

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

### Features

- 1, 2, and 4 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
- SOT packages
- Lead-free versions available

### 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

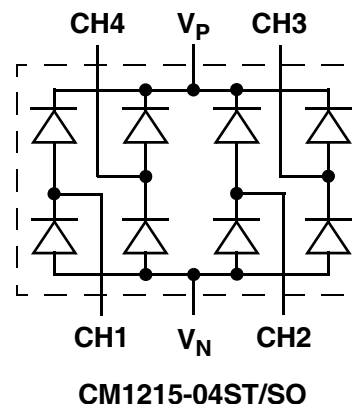
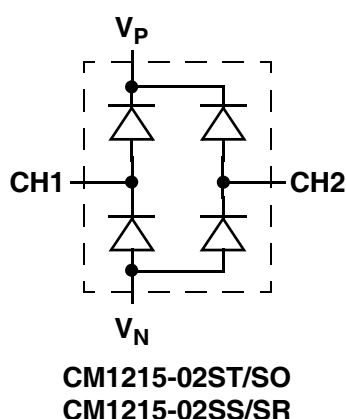
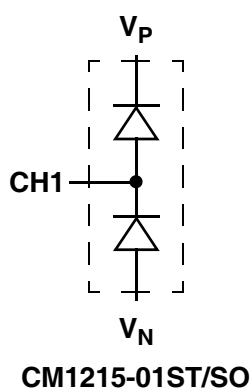
### Product Description

The CM1215 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. The CM1215 will protect against ESD pulses up to  $\pm 15$  kV per the IEC 61000-4-2 standard.

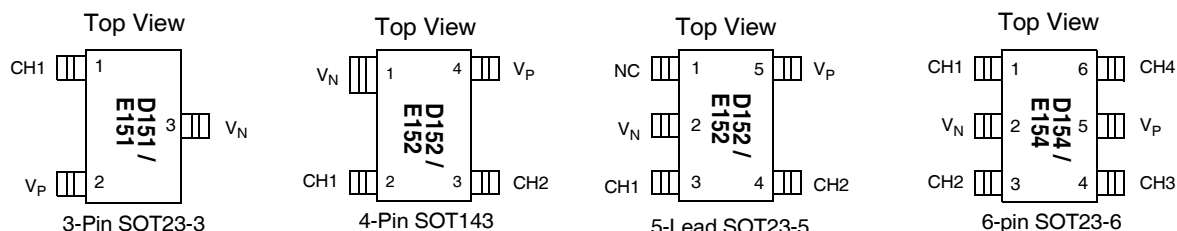
This device is particularly well-suited for protecting systems using high-speed ports such as USB2.0, IEEE1394 (Firewire®, iLink™), Serial ATA, DVI, HDMI and corresponding ports in removable storage, digital camcorders, DVD-RW drives and other applications where extremely low loading capacitance with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

The CM1215 family of devices is available with optional lead-free finishing.

### Simplified Electrical Schematic



# PACKAGE / PINOUT DIAGRAM



Note: These drawings are not to scale.

## Pin Configuration

### PACKAGE PIN DESCRIPTIONS

PIN NAMES	SOT23-3	SOT143	SOT23-5	SOT23-6	TYPE	DESCRIPTION
	PIN NO.	PIN NO.	PIN NO.	PIN NO.		
CH1	1	2	3	1	I/O	ESD Channel
V <sub>N</sub>	3	1	2	2	GND	Negative voltage supply rail
CH2	–	3	4	3	I/O	ESD Channel
CH3	–	–	–	4	I/O	ESD Channel
V <sub>P</sub>	2	4	5	5	PWR	Positive voltage supply rail
CH4	–	–	–	6	I/O	ESD Channel
N/C	–	–	1	–	–	No Connection

## Ordering Information

### PART NUMBERING INFORMATION

Pins	Package	Standard Finish		Lead-free Finish	
		Ordering Part Number <sup>1</sup>	Part Marking	Ordering Part Number <sup>1</sup>	Part Marking
3	SOT23-3	CM1215-01ST	D151	CM1215-01SO	E151
4	SOT143	CM1215-02SS	D152	CM1215-02SR	E152
5	SOT23-5	CM1215-02ST	D152	CM1215-02SO	E152
6	SOT23-6	CM1215-04ST	D154	CM1215-04SO	E154

## 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 CONDITIONS		
PARAMETER	RATING	UNITS
Temperature Range (Ambient)	-40 to +85	°C
Package Power Rating		
SOT23-3 Package (CM1215-01ST/SO)	225	mW
SOT143 Package (CM1215-02SS/SR)	225	mW
SOT23-5 Package (CM1215-02ST/SO)	225	mW
SOT23-6 Package (CM1215-04ST/SO)	225	mW

**Specifications (cont'd)**

<b>ELECTRICAL OPERATING CHARACTERISTICS</b> NOTE 1						
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 Top Diode Bottom Diode	$I_F$ = 20mA; $T_A$ = 25°C	0.6 0.6	0.8 0.8	0.95 0.95	V V
$I_{LEAK}$	Channel Leakage Current	$T_A$ = 25°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; Note2		1.6	2.0	pF
$\Delta C_{IN}$	Channel I/O to GND Capacitance Difference	Note 2		0.04		pF
$C_{MUTUAL}$	Mutual Capacitance	$(V_P$ - $V_N$ ) = 3.3V; Note 2		0.13		pF
$V_{ESD}$	ESD Protection 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°C	$\pm 15$			kV
$V_{CL}$	Channel Clamp Voltage Positive Transients Negative Transients	$I_{PP}$ = 1A, $t_P$ = 8/20 $\mu$ S; $T_A$ = 25°C; Notes 2		$V_P$ +1.5 $V_N$ -1.5		V V
$R_{DYN}$	Dynamic Resistance Positive transients Negative transients	$I_{PP}$ = 1A, $t_P$ = 8/20 $\mu$ S; $T_A$ = 25°C; Notes 2		0.4 0.4		$\Omega$ $\Omega$

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

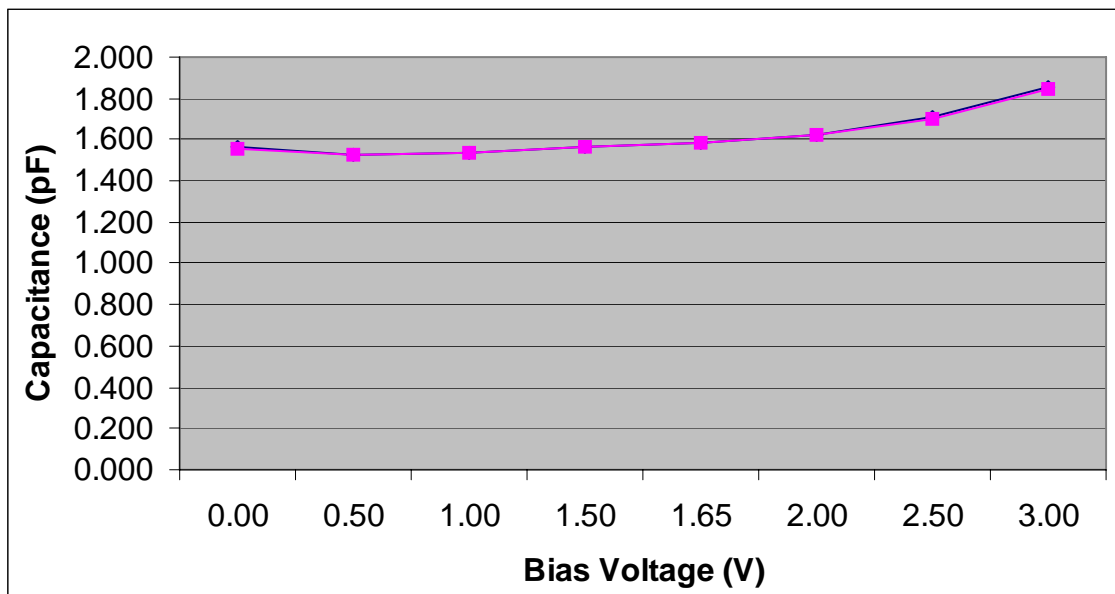
Note 2: These parameters guaranteed by design and characterization.

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

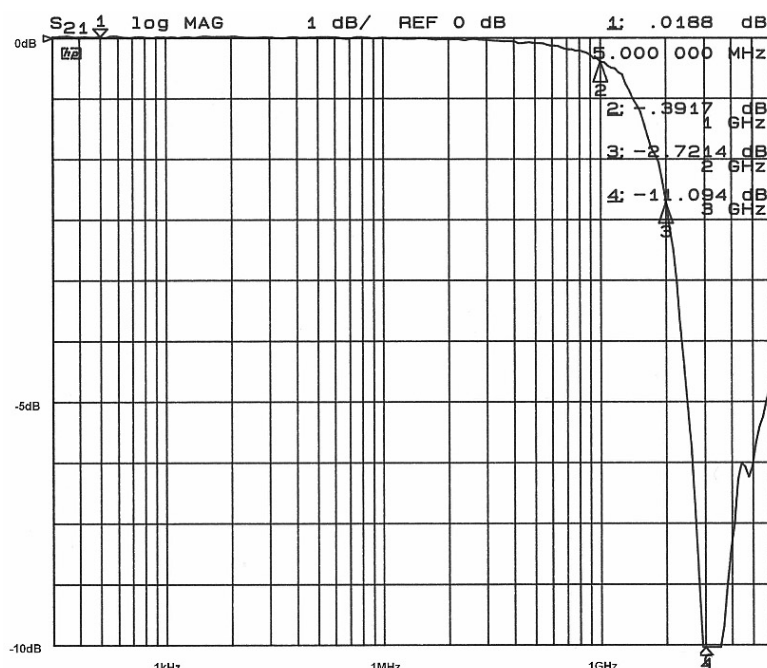
Note 4: From I/O pins to  $V_P$  or  $V_N$  only.  $V_P$  bypassed to  $V_N$  with low ESR 0.2 $\mu$ F ceramic capacitor.

## Performance Characteristics

### Input Channel Capacitance Performance Curve



**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  $V_N$ ,  $T_A = 25^\circ\text{C}$ )



**Figure 2. Typical Filter Performance (nominal conditions unless specified otherwise, 50 Ohm Environment)**

## 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:

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

where IESD is the ESD current pulse, and VSUPPLY is the positive supply voltage.

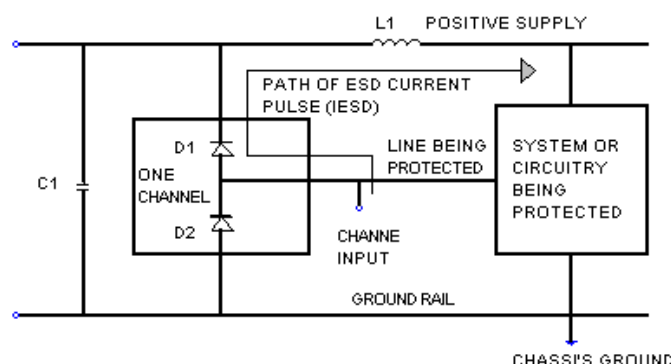
An ESD current pulse can rise from zero to its peak value in a very short time. As an example, a level 4 contact discharge per the IEC61000-4-2 standard results in a current pulse that rises from zero to 30 Amps in 1ns. Here d(IESD)/dt can be approximated by d(IESD)/dt, or 30/(1x10<sup>-9</sup>). So 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 3. Application of Positive ESD Pulse between Input Channel and Ground**

## Mechanical Details

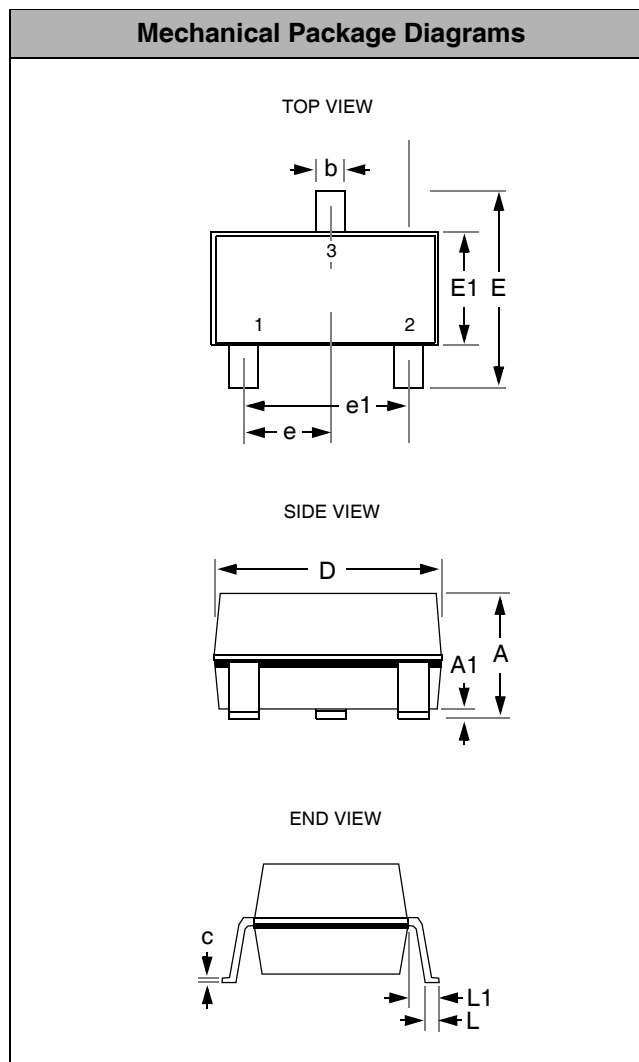
The CM1215 is supplied in SOT23-3, SOT143-4, SOT23-5 and SOT23-6 packages with a lead-free finishing option. These package drawings are presented on the following pages.

### SOT23-3 Mechanical Specifications

CM1215-01ST/SO devices are packaged in 3-pin SOT23 packages. Dimensions are presented below.

For complete information on the SOT23-3 package, see the California Micro Devices SOT23 Package Information document.

PACKAGE DIMENSIONS				
Package	SOT23-3 (JEDEC name is TO-236)			
Pins	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.

## Mechanical Details (cont'd)

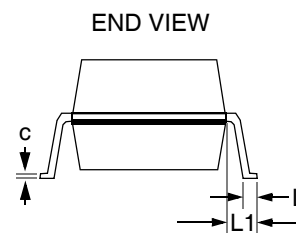
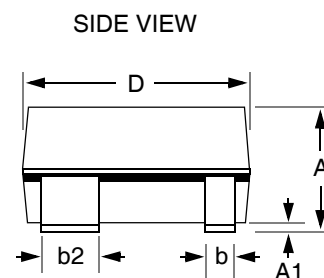
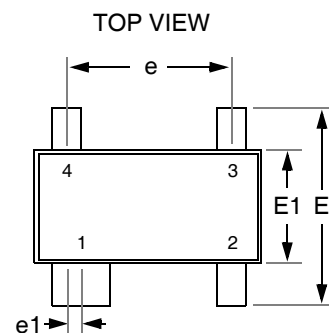
### SOT143 Mechanical Specifications

CM1215-02SS/SR devices are supplied in 4-pin SOT143 packages. Dimensions are presented below.

For complete information on the SOT143 package, 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				

### Mechanical Package Diagrams



**Package Dimensions for SOT143.**



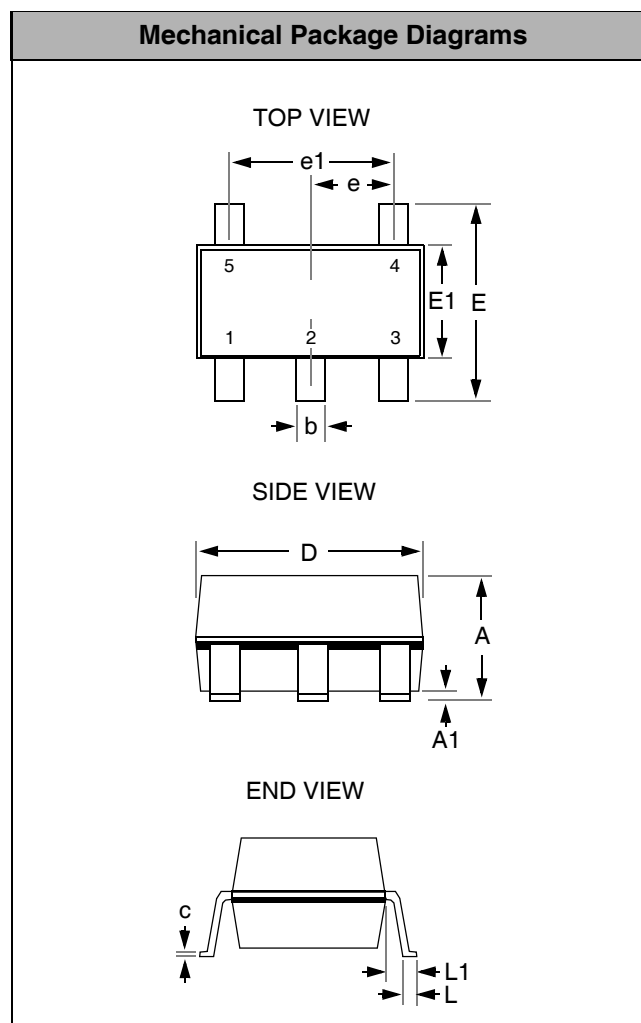
## Mechanical Details (cont'd)

### SOT23-5 Mechanical Specifications

CM1215-02ST/SO devices are supplied in 5-pin SOT23 packages. Dimensions 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				



**Package Dimensions for SOT23-5.**

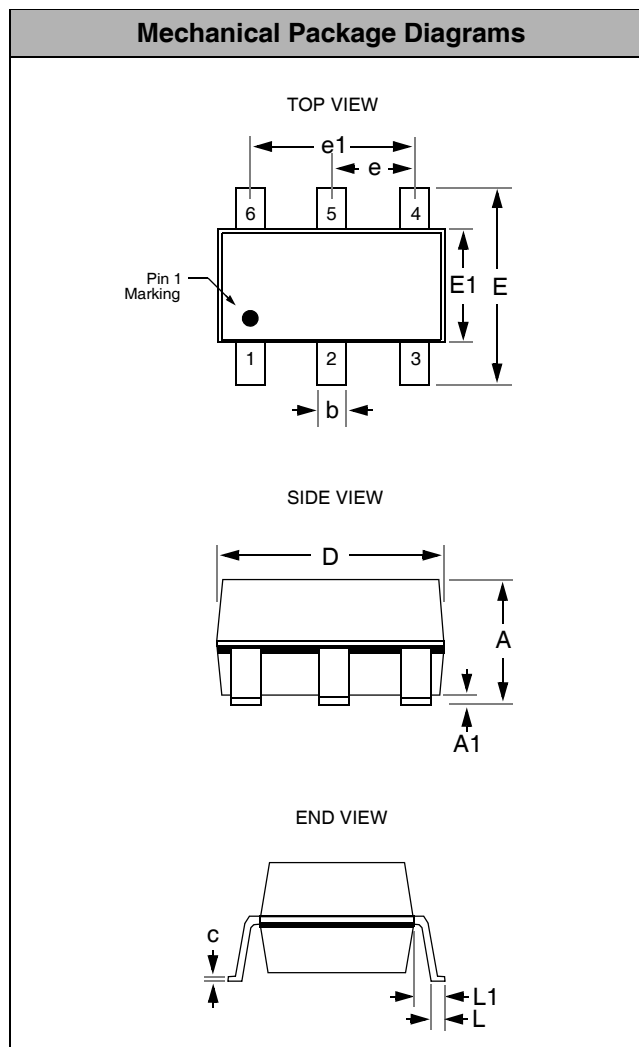
## Mechanical Details (cont'd)

### SOT23-6 Mechanical Specifications

CM1215-04ST/SO devices are supplied 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.**