



1-, 2- and 4-Channel Low Capacitance ESD Protection Arrays

CM1213A

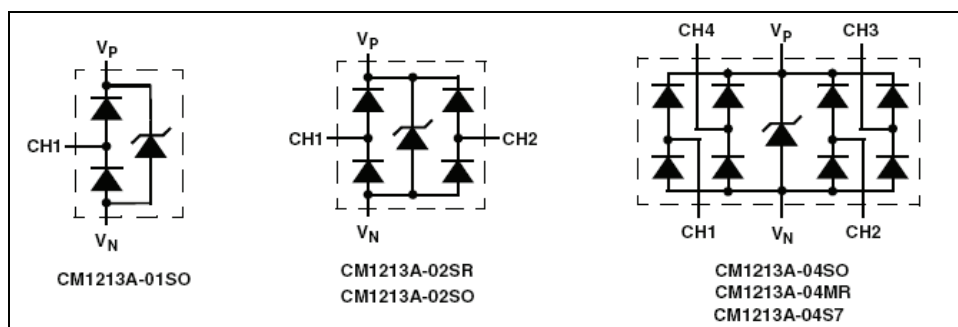
Features

- One, two, and four channels of ESD protection
Note: For 6- and 8-channel devices, see the CM1213 datasheet.
- Provides ESD protection to IEC61000-4-2 Level 4
 - $\pm 8\text{kV}$ contact discharge
- Low channel input capacitance of 0.85pF typical
- Minimal capacitance change with temperature and voltage
- Channel input capacitance matching of 0.02pF typical is ideal for differential signals
- 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, SC70, and MSOP RoHS-compliant, lead-free packages

Applications

- USB2.0 ports at 480Mbps in desktop PCs, notebooks and peripherals
- 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

Block Diagram



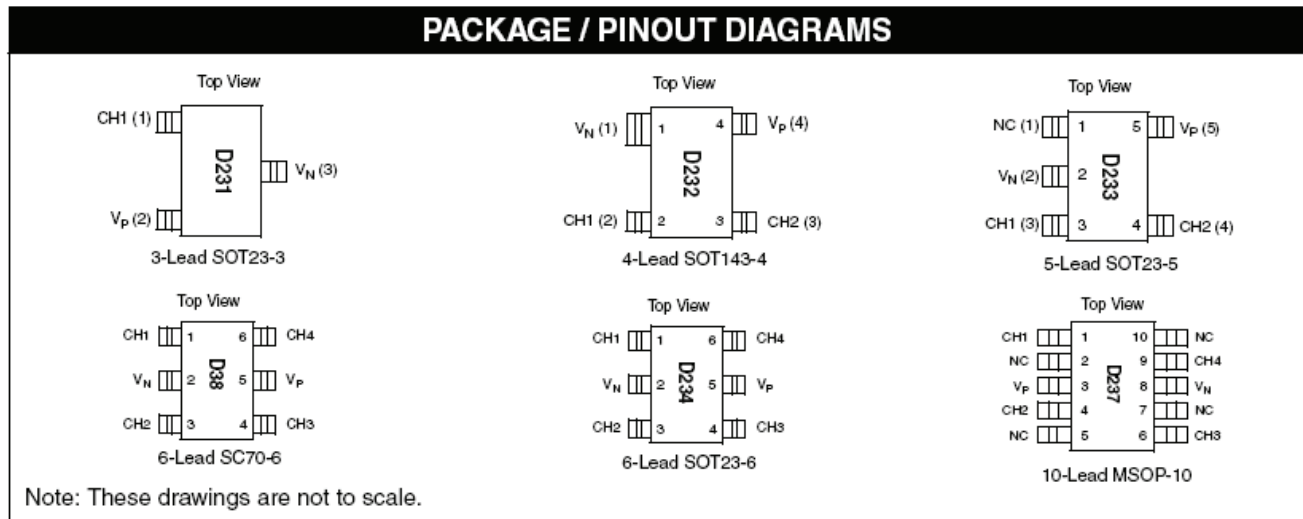
Product Description

The CM1213A family of diode arrays has been designed to provide ESD protection for electronic components or subsystems 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 CM1213A will protect against ESD pulses up to 8kV per the IEC 61000-4-2 standard.

These devices are particularly well-suited for protecting systems using high-speed ports such as USB 2.0, 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.

The CM1213A family of devices is available with RoHS-compliant, lead-free finishing.

Package/Pinout Diagrams



Pin Descriptions

| 1-CHANNEL, 3-LEAD SOT23-3 PACKAGE (CM1213A-01SO) | | | |
|--|----------------|------|------------------------------|
| PIN | NAME | TYPE | DESCRIPTION |
| 1 | CH1 | I/O | ESD Channel |
| 2 | V _p | PWR | Positive voltage supply rail |
| 3 | V _n | GND | Negative voltage supply rail |

| 2-CHANNEL, 4-LEAD SOT143-4 PACKAGE (CM1213A-02SR) | | | |
|---|----------------|------|------------------------------|
| PIN | NAME | TYPE | DESCRIPTION |
| 1 | V _n | GND | Negative voltage supply rail |
| 2 | CH1 | I/O | ESD Channel |
| 3 | CH2 | I/O | ESD Channel |
| 4 | V _p | PWR | Positive voltage supply rail |

| 2-CHANNEL, 5-LEAD SOT23-5 PACKAGE (CM1213A-02SO) | | | |
|--|----------------|------|------------------------------|
| PIN | NAME | TYPE | DESCRIPTION |
| 1 | NC | | No Connect |
| 2 | V _n | GND | Negative voltage supply rail |
| 3 | CH1 | I/O | ESD Channel |
| 4 | CH2 | I/O | ESD Channel |
| 5 | V _p | PWR | Positive voltage supply rail |

| 4-CH, 6-LEAD SOT23-6 (CM1213A-04SO) AND SC70-6 (CM1213A-04S7) | | | |
|---|----------------|------|------------------------------|
| PIN | NAME | TYPE | DESCRIPTION |
| 1 | CH1 | I/O | ESD Channel |
| 2 | V _n | GND | Negative voltage supply rail |
| 3 | CH2 | I/O | ESD Channel |
| 4 | CH3 | I/O | ESD Channel |
| 5 | V _p | PWR | Positive voltage supply rail |
| 6 | CH4 | I/O | ESD Channel |

| 4-CHANNEL, 10-LEAD MSOP-10 PACKAGE (CM1213A04MR) | | | |
|--|----------------|------|------------------------------|
| PIN | NAME | TYPE | DESCRIPTION |
| 1 | CH1 | I/O | ESD Channel |
| 2 | NC | | No Connect |
| 3 | V _p | 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 _n | GND | Negative voltage supply rail |
| 9 | CH4 | I/O | ESD Channel |
| 10 | NC | | No Connect |

CM1213A

Ordering Information

| PART NUMBERING INFORMATION | | | | |
|----------------------------|-------|----------|-----------------------------------|--------------|
| # of Channels | Leads | Package | Lead-free Finish | |
| | | | Ordering Part Number ¹ | Part Marking |
| 1 | 3 | SOT23-3 | CM1213A-01SO | D231 |
| 2 | 4 | SOT143-4 | CM1213A-02SR | D232 |
| 2 | 5 | SOT23-5 | CM1213A-02SO | D233 |
| 4 | 6 | SOT23-6 | CM1213A-04SO | D234 |
| 4 | 6 | SC70-6 | CM1213A-04S7 | D38 |
| 4 | 10 | MSOP-10 | CM1213A-04MR | D237 |

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

Specifications

| ABSOLUTE MAXIMUM RATINGS | | |
|--|------------------------------------|-------|
| PARAMETER | RATING | UNITS |
| Operating Supply Voltage ($V_p - V_N$) | 6.0 | 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 SOT23-3, SOT143-4, SOT23-5, SOT23-6, and SC70-6 Packages | 225 | mW |
| MSOP-10 Package | 400 | mW |

ELECTRICAL OPERATING CHARACTERISTICS (SEE NOTE 1)

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|-----------------|---|---|--------------|--------------|--------------|----------------------|
| 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 | μA |
| V_F | Diode Forward Voltage Top Diode Bottom Diode | $I_F = 8mA; T_A=25^\circ C$ | 0.60 0.60 | 0.80 0.80 | 0.95 0.95 | V V |
| I_{LEAK} | Channel Leakage Current | $T_A=25^\circ C; V_P=5V, V_N=0V$ | | 0.1 | 1.0 | μA |
| C_{IN} | Channel Input Capacitance | At 1 MHz, $V_P=3.3V, V_N=0V, V_{IN}=1.65V$; Note 2 | | 0.85 | 1.2 | pF |
| ΔC_{IN} | Channel Input Capacitance Matching | At 1 MHz, $V_P=3.3V, V_N=0V, V_{IN}=1.65V$; Note 2 | | 0.02 | | pF |
| V_{ESD} | ESD Protection - Peak Discharge Voltage at any channel input, in system Contact discharge per IEC 61000-4-2 standard | $T_A=25^\circ C$; Notes 2, 3, and 4 | 8 | | | kV |
| V_{CL} | Channel Clamp Voltage Positive Transients Negative Transients | $T_A=25^\circ C, I_{PP} = 1A, t_p = 8/20\mu S$; Notes 2 and 4 | | +10 -1.7 | | V V |
| R_{DYN} | Dynamic Resistance Positive Transients Negative Transients | $I_{PP} = 1A, t_p = 8/20\mu S$ Any I/O pin to Ground; Notes 2 and 4 | | 0.9 0.5 | | Ω Ω |

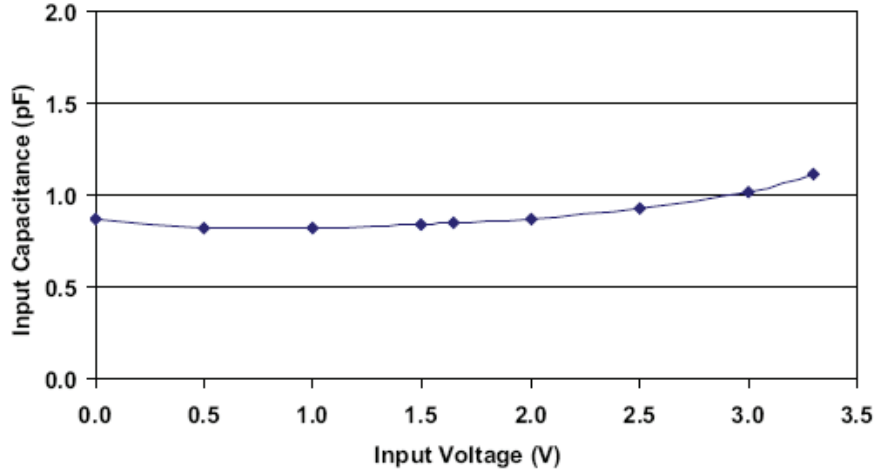
Note 1: All parameters specified at $T_A = -40^\circ C$ to $+85^\circ C$ unless otherwise noted.

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

Note 3: These measurements performed with no external capacitor on V_P (V_P floating).

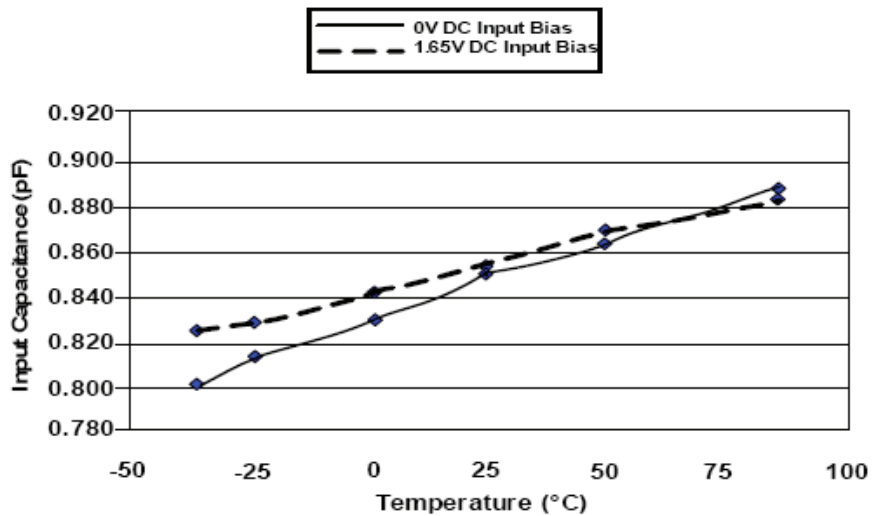
Performance Information

Input Channel Capacitance Performance Curves



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 , 25°C)



Typical Variation of C_{IN} vs. Temp

($f=1\text{MHz}$, $V_{IN}=30\text{mV}$, $V_P = 3.3\text{V}$, $V_N = 0\text{V}$, $0.1\ \mu\text{F}$ chip capacitor between V_P and V_N)

Performance Information (cont'd)

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

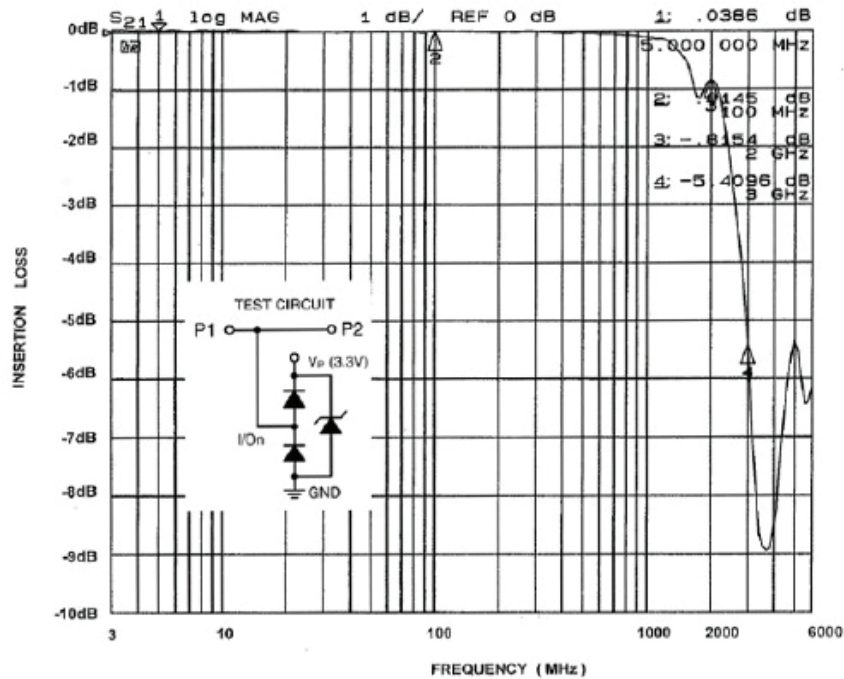


Figure 1. Insertion Loss (S21) VS. Frequency (0V DC Bias, $V_p=3.3V$)

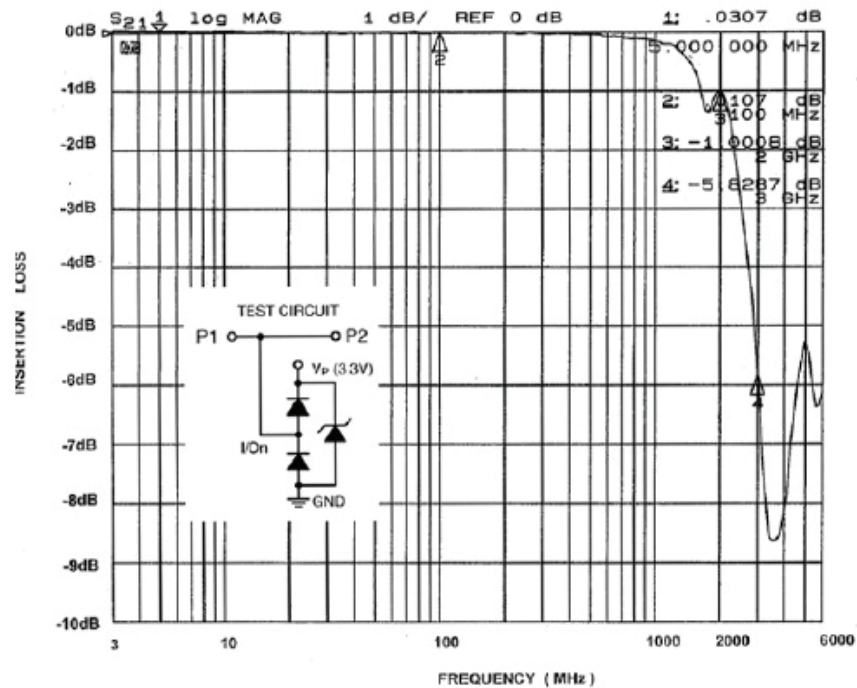


Figure 2. Insertion Loss (S21) VS. Frequency (2.5V DC Bias, $V_p=3.3V$)

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 [Error! Reference source not found.](#), 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:

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

where I_{ESD} is the ESD current pulse, and V_{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 $d(I_{ESD})/dt$ can be approximated by $\Delta I_{ESD}/\Delta t$, 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 CM1213A 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.

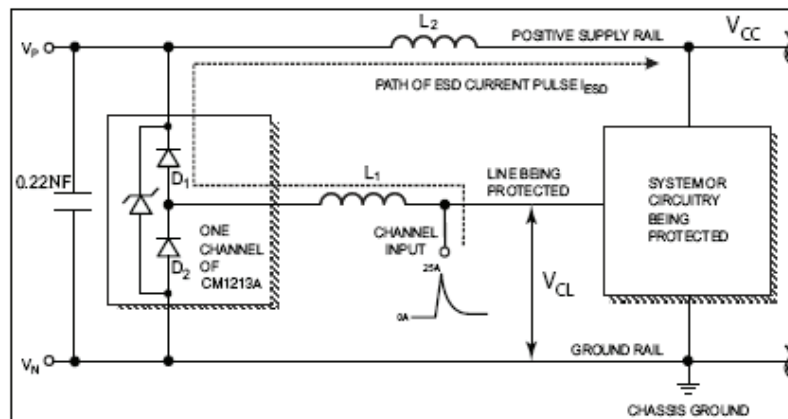


Figure 3. Application of Positive ESD Pulse Between Input Channel and Ground

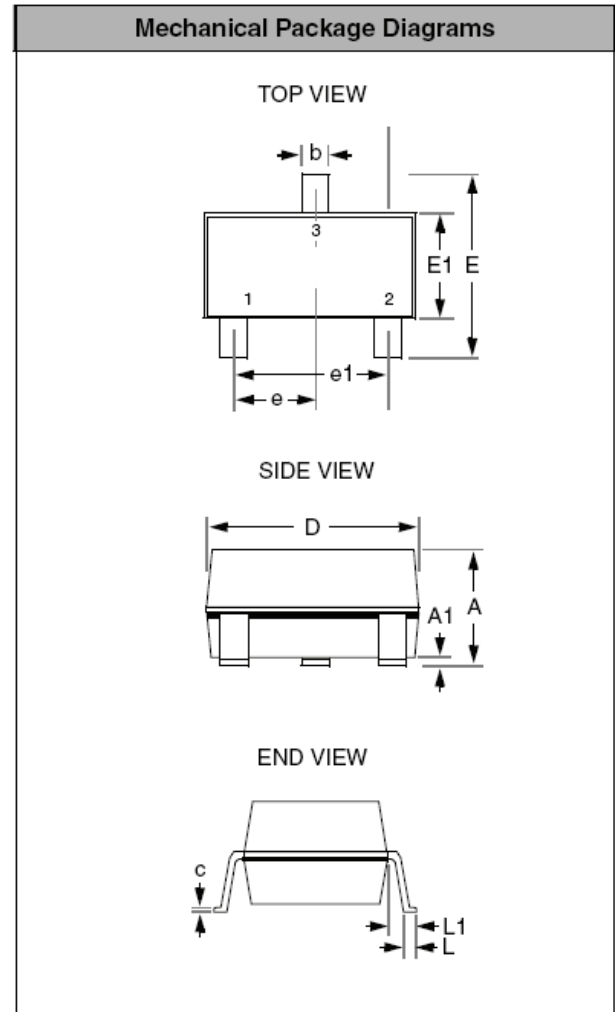
Mechanical Details

The CM1213A is available in SOT23-3, SOT143-4, and SOT23-5, SOT23-6, SC70-6, and MSOP-10 lead-free packages.

SOT23-3 Mechanical Specifications, 3 pin

The CM1213A-01SO is supplied in a 3-pin SOT23 package. Dimensions are presented below.

| PACKAGE DIMENSIONS | | | | |
|------------------------------------|--------------------------------|------|------------|--------|
| Package | SOT23-3 (JEDEC name is TO-236) | | | |
| JEDEC No. | TO-236 (Var. AB) | | | |
| Pins/Leads | 3 | | | |
| Dimensions | Millimeters | | Inches | |
| | Min | Max | Min | Max |
| A | 0.89 | 1.12 | 0.0350 | 0.0441 |
| A1 | 0.01 | 0.10 | 0.0004 | 0.0039 |
| b | 0.30 | 0.50 | 0.0118 | 0.0197 |
| c | 0.08 | 0.20 | 0.0031 | 0.0079 |
| D | 2.80 | 3.04 | 0.1102 | 0.1197 |
| E | 2.10 | 2.64 | 0.0827 | 0.1039 |
| E1 | 1.20 | 1.40 | 0.0472 | 0.0551 |
| e | 0.95 BSC | | 0.0374 BSC | |
| e1 | 1.90 BSC | | 0.0748 BSC | |
| L | 0.40 | 0.60 | 0.0157 | 0.0236 |
| L1 | 0.54 REF | | 0.0213 REF | |
| # per tape and reel | 3000 pieces | | | |
| Controlling dimension: millimeters | | | | |

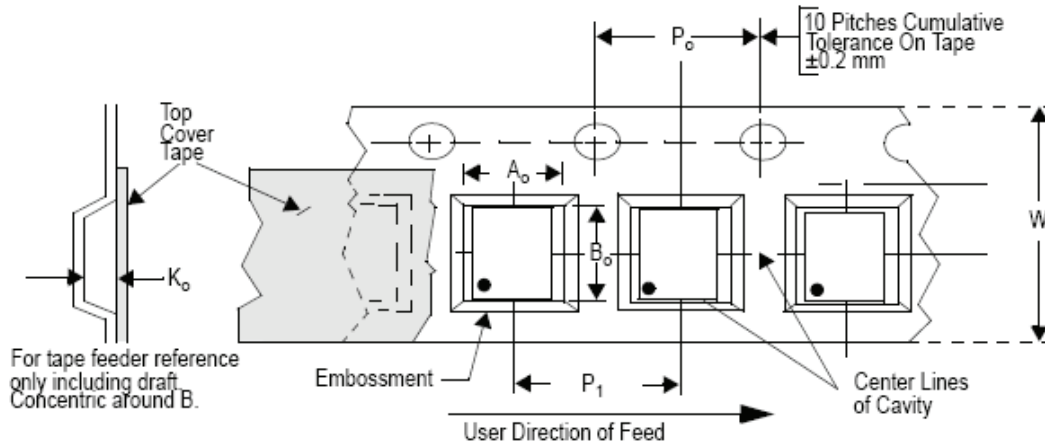


Package Dimensions for SOT23-3

CM1213A

Tape and Reel Specifications

| PART NUMBER | PACKAGE SIZE (mm) | POCKET SIZE (mm) $B_o \times A_o \times K_o$ | TAPE WIDTH W | REEL DIAMETER | QTY PER REEL | P_o | P_1 |
|--------------|--------------------|---|-----------------|---------------|--------------|-------|-------|
| CM1213A-01SO | 2.92 X 2.37 X 1.01 | 2.77 X 3.15 X 1.22 | 8mm | 178mm (7") | 3000 | 4mm | 4mm |

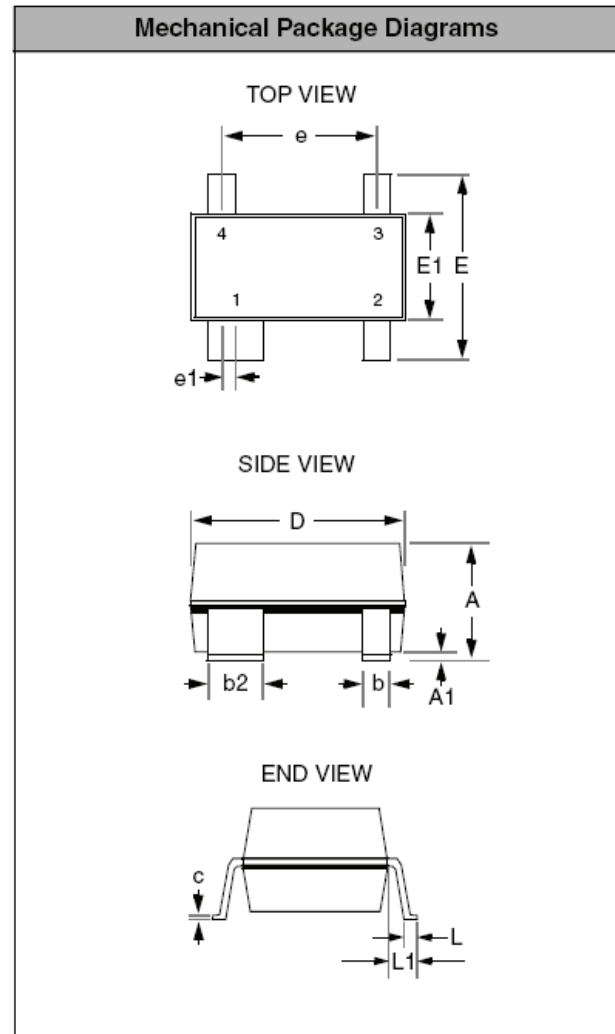


Mechanical Details (Cont'd)

SOT143-4 Mechanical Specifications, 4 pin

The CM1213A-02SR is packaged in a 4-pin SOT143 package. Dimensions are presented below.

| 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 | | | | |

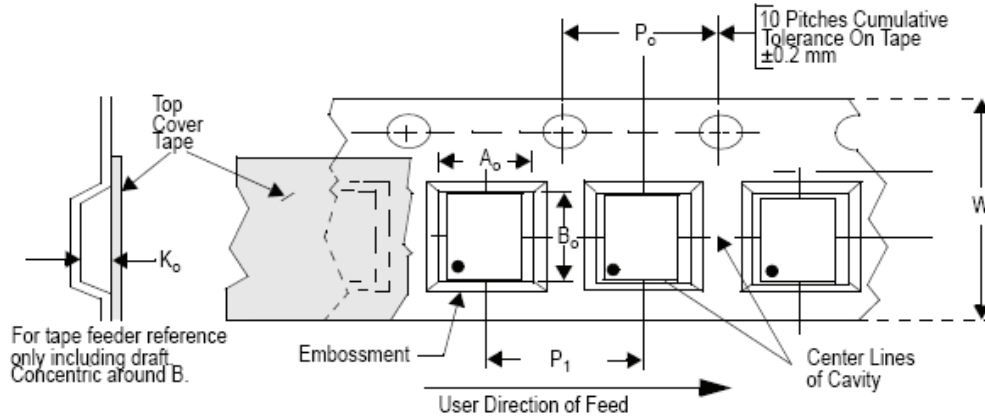


Package Dimensions for SOT143

CM1213A

Tape and Reel Specifications

| PART NUMBER | PACKAGE SIZE (mm) | POCKET SIZE (mm) $B_0 \times A_0 \times K_0$ | TAPE WIDTH W | REEL DIAMETER | QTY PER REEL | P_0 | P_1 |
|--------------|--------------------|---|-----------------|---------------|--------------|-------|-------|
| CM1213A-02SR | 2.92 X 2.37 X 1.01 | 2.60 X 3.15 X 1.20 | 8mm | 178mm (7") | 3000 | 4mm | 4mm |



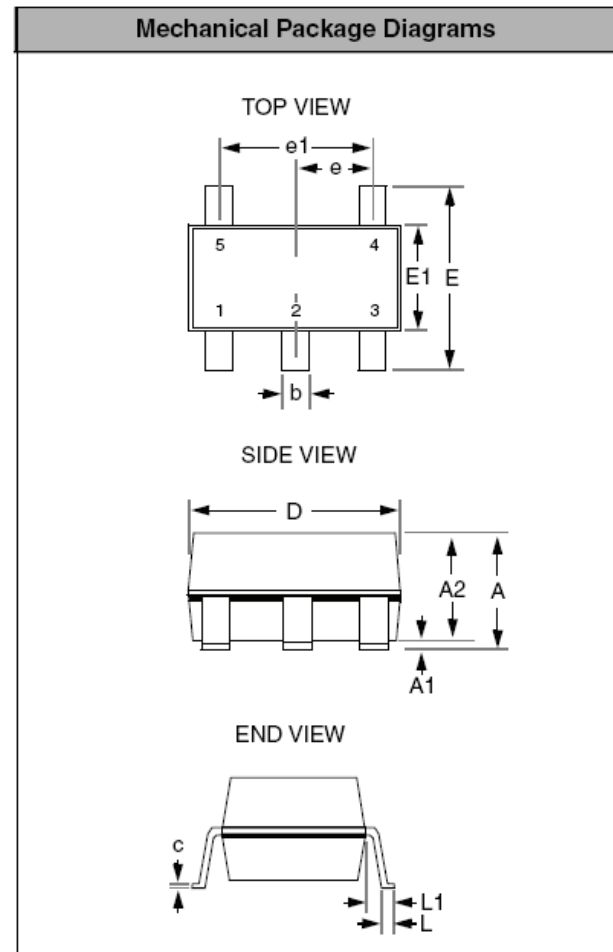
Mechanical Details (cont'd)

SOT23-5 Mechanical Specifications, 5 pin

The CM1213A-02SO is supplied in a 5-pin SOT23 package. Dimensions are presented below.

| PACKAGE DIMENSIONS | | | | | | |
|------------------------------------|------------------|------|------|-----------|-------|-------|
| Package | SOT23-5 | | | | | |
| JEDEC No. | MO-178 (Var. AA) | | | | | |
| Leads | 5 | | | | | |
| Dim. | Millimeters | | | Inches | | |
| | Min | Nom | Max | Min | Nom | Max |
| A | 1.14 | 1.24 | 1.35 | 0.045 | 0.049 | 0.053 |
| A1 | 0.05 | 0.10 | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 1.09 | 1.14 | 1.19 | 0.043 | 0.045 | 0.047 |
| b | 0.30 | 0.35 | 0.40 | 0.012 | 0.014 | 0.016 |
| c | 0.08 | 0.15 | 0.22 | 0.003 | 0.006 | 0.009 |
| D | 2.87 | 2.92 | 2.97 | 0.113 | 0.115 | 0.117 |
| E | 2.67 | 2.79 | 2.92 | 0.105 | 0.110 | 0.115 |
| E1 | 1.55 | 1.63 | 1.68 | 0.061 | 0.064 | 0.066 |
| e | 0.95 REF | | | 0.020 REF | | |
| e1 | 1.90 REF | | | 0.075 REF | | |
| L | 0.35 | 0.40 | 0.45 | 0.014 | 0.016 | 0.018 |
| L1 | 0.53 | 0.58 | 0.64 | 0.021 | 0.023 | 0.025 |
| # per tape and reel | 3000 pieces | | | | | |
| Controlling dimension: millimeters | | | | | | |

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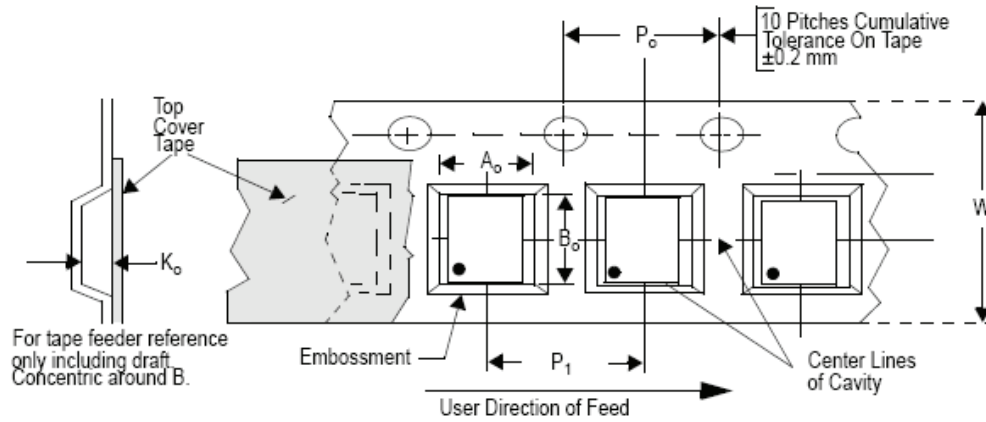


Package Dimensions for SOT23-5

CM1213A

Tape and Reel Specifications

| PART NUMBER | PACKAGE SIZE (mm) | POCKET SIZE (mm) $B_0 \times A_0 \times K_0$ | TAPE WIDTH W | REEL DIAMETER | QTY PER REEL | P_0 | P_1 |
|--------------|--------------------|---|-----------------|---------------|--------------|-------|-------|
| CM1213A-02SO | 2.92 X 2.79 X 1.24 | 3.20 X 3.20 X 1.40 | 8mm | 178mm (7") | 3000 | 4mm | 4mm |

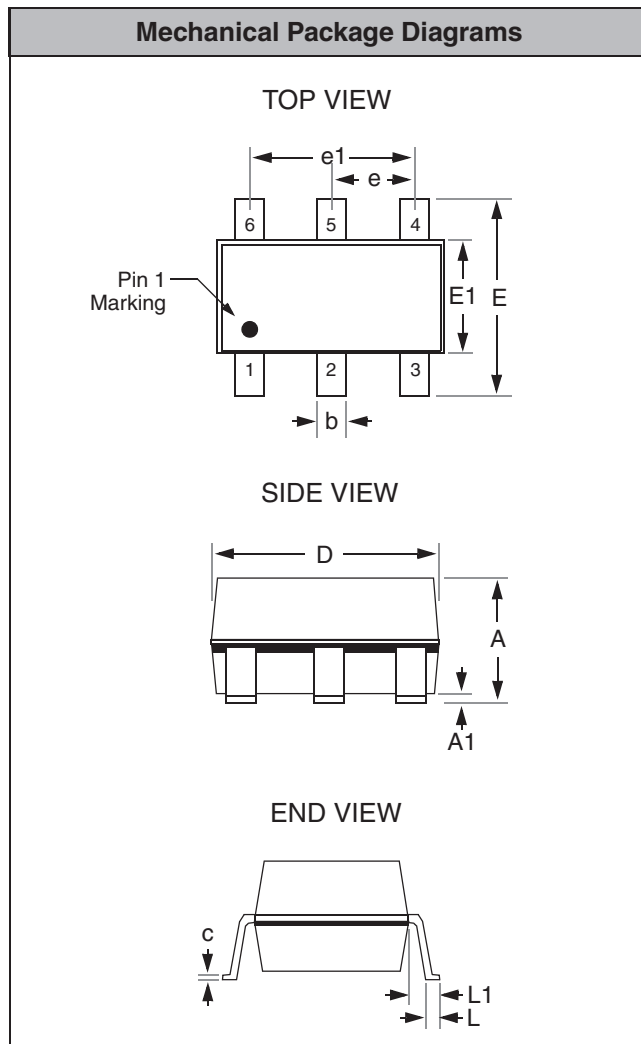


Mechanical Details (cont'd)

SOT23-6 Mechanical Specifications, 6 pin

The CM1213A-04SO is supplied in a 6-pin SOT23 package. Dimensions are presented below.

| PACKAGE DIMENSIONS | | | | |
|------------------------------------|------------------|------|------------|--------|
| Package | SOT23-6 | | | |
| JEDEC No. | MO-178 (Var. AB) | | | |
| Pins/Leads | 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 | | 0.0236REF | |
| # per tape and reel | 3000 pieces | | | |
| Controlling dimension: millimeters | | | | |

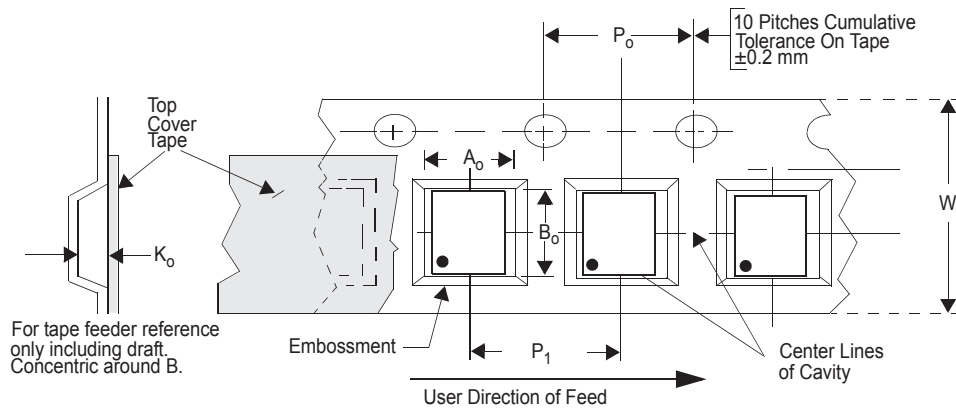


Package Dimensions for SOT23-6

CM1213A

Tape and Reel Specifications

| PART NUMBER | PACKAGE SIZE (mm) | POCKET SIZE (mm) $B_0 \times A_0 \times K_0$ | TAPE WIDTH W | REEL DIAMETER | QTY PER REEL | P_0 | P_1 |
|--------------|--------------------|---|-----------------|---------------|--------------|-------|-------|
| CM1213A-04SO | 2.90 X 2.80 X 1.45 | 2.60 X 3.15 X 1.20 | 8mm | 178mm (7") | 3000 | 4mm | 4mm |

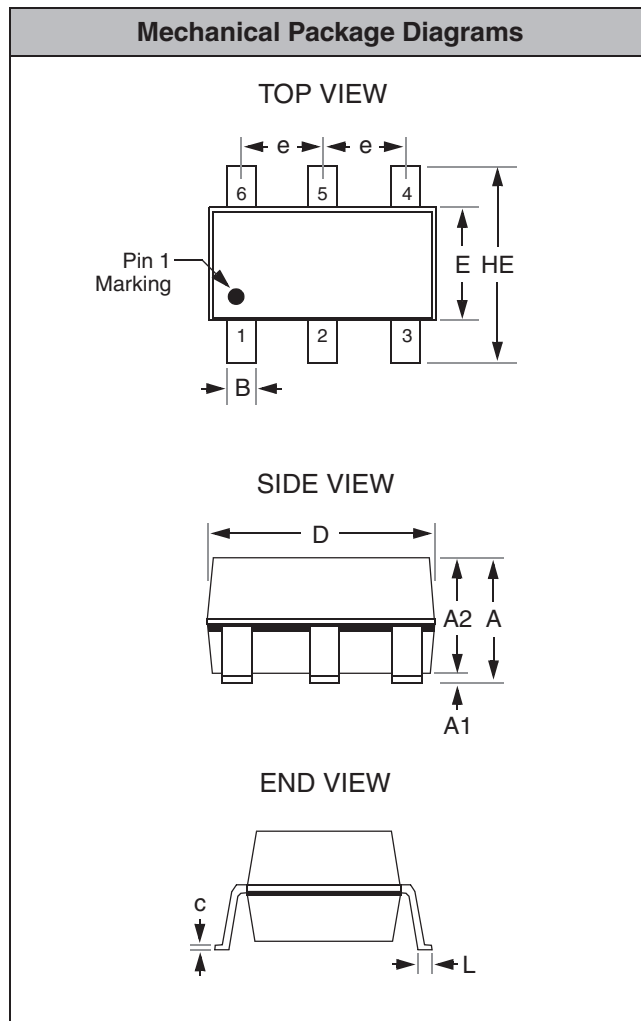


Mechanical Details (cont'd)

SC70-6 Mechanical Specifications, 6 pin

The CM1213A-04S7 is supplied in a 6-pin SC70 package. Dimensions are presented below.

| PACKAGE DIMENSIONS | | |
|------------------------------------|--|------|
| Package | SC70-6 (JEDEC name is MO-203 Issue A) | |
| Pins | 6 | |
| Dimensions | Millimeters | |
| | Min | Max |
| A | 0.80 | 1.10 |
| A1 | 0.00 | 0.10 |
| A2 | 0.70 | 1.00 |
| B | 0.15 | 0.30 |
| c | 0.08 | 0.25 |
| D | 1.85 | 2.25 |
| E | 1.15 | 1.35 |
| e | 0.65 BSC | |
| HE | 2.00 | 2.40 |
| L | 0.26 | 0.46 |
| # per tape and reel | 3000 pieces | |
| Controlling dimension: millimeters | | |

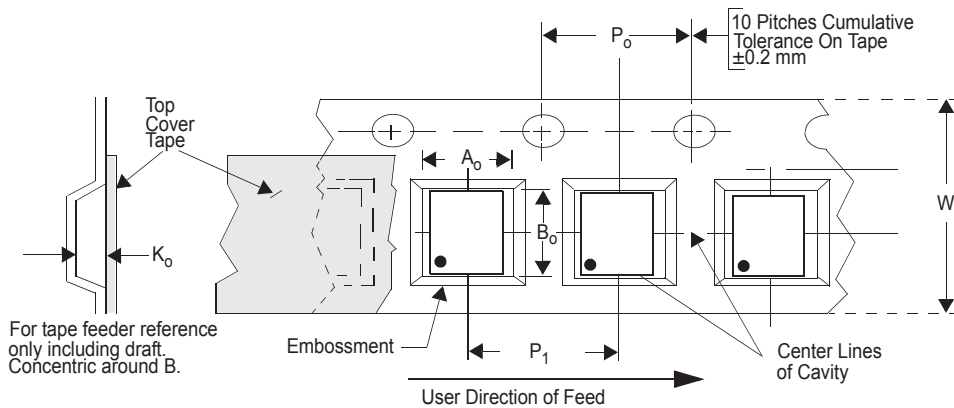


Package Dimensions for SC70-6

CM1213A

Tape and Reel Specifications

| PART NUMBER | PACKAGE SIZE (mm) | POCKET SIZE (mm) $B_0 \times A_0 \times K_0$ | TAPE WIDTH W | REEL DIAMETER | QTY PER REEL | P_0 | P_1 |
|--------------|--------------------|---|-----------------|---------------|--------------|-------|-------|
| CM1213A-04S7 | 2.05 X 1.25 X 0.95 | 2.40 X 2.25 X 1.20 | 8mm | 178mm (7") | 3000 | 4mm | 4mm |

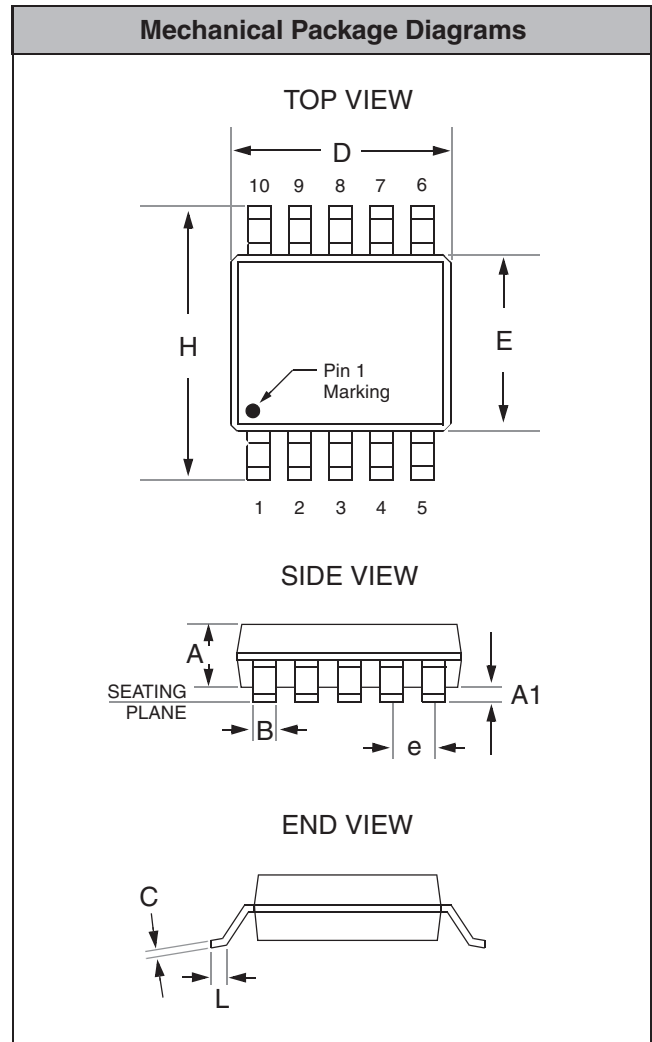


Mechanical Details (cont'd)

MSOP-10 Mechanical Specifications, 10 pin

The CM1213A-04MR is supplied in a 10-lead 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 | | | | |

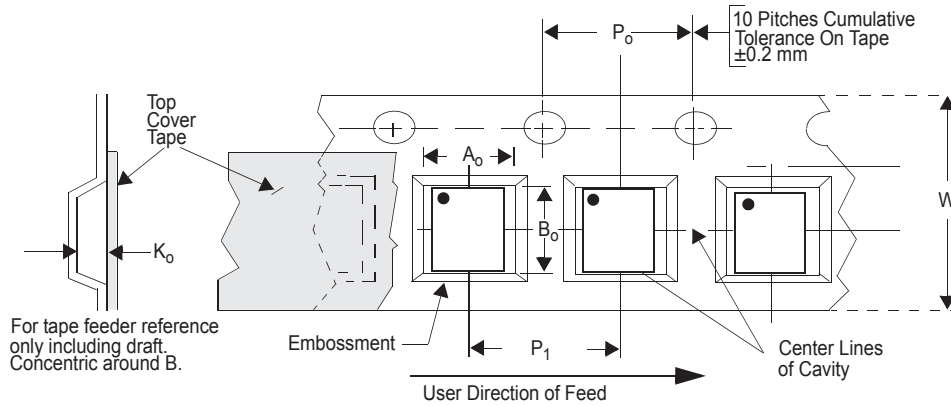



Package Dimensions for MSOP-10

CM1213A

Tape and Reel Specifications

| PART NUMBER | PACKAGE SIZE (mm) | POCKET SIZE (mm) $B_0 \times A_0 \times K_0$ | TAPE WIDTH W | REEL DIAMETER | QTY PER REEL | P_0 | P_1 |
|--------------|--------------------|---|-------------------|---------------|--------------|-------|-------|
| CM1213A-04MR | 3.00 X 3.00 X 0.85 | 3.30 X 5.30 X 1.30 | 8mm | 330mm (13") | 4000 | 4mm | 8mm |



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