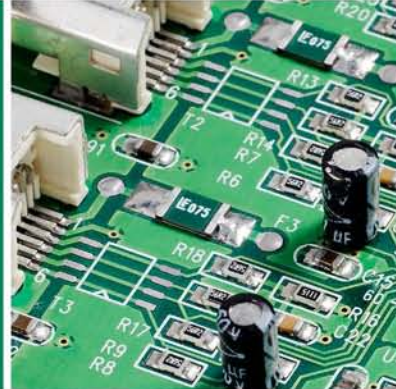




## ESD PROTECTION GUIDE



# ESD

**System-Level and  
Application Specific  
Electrostatic Discharge  
(ESD) Protection Guide**

## Introduction:

Designers of today's electronic devices have demanded more functionality with greater flexibility and higher levels of user interaction. These circumstances have helped in driving the development of nanometer chipsets along with a multitude of user interfaces or ports. The confluence of these two has made electronic devices more susceptible to ESD and required the need for a more robust solution.

## ESD Standards:

### **MIL-STD-883, Method 3015**

Historically, analog and digital designers have been required to have ESD protection "on-chip" to protect the IC during manufacturing. The most commonly used ESD standard in the manufacturing environment is the MIL-STD-883, Method 3015 and it's also referred to as the Human Body Model (HBM). This model discharges a 100pF capacitor through a 1500Ω resistor into the device under test. The table below points out the four test levels as defined in the standard.

| HBM Level | Contact Discharge (kV) | Peak Current (A) |
|-----------|------------------------|------------------|
| 1         | ±0.5                   | 0.33             |
| 2         | ±1                     | 0.67             |
| 3         | ±2                     | 1.33             |
| 4         | ±4                     | 2.67             |

The maximum level required for a typical IC had been ±2kV up until 2007, but today that level has been drastically reduced to ±0.5kV. Obviously, this has helped chip designers save valuable silicon area for more functionality, but in turn, it has made the IC much more susceptible to damage from ESD.

### **IEC61000-4-2**

Conversely, equipment manufacturers have traditionally used an ESD standard defined by the IEC (International Electrotechnical Commission) for system or application level testing. This model uses a 150pF capacitor which is discharged through a 330Ω resistor. The table below displays the four test levels as defined in the standard.

| IEC Level | Contact Discharge (kV) | Peak Current (A) |
|-----------|------------------------|------------------|
| 1         | ±2                     | 7.5              |
| 2         | ±4                     | 15               |
| 3         | ±6                     | 22.5             |
| 4         | ±8                     | 30               |

Most all manufacturers require that their equipment pass Level 4, or ±8kV, as a minimum, however, some are looking for increased reliability and require that their devices pass a much higher level like ±15kV or ±30kV.

## Conclusions:

The system level ESD test defined by the IEC produces a substantial increase in peak current compared to the military standard. If an IC is rated for 0.5kV per the MIL-STD and the equipment manufacturer tests this same IC at 8kV per the IEC specification, the chip will see nearly a 100 fold increase in peak current (i.e. 0.33A vs. 30A)!

Ultimately, hardware or board designers must add supplementary ESD devices to protect these sensitive chipsets from the high level ESD threats seen in the field.

## Solutions:

Littelfuse's Silicon Protection Arrays are an ideal choice for suppressing ESD as their speed and clamping levels are essential to protect today's integrated circuits unlike the previous MLV, MOV, and polymer technologies. The SPATM portfolio offers a wide range of devices to suit the majority of application needs available in the market today, and this guide will steer the designer toward the appropriate ESD device for the particular application they're trying to protect.

Some of the applications discussed in this guide are:

- USB1.1/2.0/3.0
- HDMI
- DVI
- 10/100/1000 Ethernet
- eSATA
- 1394a/b
- LVDS
- Audio (Speaker/Microphone)
- Analog Video
- SIM Sockets
- RS-232
- RS-485
- CAN Bus
- Keypad/Push button
- LCD/Camera display interfaces

Many of these applications can be found in electronic devices such as:

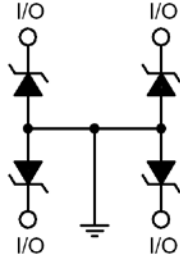
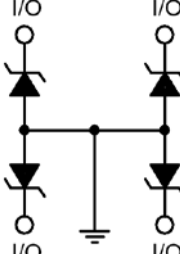
- PC's
- Portable Medical Devices
- Set Top Boxes
- LCD/PDP TV's
- Portable Navigation Devices
- Keyboards/Mouse
- Mobile Handsets
- MP3/PMP's
- PDA's
- Digital Cameras
- SIM/SD Cards
- External Storage
- Router/Hub/Modem
- Smart Phone

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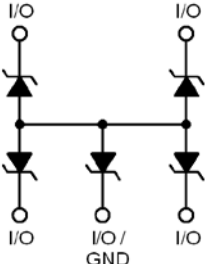
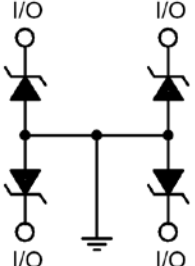
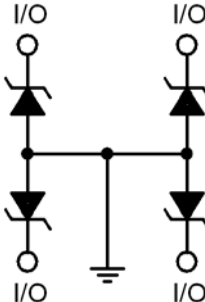
### SPA™ Series Descriptions

Unidirectional and Bidirectional TVS Arrays for ESD Protection

| Series | Schematic (Example)                                                                 | ESD Level (Contact) | I/O Cap<br>$V_R = 0V$<br>(@ Bias) | $V_{RWM}$ | Lightning<br>( $t_p = 8/20\mu s$ ) | Number of Channels | Package Options   |
|--------|-------------------------------------------------------------------------------------|---------------------|-----------------------------------|-----------|------------------------------------|--------------------|-------------------|
| SP05   |    | $\pm 30kV$          | 50pF<br>(30pF @ 2.5V)             | 5.5V      | N/A                                | 2                  | SOT23-3<br>SC70-3 |
|        |                                                                                     |                     |                                   |           |                                    | 3                  | SOT143            |
|        |                                                                                     |                     |                                   |           |                                    | 4                  | SOT23-5<br>SC70-5 |
|        |                                                                                     |                     |                                   |           |                                    | 5                  | SOT23-6<br>SC70-6 |
|        |                                                                                     |                     |                                   |           |                                    | 6                  | MSOP-8            |
| SP1001 |    | $\pm 15kV$          | 12pF<br>(8pF @ 2.5V)              | 5.5V      | 2A                                 | 2                  | SC70-3<br>SOT553  |
|        |                                                                                     |                     |                                   |           |                                    | 4                  | SC70-5<br>SOT553  |
|        |                                                                                     |                     |                                   |           |                                    | 5                  | SC70-6<br>SOT563  |
| SP1002 |  | $\pm 8kV$           | 6pF<br>(5pF @ 2.5V)               | 6V        | 2A                                 | 1                  | SC70-3            |
|        |                                                                                     |                     |                                   |           |                                    | 2                  | SC70-5            |
| SP1003 |  | $\pm 25kV$          | 30pF<br>(17pF @ 2.5V)             | 5V        | 7A                                 | 1                  | SOD723            |

### SPA™ Series Descriptions

Unidirectional and Bidirectional TVS Arrays for ESD Protection (*continued*)

| Series | Schematic (Example)                                                                 | ESD Level (Contact) | I/O Cap<br>$V_R = 0V$<br>(@ Bias) | $V_{RWM}$ | Lightning<br>( $t_p = 8/20\mu s$ ) | Number of Channels | Package Options           |
|--------|-------------------------------------------------------------------------------------|---------------------|-----------------------------------|-----------|------------------------------------|--------------------|---------------------------|
| SP1004 |    | $\pm 8kV$           | 6pF<br>(5pF @ 1.5V)               | 6V        | 2A                                 | 4                  | SOT953                    |
| SP1005 |    | $\pm 30kV$          | 30pF<br>(23pF @ 2.5V)             | 6V        | 10A                                | 1                  | 0201 Flipchip             |
| SP1007 |  | $\pm 8kV$           | 5pF<br>(3.5pF @ 5V)               | 6V        | 2A                                 | 1                  | 0201 Flipchip             |
| SP1010 |  | $\pm 8kV$           | 6pF<br>(3.5pF @ 2.5V)             | 6V        | 1A                                 | 4                  | $\mu$ DFN-6<br>1.25x1.0mm |
| SP1011 |  | $\pm 15kV$          | 12pF<br>(7pF @ 2.5V)              | 6V        | 2A                                 | 4                  | $\mu$ DFN-6<br>1.25x1.0mm |

### SPA™ Series Descriptions

Low Capacitance Diode Arrays for ESD Protection

| Series | Schematic (Example) | ESD Level (Contact) | I/O Cap<br>$V_R = 1.65V$ | $V_{RWM}$ | Lightning<br>( $t_p = 8/20\mu s$ ) | Number of Channels | Package Options                                   |
|--------|---------------------|---------------------|--------------------------|-----------|------------------------------------|--------------------|---------------------------------------------------|
| SP3001 |                     | $\pm 8kV$           | 0.65pF                   | 6V        | 2.5A                               | 4                  | SC70-6                                            |
| SP3002 |                     | $\pm 12kV$          | 0.85pF                   | 6V        | 4.5A                               | 4                  | SC70-6<br>SOT23-6<br><br>$\mu DFN-6$<br>1.6x1.6mm |
| SP3003 |                     | $\pm 8kV$           | 0.65pF                   | 6V        | 2.5A                               | 2                  | SC70-5<br>SOT553                                  |
|        |                     |                     |                          |           |                                    | 4                  | SC70-6<br>SOT563<br>MSOP-10                       |
| SP3004 |                     | $\pm 12kV$          | 0.85pF                   | 6V        | 4A                                 | 4                  | SOT563                                            |

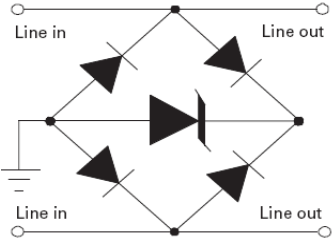
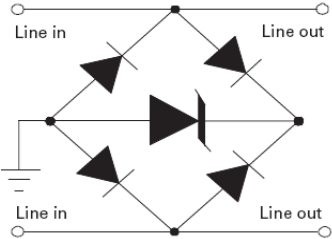
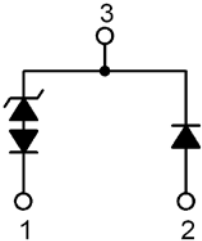
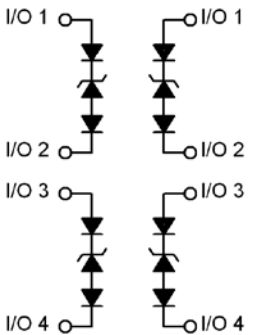
### SPA™ Series Descriptions

Low Capacitance Diode Arrays for ESD Protection (*continued*)

| Series | Schematic (Example) | ESD Level (Contact) | I/O Cap<br>$V_R = 0V$ | $V_{RWM}$ | Lightning<br>( $t_p = 8/20\mu s$ ) | Number of Channels | Package Options            |
|--------|---------------------|---------------------|-----------------------|-----------|------------------------------------|--------------------|----------------------------|
| SP3010 |                     | $\pm 8kV$           | 0.45pF                | 6V        | 3A                                 | 4                  | $\mu$ DFN-10<br>2.5x1.0mm  |
| SP3011 |                     | $\pm 8kV$           | 0.40pF                | 6V        | 3A                                 | 6                  | $\mu$ DFN-14<br>3.5x1.35mm |
| SP3050 |                     | $\pm 20kV$          | 2.4pF                 | 6V        | 10A                                | 4                  | SOT23-6                    |
| SP4060 |                     | $\pm 30kV$          | 4.4pF                 | 2.5V      | 20A                                | 8                  | MSOP-10                    |

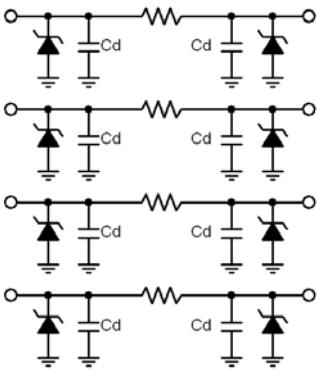
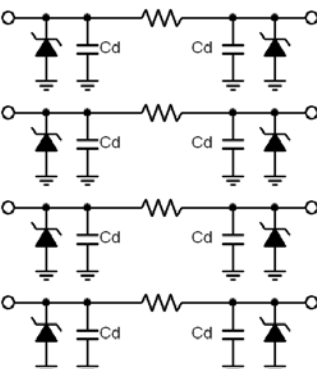
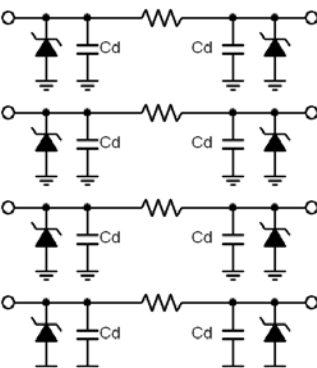
### SPA™ Series Descriptions

Low Capacitance Diode Arrays for Broadband Protection

| Series    | Schematic (Example)                                                                 | ESD Level (Contact) | I/O Cap<br>$V_R = 0V$ | $V_{RWM}$ | Lightning<br>( $t_p = 8/20\mu s$ ) | Number of Channels | Package Options |
|-----------|-------------------------------------------------------------------------------------|---------------------|-----------------------|-----------|------------------------------------|--------------------|-----------------|
| SP03-3.3  |    | $\pm 30kV$          | 16pF                  | 3.3V      | 150A                               | 2                  | SOIC-8          |
| SP03-6    |    | $\pm 30kV$          | 16pF                  | 6V        | 150A                               | 2                  | SOIC-8          |
| SPLV2.8   |  | $\pm 30kV$          | 3.8pF                 | 2.8V      | 24A                                | 1                  | SOT23-3         |
| SPLV2.8-4 |  | $\pm 30kV$          | 3.8pF                 | 2.8V      | 24A                                | 4                  | SOIC-8          |

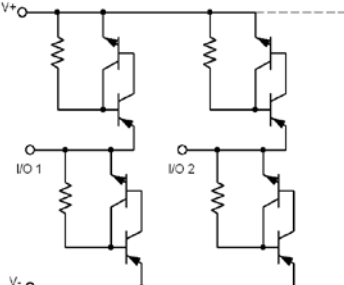
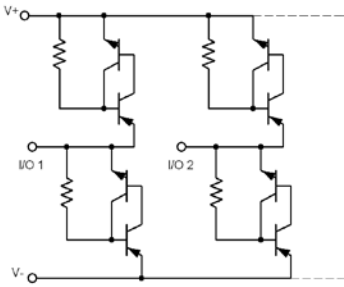
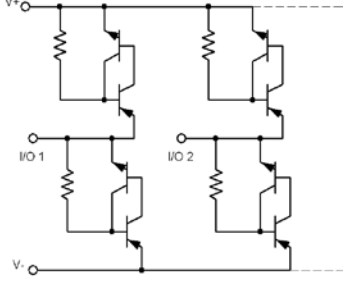
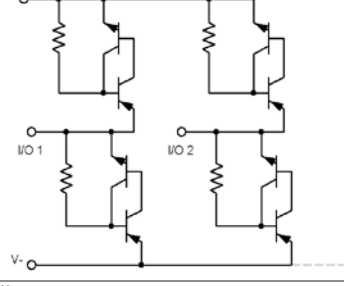
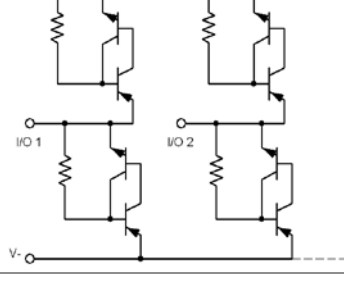
**SPA™ Series Descriptions**

EMI Filter Arrays with ESD Protection

| Series | Schematic (Example)                                                                 | ESD Level (Contact) | Line Cap (V <sub>R</sub> =2.5V)    | V <sub>RWM</sub> | Attenuation    | Number of Channels | Package Options       |
|--------|-------------------------------------------------------------------------------------|---------------------|------------------------------------|------------------|----------------|--------------------|-----------------------|
| SP6001 |    | ±30kV               | 24pF<br>(C <sub>DIODE</sub> =12pF) | 6V               | ≥ -30dB @ 1GHz | 4                  | μDFN-8<br>1.7x1.35mm  |
|        |                                                                                     |                     |                                    |                  |                | 6                  | μDFN-12<br>2.5x1.35mm |
|        |                                                                                     |                     |                                    |                  |                | 8                  | μDFN-16<br>3.3x1.35mm |
| SP6002 |  | ±30kV               | 30pF<br>(C <sub>DIODE</sub> =15pF) | 6V               | ≥ -30dB @ 1GHz | 4                  | μDFN-8<br>1.7x1.35mm  |
|        |                                                                                     |                     |                                    |                  |                | 6                  | μDFN-12<br>2.5x1.35mm |
| SP6003 |  | ±15kV               | 14pF<br>(C <sub>DIODE</sub> =7pF)  | 6V               | ≥ -20dB @ 1GHz | 4                  | μDFN-8<br>1.7x1.35mm  |
|        |                                                                                     |                     |                                    |                  |                | 6                  | μDFN-12<br>2.5x1.35mm |

**SPA™ Series Descriptions**

SCR/Diode Arrays for ESD Protection

| Series | Schematic (Example)                                                                 | ESD Level (Contact) | I/O Cap | V <sub>RWM</sub> | Lightning (t <sub>p</sub> =8/20μs) | Number of Channels | Package Options    |
|--------|-------------------------------------------------------------------------------------|---------------------|---------|------------------|------------------------------------|--------------------|--------------------|
| SP720  |    | ±4kV                | 3pF     | 30V or (±15V)    | 3A                                 | 14                 | SOIC-16<br>PDIP-16 |
| SP721  |    | ±4kV                | 3pF     | 30V or (±15V)    | 3A                                 | 6                  | SOIC-8<br>PDIP-8   |
| SP723  |   | ±8kV                | 5pF     | 30V or (±15V)    | 7A                                 | 6                  | SOIC-8<br>PDIP-8   |
| SP724  |  | ±8kV                | 3pF     | 20V or (±10V)    | 3A                                 | 4                  | SOT23-6            |
| SP725  |  | ±8kV                | 5pF     | 30V or (±15V)    | 14A                                | 4                  | SOIC-8             |

**Silicon Protection Array Ordering Guide**

| Series | Number of Channels | Package              | Orderable Part Number |
|--------|--------------------|----------------------|-----------------------|
| SP05   | 2                  | SOT23-3              | SP0502BAHTG           |
|        |                    | SC70-3               | SP0502BAJTG           |
|        | 3                  | SOT143               | SP0503BAHTG           |
|        | 4                  | SOT23-5              | SP0504BAHTG           |
|        |                    | SC70-5               | SP0504BAJTG           |
|        | 5                  | SOT23-6              | SP0505BAHTG           |
|        |                    | SC70-6               | SP0505BAJTG           |
|        | 6                  | MSOP-8               | SP0506BAATG           |
| SP1001 | 2                  | SC70-3               | SP1001-02JTG          |
|        |                    | SOT553               | SP1001-02XTG          |
|        | 4                  | SC70-5               | SP1001-04JTG          |
|        |                    | SOT553               | SP1001-04XTG          |
|        | 5                  | SC70-6               | SP1001-05JTG          |
|        |                    | SOT56                | SP1001-05XTG          |
| SP1002 | 1                  | SC70-3               | SP1002-01JTG          |
|        | 2                  | SC70-5               | SP1002-02JTG          |
| SP1003 | 1                  | SOD723               | SP1003-01DTG          |
| SP1004 | 4                  | SOT953               | SP1004-04VTG          |
| SP1005 | 1                  | 0201 Flipchip        | SP1005-01WTG          |
| SP1007 | 1                  | 0201 Flipchip        | SP1007-01WTG          |
| SP1010 | 4                  | μDFN-6 (1.25x1.0mm)  | SP1010-04UTG          |
| SP1011 | 4                  | μDFN-6 (1.25x1.0mm)  | SP1011-04UTG          |
| SP3001 | 4                  | SC70-6               | SP3001-04JTG          |
| SP3002 | 4                  | SOT23-6              | SP3002-04HTG          |
|        |                    | SC70-6               | SP3002-04JTG          |
|        |                    | μDFN-6 (1.6x1.6mm)   | SP3002-04UTG          |
| SP3003 | 2                  | SC70-5               | SP3003-02JTG          |
|        |                    | SOT553               | SP3003-02XTG          |
|        | 4                  | SC70-6               | SP3003-04JTG          |
|        |                    | SOT563               | SP3003-04XTG          |
|        |                    | MSOP-10              | SP3003-04ATG          |
| SP3004 | 4                  | SOT563               | SP3004-04XTG          |
| SP3010 | 4                  | μDFN-10 (2.5x1.0mm)  | SP3010-04UTG          |
| SP3011 | 6                  | μDFN-14 (3.5x1.35mm) | SP3011-06UTG          |

**Silicon Protection Array Ordering Guide (continued)**

| Series    | Number of Channels | Package              | Orderable Part Number |
|-----------|--------------------|----------------------|-----------------------|
| SP3050    | 4                  | SOT23-6              | SP3050-04HTG          |
| SP4060    | 8                  | MSOP-10              | SP4060-08ATG          |
| SP03-3.3  | 2                  | SOIC-8               | SP03-3.3BTG           |
| SP03-6    | 2                  | SOIC-8               | SP03-6BTG             |
| SPLV2.8   | 1                  | SOT23-3              | SPLV2.8HTG            |
| SPLV2.8-4 | 4                  | SOIC-8               | SPLV2.8-4BTG          |
| SP6001    | 4                  | μDFN-8 (1.7x1.35mm)  | SP6001-04UTG-1        |
|           | 6                  | μDFN-12 (2.5x1.35mm) | SP6001-06UTG-1        |
|           | 8                  | μDFN-16 (3.3x1.35mm) | SP6001-08UTG-1        |
| SP6002    | 4                  | μDFN-8 (1.7x1.35mm)  | SP6002-04UTG-1        |
|           | 6                  | μDFN-12 (2.5x1.35mm) | SP6002-06UTG-1        |
| SP6003    | 4                  | μDFN-8 (1.7x1.35mm)  | SP6003-04UTG-1        |
|           | 6                  | μDFN-12 (2.5x1.35mm) | SP6003-06UTG-1        |
| SP720     | 14                 | PDIP-16              | SP720APP              |
|           | 14                 | SOIC-16              | SP720AB*G             |
| SP721     | 6                  | PDIP-8               | SP721APP              |
|           | 6                  | SOIC-8               | SP721AB*G             |
| SP723     | 6                  | PDIP-8               | SP723APP              |
|           | 6                  | SOIC-8               | SP723AB*G             |
| SP724     | 4                  | SOT23-6              | SP724AHTG             |
| SP725     | 4                  | SOIC-8               | SP725AB*G             |

\*Add "T" for Tape and Reel, otherwise parts are packed in tubes

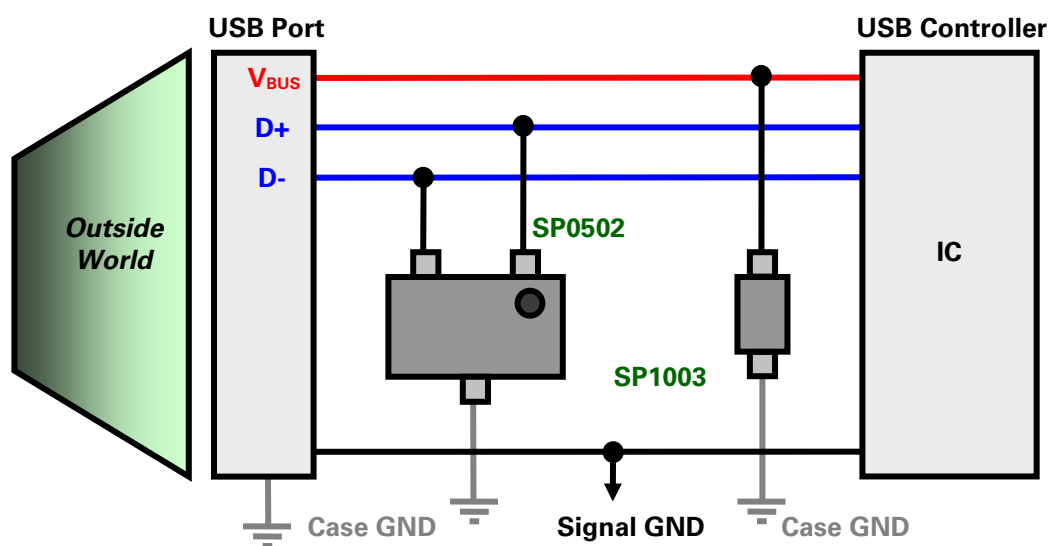
## APPLICATION SPECIFIC DEVICE SELECTION

USB1.1

### Considerations:

- Each port operates at either 1.5Mbps or 12Mbps (low and full speed respectively)
  - Parasitic capacitance should be taken into account although these relatively slow speeds can tolerate tens of picofarads
- Requires 2 channels of data line protection per port (i.e.  $D_{\pm}$ )
  - A 4 channel device can be useful if protecting a USB stack of 2 ports to make the ESD footprint as small as possible
  - $V_{BUS}$  can be protected separately with a single channel device (0402 shown)

### Application Schematic:



### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | I/O Capacitance @ $V_R=2.5V$ | # of Channels | $V_{RWM}$ | Packaging |
|-----------------|---------------------|------------------------------|---------------|-----------|-----------|
| SP0502BAJTG     | $\pm 30kV$          | 30pF                         | 2             | 5.5V      | SC70-3    |
| SP1001-02XTG    | $\pm 15kV$          | 8pF                          | 2             | 5.5V      | SOT553    |
| SP1001-04XTG    | $\pm 15kV$          | 8pF                          | 4             | 5.5V      | SOT553    |
| SP1003-01DTG    | $\pm 25kV$          | 17pF                         | 1             | 5.0V      | SOD723    |

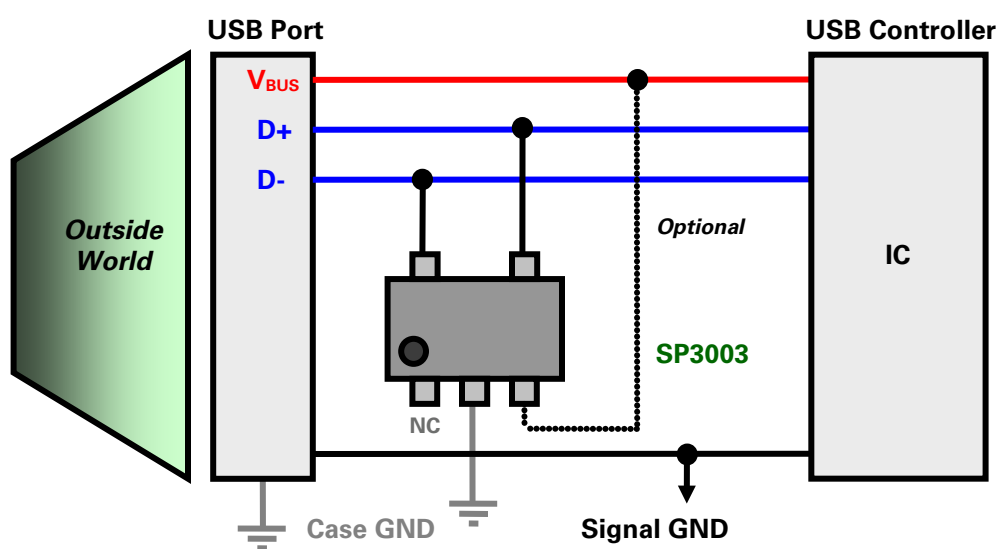
## APPLICATION SPECIFIC DEVICE SELECTION

### USB2.0

#### Considerations:

- Each port can operate up to 480Mbps
  - The high data rate requires a low capacitance device to preserve signal integrity
- Requires 2 channels of data line protection per port (i.e.  $D_{\pm}$ )
  - A 4 channel device can be useful if protecting a USB stack of 2 ports to make the ESD footprint as small as possible
  - $V_{BUS}$  can be protected by connecting it to the VCC pin on the diode array or by using a separate single channel device as previously shown (i.e. SP1003)

#### Application Schematic:



#### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | I/O Capacitance @ $V_R=1.65V$ | # of Channels | $V_{RWM}$ | Packaging               |
|-----------------|---------------------|-------------------------------|---------------|-----------|-------------------------|
| SP3003-02XTG    | $\pm 8kV$           | 0.65pF                        | 2             | 6V        | SOT553                  |
| SP3003-02JTG    | $\pm 8kV$           | 0.65pF                        | 2             | 6V        | SC70-5                  |
| SP3002-04UTG    | $\pm 12kV$          | 0.85pF                        | 4             | 6V        | $\mu$ DFN-6 (1.6x1.6mm) |
| SP3002-04JTG    | $\pm 12kV$          | 0.85pF                        | 4             | 6V        | SC70-6                  |

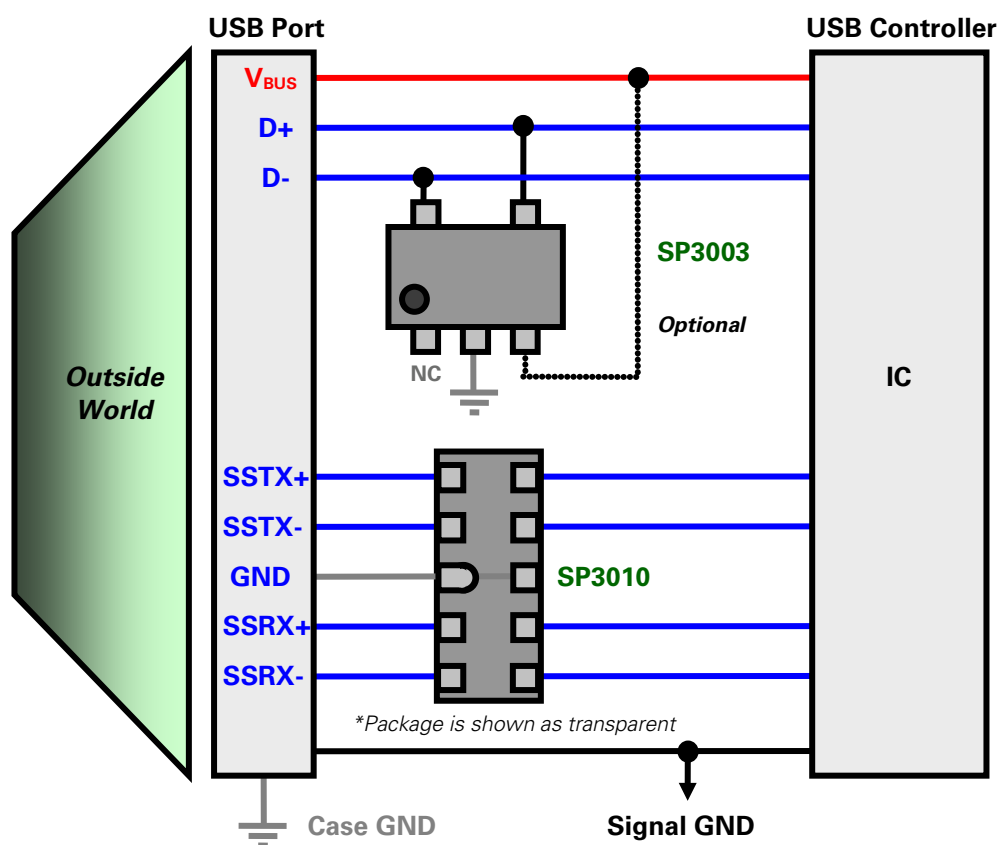
## APPLICATION SPECIFIC DEVICE SELECTION

USB3.0 (Two Device Solution)

### Considerations:

- Each port depending upon what it's connected to can operate:
  - Up to 5Gbps over the new super-speed data pairs, **SSTX±** and **SSRX±**
  - Up to 480Mbps on the legacy data pair, **D±**
- Requires 4 channels of ultra-low capacitance protection for the super-speed data pair (i.e. **SSTX±** and **SSRX±**)
- Requires 2 channels of protection for the legacy **D±** data pair
  - VBUS can be protected by connecting it to the VCC pin on the SPA or by using a separate single channel device

### Application Schematic:



### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | I/O Capacitance @ $V_R=1.65V$ | # of Channels | $V_{RWM}$ | Packaging |
|-----------------|---------------------|-------------------------------|---------------|-----------|-----------|
| SP3003-02XTG    | ±8kV                | 0.65pF                        | 2             | 6V        | SOT553    |
| SP3010-04UTG    | ±8kV                | 0.45pF                        | 4             | 6V        | μDFN-10   |

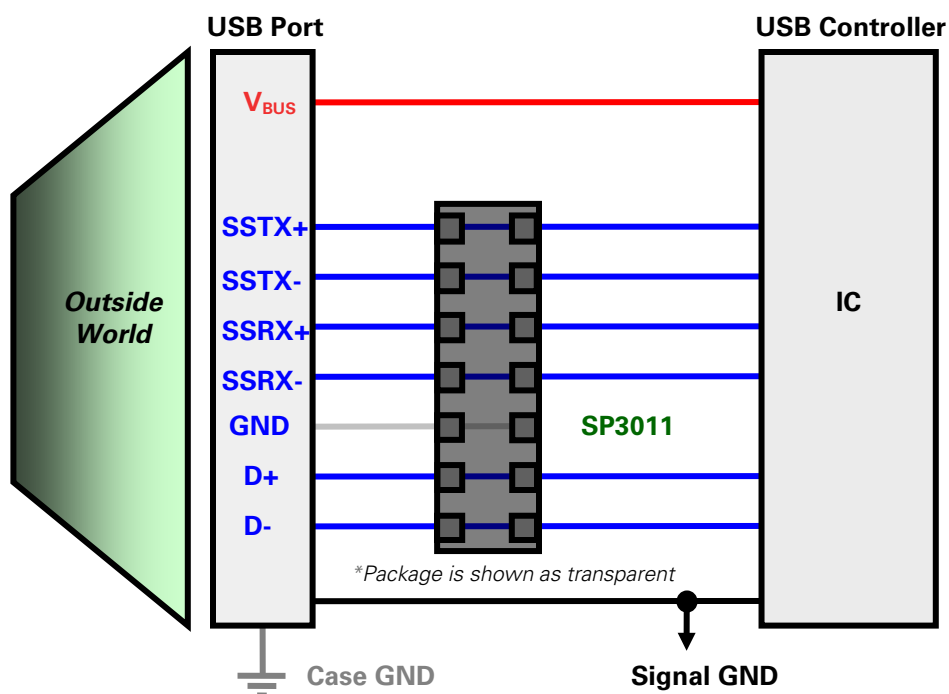
## APPLICATION SPECIFIC DEVICE SELECTION

USB3.0 (Fully Integrated Solution)

### Considerations:

- Each port depending upon what it's connected to can operate:
  - Up to 5Gbps over the new super-speed data pairs, **SSTX±** and **SSRX±**
  - Up to 480Mbps on the legacy data pair, **D±**
- Requires 4 channels of ultra-low capacitance protection for the super-speed data pair (i.e. **SSTX±** and **SSRX±**) and 2 channels of protection for the legacy **D±** data pair. The SP3011 shown below integrates all 6 channels of protection into a small form factor  $\mu$ DFN-14 package.

### Application Schematic:



### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | I/O Capacitance @ $V_R=0V$ | # of Channels | $V_{RWM}$ | Packaging    |
|-----------------|---------------------|----------------------------|---------------|-----------|--------------|
| SP3011-06UTG    | $\pm 8kV$           | 0.40pF                     | 6             | 6V        | $\mu$ DFN-14 |

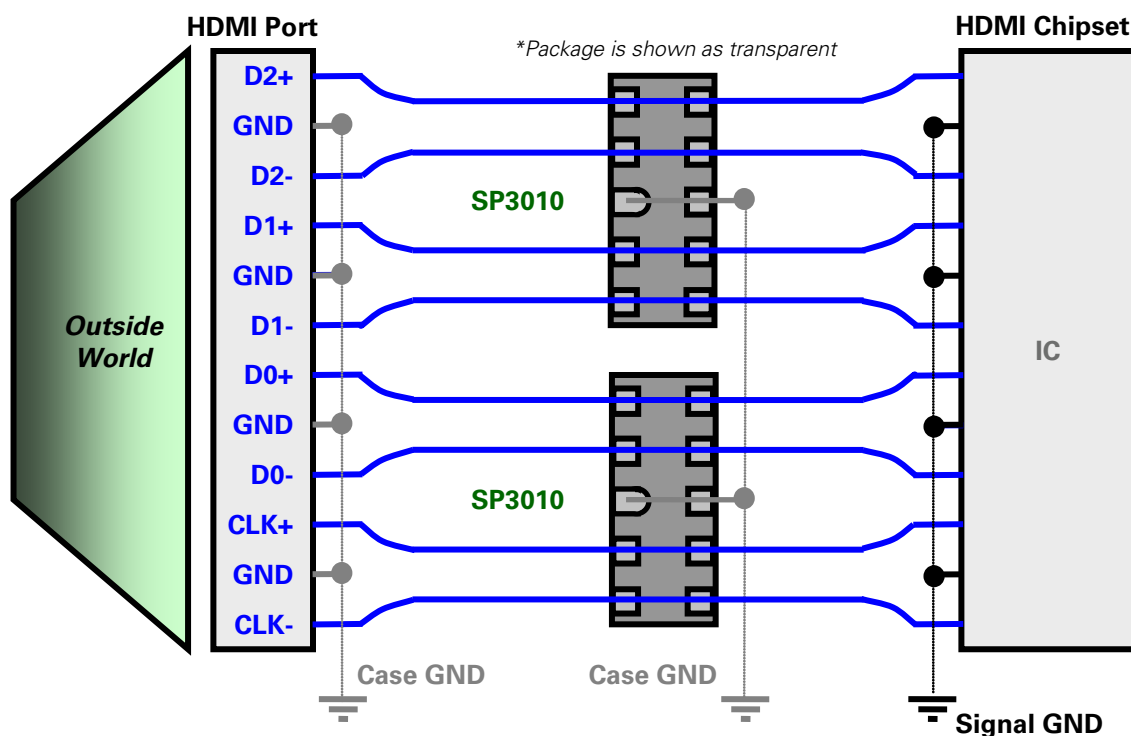
## APPLICATION SPECIFIC DEVICE SELECTION

### HDMI

#### Considerations:

- Each port has 3 differential lanes of data (i.e. **D0±, D1±, D2±**) plus a clock (**CLK±**)
  - For HDMI 1.1-1.2 the throughput is a total of 4.95Gbps (1.65Gbps per lane)
  - For HDMI 1.3 the throughput is a total of 10.2Gbps (3.4Gbps per lane)
- To maintain the differential impedance per the HDMI Compliance Test Specification (and consequently signal integrity) a very low capacitance device must be used
- To maintain the differential impedance the designer should avoid using 90° angles and vias
  - This can be accomplished by the use of an ESD device that offers a “straight-through” routing scheme
- Requires 8 channels of protection per port (**D0±, D1±, D2±, CLK±**)
- The  $V_{CC}$  pin on the SP3003-04ATG should be “NC” if backdrive is a concern. There is no  $V_{CC}$  pin on the SP3010-04UTG

#### Application Schematic:



#### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | I/O Capacitance @ $V_R=1.65V$ | # of Channels | $V_{RWM}$ | Packaging |
|-----------------|---------------------|-------------------------------|---------------|-----------|-----------|
| SP3010-04UTG    | ±8kV                | 0.45pF                        | 4             | 6V        | μDFN-10   |
| SP3003-04ATG    | ±8kV                | 0.65pF                        | 4             | 6V        | MSOP-10   |

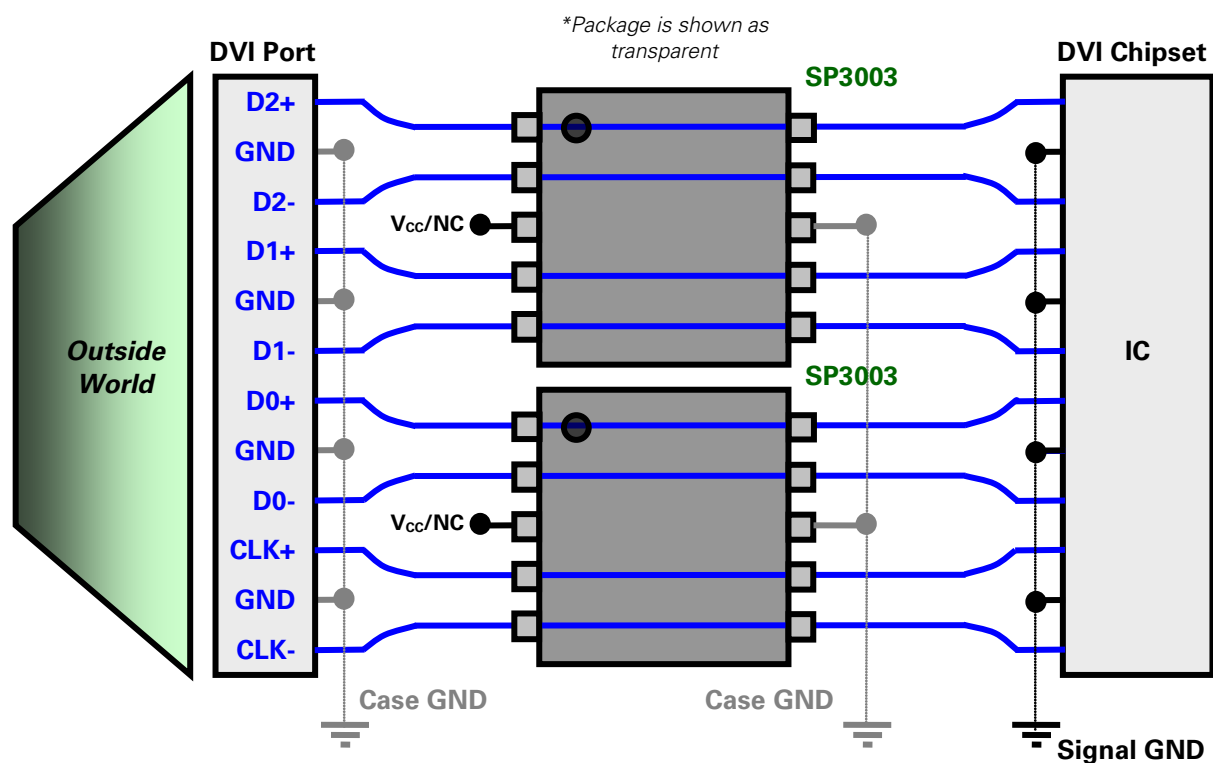
## APPLICATION SPECIFIC DEVICE SELECTION

## DVI

### Considerations:

- A DVI port may have single or dual link capability
  - Each link has 3 differential lanes of data (i.e. **D0±, D1±, D2±**) plus a clock (**CLK±**)
  - For single link, the maximum throughput can approach a total of 4.95Gbps or 1.65Gbps per lane
  - For dual link, the maximum throughput can approach a total of 8Gbps or 2.67Gbps per lane
- To maintain signal integrity a very low capacitance device must be used
- To maintain the differential impedance the designer should avoid using 90° angles and vias
  - This can be accomplished by the use of an ESD device that offers a “straight-through” routing scheme
- Requires 8 channels of protection per port (**D0±, D1±, D2±, CLK±**)

### Application Schematic:



### Recommended SPA Devices:

| Ordering Number | ESD Level<br>(Contact) | I/O Capacitance @<br>V <sub>R</sub> =1.65V | # of Channels | V <sub>RWM</sub> | Packaging |
|-----------------|------------------------|--------------------------------------------|---------------|------------------|-----------|
| SP3003-04ATG    | ±8kV                   | 0.65pF                                     | 4             | 6V               | MSOP-10   |
| SP3010-04UTG    | ±8kV                   | 0.45pF                                     | 4             | 6V               | μDFN-10   |

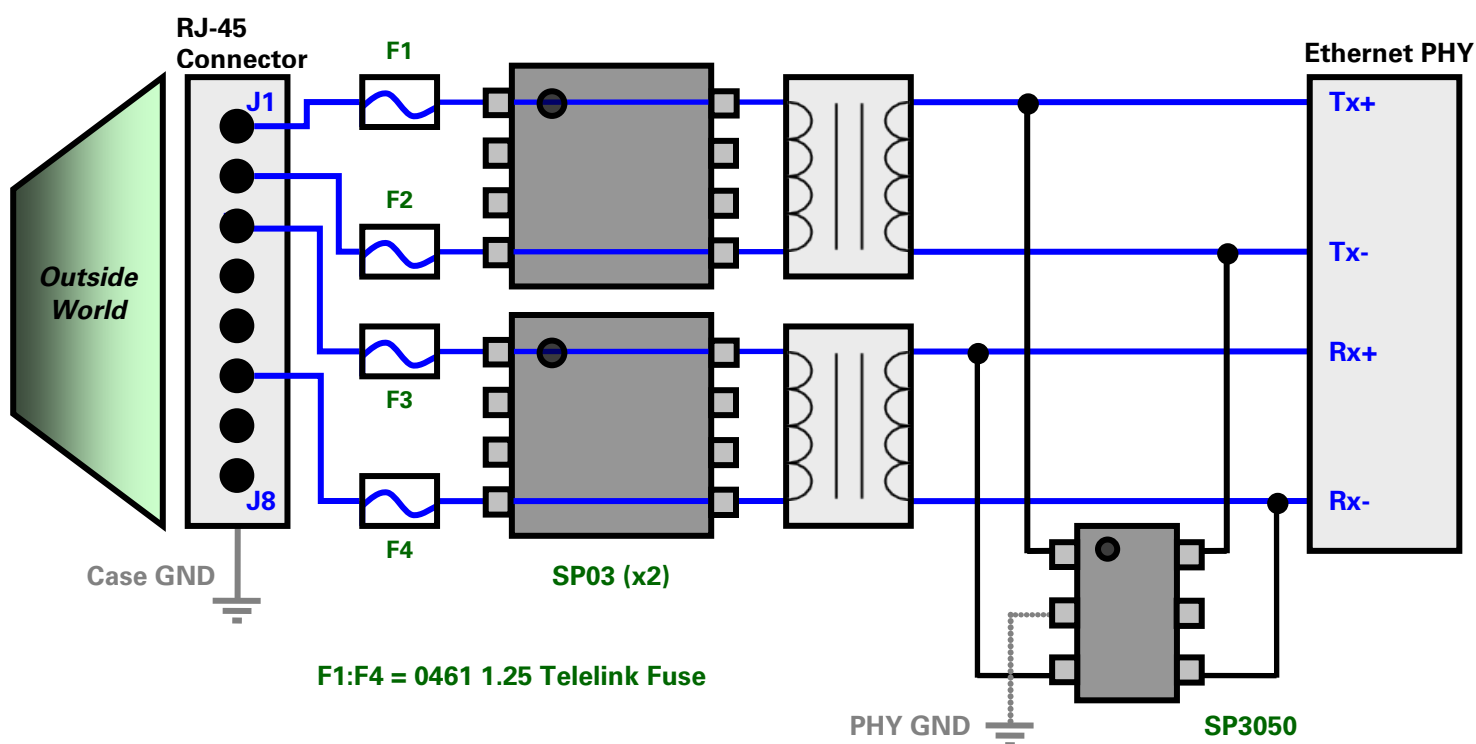
## APPLICATION SPECIFIC DEVICE SELECTION

10/100/1000 Ethernet, Intra-building Lighting Immunity (GR-1089)

### Considerations:

- 10/100/1000 relates to the data rate in Mbps (i.e. 10Mbps, 100Mbps, and 1000Mbps)
  - For 10 Base-T, data is transmitted over 2 UTP (unshielded twisted pairs) using a 10MHz clock
  - For 100 Base-TX, data is transmitted over 2 UTP using a 125MHz clock
  - For 1000 Base-T data is transmitted over 4 UTP using a 125MHz clock
  - For these data rates the parasitic capacitance needs to be taken into account to preserve signal integrity
- The 4 data lines below (**Tx±** and **Rx±**) are being protected against intra-building (i.e. 100A,  $t_p=2/10\mu s$ ) lightning transients by a two-stage protection scheme
- 1000Mbps Ethernet (or 1GbE) will require 8 channels of protection for the 4 differential pair so the below scheme should be replicated for the remaining 2 data pair

### Application Schematic:



### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Lightning ( $t_p=8/20\mu s$ ) | I/O Capacitance @ $V_R=0V$ | # of Channels | $V_{RWM}$ | Packaging |
|-----------------|---------------------|-------------------------------|----------------------------|---------------|-----------|-----------|
| SP03-xBTG       | $\pm 30kV$          | 150A                          | 8pF (I/O to I/O)           | 2             | 3.3V, 6V  | SOIC-8    |
| SP3050-04HTG    | $\pm 20kV$          | 10A                           | 2.4pF                      | 4             | 6V        | SOT23-6   |

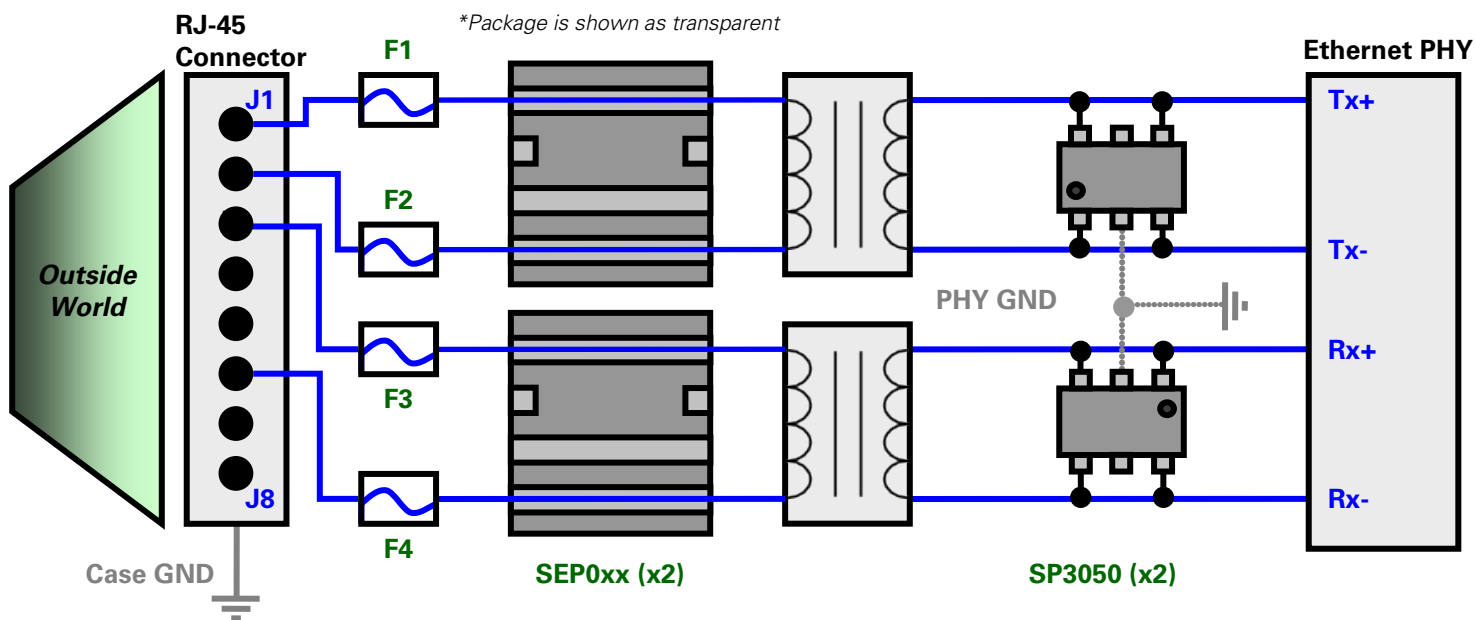
## APPLICATION SPECIFIC DEVICE SELECTION

10/100/1000 Ethernet, Inter-building Lighting Immunity (GR-1089)

### Considerations:

- 10/100/1000 relates to the data rate in Mbps (i.e. 10Mbps, 100Mbps, and 1000Mbps)
  - For 10 Base-T, data is transmitted over 2 UTP (unshielded twisted pairs) using a 10MHz clock
  - For 100 Base-TX, data is transmitted over 2 UTP using a 125MHz clock
  - For 1000 Base-T data is transmitted over 4 UTP using a 125MHz clock
  - For these data rates the parasitic capacitance needs to be taken into account to preserve signal integrity
- The 4 data lines below are being protected against inter-building (i.e. 500A,  $t_F=2/10\mu s$ ) lightning transients by a two-stage protection scheme. The 8 channel, SP4060 can be used in place of the SP3050 if a lower clamping and higher surge rated device is needed.
- The standoff voltage of the SEP Series device will be dictated by the use of PoE. If PoE is present the SEP0640 should be used; otherwise, the SEP0080 is ok for non-PoE applications. *Note: Higher voltage options are available for atypical PoE voltages.*
- 1000Mbps Ethernet (or 1GbE) will require 8 channels of protection for the 4 differential pair so the below scheme should be replicated for the remaining 2 data pair

### Application Schematic:



**F1:F4 = 0461 1.25 Telelink Fuse**

### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Lightning ( $t_F=8/20\mu s$ ) | I/O Capacitance @ $V_R=0V$ | # of Channels | $V_{RWM}$ | Packaging |
|-----------------|---------------------|-------------------------------|----------------------------|---------------|-----------|-----------|
| SEP0080Q38CB    | $\pm 30kV$          | 400A                          | See datasheet              | 2             | 6V        | QFN       |
| SEP0640Q38CB    | $\pm 30kV$          | 400A                          | See datasheet              | 2             | 58V       | QFN       |
| SP3050-04HTG    | $\pm 20kV$          | 10A                           | 2.4pF                      | 4             | 6V        | SOT23-6   |
| SP4060-08ATG    | $\pm 30kV$          | 20A                           | 4.4pF                      | 8             | 2.5V      | MSOP-8    |

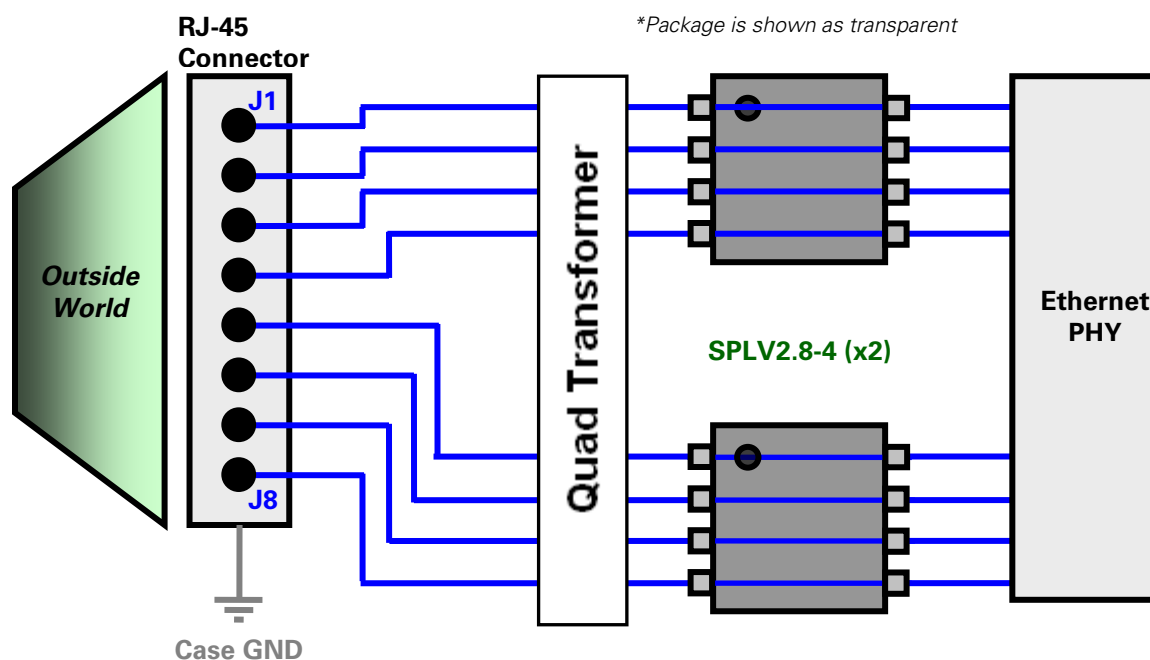
## APPLICATION SPECIFIC DEVICE SELECTION

10/100/1000 Ethernet, General Lighting Immunity (GR-1089)

### Considerations:

- 10/100/1000 relates to the data rate in Mbps (i.e. 10Mbps, 100Mbps, and 1000Mbps)
  - For 10 Base-T, data is transmitted over 2 UTP (unshielded twisted pairs) using a 10MHz clock
  - For 100 Base-TX, data is transmitted over 2 UTP using a 125MHz clock
  - For 1000 Base-T data is transmitted over 4 UTP using a 125MHz clock
  - For these data rates the parasitic capacitance needs to be taken into account to preserve signal integrity
- Some designers choose to use a robust transformer in their design to act as the first line of protection against an incoming surge event. This is usually done to minimize the parasitic capacitance on the data line and to save on the cost of the primary protector
- Using such a technique will require a robust PHY side protection device and one such option is the SPLV2.8-4 shown below. It should be noted that this device will only provide differential protection between the data pairs
- If longitudinal and differential protection are required, the SP3050-04HTG (with 2 I/O's tied per line) or SP4060-08ATG can be considered as alternatives
- Protection for 1000Mbps Ethernet (or 1GbE) is shown below. For 10 or 100Mbps interfaces only 1 SPLV2.8-4BTG is required

### Application Schematic:



### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Lightning ( $t_F=8/20\mu s$ ) | I/O Capacitance @ $V_R=0V$ | # of Channels | $V_{RWM}$ | Packaging |
|-----------------|---------------------|-------------------------------|----------------------------|---------------|-----------|-----------|
| SPLV2.8-4BTG    | $\pm 30kV$          | 24A                           | 3.8pF                      | 4             | 2.8V      | SOIC-8    |
| SP3050-04HTG    | $\pm 20kV$          | 10A                           | 2.4pF                      | 4             | 6V        | SOT23-6   |
| SP4060-08ATG    | $\pm 30kV$          | 20A                           | 4.4pF                      | 8             | 2.5V      | MSOP-8    |

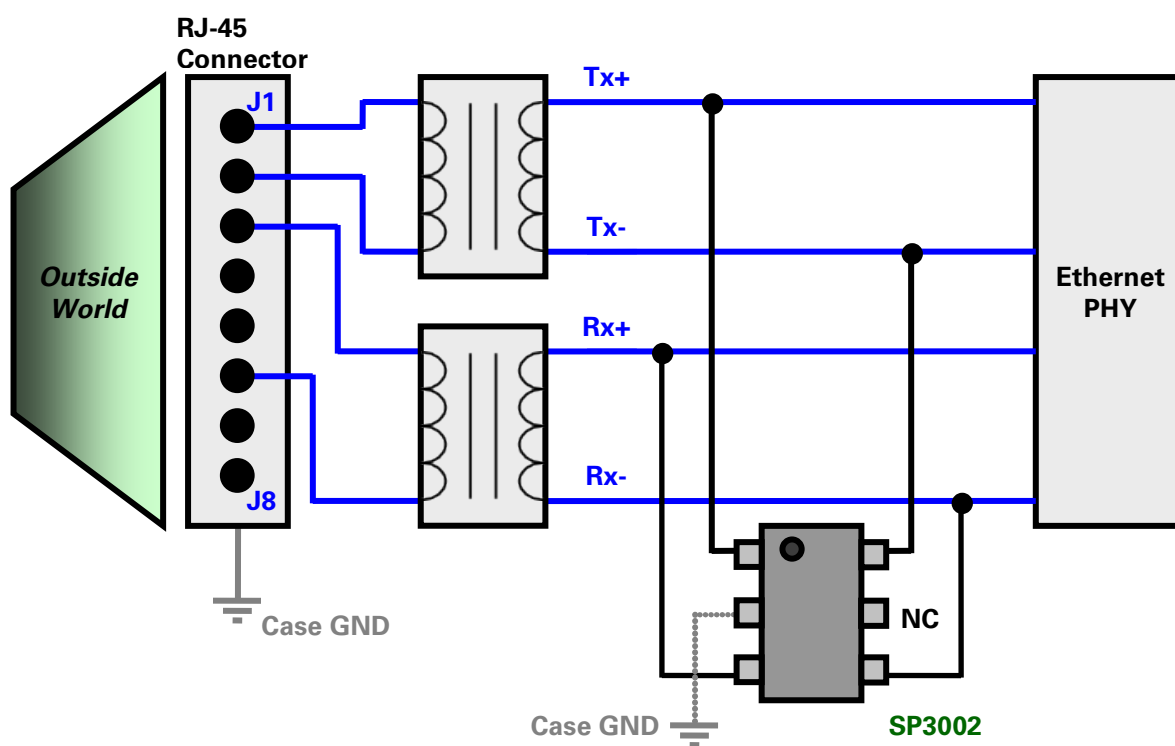
## APPLICATION SPECIFIC DEVICE SELECTION

10/100/1000 Ethernet (ESD only)

### Considerations:

- Some Ethernet ports only need be protected for ESD and not for lightning induced transients
  - These are sometimes referred to as “2M” ports or 2 Meter ports that have very short CAT5 cable installations
- Parasitic capacitance should be taken into account especially for 1GbE
- The 4 data lines below ( $Tx_{\pm}$  and  $Rx_{\pm}$ ) are being protected against ESD by a low capacitance SP3002 which is suitable for all Ethernet data rates
  - In fact, any low capacitance SP30xx device is suitable for any “ESD only” Ethernet application
- 1000Mbps Ethernet (or 1GbE) will require 8 channels of protection for the 4 differential pair so the below scheme should be replicated for the remaining 2 data pair

### Application Schematic:



### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Lightning ( $t_F=8/20\mu s$ ) | I/O Capacitance @ $V_R=1.65V$ | # of Channels | $V_{RWM}$ | Packaging |
|-----------------|---------------------|-------------------------------|-------------------------------|---------------|-----------|-----------|
| SP3002-04JTG    | $\pm 12kV$          | 4.5A                          | 0.85pF                        | 4             | 6V        | SC70-6    |
| SP3003-04XTG    | $\pm 8kV$           | 2.5A                          | 0.65pF                        | 4             | 6V        | SOT563    |
| SP3004-04XTG    | $\pm 12kV$          | 4A                            | 0.85pF                        | 4             | 6V        | SOT563    |

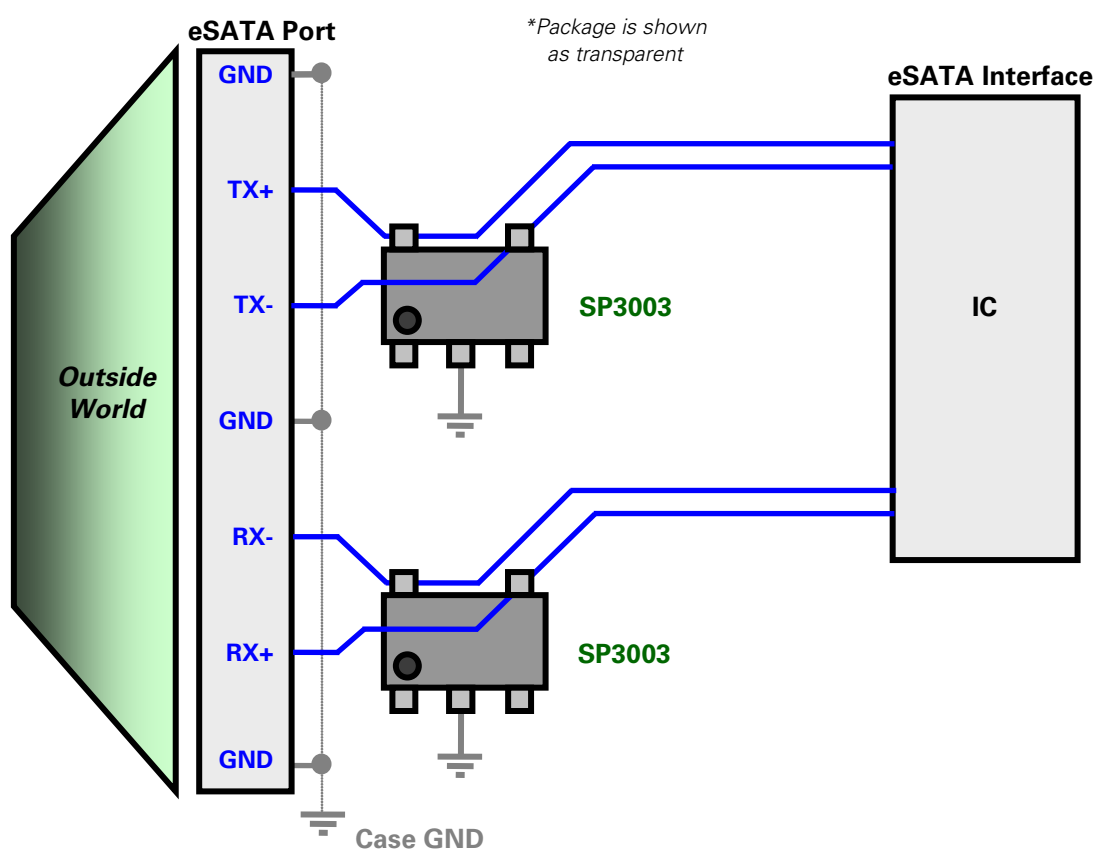
## APPLICATION SPECIFIC DEVICE SELECTION

### eSATA

#### Considerations:

- eSATA is a subset of the SATA protocol that uses 2 differential pairs for communication
  - Four lines need to be protected per port (i.e. TX $\pm$  and RX $\pm$ )
  - Currently eSATA is capable of running raw data rates of 1.5Gbps (Gen 1) and 3.0Gbps (Gen 2)
- These high bus speeds require very low capacitance devices to prevent signal degradation
- To maintain the line impedance the designer should avoid using 90° angles and vias

#### Application Schematic:



#### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | I/O Capacitance @ $V_R=1.65V$ | # of Channels | $V_{RWM}$ | Packaging    |
|-----------------|---------------------|-------------------------------|---------------|-----------|--------------|
| SP3003-02XTG    | $\pm 8kV$           | 0.65pF                        | 2             | 6V        | SOT553       |
| SP3003-04JTG    | $\pm 8kV$           | 0.65pF                        | 4             | 6V        | SC70-6       |
| SP3010-04UTG    | $\pm 8kV$           | 0.45pF                        | 4             | 6V        | $\mu$ DFN-10 |

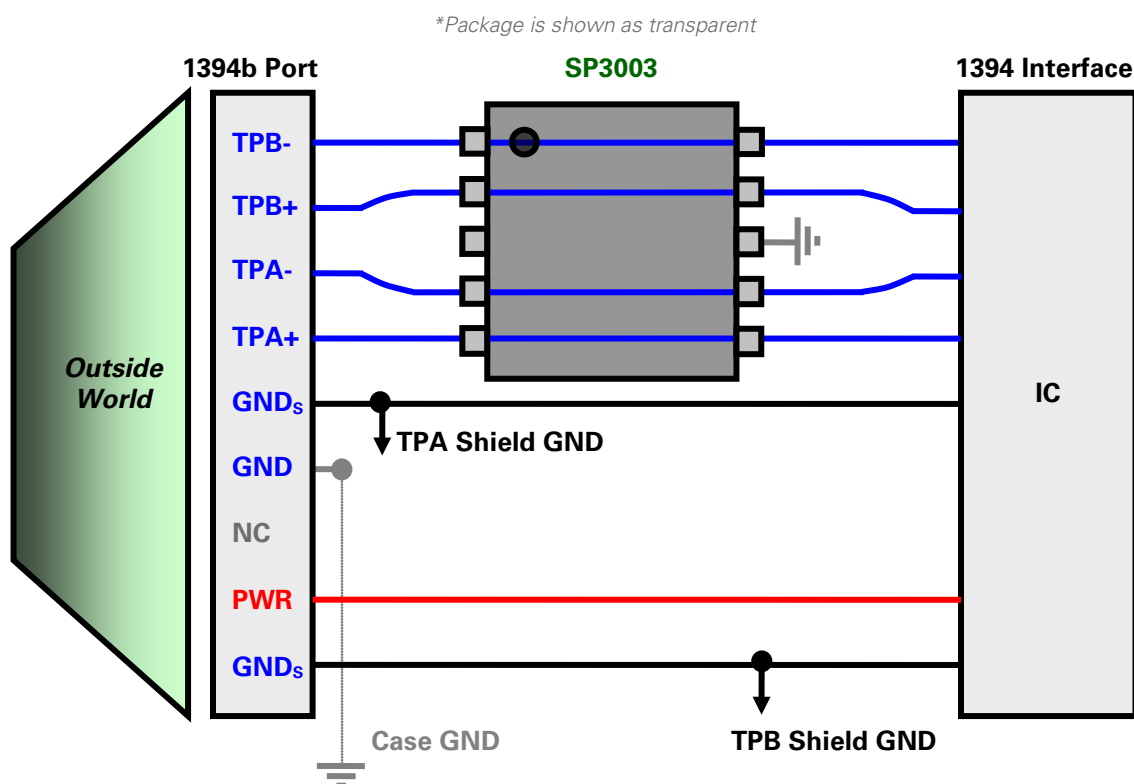
## APPLICATION SPECIFIC DEVICE SELECTION

1394a/b

### Considerations:

- 1394a (FireWire 400 or S400) was the original (1<sup>st</sup> generation) implementation
  - Allowed for two connectors, powered (6 pin) and unpowered (4 pin)
  - Data rates up to 400Mbps using 2 differential pair
- 1394b (FireWire 800 or S800) was the 2<sup>nd</sup> generation
  - Required a new 9 pin connector but was backwards compatible to S400
  - Data rates up to 800Mbps using 2 differential pair
- 1394b also had provisions for 1600Mbps and 3200Mbps (or S1600 and S3200)
  - Uses same 9 pin connector as S800
- S800, S1600, and S3200 require very low capacitance devices for the high speed data rates
  - Protection of 4 data lines is needed (i.e. **TPB±** and **TPA±**)

### Application Schematic:



### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | I/O Capacitance @ V <sub>R</sub> =1.65V | # of Channels | V <sub>RWM</sub> | Packaging |
|-----------------|---------------------|-----------------------------------------|---------------|------------------|-----------|
| SP3003-04ATG    | ±8kV                | 0.65pF                                  | 4             | 6V               | MSOP-10   |
| SP3010-04UTG    | ±8kV                | 0.45pF                                  | 4             | 6V               | μDFN-10   |

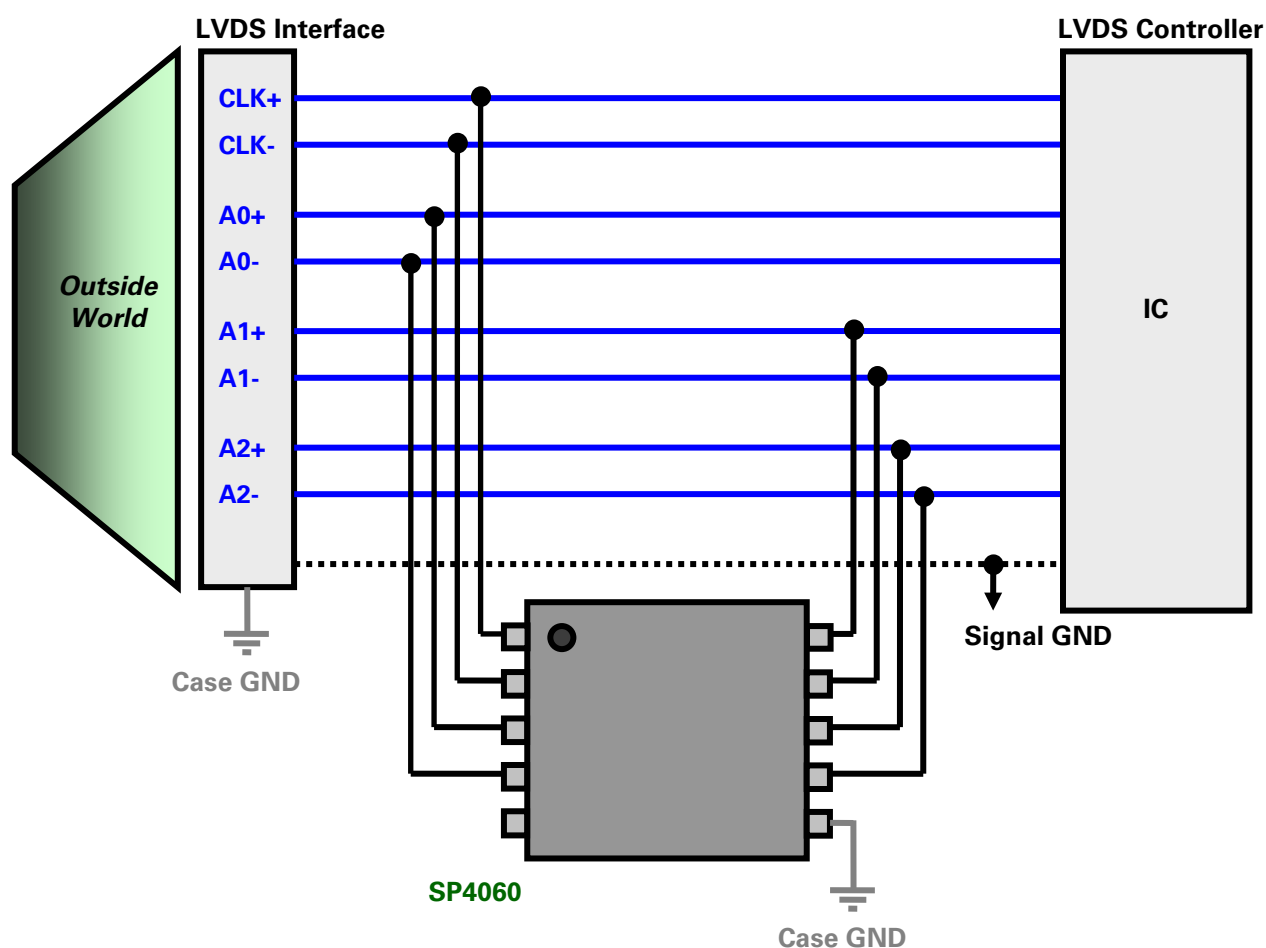
## APPLICATION SPECIFIC DEVICE SELECTION

LVDS (Low Voltage Differential Signaling)

### Considerations:

- LVDS is a low noise, low-voltage signal scheme that uses a small current (typically 3.5mA) to generate a voltage drop across a 100Ω resistor to convey information or data
  - Data rates can vary per application but the ANSI/TIA/EIA-644-A standard recommends a maximum of 655Mbps
- The medium/high speed bus requires a low capacitance device in 1-6pF range (typically)
  - LVDS schemes will vary in terms of the total number of channels used
  - Protection of 8 data lines is shown below (i.e. CLK± and Ax±)

### Application Schematic:



### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Lightning ( $t_p=8/20\mu s$ ) | I/O Capacitance @ $V_R=0V$ | # of Channels | $V_{RWM}$ | Packaging |
|-----------------|---------------------|-------------------------------|----------------------------|---------------|-----------|-----------|
| SP4060-08ATG    | ±30kV               | 20A                           | 4.4pF                      | 8             | 2.5V      | MSOP-10   |
| SP3050-04HTG    | ±20kV               | 10A                           | 2.4pF                      | 4             | 6V        | SOT23-6   |

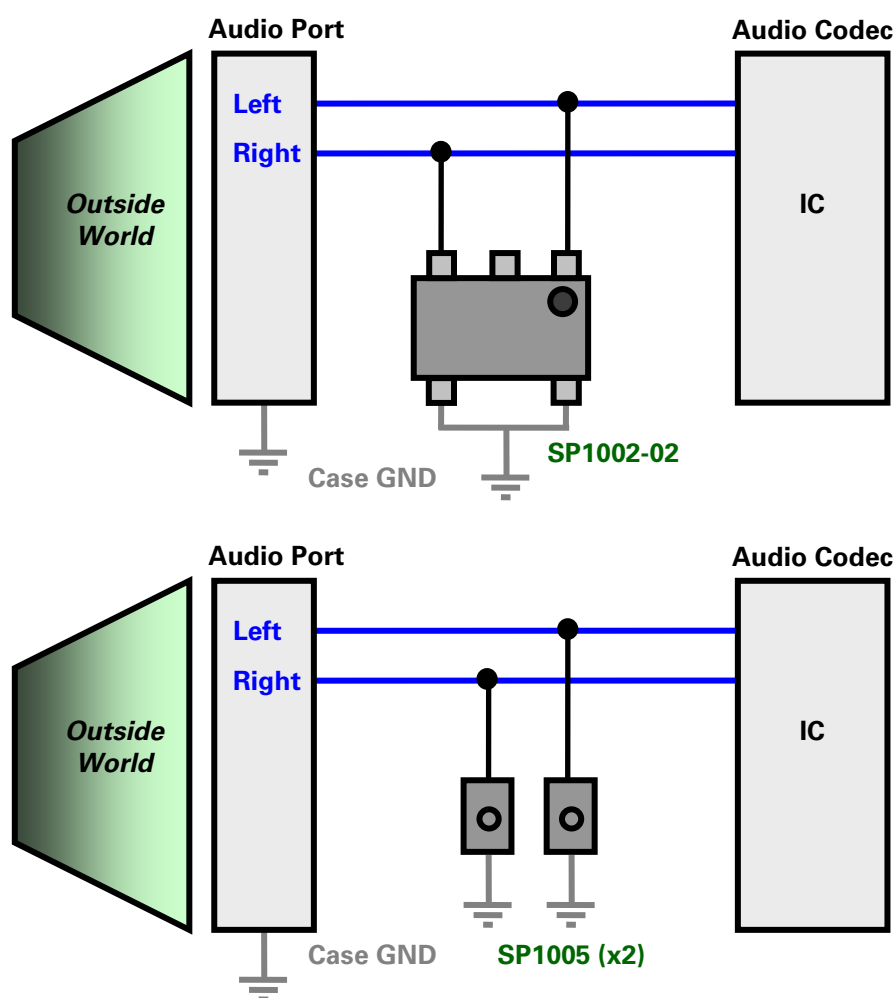
## APPLICATION SPECIFIC DEVICE SELECTION

Audio (Speaker/Microphone)

### Considerations:

- Audio ports typically have signals that swing above and below GND (i.e.  $\pm 2.5V$ )
  - If no DC bias is applied, a bidirectional protection device should be used as these devices will not clip the analog signal
  - Protection of 2 data lines is shown below (i.e. **Left** and **Right**) with an array and with discrete 0201s
- Some audio ports will bias the data bus so that the signal never swings below GND (i.e. 0-5V)
  - If a bias is applied, a unidirectional OR bidirectional protection device could be used as neither device would clip the analog signal
  - The **SP1001-02XTG** is a good option in this case (not shown for **Left** and **Right** but is listed below)

### Application Schematic:



### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Lightning ( $t_P=8/20\mu s$ ) | I/O Capacitance @ $V_R=2.5V$ | # of Channels | $V_{RWM}$ | Packaging     |
|-----------------|---------------------|-------------------------------|------------------------------|---------------|-----------|---------------|
| SP1002-02JTG    | $\pm 8kV$           | 2A                            | 5pF                          | 2             | 6V        | SC70-5        |
| SP1005-01WTG    | $\pm 30kV$          | 10A                           | 23pF                         | 1             | 6V        | 0201 Flipchip |
| SP1001-02XTG    | $\pm 15kV$          | 2A                            | 8pF                          | 2             | 5.5V      | SOT553        |

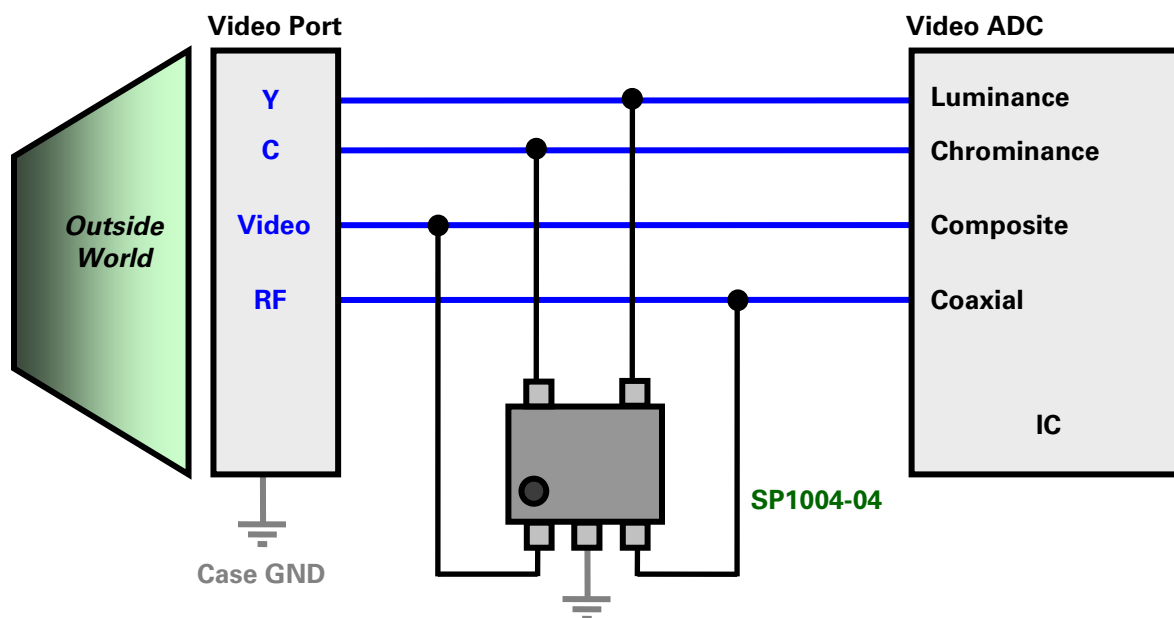
## APPLICATION SPECIFIC DEVICE SELECTION

### Analog Video

#### Considerations:

- Analog video ports typically have signals that swing above and below GND (i.e.  $\pm 2V$ )
  - A bidirectional protection device should be used as these devices will not clip the analog signal
- S-Video, Composite, and RF/Coaxial are a few of the common low-speed analog video signals in use today
  - Typical bus speeds will not exceed 5MHz so capacitance is not much of a concern
  - Protection of the three are shown below (Y, C, Video, and RF)

#### Application Schematic:



#### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Lightning ( $t_p=8/20\mu s$ ) | I/O Capacitance @ $V_R=2.5V$ | # of Channels | $V_{RWM}$ | Packaging     |
|-----------------|---------------------|-------------------------------|------------------------------|---------------|-----------|---------------|
| SP1004-04VTG    | $\pm 8kV$           | 2A                            | 4.5pF                        | 4             | 6V        | SOT953        |
| SP1002-01JTG    | $\pm 8kV$           | 2A                            | 5pF                          | 1             | 6V        | SC70-3        |
| SP1002-02JTG    | $\pm 8kV$           | 2A                            | 5pF                          | 2             | 6V        | SC70-5        |
| SP1005-01WTG    | $\pm 30kV$          | 10A                           | 23pF                         | 1             | 6V        | 0201 Flipchip |
| SP1007-01WTG    | $\pm 8kV$           | 2A                            | 3.5pF                        | 1             | 6V        | 0201 Flipchip |

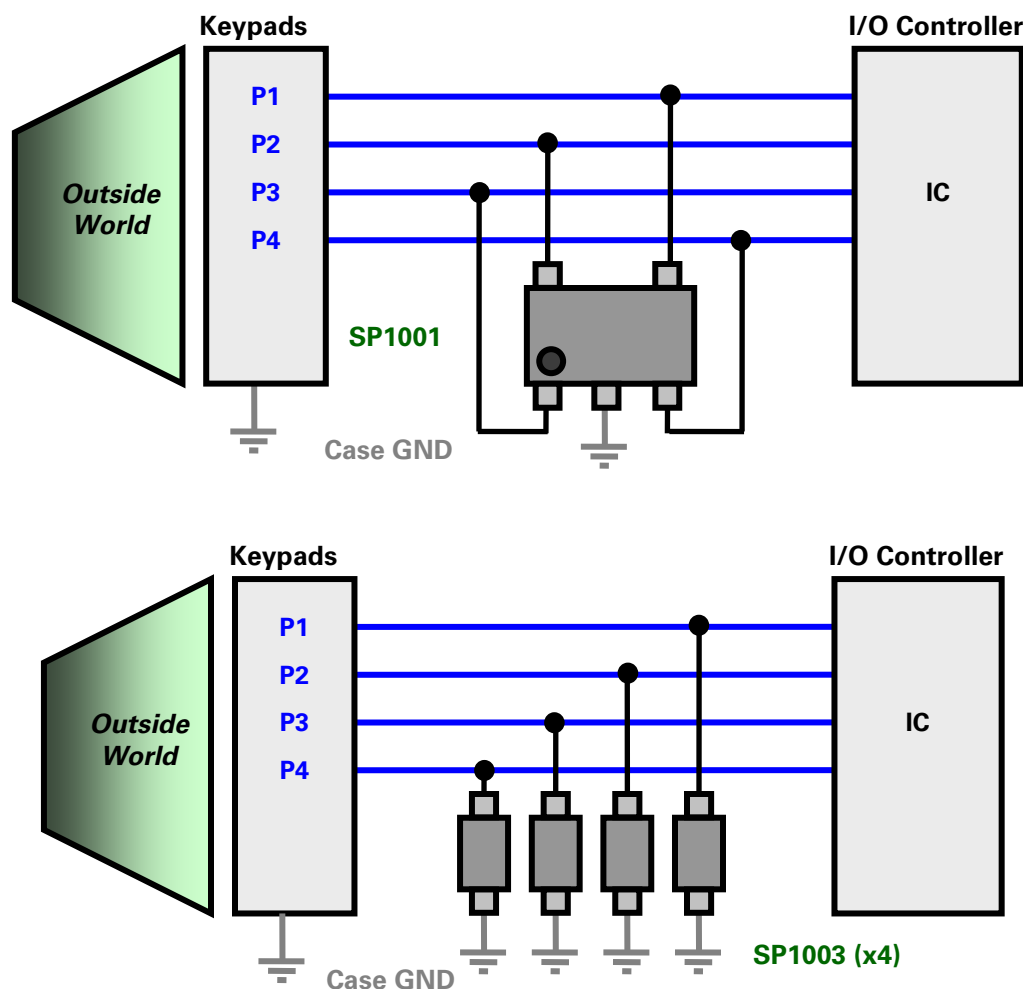
## APPLICATION SPECIFIC DEVICE SELECTION

### Keypad/Push Buttons

#### Considerations:

- Keypads and push buttons on electronic devices are particularly susceptible to ESD due to constant human interaction
  - Most are DC switches that operate at less than 5V, and for most applications capacitance will not be a concern
- The number of ports will vary with the particular application, but as an example, 4 data lines are shown below (i.e.Px)
- For space constrained applications the SP1003 or SP1005 may be considered as they are 0402 and 0201 footprints, respectively

#### Application Schematics:



#### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Lightning ( $t_r=8/20\mu s$ ) | I/O Capacitance @ $V_R=2.5V$ | # of Channels | $V_{RWM}$ | Packaging     |
|-----------------|---------------------|-------------------------------|------------------------------|---------------|-----------|---------------|
| SP1001-04XTG    | $\pm 15kV$          | 2A                            | 8pF                          | 4             | 6V        | SOT553        |
| SP1003-01DTG    | $\pm 25kV$          | 7A                            | 17pF                         | 1             | 5V        | SOD723        |
| SP1005-01WTG    | $\pm 30kV$          | 10A                           | 23pF                         | 1             | 6V        | 0201 Flipchip |

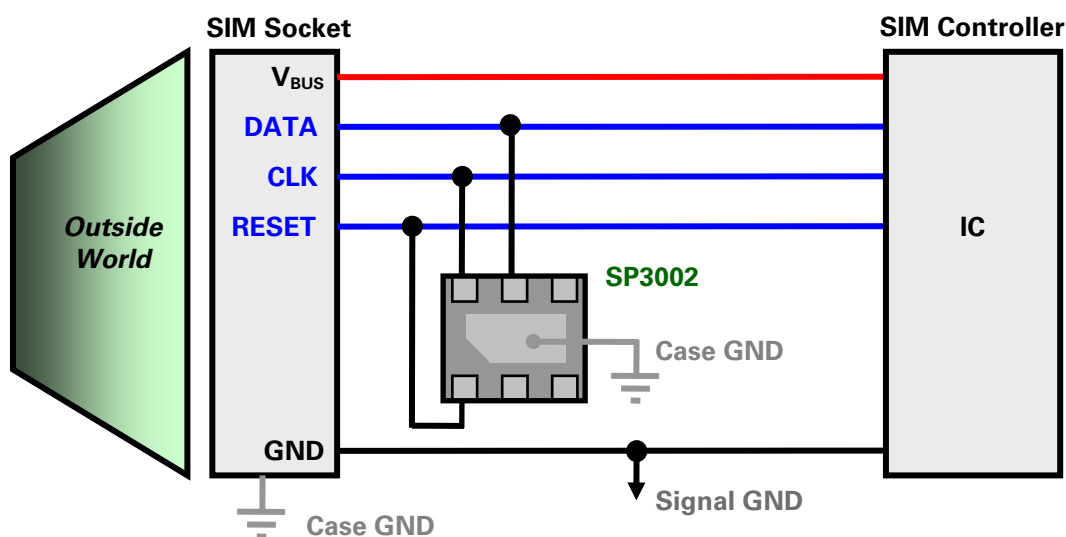
## APPLICATION SPECIFIC DEVICE SELECTION

### SIM Socket

#### Considerations:

- The SIM (Subscriber Identification Module) card has 3 data lines that are low-speed and low-voltage
  - Given the low speed of the signals, the capacitance will not be a concern
- The low-voltage signal lines are best protected by a device which has a low standoff voltage or  $V_{RWM}$
- Protection of the 3 data lines is shown below (i.e. **CLK**, **DATA**, and **RESET**)

#### Application Schematics:



#### Recommended SPA Devices:

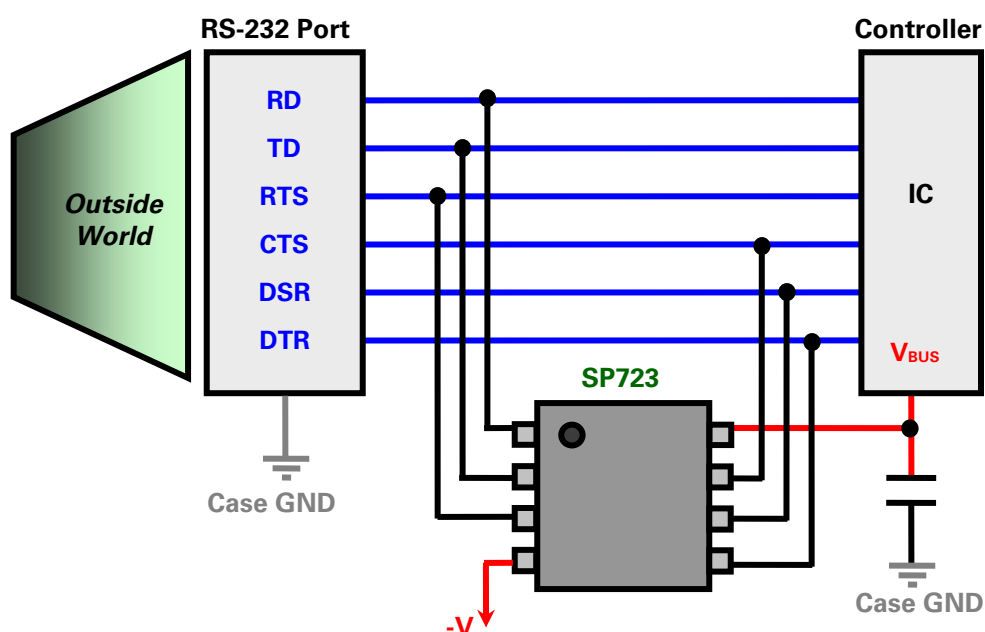
| Ordering Number | ESD Level (Contact) | Lightning ( $t_P=8/20\mu s$ ) | I/O Capacitance @ $V_R=1.65V$ | # of Channels | $V_{RWM}$ | Packaging                |
|-----------------|---------------------|-------------------------------|-------------------------------|---------------|-----------|--------------------------|
| SP3002-04UTG    | $\pm 12kV$          | 4.5A                          | 0.85pF                        | 4             | 6V        | $\mu DFN-6$ (1.6x1.6mm)  |
| SP1011-04UTG    | $\pm 15kV$          | 2A                            | 7pF                           | 4             | 6V        | $\mu DFN-6$ (1.25x1.0mm) |

## APPLICATION SPECIFIC DEVICE SELECTION

RS-232

### Considerations:

- There are numerous implementations of RS-232
  - Most involve 6 wires (as shown below) though some may only include 2, 3, or 5 wires
  - The maximum data rate is 20kbps
  - Typically bus voltages are bipolar and can swing as high as  $\pm 24V$  though most installations are limited to  $\pm 12V$  or even lower
  - For  $\pm 12V$  systems the SP72x Series is recommended and shown below
- Some implementations are a unipolar (i.e. 0-3.3V or 0-5V) or use bus voltages generally below 6V
  - In this event the SP1001 Series can be used for ESD protection or the SP03 Series could be used if lightning is the primary threat
- Every application should be evaluated thoroughly before using the recommended devices below



### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Lightning ( $t_P=8/20\mu s$ ) | I/O Capacitance @ $V_R=1.65V$ | # of Channels | $V_{RWM}$ | Packaging |
|-----------------|---------------------|-------------------------------|-------------------------------|---------------|-----------|-----------|
| SP721ABTG       | $\pm 4kV$           | 3A                            | 3pF                           | 6             | 30V       | SOIC-8    |
| SP723ABTG       | $\pm 8kV$           | 7A                            | 5pF                           | 6             | 30V       | SOIC-8    |
| SP724AHTG       | $\pm 8kV$           | 3A                            | 3pF                           | 4             | 20V       | SOT23-6   |
| SP725ABTG       | $\pm 8kV$           | 14A                           | 5pF                           | 4             | 30V       | SOIC-8    |

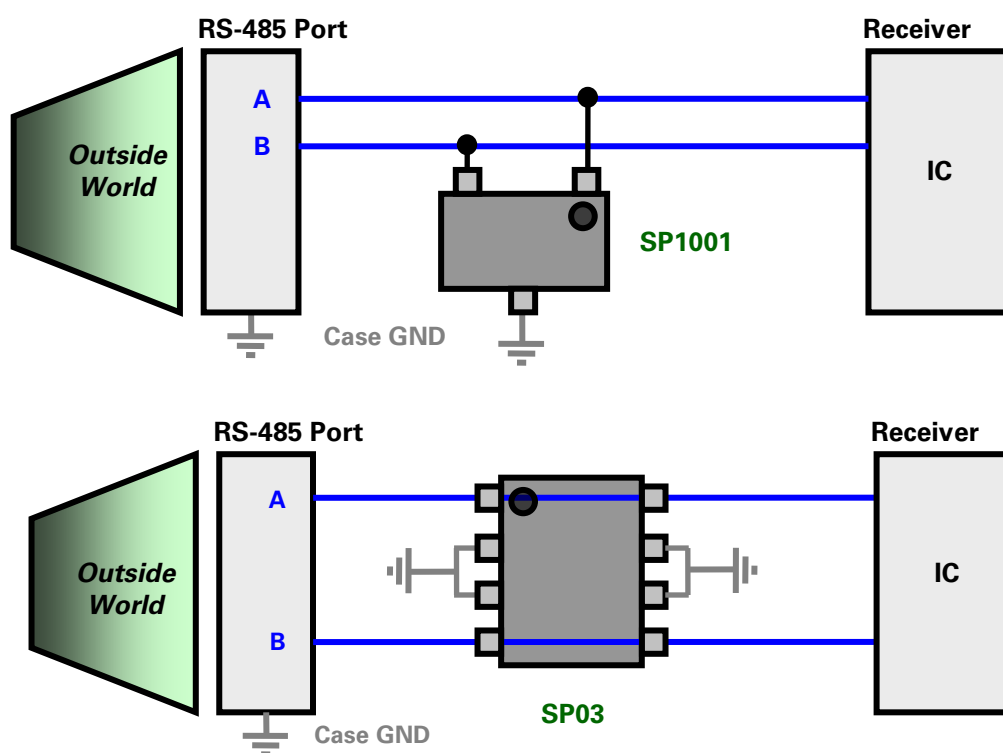
## APPLICATION SPECIFIC DEVICE SELECTION

### RS-485

#### Considerations:

- There are numerous implementations and applications of RS-485
  - Most applications involve two wires (i.e. **A** and **B**) while a few are four wire (i.e. full duplex)
  - Depending on cable length, data rates can vary from 100kbps-10Mbps
  - Bus voltages can be unipolar (i.e. 0-6V) or bipolar (i.e.  $\pm 3V$ ) and every application should be evaluated thoroughly before using the recommended devices below
- For a unipolar bus with a voltage  $\leq 6V$  (MAX):
  - The SP1001 Series is shown for ESD protection only
  - The SP03 Series is shown for lightning/surge protection
- For differential protection between **A** and **B**, the GND connection can be removed from the schematics below
- For a bipolar bus with a maximum voltage swing of  $\pm 3V$ :
  - The SP1002 or SP1004 Series can be used ESD protection only
  - The SP03 Series (x2) can still be used for lightning/surge protection with one I/O tied to GND

#### Application Schematic:



#### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Lightning ( $t_p=8/20\mu s$ ) | I/O Capacitance @ $V_R=2.5V/0V$ | # of Channels | $V_{RWM}$ | Packaging |
|-----------------|---------------------|-------------------------------|---------------------------------|---------------|-----------|-----------|
| SP1001-02JTG    | $\pm 15kV$          | 2A                            | 8pF                             | 2             | 6V        | SC70-3    |
| SP03-xBTG       | $\pm 30kV$          | 150A                          | 16pF                            | 2             | 3.3V, 6V  | SOIC-8    |

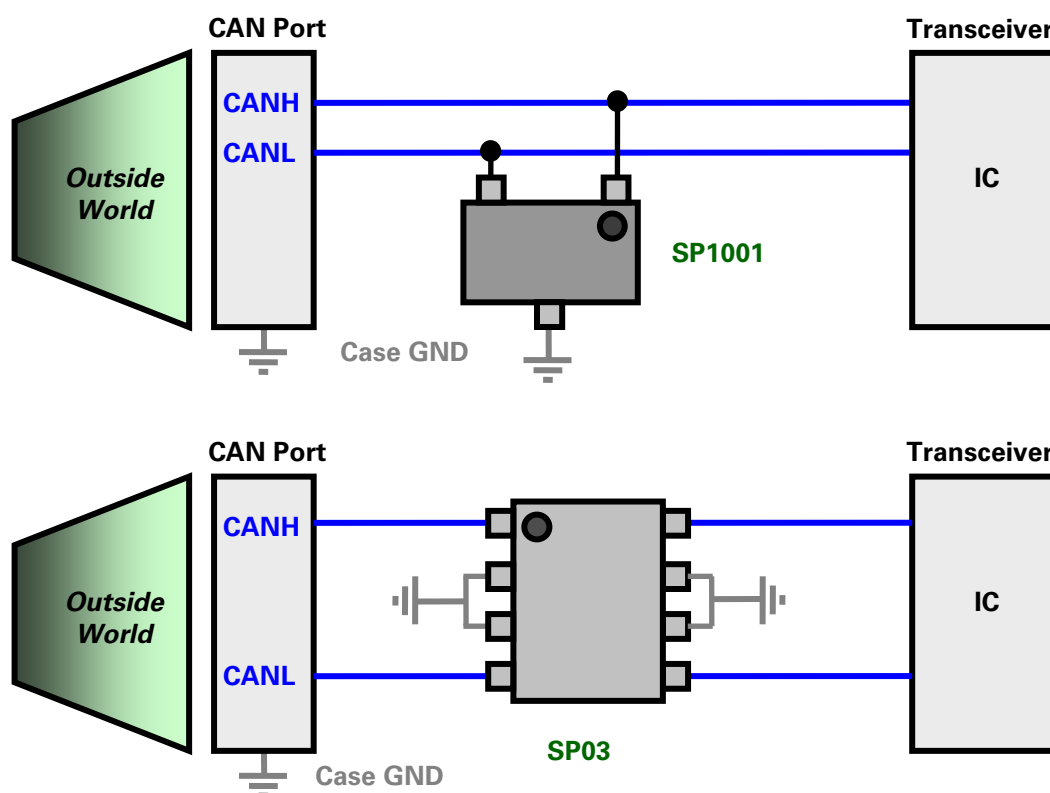
## APPLICATION SPECIFIC DEVICE SELECTION

### CAN Bus

#### Considerations:

- There are numerous implementations and applications of a CAN bus
  - Most applications involve two wires (i.e. **CANH** and **CANL**)
  - Depending on cable length, data rates can vary from 10kbps-1Mbps
  - Most applications do not exceed 0-5V to transmit a Low/High signal, however, every application should be evaluated thoroughly before using the recommended devices below
- For the described application of unipolar bus with voltages between 0 and 5V:
  - The SP1001 Series is shown for ESD protection only
  - The SP03 Series is shown for lightning/surge protection
- For differential protection between **CANH** and **CANL**, the GND connection can be removed from the schematics below

#### Application Schematic:



#### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Lightning ( $t_p=8/20\mu s$ ) | I/O Capacitance @ $V_R=2.5V/0V$ | # of Channels | $V_{RWM}$ | Packaging |
|-----------------|---------------------|-------------------------------|---------------------------------|---------------|-----------|-----------|
| SP1001-02JTG    | $\pm 15kV$          | 2A                            | 8pF                             | 2             | 6V        | SC70-3    |
| SP03-xBTG       | $\pm 30kV$          | 150A                          | 16pF                            | 2             | 3.3V, 6V  | SOIC-8    |

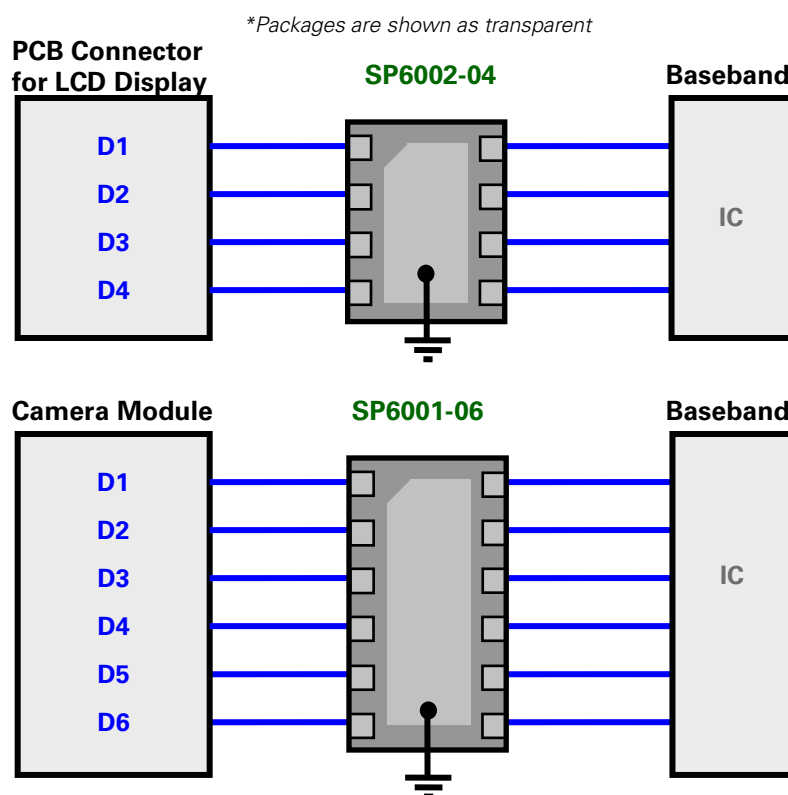
## APPLICATION SPECIFIC DEVICE SELECTION

LCD and Camera Interfaces (Mobile)

### Considerations:

- LCD and camera interfaces in mobile devices are vulnerable to EMI from the cellular band
  - Frequencies between 800-3000MHz should be attenuated to prevent distortion on the display
- The pixel clocks vary depending upon the display size but the frequency will typically fall between 5-65MHz
  - This corresponds to data rates between 10-60Mbps and with these speeds line capacitances need to be considered
  - In the majority of applications line capacitances of 20-40pF will not cause signal integrity issues
- The protection schemes below for data lines **Dx** are only examples and will vary with the particular application

### Application Schematic:



### Recommended SPA Devices:

| Ordering Number | ESD Level (Contact) | Cut-off Frequency | Line Capacitance @ $V_R=2.5V$ | # of Channels | $V_{RWM}$ | Packaging         |
|-----------------|---------------------|-------------------|-------------------------------|---------------|-----------|-------------------|
| SP6001-0xUTG-1  | $\pm 30kV$          | 115MHz            | 24pF                          | 4/6/8         | 6V        | $\mu$ DFN-8/12/16 |
| SP6002-0xUTG-1  | $\pm 30kV$          | 100MHz            | 30pF                          | 4/6           | 6V        | $\mu$ DFN-8/12    |
| SP6003-0xUTG-1  | $\pm 15kV$          | 175MHz            | 14pF                          | 4/6           | 6V        | $\mu$ DFN-8/12    |

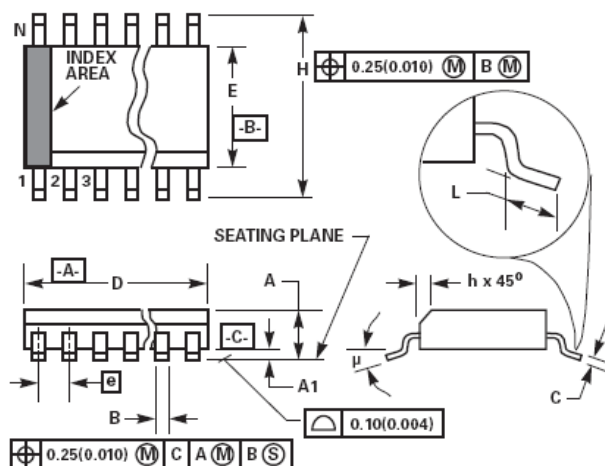
## APPENDIX A

### SPA Package Outlines

| PDIP-8         |                                  | <table><tr><th>Package</th><th colspan="5">PDIP</th></tr><tr><th>Pins</th><th colspan="5">8</th></tr><tr><th>JEDEC</th><th colspan="5">E8.3 (JEDEC MS-001-BA Issue D)</th></tr><tr><th rowspan="2"></th><th colspan="2">Millimeters</th><th colspan="2">Inches</th><th rowspan="2">Notes</th></tr><tr><th>Min</th><th>Max</th><th>Min</th><th>Max</th></tr><tr><td>A</td><td>-</td><td>5.33</td><td>-</td><td>0.210</td><td>4</td></tr><tr><td>A1</td><td>0.39</td><td>-</td><td>0.015</td><td>-</td><td>4</td></tr><tr><td>A2</td><td>2.93</td><td>4.95</td><td>0.115</td><td>0.195</td><td>-</td></tr><tr><td>B</td><td>0.356</td><td>0.558</td><td>0.014</td><td>0.022</td><td>-</td></tr><tr><td>B1</td><td>1.15</td><td>1.77</td><td>0.045</td><td>0.070</td><td>8, 10</td></tr><tr><td>C</td><td>0.204</td><td>0.355</td><td>0.008</td><td>0.014</td><td>-</td></tr><tr><td>D</td><td>9.01</td><td>10.16</td><td>0.355</td><td>0.400</td><td>5</td></tr><tr><td>D1</td><td>0.13</td><td>-</td><td>0.005</td><td>-</td><td>5</td></tr><tr><td>E</td><td>7.62</td><td>8.25</td><td>0.300</td><td>0.325</td><td>6</td></tr><tr><td>E1</td><td>6.1</td><td>7.11</td><td>0.240</td><td>0.280</td><td>5</td></tr><tr><td>e</td><td colspan="2">2.54 BSC</td><td colspan="2">0.100 BSC</td><td>-</td></tr><tr><td>e<sub>A</sub></td><td colspan="2">7.62 BSC</td><td colspan="2">0.300 BSC</td><td>6</td></tr><tr><td>e<sub>B</sub></td><td>-</td><td>10.92</td><td>-</td><td>0.430</td><td>7</td></tr><tr><td>L</td><td>2.93</td><td>3.81</td><td>0.115</td><td>0.150</td><td>4</td></tr><tr><td>N</td><td colspan="2">8</td><td colspan="2">8</td><td>9</td></tr></table>                 | Package   | PDIP   |       |  |  |  | Pins | 8                    |  |  |  |  | JEDEC | E8.3 (JEDEC MS-001-BA Issue D)   |  |  |  |  |  | Millimeters |  | Inches |  | Notes | Min | Max | Min | Max | A | -    | 5.33 | -      | 0.210  | 4 | A1 | 0.39 | -    | 0.015  | -      | 4 | A2 | 2.93 | 4.95 | 0.115 | 0.195 | - | B | 0.356 | 0.558 | 0.014  | 0.022  | - | B1 | 1.15 | 1.77  | 0.045  | 0.070  | 8, 10 | C | 0.204 | 0.355 | 0.008  | 0.014  | - | D | 9.01     | 10.16 | 0.355     | 0.400 | 5 | D1 | 0.13 | -    | 0.005  | -      | 5 | E | 7.62 | 8.25 | 0.300  | 0.325  | 6 | E1 | 6.1  | 7.11 | 0.240 | 0.280 | 5 | e | 2.54 BSC |  | 0.100 BSC |  | - | e <sub>A</sub> | 7.62 BSC |    | 0.300 BSC |    | 6 | e <sub>B</sub> | - | 10.92 | - | 0.430 | 7 | L | 2.93 | 3.81 | 0.115 | 0.150 | 4 | N | 8  |  | 8  |  | 9 |
|----------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------|-------|--|--|--|------|----------------------|--|--|--|--|-------|----------------------------------|--|--|--|--|--|-------------|--|--------|--|-------|-----|-----|-----|-----|---|------|------|--------|--------|---|----|------|------|--------|--------|---|----|------|------|-------|-------|---|---|-------|-------|--------|--------|---|----|------|-------|--------|--------|-------|---|-------|-------|--------|--------|---|---|----------|-------|-----------|-------|---|----|------|------|--------|--------|---|---|------|------|--------|--------|---|----|------|------|-------|-------|---|---|----------|--|-----------|--|---|----------------|----------|----|-----------|----|---|----------------|---|-------|---|-------|---|---|------|------|-------|-------|---|---|----|--|----|--|---|
|                |                                  | Package                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | PDIP      |        |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| Pins           | 8                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |        |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| JEDEC          | E8.3 (JEDEC MS-001-BA Issue D)   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |        |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
|                | Millimeters                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Inches    |        | Notes |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
|                | Min                              | Max                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Min       | Max    |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| A              | -                                | 5.33                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | -         | 0.210  | 4     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| A1             | 0.39                             | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0.015     | -      | 4     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| A2             | 2.93                             | 4.95                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.115     | 0.195  | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| B              | 0.356                            | 0.558                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0.014     | 0.022  | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| B1             | 1.15                             | 1.77                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.045     | 0.070  | 8, 10 |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| C              | 0.204                            | 0.355                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0.008     | 0.014  | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| D              | 9.01                             | 10.16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0.355     | 0.400  | 5     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| D1             | 0.13                             | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0.005     | -      | 5     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| E              | 7.62                             | 8.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.300     | 0.325  | 6     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| E1             | 6.1                              | 7.11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.240     | 0.280  | 5     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| e              | 2.54 BSC                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0.100 BSC |        | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| e <sub>A</sub> | 7.62 BSC                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0.300 BSC |        | 6     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| e <sub>B</sub> | -                                | 10.92                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -         | 0.430  | 7     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| L              | 2.93                             | 3.81                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.115     | 0.150  | 4     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| N              | 8                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 8         |        | 9     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| PDIP-16        |                                  | <table><tr><th>Package</th><th colspan="5">PDIP</th></tr><tr><th>Pins</th><th colspan="5">16 Lead Dual-in-Line</th></tr><tr><th>JEDEC</th><th colspan="5">E16.3 MS-001-BB Issue D</th></tr><tr><th rowspan="2"></th><th colspan="2">Millimeters</th><th colspan="2">Inches</th><th rowspan="2">Notes</th></tr><tr><th>Min</th><th>Max</th><th>Min</th><th>Max</th></tr><tr><td>A</td><td>-</td><td>5.33</td><td>-</td><td>0.210</td><td>4</td></tr><tr><td>A1</td><td>0.39</td><td>-</td><td>0.015</td><td>-</td><td>4</td></tr><tr><td>A2</td><td>2.93</td><td>4.95</td><td>0.115</td><td>0.195</td><td>-</td></tr><tr><td>B</td><td>0.356</td><td>0.558</td><td>0.014</td><td>0.022</td><td>-</td></tr><tr><td>B1</td><td>1.15</td><td>1.77</td><td>0.045</td><td>0.070</td><td>8, 10</td></tr><tr><td>C</td><td>0.204</td><td>0.355</td><td>0.008</td><td>0.014</td><td>-</td></tr><tr><td>D</td><td>18.66</td><td>19.68</td><td>0.735</td><td>0.775</td><td>5</td></tr><tr><td>D1</td><td>0.13</td><td>-</td><td>0.005</td><td>-</td><td>5</td></tr><tr><td>E</td><td>7.62</td><td>8.25</td><td>0.300</td><td>0.325</td><td>6</td></tr><tr><td>E1</td><td>6.10</td><td>7.11</td><td>0.240</td><td>0.280</td><td>5</td></tr><tr><td>e</td><td colspan="2">2.54 BSC</td><td colspan="2">0.100 BSC</td><td>-</td></tr><tr><td>e<sub>A</sub></td><td colspan="2">7.62 BSC</td><td colspan="2">0.300 BSC</td><td>6</td></tr><tr><td>e<sub>B</sub></td><td>-</td><td>10.92</td><td>-</td><td>0.430</td><td>7</td></tr><tr><td>L</td><td>2.93</td><td>3.81</td><td>0.115</td><td>0.150</td><td>4</td></tr><tr><td>N</td><td colspan="2">16</td><td colspan="2">16</td><td>9</td></tr></table> | Package   | PDIP   |       |  |  |  | Pins | 16 Lead Dual-in-Line |  |  |  |  | JEDEC | E16.3 MS-001-BB Issue D          |  |  |  |  |  | Millimeters |  | Inches |  | Notes | Min | Max | Min | Max | A | -    | 5.33 | -      | 0.210  | 4 | A1 | 0.39 | -    | 0.015  | -      | 4 | A2 | 2.93 | 4.95 | 0.115 | 0.195 | - | B | 0.356 | 0.558 | 0.014  | 0.022  | - | B1 | 1.15 | 1.77  | 0.045  | 0.070  | 8, 10 | C | 0.204 | 0.355 | 0.008  | 0.014  | - | D | 18.66    | 19.68 | 0.735     | 0.775 | 5 | D1 | 0.13 | -    | 0.005  | -      | 5 | E | 7.62 | 8.25 | 0.300  | 0.325  | 6 | E1 | 6.10 | 7.11 | 0.240 | 0.280 | 5 | e | 2.54 BSC |  | 0.100 BSC |  | - | e <sub>A</sub> | 7.62 BSC |    | 0.300 BSC |    | 6 | e <sub>B</sub> | - | 10.92 | - | 0.430 | 7 | L | 2.93 | 3.81 | 0.115 | 0.150 | 4 | N | 16 |  | 16 |  | 9 |
| Package        | PDIP                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |        |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| Pins           | 16 Lead Dual-in-Line             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |        |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| JEDEC          | E16.3 MS-001-BB Issue D          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |        |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
|                | Millimeters                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Inches    |        | Notes |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
|                | Min                              | Max                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Min       | Max    |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| A              | -                                | 5.33                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | -         | 0.210  | 4     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| A1             | 0.39                             | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0.015     | -      | 4     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| A2             | 2.93                             | 4.95                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.115     | 0.195  | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| B              | 0.356                            | 0.558                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0.014     | 0.022  | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| B1             | 1.15                             | 1.77                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.045     | 0.070  | 8, 10 |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| C              | 0.204                            | 0.355                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0.008     | 0.014  | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| D              | 18.66                            | 19.68                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0.735     | 0.775  | 5     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| D1             | 0.13                             | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0.005     | -      | 5     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| E              | 7.62                             | 8.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.300     | 0.325  | 6     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| E1             | 6.10                             | 7.11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.240     | 0.280  | 5     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| e              | 2.54 BSC                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0.100 BSC |        | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| e <sub>A</sub> | 7.62 BSC                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0.300 BSC |        | 6     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| e <sub>B</sub> | -                                | 10.92                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -         | 0.430  | 7     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| L              | 2.93                             | 3.81                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.115     | 0.150  | 4     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| N              | 16                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 16        |        | 9     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| SOIC-8         |                                  | <table><tr><th>Package</th><th colspan="5">SOIC</th></tr><tr><th>Pins</th><th colspan="5">16</th></tr><tr><th>JEDEC</th><th colspan="5">M16.15 (JEDEC MS-012-AC Issue C)</th></tr><tr><th rowspan="2"></th><th colspan="2">Millimeters</th><th colspan="2">Inches</th><th rowspan="2">Notes</th></tr><tr><th>Min</th><th>Max</th><th>Min</th><th>Max</th></tr><tr><td>A</td><td>1.35</td><td>1.75</td><td>0.0532</td><td>0.0688</td><td>-</td></tr><tr><td>A1</td><td>0.10</td><td>0.25</td><td>0.0040</td><td>0.0098</td><td>-</td></tr><tr><td>B</td><td>0.33</td><td>0.51</td><td>0.013</td><td>0.020</td><td>9</td></tr><tr><td>C</td><td>0.19</td><td>0.25</td><td>0.0075</td><td>0.0098</td><td>-</td></tr><tr><td>D</td><td>9.80</td><td>10.00</td><td>0.3859</td><td>0.3937</td><td>3</td></tr><tr><td>E</td><td>3.80</td><td>4.00</td><td>0.1497</td><td>0.1574</td><td>4</td></tr><tr><td>e</td><td colspan="2">1.27 BSC</td><td colspan="2">0.050 BSC</td><td>-</td></tr><tr><td>H</td><td>5.80</td><td>6.20</td><td>0.2284</td><td>0.2440</td><td>-</td></tr><tr><td>h</td><td>0.25</td><td>0.50</td><td>0.0099</td><td>0.0196</td><td>5</td></tr><tr><td>L</td><td>0.40</td><td>1.27</td><td>0.016</td><td>0.050</td><td>6</td></tr><tr><td>N</td><td colspan="2">16</td><td colspan="2">16</td><td>7</td></tr><tr><td>μ</td><td>0°</td><td>8°</td><td>0°</td><td>8°</td><td>-</td></tr></table>                                                                                                                                                                                                                                                                              | Package   | SOIC   |       |  |  |  | Pins | 16                   |  |  |  |  | JEDEC | M16.15 (JEDEC MS-012-AC Issue C) |  |  |  |  |  | Millimeters |  | Inches |  | Notes | Min | Max | Min | Max | A | 1.35 | 1.75 | 0.0532 | 0.0688 | - | A1 | 0.10 | 0.25 | 0.0040 | 0.0098 | - | B  | 0.33 | 0.51 | 0.013 | 0.020 | 9 | C | 0.19  | 0.25  | 0.0075 | 0.0098 | - | D  | 9.80 | 10.00 | 0.3859 | 0.3937 | 3     | E | 3.80  | 4.00  | 0.1497 | 0.1574 | 4 | e | 1.27 BSC |       | 0.050 BSC |       | - | H  | 5.80 | 6.20 | 0.2284 | 0.2440 | - | h | 0.25 | 0.50 | 0.0099 | 0.0196 | 5 | L  | 0.40 | 1.27 | 0.016 | 0.050 | 6 | N | 16       |  | 16        |  | 7 | μ              | 0°       | 8° | 0°        | 8° | - |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| Package        | SOIC                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |        |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| Pins           | 16                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |        |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| JEDEC          | M16.15 (JEDEC MS-012-AC Issue C) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |        |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
|                | Millimeters                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Inches    |        | Notes |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
|                | Min                              | Max                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Min       | Max    |       |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| A              | 1.35                             | 1.75                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.0532    | 0.0688 | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| A1             | 0.10                             | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.0040    | 0.0098 | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| B              | 0.33                             | 0.51                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.013     | 0.020  | 9     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| C              | 0.19                             | 0.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.0075    | 0.0098 | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| D              | 9.80                             | 10.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0.3859    | 0.3937 | 3     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| E              | 3.80                             | 4.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.1497    | 0.1574 | 4     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| e              | 1.27 BSC                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0.050 BSC |        | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| H              | 5.80                             | 6.20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.2284    | 0.2440 | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| h              | 0.25                             | 0.50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.0099    | 0.0196 | 5     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| L              | 0.40                             | 1.27                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.016     | 0.050  | 6     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| N              | 16                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 16        |        | 7     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |
| μ              | 0°                               | 8°                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0°        | 8°     | -     |  |  |  |      |                      |  |  |  |  |       |                                  |  |  |  |  |  |             |  |        |  |       |     |     |     |     |   |      |      |        |        |   |    |      |      |        |        |   |    |      |      |       |       |   |   |       |       |        |        |   |    |      |       |        |        |       |   |       |       |        |        |   |   |          |       |           |       |   |    |      |      |        |        |   |   |      |      |        |        |   |    |      |      |       |       |   |   |          |  |           |  |   |                |          |    |           |    |   |                |   |       |   |       |   |   |      |      |       |       |   |   |    |  |    |  |   |

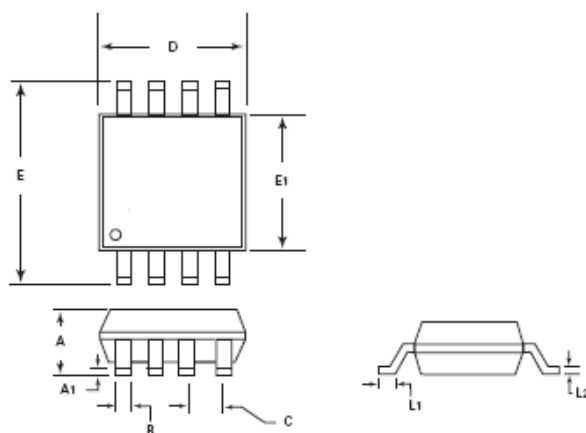
SPA Package Outlines (continued)

SOIC-16



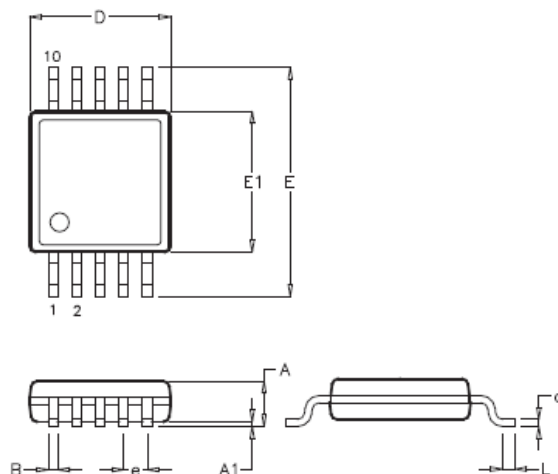
| Package | SOIC                             |       |           |        |       |
|---------|----------------------------------|-------|-----------|--------|-------|
| Pins    | 16                               |       |           |        |       |
| JEDEC   | M16.15 (JEDEC MS-012-AC Issue C) |       |           |        |       |
|         | Millimeters                      |       | Inches    |        | Notes |
|         | Min                              | Max   | Min       | Max    |       |
| A       | 1.35                             | 1.75  | 0.0532    | 0.0688 | -     |
| A1      | 0.10                             | 0.25  | 0.0040    | 0.0098 | -     |
| B       | 0.33                             | 0.51  | 0.013     | 0.020  | 9     |
| C       | 0.19                             | 0.25  | 0.0075    | 0.0098 | -     |
| D       | 9.80                             | 10.00 | 0.3859    | 0.3937 | 3     |
| E       | 3.80                             | 4.00  | 0.1497    | 0.1574 | 4     |
| e       | 1.27 BSC                         |       | 0.050 BSC |        | -     |
| H       | 5.80                             | 6.20  | 0.2284    | 0.2440 | -     |
| h       | 0.25                             | 0.50  | 0.0099    | 0.0196 | 5     |
| L       | 0.40                             | 1.27  | 0.016     | 0.050  | 6     |
| N       | 16                               |       | 16        |        | 7     |
| μ       | 0°                               | 8°    | 0°        | 8°     | -     |

MSOP-8



| Package | MSOP-8      |         |        |          |
|---------|-------------|---------|--------|----------|
| Pins    | 8           |         |        |          |
|         | Millimeters |         | Inches |          |
|         | Min         | Max     | Min    | Max      |
| D       | 2.90        | 3.10    | 0.114  | .122     |
| E       | 4.78        | 4.98    | .188   | .196     |
| E1      | 2.90        | 3.10    | .114   | .122     |
| A       | 0.87        | 1.17    | .034   | .046     |
| A1      | 0.05        | 0.25    | .002   | 0.010    |
| B       | -           | 0.30TYP | -      | 0.012TYP |
| C       | -           | 0.65TYP | -      | 0.026TYP |
| L1      | 0.52        | 0.54    | 0.020  | 0.021    |
| L2      | -           | 0.18TYP | -      | .007TYP  |
| F       | -           | 5.28    | -      | .208     |
| F1      | -           | 4.24    | -      | .167     |
| G       | -           | 0.65    | -      | 0.026    |
| H       | -           | 0.38    | -      | .015     |
| I       | -           | 1.04    | -      | .041     |

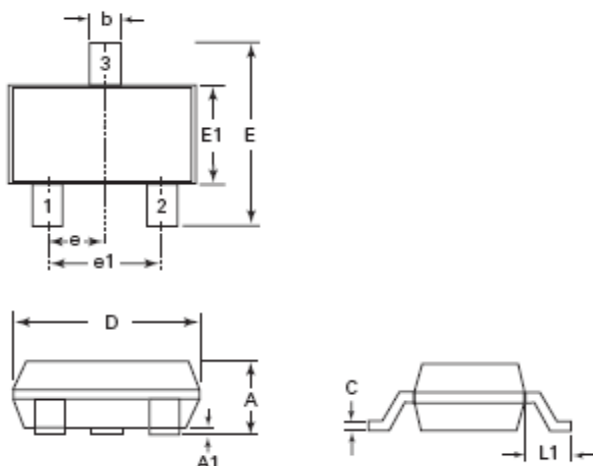
MSOP-10



| Package | MSOP10      |      |           |       |
|---------|-------------|------|-----------|-------|
| Pins    | 10          |      |           |       |
|         | Millimeters |      | Inches    |       |
|         | Min         | Max  | Min       | Max   |
| A       | -           | 1.10 | -         | 0.043 |
| A1      | 0.00        | 0.15 | 0.000     | 0.006 |
| B       | 0.17        | 0.27 | 0.007     | 0.011 |
| c       | 0.08        | 0.23 | 0.003     | 0.009 |
| D       | 2.90        | 3.10 | 0.114     | 0.122 |
| E       | 4.67        | 5.10 | 0.184     | 0.200 |
| E1      | 2.90        | 3.10 | 0.114     | 0.122 |
| e       | 0.50 BSC    |      | 0.020 BSC |       |
| HE      | 0.40        | 0.80 | 0.016     | 0.031 |

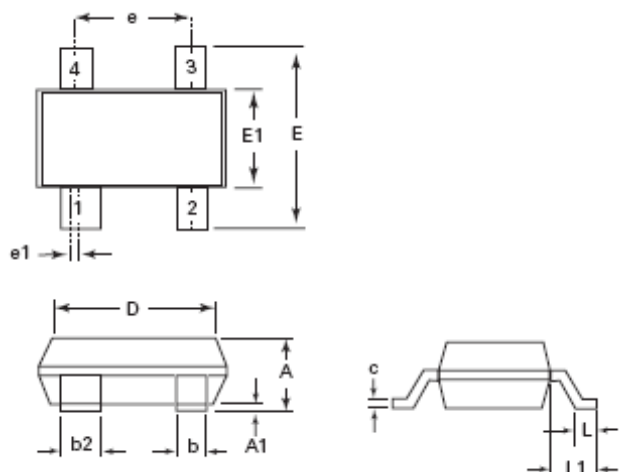
SPA Package Outlines (continued)

SOT23-3



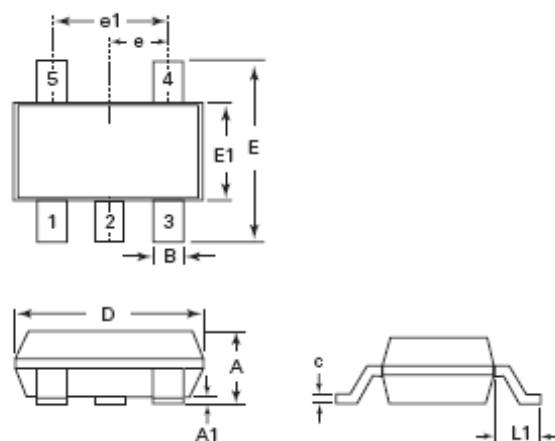
| Package | SOT23-3     |      |           |         |
|---------|-------------|------|-----------|---------|
| Pins    | 3           |      |           |         |
| JEDEC   | TO-236      |      |           |         |
|         | Millimeters |      | Inches    |         |
|         | Min         | Max  | Min       | Max     |
| A       | 0.89        | 1.12 | 0.035     | 0.044   |
| A1      | 0.01        | 0.1  | 0.0004    | 0.004   |
| b       | 0.3         | 0.5  | 0.012     | 0.020   |
| c       | 0.08        | 0.2  | 0.003     | 0.008   |
| D       | 2.8         | 3.04 | 0.110     | 0.120   |
| E       | 2.1         | 2.64 | 0.083     | 0.104   |
| E1      | 1.2         | 1.4  | 0.047     | 0.055   |
| e       | 0.95 BSC    |      | 0.038 BSC |         |
| e1      | 1.90 BSC    |      | 0.075 BSC |         |
| L1      | 0.54 REF    |      | 0.021 REF |         |
| M       |             | 2.29 |           | .090    |
| N       |             | 0.95 |           | 0.038   |
| O       |             | 0.78 |           | .030TYP |
| P       |             | 0.78 |           | .030TYP |

SOT143



| Package | SOT143-4    |      |           |       |
|---------|-------------|------|-----------|-------|
| Pins    | 4           |      |           |       |
| JEDEC   | TO-253      |      |           |       |
|         | Millimeters |      | Inches    |       |
|         | Min         | Max  | Min       | Max   |
| A       | 0.08        | 1.22 | 0.003     | 0.048 |
| A1      | 0.05        | 0.15 | 0.002     | 0.006 |
| b       | 0.30        | 0.50 | 0.012     | 0.020 |
| 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     | 0.120 |
| E       | 2.10        | 2.64 | 0.082     | 0.104 |
| E1      | 1.20        | 1.40 | 0.047     | 0.055 |
| e       | 1.92 BSC    |      | 0.076 BSC |       |
| e1      | 0.20 BSC    |      | 0.008 BSC |       |
| L       | 0.4         | 0.6  | 0.016     | 0.024 |
| L1      | 0.550 REF   |      | 0.022 REF |       |

SOT23-5



| Package | SOT23-5     |      |           |         |
|---------|-------------|------|-----------|---------|
| Pins    | 5           |      |           |         |
| JEDEC   | MO-178      |      |           |         |
|         | Millimeters |      | Inches    |         |
|         | Min         | Max  | Min       | Max     |
| A       | -           | 1.45 | -         | 0.057   |
| A1      | 0           | 0.15 | 0         | 0.006   |
| b       | 0.3         | 0.5  | 0.012     | 0.020   |
| c       | 0.08        | 0.22 | 0.003     | 0.009   |
| D       | 2.75        | 3.05 | 0.108     | 0.120   |
| E       | 2.6         | 3.0  | 0.102     | 0.118   |
| E1      | 1.45        | 1.75 | 0.057     | 0.069   |
| e       | 0.95 BSC    |      | 0.038 BSC |         |
| e1      | 1.90 BSC    |      | 0.075 BSC |         |
| L1      | 0.60 REF    |      | 0.024 REF |         |
| M       |             | 2.59 |           | .102    |
| N       |             | 0.95 |           | .038    |
| O       |             | 0.69 |           | .027TYP |
| P       |             | 0.99 |           | .039TYP |

SPA Package Outlines (continued)

SOT23-6

Top view: Dimensions include pin pitch  $e_1$ , pin width  $e$ , body width  $b$ , body length  $E$ , and pin length  $E_1$ . Pins are numbered 1-6.

Side view: Dimensions include body width  $D$ , body height  $A$ , pin height  $A_1$ , and pin thickness  $c$ .

Cross-sectional view: Dimension  $L_1$  is shown.

| Package | SOT23-6     |      |           |         |
|---------|-------------|------|-----------|---------|
| Pins    | 6           |      |           |         |
| JEDEC   | MO-178      |      |           |         |
|         | Millimeters |      | Inches    |         |
|         | Min         | Max  | Min       | Max     |
| A       | -           | 1.45 | -         | 0.057   |
| A1      | 0           | 0.15 | 0         | 0.006   |
| b       | 0.3         | 0.5  | 0.012     | 0.020   |
| c       | 0.08        | 0.22 | 0.003     | 0.009   |
| D       | 2.75        | 3.05 | 0.108     | 0.120   |
| E       | 2.6         | 3.0  | 0.102     | 0.118   |
| E1      | 1.45        | 1.75 | 0.057     | 0.069   |
| e       | 0.95 BSC    |      | 0.038 BSC |         |
| e1      | 1.90 BSC    |      | 0.075 BSC |         |
| L1      | 0.60 REF    |      | 0.024 REF |         |
| M       |             | 2.59 |           | .102    |
| N       |             | 0.95 |           | 0.038   |
| O       |             | 0.69 |           | .027TYP |
| P       |             | 0.99 |           | .039TYP |

SC70-3

Top view: Dimensions include pin pitch  $e$ , pin width  $B$ , body width  $D$ , body length  $E$ , and pin length  $HE$ . Pins are numbered 1-3.

Side view: Dimensions include body width  $D$ , body height  $A$ , pin height  $A_1$ , and pin thickness  $C$ .

Cross-sectional view: Dimension  $L$  is shown.

| Package | SC70-3         |      |           |       |
|---------|----------------|------|-----------|-------|
| Pins    | 3              |      |           |       |
| JEDEC   | MO-203 Issue A |      |           |       |
|         | Millimeters    |      | Inches    |       |
|         | Min            | Max  | Min       | Max   |
| A       | 0.80           | 1.10 | 0.031     | 0.043 |
| A1      | 0.00           | 0.10 | 0.000     | 0.004 |
| A2      | 0.70           | 1.00 | 0.028     | 0.039 |
| B       | 0.15           | 0.30 | 0.006     | 0.012 |
| c       | 0.08           | 0.25 | 0.003     | 0.010 |
| D       | 1.85           | 2.25 | 0.073     | 0.089 |
| E       | 1.15           | 1.35 | 0.045     | 0.053 |
| e       | 0.66 BSC       |      | 0.026 BSC |       |
| HE      | 2.00           | 2.40 | 0.079     | 0.094 |
| L       | 0.26           | 0.46 | 0.010     | 0.018 |

SC70-5

Top view: Dimensions include pin pitch  $e$ , pin width  $B$ , body width  $D$ , body length  $E$ , and pin length  $HE$ . Pins are numbered 1-6, with pin 5 labeled 'not used'.

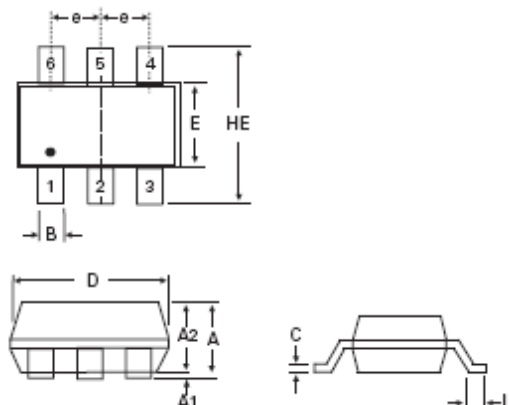
Side view: Dimensions include body width  $D$ , body height  $A$ , pin height  $A_1$ , and pin thickness  $C$ .

Cross-sectional view: Dimension  $L$  is shown.

| Package | SC70-5         |      |           |       |
|---------|----------------|------|-----------|-------|
| Pins    | 5              |      |           |       |
| JEDEC   | MO-203 Issue A |      |           |       |
|         | Millimeters    |      | Inches    |       |
|         | Min            | Max  | Min       | Max   |
| A       | 0.80           | 1.10 | 0.031     | 0.043 |
| A1      | 0.00           | 0.10 | 0.000     | 0.004 |
| A2      | 0.70           | 1.00 | 0.028     | 0.039 |
| B       | 0.15           | 0.30 | 0.006     | 0.012 |
| c       | 0.08           | 0.25 | 0.003     | 0.010 |
| D       | 1.85           | 2.25 | 0.073     | 0.089 |
| E       | 1.15           | 1.35 | 0.045     | 0.053 |
| e       | 0.65 BSC       |      | 0.026 BSC |       |
| HE      | 2.00           | 2.40 | 0.079     | 0.094 |
| L       | 0.26           | 0.46 | 0.010     | 0.018 |

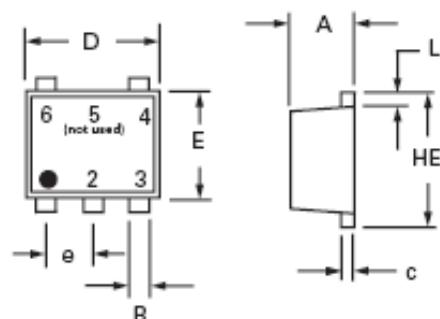
SPA Package Outlines (continued)

SC70-6



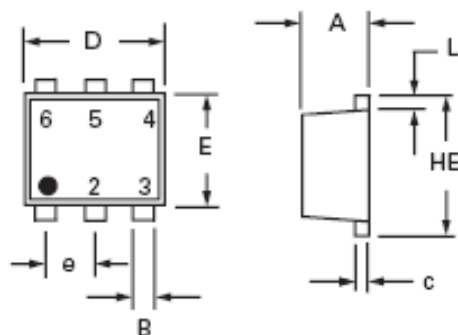
| Package | SC70-6         |      |           |       |
|---------|----------------|------|-----------|-------|
| Pins    | 6              |      |           |       |
| JEDEC   | MO-203 Issue A |      |           |       |
|         | Millimeters    |      | Inches    |       |
|         | Min            | Max  | Min       | Max   |
| A       | 0.80           | 1.10 | 0.031     | 0.043 |
| A1      | 0.00           | 0.10 | 0.000     | 0.004 |
| A2      | 0.70           | 1.00 | 0.028     | 0.039 |
| B       | 0.15           | 0.30 | 0.006     | 0.012 |
| c       | 0.08           | 0.25 | 0.003     | 0.010 |
| D       | 1.85           | 2.25 | 0.073     | 0.089 |
| E       | 1.15           | 1.35 | 0.045     | 0.053 |
| e       | 0.65 BSC       |      | 0.026 BSC |       |
| HE      | 2.00           | 2.40 | 0.079     | 0.094 |
| L       | 0.26           | 0.46 | 0.010     | 0.018 |

SOT553



| Package | SOT 553     |      |           |       |
|---------|-------------|------|-----------|-------|
| Pins    | 5           |      |           |       |
|         | Millimeters |      | Inches    |       |
|         | Min         | Max  | Min       | Max   |
| A       | 0.50        | 0.60 | 0.020     | 0.024 |
| B       | 0.17        | 0.27 | 0.007     | 0.011 |
| c       | 0.08        | 0.18 | 0.003     | 0.007 |
| D       | 1.50        | 1.70 | 0.059     | 0.067 |
| E       | 1.10        | 1.30 | 0.043     | 0.051 |
| e       | 0.50 BSC    |      | 0.020 BSC |       |
| L       | 0.10        | 0.30 | 0.004     | 0.012 |
| HE      | 1.50        | 1.70 | 0.059     | 0.067 |

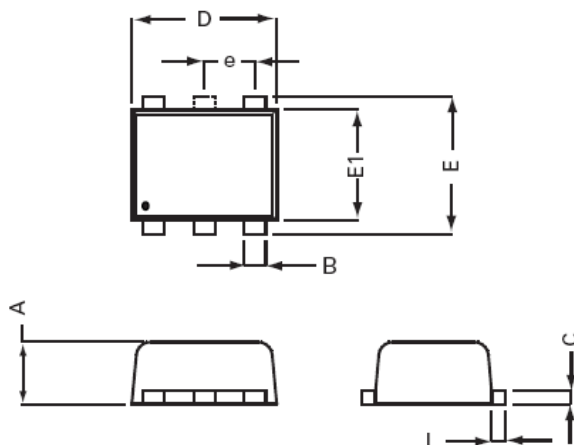
SOT563



| Package | SOT 563     |      |           |       |
|---------|-------------|------|-----------|-------|
| Pins    | 6           |      |           |       |
|         | Millimeters |      | Inches    |       |
|         | Min         | Max  | Min       | Max   |
| A       | 0.50        | 0.60 | 0.020     | 0.024 |
| B       | 0.17        | 0.27 | 0.007     | 0.011 |
| c       | 0.08        | 0.18 | 0.003     | 0.007 |
| D       | 1.50        | 1.70 | 0.059     | 0.067 |
| E       | 1.10        | 1.30 | 0.043     | 0.051 |
| e       | 0.50 BSC    |      | 0.020 BSC |       |
| L       | 0.10        | 0.30 | 0.004     | 0.012 |
| HE      | 1.50        | 1.70 | 0.059     | 0.067 |

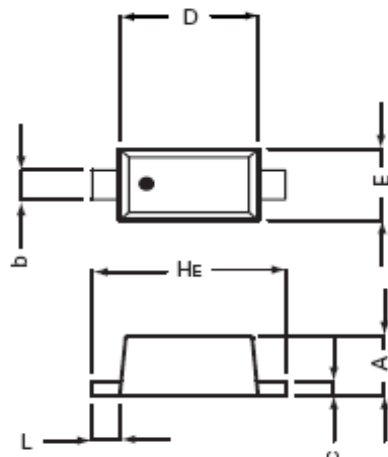
SPA Package Outlines (continued)

SOT953



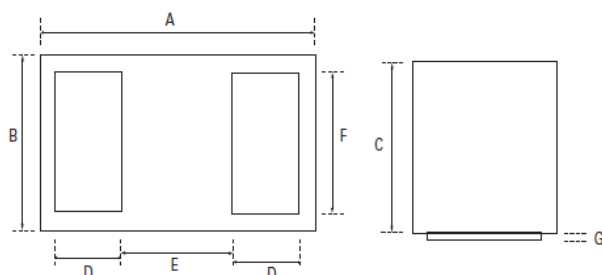
| Symbol | SOT953      |      |           |       |
|--------|-------------|------|-----------|-------|
|        | Millimeters |      | Inches    |       |
|        | Min         | Max  | Min       | Max   |
| A      | 0.44        | 0.5  | 0.0170    | 0.020 |
| B      | 0.10        | 0.20 | 0.004     | 0.008 |
| c      | 0.05        | 0.15 | 0.002     | 0.006 |
| D      | 0.95        | 1.05 | 0.037     | 0.041 |
| E      | 0.95        | 1.05 | 0.037     | 0.041 |
| E1     | 0.75        | 0.85 | 0.029     | 0.033 |
| e      | 0.35 BSC    |      | 0.014 BSC |       |
| L      | 0.05        | 0.15 | 0.002     | 0.006 |

SOD723



| Symbol | SOD723      |      |        |       |
|--------|-------------|------|--------|-------|
|        | Millimeters |      | Inches |       |
|        | Min         | Max  | Min    | Max   |
| A      | 0.46        | 0.51 | 0.018  | 0.020 |
| b      | 0.23        | 0.28 | 0.009  | 0.011 |
| c      | 0.08        | 0.13 | 0.003  | 0.005 |
| D      | 0.99        | 1.04 | 0.039  | 0.041 |
| E      | 0.58        | 0.64 | 0.023  | 0.025 |
| HE     | 1.37        | 1.47 | 0.054  | 0.058 |
| L      | 0.15        | 0.25 | 0.006  | 0.010 |

0201 Flipchip



| Symbol | 0201 Flipchip |       |       |        |        |        |
|--------|---------------|-------|-------|--------|--------|--------|
|        | Millimeters   |       |       | Inches |        |        |
|        | Min           | Typ   | Max   | Min    | Typ    | Max    |
| A      | 0.595         | 0.620 | 0.645 | 0.0234 | 0.0244 | 0.0254 |
| B      | 0.295         | 0.320 | 0.345 | 0.0116 | 0.0126 | 0.0136 |
| C      | 0.245         | 0.275 | 0.305 | 0.0096 | 0.0108 | 0.0120 |
| D      | 0.145         | 0.150 | 0.155 | 0.0057 | 0.0059 | 0.0061 |
| E      | 0.245         | 0.250 | 0.255 | 0.0096 | 0.0098 | 0.0100 |
| F      | 0.245         | 0.250 | 0.255 | 0.0096 | 0.0098 | 0.0100 |
| G      | 0.005         | 0.010 | 0.015 | 0.0002 | 0.0004 | 0.0006 |

SPA Package Outlines (continued)

μDFN-6  
(1.25x1.0)

| μDFN-6 (1.25x1.0x0.5mm) |             |      |           |       |
|-------------------------|-------------|------|-----------|-------|
| Symbol                  | Millimeters |      | Inches    |       |
|                         | Min         | Max  | Min       | Max   |
| A                       | 0.45        | 0.55 | 0.018     | 0.022 |
| A1                      | 0.00        | 0.05 | 0.000     | 0.002 |
| A3                      | 0.127 REF   |      | 0.005 REF |       |
| b                       | 0.15        | 0.25 | 0.006     | 0.010 |
| D                       | 1.20        | 1.30 | 0.047     | 0.051 |
| D2                      | -           | -    | -         | -     |
| E                       | 0.95        | 1.05 | 0.037     | 0.041 |
| E2                      | -           | -    | -         | -     |
| e                       | 0.4 REF     |      | 0.016 REF |       |
| L                       | 0.25        | 0.35 | 0.010     | 0.014 |

μDFN-6  
(1.6x1.6)

| μDFN (1.6x1.6x0.5mm) |             |       |           |       |
|----------------------|-------------|-------|-----------|-------|
| Symbol               | Millimeters |       | Inches    |       |
|                      | Min         | Max   | Min       | Max   |
| A                    | 0.45        | 0.55  | 0.018     | 0.022 |
| A1                   | 0.00        | 0.05  | 0.000     | 0.002 |
| A3                   | 0.127 Ref   |       | 0.005 Ref |       |
| b                    | 0.20        | 0.30  | 0.008     | 0.012 |
| D                    | 1.50        | 1.70  | 0.060     | 0.067 |
| D2                   | 1.05        | 1.30  | 0.042     | 0.052 |
| E                    | 1.50        | 1.70  | 0.060     | 0.067 |
| E2                   | 0.40        | 0.65  | 0.016     | 0.026 |
| e                    | 0.50 Ref    |       | 0.020 Ref |       |
| L                    | 0.100       | 0.600 | 0.004     | 0.023 |

μDFN-8  
(1.7x1.35)

| Symbol | UDFN-08     |       |           |       |
|--------|-------------|-------|-----------|-------|
|        | Millimeters |       | Inches    |       |
|        | Min         | Max   | Min       | Max   |
| A      | 0.450       | 0.550 | 0.018     | 0.022 |
| A1     | 0.000       | 0.050 | 0.000     | 0.002 |
| A3     | 0.127 REF   |       | 0.005 REF |       |
| b      | 0.150       | 0.250 | 0.006     | 0.010 |
| D      | 1.600       | 1.800 | 0.063     | 0.071 |
| D2     | 1.100       | 1.300 | 0.043     | 0.051 |
| E      | 1.250       | 1.450 | 0.049     | 0.057 |
| E2     | 0.300       | 0.500 | 0.012     | 0.020 |
| e      | 0.400 BSC   |       | 0.016 BSC |       |
| K      | 0.200       |       | 0.008     | 0.000 |
| L      | 0.150       | 0.350 | 0.006     | 0.014 |

SPA Package Outlines (continued)

μDFN-10  
(2.5x1.0)

Top View: Dimensions D (width) and E (height). Pin 1 is indicated by a shaded square.

Side View: Dimensions A (total height), A1 (height to seating plane), A3 (height to pin top), b (pitch), b1 (pitch to last pin), and C (coplanarity).

Bottom View: Dimensions L (length), e (pitch), and 2xR0.075mm (7x) (fillet radius). A note R.0125 is present.

Seating Plane: Indicated by a dashed line and dimension C (coplanarity).

| μDFN-10 (2.5x1.0x0.5mm) |             |       |      |           |       |       |
|-------------------------|-------------|-------|------|-----------|-------|-------|
| Symbol                  | Millimeters |       |      | Inches    |       |       |
|                         | Min         | Nom   | Max  | Min       | Nom   | Max   |
| A                       | 0.48        | 0.515 | 0.55 | 0.019     | 0.020 | 0.021 |
| A1                      | 0.00        | —     | 0.05 | 0.000     |       | 0.022 |
| A3                      | 0.125 Ref   |       |      | 0.005 Ref |       |       |
| b                       | 0.15        | 0.20  | 0.25 | 0.006     | 0.008 | 0.012 |
| b1                      | 0.35        | 0.40  | 0.45 | 0.014     | 0.016 | 0.018 |
| D                       | 2.40        | 2.50  | 2.60 | 0.094     | 0.098 | 0.102 |
| E                       | 0.90        | 1.00  | 1.10 | 0.035     | 0.039 | 0.043 |
| e                       | 0.50 BSC    |       |      | 0.020 BSC |       |       |
| L                       | 0.30        | 0.365 | 0.43 | 0.012     | 0.014 | 0.016 |

μDFN-12  
(2.5x1.35)

Top View: Dimensions D (width) and E (height). Pin 1 is indicated by a dot.

Side View: Dimensions A (total height), A1 (height to seating plane), A3 (height to pin top), b (pitch), b1 (pitch to last pin), and C (coplanarity).

Bottom View: Dimensions L (length), e (pitch), and 2xR0.075mm (7x) (fillet radius). A note R.0125 is present.

Seating Plane: Indicated by a dashed line and dimension C (coplanarity).

| Symbol | UDFN-12     |       |           |       |
|--------|-------------|-------|-----------|-------|
|        | Millimeters |       | Inches    |       |
|        | Min         | Max   | Min       | Max   |
| A      | 0.450       | 0.550 | 0.018     | 0.022 |
| A1     | 0.000       | 0.050 | 0.000     | 0.002 |
| A3     | 0.127 REF   |       | 0.005 REF |       |
| b      | 0.150       | 0.250 | 0.006     | 0.010 |
| D      | 2.400       | 2.600 | 0.094     | 0.102 |
| D2     | 1.900       | 2.100 | 0.075     | 0.083 |
| E      | 1.250       | 1.450 | 0.049     | 0.057 |
| E2     | 0.300       | 0.500 | 0.012     | 0.020 |
| e      | 0.400 BSC   |       | 0.016 BSC |       |
| K      | 0.200       |       | 0.008     | 0.000 |
| L      | 0.150       | 0.350 | 0.006     | 0.014 |

μDFN-14  
(3.5x1.35)

Top View: Dimensions D (width) and E (height). Pin 1 is indicated by a shaded square. PIN 1 Index Area is labeled.

Side View: Dimensions A (total height), A1 (height to seating plane), A2 (height to pin top), b (pitch), b1 (pitch to last pin), and C (coplanarity).

Bottom View: Dimensions L (length), e (pitch), and 2xR0.075mm (7x) (fillet radius). A note R.0125 is present.

Seating Plane: Indicated by a dashed line and dimension C (coplanarity).

Pin 1 Identification Chamfer 0.10X45° is labeled.

| μDFN-14 (3.5x1.35x0.5mm) |             |      |      |           |       |       |
|--------------------------|-------------|------|------|-----------|-------|-------|
| Symbol                   | Millimeters |      |      | Inches    |       |       |
|                          | Min         | Nom  | Max  | Min       | Nom   | Max   |
| A                        | 0.45        | 0.50 | 0.55 | 0.018     | 0.020 | 0.022 |
| A1                       | 0.00        | 0.02 | 0.05 | 0.000     | 0.001 | 0.002 |
| A2                       | 0.203 Ref   |      |      | 0.008 Ref |       |       |
| b                        | 0.15        | 0.20 | 0.25 | 0.006     | 0.008 | 0.012 |
| D                        | 3.40        | 3.50 | 3.60 | 0.134     | 0.138 | 0.142 |
| D2                       | -           | -    | -    | -         | -     | -     |
| E                        | 1.25        | 1.35 | 1.45 | 0.050     | 0.054 | 0.058 |
| E1                       | -           | -    | -    | -         | -     | -     |
| e                        | 0.500 BSC   |      |      | 0.020 BSC |       |       |
| L                        | 0.25        | 0.30 | 0.35 | 0.010     | 0.012 | 0.014 |

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Silicon Protection Arrays

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