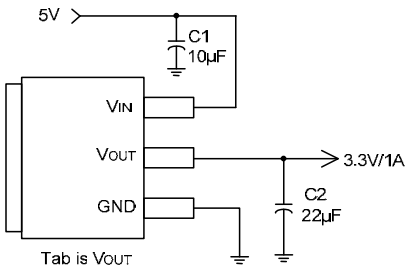
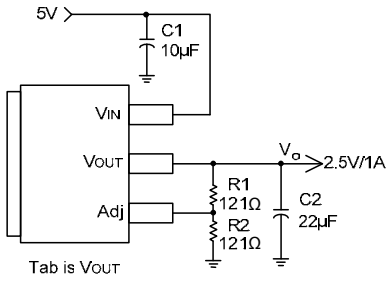
## Typical Applications Circuit




( 5V/3.3V fixed output )



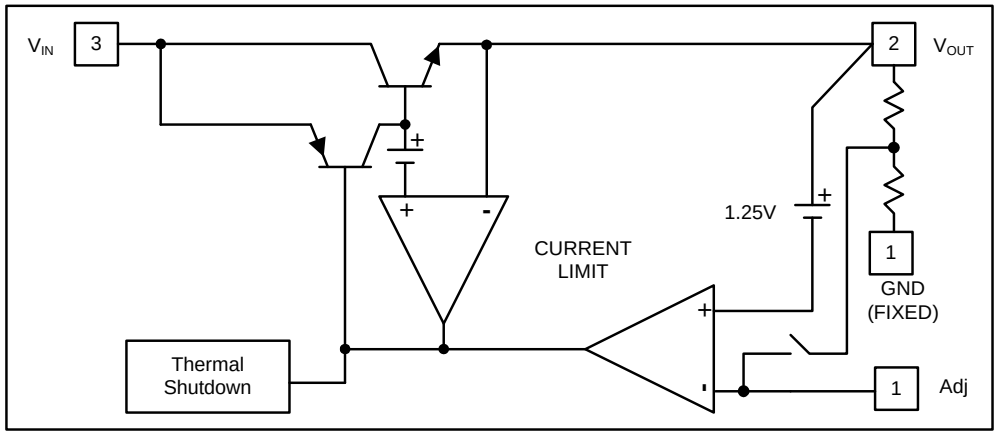

( 5V/2.5V ADJ output )

Note: $V_o = V_{REF} \times (1 + \frac{R_2}{R_1})$

## Pin Descriptions

| Pin Number | I/O | Pin Name | Function |
|---|---|---|---|
| 1 | I | Adj (GND) | A resistor divider from this pin to the $V_{OUT}$ pin and ground sets the output voltage (Ground only for Fixed-Mode). |
| 2 | O | $V_{OUT}$ | The output of the regulator. A minimum of 4.7μF capacitor (0.15Ω ≤ ESR ≤ 0.5Ω) must be connected from this pin to ground to insure stability. |
| 3 | I | $V_{IN}$ | The input pin of regulator. Typically a large storage capacitor is connected from this pin to ground to insure that the input voltage does not sag below the minimum dropout voltage during the load transient response. This pin must always be 1.3V higher than $V_{OUT}$ in order for the device to regulate properly. A minimum of 4.7μF capacitor (0.15Ω ≤ ESR ≤0.5Ω) must be connected from this pin to ground to insure stability. |

## Functional Block Diagram





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## Absolute Maximum Ratings (@$T_A$ = +25°C, unless otherwise specified.)

| Symbol | Parameter | Rating | Unit |
|---|---|---|---|
| $V_{IN}$ | DC Supply Voltage | -0.3 to +18 | V |
| $T_{MJ}$ | Maximum Junction Temperature | +150 | °C |
| $P_D$ | Power Dissipation<br>SOT89-3<br>SOT223<br>TO220-3<br>TO252<br>TO263 | Internally limited by maximum junction temperature of +150°C (Note 4) | mW |
| $T_{ST}$ | Storage Temperature | -65 to +150 | °C |

Notes: 4. AP1117 contains an internal thermal limiting circuit that is designed to protect the regulator in the event that the maximum junction temperature exceeded. When activated, typically at +150°C, the regulator output switches off and then back on as the die cools.

## Recommended Operating Conditions (@$T_A$ = +25°C, unless otherwise specified.)

| Symbol | Parameter | | Min | Max | Unit |
|---|---|---|---|---|---|
| $T_{OP}$ | Operating Junction Temperature Range | AP1117 | 0 | +125 | °C |
| | | AP1117I | -40 | +125 | |

Note: 11. 22uF is suggested for $C_{in}/C_{out}$ value when application is required to work under 0℃.

## Electrical Characteristics (@$T_A$ = +25°C, unless otherwise specified.)

| Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Reference Voltage | AP1117-ADJ | $T_A$ = +25°C, ($V_{IN}$-$_{OUT}$) = 1.5V<br>$I_O$ = 10mA | 1.225 | 1.250 | 1.275 | V |
| Output Voltage | AP1117-1.5 | $I_{OUT}$ = 10mA, $T_A$ = +25°C,<br>3V ≤ $V_{IN}$ ≤ 12V | 1.470 | 1.500 | 1.530 | V |
| | AP1117-1.8 | $I_{OUT}$ = 10mA, $T_A$ = +25°C,<br>3.3V ≤ $V_{IN}$ ≤ 12V | 1.764 | 1.800 | 1.836 | V |
| | AP1117-2.5 | $I_{OUT}$ = 10mA, $T_A$ = +25°C,<br>4V ≤ $V_{IN}$ ≤ 12V | 2.450 | 2.500 | 2.550 | V |
| | AP1117-3.3 | $I_{OUT}$ = 10mA, $T_A$ = +25°C,<br>4.8V ≤ $V_{IN}$ ≤ 12V | 3.235 | 3.300 | 3.365 | V |
| | AP1117-5.0 | $I_{OUT}$ = 10mA, $T_A$ = +25°C,<br>6.5V ≤ $V_{IN}$ ≤ 12V | 4.900 | 5.000 | 5.100 | V |
| Line Regulation | AP1117-XXX | $I_O$ = 10mA,$V_{OUT}$ +1.5V < $V_{IN}$ < 12V,<br>$T_A$ = 25°C | — | — | 0.2 | % |
| Load Regulation | AP1117-ADJ | $V_{IN}$ = 3.3V,$V_{ADJ}$ = 0, 0mA < $I_O$ < 1A,<br>$T_A$ = +25°C (Notes 5, 6) | — | — | 1 | % |
| | AP1117-1.5 | $V_{IN}$ = 3V, 0mA < $I_O$ < 1A,<br>$T_A$ = +25°C (Notes 5, 6) | — | 12 | 15 | mV |
| | AP1117-1.8 | $V_{IN}$ = 3.3V, 0mA < $I_O$ < 1A,<br>$T_A$ = +25°C (Notes 5, 6) | — | 15 | 18 | mV |
| | AP1117-2.5 | $V_{IN}$ = 4V, 0mA < $I_O$ < 1A,<br>$T_A$ = +25°C (Notes 5, 6) | — | 20 | 25 | mV |

Notes: 5. See thermal regulation specifications for changes in output voltage due to heating effects. Line and load regulation are measured at a constant junction temperature by low duty cycle pulse testing. Load regulation is measured at the output lead = 1/18" from the package.
6. Line and load regulation are guaranteed up to the maximum power dissipation of 15W. Power dissipation is determined by the difference between input and output differential and the output current. Guaranteed maximum power dissipation will not be available over the full input/output range.


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## Electrical Characteristics (cont.) (@$T_A$ = +25°C, unless otherwise specified.)

| Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Load Regulation (cont.) | AP1117-3.3 | $V_{IN}$ = 5V, 0 ≤ $I_{OUT}$ ≤ 1A, $T_A$ = +25°C (Notes 5, 6) | — | 26 | 33 | mV |
| | AP1117-5.0 | $V_{IN}$ = 8V, 0 ≤ $I_{OUT}$ ≤ 1A, $T_A$ = +25°C (Notes 5, 6) | — | 40 | 50 | mV |
| Dropout Voltage ($V_{IN}$-$V_{OUT}$) | AP1117-ADJ/1.5/1.8 2.5/3.3/5.0 | $I_{OUT}$ = 800mA, $\Delta V_{OUT}$ = 1% $V_{OUT}$ 0°C ≤ $T_J$ ≤ +125°C | — | 1.2 | 1.3 | V |
| Dropout Voltage ($V_{IN}$-$V_{OUT}$) | AP1117-ADJ/1.5/1.8 2.5/3.3/5.0 | $I_{OUT}$ = 1A, $\Delta V_{OUT}$ = 1% $V_{OUT}$, 0°C ≤ $T_J$ ≤ +125°C | — | 1.3 | 1.4 | V |
| | AP1117I-ADJ/1.5/1.8 2.5/3.3/5.0 | $I_{OUT}$ = 1A, $\Delta V_{OUT}$ = 1% $V_{OUT}$, -40°C ≤ $T_J$ ≤ +125°C | — | 1.3 | 1.4 | V |
| Current Limit | AP1117-ADJ/1.5/1.8 2.5/3.3/5.0 | ($V_{IN}$-$V_{OUT}$) = 5V | 1. 1 | — | — | A |
| Minimum Load Current (Note 7) | AP1117-XXX | 0°C ≤ $T_J$ ≤ +125°C | — | 5 | 10 | mA |
| Thermal Regulation | $T_A$ = +25°C, 30ms pulse | | — | 0.008 | 0.040 | %/W |
| Ripple Rejection | F = 180Hz, $C_{OUT}$ = 25µF Tantalum, $I_{OUT}$ = 1A | | — | — | — | — |
| | AP1117-XXX | $V_{IN}$ = $V_{OUT}$ +3V | — | 60 | 70 | dB |
| Temperature Stability | $I_O$ = 10mA | | — | 0.5 | — | % |
| $\theta_{JA}$ Thermal Resistance Junction-to-Ambient $\theta_{JA}$ | SOT89-3: Control Circuitry/Power Transistor (Note 8) | | — | 164 | — | °C/W |
| | SOT223: Control Circuitry/Power Transistor (Note 9) | | — | 107 | — | |
| | TO252: Control Circuitry/Power Transistor (Note 8) | | — | 73 | — | |
| | TO220-3: Control Circuitry/Power Transistor (Note 8) | | — | 78 | — | |
| | TO263: Control Circuitry/Power Transistor (Note 8) | | — | 60 | — | |
| $\theta_{JC}$ Thermal Resistance Junction-to-Case | SOT89-3: Control Circuitry/Power Transistor (Note 8) | | — | 42 | — | °C/W |
| | SOT223: Control Circuitry/Power Transistor (Note 9) | | — | 15 | — | |
| | TO252: Control Circuitry/Power Transistor (Note 8) | | — | 12 | — | |
| | TO220-3: Control Circuitry/Power Transistor (Note 8) | | — | 3.5 | — | |
| | TO263: Control Circuitry/Power Transistor (Note 8) | | — | 3.5 | — | |

Notes:
7. Quiescent current is defined as the minimum output current required in maintaining regulation. At 12V input/output differential the device is guaranteed to regulate if the output current is greater than 10mA.
8. Test conditions for SOT89-3, TO220-3, TO252 and TO263: Devices mounted on FR-4 substrate, single sided PC board, 2oz copper,with minimum recommended pad layout, no air flow. The case point of $\theta_{JC}$ is located on the thermal tab.
9. Test conditions for SOT223: Devices mounted on FR-4 substrate, single sided PC board, 2oz copper, with 5mm x 5mm thermal pad layout, no air flow. The case point of $\theta_{JC}$ is located on the thermal tab.


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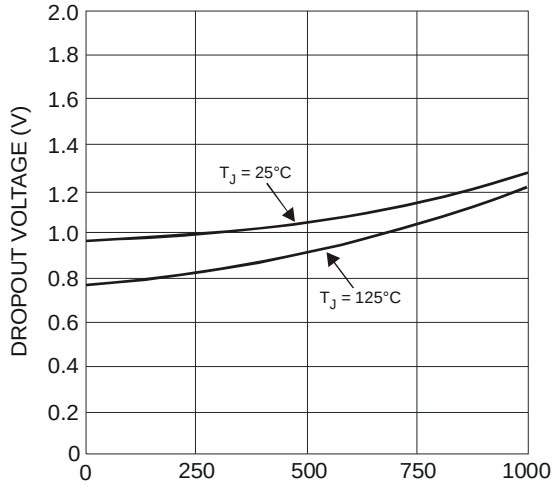
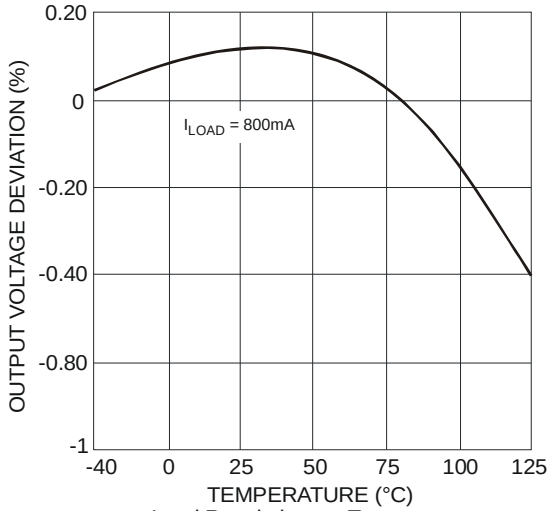
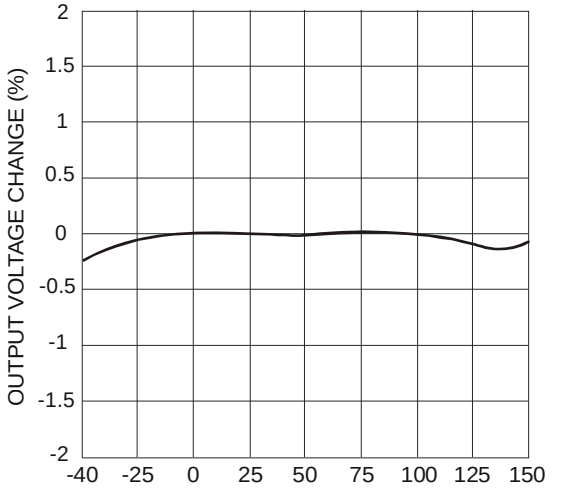
## Typical Performance Characteristics



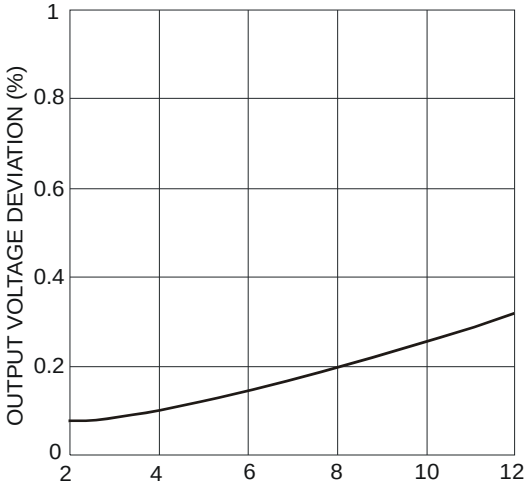
Dropout Voltage vs. Output Current



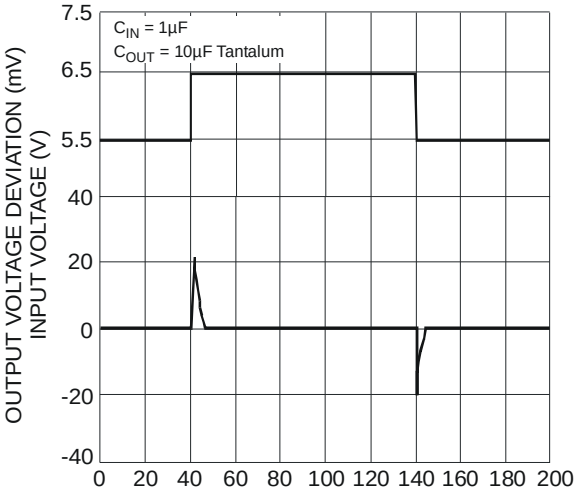
Load Regulation vs. Temperature



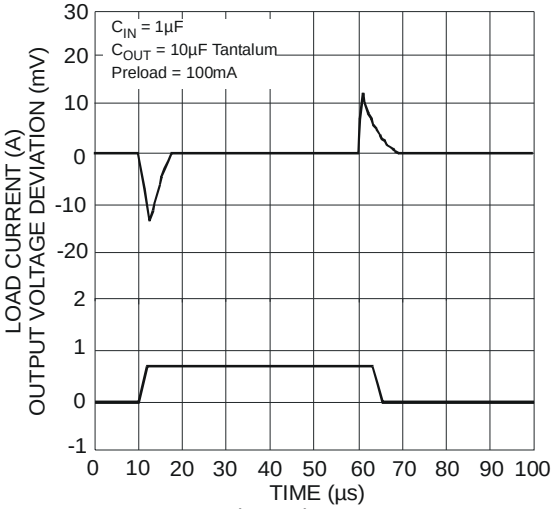
Percent Change in Output Voltage vs. Temperature



Line Regulation



Line Transient Response



Load Transient Response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## Application Information

### Load Regulation

For improved load regulation the AP1117-ADJ should have the upper feedback resistor, R1, connected as close as possible to $V_{OUT}$ and the lower resistor, R2, connected as close as possible to the load GND return. This helps reduce any parasitic resistance in series with the load.

### Stability and Decoupling Capacitors

#### Input Capacitors

To ensure stable operation, the input supply must be low impedance up to a frequency of a few MHz. This requires a closely placed input decoupling capacitor of 4.7µF minimum. This can be either ceramic or solid tantalum. The ESR of this capacitor must be less than 0.5Ω.

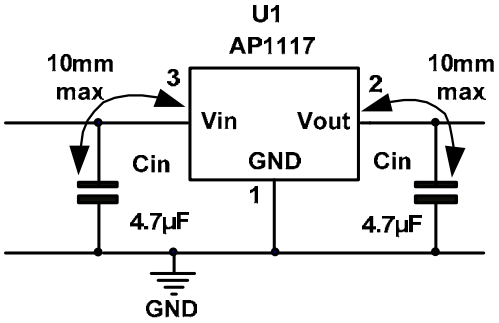
#### Output Capacitor

The AP1117 also requires a closely placed output capacitor as part of the device frequency compensation. As part of its improved performance over industry standard 1117, the AP1117 is suitable for use with MLCC (Multi-Layer Ceramic Chip) capacitors. A minimum output capacitor of 4.7µF ceramic X7R or 4.7µF solid tantalum is required. Aluminum electrolytic can be used but a minimum of 47µF is required. When using Aluminum electrolytic it is still recommended to also use a 1µF MLCC in parallel. The ESR of the output capacitors must be less than 0.5Ω.

The AP1117 is stable when using the correct value of MLCC capacitors. When using MLCC capacitors X7R dielectric is recommended. Do not use Y5V dielectrics.

#### Capacitor Track Length

Both input and output capacitors must be placed close to the AP1117. PCB traces not longer than 10mm are recommended between the AP1117 and the capacitors.




#### Thermal Considerations

Thermal protection circuitry will shut down the regulator should the junction temperature exceed typically +150°C at the sense point.

The AP1117 is pin compatible with similar '1117 regulators and offers extended temperature range and improved regulation specifications.

AP1117 series regulators have internal thermal limiting circuitry designed to protect the device during overload conditions. For continuous normal load conditions however, the maximum junction temperature rating of +125°C must not be exceeded.

It is important to give careful consideration to all sources of thermal resistance from junction to ambient. For the SOT223 and TO252 packages, which are designed to be surface mounted, additional heat sources mounted near the device must also be considered. Heat sinking is accomplished using the heat spreading capability of the PCB and its copper traces. The $\theta_{JC}$ (junction to tab) of the TO252 and SOT223 are +12°C/W and +15°C/W respectively.

Thermal resistances from tab to ambient can be as low as 30°C/W. The total thermal resistance from junction to ambient ($\theta_{JA}$) can be as low as +42 ~ +46°C/W. This requires a reasonable sized PCB with at least one layer of copper to spread the heat across the board and couple it into the surrounding air. Datasheet specifications using 2 oz copper and a 5mm x 5mm pad with $T_A$ = +27°C, no air flow yielded $\theta_{JA}$ (junction to tab) of +73°C/W and +107°C/W for TO252 and SOT223 respectively.

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. See graphs of power dissipation and thermal pictures of different size PCB copper area for guidance.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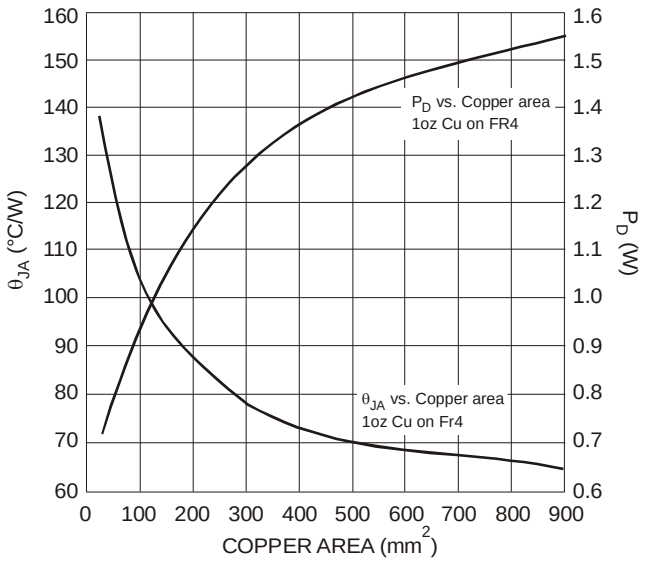


## Ordering Information

**AP1117 X X XX X - X**

| Temperature | Package | $V_{OUT}$ | Lead Free | Packing |
|---|---|---|---|---|
| Blank : Commercial<br>I : Industrial | D : TO252<br>E : SOT223<br>K : TO263<br>T : TO220-3<br>Y : SOT89-3 | Blank : ADJ<br>15 : 1.5V<br>18 : 1.8V<br>25 : 2.5V<br>33 : 3.3V<br>50 : 50V | L : Lead Free<br>G : Green | U : Tube<br>13 : Tape & Reel |

| Device | Junction Temperature Range | Package Code | Packaging (Note 10) | Tube | | 13" Tape and Reel | |
|---|---|---|---|---|---|---|---|
| | | | | Quantity | Part Number Suffix | Quantity | Part Number Suffix |
| AP1117DXXL-13 | 0 to +125°C | D | TO252 | NA | NA | 2500/Tape & Reel | -13 |
| AP1117DXXG-13 | -20 to +125°C | D | TO252 | NA | NA | 2500/Tape & Reel | -13 |
| AP1117IDXXG-13 | -40 to +125°C | D | TO252 | NA | NA | 2500/Tape & Reel | -13 |
| AP1117EXXL-13 | 0 to +125°C | E | SOT223 | NA | NA | 2500/Tape & Reel | -13 |
| AP1117EXXG-13 | -20 to +125°C | E | SOT223 | NA | NA | 2500/Tape & Reel | -13 |
| AP1117IEXXG-13 | -40 to +125°C | E | SOT223 | NA | NA | 2500/Tape & Reel | -13 |
| AP1117KXXL-13 | 0 to +125°C | K | TO263 | NA | NA | 800/Tape & Reel | -13 |
| AP1117KXXG-13 | 0 to +125°C | K | TO263 | NA | NA | 800/Tape & Reel | -13 |
| AP1117TXXL-U | 0 to +125°C | T | TO220-3 | 50 | -U | NA | NA |
| AP1117TXXG-U | 0 to +125°C | T | TO220-3 | 50 | -U | NA | NA |
| AP1117YXXL-13 | 0 to +125°C | Y | SOT89-3 | NA | NA | 2500/Tape & Reel | -13 |
| AP1117YXXG-13 | 0 to +125°C | Y | SOT89-3 | NA | NA | 2500/Tape & Reel | -13 |

Notes: 10. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at http://www.diodes.com/datasheets/ap02001.pdf.

Note: 11. 22uF is suggested for $C_{in}/C_{out}$ value when application is required to work under 0℃.


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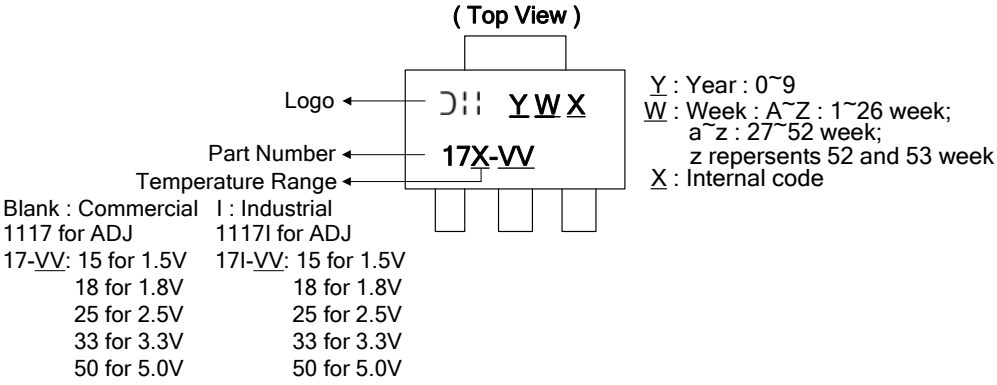
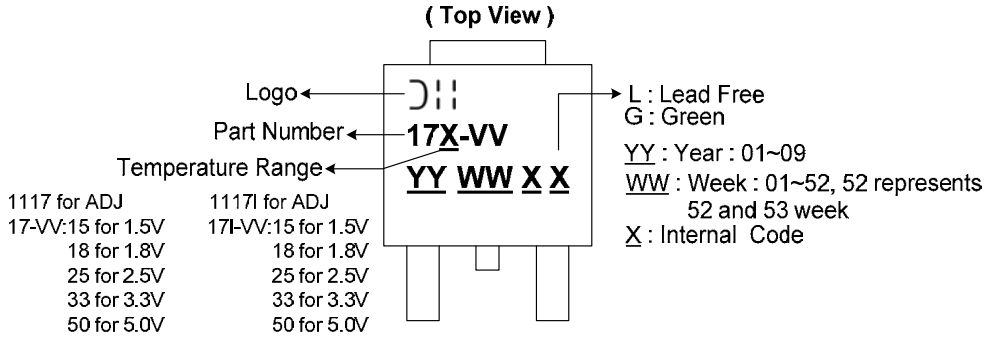
## Marking Information

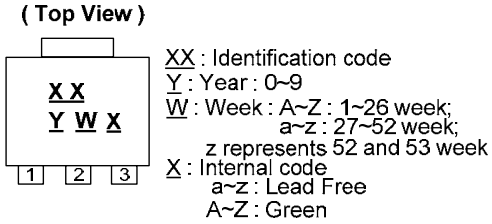
### (1) SOT223




### (2) TO252




### (3) SOT89-3




| Identification Code | Output Version |
|---|---|
| DA | AP1117-ADJ |
| DB | AP1117-1.5V |
| DC | AP1117-1.8V |
| DD | AP1117-2.5V |
| DE | AP1117-3.3V |
| DF | AP1117-5.0V |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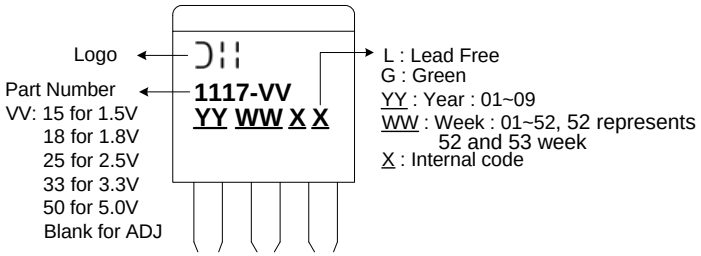
## Marking Information (cont.)

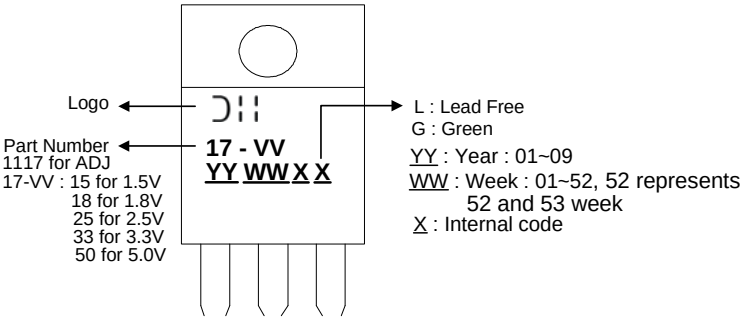
### (4) TO263

( Top View )



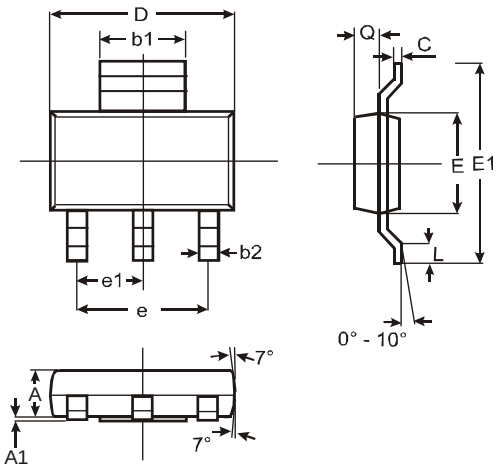

### (5) TO220-3

( Top View )




## Package Outline Dimensions (All dimensions in mm.)

### (1) Package Type: SOT223




| SOT223 | | | |
|---|---|---|---|
| **Dim** | **Min** | **Max** | **Typ** |
| **A** | 1.55 | 1.65 | 1.60 |
| **A1** | 0.010 | 0.15 | 0.05 |
| **b1** | 2.90 | 3.10 | 3.00 |
| **b2** | 0.60 | 0.80 | 0.70 |
| **C** | 0.20 | 0.30 | 0.25 |
| **D** | 6.45 | 6.55 | 6.50 |
| **E** | 3.45 | 3.55 | 3.50 |
| **E1** | 6.90 | 7.10 | 7.00 |
| **e** | — | — | 4.60 |
| **e1** | — | — | 2.30 |
| **L** | 0.85 | 1.05 | 0.95 |
| **Q** | 0.84 | 0.94 | 0.89 |
| **All Dimensions in mm** | | | |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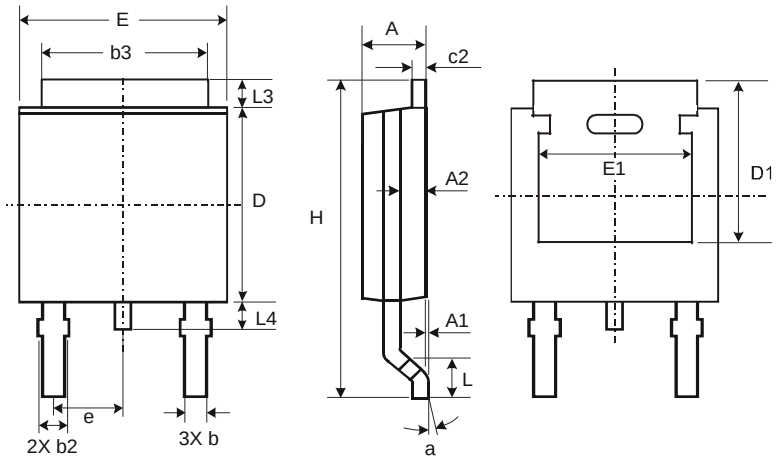
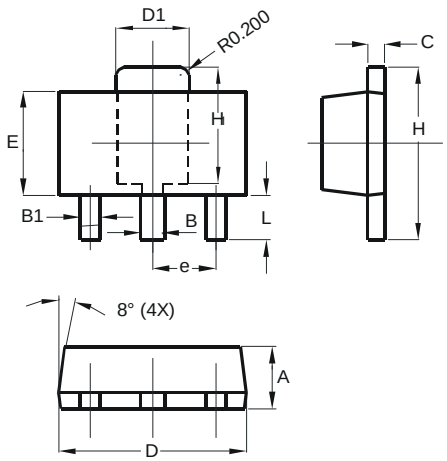
## Package Outline Dimensions (cont.) (All dimensions in mm.)

### (2) Package Type: TO252



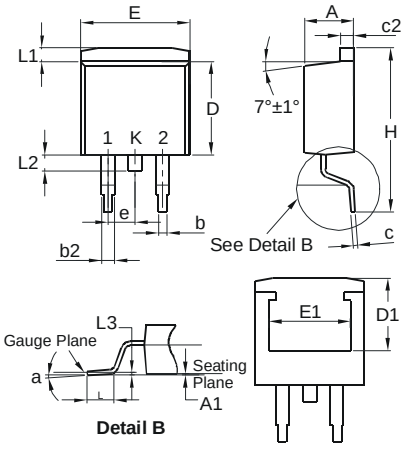

| TO252 | | | |
|---|---|---|---|
| Dim | Min | Max | Typ |
| A | 2.19 | 2.39 | 2.29 |
| A1 | 0.00 | 0.13 | 0.08 |
| A2 | 0.97 | 1.17 | 1.07 |
| b | 0.64 | 0.88 | 0.783 |
| b2 | 0.76 | 1.14 | 0.95 |
| b3 | 5.21 | 5.46 | 5.33 |
| c2 | 0.45 | 0.58 | 0.531 |
| D | 6.00 | 6.20 | 6.10 |
| D1 | 5.21 | – | – |
| e | – | – | 2.286 |
| E | 6.45 | 6.70 | 6.58 |
| E1 | 4.32 | – | – |
| H | 9.40 | 10.41 | 9.91 |
| L | 1.40 | 1.78 | 1.59 |
| L3 | 0.88 | 1.27 | 1.08 |
| L4 | 0.64 | 1.02 | 0.83 |
| a | 0° | 10° | – |
| All Dimensions in mm | | | |

### (3) Package Type: SOT89




| SOT89 | | |
|---|---|---|
| Dim | Min | Max |
| A | 1.40 | 1.60 |
| B | 0.44 | 0.62 |
| B1 | 0.35 | 0.54 |
| C | 0.35 | 0.44 |
| D | 4.40 | 4.60 |
| D1 | 1.62 | 1.83 |
| E | 2.29 | 2.60 |
| e | 1.50 Typ | |
| H | 3.94 | 4.25 |
| H1 | 2.63 | 2.93 |
| L | 0.89 | 1.20 |
| All Dimensions in mm | | |

### (4) Package Type: TO263




| TO263 | | |
|---|---|---|
| Dim | Min | Max |
| A | 4.07 | 4.82 |
| A1 | 0.00 | 0.25 |
| b | 0.51 | 0.99 |
| b2 | 1.15 | 1.77 |
| c | 0.356 | 0.73 |
| c2 | 1.143 | 1.65 |
| D | 8.39 | 9.65 |
| D1 | 6.55 | — |
| E | 9.66 | 10.66 |
| E1 | 6.23 | — |
| e | 2.54 Typ | |
| H | 14.61 | 15.87 |
| L | 1.78 | 2.79 |
| L1 | — | 1.67 |
| L2 | — | 1.77 |
| a | 0° | 8° |
| All Dimensions in mm | | |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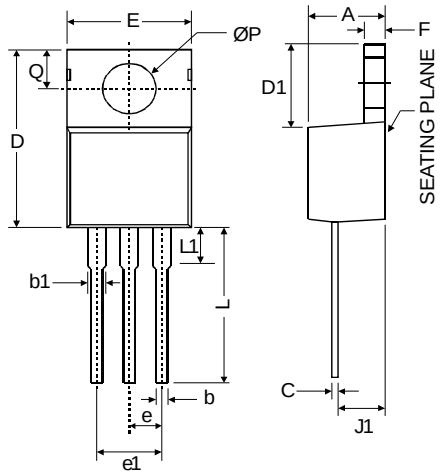
## Package Outline Dimensions (cont.) (All dimensions in mm.)

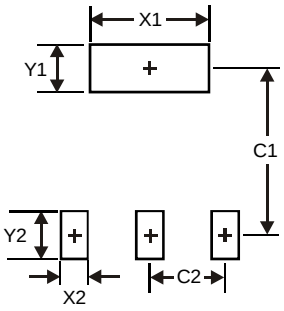
### (5) Package Type: TO220-3




| TO220-3 | | |
|---|---|---|
| **Dim** | **Min** | **Max** |
| **A** | 3.55 | 4.85 |
| **b** | 0.51 | 1.14 |
| **b1** | 1.14 | 1.78 |
| **C** | 0.31 | 1.14 |
| **D** | 14.20 | 16.50 |
| **D1** | 5.84 | 6.86 |
| **E** | 9.70 | 10.70 |
| **e** | 2.79 | 2.99 |
| **e1** | 4.83 | 5.33 |
| **F** | 0.51 | 1.40 |
| **J1** | 2.03 | 2.92 |
| **L** | 12.72 | 14.72 |
| **L1** | 3.66 | 6.35 |
| **P** | 3.53 | 4.09 |
| **Q** | 2.54 | 3.43 |
| **All Dimensions in mm** | | |

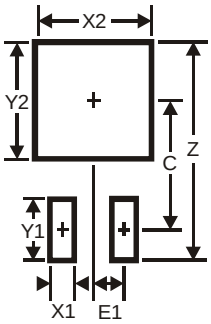
## Suggested Pad Layout

### (1) Package Type: SOT223




| Dimensions | Value (in mm) |
|---|---|
| **X1** | 3.3 |
| **X2** | 1.2 |
| **Y1** | 1.6 |
| **Y2** | 1.6 |
| **C1** | 6.4 |
| **C2** | 2.3 |

### (2) Package Type: TO252




| Dimensions | Value (in mm) |
|---|---|
| **Z** | 11.6 |
| **X1** | 1.5 |
| **X2** | 7.0 |
| **Y1** | 2.5 |
| **Y2** | 7.0 |
| **C** | 6.9 |
| **E1** | 2.3 |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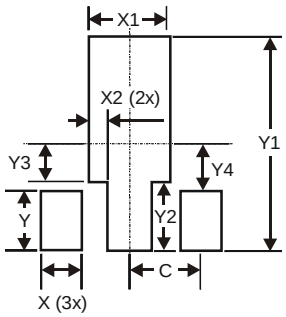
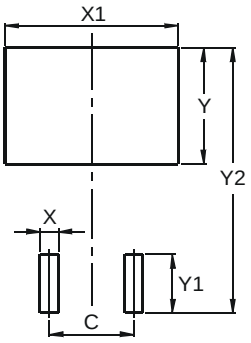
## Suggested Pad Layout (cont.)

### (3) Package Type: SOT89




| Dimensions | Value (in mm) |
|---|---|
| X | 0.900 |
| X1 | 1.733 |
| X2 | 0.416 |
| Y | 1.300 |
| Y1 | 4.600 |
| Y2 | 1.475 |
| Y3 | 0.950 |
| Y4 | 1.125 |
| C | 1.500 |

### (4) Package Type: TO263




| Dimensions | Value (in mm) |
|---|---|
| C | 5.08 |
| X | 1.10 |
| X1 | 10.41 |
| Y | 3.50 |
| Y1 | 7.01 |
| Y2 | 15.99 |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