

# Common Mode Filter with ESD Protection

> 900 MHz Common Mode Stop Band Attenuation for HDMI Interfaces

## EMI804x Series

### Functional Description

The EMI804x is a family of Common Mode Filters (CMF) with integrated ESD protection, a first in the industry. Differential signaling I/Os can now have both common mode filtering and ESD protection in one package. The EMI804x protects against ESD pulses up to  $\pm 15$  kV contact per the IEC61000-4-2 standard.

The EMI804x is well-suited for protecting systems using high-speed differential ports such as USB 3.0, HDMI 1.3/1.4/2.0; corresponding ports in removable storage and other applications.

The EMI804x is available in a RoHS-compliant, XDFN6 for 1 Differential Pair, XDFN10 for 2 Differential Pair and XDFN16 package for 3 Differential Pair.

### Features

- Total Insertion Loss  $DM_{LOSS} < 2.5$  dB at 2.5 GHz
- Large Differential Mode Cutoff Frequency  $f_{3dB} > 5$  GHz
- High Common Mode Stop Band Attenuation:  
15 dB at 700 MHz, 30 dB at 2.4 GHz
- Low Channel Resistance  $6.0 \Omega$
- Provides ESD Protection to IEC61000-4-2 Level 4,  $\pm 15$  kV Contact
- SZ Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

- USB 3.0
- HDMI 1.3/1.4/2.0
- MHL 2.0
- ESATA
- Automotive Cameras

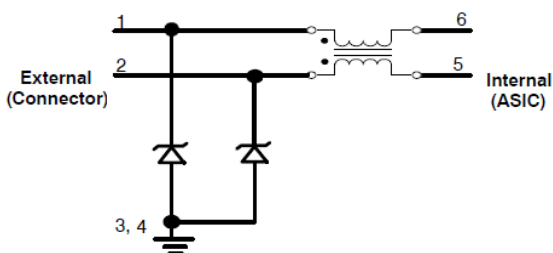
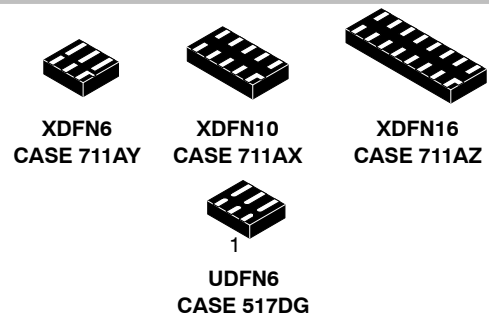


Figure 1. EMI8041 Electrical Schematic

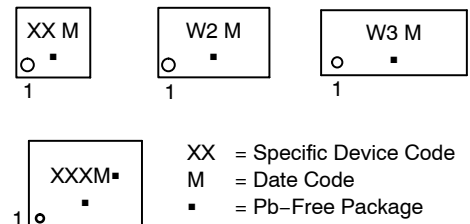


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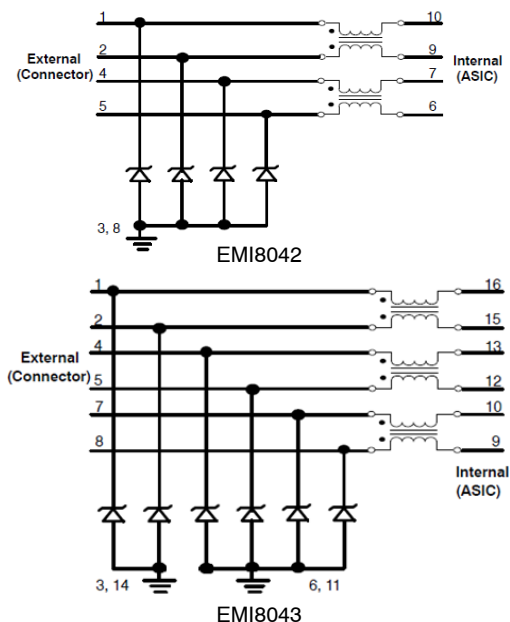
[www.onsemi.com](http://www.onsemi.com)



### MARKING DIAGRAMS



### ELECTRICAL SCHEMATICS



### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

## EMI804x Series

### PIN FUNCTION DESCRIPTION

| Pin Name | Device Pin |         |           | Type | Description                            |
|----------|------------|---------|-----------|------|----------------------------------------|
|          | EMI8041    | EMI8042 | EMI8043   |      |                                        |
| In_1+    | 1          | 1       | 1         | I/O  | CMF Channel 1+ to Connector (External) |
| In_1–    | 2          | 2       | 2         | I/O  | CMF Channel 1– to Connector (External) |
| Out_1+   | 6          | 10      | 16        | I/O  | CMF Channel 1+ to ASIC (Internal)      |
| Out_1–   | 5          | 9       | 15        | I/O  | CMF Channel 1– to ASIC (Internal)      |
| In_2+    | NA         | 4       | 4         | I/O  | CMF Channel 2+ to Connector (External) |
| In_2–    | NA         | 5       | 5         | I/O  | CMF Channel 2– to Connector (External) |
| Out_2+   | NA         | 7       | 13        | I/O  | CMF Channel 2+ to ASIC (Internal)      |
| Out_2–   | NA         | 6       | 12        | I/O  | CMF Channel 2– to ASIC (Internal)      |
| In_3+    | NA         | NA      | 7         | I/O  | CMF Channel 3+ to Connector (External) |
| In_3–    | NA         | NA      | 8         | I/O  | CMF Channel 3– to Connector (External) |
| Out_3+   | NA         | NA      | 10        | I/O  | CMF Channel 3+ to ASIC (Internal)      |
| Out_3–   | NA         | NA      | 9         | I/O  | CMF Channel 3– to ASIC (Internal)      |
| VN       | 3,4        | 3, 8    | 3,6,14,11 | GND  | Ground                                 |

### ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise noted)

| Parameter                                                                          | Symbol            | Value       | Unit |
|------------------------------------------------------------------------------------|-------------------|-------------|------|
| Operating Temperature Range                                                        | T <sub>OP</sub>   | –40 to +85  | °C   |
| Storage Temperature Range                                                          | T <sub>STG</sub>  | –65 to +150 | °C   |
| Maximum Lead Temperature for Soldering Purposes<br>(1/8" from Case for 10 seconds) | T <sub>L</sub>    | 260         | °C   |
| DC Current per Line                                                                | I <sub>LINE</sub> | 100         | mA   |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

## EMI804x Series

### ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

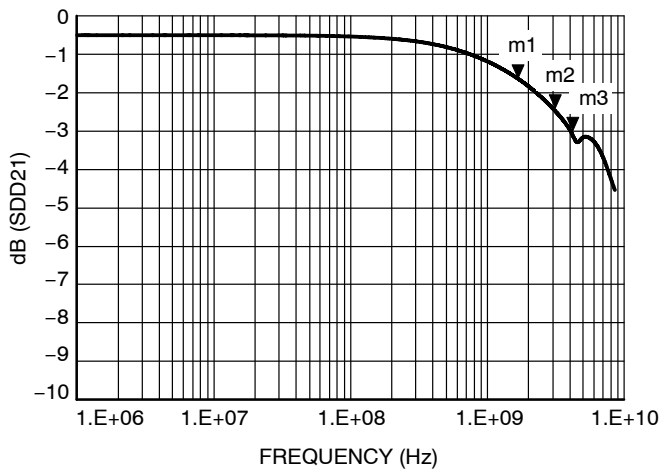
| Symbol      | Parameter                                                                                                                                                                                                   | Test Conditions                                                                                                                      | Min                 | Typ                          | Max | Unit          |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------------|-----|---------------|
| $V_{RWM}$   | Reverse Working Voltage                                                                                                                                                                                     | (Note 3)                                                                                                                             |                     | 3.3                          |     | V             |
| $V_{BR}$    | Breakdown Voltage                                                                                                                                                                                           | $I_T = 1\text{ mA}$ ; (Note 4)                                                                                                       | 4.0                 |                              | 9.0 | V             |
| $I_{LEAK}$  | Channel Leakage Current                                                                                                                                                                                     | $T_A = 25^\circ\text{C}$ , $V_{IN} = 3.3\text{ V}$ , $GND = 0\text{ V}$                                                              |                     |                              | 1.0 | $\mu\text{A}$ |
| $R_{CH}$    | Channel Resistance<br>(Pins 1–6, 2–5) – EMI8041<br>(Pins 1–10, 2–9, 4–7 and 5–6) – EMI8042<br>(Pins 1–16, 2–15, 4–13, 5–12, 7–10 and 8–9) – EMI8043                                                         |                                                                                                                                      |                     | 6.0                          |     | $\Omega$      |
| $DM_{LOSS}$ | Differential Mode Insertion Loss                                                                                                                                                                            | @ 2.5 GHz                                                                                                                            |                     | 2.5                          |     | dB            |
| $f_{3dB}$   | Differential Mode Cut-off Frequency                                                                                                                                                                         | 50 $\Omega$ Source and Load Termination                                                                                              |                     | 5.0                          |     | GHz           |
| $F_{atten}$ | Common Mode Stop Band Attenuation                                                                                                                                                                           | @ 700 MHz                                                                                                                            |                     | 15                           |     | dB            |
| $V_{ESD}$   | In-system ESD Withstand Voltage<br>a) Contact discharge per IEC 61000-4-2 standard, Level 4<br><b>(External Pins)</b><br>b) Contact discharge per IEC 61000-4-2 standard, Level 1<br><b>(Internal Pins)</b> | (Notes 1 and 2)                                                                                                                      | $\pm 15$<br>$\pm 2$ |                              |     | kV            |
| $V_{CL}$    | TLP Clamping Voltage                                                                                                                                                                                        | Forward $I_{PP} = 8\text{ A}$<br>Forward $I_{PP} = 16\text{ A}$<br>Forward $I_{PP} = -8\text{ A}$<br>Forward $I_{PP} = -16\text{ A}$ |                     | 7.26<br>11.8<br>-3.5<br>-6.7 |     | V             |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

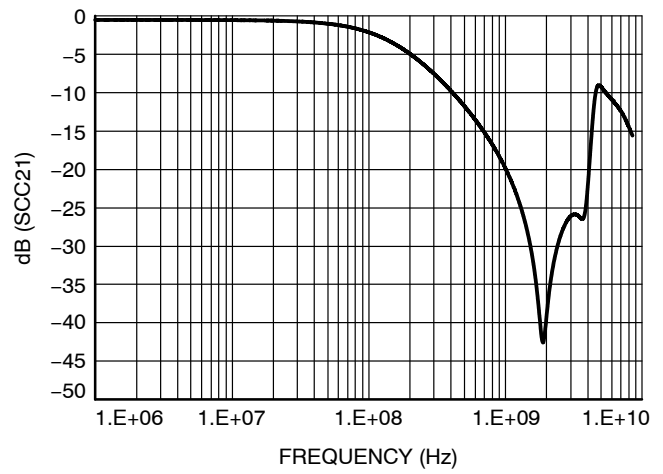
1. Standard IEC61000-4-2 with  $C_{Discharge} = 150\text{ pF}$ ,  $R_{Discharge} = 330$ , GND grounded.
2. These measurements performed with no external capacitor.
3. TVS devices are normally selected according to the working peak reverse voltage ( $V_{RWM}$ ), which should be equal to or greater than the DC or continuous peak operating voltage level.
4.  $V_{BR}$  is measured at pulse test current  $I_T$ .

# EMI804x Series

## TYPICAL CHARACTERISTICS



**Figure 2. Typical Differential Mode Attenuation vs. Frequency**



**Figure 3. Typical Common Mode Attenuation vs. Frequency**

| Interface    | Data Rate (Gb/s) | Fundamental Frequency (GHz) | EMI804x Insertion Loss (dB) |
|--------------|------------------|-----------------------------|-----------------------------|
| HDMI 1.3/1.4 | 3.4              | 1.7 (m1)                    | m1 = 1.65                   |
| USB 3.0      | 5.0              | 2.5 (m2)                    | m2 = 2.13                   |
| HDMI 2.0     | 6.0              | 3.0 (m3)                    | m3 = 2.41                   |

## TRANSMISSION LINE PULSE (TLP) MEASUREMENTS

Transmission Line Pulse (TLP) provides current versus voltage (I-V) curves in which each data point is obtained from a 100 ns long rectangular pulse from a charged transmission line. A simplified schematic of a typical TLP system is shown in Figure 4. TLP I-V curves of ESD protection devices accurately demonstrate the product's ESD capability because the 10 s of amps current levels and under 100 ns time scale match those of an ESD event. This is illustrated in Figure 5 where an 8 kV IEC61000-4-2 current waveform is compared with TLP current pulses at 8 A and 16 A. A TLP curve shows the voltage at which the device turns on as well as how well the device clamps voltage over a range of current levels. Typical TLP I-V curves for the EMI804x are shown in Figure 4.

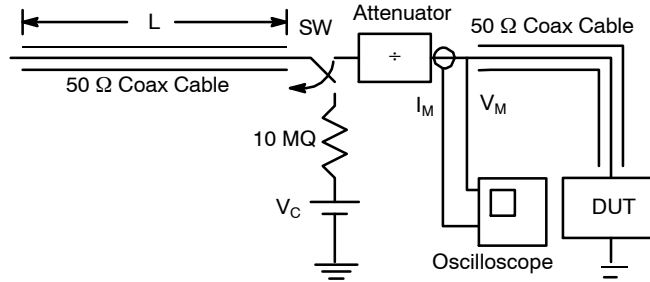


Figure 4. Simplified Schematic of a Typical TLP System

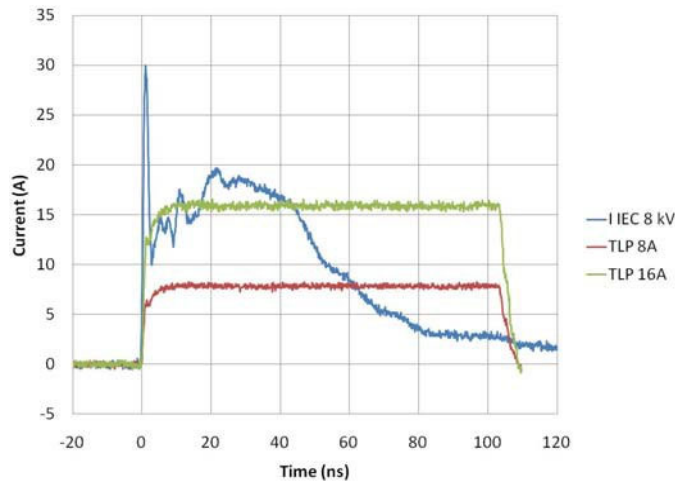


Figure 5. Comparison Between 8 kV IEC61000-4-2 and 8 A and 16 A TLP Waveforms

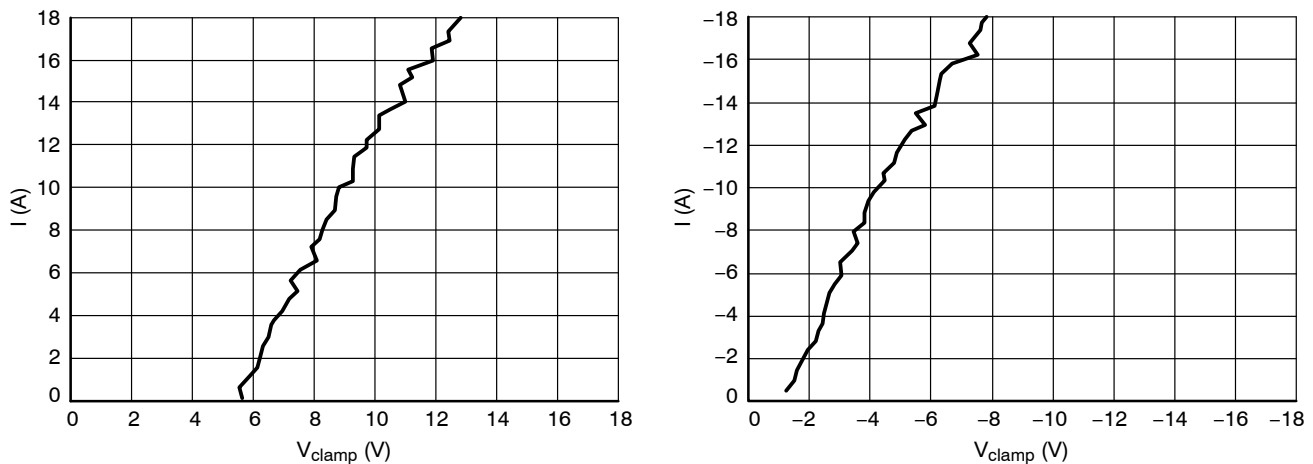


Figure 6. Positive and Negative TLP Waveforms

## EMI804x Series

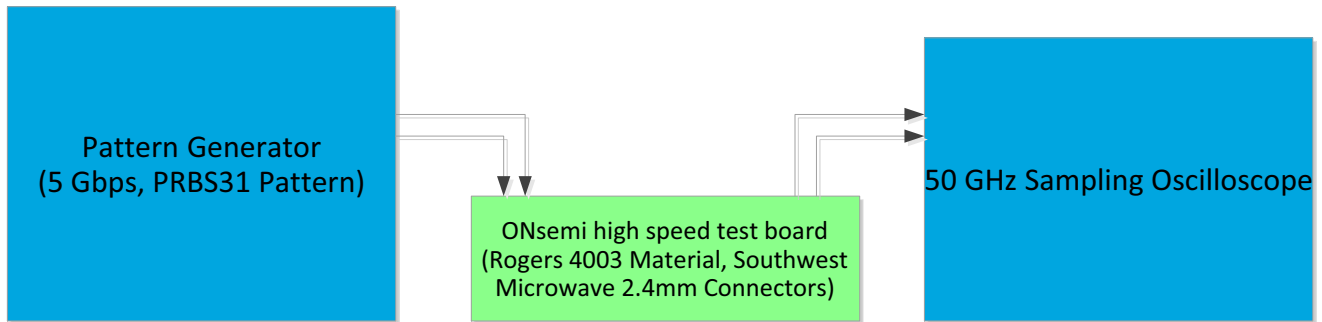


Figure 7. Eye Diagram Test Setup for 5Gbps Data Rate

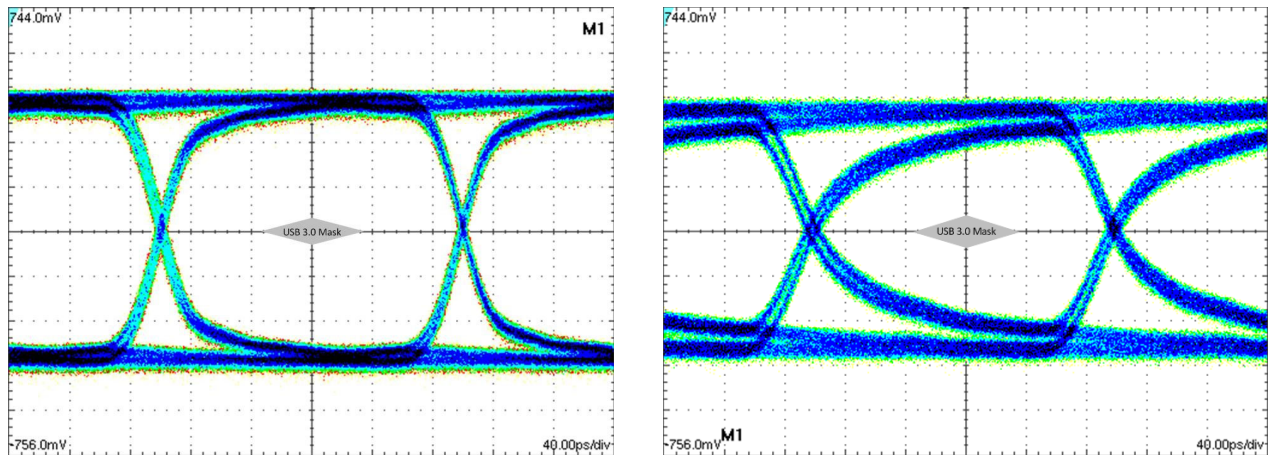


Figure 8. Eye Diagram 5Gbps with and without EMI804x

|                                   | Eye Height (mVppd) | Rise Time (ps) | Fall Time (ps) | Jrms (ps) | Jpp (ps) |
|-----------------------------------|--------------------|----------------|----------------|-----------|----------|
| Reference (No Device)-Left Figure | 724                | 30.4           | 29.6           | 1.997     | 9.6      |
| EMI804x Right Figure              | 405                | 60             | 60.8           | 3.484     | 16       |

### ORDERING INFORMATION

| Orderable Part Number            | Marking | Package             | Shipping†          |
|----------------------------------|---------|---------------------|--------------------|
| EMI8041MUTAG,<br>SZEMI8041MUTAG* | WA      | XDFN6<br>(Pb-Free)  | 3000 / Tape & Reel |
| EMI8042MUTAG,<br>SZEMI8042MUTAG* | W2      | XDFN10<br>(Pb-Free) | 3000 / Tape & Reel |
| EMI8043MUTAG,<br>SZEMI8043MUTAG* | W3      | XDFN16<br>(Pb-Free) | 3000 / Tape & Reel |
| EMI8041BMUTAG                    | MA      | UDFN6<br>(Pb-Free)  | 3000 / Tape & Reel |

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

\*SZ Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable.

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

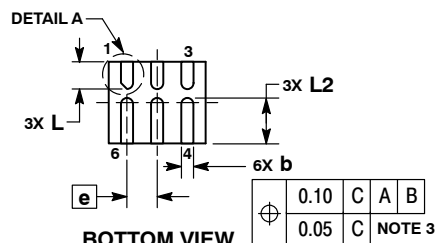
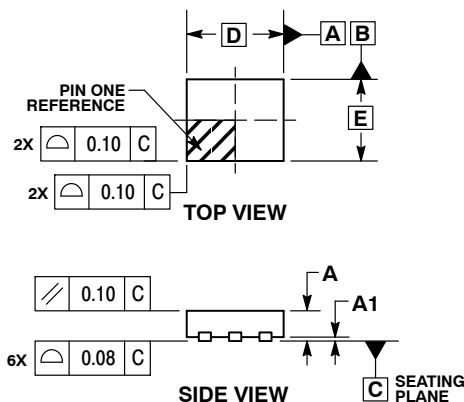
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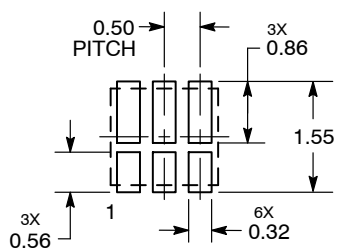
SCALE 4:1

UDFN6 1.6x1.35, 0.5P  
CASE 517DG  
ISSUE O

DATE 21 SEP 2015



### RECOMMENDED MOUNTING FOOTPRINT



#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 mm FROM THE TERMINAL TIP.

| MILLIMETERS |      |      |
|-------------|------|------|
| DIM         | MIN  | MAX  |
| A           | 0.45 | 0.55 |
| A1          | 0.00 | 0.05 |
| b           | 0.15 | 0.25 |
| D           | 1.60 | BSC  |
| E           | 1.35 | BSC  |
| e           | 0.50 | BSC  |
| L           | 0.35 | 0.55 |
| L2          | 0.65 | 0.85 |

### GENERIC MARKING DIAGRAM\*



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

(Note: Microdot may be in either location)  
\*This information is generic. Please refer to device data sheet for actual part marking.  
Pb-Free indicator, "G" or microdot "▪", may or may not be present.

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

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# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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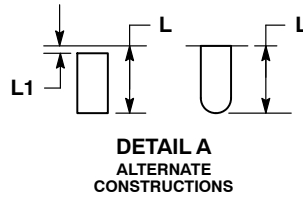
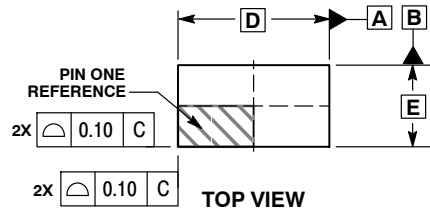
ON



SCALE 4:1

**XDFN10 2.50x1.35, 0.5P**  
CASE 711AX  
ISSUE A

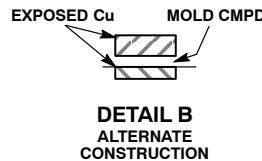
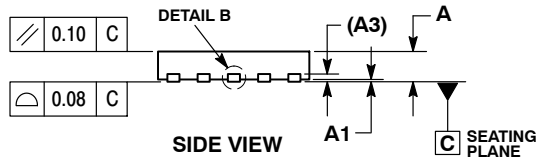
DATE 12 APR 2016



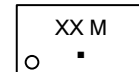
### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSIONS b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM THE TERMINAL TIP.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 0.40        | 0.50 |
| A1  | 0.00        | 0.05 |
| A3  | 0.15 REF    |      |
| b   | 0.15        | 0.25 |
| D   | 2.50 BSC    |      |
| E   | 1.35 BSC    |      |
| e   | 0.50 BSC    |      |
| L   | 0.40        | 0.60 |
| L1  | ---         | 0.15 |

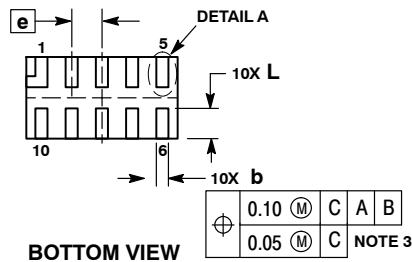


### GENERIC MARKING DIAGRAM\*

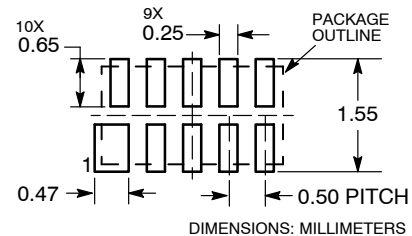


- XX = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.



### RECOMMENDED MOUNTING FOOTPRINT



|                         |                               |                                                                                                                                                                                  |
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| <b>DESCRIPTION:</b>     | <b>XDFN10 2.50X1.35, 0.5P</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                               |

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# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

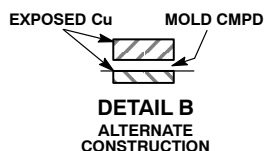
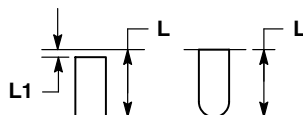
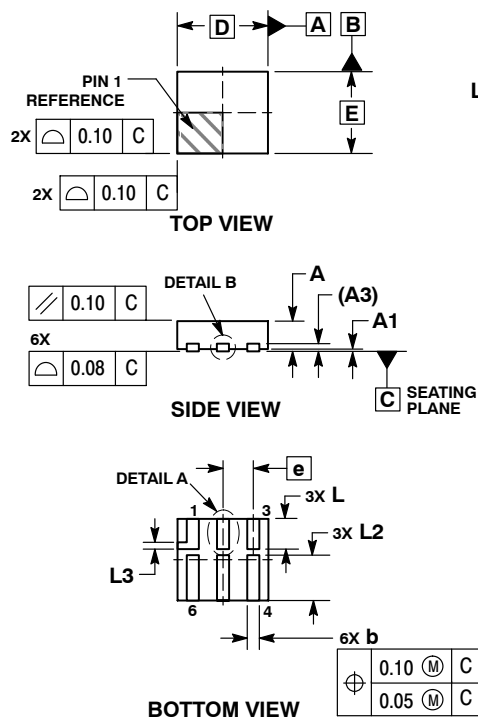
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SCALE 4:1

XDFN6 1.50x1.35, 0.5P  
CASE 711AY  
ISSUE O

DATE 09 SEP 2014

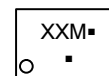


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSIONS b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM TERMINAL TIP.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 0.40        | 0.50 |
| A1  | 0.00        | 0.05 |
| A3  | 0.15 REF    |      |
| b   | 0.15        | 0.25 |
| D   | 1.50 BSC    |      |
| E   | 1.35 BSC    |      |
| e   | 0.50 BSC    |      |
| L   | 0.35        | 0.55 |
| L1  | —           | 0.15 |
| L2  | 0.65        | 0.85 |
| L3  | 0.15 REF    |      |

### GENERIC MARKING DIAGRAM\*

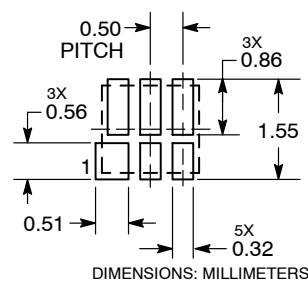


XX = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

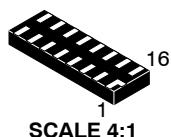
\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.

### RECOMMENDED MOUNTING FOOTPRINT



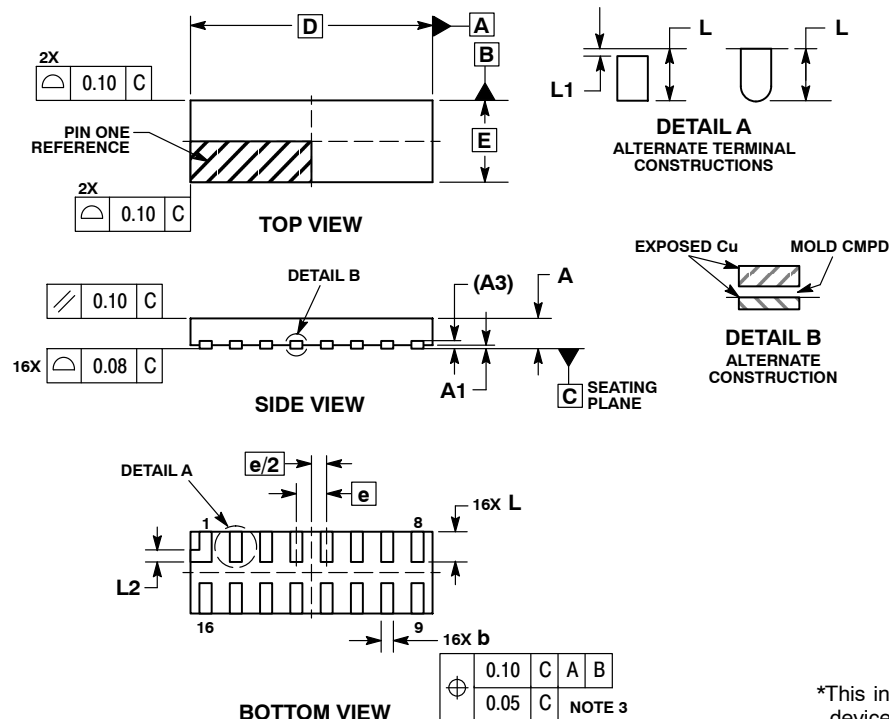
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**XDFN16 4.0x1.35, 0.5P**  
CASE 711AZ  
ISSUE 0

DATE 09 SEP 2014

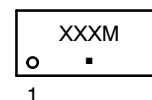


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 mm FROM THE TERMINAL TIP.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 0.40        | 0.50 |
| A1  | 0.00        | 0.05 |
| A3  | 0.15 REF    |      |
| b   | 0.15        | 0.25 |
| D   | 4.00 BSC    |      |
| E   | 1.35 BSC    |      |
| e   | 0.50 BSC    |      |
| L   | 0.40        | 0.60 |
| L1  | —           | 0.15 |
| L2  | 0.20 REF    |      |

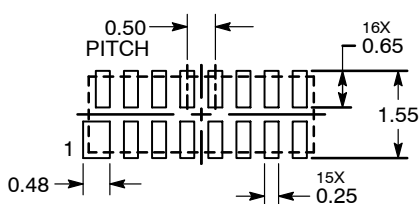
### GENERIC MARKING DIAGRAM\*



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

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.

### RECOMMENDED SOLDERING FOOTPRINT\*



DIMENSIONS: MILLIMETERS

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

|                         |                              |                                                                                                                                                                                     |
|-------------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| <b>DESCRIPTION:</b>     | <b>XDFN16 4.0X1.35, 0.5P</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                                  |

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