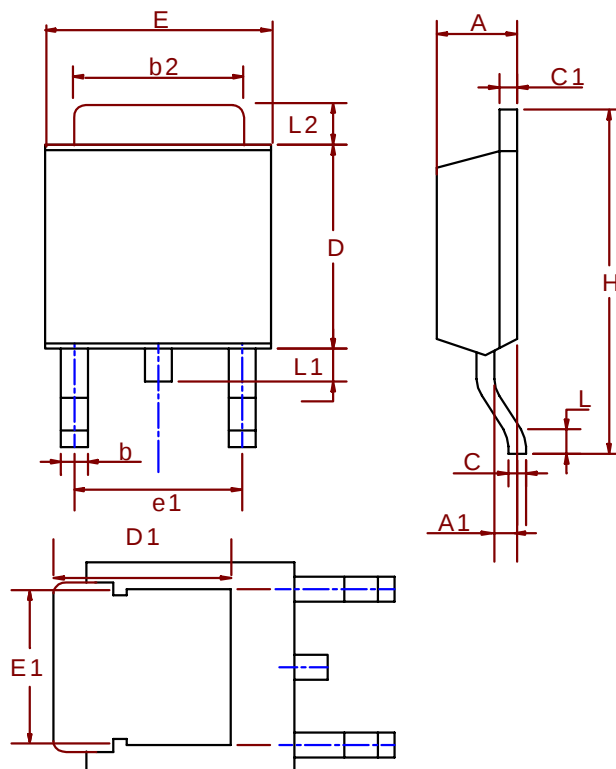
SOT-223( Reference JEDEC Registration SOT-223)



| 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°      |      |

## Package Informaion

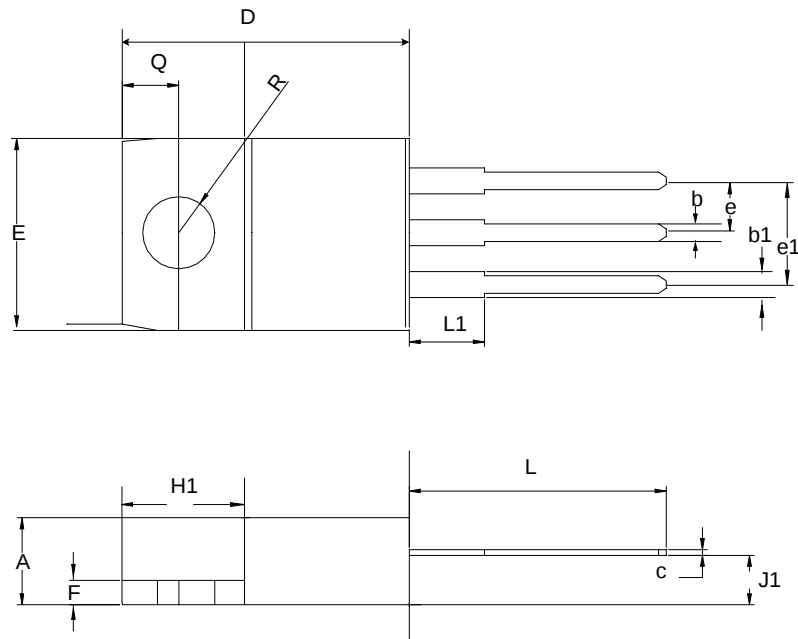
TO-252( Reference JEDEC Registration TO-252)



| 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 Informaion

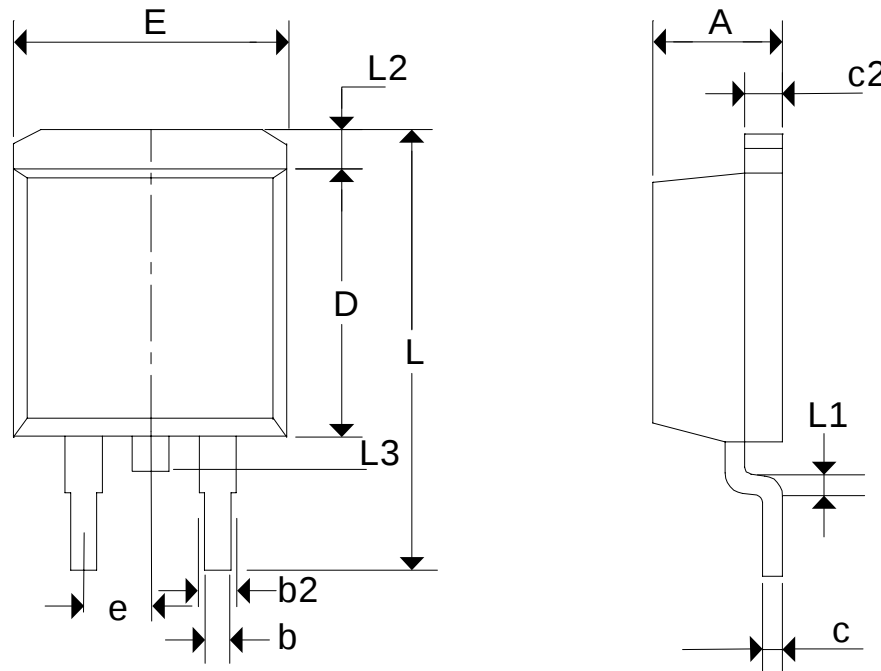
TO-220 ( Reference JEDEC Registration TO-220)



| 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-263 ( Reference JEDEC Registration TO-263)



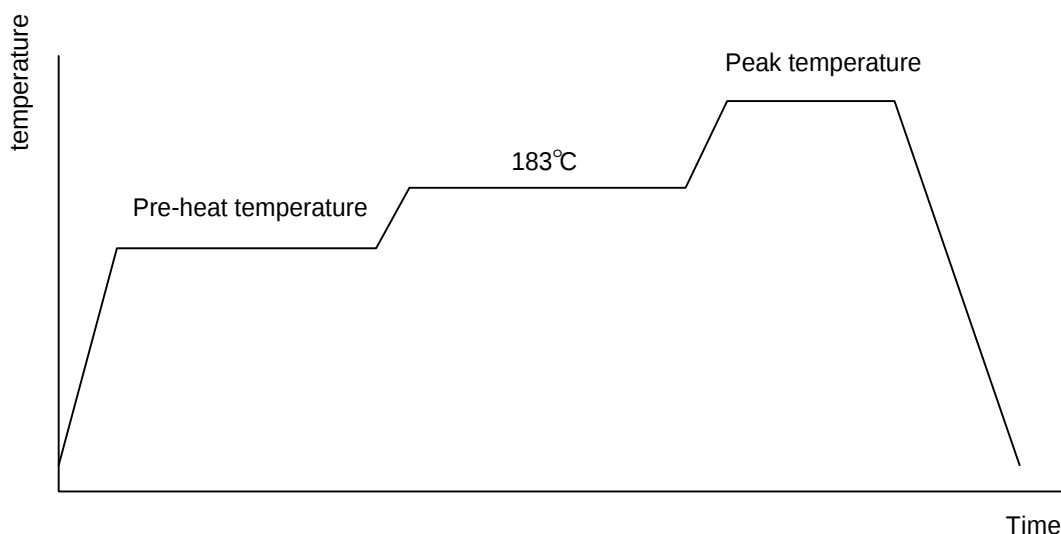
| Dim | Millimeters |        | Inches     |       |
|-----|-------------|--------|------------|-------|
|     | Min.        | Max.   | Min.       | Max.  |
| A   | 4.06        | 4.83   | 0.160      | 0.190 |
| b   | 0.51        | 0.992  | 0.02       | 0.039 |
| b2  | 1.14        | 1.399  | 0.045      | 0.055 |
| 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   | 9.66        | 10.299 | 0.380      | 0.405 |
| e   | 2.543 BSC.  |        | 0.100 BSC. |       |
| L   | 14.60       | 15.88  | 0.575      | 0.625 |
| L1  | 2.24        | 2.84   | 0.090      | 0.110 |
| L2  | -           | 2.92   | -          | 0.115 |
| L3  | 1.20        | 1.78   | 0.050      | 0.070 |

## 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. |

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

Reference JEDEC Standard J-STD-020A APRIL 1999



## Classification Reflow Profiles

|                                            | Convection or IR/<br>Convection | VPR                      |
|--------------------------------------------|---------------------------------|--------------------------|
| Average ramp-up rate(183°C to Peak)        | 3°C/second max.                 | 10 °C /second max.       |
| Preheat temperature 125 ± 25°C)            | 120 seconds max                 |                          |
| Temperature maintained above 183°C         | 60 – 150 seconds                |                          |
| Time within 5°C of actual peak temperature | 10 – 20 seconds                 | 60 seconds               |
| Peak temperature range                     | 220 +5/-0°C or 235 +5/-0°C      | 215-219°C or 235 +5/-0°C |
| Ramp-down rate                             | 6 °C /second max.               | 10 °C /second max.       |
| Time 25°C to peak temperature              | 6 minutes max.                  |                          |

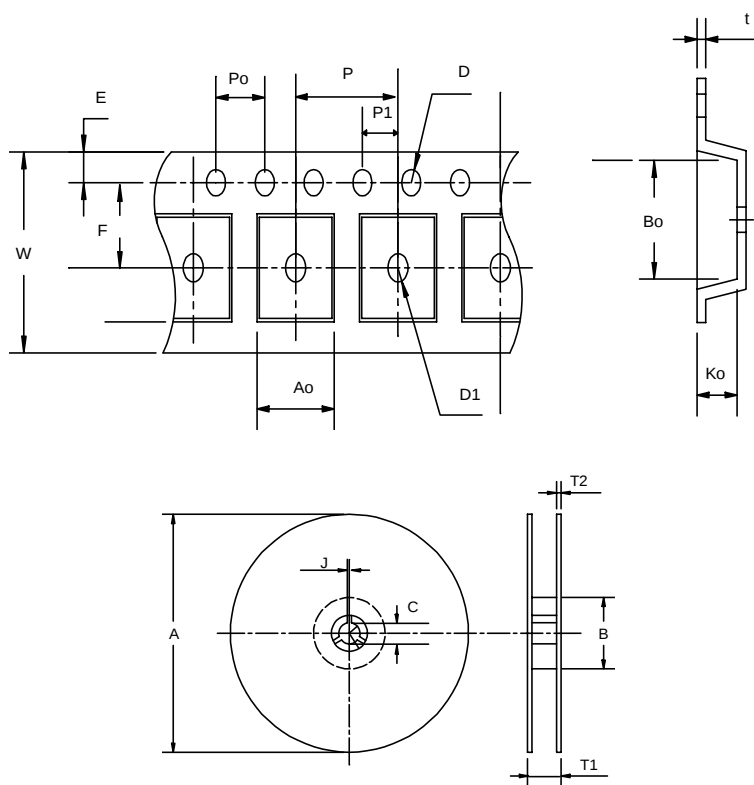
## Package Reflow Conditions

| pkg. thickness ≥ 2.5mm<br>and all bgas | pkg. thickness < 2.5mm and<br>pkg. volume ≥ 350 mm <sup>3</sup> | pkg. thickness < 2.5mm and pkg.<br>volume < 350mm <sup>3</sup> |
|----------------------------------------|-----------------------------------------------------------------|----------------------------------------------------------------|
| Convection 220 +5/-0 °C                |                                                                 | Convection 235 +5/-0 °C                                        |
| VPR 215-219 °C                         |                                                                 | VPR 235 +5/-0 °C                                               |
| IR/Convection 220 +5/-0 °C             |                                                                 | IR/Convection 235 +5/-0 °C                                     |

## Reliability test program

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

## Carrier Tape & Reel Dimensions



| 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         | P0        | P1                 | A0         | 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         | P0        | P1                 | A0         | 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 |

(mm)

**Reel Dimensions (Cont.)**

| Application | A          | B        | C              | J         | T1         | T2        | W        | P        | E         |
|-------------|------------|----------|----------------|-----------|------------|-----------|----------|----------|-----------|
| SOT-223     | 330±1      | 62±1.5   | 12.75±<br>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  |

(mm)

**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             |

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