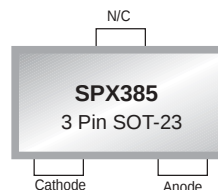


## Micropower Voltage Reference

### FEATURES

- Trimmed Bandgap ..... 1% and 2%
- Wide Operating Current ..... 20 $\mu$ A to 20mA
- Extended Temperature Range ... -40°C to +85°C
- Dynamic Impedance ..... 1 $\Omega$  max
- Offered in SOT-23, TO-92, SOIC, and SOT-89
- Improved Replacement for LM185/285/385-2.5V, AS385-2.5
- Temp Co 140ppm/°C



*Now Available in Lead Free Packaging*

Refer to page 4 for pinouts.

### APPLICATIONS

- Battery Operating Equipment
- Adjustable Supplies
- Switching Power Supplies
- Error Amplifiers
- Single Supply Amplifier
- Monitors / VCR / TV
- Personal Computers

### DESCRIPTION

The SPX385-2.5 is a micropower 2-terminal band-gap voltage reference with a very wide operating current range from 20 $\mu$ A to 20mA that provides a stable voltage. The high stability of this device is primarily the result of the low temperature coefficient Thin Film Resistor process and Laser Trimming of the output voltage at the wafer level.

The SPX385-2.5 is available in a SOT-23, TO-92, SOIC-8 and SOT-89 package with an operating temperature range of -40°C to 85°C. A 1.2 and 5 volt device is also available - SPX385-1.2 and SPX385-5.

### BLOCK DIAGRAM

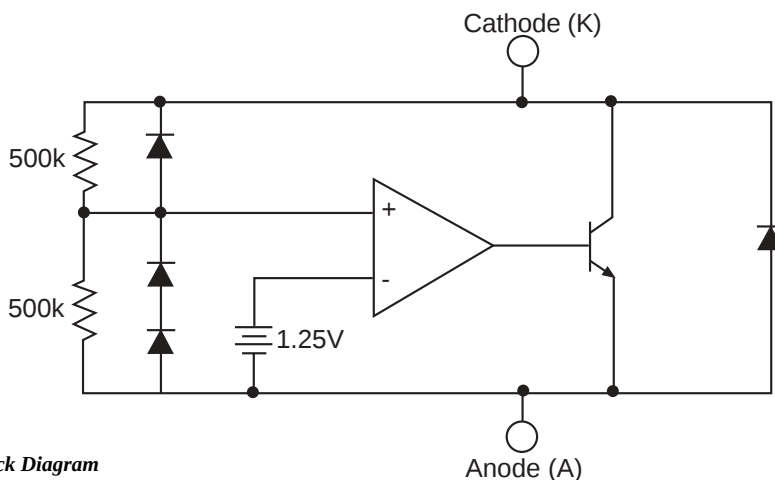


Figure 1: Block Diagram

## ABSOLUTE MAXIMUM RATINGS

Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Reverse Current ( $I_{KA}$ ) ..... 30mA  
 Forward Current ( $I_{AK}$ ) ..... 10mA  
 Operating Temperature Range ( $T_A$ ) ..... -40 to +85°C  
 Junction Temperature ( $T_J$ ) ..... 150°C  
 Storage Temperature ( $T_{STG}$ ) ..... - 65 to 150°C  
 Lead Temperature (Soldering 10 sec.),  $T_L$  ..... 300°C

## TYPICAL THERMAL RESISTANCES

| PACKAGE | $\theta_{JA}$ | $\theta_{JC}$ | TYPICAL DERATING |
|---------|---------------|---------------|------------------|
| TO-92   | 160°C/W       | 80°C/W        | 6.3 mW/°C        |
| SOT-23  | 575°C/W       | 150°C/W       | 1.7 mW/°C        |
| SOIC-8  | 175°C/W       | 45°C/W        | 5.7 mW/°C        |
| SOT-89  | 110°C/W       | 8°C/W         | 9.1 mW/°C        |

Typical deratings of the thermal resistances are given for ambient temperature >25°.

## ELECTRICAL CHARACTERISTICS

$I_{IN} = 100\mu A$ ,  $T_A = 25^\circ C$ , unless otherwise specified.

| PARAMETER                           | CONDITIONS                                      | SPX385A-2.5 |       |       | SPX385-2.5 |       |       | UNIT          |
|-------------------------------------|-------------------------------------------------|-------------|-------|-------|------------|-------|-------|---------------|
|                                     |                                                 | MIN.        | TYP.  | MAX   | MIN.       | TYP.  | MAX.  |               |
| Reference Voltage                   |                                                 | 2.475       | 2.500 | 2.525 | 2.450      | 2.500 | 2.550 | V             |
| Dynamic Output Impedance            | F = 20Hz<br>$I_R = 100\mu A$                    |             | 0.6   | 1.0   |            | 0.6   | 1.0   | $\Omega$      |
| Reference Voltage Change with $I_R$ | $20\mu A \leq I_R \leq 20mA$                    |             | 10    | 20    |            | 10    | 20    | mV            |
| Temperature Coefficient             | Note 1                                          |             | 80    | 140   |            | 80    | 140   | ppm/°C        |
| Minimum Operating Current           |                                                 |             | 15    | 20    |            | 15    | 20    | $\mu A$       |
| Output Wideband Noise               | $10Hz \leq f \leq 10kHz$                        |             | 120   |       |            | 120   |       | $\mu V_{rms}$ |
| Long Term Stability                 | T=1000Hr;<br>$T_A = 25^\circ C \pm 0.1^\circ C$ |             | 60    |       |            | 60    |       | ppm           |
| Operating Temperature               |                                                 | -40         |       | +85   | -40        |       | +85   | °C            |

Note 1. Three-point measurement guarantees the error band over the specified temperature range.

## \*CALCULATING AVERAGE TEMPERATURE COEFFICIENT (TC)

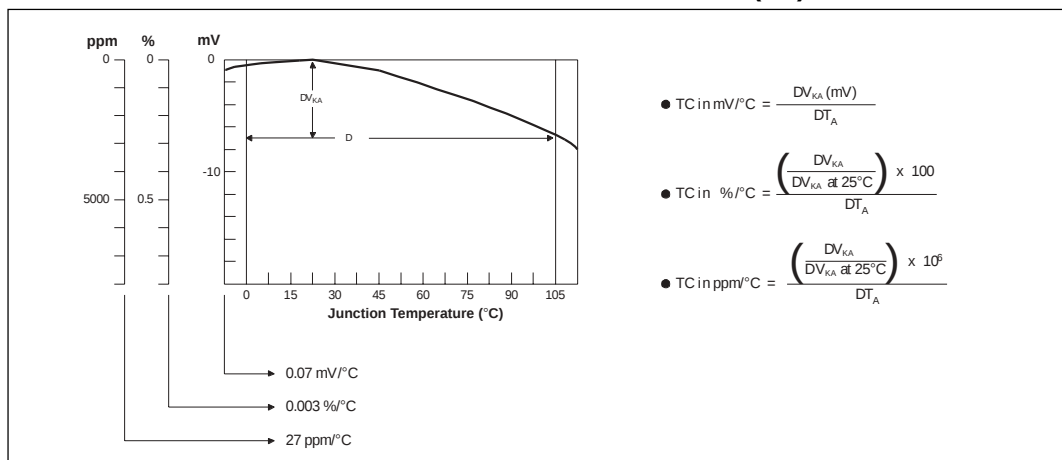


Figure 2.  $V_{KA}$  vs. Temperature

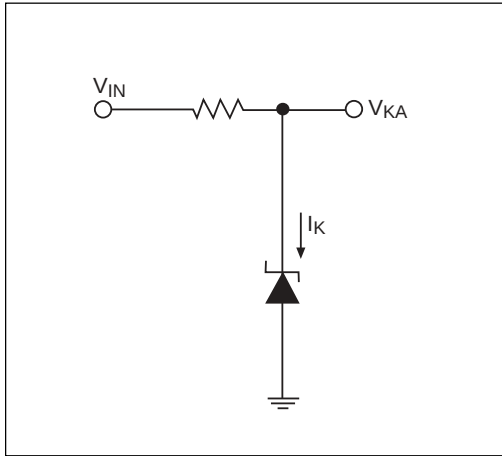


Figure 3. Test Circuit

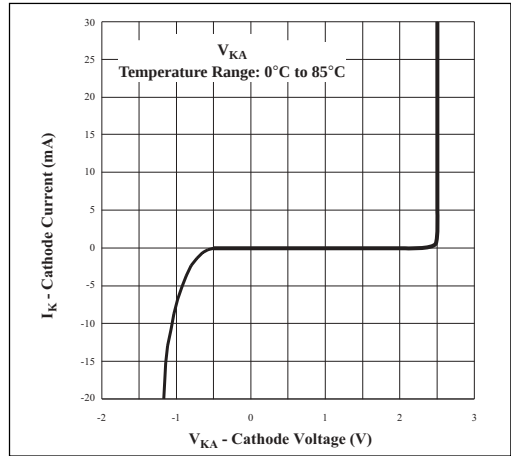


Figure 4. High Current Operating Characteristics

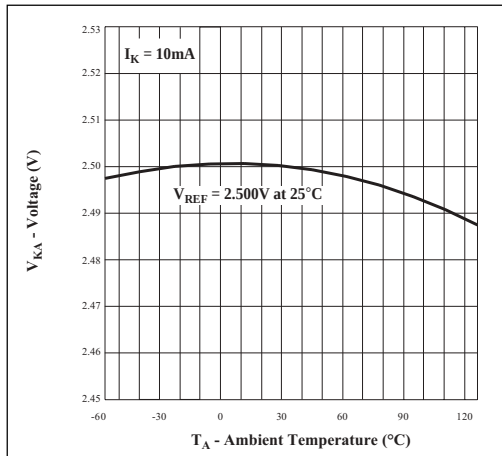


Figure 5. Reference Voltage vs. Ambient Temperature

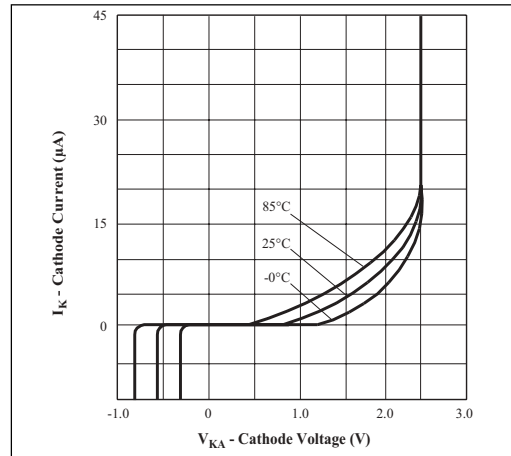


Figure 6. Low Current Operating Characteristics

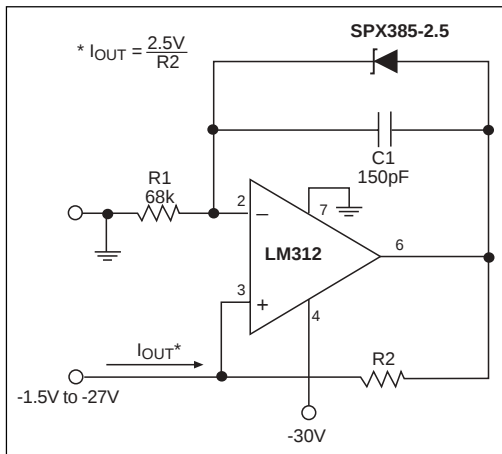


Figure 7a. Precision 1µA to 1mA Current Sink

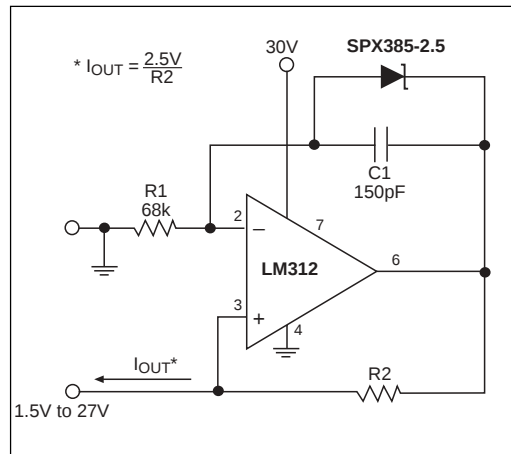
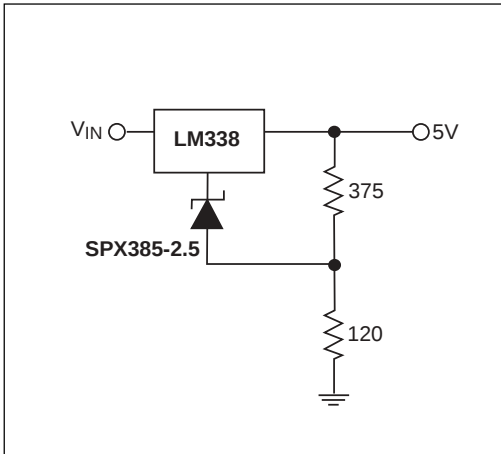
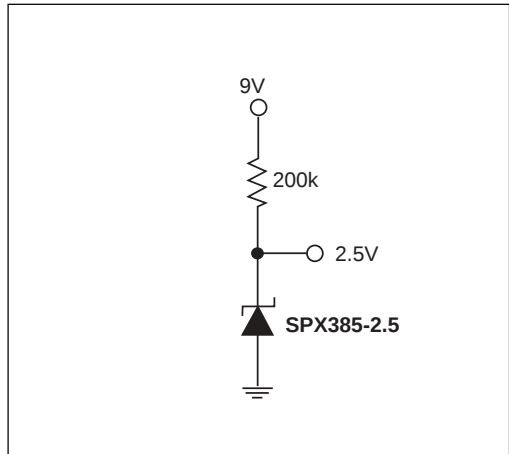


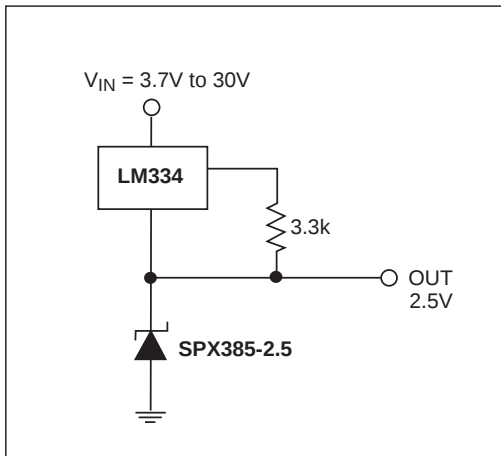
Figure 7b. Precision 1µA to 1mA Current Source



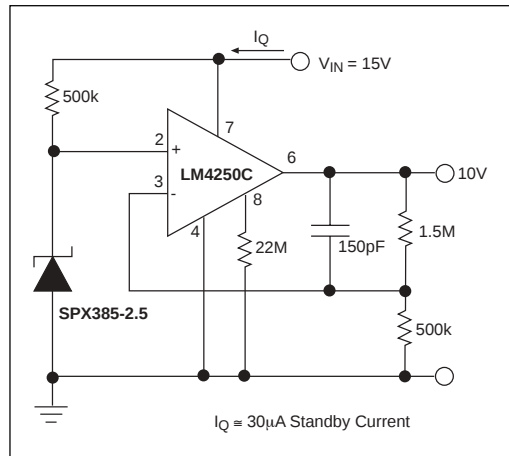
**Figure 8. Improving Regulation of Adjustable Regulators**



**Figure 9. Micropower Reference from 9V Battery**

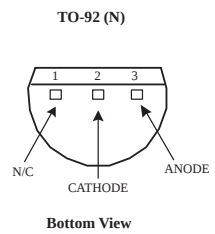
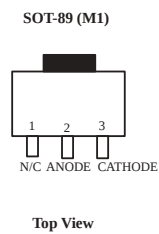
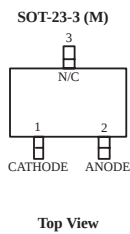
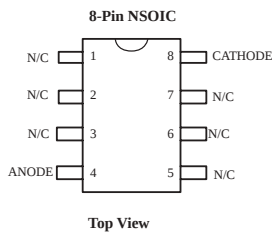


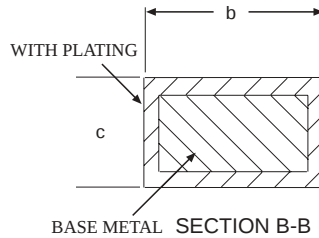
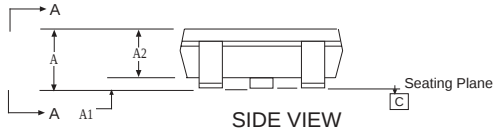
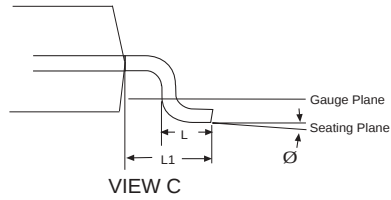
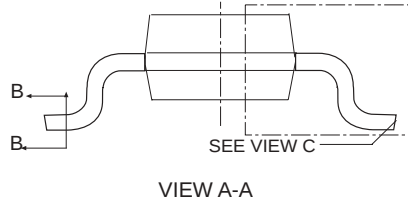
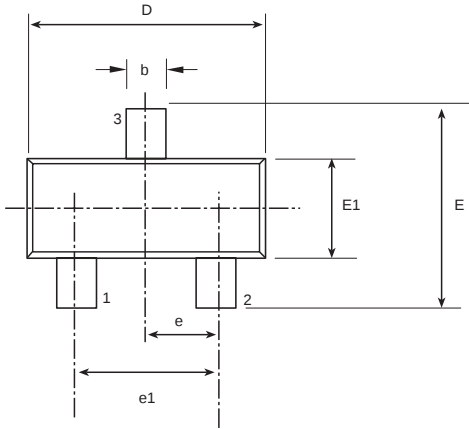
**Figure 10. Wide Input Range Reference**



**Figure 11. Precision Micropower 10V Reference**

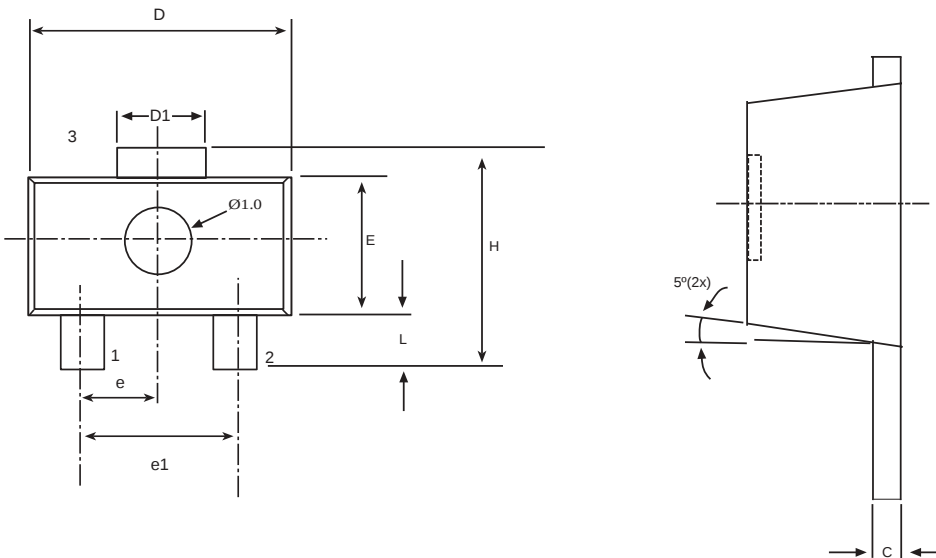
## PACKAGE PINOUTS





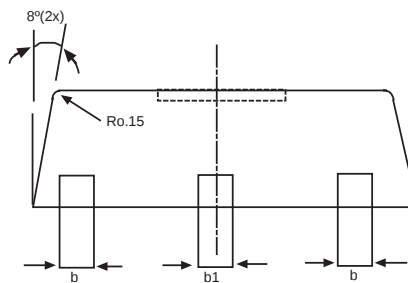
| 3 Pin SOT-23 JEDEC TO-236 (AB) Variation |          |      |      |
|------------------------------------------|----------|------|------|
| SYMBOL                                   | MIN      | NOM  | MAX  |
| A                                        | 0.89     | -    | 1.12 |
| A1                                       | 0.01     | -    | 0.1  |
| A2                                       | 0.88     | 0.95 | 1.02 |
| b                                        | 0.3      | -    | 0.5  |
| c                                        | 0.08     | -    | 0.2  |
| D                                        | 2.8      | 2.9  | 3.04 |
| e                                        | 0.95 BSC |      |      |
| e1                                       | 1.90 BSC |      |      |
| E                                        | 0.95     | -    | 2.64 |
| E1                                       | 1.2      | 1.3  | 1.4  |
| L                                        | 0.4      | 0.5  | 0.6  |
| L1                                       | 0.54 REF |      |      |
| Ø                                        | 0°       | -    | 8°   |

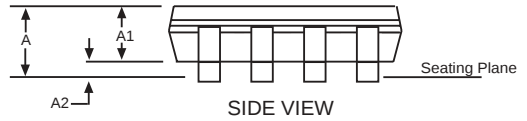
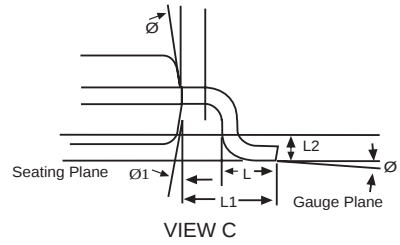
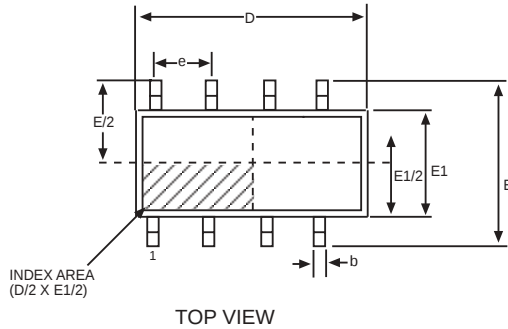
Note: Dimensions in (mm)



| 3 Pin SOT-89 |      |      |      |
|--------------|------|------|------|
| SYMBOL       | MIN  | NOM  | MAX  |
| b            | 0.36 | 0.42 | 0.48 |
| L            | 0.8  | -    | 1.2  |
| b1           | 0.41 | 0.47 | 0.53 |
| C            | 0.38 | 0.4  | 0.43 |
| D            | 4.4  | 4.5  | 4.6  |
| D1           | 1.4  | 1.6  | 1.75 |
| H            | 3.94 | -    | 4.25 |
| E            | 2.4  | 2.5  | 2.6  |
| e            | 1.45 | 1.5  | 1.55 |
| e1           | 2.9  | 3    | 3.1  |

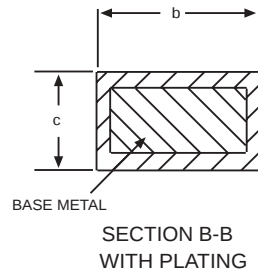
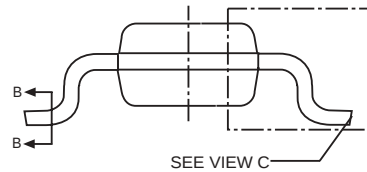
Note: Dimensions in (mm)

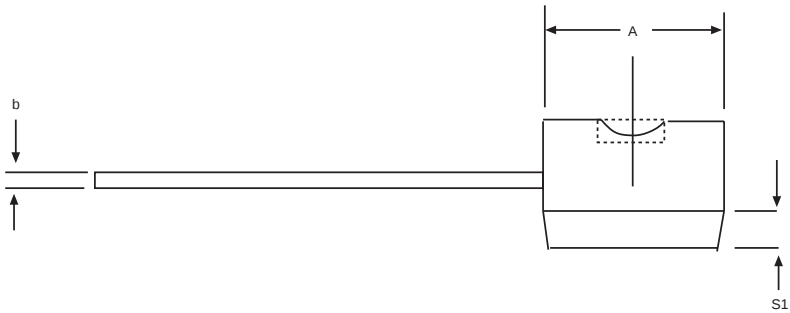
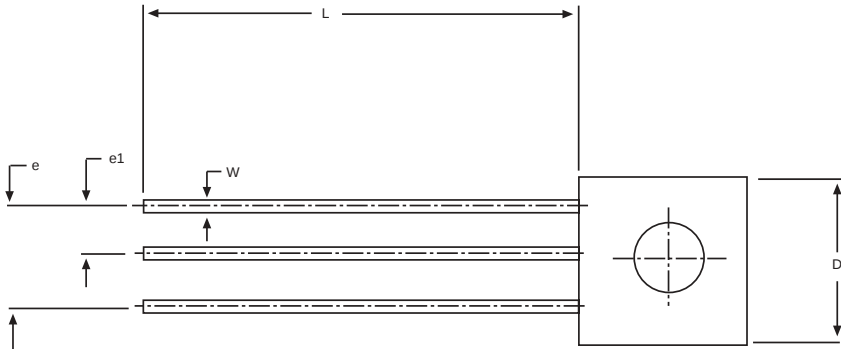




| 8 Pin NSOIC JEDEC MO-012 (AA) Variation |          |     |      |
|-----------------------------------------|----------|-----|------|
| SYMBOL                                  | MIN      | NOM | MAX  |
| A                                       | 1.35     | -   | 1.75 |
| A1                                      | 0.1      | -   | 0.25 |
| A2                                      | 1.25     | -   | 1.65 |
| b                                       | 0.31     | -   | 0.51 |
| c                                       | 0.17     | -   | 0.24 |
| D                                       | 4.90 BSC |     |      |
| E                                       | 6.00 BSC |     |      |
| E1                                      | 3.90 BSC |     |      |
| e                                       | 1.27 BSC |     |      |
| L                                       | 0.4      | -   | 1.27 |
| L1                                      | 1.04 REF |     |      |
| L2                                      | 0.25 BSC |     |      |
| Ø                                       | 0°       | -   | 8°   |
| Ø1                                      | 5°       | -   | 15°  |

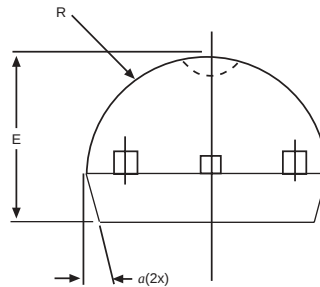
Note: Dimensions in (mm)





| 3 Pin TO-92 |       |     |       |
|-------------|-------|-----|-------|
| SYMBOL      | MIN   | NOM | MAX   |
| A           | 0.17  | -   | 0.195 |
| b           | 0.014 | -   | 0.02  |
| E           | 0.13  | -   | 0.155 |
| e           | 0.95  | -   | 0.105 |
| e1          | 0.045 | -   | 0.055 |
| L           | 0.5   | -   | 0.61  |
| R           | 0.085 | -   | 0.095 |
| S1          | 0.045 | -   | 0.06  |
| W           | 0.016 | -   | 0.022 |
| D           | 0.175 | -   | 0.195 |
| a           | 4°    | -   | 6°    |

Note: Dimensions in (inches)



| Part Number      | Accuracy | Output Voltage | Package Type |
|------------------|----------|----------------|--------------|
| SPX385AM-2.5     | 1.0%     | 2.5V           | 3-Pin SOT-23 |
| SPX385AM-2.5/TR  | 1.0%     | 2.5V           | 3-Pin SOT-23 |
| SPX385AM1-2.5    | 1.0%     | 2.5V           | 3-Pin SOT-89 |
| SPX385AM1-2.5/TR | 1.0%     | 2.5V           | 3-Pin SOT-89 |
| SPX385AS-2.5     | 1.0%     | 2.5V           | 8-Pin NSOIC  |
| SPX385AS-2.5/TR  | 1.0%     | 2.5V           | 8-Pin NSOIC  |
| SPX385AN-2.5     | 1.0%     | 2.5V           | 3-Pin TO-92  |
| SPX385AN-2.5/TR  | 1.0%     | 2.5V           | 3-Pin TO-92  |
| SPX385M-2.5      | 2.0%     | 2.5V           | 3-Pin SOT-23 |
| SPX385M-2.5/TR   | 2.0%     | 2.5V           | 3-Pin SOT-23 |
| SPX385M1-2.5     | 2.0%     | 2.5V           | 3-Pin SOT-89 |
| SPX385M1-2.5/TR  | 2.0%     | 2.5V           | 3-Pin SOT-89 |
| SPX385S-2.5      | 2.0%     | 2.5V           | 8-Pin NSOIC  |
| SPX385S-2.5/TR   | 2.0%     | 2.5V           | 8-Pin NSOIC  |
| SPX385N-2.5      | 2.0%     | 2.5V           | 3-Pin TO-92  |
| SPX385N-2.5/TR   | 2.0%     | 2.5V           | 3-Pin TO-92  |

Available in lead free packaging. To order add "-L" suffix to part number.

Example: SPX385S-2.5/TR = standard; SPX385S-L-2.5/TR = lead free

/TR = Tape and Reel

Pack quantity is 2000 for TO-92 and 2500 for SOT-23, SOT-89 and NSOIC.



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