

Precision-Matched Resistor-Divider in SOT23

General Description

The MAX5491 precision resistor-divider consists of two accurately matched resistors with access to the ends and center of the divider. This device offers excellent resistance matching of 0.035% (A grade), 0.05% (B grade), and 0.1% (C grade). The MAX5491 includes an extremely low resistance-ratio temperature drift of 2ppm/°C over -40°C to +85°C, and has an end-to-end resistance of 30kΩ. Resistance ratios from 1:1 to 30:1 are available. Ten standard ratios are available (see Table 1), and custom ratios are also available upon request. To enhance device and system robustness, the MAX5491 also features ±2kV Human Body Model electrostatic discharge (ESD) protection to ensure against real-world ESD events. The MAX5491 is ideal for precision gain-setting applications where tight resistance matching and low temperature drift are necessary.

The MAX5491 is available in a space-saving 3-pin SOT23 package, and is guaranteed over the extended -40°C to +85°C temperature range.

Applications

Industrial Process Control
Instrumentation
Precision Gain Setting
Medical Equipment
Automatic Test Equipment
Base Stations

Features

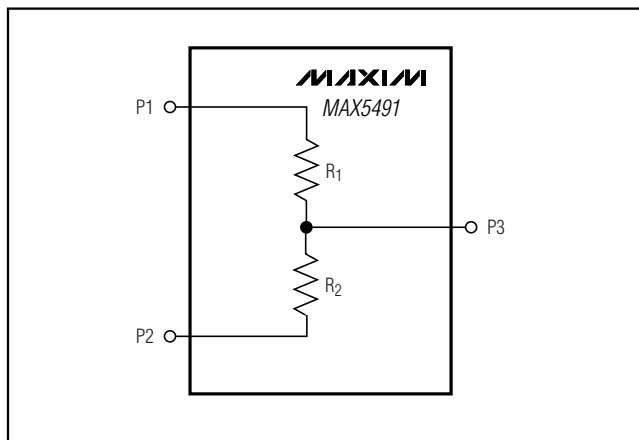
- ◆ Resistance Ratios from 1:1 to 30:1
- ◆ Custom Ratios Available Upon Request
- ◆ ±2kV Human Body Model ESD Protection
- ◆ Tight Initial Ratio Accuracy
 - 0.035% (MAX5491A)
 - 0.05% (MAX5491B)
 - 0.1% (MAX5491C)
- ◆ Low 2ppm/°C Resistor-Ratio-Drift
- ◆ Up to 50V Operating Voltage Across Sum of R1 and R2
- ◆ Tiny 3-Pin SOT23 Package

Ordering Information*

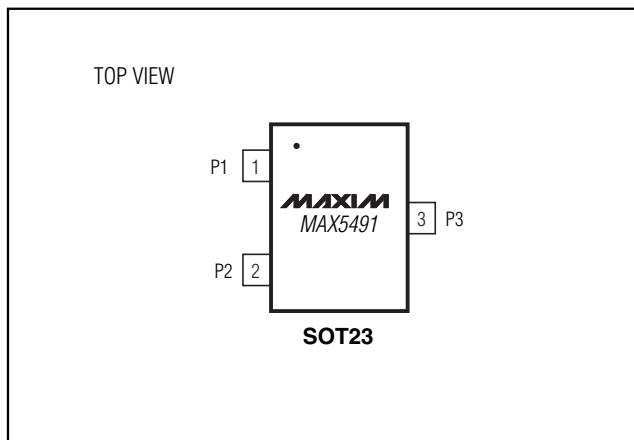
| PART | TEMP RANGE | PIN-PACKAGE | RATIO ACCURACY (%) |
|------------------|----------------|-------------|--------------------|
| MAX5491_A_-----T | -40°C to +85°C | 3 SOT23-3 | 0.035 |
| MAX5491_B_-----T | -40°C to +85°C | 3 SOT23-3 | 0.05 |
| MAX5491_C_-----T | -40°C to +85°C | 3 SOT23-3 | 0.1 |

*See the How to Order section for more details.

Block Diagram



Pin Configuration



Precision-Matched Resistor-Divider in SOT23

ABSOLUTE MAXIMUM RATINGS

| | | | |
|---|---------|--|-----------------|
| Voltage Between P1 and P2..... | 50V | Operating Temperature Range | -40°C to +85°C |
| Continuous Current into Any Pin..... | ±1.75mA | Junction Temperature..... | +150°C |
| Continuous Power Dissipation (T _A = +70°C) | | Storage Temperature Range | -65°C to +150°C |
| 3-Pin SOT23 (derate 7.1mW/°C above +70°C)..... | 571.4mW | Lead Temperature (soldering, 10s)..... | +300°C |

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC ELECTRICAL CHARACTERISTICS

(T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|--------------------|-----------------------------------|------|-------|--------|--------|
| Initial Resistor Ratio Error (Note 2) | | MAX5491_A, T _A = +25°C | | | ±0.035 | % |
| | | MAX5491_B, T _A = +25°C | | | ±0.05 | |
| | | MAX5491_C, T _A = +25°C | | | ±0.1 | |
| Resistance-Ratio Temperature Coefficient (Note 3) | | 1:1 ≤ ratio ≤ 3.2:1 | | 2 | | ppm/°C |
| | | 3.2:1 < ratio ≤ 10:1 | | 4 | | |
| | | 10:1 < ratio ≤ 30:1 | | 5.5 | | |
| Absolute Temperature Coefficient of Resistance | TCR | (Note 4) | | 35 | | ppm/°C |
| Voltage Coefficient of Resistance | VCR | (Note 5) | | 0.1 | | ppm/V |
| End-to-End Resistance (R ₁ + R ₂) | | | 28.5 | 30 | 31.5 | kΩ |
| Continuous Current | | I _{R1} , I _{R2} | | | ±1.75 | mA |
| Continuous Working Voltage Between P1 and P2 | V _{P1-P2} | | 0 | | 50 | V |
| Power Rating | | | | | 87.5 | mW |
| Pin Capacitance | | | | 2 | | pF |
| Resistance Ratio Long-Term Stability | | 2000hr at +70°C | | ±0.03 | | % |

Note 1: The MAX5491 is 100% production tested at T_A = +25°C. Specifications over -40°C to +85°C are guaranteed by design.

Note 2: Testing conditions: T_A = +25°C, V_{P1-P2} = 9V and 50V.

Note 3: Resistance-ratio temperature coefficient is defined as

$$\frac{\Delta \left(\frac{R_1}{R_2} \right)}{\frac{R_1}{R_2} \times \Delta T}$$

Note 4: Absolute TCR is defined as and is tested at 9V and 50V.

$$\frac{\Delta(R_1 + R_2)}{(R_1 + R_2) \times \Delta T}$$

Note 5: Resistance-ratio voltage coefficient is defined as

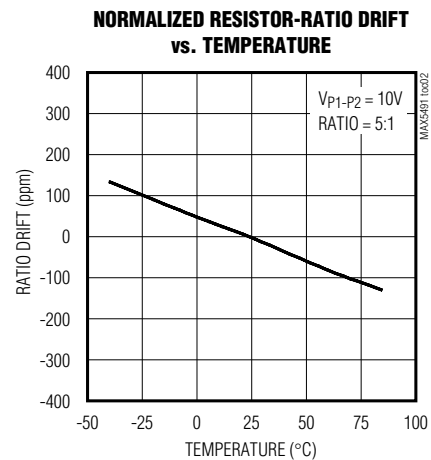
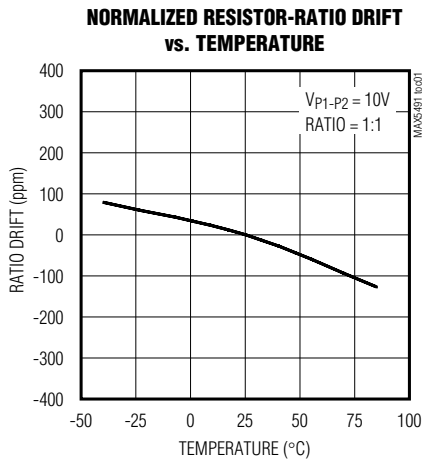
$$\frac{\Delta \left(\frac{R_1}{R_2} \right)}{\frac{R_1}{R_2} \times \Delta V}$$

Precision-Matched Resistor-Divider in SOT23

MAX5491

Typical Operating Characteristics

($V_{P1-P2} = 10V$, $T_A = +25^\circ C$, unless otherwise noted.)



Pin Description

| PIN | NAME | FUNCTION |
|-----|------|---|
| 1 | P1 | R ₁ Connection Terminal |
| 2 | P2 | R ₂ Connection Terminal |
| 3 | P3 | Midpoint Between R ₁ and R ₂ Connection Terminals |

Detailed Description

As shown in the *Block Diagram*, the MAX5491 consists of two precision, low-ratio-drift resistors with an end-to-end resistance of 30k Ω (R₁ + R₂). P3 is the center tap of the divider. The maximum working voltage of the MAX5491 is 50V. This device offers a wide range of

resistance ratios (R₁/R₂) from 1:1 to 30:1 and is ideally suited for precision operational amplifier gain/attenuation control. The MAX5491 features a $\pm 2kV$ ESD protection that enhances system robustness. A maximum initial ratio accuracy of 0.035% and a low 2ppm/ $^\circ C$ ratio drift enhance system accuracy.

Precision-Matched Resistor-Divider in SOT23

Typical Applications

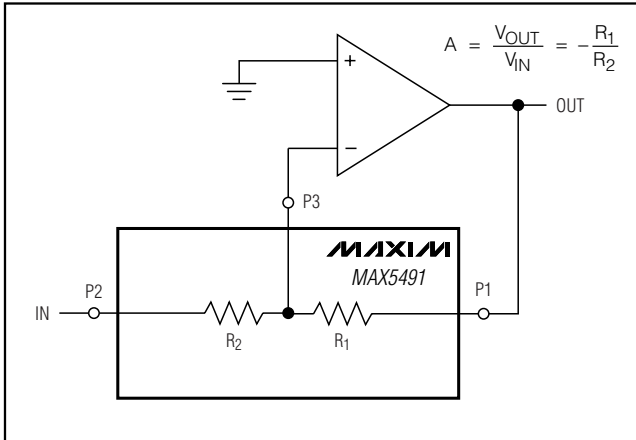


Figure 1. Inverting Amplifier Configuration

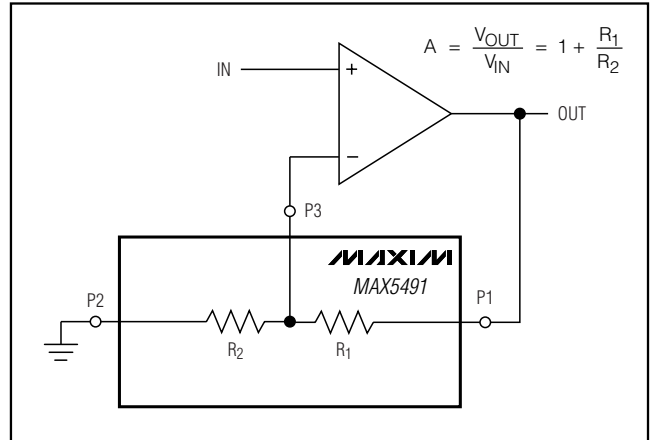


Figure 2. Noninverting Amplifier Configuration

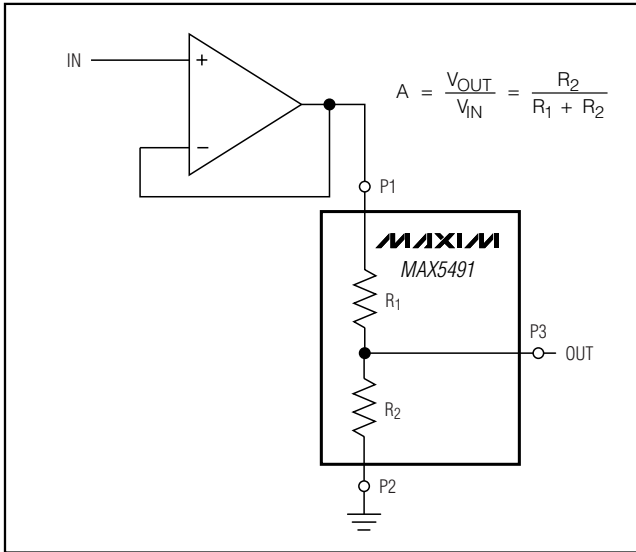


Figure 3. Buffered Attenuator

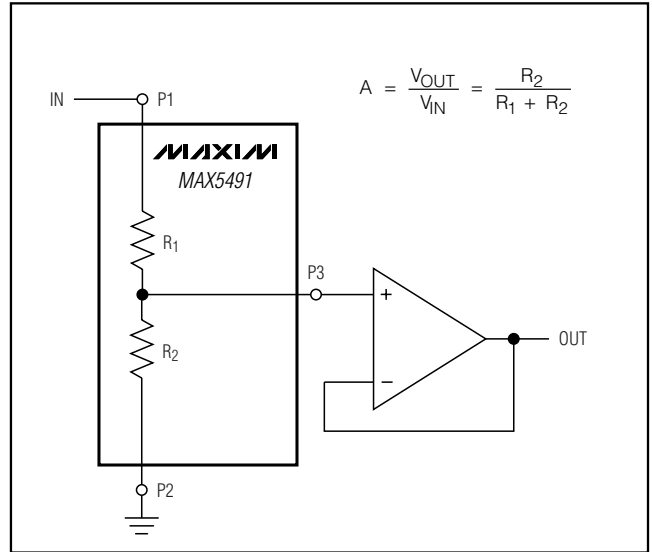


Figure 4. Attenuator with Buffer

Applications Information

Self-Heating and Error

Applying a voltage across terminals P1 and P2 causes the device to heat up due to power dissipation. In high-voltage applications, consider the error in resistance-temperature coefficient caused by self-heating. The worst-case self-heating occurs when the operating voltage attains its maximum value. Approximate the result of power dissipation under this condition as:

$$P_{DISS} = \frac{(V_{MAX})^2}{R} = \frac{(50V)^2}{30k\Omega} = 83.3mW$$

The thermal resistance from junction to ambient, θ_{JA} , for a 3-pin SOT23 package is 141°C/W. Calculate the resulting temperature rise as:

$$\Delta T = 83.3mW \times 141^\circ C/W = 11.7^\circ C$$

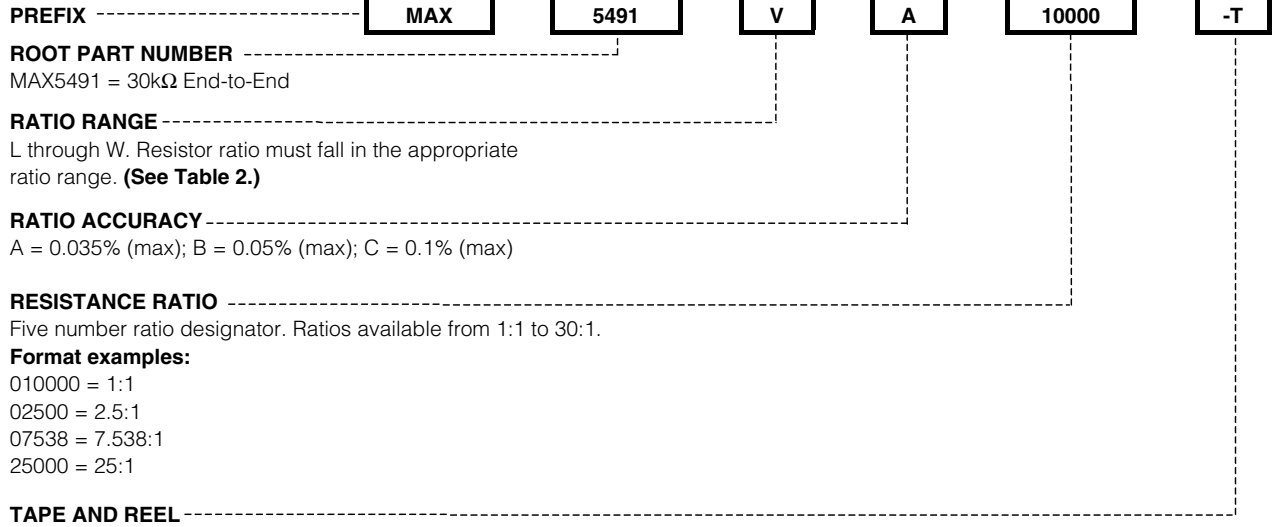
If the ratio temperature coefficient is 2ppm/°C (typ), the total error introduced by self-heating is:

$$11.7^\circ C \times 2ppm/^\circ C = 23.4ppm$$

Precision-Matched Resistor-Divider in SOT23

How to Order

MAX5491



Example Part Numbers

| PART | RESISTOR-RATIO RANGE | RESISTOR-RATIO ACCURACY (% MAX) | RESISTOR RATIO |
|------------------|----------------------|---------------------------------|----------------|
| MAX5491RA02500-T | 2.000 to 2.899 | 0.035 | 2.5:1 |
| MAX5491VC10000-T | 10.000 to 15.999 | 0.100 | 10:1 |
| MAX5491SB03200-T | 2.900 to 3.999 | 0.050 | 3.2:1 |
| MAX5491UA07538-T | 6.000 to 9.999 | 0.035 | 7.538:1 |

Table 1. Standard Ratios*

| PART | RESISTOR RATIO | RESISTOR-RATIO SUFFIX | RESISTOR-RATIO ACCURACY (% MAX) | TOP MARK |
|------------------|----------------|-----------------------|---------------------------------|----------|
| MAX5491LA01000-T | 1:1 | 01000 | 0.035 | FZPD |
| MAX5491LB01000-T | 1:1 | 01000 | 0.050 | FZPE |
| MAX5491LC01000-T | 1:1 | 01000 | 0.100 | FZPF |
| MAX5491MA01100-T | 1.1:1 | 01100 | 0.035 | FZPA |
| MAX5491MB01100-T | 1.1:1 | 01100 | 0.050 | FZPB |
| MAX5491MC01100-T | 1.1:1 | 01100 | 0.100 | FZPC |
| MAX5491NA01500-T | 1.5:1 | 01500 | 0.035 | FZOX |
| MAX5491NB01500-T | 1.5:1 | 01500 | 0.050 | FZOY |
| MAX5491NC01500-T | 1.5:1 | 01500 | 0.100 | FZOZ |
| MAX5491PA02000-T | 2:1 | 02000 | 0.035 | FZOO |
| MAX5491PB02000-T | 2:1 | 02000 | 0.050 | FZOP |
| MAX5491PC02000-T | 2:1 | 02000 | 0.100 | FZOQ |
| MAX5491RA02500-T | 2.5:1 | 02500 | 0.035 | FZPP |

Precision-Matched Resistor-Divider in SOT23

MAX5491

Table 1. Standard Ratios* (continued)

| PART | RESISTOR RATIO | RESISTOR-RATIO SUFFIX | RESISTOR-RATIO ACCURACY (% MAX) | TOP MARK |
|------------------|----------------|-----------------------|---------------------------------|----------|
| MAX5491RB02500-T | 2.5:1 | 02500 | 0.050 | FZPQ |
| MAX5491RC02500-T | 2.5:1 | 02500 | 0.100 | FZON |
| MAX5491SA03200-T | 3.2:1 | 03200 | 0.035 | FZOU |
| MAX5491SB03200-T | 3.2:1 | 03200 | 0.050 | FZOV |
| MAX5491SC03200-T | 3.2:1 | 03200 | 0.100 | FZOW |
| MAX5491TA05000-T | 5:1 | 05000 | 0.035 | FZOR |
| MAX5491TB05000-T | 5:1 | 05000 | 0.050 | FZOS |
| MAX5491TC05000-T | 5:1 | 05000 | 0.100 | FZOT |
| MAX5491UA07538-T | 7.538:1 | 07538 | 0.035 | FZPM |
| MAX5491UB07538-T | 7.538:1 | 07538 | 0.050 | FZPN |
| MAX5491UC07538-T | 7.538:1 | 07538 | 0.100 | FZPO |
| MAX5491VA10000-T | 10:1 | 10000 | 0.035 | FZPJ |
| MAX5491VB10000-T | 10:1 | 10000 | 0.050 | FZPK |
| MAX5491VC10000-T | 10:1 | 10000 | 0.100 | FZPL |
| MAX5491WA30000-T | 30:1 | 30000 | 0.035 | FZPG |
| MAX5491WB30000-T | 30:1 | 30000 | 0.050 | FZPH |
| MAX5491WC30000-T | 30:1 | 30000 | 0.100 | FZPI |

*Standard ratios are available for ordering in any quantity. Nonstandard ratios are also available for values between 1:1 to 30:1. A minimum order quantity of 10,000 units is required for nonstandard ratios. Please contact factory for more information.

Table 2. Ratio Ranges

| LETTER SUFFIX | RESISTOR-RATIO RANGE |
|---------------|----------------------|
| L | 1.000 to 1.099 |
| M | 1.100 to 1.349 |
| N | 1.350 to 1.699 |
| P | 1.700 to 2.000 |
| R | 2.001 to 2.899 |
| S | 2.900 to 3.999 |
| T | 4.000 to 5.999 |
| U | 6.000 to 9.999 |
| V | 10.000 to 15.999 |
| W | 16.000 to 30.000 |

Chip Information

TRANSISTOR COUNT: 0
PROCESS: BiCMOS

Precision-Matched Resistor-Divider in SOT23

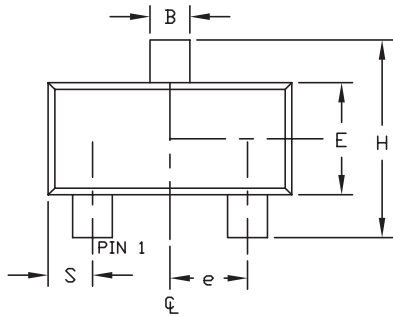
Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to www.maxim-ic.com/packages.)

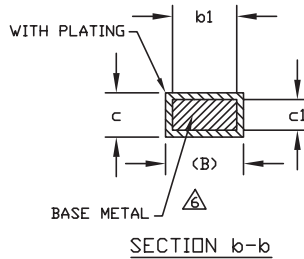
MAX5491

NOTES:

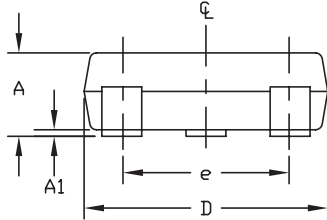
1. D&E DO NOT INCLUDE MOLD FLASH.
 2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006").
 3. CONTROLLING DIMENSION: MILLIMETERS.
 4. REFERENCE JEDEC TO236-VARIATION AB.
 5. LEADS TO BE COPLANAR WITHIN 0.10mm.
- △ DIMENSIONS MEASURED AT FLAT SECTION OF LEAD BETWEEN 0.08mm AND 0.15mm FROM LEAD TIP.



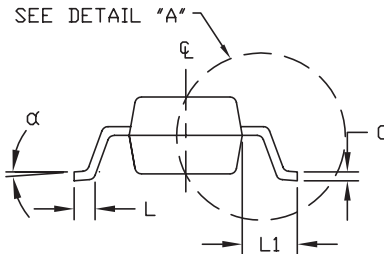
TOP VIEW



SECTION b-b



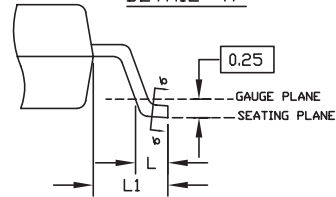
FRONT VIEW



SIDE VIEW

| DIM | INCHES | | MILLIMETERS | |
|-------|--------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.035 | 0.044 | 0.890 | 1.120 |
| A1 | 0.001 | 0.004 | 0.013 | 0.100 |
| B | 0.015 | 0.020 | 0.370 | 0.500 |
| b1 | 0.012 | 0.018 | 0.300 | 0.450 |
| c | 0.003 | 0.071 | 0.085 | 0.180 |
| c1 | 0.003 | 0.071 | 0.080 | 0.160 |
| D | 0.110 | 0.120 | 2.800 | 3.040 |
| E | 0.047 | 0.055 | 1.200 | 1.400 |
| e | 0.037 | BSC. | 0.950 | BSC. |
| e1 | 0.075 | BSC. | 1.900 | BSC. |
| H | 0.083 | 0.104 | 2.100 | 2.640 |
| L | 0.015 | 0.023 | 0.400 | 0.600 |
| L1 | 0.021 | REF | 0.54 | REF |
| S | 0.018 | 0.024 | 0.45 | 0.60 |
| alpha | 0° | 8° | 0° | 8° |

DETAIL "A"



| | | |
|--------------------------------------|---------------------------------|---------------|
| | | |
| PROPRIETARY INFORMATION | | |
| TITLE: PACKAGE OUTLINE, 3L SOT-23 | | |
| APPROVAL: | DOCUMENT CONTROL NO. 21-0051 | REV. F 1/1 |

SOT23 LEPS

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