1, 2, 4 and 8-Channel Very Low Capacitance ESD Protectors

Features

- 1,2,4 and 8 channels of ESD protection
- Very low loading capacitance (1.0pF typical)
- ±6 kV ESD protection per channel (IEC 61000-4-2 standard)
- Available in SOT23, SOT143, SC70 and MSOP packages
- Lead-free versions available

Applications

- USB2.0 ports at 480Mbps
- IEEE1394 Firewire ports at 400Mbps
- Gigabit Ethernet ports
- Flat panel display interfaces
- Wireless antennas
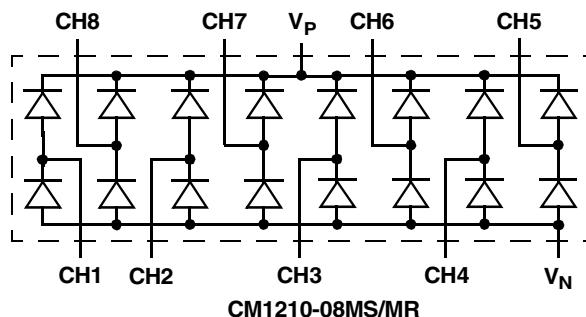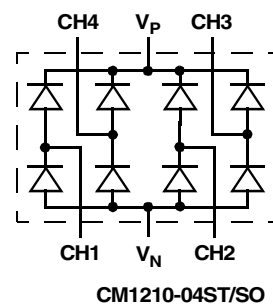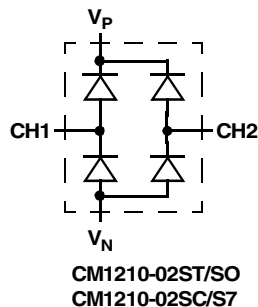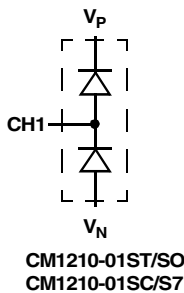- General purpose high-speed data line ESD protection

Product Description

The CM1210 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 which will steer the ESD current pulse to either the positive (V_P) or negative (V_N) supply rail. The CM1210 will protect against ESD pulses up to ±6KV per the IEC 61000-4-2 standard.

This device is particularly well-suited for systems using high-speed port implementations such as USB2.0, IEEE1394 (Firewire®, i.Link™), Gigabit Ethernet 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.
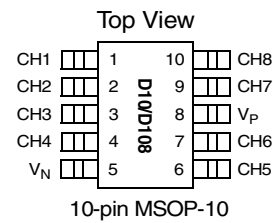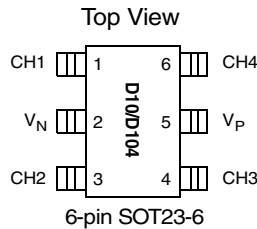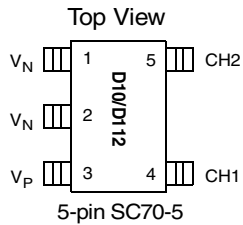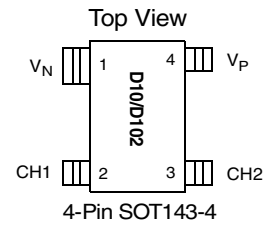
The CM1210 family of devices is optionally available with lead-free finishing.

Electrical Schematics

CM1210-01ST/SO
CM1210-01SC/S7

CM1210-02ST/SO
CM1210-02SC/S7

CM1210-04ST/SO

CM1210-08MS/MR

PACKAGE / PINOUT DIAGRAMS

Top View

CH1 — 1
D10/D101
V_P — 2
3 — V_N

3-Pin SOT23-3

Top View

CH1 — 1
D10/D111
V_P — 2
3 — V_N

3-Pin SC70-3

Top View

V_N — 1   4 — V_P
D10/D102
CH1 — 2   3 — CH2

4-Pin SOT143-4

Top View

V_N — 1   5 — CH2
V_N — 2
D10/D12
V_P — 3   4 — CH1

5-pin SC70-5

Top View

CH1 — 1   6 — CH4
V_N — 2   5 — V_P
D10/D104
CH2 — 3   4 — CH3

6-pin SOT23-6

Top View

CH1 — 1   10 — CH8
CH2 — 2   9 — CH7
CH3 — 3   8 — V_P
CH4 — 4   7 — CH6
V_N — 5   6 — CH5
D10/D108

10-pin MSOP-10
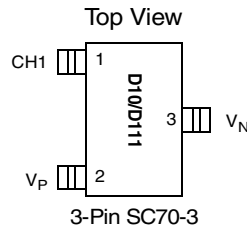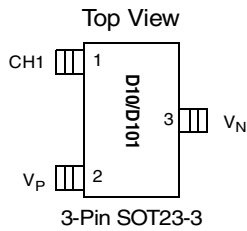
Note: These drawings are not to scale.

SOT23-3 & SC70-3 PACKAGE PIN DESCRIPTIONS

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

SC70-5 PACKAGE PIN DESCRIPTIONS

PIN	NAME	TYPE	DESCRIPTION
1	V_N	GND	Negative voltage supply rail
2	V_N	GND	Negative voltage supply rail
3	V_P	PWR	Positive voltage supply rail
4	CH1	I/O	ESD Channel
5	CH2	I/O	ESD Channel

SOT23-6 PACKAGE PIN DESCRIPTIONS

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

SOT143-4 PACKAGE PIN DESCRIPTIONS

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

MSOP-10 PACKAGE PIN DESCRIPTIONS

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_N	GND	Negative voltage supply rail
6	CH5	I/O	ESD Channel
7	CH6	I/O	ESD Channel
8	V_P	PWR	Positive 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	
Pins	Package	Ordering Part Number[1]	Part Marking	Ordering Part Number[1]	Part Marking
3	SOT23-3	CM1210-01ST	D10	CM1210-01SO	D101
3	SC70-3	CM1210-01SC	D10	CM1210-01S7	D111
4	SOT143-4	CM1210-02ST	D10	CM1210-02SO	D102
5	SC70-5	CM1210-02SC	D10	CM1210-02S7	D112
6	SOT23-6	CM1210-04ST	D10	CM1210-04SO	D104
10	MSOP-10	CM1210-08MS	D10	CM1210-08MR	D108

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

Specifications

ABSOLUTE MAXIMUM RATINGS		
PARAMETER	RATING	UNITS
Supply Voltage (V_P - V_N)	8.0	V
Diode Forward DC Current (Note 1)	8	mA
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

Package Power Rating
   SOT23-3 Package (CM1210-01ST/SO)
   SC70-3 Package (CM1210-01SC/S7)
   SOT143 Package (CM1210-02ST/SO)
   SC70-5 Package (CM1210-02SC/S7)
   SOT23-6 Package (CM1210-04ST/SO)
   MSOP10 Package (CM1210-08MS/MR)
	
	225
	200
	225
	200
	225
	400
		
		mW
		mW
		mW
		mW
		mW
		mW

Note 1: Only one diode conducting at a time.

STANDARD OPERATING CONDITIONS		
PARAMETER	RATING	UNITS
Operating Temperature Range	-40 to +85	°C
Operating Supply Voltage (V_P - V_N)	0 to 5.5	V

	ELECTRICAL OPERATING CHARACTERISTICS (SEE NOTE 1)					
SYMBOL	**PARAMETER**	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**UNITS**
I_P	Supply Current	(V_P-V_N)=3.3V			8.0	µA

V_F	Diode Forward Voltage
	    Top Diode
	    Bottom Diode
		I_F = 8mA	0.60
			0.60
				0.80
				0.80
					0.95
					0.95
						V
						V

I_{LEAK}	Channel Leakage Current			±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 applies		1.0	1.3	pF

V_{ESD}	ESD Protection
	    Peak Discharge Voltage at any channel input, in system
	    a) Contact discharge per IEC 61000-4-2 standard
		Notes 2,3 and 5; T_A=25°C	6			kV

V_{CL}	Channel Clamp Voltage
	CM1210-01ST, CM1210-01SC,
	CM1210-02ST, CM1210-02SC
	    Positive Transients
	    Negative Transients
		At 8kV ESD HBM; Notes 2 & 4			V_P + 10.0
					V_N - 10.0
						V
						V

	Channel Clamp Voltage
	CM1210-04ST, CM1210-08MS
	    Positive Transients
	    Negative Transients
		At 8kV ESD HBM; Notes 2 & 4			V_P + 13.0
					V_N - 13.0
						V
						V

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: From I/O pins to V_P or V_N only. V_P bypassed to V_N with a 0.22µF ceramic capacitor (see Application Information for more details).
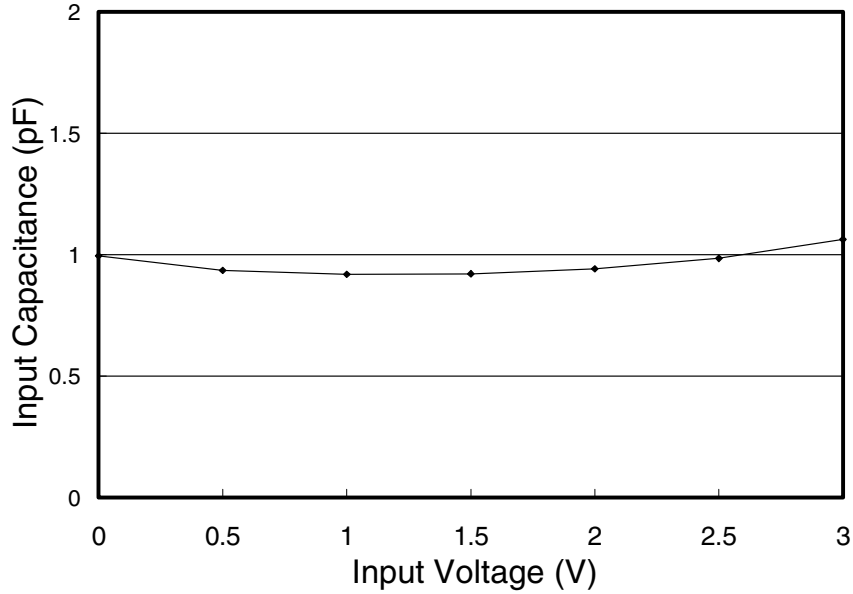
Note 4: Human Body Model per MIL-STD-883, Method 3015, $C_{Discharge}$ = 100pF, $R_{Discharge}$ = 1.5KΩ, V_P = 3.3V, V_N grounded.

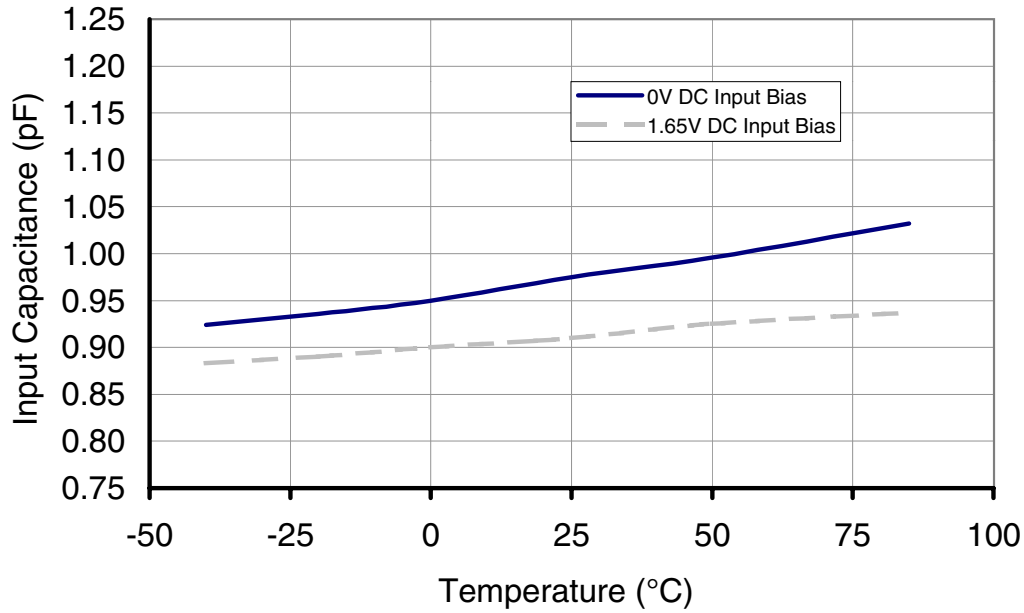Note 5: Standard IEC 61000-4-2 with $C_{Discharge}$ = 150pF, $R_{Discharge}$ = 330Ω, V_P = 3.3V, V_N grounded.

Performance Information

Input Channel Capacitance Performance Curves

Typical Variation of C_{IN} vs. V_{IN}

(f=1MHz, V_P = 3.3V, V_N = 0V, 0.1 µF chip capacitor between V_P and V_N, 25°C)

Typical Variation of C_{IN} vs. Temp

(f=1MHz, V_{IN}=30mV, V_P = 3.3V, V_N = 0V,
0.1 µF chip capacitor between V_P and V_N)

Performance Information (Cont'd)

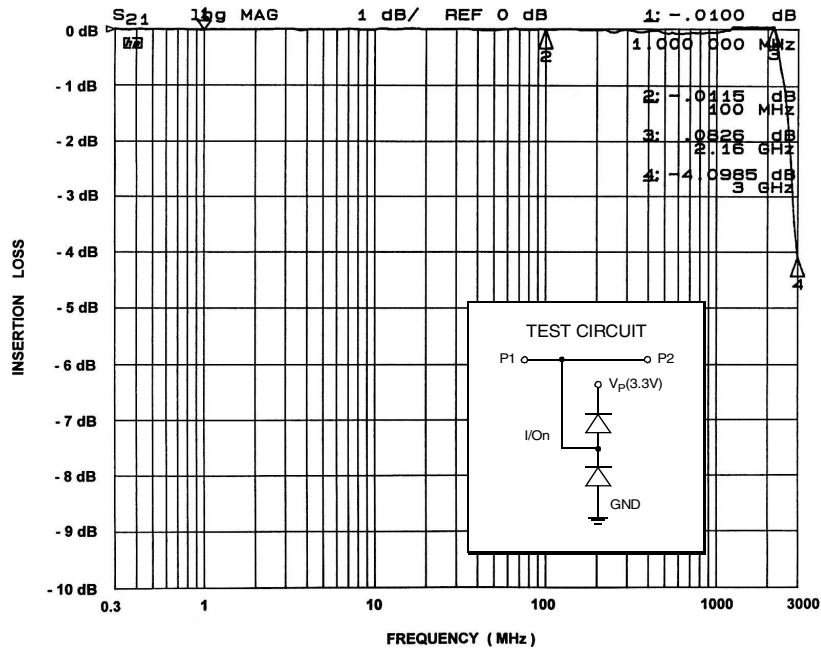**Typical Filter Performance (nominal conditions unless specified otherwise, 50 Ohm Environment)**

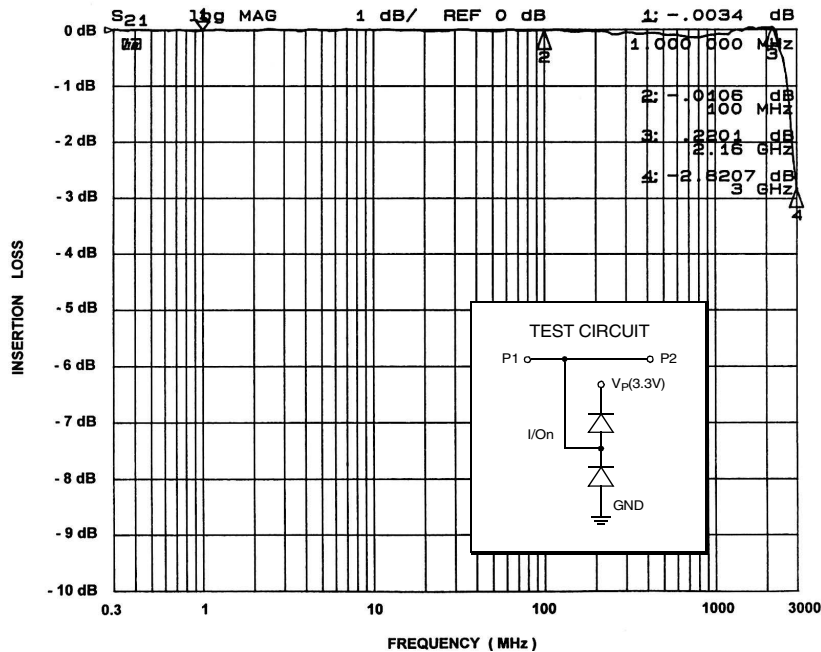**Figure 1. Insertion Loss (S21) VS. Frequency (0V DC Bias, V_P=3.3V)**

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 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:

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

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 $30/(1\times10^{-9})$. So just 910nH 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.

Another consideration is the output impedance of the power supply for fast transient currents. Most power supplies exhibit a much higher output impedance to fast transient current spikes. In the V_{CL} equation above, the V_{SUPPLY} term, in reality, is given by ($V_{DC} + I_{ESD} \times R_{OUT}$), where V_{DC} and R_{OUT} are the nominal supply DC output voltage and effective output impedance of the power supply respectively. As an example,

a R_{OUT} of 1 ohm would result in a 10V increment in V_{CL} for a peak I_{ESD} of 10A.

If the inductances and resistance described above are close to zero, the rail-clamp ESD protection diodes will do a good job of protection. However, since this is not possible in practical situations, a bypass capacitor must be used to absorb the very high frequency ESD energy. So for any brand of rail-clamp ESD protection diodes, a bypass capacitor should be connected between the V_P pin of the diodes and the ground plane (V_N pin of the diodes) as shown in the Application Circuit diagram below. A value of 0.22µF is adequate. Ceramic chip capacitors mounted with short printed circuit board traces are good choices for this application. Electrolytic capacitors should be avoided as they have poor high frequency characteristics. For extra protection, connect a zener diode in parallel with the bypass capacitor to mitigate the effects of the parasitic series inductance inherent in the capacitor. The breakdown voltage of the zener diode should be slightly higher than the maximum supply voltage.

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 Notes AP209, "Design Considerations for ESD Protection" and APxxx, "ESD Protection for USB 2.0 Systems".
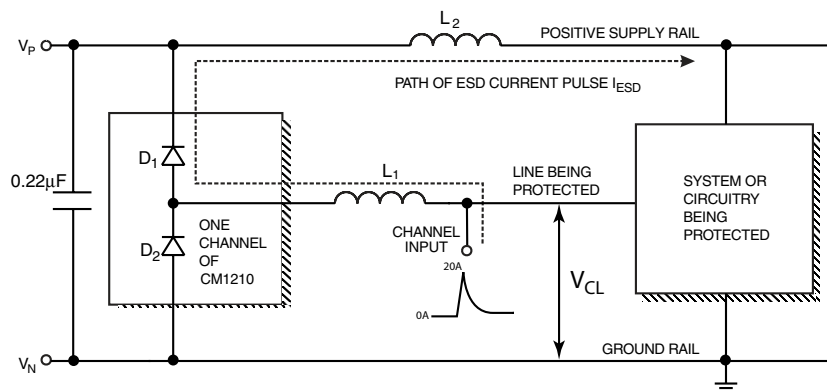

Figure 3. Application of Positive ESD Pulse between Input Channel and Ground
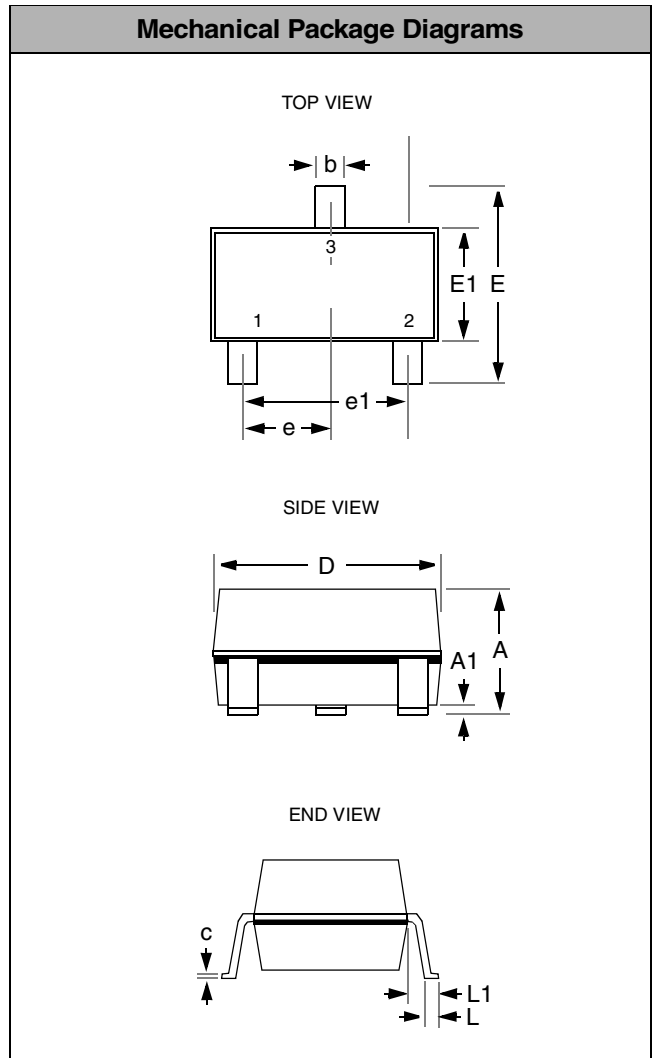
Mechanical Details

The CM1210 is available in SOT23-3, SC70-3, SC70-5, SOT23-6, SOT143-4 and MSOP-10 packages.The various package drawings are presented below.

SOT23-3 Mechanical Specifications

Dimensions for CM1210 devices packaged in 3-pin SOT23 packages 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				

Mechanical Package Diagrams

TOP VIEW

SIDE VIEW

END VIEW
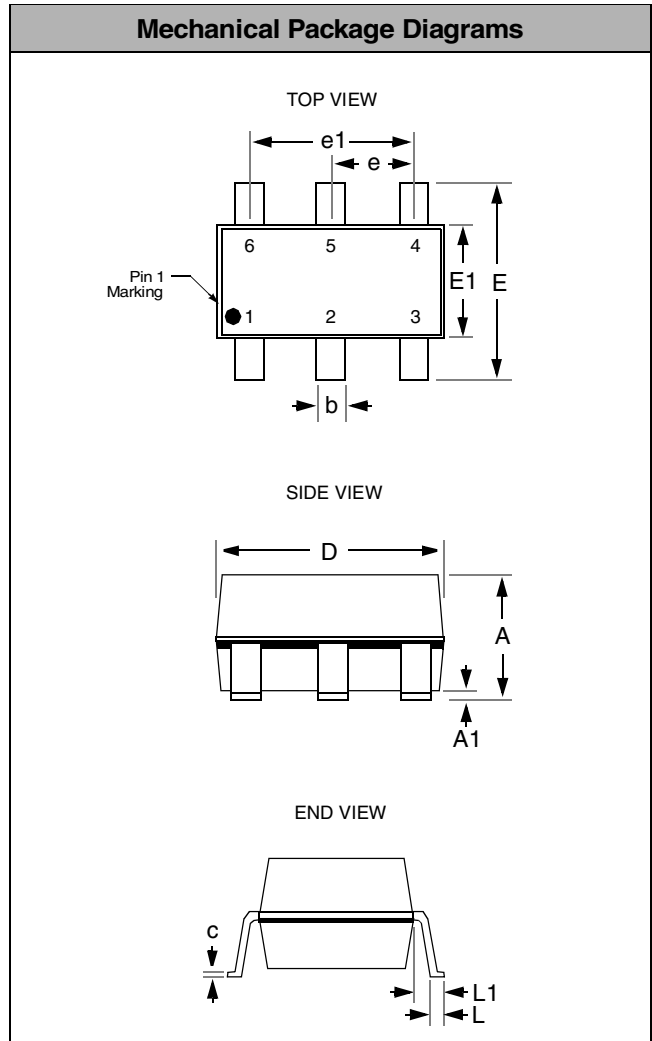
Package Dimensions for SOT23-3.

Mechanical Details (cont'd)

SOT23-6 Mechanical Specifications

CM1210 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				

Mechanical Package Diagrams

TOP VIEW

SIDE VIEW

END VIEW
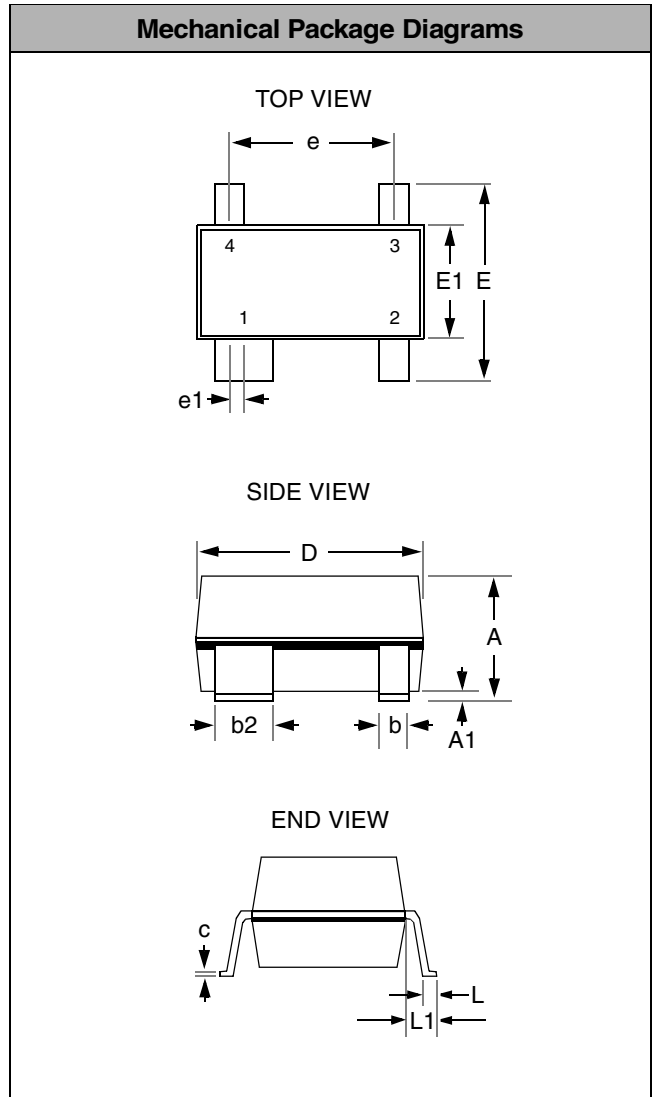
Package Dimensions for SOT23-6.

Mechanical Details (cont'd)

SOT143 Mechanical Specifications

Dimensions for CM1210 devices packaged in 4-pin SOT143 packages 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

TOP VIEW

SIDE VIEW

END VIEW
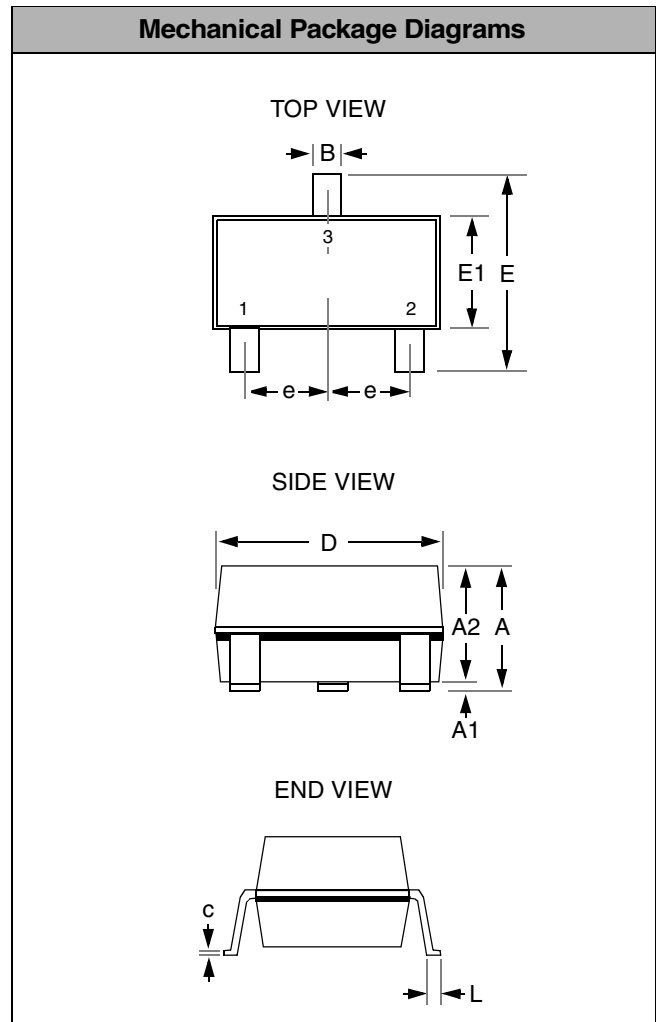
Package Dimensions for SOT143.

Mechanical Details (cont'd)

SC70-3 Mechanical Specifications

Dimensions for CM1210 devices packaged in 3-pin SC70 packages are presented below.

For complete information on the SC70-3 package, see the California Micro Devices SC70 Package Information document.

PACKAGE DIMENSIONS		
Package	SC70-3 (JEDEC name is MO-203 Issue A)	
Pins	3	
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
E1	1.15	1.35
e	0.65 BSC	
E	2.00	2.40
L	0.26	0.46
# / tape and reel	3000 pieces	

Mechanical Package Diagrams

TOP VIEW

SIDE VIEW

END VIEW
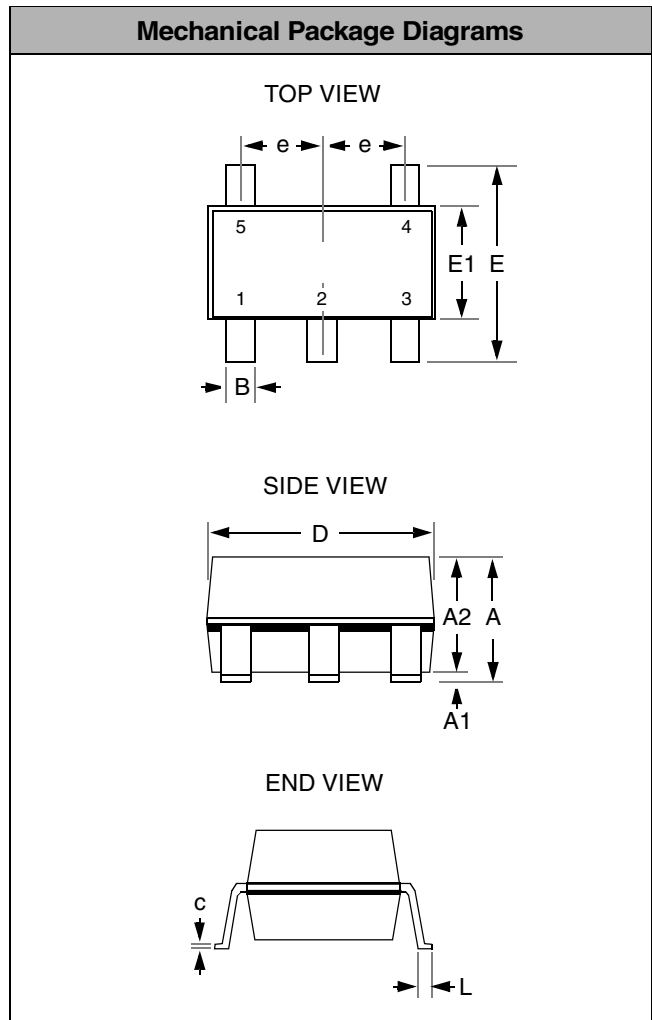
Package Dimensions for SC70-3.

Mechanical Details (cont'd)

SC70-5 Mechanical Specifications:

Dimensions for CM1210 devices packaged in 5-pin SC70 packages are presented below.

For complete information on the SC70-5 package, see the California Micro Devices SC70 Package Information document.

PACKAGE DIMENSIONS		
Package	SC70-5 (JEDEC name is MO-203 Issue A)	
Pins	5	
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
E1	1.15	1.35
e	0.65 BSC	
E	2.00	2.40
L	0.26	0.46
# / tape and reel	3000 pieces	

Mechanical Package Diagrams

TOP VIEW

SIDE VIEW

END VIEW

Package Dimensions for SC70-5.
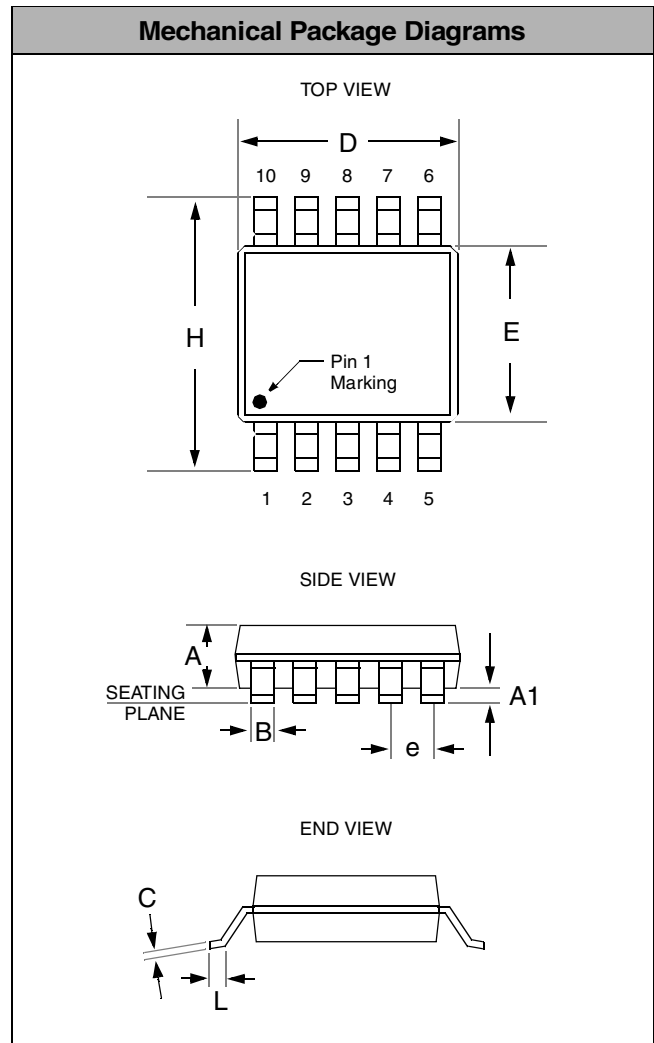
Mechanical Details (cont'd)

MSOP Mechanical Specifications

CM1210 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 tube	80 pieces*			
# per tape and reel	4000			
Controlling dimension: inches				

* This is an approximate number which may vary.

Mechanical Package Diagrams

Package Dimensions for MSOP-10