## ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range.....-65°C to +150°C
Operating Junction Temperature Range.....-40°C to +125°C
Input Voltage (Note 7).....16V

## ELECTRICAL CHARACTERISTICS

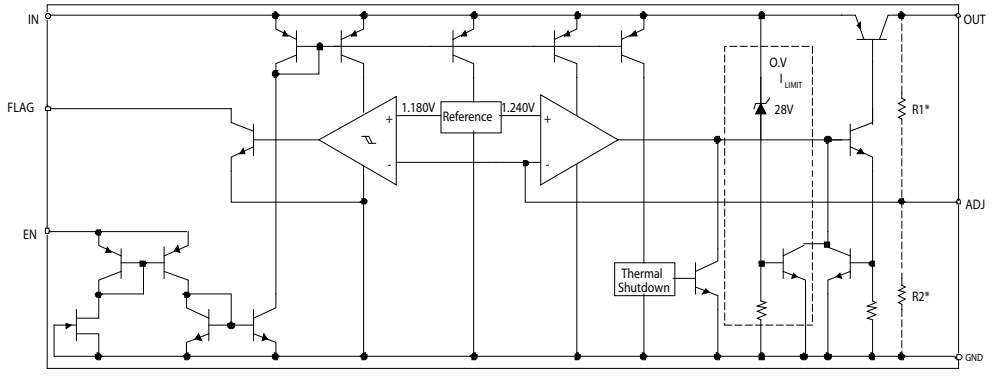
at $V_{IN}=V_{OUT}$ + 1V and $I_{OUT}$ = 10mA, $C_{IN}$ = 6.8µF, $C_{OUT}$ = 10µF, $T_A$ = 25°C, unless otherwise specified. The **Boldface** applies over the junction temperature range. Adjustable versions are set to 5.0V.

| PARAMETER | CONDITIONS | Typ | SPX29150/51 Min | SPX29150/51 Max | Units |
|---|---|---|---|---|---|
| **1.8V Version** | | | | | |
| Output Voltage | $I_{OUT}$ = 10mA<br>10mA ≤ $I_{OUT}$ ≤ 1.5A, 2.5V ≤ $V_{IN}$ ≤ 16V | 1.8<br>**1.8** | 1.782<br>**1.764** | 1.818<br>**1.836** | V |
| **2.5V Version** | | | | | |
| Output Voltage | $I_{OUT}$ = 10mA<br>10mA ≤$I_{OUT}$≤1.5A, 3.5V≤$V_{IN}$ ≤16V | 2.5<br>**2.5** | 2.475<br>**2.450** | 2.525<br>**2.550** | V |
| **3.3V Version** | | | | | |
| Output Voltage | $I_{OUT}$ = 10mA<br>10mA ≤$I_{OUT}$≤1.5A, 4.3V≤$V_{IN}$ ≤16V | 3.3<br>**3.3** | 3.267<br>**3.234** | 3.333<br>**3.366** | V |
| **5.0V Version** | | | | | |
| Output Voltage | $I_{OUT}$ = 10mA<br>10mA ≤$I_{OUT}$≤1.5A, 6.0V≤$V_{IN}$ ≤16V | 5.0<br>**5.0** | 4.950<br>**4.900** | 5.050<br>**5.100** | V |
| **All Voltage Options SPX29150/51/52/53** | | | | | |
| Line Regulation | $I_O$ = 10mA, ($V_{OUT}$ + 1V) ≤ $V_{IN}$ ≤ 16V | 0.1 | | 0.5 | % |
| Load Regulation | $V_{IN}$ = $V_{OUT}$ + 1V, 10mA ≤ $I_{OUT}$≤ $I_{FULL-LOAD}$ | 0.2 | | 1 | % |
| $\frac{\Delta V}{\Delta T}$ | Output Voltage Temperature Coefficient | **13** | | **100** | ppm/°C |
| Dropout Voltage (Note 1) (except 1.8V version) | $I_O$ = 100mA | 70 | | **200** | mV |
| | $I_O$ = 750mA | 230 | | | |
| | $I_O$ = 1.5A | 390 | | **600** | |
| Ground Current (Note 3) | $I_O$ = 750mA, $V_{IN}$ = $V_{OUT}$, +1V<br>$I_O$ = 1.5A | 12<br>45 | | **25** | mA |
| $I_{GNDDO}$ Ground Pin Current at Dropout | $V_{IN}$ = 0.1V less than specified $V_{OUT}$<br>$I_{OUT}$ = 10mA | 0.9 | | | mA |
| Current Limit | $V_{OUT}$ = 0.0V (Note 2) | 2.2 | 1.7 | | A |
| Output Noise Voltage (10Hz to 100kHz)<br>$I_L$ = 100mA | $C_L$ = 10µF<br><br>$C_L$ = 33µF | 400<br><br>260 | | | $\mu V_{RMS}$ |
| Reference Voltage | Adjustable version only | 1.240 | 1.228<br>**1.215** | 1.252<br>**1.265** | V |
| Reference Voltage | Adjustable version only (Note 8) | | 1.203 | 1.277 | |
| Adjust Pin Bias Current | | 40 | | 80<br>**120** | nA |
| Reference Voltage Temperature Coefficient | (Note 4) | 13 | | | ppm/°C |
| Adjust Pin Bias Current Temperature Coefficient | | 0.1 | | | nA/°C |
| **Flag Output (Error Comparator) SPX29151/53** | | | | | |
| Output Leakage Current | $V_{OH}$=16V | 0.1 | | 1.00<br>**2.00** | UA |
| Output Low Voltage | Device set for 5V, $V_{IN}$=4.5V,<br>$I_{OL}$=250µA | 200 | | 300<br>**400** | mV |

| PARAMETER | CONDITIONS | Typ | SPX29150/51 Min | SPX29150/51 Max | Units |
|---|---|---|---|---|---|
| Upper Threshold Voltage | Device set for 5V (Note 5) | 60 | 40<br>**25** | | mV |
| Lower Threshold Voltage | Device set for 5V (Note 5) | 75 | | 95<br>**140** | mV |
| Hysteresis | Device set for 5V (Note 5) | 15 | | | mV |
| **ENABLE input SPX29151/52** | | | | | |
| Input Logic Voltage<br>Low (OFF)<br>High (ON) | $V_{IN}$ < 10V | | <br>**2.4V** | **0.8** | V |
| Enable Input Pin Input Current | $V_{EN}$=16V | 100 | | 600<br>**750** | µA |
| | $V_{EN}$=0.8V | | | **1**<br>**2** | µA |
| Regulator Output Current in Shutdown | (Note 6) | 10 | | **500** | µA |
| Thermal Resistance | TO-220 Junction to Case, at Tab<br>TO-220 Junction to Ambient<br><br>TO-263 Junction to Case, at Tab<br>TO-263 Junction to Ambient | 3<br>30<br><br>3<br>32 | | | °C/W |

NOTES:
Note 1: Dropout voltage is defined as the input to output differential when the output voltage drops to 99% of its nominal value.
Note 2: $V_{IN}$ = $V_{OUT}$ (NOMINAL) +1V. For example, use $V_{IN}$ = 4.3V for a 3.3V regulator. Employ pulse-testing procedures to minimize temperature rise.
Note 3: Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the load current to the ground current.
Note 4: Thermal regulation is defined as the change in the output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects.
Note 5: Comparator threshold is expressed in terms of a voltage differential at the Adjust terminal below the nominal reference voltage measured 6V input. To express these thresholds in terms of output voltage change, multiply the error amplifier gain = $V_{OUT}/V_{REF}$ = (R1 + R2)/R2. For example, at a programmable output voltage of 5V, the Error output is guaranteed to go low when the output drops by 95mVx 5V/ 1.240V = 38mV. Thresholds remain constant as a percent of $V_{OUT}$ as $V_{OUT}$ is varied, with the dropout warning occurring at typically 5% below nominal, 7.7% guaranteed.
Note 6: $V_{EN} \leq 0.8V$ and $V_{IN} \leq 16V$, $V_{OUT}$ = 0.
Note 7: Maximum positive supply voltage of 20V must be of limited duration (<100m_) < 1%. The maximum continuous supply voltage is 16V.
Note 8: $V_{REF} \leq V_{OUT} \leq (V_{IN}-1)$, $2.5V \leq V_{IN} \leq 16V$, $10mA \leq I_L \leq I_{FL}$, $T_J < T_{JMAX}$.

## BLOCK DIAGRAM



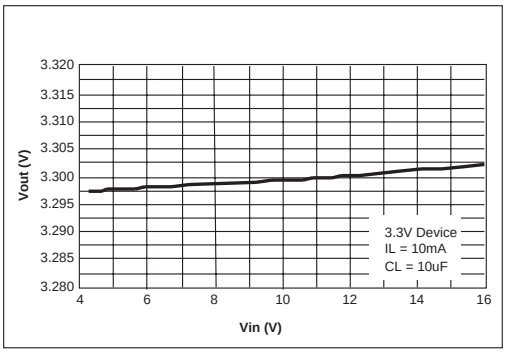



Figure 3. Line Regulation

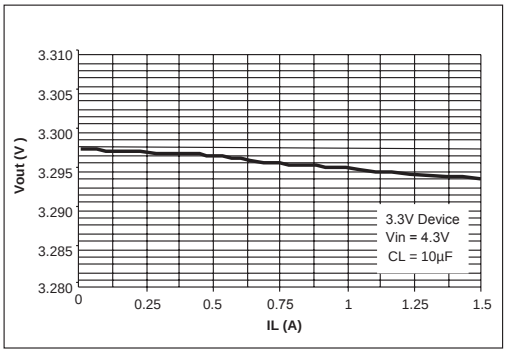



Figure 4. Load Regulation

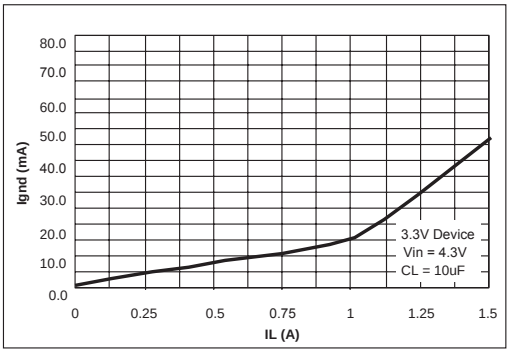



Figure 5. Ground Current vs Load Current

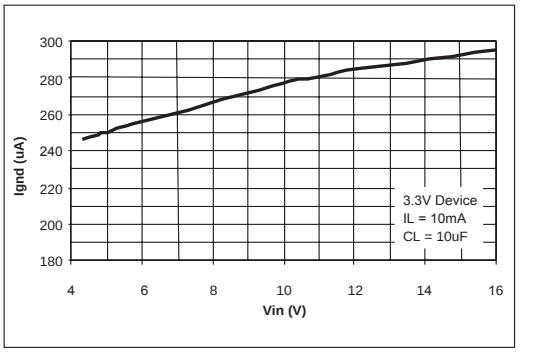



Figure 6. Ground Current vs Input Voltage

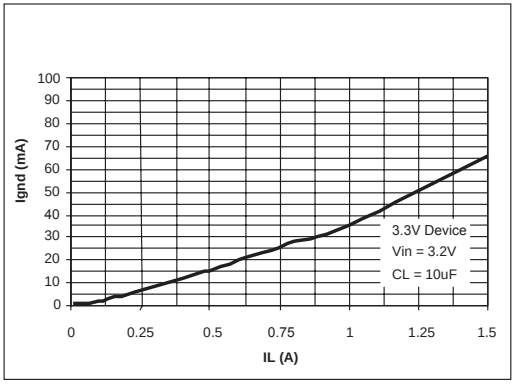



Figure 7. Ground Current vs Load Current in Dropout

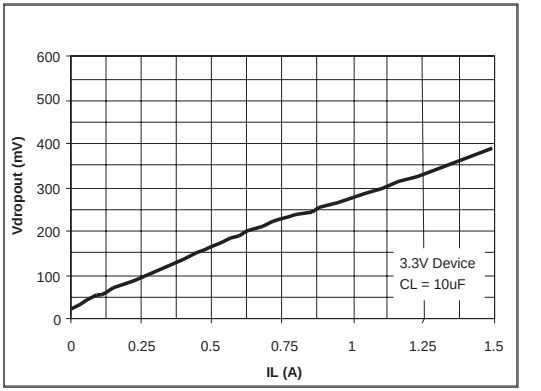



Figure 8. Dropout Voltage vs Load Current

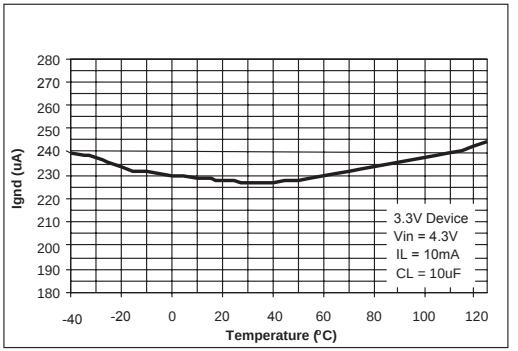



Figure 9. Ground Current vs Temperature at $I_{LOAD}$=10mA

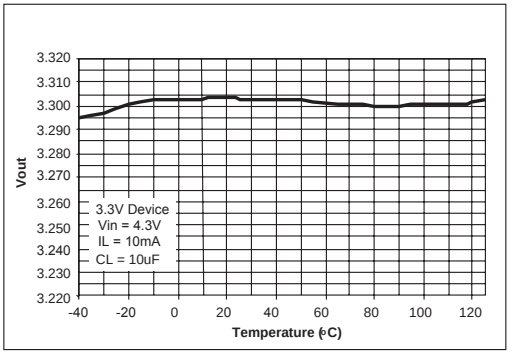



Figure 10. Output Voltage vs Temperature at $I_{LOAD}$=10mA

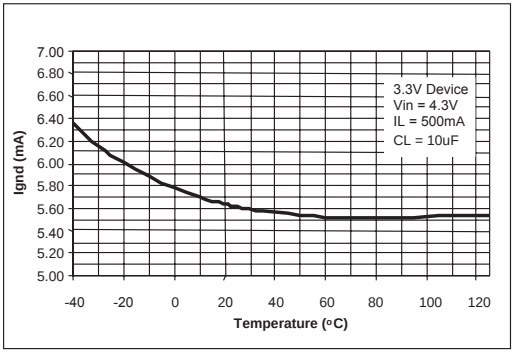



Figure 11. Ground Current vs Temperature at $I_{LOAD}$=500mA

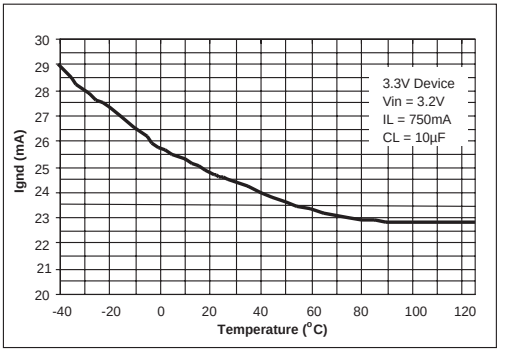



Figure 12. Ground Current vs Temperature in Dropout at $I_{LOAD}$=750mA

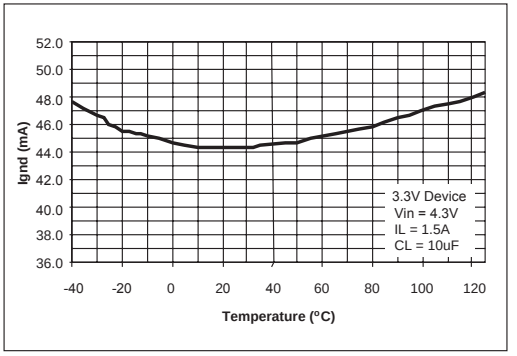



Figure 13. Ground Current vs Temperature at $I_{LOAD}$=1.5A

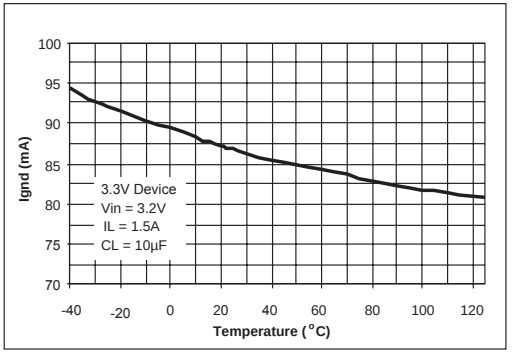



Figure 14. Ground Current vs Temperature in Dropout at $I_{LOAD}$=1.5A

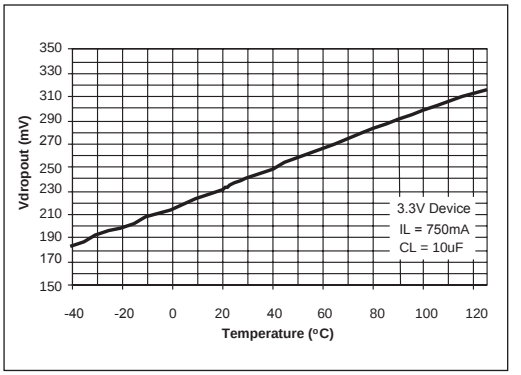



Figure 15. Dropout Voltage vs Temperature at $I_{LOAD}$=750mA

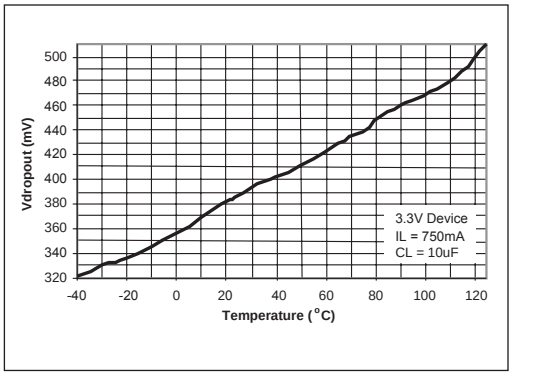



Figure 16. Dropout Voltage vs Temperature at $I_{LOAD}$=1.5A

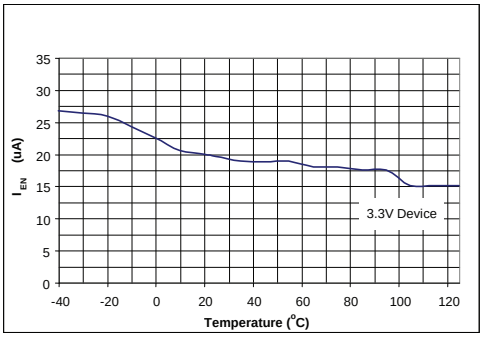



Figure 17. ENABLE Current vs Temperature at $V_{EN}$=16V

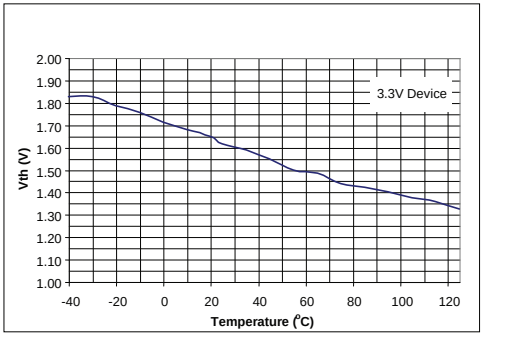



Figure 18. ENABLE Threshold vs Temperature

The SPX29150/51/52/53 incorporates protection against over-current faults, reversed load insertion, over temperature operation, and positive and negative transient voltages.

### Thermal Considerations

Although the SPX29150/51/52/53 offers limiting circuitry for overload conditions, it is still necessary to insure that the maximum junction temperature is not exceeded in the application. Heat will flow through the lowest resistance path, the junction-to-case path. In order to insure the best thermal flow of the component, proper mounting is required. Consult the heatsink manufacturer for thermal resistance and heat sink design.

### TO-220 Design Example:

Assume that $V_{IN}$ = 10V, $V_{OUT}$ = 5V, $I_{OUT}$ = 1.5A, $T_A$ = 50°C, $\theta_H$= 1°C/W, $\theta_{CH}$= 2°C/W, and $\theta_{JC}$= 3C°/W, where:

$T_A$ = ambient temperature,

$\theta_{HA}$ = heatsink to ambient thermal resistance

$\theta_{CH}$ = case to heatsink thermal resistance

$\theta_{JC}$ = junction to case thermal resistance

The power calculated under these conditions is:

$P_D = (V_{IN} – V_{OUT}) * I_{OUT}$ = 7.5W.

And the junction temperature is calculated as

$$T_J = T_A + P_D * (\theta_{HA} + \theta_{CH} + \theta_{JC})$$ or

$$T_J = 50 + 7.5 * (1+2+3) = 95°C$$

Reliable operation is insured.

### Capacitor Requirements

The output capacitor is needed to insure stability and minimize the output noise. The value of the capacitor varies with the load. However, a minimum value of 10µF aluminum capacitor will guarantee stability over all load conditions. A tantalum capacitor is recommended if a faster load transient response is needed. If the power source has a high AC impedance, a 0.1µF ceramic capacitor between input & ground is recommended. The output capacitors maximum ESR value for stable operation is 0.33ohms.

### Minimum Load Current

To ensure proper behavior of the regulator under light loads, a minimum load of 5mA for SPX29150/51/52/53 is required.

### Typical Application Circuits

Figure 19 represents a typical fixed output regulator. Figure 20 represents an adjustable output regulator. The values of R1 and R2 set the output voltage value as follows: $V_{OUT} = V_{REF} * [1 + (R1/R2)]$. A minimum value of 10kΩ is recommended for R2 with a range between 10kΩ and 47kΩ.

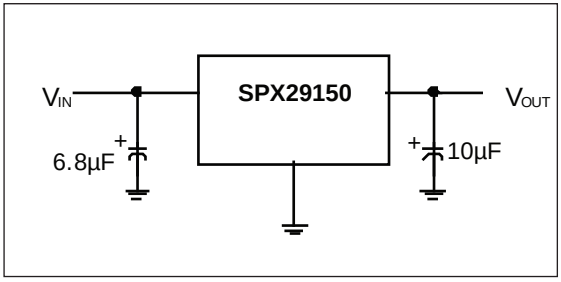



Figure 19. Fixed Output Linear Regulator

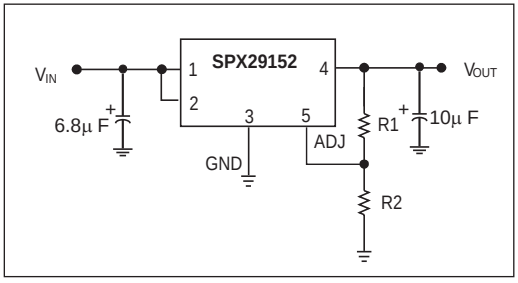
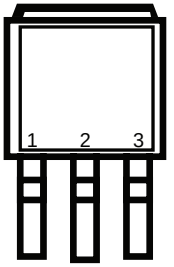



Figure 20. Adjustable Output Linear Regulator

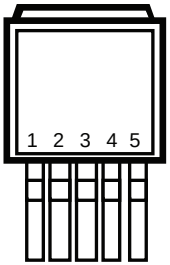
**TO-263-3 Package (T)**




$V_{IN}$ GND $V_{OUT}$

**Front View**

**TO-263-5 Package (T5)**

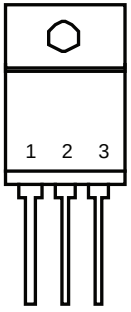



**Top View**

| SPX29151 | SPX29152 | SPX29153 |
|---|---|---|
| 1) ENABLE | 1) ENABLE | 1) FLAG |
| 2) INPUT | 2) INPUT | 2) INPUT |
| 3) GND | 3) GND | 3) GND |
| 4) OUTPUT | 4) OUTPUT | 4) OUTPUT |
| 5) FLAG | 5) ADJUST | 5) ADJUST |

*Tab is internally connected to GND

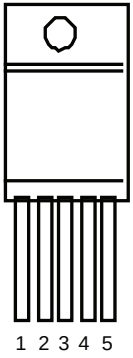
**TO-220-3 Package (U)**




$V_{IN}$ GND $V_{OUT}$

**Front View**

**TO-220-5 Package (U5)**

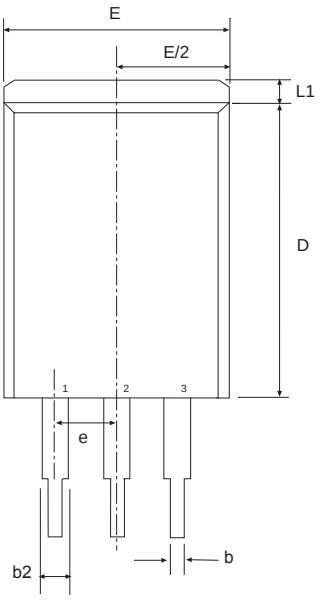


1 2 3 4 5

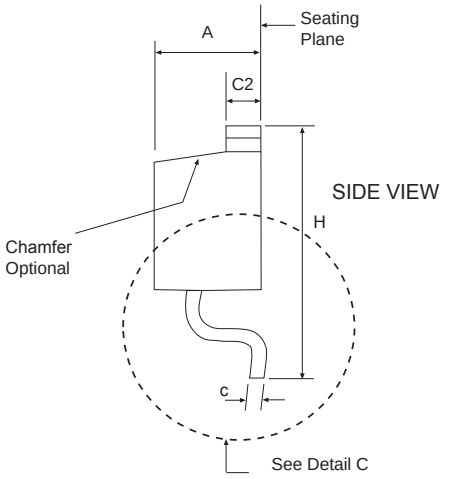
**Top View**

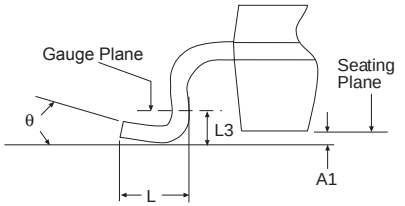
| SPX29151 | SPX29152 | SPX29153 |
|---|---|---|
| 1) ENABLE | 1) ENABLE | 1) FLAG |
| 2) INPUT | 2) INPUT | 2) INPUT |
| 3) GND | 3) GND | 3) GND |
| 4) OUTPUT | 4) OUTPUT | 4) OUTPUT |
| 5) FLAG | 5) ADJUST | 5) ADJUST |

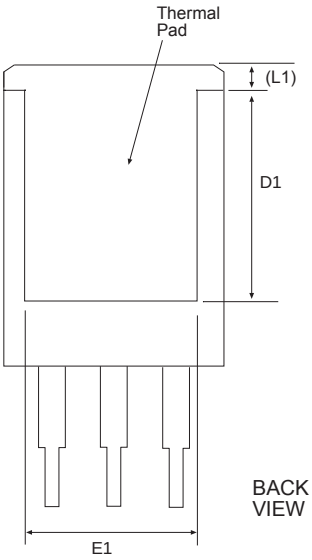



FRONT VIEW



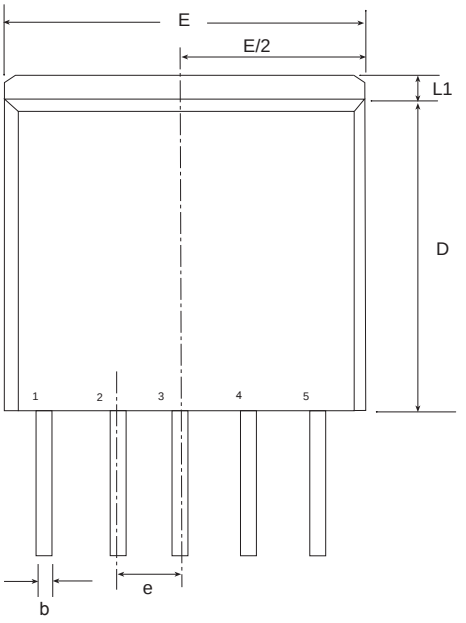

DETAIL C



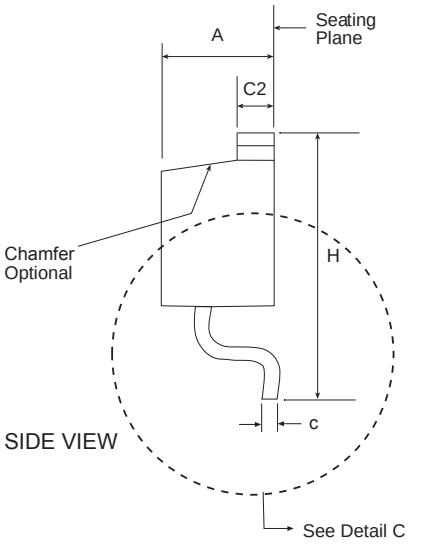

BACK
VIEW

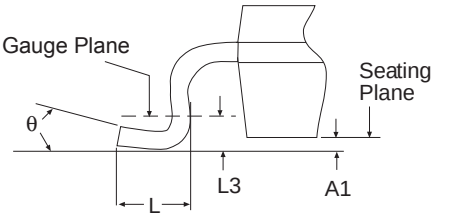
| 3 Pin TO-263 JEDEC TO-263 Variation AA | | | | | | |
|---|---|---|---|---|---|---|
| SYMBOL | Inches Controlling Dimension | | | Millimeters Conversion Factor: 1 Inch = 25.40 mm | | |
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.160 | - | 0.190 | 4.06 | - | 4.83 |
| A1 | 0.000 | - | 0.010 | 0.00 | - | 0.25 |
| b | 0.020 | - | 0.039 | 0.51 | - | 0.99 |
| b2 | 0.045 | - | 0.070 | 1.14 | - | 1.78 |
| c | 0.015 | - | 0.029 | 0.38 | - | 0.74 |
| c2 | 0.045 | - | 0.065 | 1.14 | - | 1.65 |
| D | 0.330 | - | 0.380 | 8.38 | - | 9.65 |
| D1 | 0.270 | - | - | 6.86 | - | - |
| E | 0.380 | - | 0.420 | 9.65 | - | 10.67 |
| E1 | 0.245 | - | - | 6.22 | - | - |
| e | .100 BSC | | | 2.54 BSC | | |
| H | 0.575 | - | 0.625 | 14.61 | - | 15.88 |
| L | 0.070 | - | 0.110 | 1.78 | - | 2.79 |
| L1 | - | - | 0.066 | - | - | 1.68 |
| L3 | .010 BSC | | | 0.25 BSC | | |
| Θ | 0˚ | - | 8˚ | 0˚ | - | 8˚ |
| EXAR Pkg Signoff Date/Rev: | | | | JL Aug5-05 / Rev A | | |

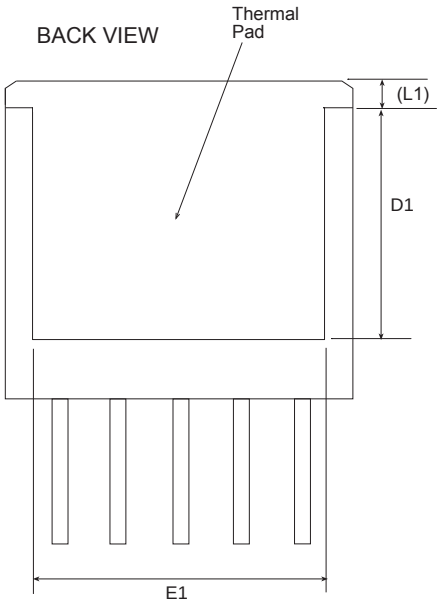



FRONT VIEW



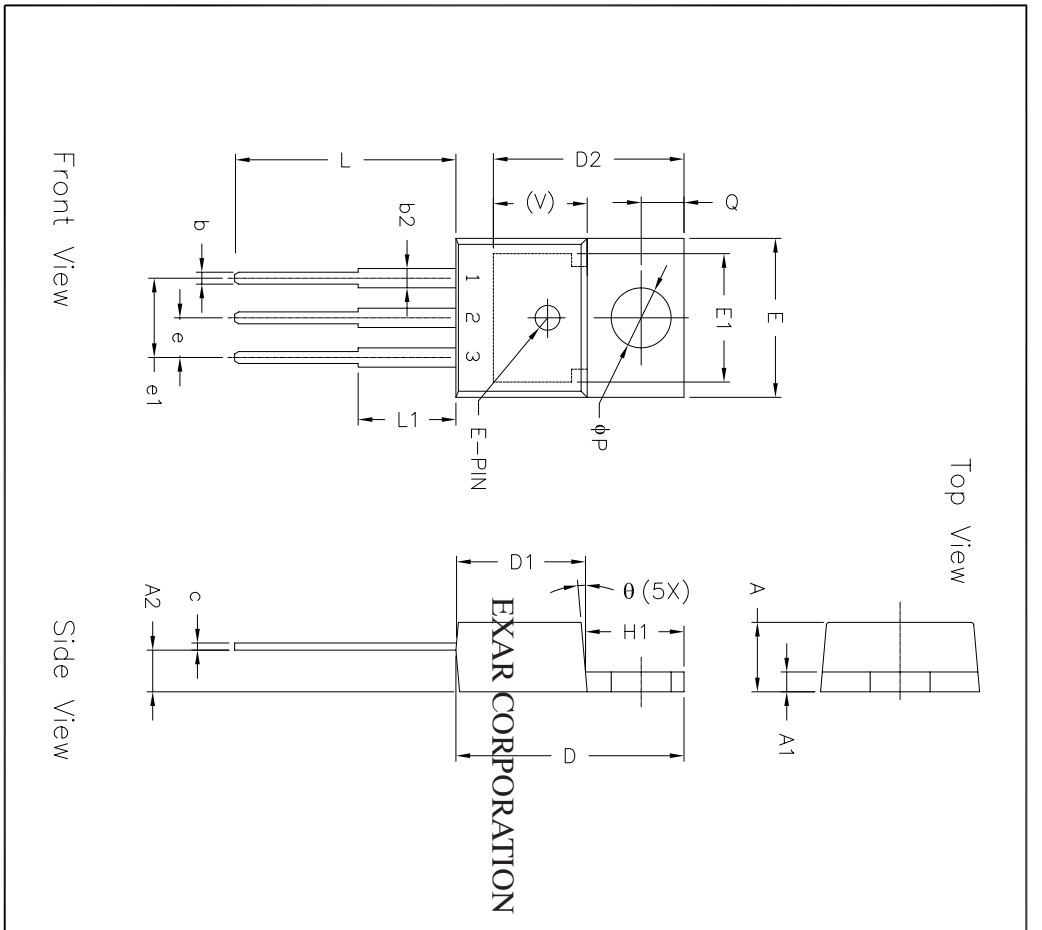




DETAIL C




| 5 Pin TO-263 JEDEC TO-263 Variation BA | | | | | | |
|---|---|---|---|---|---|---|
| | Dimensions in Inches: Controlling Dimension | | | Dimensions in Millimeters Conversion Factor: 1 Inch = 25.40 mm | | |
| SYMBOL | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.160 | - | 0.190 | 4.06 | - | 4.83 |
| A1 | 0.000 | - | 0.010 | 0.00 | - | 0.25 |
| b | 0.020 | - | 0.039 | 0.51 | - | 0.99 |
| c | 0.015 | - | 0.029 | 0.38 | - | 0.74 |
| c2 | 0.045 | - | 0.065 | 1.14 | - | 1.65 |
| D | 0.330 | - | 0.380 | 8.38 | - | 9.65 |
| D1 | 0.270 | - | - | 6.86 | - | - |
| E | 0.380 | - | 0.420 | 9.65 | - | 10.67 |
| E1 | 0.245 | - | - | 6.22 | - | - |
| e | .067 BSC | | | 1.702 BSC | | |
| H | 0.575 | - | 0.625 | 14.61 | - | 15.88 |
| L | 0.070 | - | 0.110 | 1.78 | - | 2.79 |
| L1 | - | - | 0.066 | - | - | 1.68 |
| L3 | .010 BSC | | | 0.254 BSC | | |
| Θ | 0° | - | 8° | 0° | - | 8° |
| EXAR Pkg Signoff Date/Rev: | | | | JL Jun12-06 / Rev B | | |




| REVISION HISTORY | | | |
|---|---|---|---|
| REV. | DESCRIPTION | DATE | APP'D |
| A | DRAWING ORIGINATION | 08/04/05 | JL |
| B | DRAWING FORMAT MODIFICATION | 05/25/06 | JL |

3 Pin TO-220 (Option 1)* JEDEC TO-220-AB

| SYMBOLS | DIMENSIONS IN INCH (Control Unit) | | DIMENSIONS IN MM (Reference Unit) | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.140 | 0.190 | 3.56 | 4.82 |
| A1 | 0.020 | 0.055 | 0.51 | 1.40 |
| A2 | 0.080 | 0.115 | 2.03 | 2.92 |
| b | 0.015 | 0.040 | 0.38 | 1.02 |
| c | 0.014 | 0.024 | 0.36 | 0.61 |
| D | 0.560 | 0.650 | 14.22 | 16.51 |
| D1 | 0.330 | 0.355 | 8.38 | 9.02 |
| D2 | 0.480 | 0.507 | 12.19 | 12.88 |
| E | 0.380 | 0.420 | 9.65 | 10.67 |
| E1 | 0.270 | 0.350 | 6.86 | 8.89 |
| e | 0.100 BSC | | 2.54 BSC | |
| e1 | 0.200 BSC | | 5.08 BSC | |
| H1 | 0.230 | 0.270 | 5.84 | 6.86 |
| L | 0.500 | 0.580 | 12.70 | 14.73 |
| L1 | — | 0.250 | — | 6.35 |
| P | 0.139 | 0.156 | 3.53 | 3.96 |
| Q | 0.103 | 0.113 | 2.62 | 2.87 |
| V | 0.240 REF | | 6.10 REF | |
| θ | 3° | 7° | 3° | 7° |
| N | 3 | | 3 | |

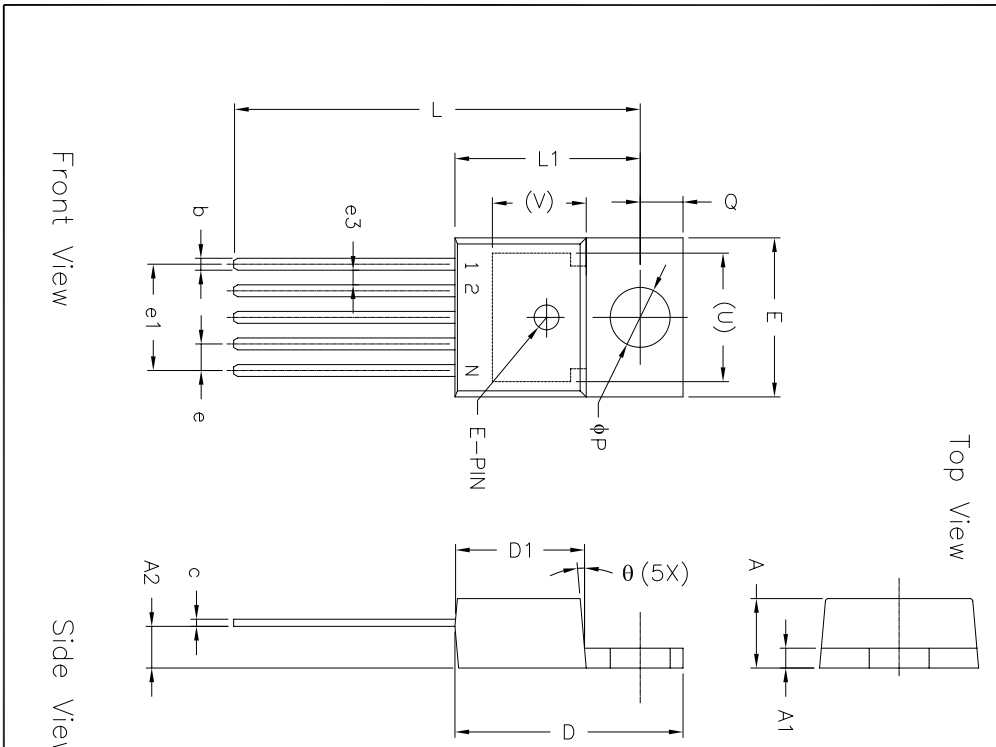
* Refer to product datasheet for POD option being used

SIPEX CORPORATION

3 PIN TO-220 PACKAGE OUTLINE

| Packaging Approval: | Drawing No: 3-PIN TO-220 |
|---|---|
| By: JL Date: 05/25/06 | Revision: B Sheet: 1 OF 2 |




| REVISION HISTORY | | | |
|---|---|---|---|
| REV. | DISCRIPTION | DATE | APP'D |
| A | DRAWING ORIGINATION | 06/30/05 | JL |
| B | DRAWING FORMAT MODIFICATION | 05/09/06 | JL |

5 Pin TO-220 JEDEC TS-001 Variation AA

| SYMBOLS | DIMENSIONS IN INCH (Control Unit) | | DIMENSIONS IN MM (Reference Unit) | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.165 | 0.190 | 4.19 | 4.82 |
| A1 | 0.035 | 0.055 | 0.89 | 1.39 |
| A2 | 0.085 | 0.115 | 2.16 | 2.92 |
| b | 0.020 | 0.040 | 0.51 | 1.01 |
| c | 0.012 | 0.025 | 0.31 | 0.63 |
| D | 0.570 | 0.625 | 14.48 | 15.87 |
| D1 | 0.330 | 0.370 | 8.39 | 9.39 |
| E | 0.390 | 0.415 | 9.91 | 10.54 |
| e | 0.067 BSC | | 1.70 BSC | |
| e1 | 0.263 | 0.273 | 6.68 | 6.93 |
| e3 | 0.030 | 0.040 | 0.76 | 1.02 |
| L | 0.945 | 1.045 | 24.00 | 26.54 |
| L1 | 0.465 | 0.539 | 11.81 | 13.69 |
| P | 0.139 | 0.156 | 3.53 | 3.96 |
| Q | 0.103 | 0.113 | 2.62 | 2.87 |
| U | 0.300 REF | | 7.62 REF | |
| V | 0.240 REF | | 6.10 REF | |
| θ | 3° | 7° | 3° | 7° |
| N | 5 | | 5 | |

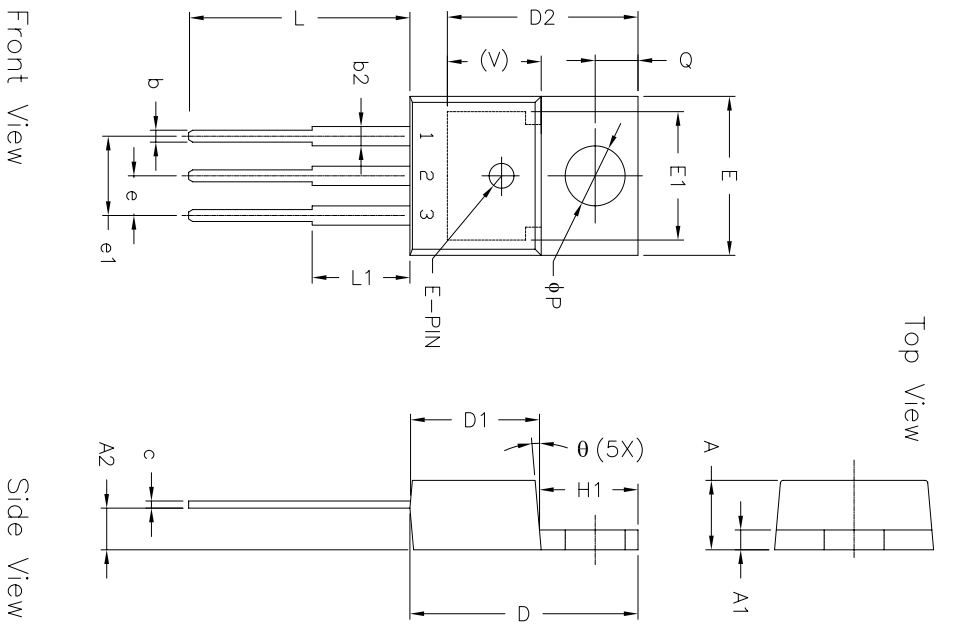
EXAR CORPORATION

5 PIN TO-220 PACKAGE OUTLINE

Drawing No: 5-PIN TO-220

Revision: B Sheet: 1 OF 1

Packaging Approval: By: JL Date: 05/09/06




| REVISION HISTORY | | | |
|---|---|---|---|
| REV. | DESCRIPTION | DATE | APP'D |
| A | DRAWING ORIGINATION | 08/04/05 | JL |
| B | DRAWING FORMAT MODIFICATION | 05/25/06 | JL |

3 Pin TO-220 (Option 1)* JEDEC TO-220-AB

| SYMBOLS | DIMENSIONS IN INCH (Control Unit) | | DIMENSIONS IN MM (Reference Unit) | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.140 | 0.190 | 3.56 | 4.82 |
| A1 | 0.020 | 0.055 | 0.51 | 1.40 |
| A2 | 0.080 | 0.115 | 2.03 | 2.92 |
| b | 0.015 | 0.040 | 0.38 | 1.02 |
| c | 0.014 | 0.024 | 0.36 | 0.61 |
| D | 0.560 | 0.650 | 14.22 | 16.51 |
| D1 | 0.330 | 0.355 | 8.38 | 9.02 |
| D2 | 0.480 | 0.507 | 12.19 | 12.88 |
| E | 0.380 | 0.420 | 9.65 | 10.67 |
| E1 | 0.270 | 0.350 | 6.86 | 8.89 |
| e | 0.100 BSC | | 2.54 BSC | |
| e1 | 0.200 BSC | | 5.08 BSC | |
| H1 | 0.230 | 0.270 | 5.84 | 6.86 |
| L | 0.500 | 0.580 | 12.70 | 14.73 |
| L1 | — | 0.250 | — | 6.35 |
| P | 0.139 | 0.156 | 3.53 | 3.96 |
| Q | 0.103 | 0.113 | 2.62 | 2.87 |
| V | 0.240 REF | | 6.10 REF | |
| θ | 3° | 7° | 3° | 7° |
| N | 3 | | 3 | |

* Refer to product datasheet for POD option being used

| | | | |
|---|---|---|---|
| By: JL | Date: 05/25/06 | SIPEX CORPORATION | |
| Packaging Approval: | | 3 PIN TO-220 PACKAGE OUTLINE | |
| Drawing No: 3-PIN TO-220 | | Revision: B | Sheet: 1 OF 2 |