

# CM1213A

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

### 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 8 kV 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<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.

### 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
  - ♦  $\pm 8$  kV Contact Discharge
- Low Channel Input Capacitance of 0.85 pF Typical
- Minimal Capacitance Change with Temperature and Voltage
- Channel Input Capacitance Matching of 0.02 pF 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\*
- These Devices are Pb-Free and are RoHS Compliant

### Applications

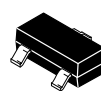
- USB2.0 Ports at 480 Mbps in Desktop PCs, Notebooks and Peripherals
- IEEE1394 Firewire<sup>®</sup> Ports at 400 Mbps/800 Mbps
- DVI Ports, HDMI Ports in Notebooks, Set Top Boxes, Digital TVs, LCD Displays
- Serial ATA Ports in Desktop PCs and Hard Disk Drives
- PCI Express Ports
- General Purpose High-Speed Data Line ESD Protection

\*Standard test condition is IEC61000-4-2 level 4 test circuit with each pin subjected to  $\pm 8$  kV contact discharge for 1000 pulses. Discharges are timed at 1 second intervals and all 1000 strikes are completed in one continuous test run. The part is then subjected to standard production test to verify that all of the tested parameters are within spec after the 1000 strikes.

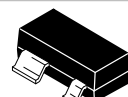


ON Semiconductor<sup>®</sup>

<http://onsemi.com>



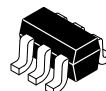
SOT23-3  
SO SUFFIX  
CASE 318



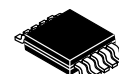
SOT-143  
SR SUFFIX  
CASE 318A



SC-74  
SO SUFFIX  
CASE 318F

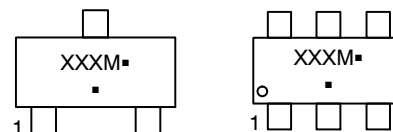


SC70-6  
S7 SUFFIX  
CASE 419AD



MSOP-10  
MR SUFFIX  
CASE 846AE

### MARKING DIAGRAM



XXX = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package

(\*Note: Microdot may be in either location)

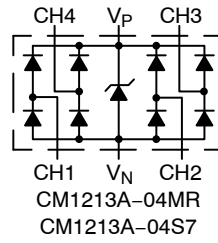
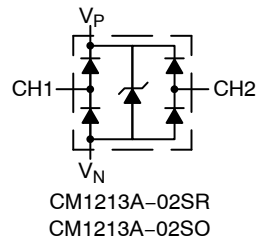
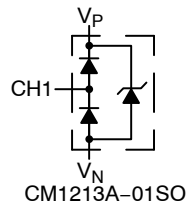
### ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
CM1213A-01SO	SOT23-3 (Pb-Free)	3,000 / Tape & Reel
CM1213A-02SR	SOT143-4 (Pb-Free)	3,000 / Tape & Reel
CM1213A-02SO	SC-74 (Pb-Free)	3,000 / Tape & Reel
CM1213A-04S7	SC70-6 (Pb-Free)	3,000 / Tape & Reel
CM1213A-04MR	MSOP-10 (Pb-Free)	4,000 / Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

# CM1213A

## BLOCK DIAGRAM



# CM1213A

**Table 1. PIN DESCRIPTIONS**

1-Channel, 3-Lead SOT23-3 Package (CM1213A-01SO)			
Pin	Name	Type	Description
1	CH1	I/O	ESD Channel
2	V <sub>P</sub>	PWR	Positive Voltage Supply Rail
3	V <sub>N</sub>	GND	Negative Voltage Supply Rail

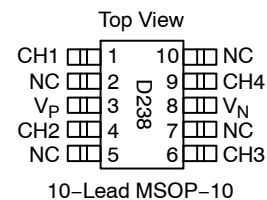
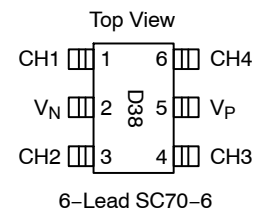
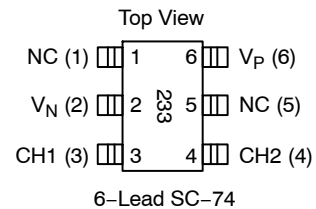
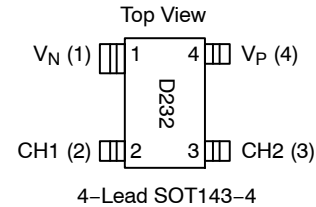
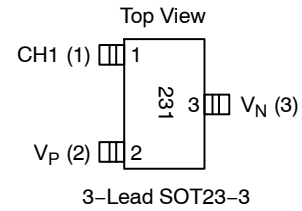
2-Channel, 4-Lead SOT143-4 Package (CM1213A-02SR)			
Pin	Name	Type	Description
1	V <sub>N</sub>	GND	Negative Voltage Supply Rail
2	CH1	I/O	ESD Channel
3	CH2	I/O	ESD Channel
4	V <sub>P</sub>	PWR	Positive Voltage Supply Rail

2-Channel, SC-74 Package (CM1213A-02SO)			
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	NC	-	No Connect
6	V <sub>P</sub>	PWR	Positive Voltage Supply Rail

4-Channel, 6-Lead SC70-6 (CM1213A-04S7)			
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

4-Channel, 10-Lead MSOP-10 Package (CM1213A04MR)			
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

## PACKAGE/PINOUT DIAGRAMS



# CM1213A

## SPECIFICATIONS

**Table 2. 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

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

**Table 3. STANDARD OPERATING CONDITIONS**

Parameter	Rating	Units
Operating Temperature Range	-40 to +85	°C
Package Power Rating SOT23-3, SOT143-4, SC-74, and SC70-6 Packages MSOP-10 Package	225 400	mW

**Table 4. ELECTRICAL OPERATING CHARACTERISTICS** (Note1)

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	$(V_P - V_N) = 3.3$ V			8.0	μA
$V_F$	Diode Forward Voltage Top Diode Bottom Diode	$I_F = 8$ mA; $T_A = 25^\circ\text{C}$	0.60 0.60	0.80 0.80	0.95 0.95	V
$I_{LEAK}$	Channel Leakage Current	$T_A = 25^\circ\text{C}$ ; $V_P = 5$ V, $V_N = 0$ V		0.1	1.0	μA
$C_{IN}$	Channel Input Capacitance	At 1 MHz, $V_P = 3.3$ V, $V_N = 0$ V, $V_{IN} = 1.65$ V (Note 2)		0.85	1.2	pF
$\Delta C_{IN}$	Channel Input Capacitance Matching	At 1 MHz, $V_P = 3.3$ V, $V_N = 0$ V, $V_{IN} = 1.65$ V (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	$T_A = 25^\circ\text{C}$ (Notes 2 and 3)	8			kV
$V_{CL}$	Channel Clamp Voltage Positive Transients Negative Transients	$T_A = 25^\circ\text{C}$ , $I_{PP} = 1$ A, $t_P = 8/20$ μS (Note 2)		+10 -1.7		V
$R_{DYN}$	Dynamic Resistance Positive Transients Negative Transients	$I_{PP} = 1$ A, $t_P = 8/20$ μS Any I/O pin to Ground (Note 2)		0.9 0.5		Ω

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

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

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

## PERFORMANCE INFORMATION

## Input Channel Capacitance Performance Curves

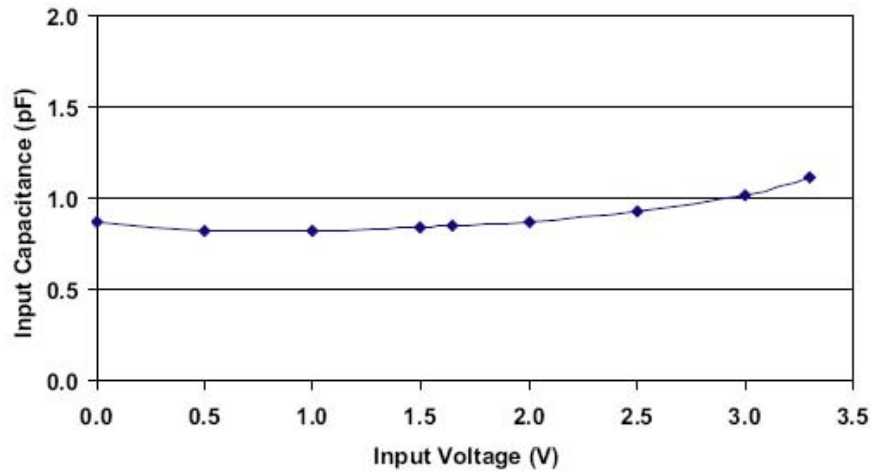


Figure 1. Typical Variation of  $C_{IN}$  vs.  $V_{IN}$   
 ( $f = 1 \text{ MHz}$ ,  $V_P = 3.3 \text{ V}$ ,  $V_N = 0 \text{ V}$ ,  $0.1 \mu\text{F}$  Chip Capacitor between  $V_P$  and  $V_N$ ,  $25^\circ\text{C}$ )

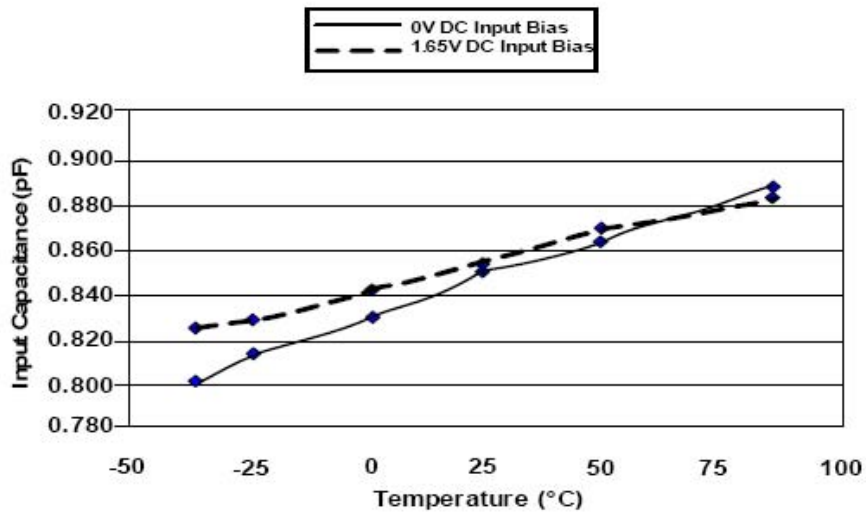


Figure 2. Typical Variation of  $C_{IN}$  vs. Temp  
 ( $f = 1 \text{ MHz}$ ,  $V_{IN} = 30 \text{ mV}$ ,  $V_P = 3.3 \text{ V}$ ,  $V_N = 0 \text{ V}$ ,  $0.1 \mu\text{F}$  Chip Capacitor between  $V_P$  and  $V_N$ )

# CM1213A

## PERFORMANCE INFORMATION (Cont'd)

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

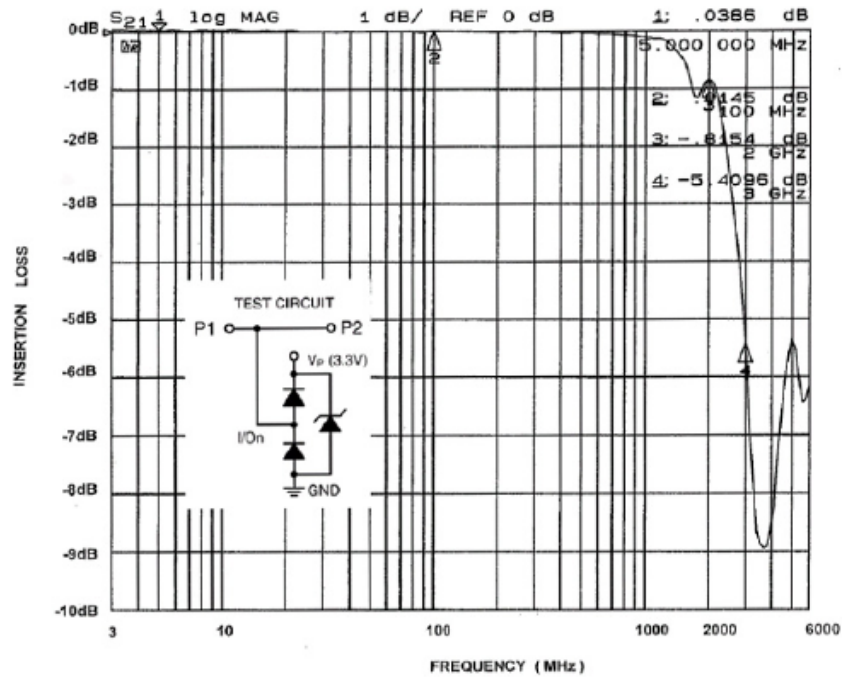


Figure 3. Insertion Loss (S21) vs. Frequency (0 V DC Bias,  $V_p = 3.3$  V)

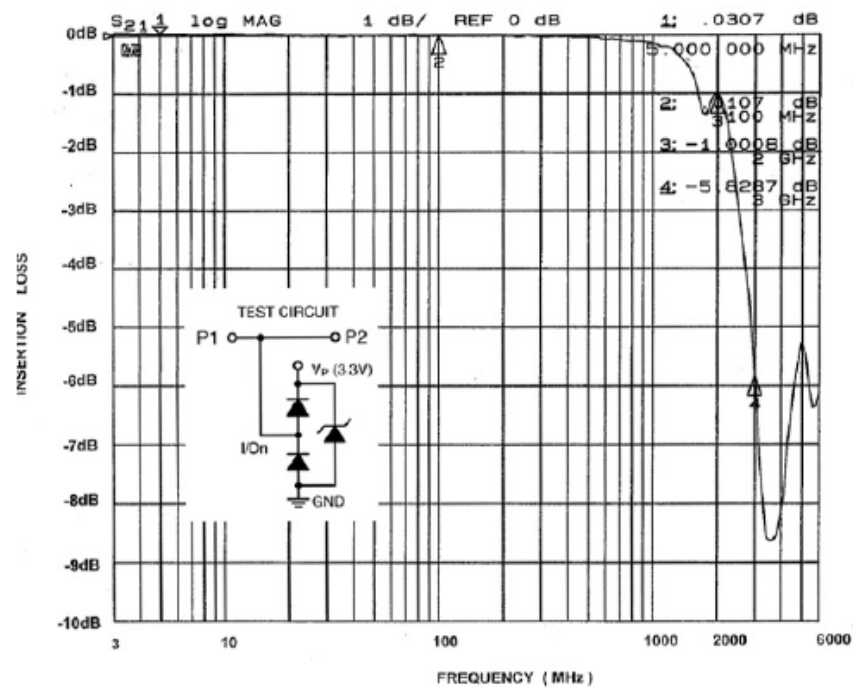


Figure 4. Insertion Loss (S21) vs. Frequency (2.5 V DC Bias,  $V_p = 3.3$  V)

## 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 Application of Positive ESD Pulse between Input Channel and Ground, 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 1 ns. Here  $d(I_{ESD})/dt$  can be approximated by  $\Delta I_{ESD}/\Delta t$ , or  $30/(1 \times 10^{-9})$ . So just 10 nH of series inductance ( $L_1$  and  $L_2$  combined) will lead to a 300 V 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 0.22  $\mu F$  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 ON Semiconductor Application Note “Design Considerations for ESD Protection”, in the Applications section.

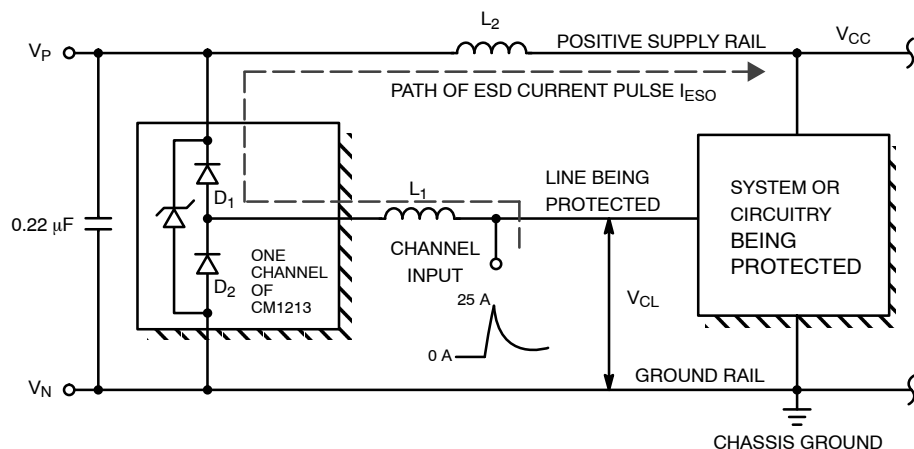
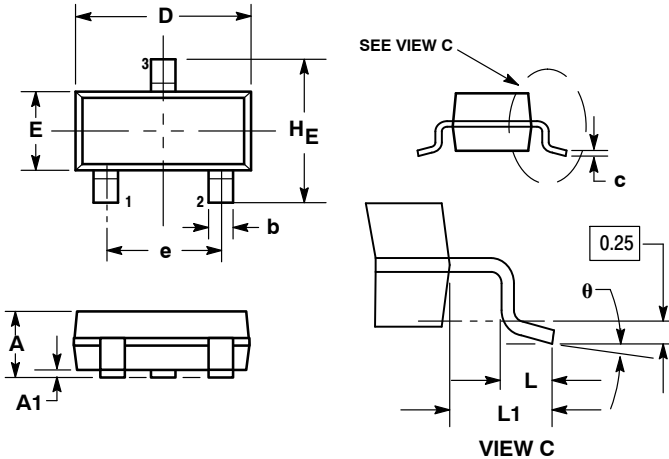


Figure 5. Application of Positive ESD Pulse between Input Channel and Ground

# CM1213A

## PACKAGE DIMENSIONS

**SOT-23 (TO-236)**  
CASE 318-08  
ISSUE AP

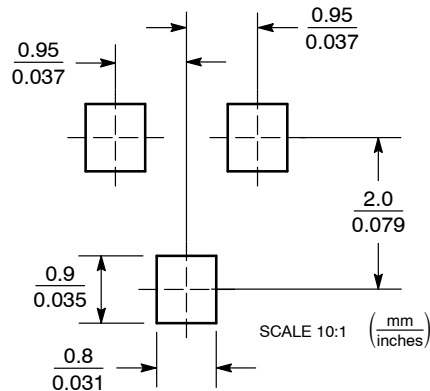


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.89	1.00	1.11	0.035	0.040	0.044
A1	0.01	0.06	0.10	0.001	0.002	0.004
b	0.37	0.44	0.50	0.015	0.018	0.020
c	0.09	0.13	0.18	0.003	0.005	0.007
D	2.80	2.90	3.04	0.110	0.114	0.120
E	1.20	1.30	1.40	0.047	0.051	0.055
e	1.78	1.90	2.04	0.070	0.075	0.081
L	0.10	0.20	0.30	0.004	0.008	0.012
L1	0.35	0.54	0.69	0.014	0.021	0.029
HE	2.10	2.40	2.64	0.083	0.094	0.104
θ	0°	---	10°	0°	---	10°

### SOLDERING FOOTPRINT\*



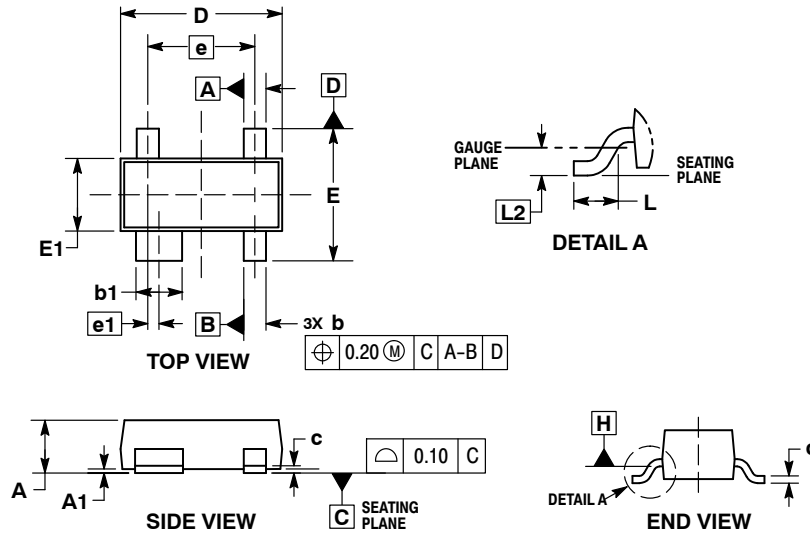
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



# CM1213A

## PACKAGE DIMENSIONS

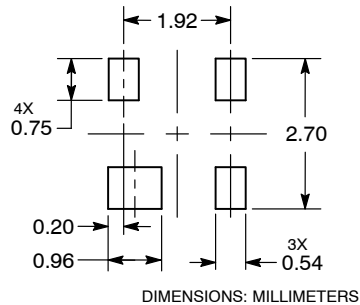
**SOT-143**  
CASE 318A-06  
ISSUE U



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  2. CONTROLLING DIMENSION: MILLIMETERS.
  3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
  4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, AND GATE BURRS SHALL NOT EXCEED 0.25 PER SIDE. DIMENSION E1 DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH AND PROTRUSION SHALL NOT EXCEED 0.25 PER SIDE.
  5. DIMENSIONS D AND E1 ARE DETERMINED AT DATUM H.
  6. DATUMS A AND B ARE DETERMINED AT DATUM H.

DIM	MILLIMETERS	
	MIN	MAX
A	0.80	1.12
A1	0.01	0.15
b	0.30	0.51
b1	0.76	0.94
c	0.08	0.20
D	2.80	3.05
E	2.10	2.64
E1	1.20	1.40
e	1.92 BSC	
e1	0.20 BSC	
L	0.35	0.70
L2	0.25 BSC	

### RECOMMENDED SOLDERING FOOTPRINT\*

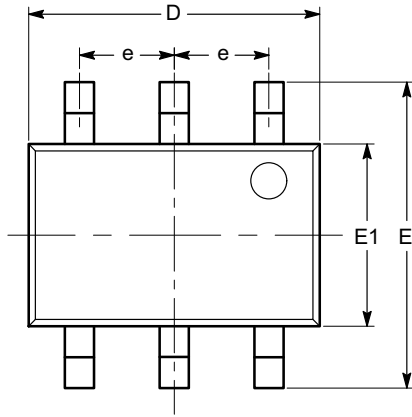


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# CM1213A

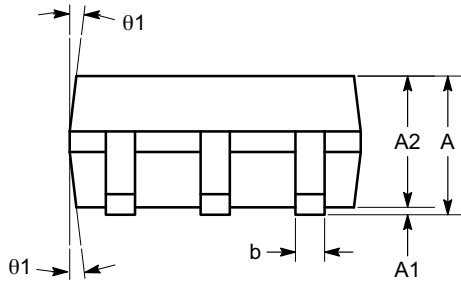
## PACKAGE DIMENSIONS

**SC-88 (SC-70 6 Lead), 1.25x2**  
CASE 419AD-01  
ISSUE A

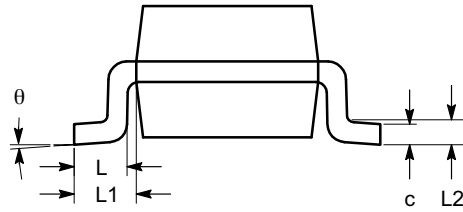


**TOP VIEW**

SYMBOL	MIN	NOM	MAX
A	0.80		1.10
A1	0.00		0.10
A2	0.80		1.00
b	0.15		0.30
c	0.10		0.18
D	1.80	2.00	2.20
E	1.80	2.10	2.40
E1	1.15	1.25	1.35
e	0.65 BSC		
L	0.26	0.36	0.46
L1	0.42 REF		
L2	0.15 BSC		
$\theta$	0°		8°
$\theta_1$	4°		10°



**SIDE VIEW**



**END VIEW**

### Notes:

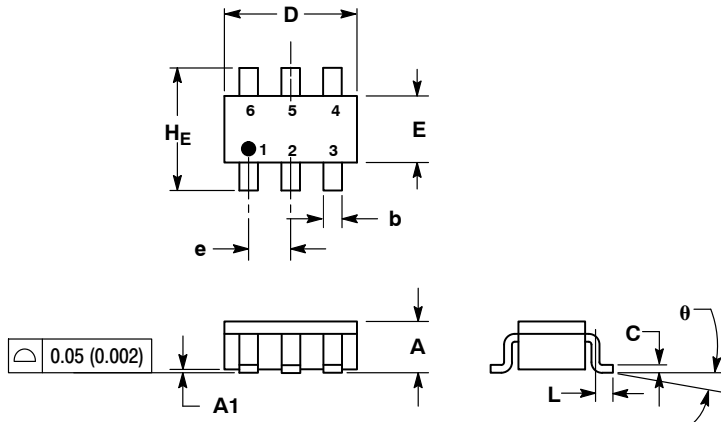
- (1) All dimensions are in millimeters. Angles in degrees.
- (2) Complies with JEDEC MO-203.

# CM1213A

## PACKAGE DIMENSIONS

**SC-74**  
CASE 318F-05  
ISSUE N

SCALE 2:1

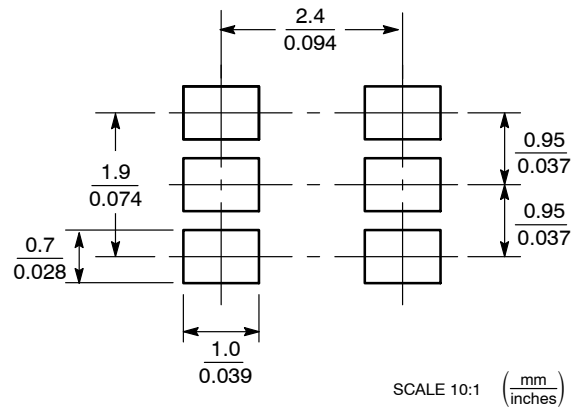


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318F-01, -02, -03, -04 OBSOLETE. NEW STANDARD 318F-05.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.90	1.00	1.10	0.035	0.039	0.043
A1	0.01	0.06	0.10	0.001	0.002	0.004
b	0.25	0.37	0.50	0.010	0.015	0.020
c	0.10	0.18	0.26	0.004	0.007	0.010
D	2.90	3.00	3.10	0.114	0.118	0.122
E	1.30	1.50	1.70	0.051	0.059	0.067
e	0.85	0.95	1.05	0.034	0.037	0.041
L	0.20	0.40	0.60	0.008	0.016	0.024
H	2.50	2.75	3.00	0.099	0.108	0.118
$\theta$	0°	—	10°	0°	—	10°

### SOLDERING FOOTPRINT\*



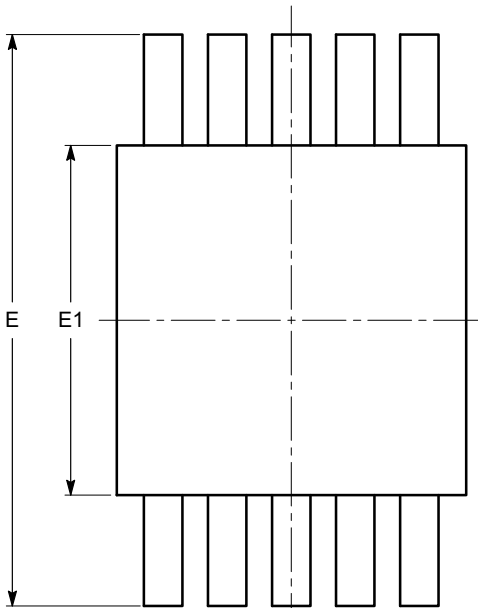
SCALE 10:1  $\left( \frac{\text{mm}}{\text{inches}} \right)$

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

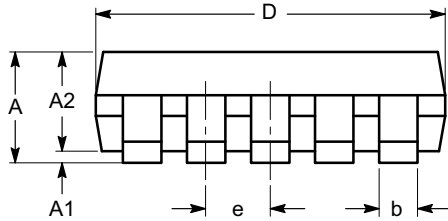
# CM1213A

## PACKAGE DIMENSIONS

**MSOP 10, 3x3**  
CASE 846AE-01  
ISSUE O

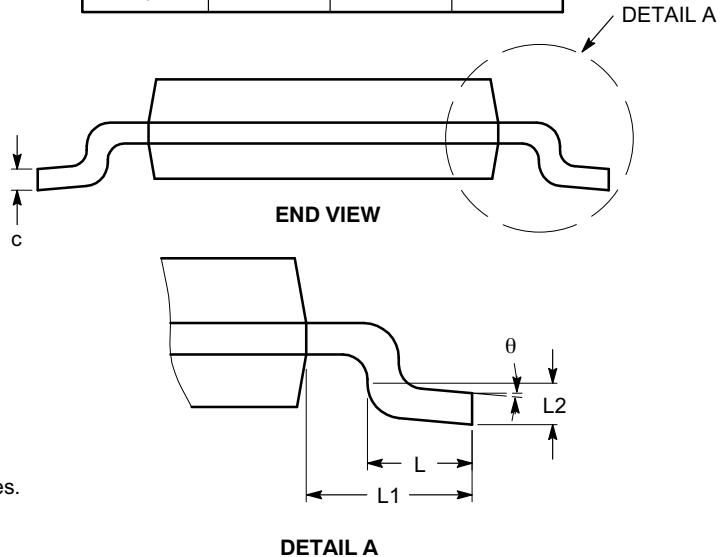


TOP VIEW



SIDE VIEW

SYMBOL	MIN	NOM	MAX
A			1.10
A1	0.00	0.05	0.15
A2	0.75	0.85	0.95
b	0.17		0.27
c	0.13		0.23
D	2.90	3.00	3.10
E	4.75	4.90	5.05
E1	2.90	3.00	3.10
e	0.50 BSC		
L	0.40	0.60	0.80
L1	0.95 REF		
L2	0.25 BSC		
θ	0°		8°



### Notes:

- (1) All dimensions are in millimeters. Angles in degrees.
- (2) Complies with JEDEC MO-187.

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