

## 6- and 8-Channel Low Capacitance ESD Arrays

### Features

- Six and eight channels of ESD protection
- Provides  $\pm 15$  kV ESD protection on each channel per the IEC 61000-4-2 ESD requirements
- Channel loading capacitance of 1.6 pF typical
- Channel I/O to GND capacitance difference of 0.04pF typical
- Mutual capacitance of 0.13pF typical
- Minimal capacitance change with temperature and voltage
- Each I/O pin can withstand over 1000 ESD strikes
- SOIC and MSOP packages
- RoHs-compliant, lead-free packaging

### Applications

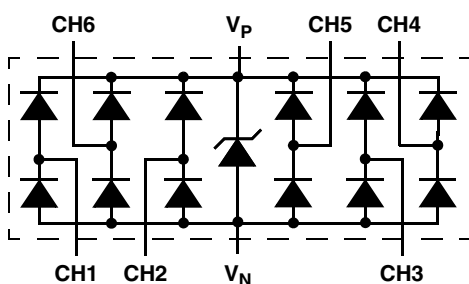
- IEEE1394 Firewire® ports at 400Mbps / 800Mbps
- DVI ports, HDMI ports in notebooks, set top boxes, digital TVs, LCD displays
- Serial ATA ports in desktop PCs and hard disk drives
- PCI Express ports
- General purpose high-speed data line ESD protection

### Product Description

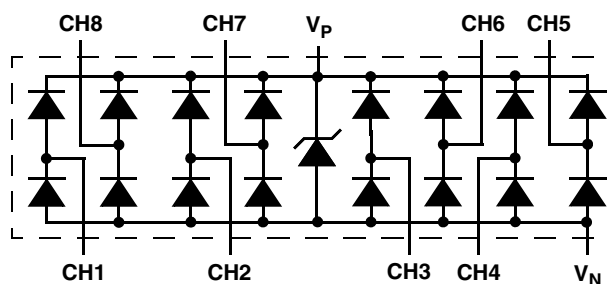
The CM1216 family of diode arrays provide sESD protection for electronic components or sub-systems requiring minimal capacitive loading. These devices are ideal for protecting systems with high data and clock rates or for circuits requiring low capacitive loading. Each ESD channel consists of a pair 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. The CM1216 protects against ESD pulses up to  $\pm 15$  kV per the IEC 61000-4-2 standard.

This device is particularly well-suited for protecting systems using high-speed ports such as USB2.0, IEEE1394 (Firewire®, iLink™), 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.

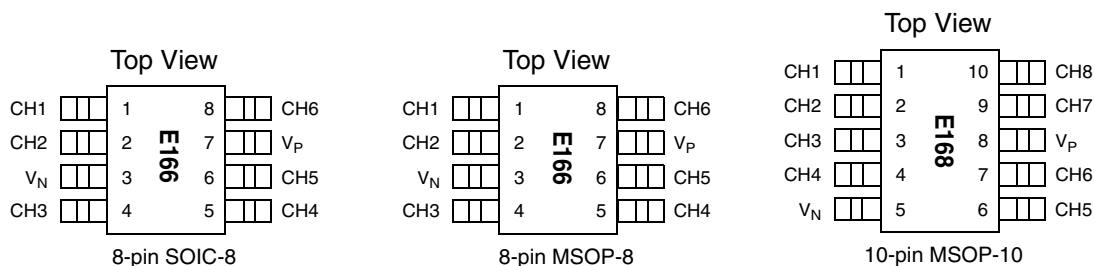
### Simplified Electrical Schematic



CM1216-06MR  
CM1216-06SM



CM1216-08MR

**PACKAGE / PINOUT DIAGRAM**


Note: These drawings are not to scale.

## Pin Configuration

| PIN NAME       | MSOP-8  | SOIC-8  | MSOP-10 | TYPE | DESCRIPTION                  |
|----------------|---------|---------|---------|------|------------------------------|
|                | PIN NO. | PIN NO. | PIN NO. |      |                              |
| CH1            | 1       | 1       | 1       | I/O  | ESD Channel                  |
| CH2            | 2       | 2       | 2       | I/O  | ESD Channel                  |
| CH3            | 4       | 4       | 3       | I/O  | ESD Channel                  |
| CH4            | 5       | 5       | 4       | I/O  | ESD Channel                  |
| V <sub>N</sub> | 3       | 3       | 5       | GND  | Negative voltage supply rail |
| CH5            | 6       | 6       | 6       | I/O  | ESD Channel                  |
| CH6            | 8       | 8       | 7       | I/O  | ESD Channel                  |
| V <sub>P</sub> | 7       | 7       | 8       | PWR  | Positive voltage supply rail |
| CH7            | —       | —       | 9       | I/O  | ESD Channel                  |
| CH8            | —       | —       | 10      | I/O  | ESD Channel                  |

## Ordering Information

**PART NUMBERING INFORMATION**

| Pins | Package | Lead-free Finish                  |              |
|------|---------|-----------------------------------|--------------|
|      |         | Ordering Part Number <sup>1</sup> | Part Marking |
| 8    | SOIC    | CM1216-06SM                       | E166         |
| 8    | MSOP    | CM1216-06MR                       | E166         |
| 10   | MSOP    | CM1216-08MR                       | E168         |

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

## Specifications

| ABSOLUTE MAXIMUM RATINGS               |                                |       |
|----------------------------------------|--------------------------------|-------|
| PARAMETER                              | RATING                         | UNITS |
| Operating Supply Voltage ( $V_P-V_N$ ) | 6                              | V     |
| Diode Forward DC Current (Note 1)      | 20                             | mA    |
| DC Voltage at any Channel Input        | ( $V_N-0.5$ ) to ( $V_P+0.5$ ) | V     |
| Operating Temperature Range            |                                |       |
| Ambient                                | -40 to +85                     | °C    |
| Junction                               | -40 to +125                    | °C    |
| Storage Temperature Range              | -40 to +150                    | °C    |

## Standard Operating Condition

| STANDARD OPERATING CONDITIONS |            |       |
|-------------------------------|------------|-------|
| PARAMETER                     | RATING     | UNITS |
| Temperature Range (Ambient)   | -40 to +85 | °C    |
| Package Power Rating          |            |       |
| MSOP8 Package (CM1216-06MR)   | 400        | mW    |
| SOIC8 Package (CM1216-06SM)   | 600        | mW    |
| MSOP10 Package (CM1216-08MR)  | 400        | mW    |

## Specifications (cont'd)

| <b>ELECTRICAL OPERATING CHARACTERISTICS</b> <small>NOTE 1</small> |                                                                                                                        |                                                                |            |              |              |                      |
|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|------------|--------------|--------------|----------------------|
| SYMBOL                                                            | PARAMETER                                                                                                              | CONDITIONS                                                     | MIN        | TYP          | MAX          | UNIT                 |
| $V_P$                                                             | Operating Supply Voltage ( $V_P-V_N$ )                                                                                 |                                                                |            | 3.3          | 5.5          | V                    |
| $I_P$                                                             | Operating Supply Current                                                                                               | $(V_P-V_N) = 3.3V$                                             |            |              | 8            | $\mu A$              |
| $V_F$                                                             | Diode Forward Voltage<br>Top Diode<br>Bottom Diode                                                                     | $I_F = 20mA$ ; $T_A=25^\circ C$                                | 0.6<br>0.6 | 0.8<br>0.8   | 0.95<br>0.95 | V<br>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, $V_P=3.3V$ , $V_N=0V$ , $V_{IN}=1.65V$ ; Note 2      |            | 1.6          | 2.0          | pF                   |
| $\Delta C_{IN}$                                                   | Channel Input Capacitance Matching                                                                                     | Note 2                                                         |            | 0.04         |              | pF                   |
| $C_{MUTUAL}$                                                      | Mutual Capacitance                                                                                                     | $(V_P-V_N) = 3.3V$ ; Note 2                                    |            | 0.13         |              | pF                   |
| $V_{ESD}$                                                         | ESD Protection<br>Peak Discharge Voltage at any channel input, in system, contact discharge per IEC 61000-4-2 standard | Notes 2, 3, and 4; $T_A = 25^\circ C$                          | $\pm 15$   |              |              | kV                   |
| $V_{CL}$                                                          | Channel Clamp Voltage<br>Positive Transients<br>Negative Transients                                                    | $I_{PP} = 1A$ , $t_P = 8/20\mu S$ ; $T_A=25^\circ C$ ; Notes 2 |            | +9.0<br>-1.5 |              | V<br>V               |
| $R_{DYN}$                                                         | Dynamic Resistance<br>Positive transients<br>Negative transients                                                       | $I_{PP} = 1A$ , $t_P = 8/20\mu S$ ; $T_A=25^\circ C$ ; Notes 2 |            | 0.6<br>0.4   |              | $\Omega$<br>$\Omega$ |

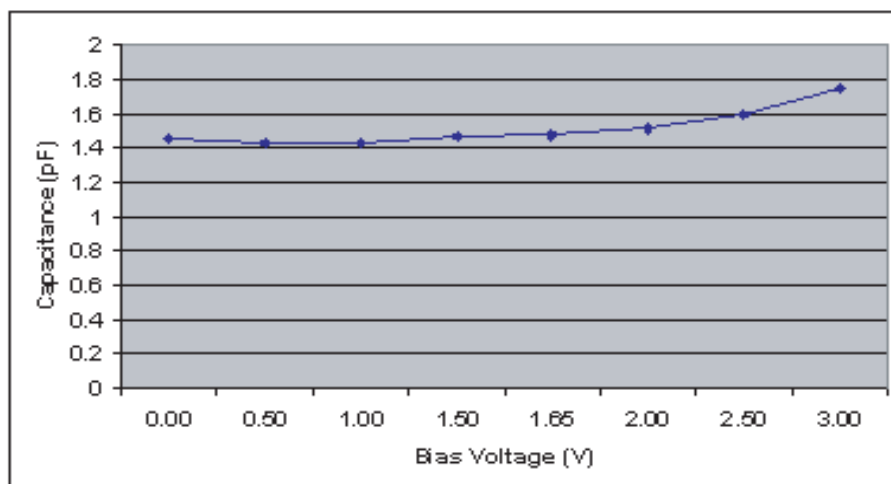
Note 1: All parameters specified at  $T_A = -40^\circ C$  to  $+85^\circ C$  unless otherwise noted.

Note 2: These parameters guaranteed by design and characterization.

Note 3: Standard IEC 61000-4-2 with  $C_{Discharge} = 150pF$ ,  $R_{Discharge} = 330\Omega$ ,  $V_P = 3.3V$ ,  $V_N$  grounded.

Note 4: From I/O pins to  $V_P$  or  $V_N$  only.  $V_P$  bypassed to  $V_N$  with low ESR 0.2 $\mu F$  ceramic capacitor.

## Performance Characteristics



**Figure 1. Typical Variation of  $C_{IN}$  vs.  $V_{IN}$**   
 ( $f = 1\text{MHz}$ ,  $V_P = 3.3\text{V}$ ,  $V_N = 0\text{V}$ ,  $0.1\mu\text{F}$  chip capacitor between  $V_P$  and  $V_N$ ,  $T_A = 25^\circ\text{C}$ )

## 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 1, 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 L1 and L2. The voltage VCL 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 IESD is the ESD current pulse, and VSUPPLY 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(IESD)/dt can be approximated by d(IESD)/dt, or 30/(1x10<sup>-9</sup>). So just 10nH of series inductance (L1 and L2 combined) will lead to a 300V increment in VCL!

Similarly for negative ESD pulses, parasitic series inductance from the V<sub>N</sub> pin to the ground rail will lead to drastically increased negative voltage on the line being protected.

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<sub>P</sub> 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 AP-209, "Design Considerations for ESD Protection", in the Applications section at [www.calmicro.com](http://www.calmicro.com).

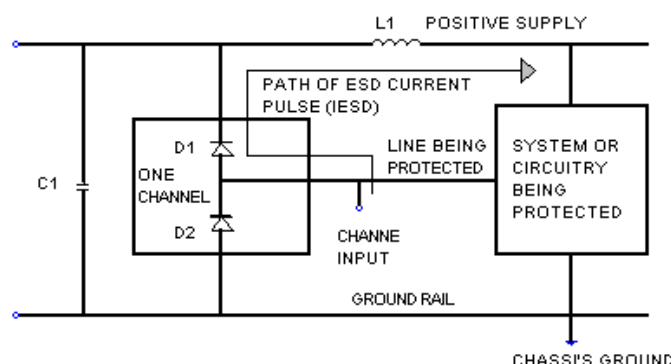


Figure 2. Application of Positive ESD Pulse between Input Channel and Ground

## Mechanical Details

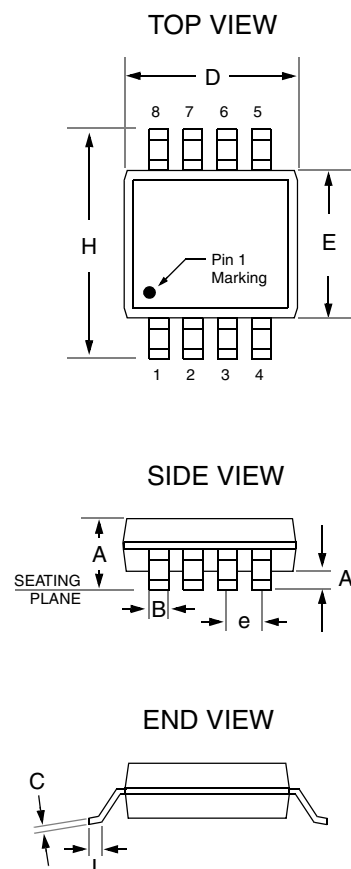
### SOIC-8 Mechanical Specifications

The CM1216-06SM is supplied in an 8-pin SOIC package. Dimensions are presented below.

| PACKAGE DIMENSIONS                 |             |      |           |       |
|------------------------------------|-------------|------|-----------|-------|
| Package                            | SOIC        |      |           |       |
| Pins                               | 8           |      |           |       |
| Dimensions                         | Millimeters |      | Inches    |       |
|                                    | Min         | Max  | Min       | Max   |
| A                                  | 1.35        | 1.75 | 0.053     | 0.069 |
| A <sub>1</sub>                     | 0.10        | 0.25 | 0.004     | 0.010 |
| B                                  | 0.33        | 0.51 | 0.013     | 0.020 |
| C                                  | 0.19        | 0.25 | 0.007     | 0.010 |
| D                                  | 4.80        | 5.00 | 0.189     | 0.197 |
| E                                  | 3.80        | 4.19 | 0.150     | 0.165 |
| e                                  | 1.27 BSC    |      | 0.050 BSC |       |
| H                                  | 5.80        | 6.20 | 0.228     | 0.244 |
| L                                  | 0.40        | 1.27 | 0.016     | 0.050 |
| # per tube                         | 100 pieces* |      |           |       |
| # per tape and reel                | 2500 pieces |      |           |       |
| Controlling dimension: millimeters |             |      |           |       |

\* This is an approximate number which may vary.

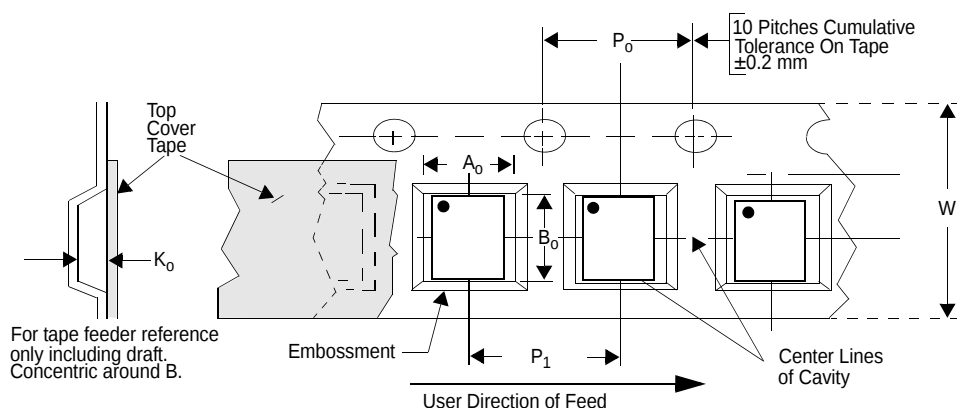
### Mechanical Package Diagrams



**Package Dimensions for SOIC-8**

# Tape and Reel Specifications

| PART NUMBER | PACKAGE SIZE (mm)  | POCKET SIZE (mm)<br>$B_0 \times A_0 \times K_0$ | TAPE WIDTH<br>W | REEL<br>DIAMETER | QTY PER<br>REEL | $P_0$ | $P_1$ |
|-------------|--------------------|-------------------------------------------------|-----------------|------------------|-----------------|-------|-------|
| CM1216-06SM | 4.90 X 6.00 X 1.55 | 5.30 X 6.50 X 2.10                              | 12mm            | 330mm (13")      | 2500            | 4mm   | 8mm   |

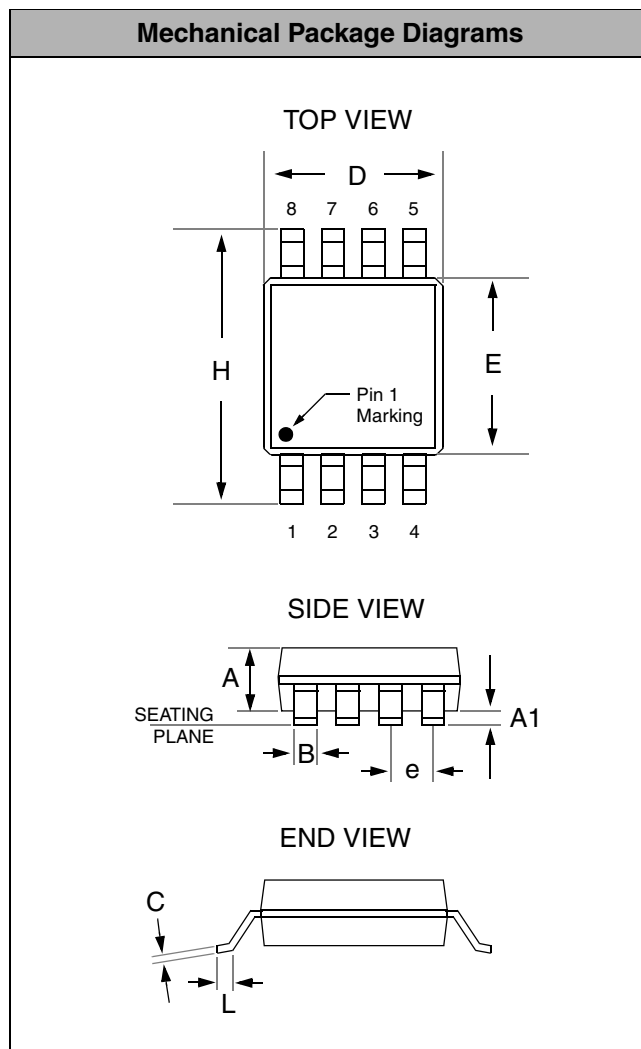


## Mechanical Details

### MSOP-8 Mechanical Specifications:

The CM1216-06MR is supplied in an 8-pin MSOP package. Dimensions are presented below.

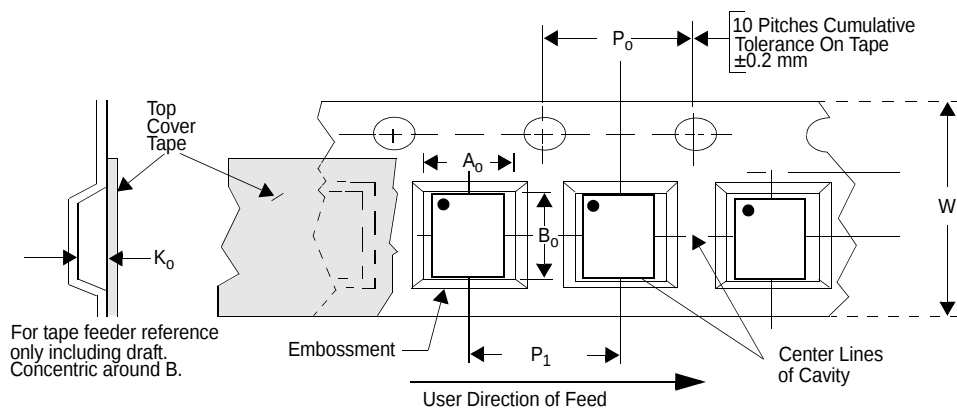
| PACKAGE DIMENSIONS                 |             |      |           |       |
|------------------------------------|-------------|------|-----------|-------|
| Package                            | MSOP        |      |           |       |
| Pins                               | 8           |      |           |       |
| Dimensions                         | Millimeters |      | Inches    |       |
|                                    | Min         | Max  | Min       | Max   |
| A                                  | 0.75        | 0.95 | 0.030     | 0.037 |
| A1                                 | 0.05        | 0.15 | 0.002     | 0.006 |
| B                                  | 0.28        | 0.38 | 0.011     | 0.015 |
| C                                  | 0.13        | 0.23 | 0.005     | 0.009 |
| D                                  | 2.90        | 3.10 | 0.114     | 0.122 |
| E                                  | 2.90        | 3.10 | 0.114     | 0.122 |
| e                                  | 0.65 BSC    |      | 0.026 BSC |       |
| H                                  | 4.90 BSC    |      | 0.193 BSC |       |
| L                                  | 0.40        | 0.70 | 0.016     | 0.028 |
| # per tape and reel                | 4000 pieces |      |           |       |
| Controlling dimension: millimeters |             |      |           |       |



**Package Dimensions for MSOP-8**

**Tape and Reel Specifications**

| PART NUMBER | PACKAGE SIZE (mm)  | POCKET SIZE (mm)<br>$B_0 \times A_0 \times K_0$ | TAPE WIDTH<br>W | REEL<br>DIAMETER | QTY PER<br>REEL | $P_0$ | $P_1$ |
|-------------|--------------------|-------------------------------------------------|-----------------|------------------|-----------------|-------|-------|
| CM1216-06MR | 3.00 X 4.90 X 0.95 | 3.30 X 5.30 X 1.30                              | 12mm            | 330mm (13")      | 4000            | 4mm   | 8mm   |

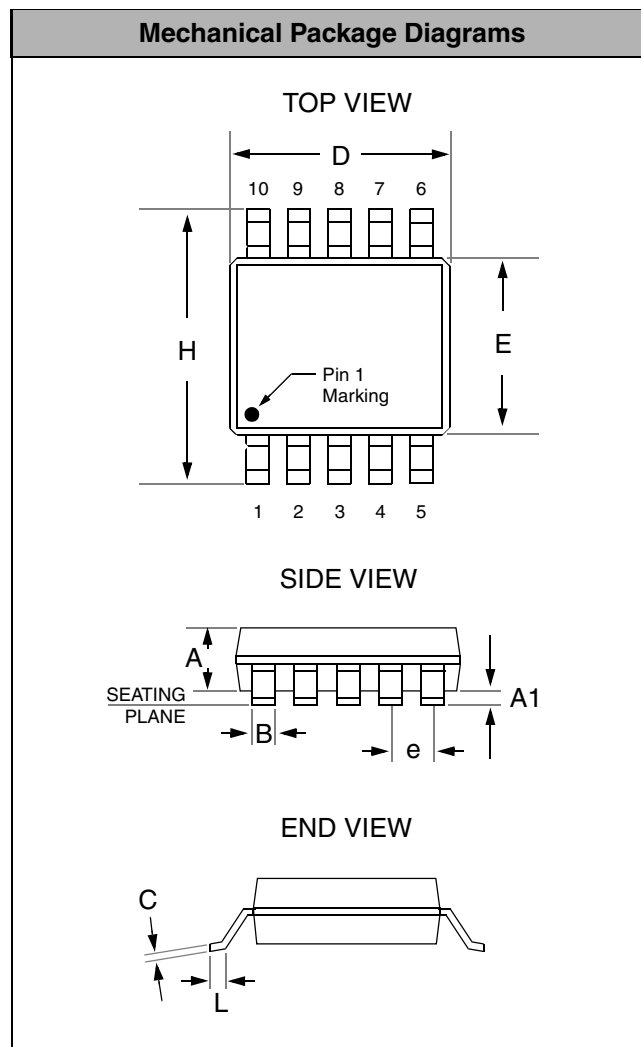


## Mechanical Details (cont'd)

### MSOP-10 Mechanical Specifications

The CM1216-08MR is supplied in a 10-pin MSOP package. Dimensions are presented below.

| 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                                  | 0.17        | 0.27 | 0.007      | 0.013 |
| C                                  | 0.13        | 0.23 | 0.005      | 0.009 |
| 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                                  | 4.90 BSC    |      | 0.193 BSC  |       |
| L                                  | 0.40        | 0.70 | 0.0137     | 0.029 |
| # per tape and reel                | 4000        |      |            |       |
| Controlling dimension: millimeters |             |      |            |       |



**Package Dimensions for MSOP-10**

**Tape and Reel Specifications**

| PART NUMBER | PACKAGE SIZE (mm)  | POCKET SIZE (mm)<br>$B_0 \times A_0 \times K_0$ | TAPE WIDTH<br>W | REEL<br>DIAMETER | QTY PER<br>REEL | $P_0$ | $P_1$ |
|-------------|--------------------|-------------------------------------------------|-----------------|------------------|-----------------|-------|-------|
| CM1216-08MR | 3.00 X 4.90 X 0.95 | 3.30 X 5.30 X 1.30                              | 12mm            | 330mm (13")      | 4000            | 4mm   | 8mm   |

