

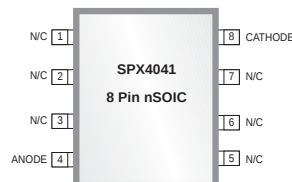
## Precision 1.24V Shunt Voltage Reference

### FEATURES

- Voltage Tolerance.....1% and 2%
- Wide Operating Current.....100 $\mu$ A to 15mA
- Low Temperature Coefficient.....50ppm/ $^{\circ}$ C
- Fixed Reverse Breakdown Voltage.....1.24V
- No Output Capacitance Required
- Two Terminal "Zener" Operation
- Improved Replacement for TL431

### APPLICATIONS

- Constant Current Source
- Digital Voltmeter
- Power Management
- Precision Regulators
- Battery Powered Equipment
- Instrumentation
- Automotive Electronics
- Data Acquisition Systems



*Now Available in Lead Free Packaging*

### DESCRIPTION

The SPX4041 is a 2-terminal, temperature compensated, band-gap voltage reference which provides a fixed 1.24V output for input currents between 160 $\mu$ A and 15mA. The bandgap voltage (1.24V) is independently laser trimmed from the output voltage to achieve a very low temperature coefficient, then the output voltage is trimmed to 1.24V. This trimming technique and the low temperature coefficient (A grade: 50 ppm/ $^{\circ}$ C) thin film resistor process gives a very stable device over the full temperature range. The SPX4041 is available in the sub miniature 3 pin SOT-23, 3 pin TO-92 or 8 pin NSOIC packages. The operating temperature is -40 $^{\circ}$ C to 85 $^{\circ}$ C. The SPX4041 advanced design eliminates the need for an external stabilized capacitor while insuring stability with any capacitive load, making it easy to use.

### TYPICAL APPLICATIONS CIRCUIT

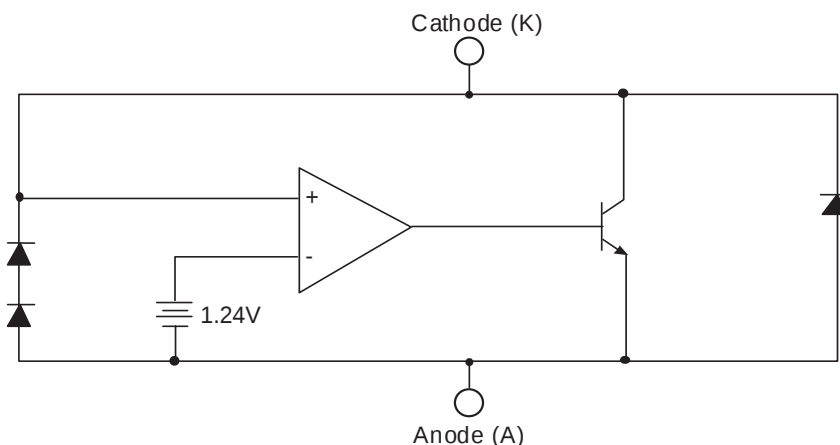


Figure 1: Block Diagram

## 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 ( $I_{KA}$ ) ..... 20mA  
 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

## ELECTRICAL CHARACTERISTICS $I_{IN} = 1000\mu A$ , $T_A = 25^\circ C$ , unless otherwise specified.

| PARAMETER                   | CONDITIONS                                                                                                                                 | SPX4041A |                                      |                      | SPX4041 |                                      |                      | UNIT            |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------------|----------------------|---------|--------------------------------------|----------------------|-----------------|
|                             |                                                                                                                                            | MIN.     | TYP.                                 | MAX                  | MIN.    | TYP.                                 | MAX.                 |                 |
| Reverse Breakdown Voltage   | $I_R = 500\mu A$                                                                                                                           |          | 1.24                                 |                      |         | 1.24                                 |                      | V               |
| Reverse Breakdown Tolerance | $I_R = 500\mu A$<br>$-40^\circ C \leq T_A \leq 85^\circ C$                                                                                 |          |                                      | $\pm 12$<br>$\pm 29$ |         |                                      | $\pm 25$<br>$\pm 49$ | mV              |
| Dynamic Output Impedance    |                                                                                                                                            |          | 0.60                                 | 2.00                 |         | 0.60                                 | 2.00                 | $\Omega$        |
| Noise Voltage               | $0.1kHz \leq f \leq 10Hz$                                                                                                                  |          | 15                                   |                      |         | 15                                   |                      | $\mu V_{PP}$    |
| Temperature Coefficient     | Note 1                                                                                                                                     |          |                                      | 100                  |         |                                      | 100                  | ppm/ $^\circ C$ |
| Turn-on Setting             | 0.1% of $V_{OUT}$                                                                                                                          |          | 30                                   |                      |         | 30                                   |                      | $\mu s$         |
| Temperature Range ( $T_A$ ) |                                                                                                                                            | -40      |                                      | 85                   | -40     |                                      | 85                   | $^\circ C$      |
| Operating Current Range     |                                                                                                                                            | 0.5      |                                      | 5.0<br>15.0          | 0.5     |                                      | 5.0<br>15.0          | mA              |
| Thermal Resistance          | TO-92 $\theta_{JA}$<br>TO-92 $\theta_{JC}$<br>SOIC-8 $\theta_{JA}$<br>SOIC-8 $\theta_{JC}$<br>SOT-23 $\theta_{JA}$<br>SOT-23 $\theta_{JC}$ |          | 160<br>80<br>175<br>45<br>575<br>150 |                      |         | 160<br>80<br>175<br>45<br>575<br>150 |                      | $^\circ C/W$    |

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

## \*CALCULATING AVERAGE TEMPERATURE COEFFICIENT (TC)

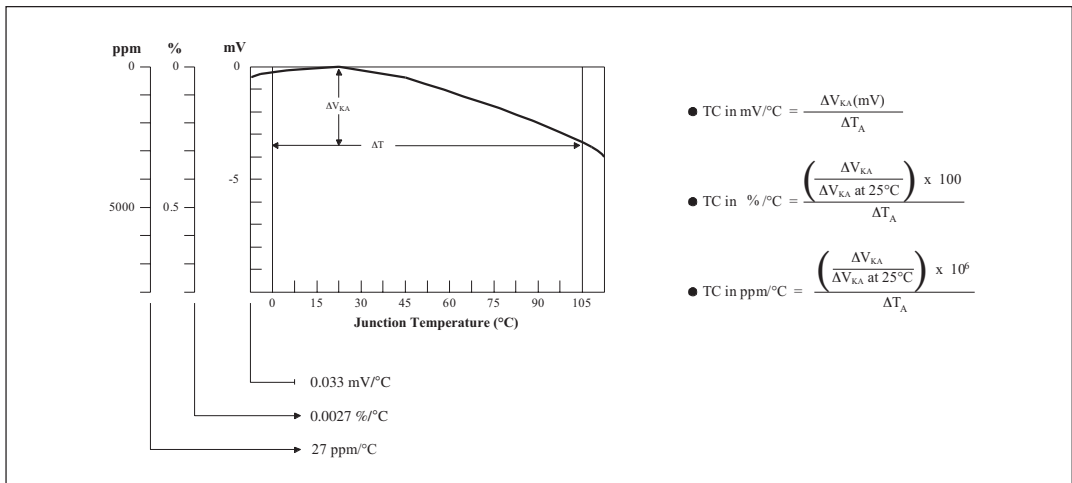


Figure 2.  $V_{REF}$  vs. Temperature

## TYPICAL PERFORMANCE CHARACTERISTICS

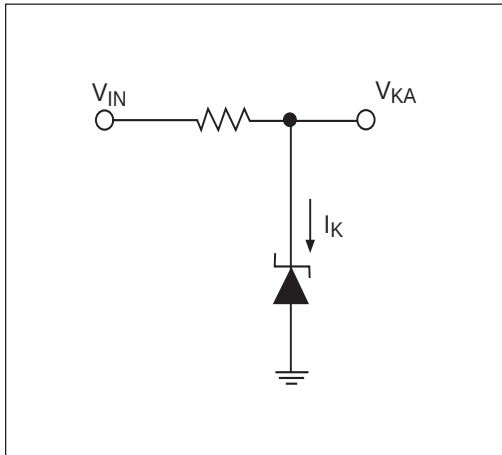


Figure 3. Test Circuit for  $V_{KA} = V_{REF}$

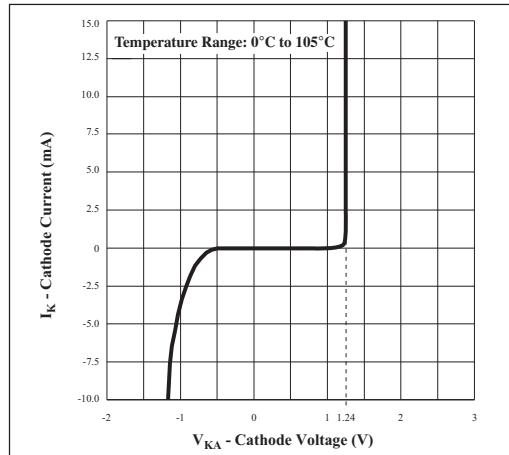


Figure 4. High Current Operating Characteristics

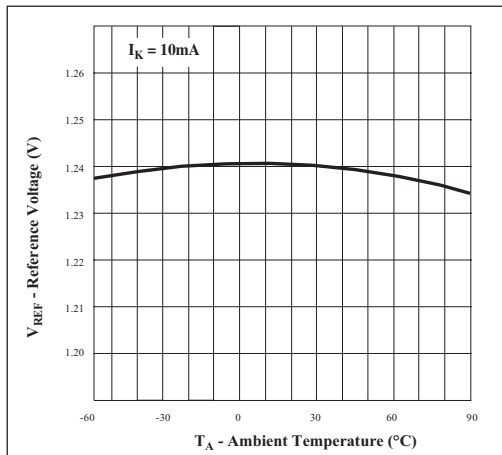


Figure 5. Reference Voltage vs. Ambient Temperature

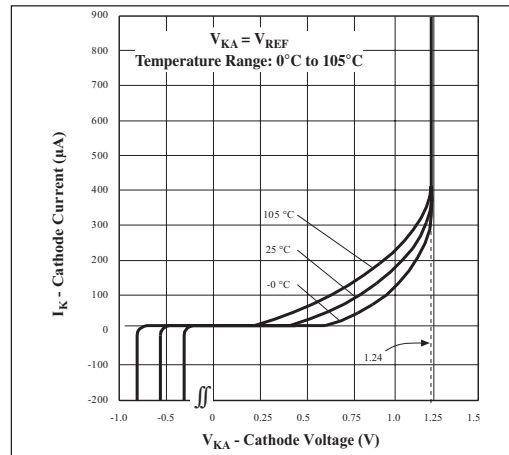


Figure 6. Low Current Operating Characteristics

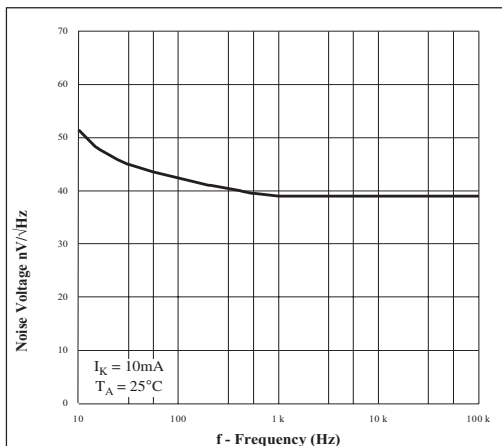


Figure 7. Noise Voltage vs Frequency

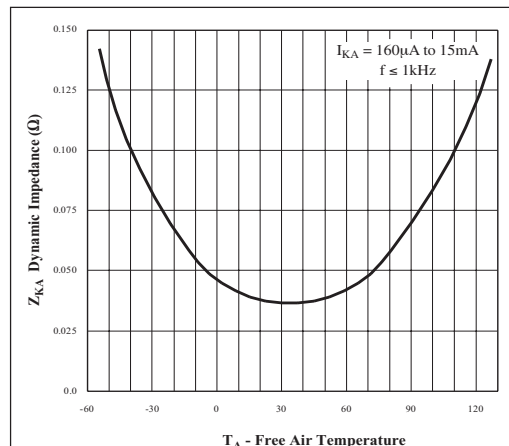


Figure 8. Low Frequency Dynamic Output Impedance vs  $T_A$

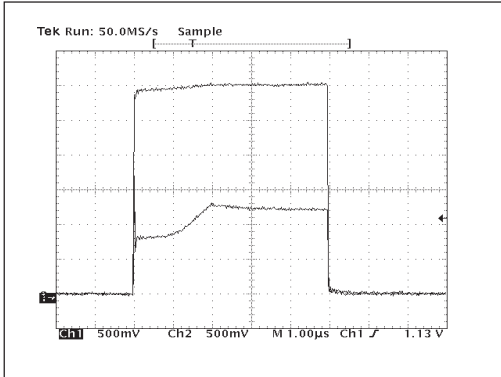


Figure 9. Frequency=100kHz,  $I_K=10mA$ ,  $T_A=25^\circ C$

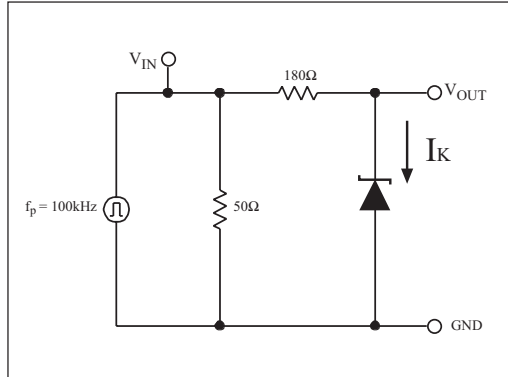


Figure 10. Test Circuit for Pulse Response

## APPLICATION INFORMATION

This device is designed for stable operation and has no need of an external capacitor. The reference remains stable if a bypass capacitor is used.

### SOT-23

The SPX4041 in the SOT-23 package has a parasitic Schottky diode between pin 3 and pin 1. Pin 1 of SOT-23 must float or be connected to pin 3.

### Conventional Shunt Regulator

In a conventional shunt regulator application (see Figure 11), an external series resistor ( $R_S$ ) is connected between the supply voltage and the SPX4041.  $R_S$  determines the current that flows through the load ( $I_L$ ) and the reference ( $I_Q$ ). Since

load current and supply voltage may vary,  $R_S$  should be small enough to supply at least the minimum acceptable  $I_Q$  to the reference even when the supply voltage is at its minimum and the load current is at its maximum value. When the supply voltage is at its maximum and  $I_L$  is at its minimum,  $R_S$  should be large enough so that the current flowing through the SPX4041 is less than 15mA.

$R_S$  is determined by the supply voltage ( $V_S$ ), the load and operating current ( $I_L$  and  $I_Q$ ), reference's reverse breakdown voltage ( $V_R$ ).

$$R_S = (V_S - V_R) / (I_L + I_Q)$$

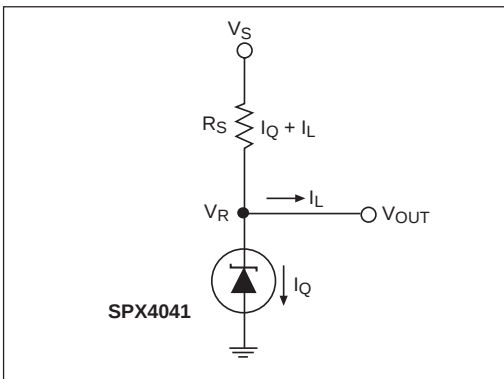


Figure 11. SPX4041 Fixed Shunt Regulator

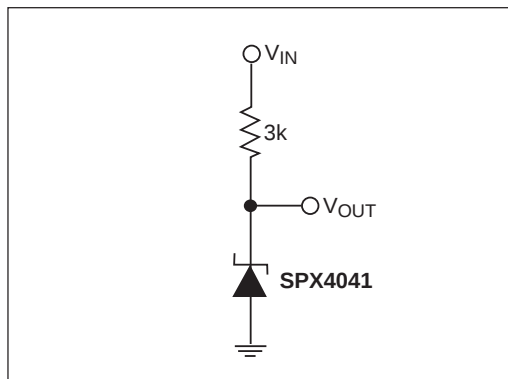


Figure 12. 1.24V Reference Circuit

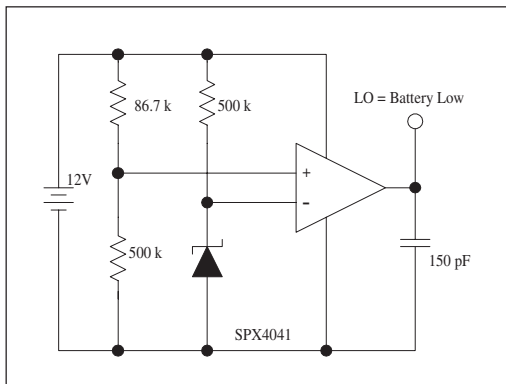


Figure 13. Low Battery Detector

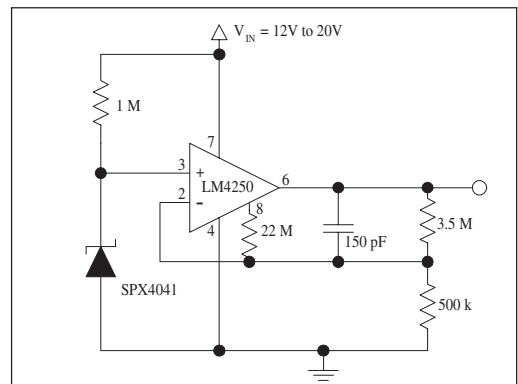
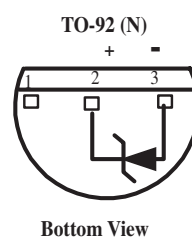
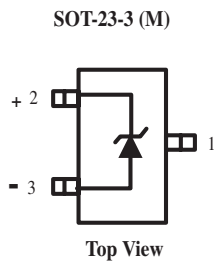
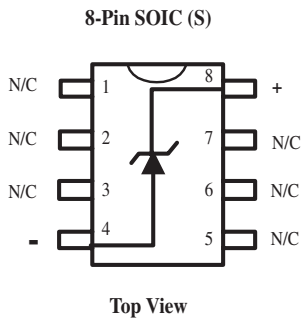
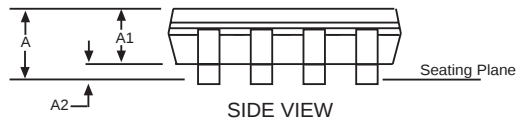
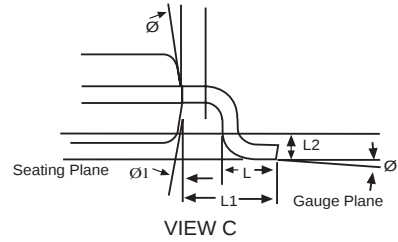
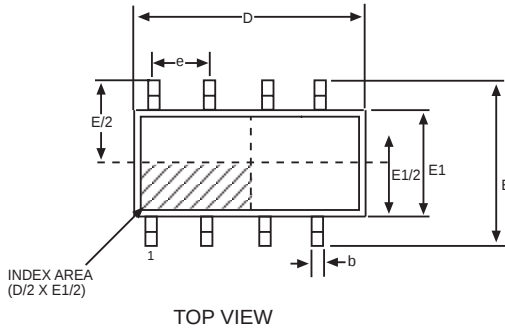


Figure 14. Micropower 10V Reference

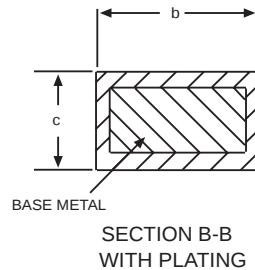
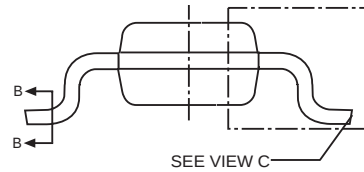
## PACKAGE PINOUTS

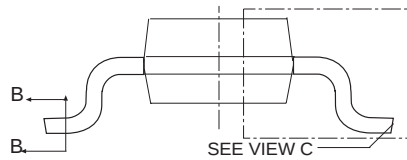
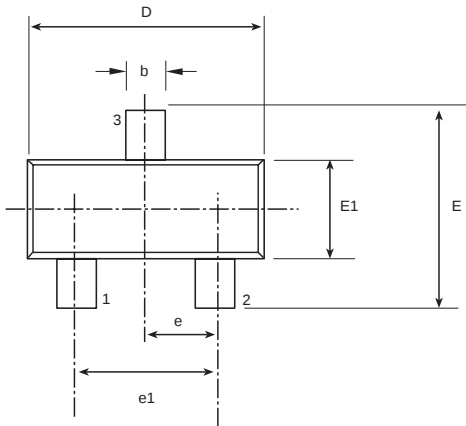
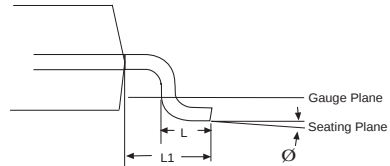




| 8 Pin NSOIC JEDEC MO-012 (AA) Variation |          |     |      |
|-----------------------------------------|----------|-----|------|
| SYMBOL                                  | MIN      | NOM | MAX  |
| A                                       | 1.35     | -   | 1.75 |
| A1                                      | 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°  |

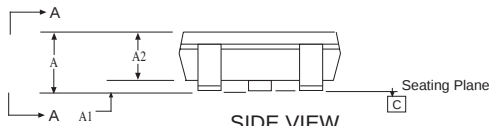
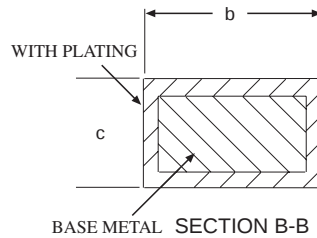
Note: Dimensions in (mm)

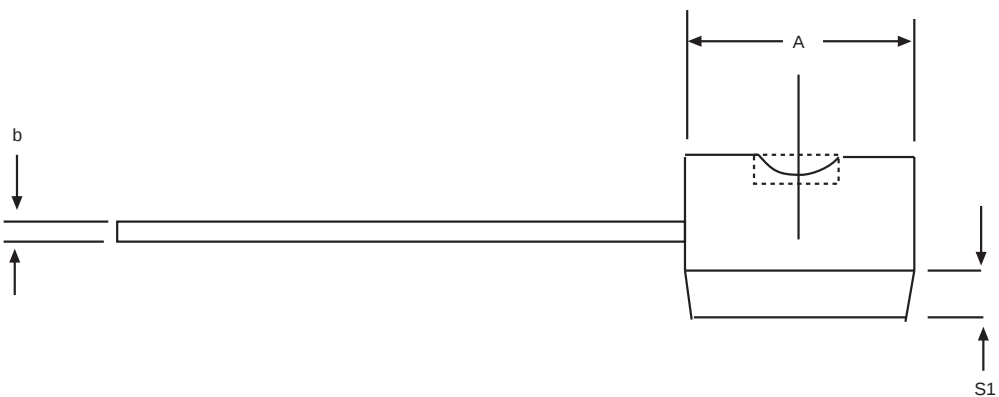
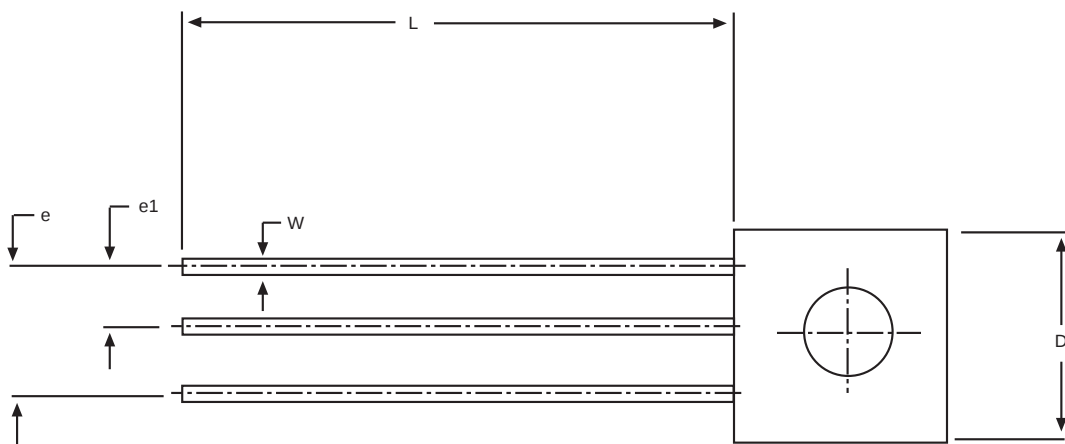



**VIEW A-A**

**VIEW C**

| 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 |      |      |
| $\phi$                                   | 0°       | -    | 8°   |

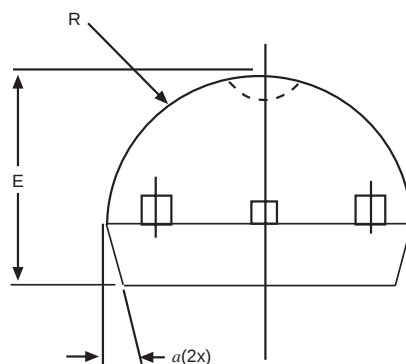
Note: Dimensions in (mm)


**SIDE VIEW**

**BASE METAL SECTION B-B**



| 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)



| <b>Part Number</b> | <b>Accuracy</b> | <b>Output Voltage</b> | <b>Package Type</b> |
|--------------------|-----------------|-----------------------|---------------------|
| SPX4041AM          | 1.0%            | 1.24V                 | 3-Pin SOT-23        |
| SPX4041AM/TR       | 1.0%            | 1.24V                 | 3-Pin SOT-23        |
| SPX4041AS          | 1.0%            | 1.24V                 | 8-Pin NSOIC         |
| SPX4041AS/TR       | 1.0%            | 1.24V                 | 8-Pin NSOIC         |
| SPX4041AN          | 1.0%            | 1.24V                 | 3-Pin TO-92         |
| SPX4041AN/TR       | 1.0%            | 1.24V                 | 3-Pin TO-92         |
| SPX4041M           | 2.0%            | 1.24V                 | 3-Pin SOT-23        |
| SPX4041M/TR        | 2.0%            | 1.24V                 | 3-Pin SOT-23        |
| SPX4041S           | 2.0%            | 1.24V                 | 8-Pin NSOIC         |
| SPX4041S/TR        | 2.0%            | 1.24V                 | 8-Pin NSOIC         |
| SPX4041N           | 2.0%            | 1.24V                 | 3-Pin TO-92         |
| SPX4041N/TR        | 2.0%            | 1.24V                 | 3-Pin TO-92         |

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

Example: SPX4041S/TR = standard; SPX4041S-L/TR = lead free

/TR = Tape and Reel

Pack quantity is 2,000 for TO-92, 2,500 for NSOIC and SOT-23.

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