

## 2, 4, and 8-Channel Low Capacitance ESD Protection Arrays

### Features

- 2, 4, and 8 channels of ESD protection
- Provides ESD protection to IEC61000-4-2
  - 8kV contact discharge
  - 15kV air discharge
- Low loading capacitance of 2.0pF max.
- Low clamping voltage
- Channel I/O to I/O capacitance 1.5pF typical
- Zener diode protects supply rail and eliminates the need for external by-pass capacitors
- Each I/O pin can withstand over 1000 ESD strikes
- Available in SOT, and MSOP packages
- Lead-free version available

### Applications

- DVI ports, HDMI ports in notebooks, set top boxes, digital TVs, LCD displays
- Serial ATA ports in desktop PCs and hard disk drives
- PCI Express ports
- General purpose high-speed data line ESD protection

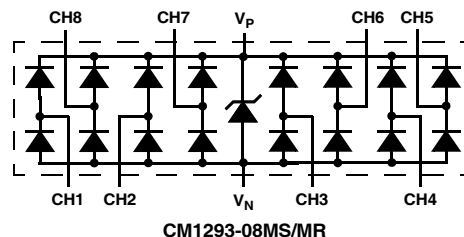
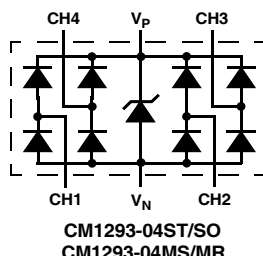
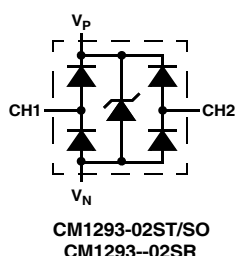
### Product Description

The CM1293 family of diode arrays has been designed to provide ESD protection for electronic components or sub-systems requiring minimal capacitive loading. These devices are ideal for protecting systems with high data and clock rates or for circuits requiring low capacitive loading. Each ESD channel consists of a pair of diodes in series which steer the positive or negative ESD current pulse to either the positive ( $V_P$ ) or negative ( $V_N$ ) supply rail. A Zener diode is embedded between  $V_P$  and  $V_N$ , offering two advantages. First, it protects the  $V_{CC}$  rail against ESD strikes, and second, it eliminates the need for a bypass capacitor that would otherwise be needed for absorbing positive ESD strikes to ground. The CM1293 will protect against ESD pulses up to ( $\pm 15$ kV air,  $\pm 8$ kV contact discharge) per the IEC 61000-4-2 Level 4 standard.

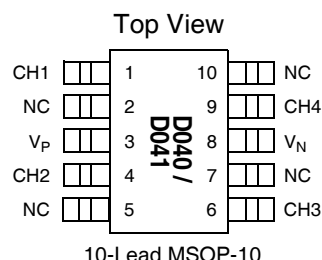
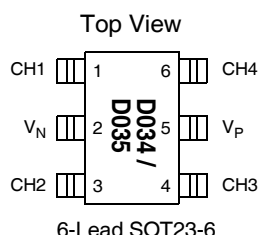
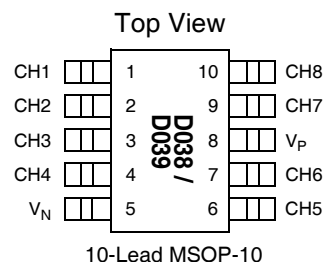
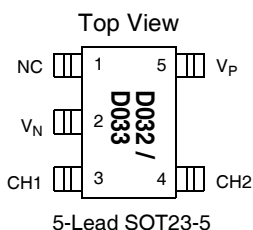
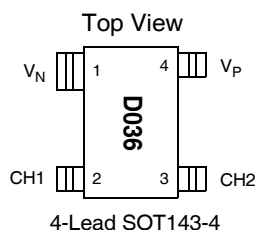
This device is particularly well-suited for protecting systems using high-speed ports such as USB2.0, IEEE1394 (Firewire<sup>®</sup>, iLink<sup>™</sup>), Serial ATA, DVI, HDMI and corresponding ports in removable storage, digital camcorders, DVD-RW drives and other applications where extremely low loading capacitance with ESD protection are required in a small package footprint.

The CM1293 family of devices is available with optional lead-free finishing.

### Electrical Schematics



# PACKAGE / PINOUT DIAGRAMS



Note: These drawings are not to scale.

## PIN DESCRIPTIONS

### 2-CHANNEL, 4-LEAD SOT143-4 PACKAGE

| PIN | NAME           | TYPE | PIN |
|-----|----------------|------|-----|
| 1   | V <sub>N</sub> | GND  | 1   |
| 2   | CH1            | I/O  | 2   |
| 3   | CH2            | I/O  | 3   |
| 4   | V <sub>P</sub> | PWR  | 4   |

### 2-CHANNEL, 5-LEAD SOT23-5 PACKAGE

| PIN | NAME           | TYPE | DESCRIPTION                  |
|-----|----------------|------|------------------------------|
| 1   | NC             |      | No connect                   |
| 2   | V <sub>N</sub> | GND  | Negative voltage supply rail |
| 3   | CH1            | I/O  | ESD Channel                  |
| 4   | CH2            | I/O  | ESD Channel                  |
| 5   | V <sub>P</sub> | PWR  | Positive voltage supply rail |

### 4-CHANNEL, 6-LEAD SOT23-6 PACKAGE

| PIN | NAME           | TYPE | DESCRIPTION                  |
|-----|----------------|------|------------------------------|
| 1   | CH1            | I/O  | ESD Channel                  |
| 2   | V <sub>N</sub> | GND  | Negative voltage supply rail |
| 3   | CH2            | I/O  | ESD Channel                  |
| 4   | CH3            | I/O  | ESD Channel                  |
| 5   | V <sub>P</sub> | PWR  | Positive voltage supply rail |
| 6   | CH4            | I/O  | ESD Channel                  |
| 5   | V <sub>P</sub> | PWR  | Positive voltage supply rail |
| 6   | CH4            | I/O  | ESD Channel                  |

### 4-CHANNEL, 10-LEAD MSOP-10 PACKAGE

| PIN | NAME           | TYPE | DESCRIPTION                  |
|-----|----------------|------|------------------------------|
| 1   | CH1            | I/O  | ESD Channel                  |
| 2   | NC             |      | No connect                   |
| 3   | V <sub>P</sub> | PWR  | Positive voltage supply rail |
| 4   | CH2            | I/O  | ESD Channel                  |
| 5   | NC             |      | No connect                   |
| 6   | CH3            | I/O  | ESD Channel                  |
| 7   | NC             |      | No connect                   |
| 8   | V <sub>N</sub> | GND  | Negative voltage supply rail |
| 9   | CH4            | I/O  | ESD Channel                  |
| 10  | NC             |      | No connect                   |

### 8-CHANNEL, 10-LEAD MSOP-10 PACKAGE

| PIN | NAME           | TYPE | DESCRIPTION                  |
|-----|----------------|------|------------------------------|
| 1   | CH1            | I/O  | ESD Channel                  |
| 2   | CH2            | I/O  | ESD Channel                  |
| 3   | CH3            | I/O  | ESD Channel                  |
| 4   | CH4            | I/O  | ESD Channel                  |
| 5   | V <sub>N</sub> | PWR  | Positive voltage supply rail |
| 6   | CH5            | I/O  | ESD Channel                  |
| 7   | CH6            | I/O  | ESD Channel                  |
| 8   | V <sub>N</sub> | GND  | Negative voltage supply rail |
| 9   | CH7            | I/O  | ESD Channel                  |
| 10  | CH8            | I/O  | ESD Channel                  |

## Ordering Information

| PART NUMBERING INFORMATION |       |          |                                   |              |                                   |              |
|----------------------------|-------|----------|-----------------------------------|--------------|-----------------------------------|--------------|
|                            |       |          | Standard Finish                   |              | Lead-free Finish                  |              |
| # of Channels              | Leads | Package  | Ordering Part Number <sup>1</sup> | Part Marking | Ordering Part Number <sup>1</sup> | Part Marking |
| 2                          | 4     | SOT143-4 |                                   |              | CM1293-02SR                       | D036         |
| 2                          | 5     | SOT23-5  | CM1293-02ST                       | D032         | CM1293-02SO                       | D033         |
| 4                          | 6     | SOT23-6  | CM1293-04ST                       | D034         | CM1293-04SO                       | D035         |
| 4                          | 10    | MSOP-10  | CM1293-04MS                       | D040         | CM1293-04MR                       | D041         |
| 8                          | 10    | MSOP-10  | CM1293-08MS                       | D038         | CM1293-08MR                       | D039         |

Note 1: Parts are shipped in Tape & Reel form unless otherwise specified.

## Specifications

| ABSOLUTE MAXIMUM RATINGS                 |                                    |       |
|--|------------------------------------|-------|
| PARAMETER                                | RATING                             | UNITS |
| Operating Supply Voltage ( $V_P - V_N$ ) | 6.0                                | V     |
| Operating Temperature Range              | -40 to +85                         | °C    |
| Storage Temperature Range                | -65 to +150                        | °C    |
| DC Voltage at any channel input          | ( $V_N - 0.5$ ) to ( $V_P + 0.5$ ) | V     |

| STANDARD OPERATING CONDITIONS    |            |       |
|----------------------------------|------------|-------|
| PARAMETER                        | RATING     | UNITS |
| Operating Temperature Range      | -40 to +85 | °C    |
| Package Power Rating             |            |       |
| SOT143-4 Package (CM1293-02SR)   | 225        | mW    |
| SOT23-5 Package (CM1293-02ST/SO) | 225        | mW    |
| SOT23-6 Package (CM1293-04ST/SO) | 225        | mW    |
| MSOP-10 Package (CM1293-04MS/MR) | 400        | mW    |
| MSOP-10 Package (CM1293-08MS/MR) | 400        | mW    |

## Specifications (cont'd)

| <b>ELECTRICAL OPERATING CHARACTERISTICS<sup>1</sup></b> |  |  |            |            |            |              |
|---|--|--|------------|------------|------------|--------------|
| <b>SYMBOL</b>   | <b>PARAMETER</b>   | <b>CONDITIONS</b>  | <b>MIN</b> | <b>TYP</b> | <b>MAX</b> | <b>UNITS</b> |
| $V_P$   | Operating Supply Voltage ( $V_P-V_N$ )   |  |            | 3.3        | 5.5        | V            |
| $I_P$   | Operating Supply Current   | $(V_P-V_N)=3.3V$   |            |            | 8.0        | $\mu A$      |
| $V_F$   | Diode Forward Voltage<br>Top Diode   | $I_F = 8mA$ ; $T_A=25^\circ C$                               | 0.60       | 0.80       | 0.95       | V            |
|   | Bottom Diode   |  | 0.60       | 0.80       | 0.95       | V            |
| $I_{LEAK}$  | Channel Leakage Current  | $T_A=25^\circ C$ ; $V_P=5V$ , $V_N=0V$                       |            | $\pm 0.1$  | $\pm 1.0$  | $\mu A$      |
| $C_{IN}$  | Channel Input Capacitance  | At 1 MHz, $V_P=3.3V$ , $V_N=0V$ , $V_{IN}=1.65V$ ;<br>Note 2 |            |            | 2.0        | pF           |
| $\Delta C_{IO}$   | Channel I/O to I/O capacitance   |  |            | 1.5        |            | pF           |
| $V_{ESD}$   | ESD Protection<br>Peak Discharge Voltage at any<br>channel input, in system<br>a) Contact discharge per<br>IEC 61000-4-2 standard<br>b) Human Body Model,<br>MIL-STD-883, Method<br>3015 | Notes 2, 4 & 5; $T_A=25^\circ C$                             | $\pm 8$    |            |            | kV           |
|   |  | Notes 2, 3 & 5; $T_A=25^\circ C$                             | $\pm 15$   |            |            | kV           |
| $V_{CL}$  | Channel Clamp Voltage<br>Positive Transients   | At 8kV ESD HBM; $T_A=25^\circ C$ ; Notes 2 & 3               |            | +9.0       |            | V            |
|   | Negative Transients  |  |            | -9.0       |            | V            |
| $R_{DYN}$   | Dynamic Resistance<br>Positive Transients  | $T_A=25^\circ C$ ; Notes 5 & 6                               |            | 1.2        |            | $\Omega$     |
|   | Negative Transients  |  |            | 0.6        |            | $\Omega$     |

Note 1: All parameters specified at  $T_A = -40^\circ C$  to  $+85^\circ C$  unless otherwise noted.

Note 2: These parameters guaranteed by design and characterization.

Note 3: Human Body Model per MIL-STD-883, Method 3015,  $C_{Discharge} = 100pF$ ,  $R_{Discharge} = 1.5K\Omega$ ,  $V_P = 3.3V$ ,  $V_N$  grounded.

Note 4: Standard IEC 61000-4-2 with  $C_{Discharge} = 150pF$ ,  $R_{Discharge} = 330\Omega$ ,  $V_P = 3.3V$ ,  $V_N$  grounded.

Note 5: These measurements performed with no external capacitor on  $V_P$ .

Note 6: Measured under pulsed conditions, pulse width = 0.7mS, maximum current = 1.5A.

## Performance Information (Cont'd)

Typical Filter Performance (nominal conditions unless specified otherwise, 50 Ohm Environment)

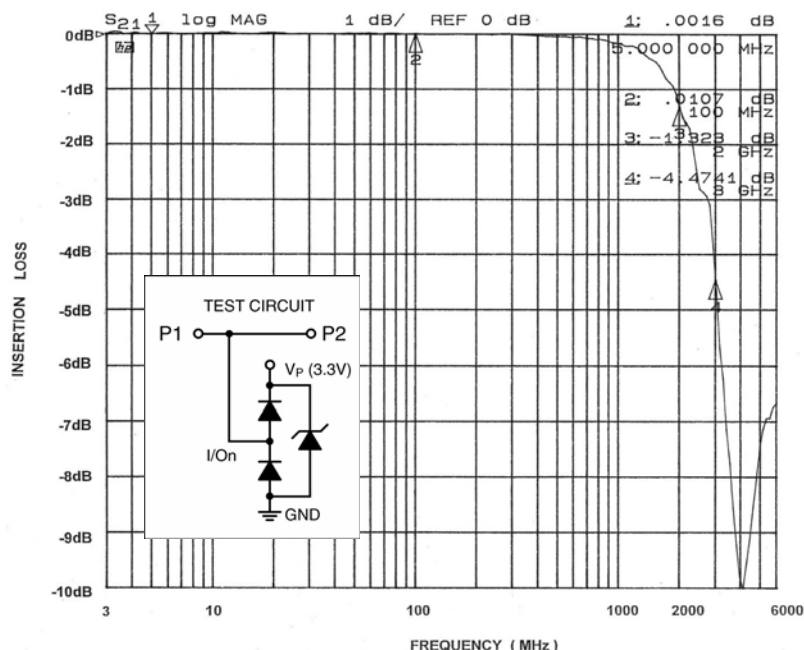


Figure 1. Insertion Loss (S21) VS. Frequency (0V DC Bias,  $V_p = 3.3V$ )

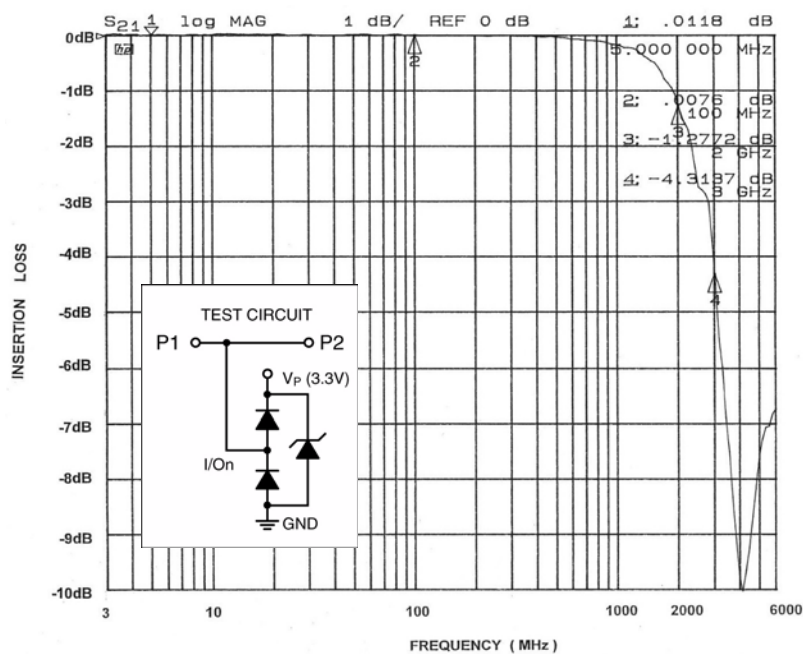


Figure 2. Insertion Loss (S21) VS. Frequency (2.5V DC Bias,  $V_p = 3.3V$ )

## Application Information

### Design Considerations

In order to realize the maximum protection against ESD pulses, care must be taken in the PCB layout to minimize parasitic series inductances on the Supply/Ground rails as well as the signal trace segment between the signal input (typically a connector) and the ESD protection device. Refer to [Figure 3](#), which illustrates an example of a positive ESD pulse striking an input channel. The parasitic series inductance back to the power supply is represented by  $L_1$  and  $L_2$ . The voltage  $V_{CL}$  on the line being protected is:

$$V_{CL} = \text{Fwd voltage drop of } D_1 + V_{\text{SUPPLY}} + L_1 \times d(I_{\text{ESD}}) / dt + L_2 \times d(I_{\text{ESD}}) / dt$$

where  $I_{\text{ESD}}$  is the ESD current pulse, and  $V_{\text{SUPPLY}}$  is the positive supply voltage.

An ESD current pulse can rise from zero to its peak value in a very short time. As an example, a level 4 contact discharge per the IEC61000-4-2 standard results in a current pulse that rises from zero to 30 Amps in 1ns. Here  $d(I_{\text{ESD}})/dt$  can be approximated by  $\Delta I_{\text{ESD}}/\Delta t$ , or  $30/(1 \times 10^{-9})$ . So just 10nH of series inductance ( $L_1$  and  $L_2$  combined) will lead to a 300V increment in  $V_{CL}$ !

Similarly for negative ESD pulses, parasitic series inductance from the  $V_N$  pin to the ground rail will lead to drastically increased negative voltage on the line being protected.

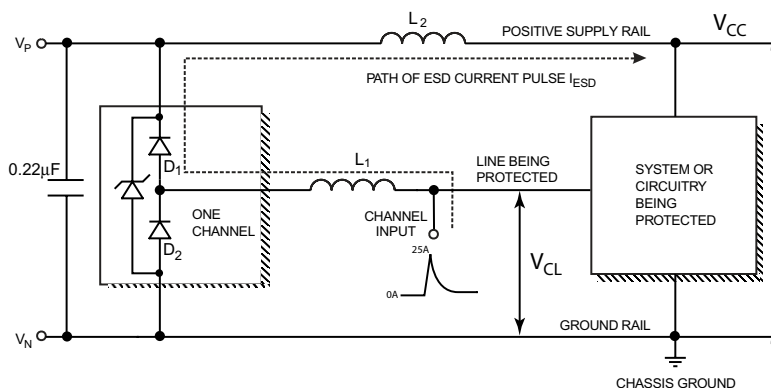
The CM1293 has an integrated Zener diode between  $V_P$  and  $V_N$ . This greatly reduces the effect of supply rail

inductance  $L_2$  on  $V_{CL}$  by clamping  $V_P$  at the breakdown voltage of the Zener diode. However, for the lowest possible  $V_{CL}$ , especially when  $V_P$  is biased at a voltage significantly below the Zener breakdown voltage, it is recommended that a 0.22μF ceramic chip capacitor be connected between  $V_P$  and the ground plane.

As a general rule, the ESD Protection Array should be located as close as possible to the point of entry of expected electrostatic discharges. The power supply bypass capacitor mentioned above should be as close to the  $V_P$  pin of the Protection Array as possible, with minimum PCB trace lengths to the power supply, ground planes and between the signal input and the ESD device to minimize stray series inductance.

### Additional Information

See also California Micro Devices Application Note AP209, "Design Considerations for ESD Protection", in the Applications section at [www.calmicro.com](http://www.calmicro.com).



**Figure 3. Application of Positive ESD Pulse between Input Channel and Ground**

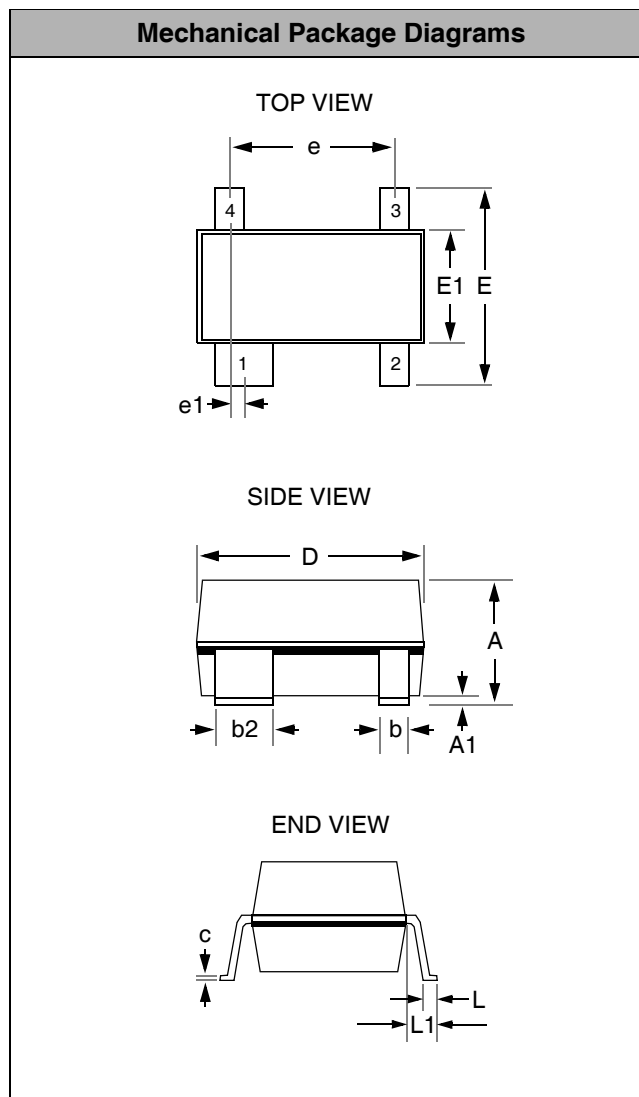
## Mechanical Details

### SOT143 Mechanical Specifications

Dimensions for CM1293-02SR devices supplied in 4-pin SOT143 packages are presented below.

For complete information on the SOT143, see the California Micro Devices SOT143 Package Information document.

| PACKAGE DIMENSIONS                 |             |      |           |       |
|------------------------------------|-------------|------|-----------|-------|
| Package                            | SOT143      |      |           |       |
| Pins                               | 4           |      |           |       |
| Dimensions                         | Millimeters |      | Inches    |       |
|                                    | Min         | Max  | Min       | Max   |
| A                                  | 0.80        | 1.22 | 0.031     | 0.048 |
| A1                                 | 0.05        | 0.15 | 0.002     | 0.006 |
| b                                  | 0.30        | 0.50 | 0.012     | 0.019 |
| b2                                 | 0.76        | 0.89 | 0.030     | 0.035 |
| c                                  | 0.08        | 0.20 | 0.003     | 0.008 |
| D                                  | 2.80        | 3.04 | 0.110     | 0.119 |
| E                                  | 2.10        | 2.64 | 0.082     | 0.103 |
| E1                                 | 1.20        | 1.40 | 0.047     | 0.055 |
| e                                  | 1.92 BSC    |      | 0.075 BSC |       |
| e1                                 | 0.20 BSC    |      | 0.008 BSC |       |
| L                                  | 0.4         | 0.6  | 0.016     | 0.024 |
| L1                                 | 0.54 REF    |      | 0.021 REF |       |
| # per tape and reel                | 3000 pieces |      |           |       |
| Controlling dimension: millimeters |             |      |           |       |



Package Dimensions for SOT143.

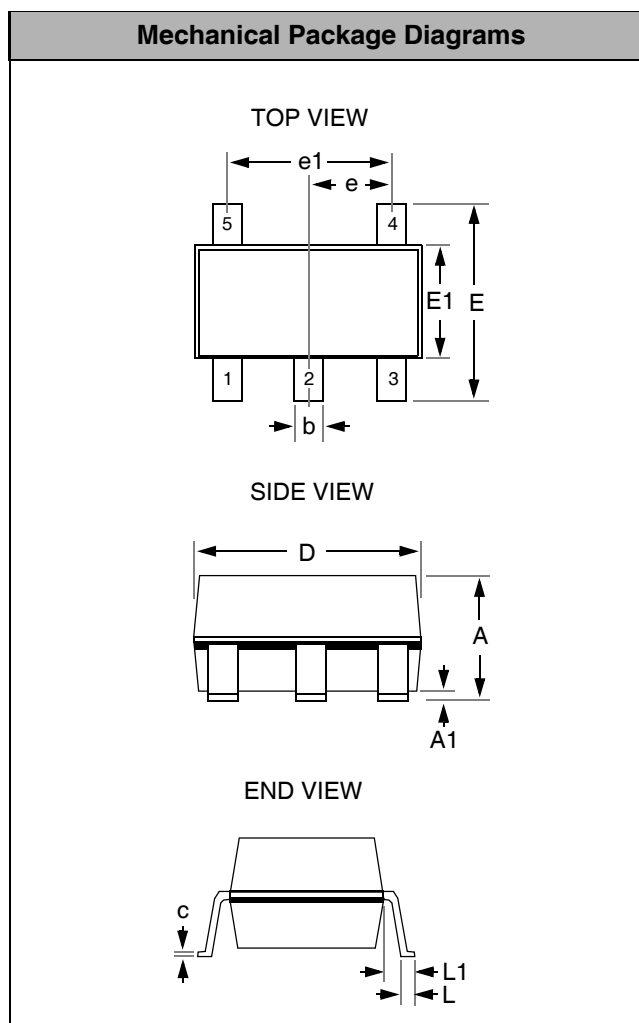
## Mechanical Details (cont'd)

### SOT23-5 Mechanical Specifications

Dimensions for CM1293-02ST/SO devices packaged in 5-pin SOT23 packages are presented below.

For complete information on the SOT23-5 package, see the California Micro Devices SOT23 Package Information document.

| PACKAGE DIMENSIONS                 |                                |      |            |        |
|------------------------------------|--------------------------------|------|------------|--------|
| Package                            | SOT23-5 (JEDEC name is MO-178) |      |            |        |
| Pins                               | 5                              |      |            |        |
| Dimensions                         | Millimeters                    |      | Inches     |        |
|                                    | Min                            | Max  | Min        | Max    |
| A                                  | --                             | 1.45 | --         | 0.0571 |
| A1                                 | 0.00                           | 0.15 | 0.0000     | 0.0059 |
| b                                  | 0.30                           | 0.50 | 0.0118     | 0.0197 |
| c                                  | 0.08                           | 0.22 | 0.0031     | 0.0087 |
| D                                  | 2.75                           | 3.05 | 0.1083     | 0.1201 |
| E                                  | 2.60                           | 3.00 | 0.1024     | 0.1181 |
| E1                                 | 1.45                           | 1.75 | 0.0571     | 0.0689 |
| e                                  | 0.95 BSC                       |      | 0.0374 BSC |        |
| e1                                 | 1.90 BSC                       |      | 0.0748 BSC |        |
| L                                  | 0.30                           | 0.60 | 0.0118     | 0.0236 |
| L1                                 | 0.60 REF                       |      | 0.0236 REF |        |
| # per tape and reel                | 3000 pieces                    |      |            |        |
| Controlling dimension: millimeters |                                |      |            |        |





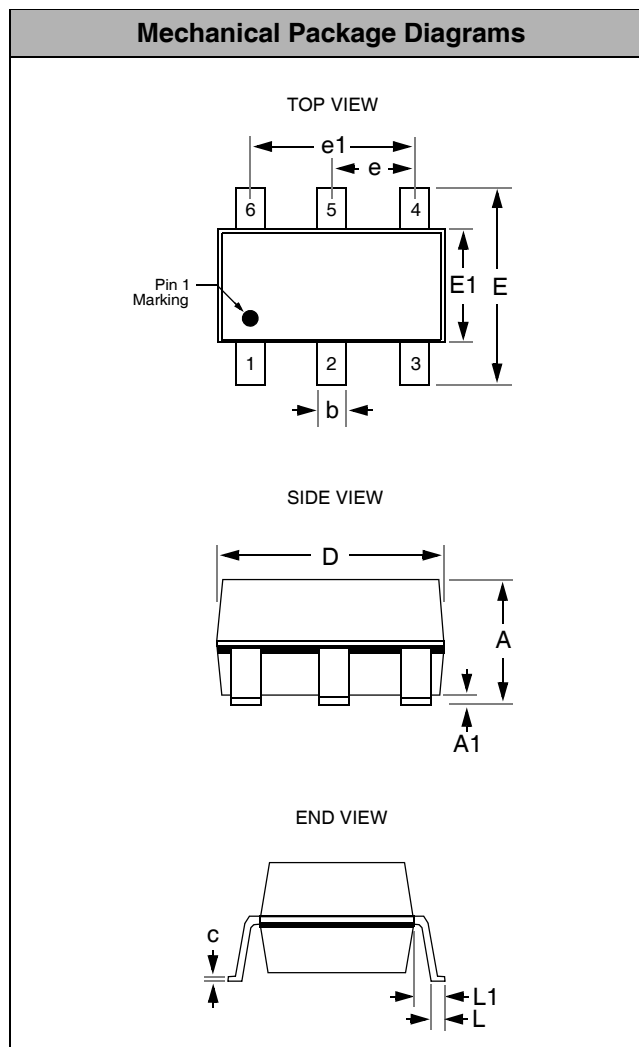
## Mechanical Details (cont'd)

### SOT23-6 Mechanical Specifications

CM1293-04ST/SO devices are packaged in 6-pin SOT23 packages. Dimensions are presented below.

For complete information on the SOT23-6 package, see the California Micro Devices SOT23 Package Information document.

| PACKAGE DIMENSIONS                 |                                |      |            |        |
|------------------------------------|--------------------------------|------|------------|--------|
| Package                            | SOT23-6 (JEDEC name is MO-178) |      |            |        |
| Pins                               | 6                              |      |            |        |
| Dimensions                         | Millimeters                    |      | Inches     |        |
|                                    | Min                            | Max  | Min        | Max    |
| A                                  | --                             | 1.45 | --         | 0.0571 |
| A1                                 | 0.00                           | 0.15 | 0.0000     | 0.0059 |
| b                                  | 0.30                           | 0.50 | 0.0118     | 0.0197 |
| c                                  | 0.08                           | 0.22 | 0.0031     | 0.0087 |
| D                                  | 2.75                           | 3.05 | 0.1083     | 0.1201 |
| E                                  | 2.60                           | 3.00 | 0.1024     | 0.1181 |
| E1                                 | 1.45                           | 1.75 | 0.0571     | 0.0689 |
| e                                  | 0.95 BSC                       |      | 0.0374 BSC |        |
| e1                                 | 1.90 BSC                       |      | 0.0748 BSC |        |
| L                                  | 0.30                           | 0.60 | 0.0118     | 0.0236 |
| L1                                 | 0.60 REF                       |      | 0.0236 REF |        |
| # per tape and reel                | 3000 pieces                    |      |            |        |
| Controlling dimension: millimeters |                                |      |            |        |



**Package Dimensions for SOT23-6.**

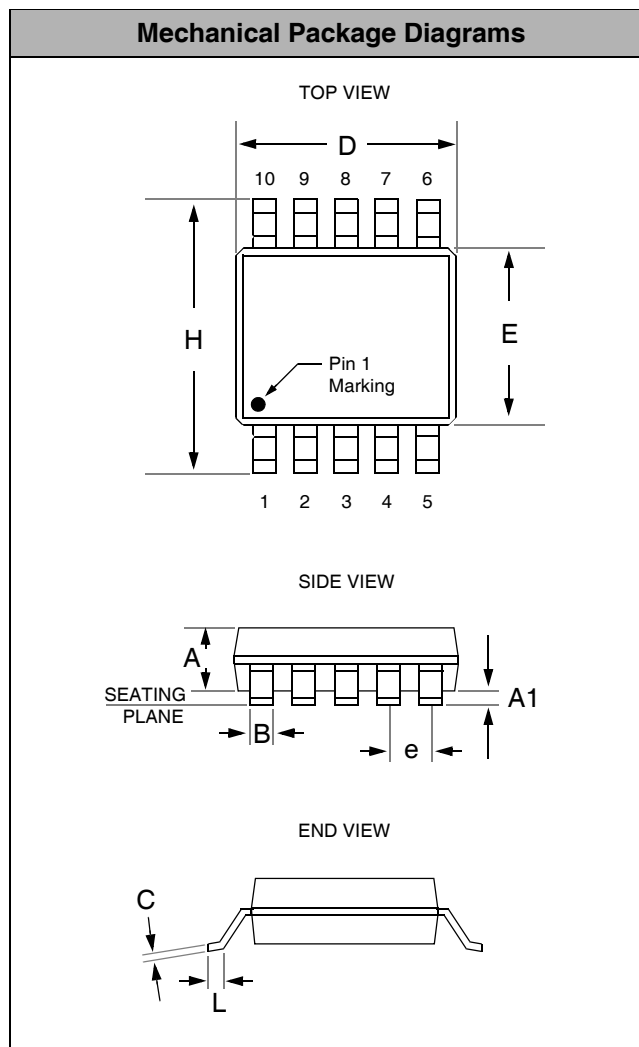
## Mechanical Details (cont'd)

### MSOP-10 Mechanical Specifications

CM1293-04MS/MR and CM1293-08MS/MR devices are packaged in 10-pin MSOP packages. Dimensions are presented below.

For complete information on the MSOP-10 package, see the California Micro Devices MSOP Package Information document.

| PACKAGE DIMENSIONS            |             |      |            |       |
|-------------------------------|-------------|------|------------|-------|
| Package                       | MSOP        |      |            |       |
| Pins                          | 10          |      |            |       |
| Dimensions                    | Millimeters |      | Inches     |       |
|                               | Min         | Max  | Min        | Max   |
| A                             | 0.75        | 0.95 | 0.028      | 0.038 |
| A1                            | 0.05        | 0.15 | 0.002      | 0.006 |
| B                             | 0.18        | 0.40 | 0.006      | 0.016 |
| C                             | 0.18        |      | 0.007      |       |
| D                             | 2.90        | 3.10 | 0.114      | 0.122 |
| E                             | 2.90        | 3.10 | 0.114      | 0.122 |
| e                             | 0.50 BSC    |      | 0.0196 BSC |       |
| H                             | 4.76        | 5.00 | 0.187      | 0.197 |
| L                             | 0.40        | 0.70 | 0.0137     | 0.029 |
| # per tape and reel           | 4000        |      |            |       |
| Controlling dimension: inches |             |      |            |       |



Package Dimensions for MSOP-10