

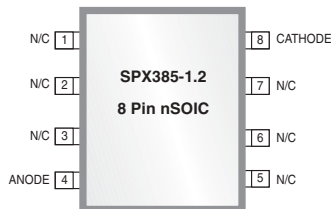
## Micropower Voltage Reference

### FEATURES

- Low Output Voltage ..... 1.235V
- Dynamic Impedance.....1 $\Omega$  max
- Low Temperature Coefficient.....30ppm/ $^{\circ}$ C (typ)
- Operating Current..... 10 $\mu$ A to 20mA
- Extended Temperature Range .. -40 $^{\circ}$ C to +85 $^{\circ}$ C
- Initial Tolerance.....1% and 2%
- Pin Compatible with LM185/285/385, 1.23V

### APPLICATIONS

- Portable Meter Reference
- Portable Test Instruments
- Battery Operated Systems
- Panel Meters



*Now Available in Lead Free Packaging*

### DESCRIPTION

The SPX385-1.2 is a micropower 2-terminal band-gap voltage reference with a very wide operating current range from 10 $\mu$ 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 SPX385-1.2 is available in a TO-92, SOIC-8 and SOT-89 package with an operating temperature range of -40 $^{\circ}$ C to 85 $^{\circ}$ C. A 2.5 and 5.0 volt devices are also available - SPX385-2.5, SPX385-5.0.

### BLOCK DIAGRAM

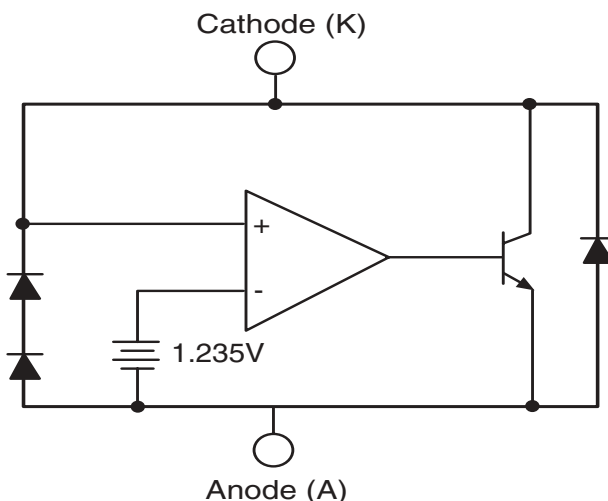


Figure 1: Block Diagram

## ABSOLUTE MAXIMUM RATINGS

|                                                |               |
|------------------------------------------------|---------------|
| Reverse Current ( $I_{KA}$ )                   | 30mA          |
| Forward Current ( $I_{AK}$ )                   | 10mA          |
| Operating Temperature Range ( $T_A$ )          | -40 to +85°C  |
| Continuous Power Dissipation at 25°C ( $P_D$ ) |               |
| TO-92                                          | 775mW         |
| SOIC-8                                         | 750mW         |
| SOT-89                                         | 1000mW        |
| Junction Temperature ( $T_J$ )                 | 150°C         |
| Storage Temperature ( $T_{STG}$ )              | - 65 to 150°C |
| Lead Temperature (Soldering 10 sec.), $T_L$    | 300°C         |

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.

## TYPICAL THERMAL RESISTANCES

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

## ELECTRICAL CHARACTERISTICS

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

| PARAMETER                           | CONDITIONS                             | SPX385A-1.2 |       |       | SPX385-1.2 |       |       | UNIT          |
|-------------------------------------|----------------------------------------|-------------|-------|-------|------------|-------|-------|---------------|
|                                     |                                        | MIN.        | TYP.  | MAX   | MIN.       | TYP.  | MAX.  |               |
| Reference Voltage                   |                                        | 1.223       | 1.235 | 1.247 | 1.205      | 1.235 | 1.260 | V             |
| Dynamic Output Impedance            | $F = 20\text{Hz}$<br>$I_R = 100\mu A$  |             | 0.6   | 1.0   |            | 0.6   | 1.0   | $\Omega$      |
| Reference Voltage Change with $I_R$ | $10\mu A \leq I_R \leq 20\text{mA}$    |             | 10    | 20    |            | 10    | 20    | mV            |
| Temperature Coefficient             | Note 1                                 |             | 30    | 50    |            | 30    | 50    | ppm/°C        |
| Minimum Operating Current           |                                        |             | 8     | 10    |            | 8     | 10    | $\mu A$       |
| Output Wideband Noise               | $10\text{Hz} \leq f \leq 10\text{kHz}$ |             | 60    |       |            | 60    |       | $\mu V_{rms}$ |
| 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)

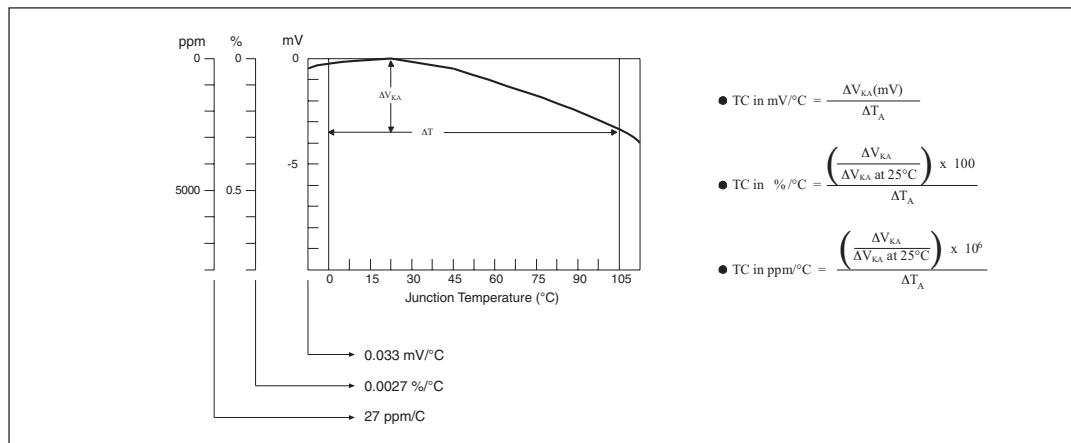


Figure 2.  $V_{REF}$  vs. Temperature

## TYPICAL PERFORMANCE CHARACTERISTICS

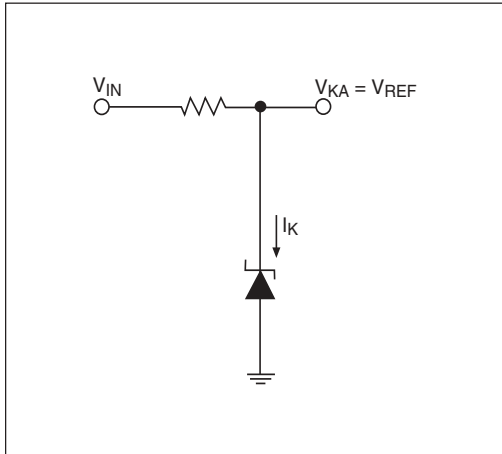


Figure 3. Test Circuit for  $V_{KA} = V_{REF}$

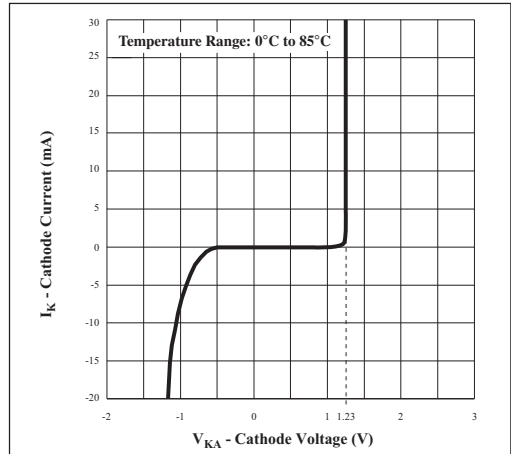


Figure 4. High Current Operating Characteristics

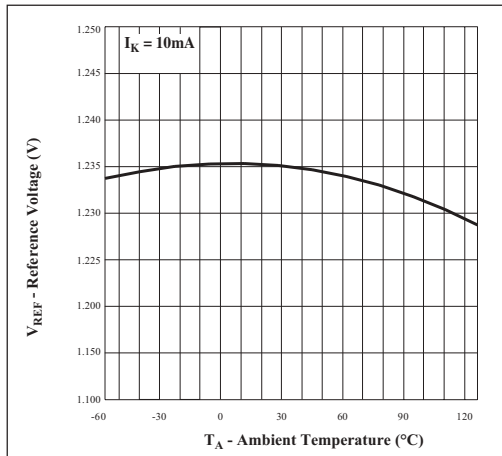


Figure 5. Reference Voltage vs. Ambient Temperature

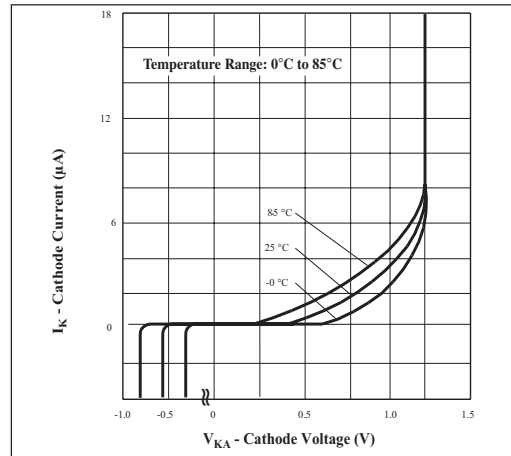


Figure 6. Low Current Operating Characteristics

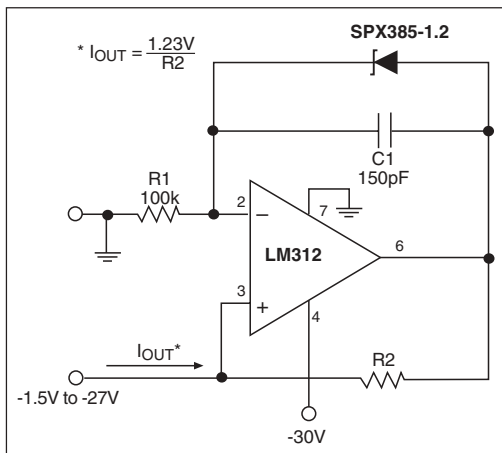


Figure 7a. Precision  $1\mu\text{A}$  to  $1\text{mA}$  Current Sink

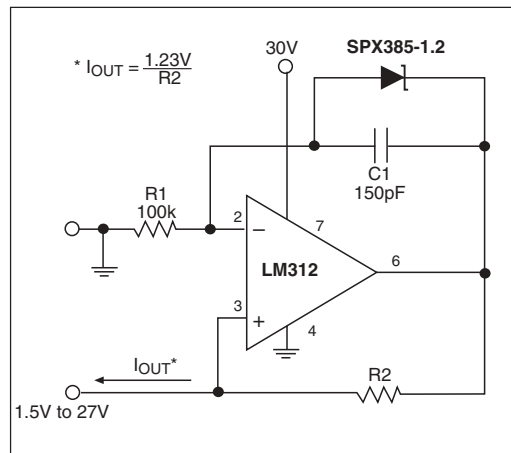


Figure 7b. Precision  $1\mu\text{A}$  to  $1\text{mA}$  Current Source

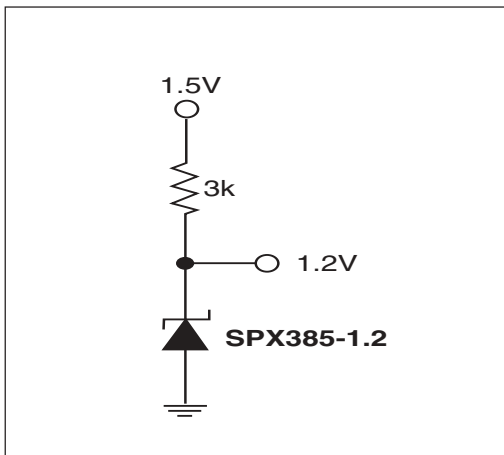


Figure 8. Reference from 1.5V Battery

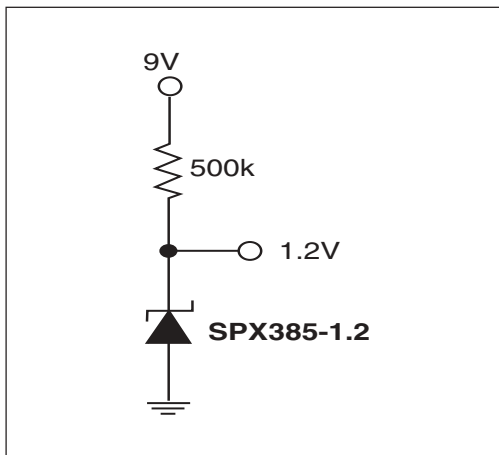


Figure 9. Micropower Reference from 9V Battery

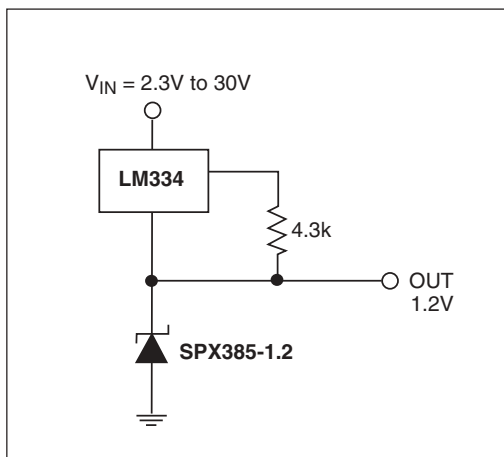


Figure 10. Wide Input Range Reference

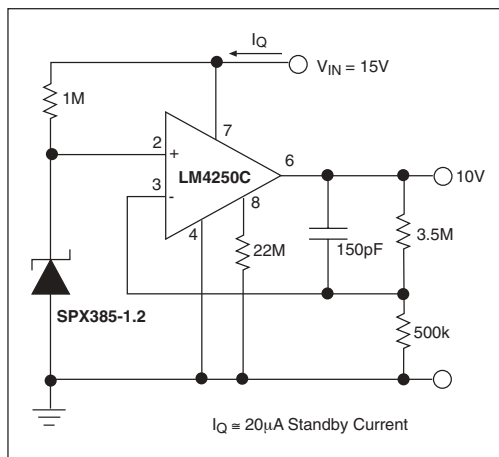
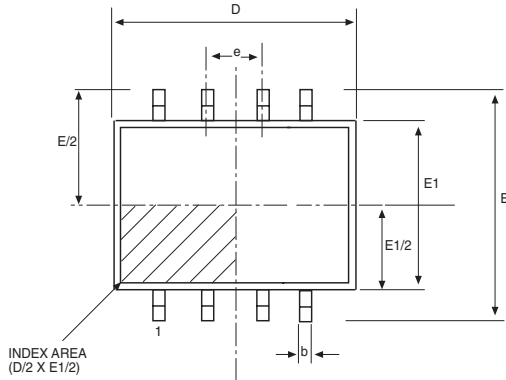
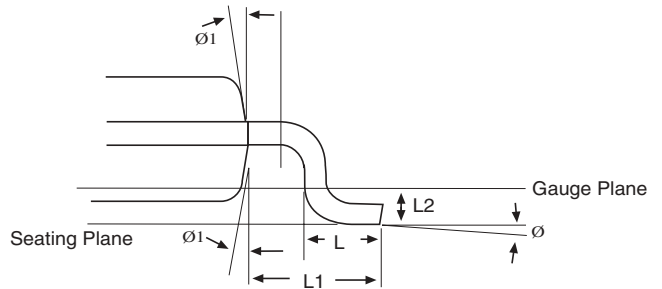
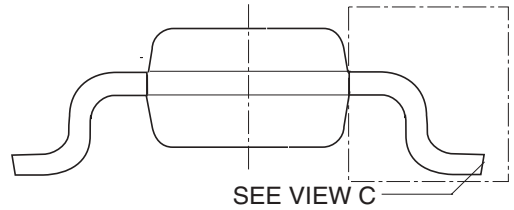


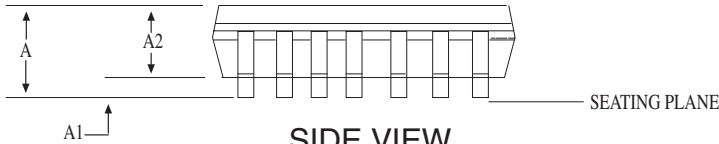
Figure 11. Precision Micropower 10V Reference



TOP VIEW

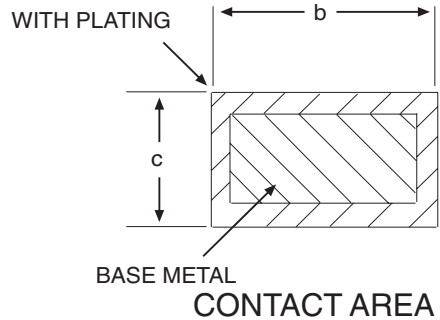


VIEW C

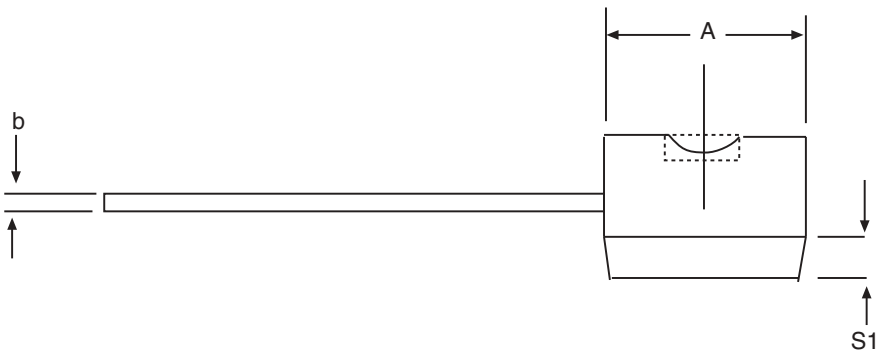
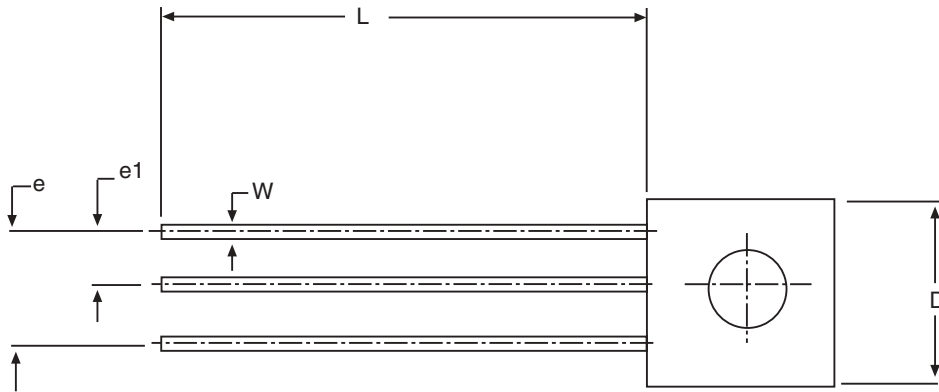


SIDE VIEW

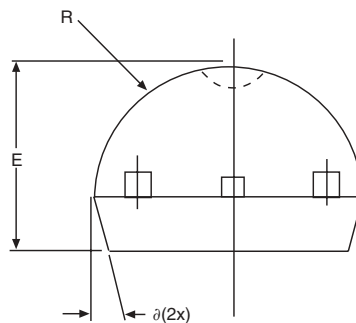
| 8 Pin NSOIC<br>(JEDEC MS-012,<br>AA - VARIATION) |          | DIMENSIONS<br>Minimum/Maximum<br>(mm) |      |  |
|--------------------------------------------------|----------|---------------------------------------|------|--|
| COMMON HEIGHT DIMENSION                          |          |                                       |      |  |
| SYMBOL                                           | MIN      | NOM                                   | MAX  |  |
| A                                                | 1.35     | -                                     | 1.75 |  |
| A1                                               | 0.10     | -                                     | 0.25 |  |
| A2                                               | 1.25     | -                                     | 1.65 |  |
| b                                                | 0.31     | -                                     | 0.51 |  |
| c                                                | 0.17     | -                                     | 0.25 |  |
| D                                                | 4.90 BSC |                                       |      |  |
| E                                                | 6.00 BSC |                                       |      |  |
| E1                                               | 3.90 BSC |                                       |      |  |
| e                                                | 1.27 BSC |                                       |      |  |
| L                                                | 0.40     | -                                     | 1.27 |  |
| L1                                               | 1.04 REF |                                       |      |  |
| L2                                               | 0.25 BSC |                                       |      |  |
| Ø                                                | 0°       | -                                     | 8°   |  |
| Ø1                                               | 5°       | -                                     | 15°  |  |



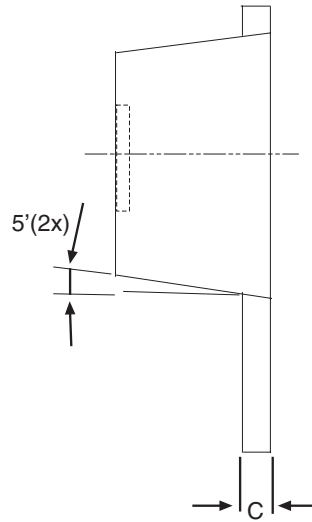
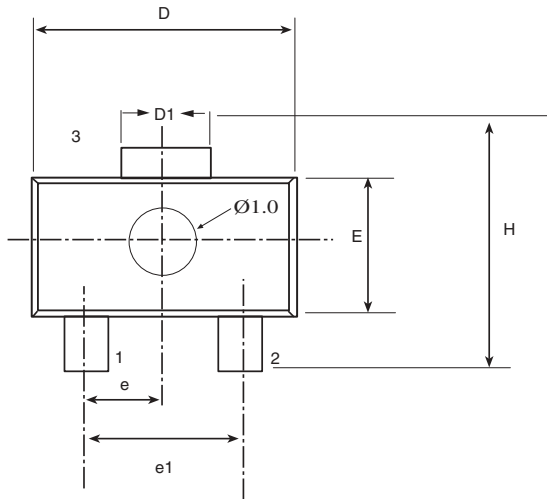
8 PIN NSOIC



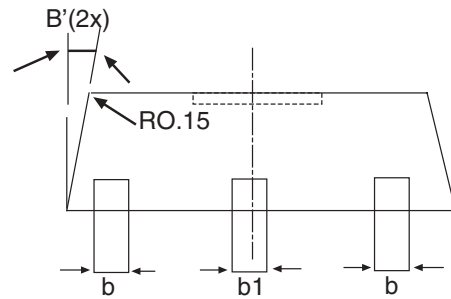
|                                          |       |                                       |       |  |
|------------------------------------------|-------|---------------------------------------|-------|--|
| 3 PIN TO-92<br>CARSEM DWG #<br>TLG920001 |       | DIMENSIONS<br>Minimum/Maximum<br>(mm) |       |  |
| COMMON HEIGHT DIMENSION                  |       |                                       |       |  |
| SYMBOL                                   | MIN   | NOM                                   | MAX   |  |
| A                                        | 4.32  | -                                     | 4.95  |  |
| b                                        | 0.36  | -                                     | 0.51  |  |
| E                                        | 3.30  | -                                     | 3.94  |  |
| e                                        | 2.41  | -                                     | 2.67  |  |
| e1                                       | 1.14  | -                                     | 1.40  |  |
| L                                        | 12.70 | -                                     | 15.49 |  |
| R                                        | 2.16  | -                                     | 2.41  |  |
| S1                                       | 1.14  | -                                     | 1.52  |  |
| W                                        | 0.41  | -                                     | 0.56  |  |
| D                                        | 4.45  | -                                     | 4.95  |  |
| θ                                        | 4°    | -                                     | 6°    |  |



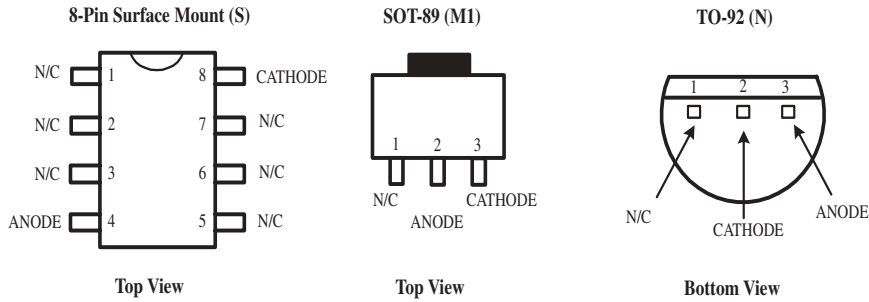
## 3 PIN TO-92



| 3 PIN SOT-89<br>LINGSSEN #<br>PO-SOT-004 | Dimensions in (mm) |      |      |
|------------------------------------------|--------------------|------|------|
|                                          | MIN                | NOM  | MAX  |
| A                                        | 1.40               | 1.50 | 1.60 |
| b                                        | 0.36               | 0.42 | 0.48 |
| b1                                       | 0.41               | 0.47 | 0.53 |
| C                                        | 0.38               | 0.40 | 0.43 |
| D                                        | 4.40               | 4.50 | 4.60 |
| D1                                       | 1.40               | 1.60 | 1.75 |
| E                                        | 2.40               | 2.50 | 2.60 |
| e                                        | 1.45               | 1.50 | 1.55 |
| e1                                       | 2.90               | 3.00 | 3.10 |
| H                                        | 3.94               | -    | 4.25 |
| L                                        | 0.80               | -    | 1.20 |



## 3 PIN SOT-89



## ORDERING INFORMATION

| Part Number      | Accuracy | Output Voltage | Package Type |
|------------------|----------|----------------|--------------|
| SPX385AM1-1.2    | 1.0%     | 1.235V         | 3-Pin SOT-89 |
| SPX385AM1-1.2/TR | 1.0%     | 1.235V         | 3-Pin SOT-89 |
| SPX385AS-1.2     | 1.0%     | 1.235V         | 8-Pin NSOIC  |
| SPX385AS-1.2/TR  | 1.0%     | 1.235V         | 8-Pin NSOIC  |
| SPX385AN-1.2     | 1.0%     | 1.235V         | 3-Pin TO-92  |
| SPX385AN-1.2/TR  | 1.0%     | 1.235V         | 3-Pin TO-92  |
| SPX385M1-1.2     | 2.0%     | 1.235V         | 3-Pin SOT-89 |
| SPX385M1-1.2/TR  | 2.0%     | 1.235V         | 3-Pin SOT-89 |
| SPX385S-1.2      | 2.0%     | 1.235V         | 8-Pin NSOIC  |
| SPX385S-1.2/TR   | 2.0%     | 1.235V         | 8-Pin NSOIC  |
| SPX385N-1.2      | 2.0%     | 1.235V         | 3-Pin TO-92  |
| SPX385N-1.2/TR   | 2.0%     | 1.235V         | 3-Pin TO-92  |

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

Example: SPX385S-1.2/TR = standard; SPX385S-L-1.2/TR = lead free

/TR = Tape and Reel

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



ANALOG EXCELLENCE

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