# EMI8141, EMI8142, EMI8143

# Common Mode Filter with ESD Protection

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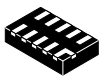
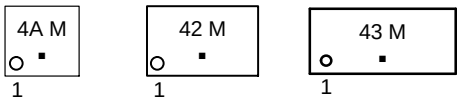
XDFN6
CASE 711AV



XDFN10
CASE 711AU

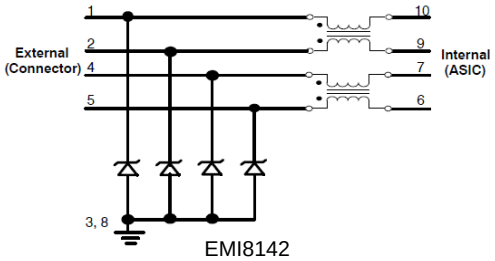
XDFN16
CASE 711AW

### MARKING DIAGRAMS

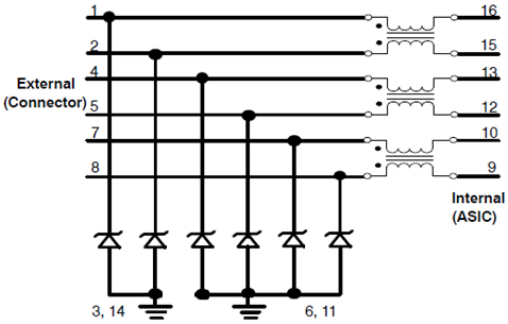



XX = Specific Device Code
M = Date Code
▪ = Pb−Free Package

### ELECTRICAL SCHEMATICS




EMI8142




EMI8143

### Functional Description

The EMI814x 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 EMI814x protects against ESD pulses up to ±15 kV contact per the IEC61000−4−2 standard.

The EMI814x is well−suited for protecting systems using high−speed differential ports such as USB 3.0, MIPI D−PHY; corresponding ports in removable storage, and other applications where ESD protection are required in a small footprint package.

The EMI814x is available in a RoHS−compliant, XDFN6 for 1 Differential Pair, XDFN−10 for 2 Differential Pair and XDFN−16 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:
  > 10 dB at 500 MHz , 15 dB at 700 MHz
- Low Channel Resistance 6.0 Ω
- Provides ESD Protection to IEC61000−4−2 Level 4, ±15 kV Contact
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

- USB 3.0
- MHL 2.0
- μSD Card
- eSATA
- HDMI/DVI Display in Mobile Phones
- MIPI D−PHY (CSI−2, DSI, etc) in Mobile Phones and Digital Still Cameras

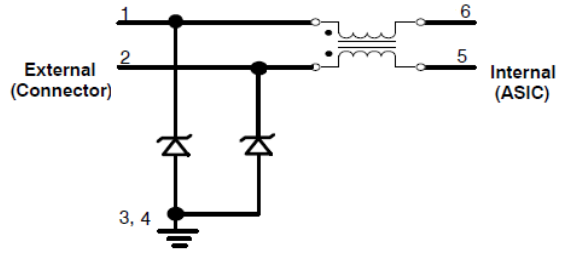



**Figure 1. EMI8141 Electrical Schematic**

### ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| EMI8141MUTAG | XDFN6 | 3000 / Tape & Reel |
| EMI8142MUTAG | XDFN10 | 3000 / Tape & Reel |
| EMI8143MUTAG | XDFN16 | 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.

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**PIN FUNCTION DESCRIPTION**

| Pin Name | Device Pin | | | Type | Description |
|---|---|---|---|---|---|
| | EMI8141 | EMI8142 | EMI8143 | | |
| 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) |
| $V_N$ | 3,4 | 3, 8 | 3,6,14,11 | GND | Ground |

**ABSOLUTE MAXIMUM RATINGS** ($T_A$ = 25°C unless otherwise noted)

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Operating Temperature Range | $T_{OP}$ | −40 to +85 | °C |
| Storage Temperature Range | $T_{STG}$ | −65 to +150 | °C |
| Maximum Lead Temperature for Soldering Purposes (1/8” from Case for 10 seconds) | $T_L$ | 260 | °C |
| DC Current per Line | $I_{LINE}$ | 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.

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°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 mA; (Note 4) | 4.0 | | 9.0 | V |
| $I_{LEAK}$ | Channel Leakage Current | $T_A$ = 25°C, $V_{IN}$ = 3.3 V, GND = 0 V | | | 1.0 | μA |
| $R_{CH}$ | Channel Resistance<br>(Pins 1−6, 2−5) − EMI8141<br>(Pins 1−10, 2−9, 4−7 and 5−6) − EMI8142<br>(Pins 1−16, 2−15, 4−13, 5−12, 7−10 and 8−9) − EMI8143 | | | 6.0 | | Ω |
| $DM_{LOSS}$ | Differential Mode Insertion Loss | @ 2.5 GHz | | 2.5 | | dB |
| $f_{3dB}$ | Differential Mode Cut-off Frequency | 50 Ω 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 **(External Pins)**<br>b) Contact discharge per IEC 61000-4-2 standard, Level 1 **(Internal Pins)** | (Notes 1 and 2) | <br>±15<br>±2 | | | kV |
| $V_{CL}$ | TLP Clamping Voltage | Forward $I_{PP}$ = 8 A<br>Forward $I_{PP}$ = 16 A<br>Forward $I_{PP}$ = −8 A<br>Forward $I_{PP}$ = −16 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 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 $I_T$.

## TYPICAL CHARACTERISTICS

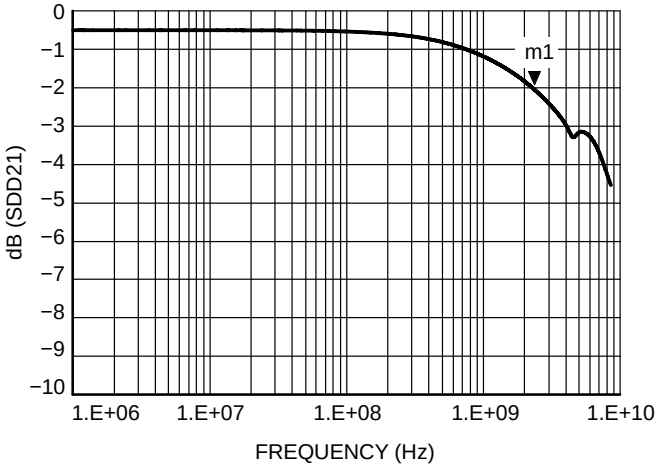



**Figure 2. Typical Differential Mode Attenuation vs. Frequency**

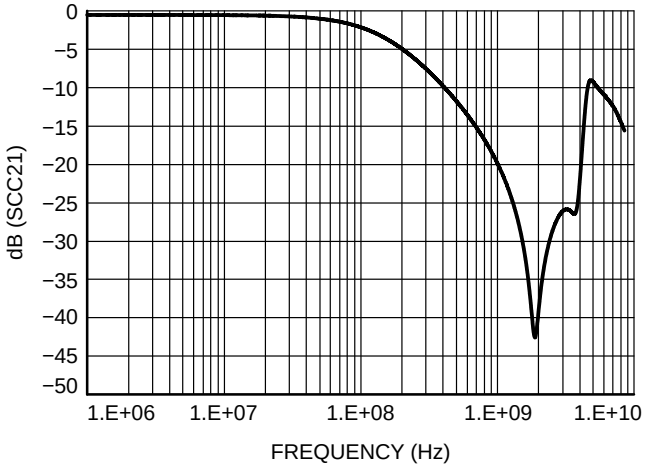



**Figure 3. Typical Common Mode Attenuation vs. Frequency**

| Interface | Data Rate (Gb/s) | Fundamental Frequency (GHz) | ESD814x Insertion Loss (dB) |
|---|---|---|---|
| USB 3.0 | 5 | 2.5 (m1) | m1 = 2.13 |

## 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 EMI814x are shown in Figure 4.

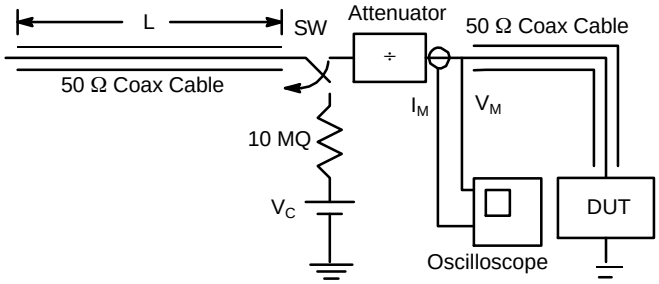



**Figure 4. Simplified Schematic of a Typical TLP System**

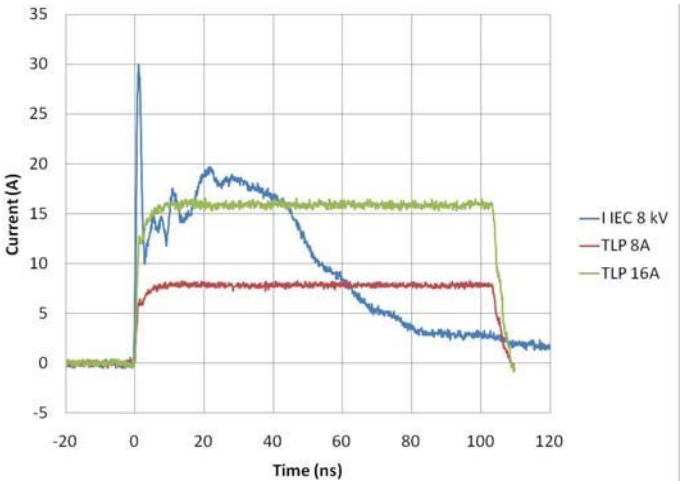



**Figure 5. Comparison Between 8 kV IEC61000-4-2 and 8 A and 16 A TLP Waveforms**

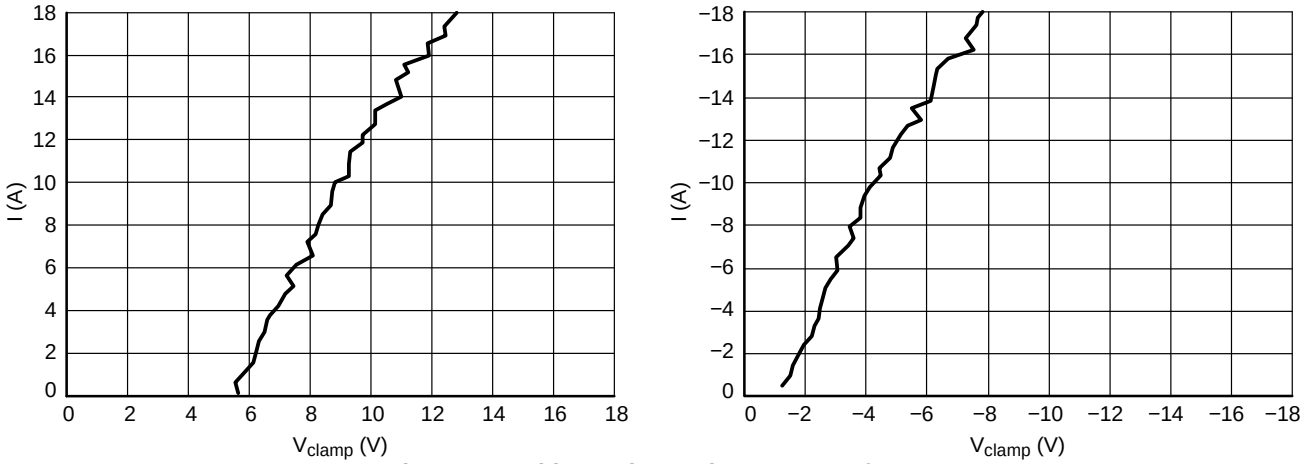



**Figure 6. Positive and Negative TLP Waveforms**

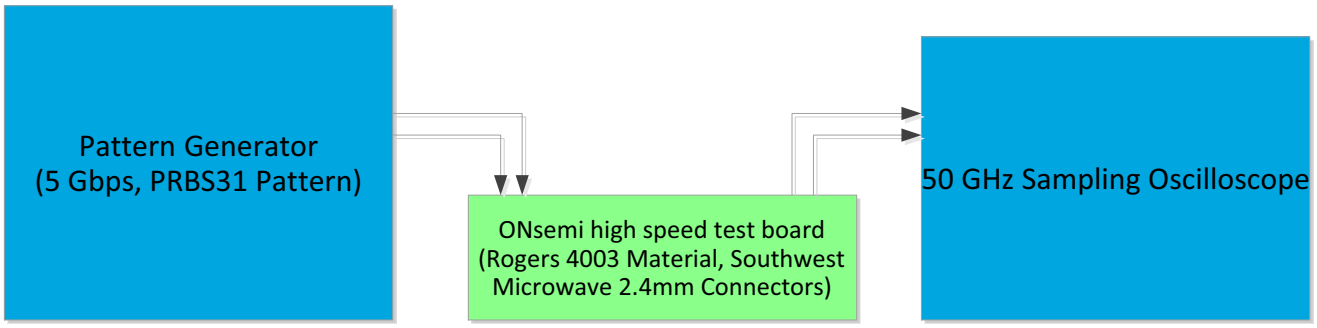



**Figure 7. Eye Diagram Test Setup for 5Gbps Data Rate**

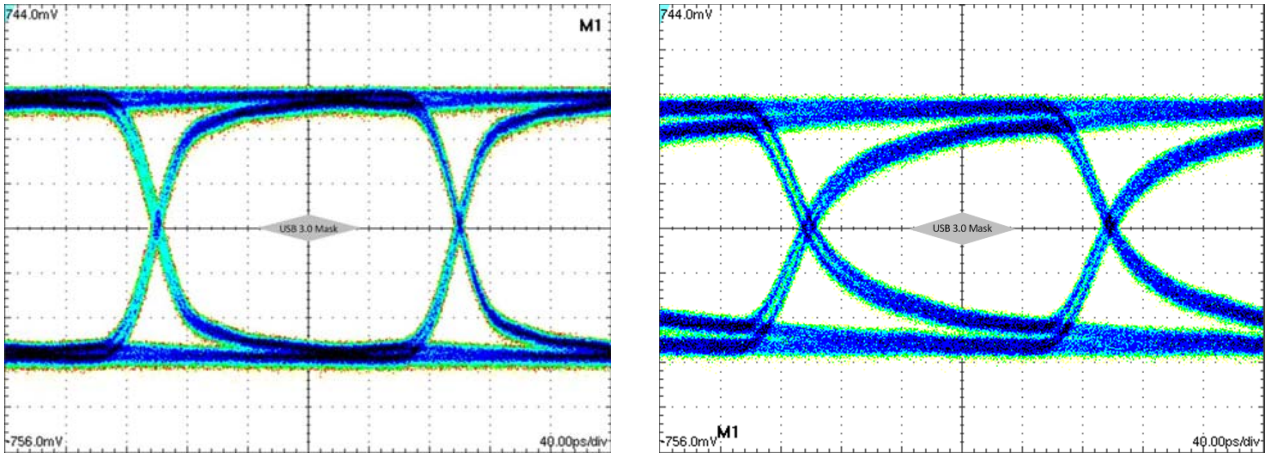


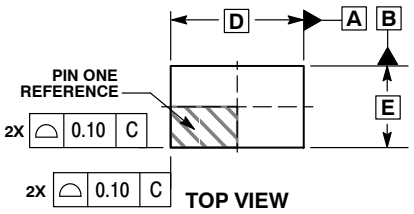

**Figure 8. Eye Diagram 5Gbps with and without EMI814x**

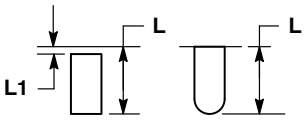
| | Eye Height (mVppd) | Rise Time (ps) | Fall Time (ps) | Jrms (ps) | Jpp (ps) |
|---|---|---|---|---|---|
| Reference (No Device)-Left Figure | 724 | 30.4 | 29.6 | 1.997 | 9.6 |
| EMI814x Right Figure | 405 | 60 | 60.8 | 3.484 | 16 |

**SCALE 4:1**

**XDFN10 2.2x1.35, 0.4P**
CASE 711AU
ISSUE B

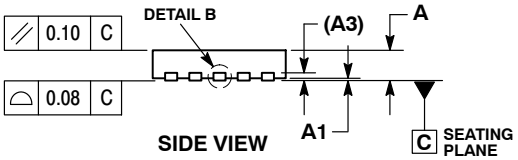
DATE 17 JUN 2014

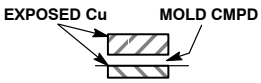


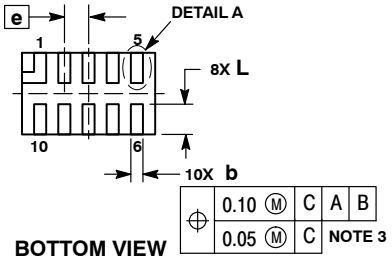




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSIONS b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM THE TERMINAL TIP.

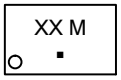
| | MILLIMETERS | |
|---|---|---|
| DIM | MIN | MAX |
| A | 0.40 | 0.50 |
| A1 | 0.00 | 0.05 |
| A3 | 0.15 REF | |
| b | 0.15 | 0.25 |
| D | 2.20 BSC | |
| E | 1.35 BSC | |
| e | 0.40 BSC | |
| L | 0.40 | 0.60 |
| L1 | --- | 0.15 |



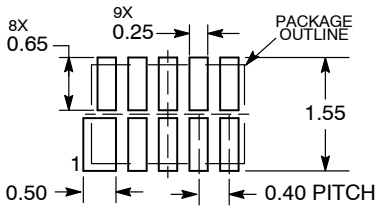

## GENERIC MARKING DIAGRAM*




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




DIMENSIONS: MILLIMETERS

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| **DESCRIPTION:** | **XDFN10 2.2X1.35, 0.4P** | | **PAGE 1 OF 1** |

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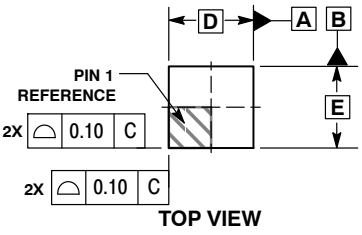
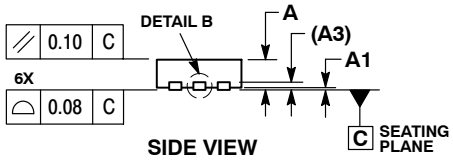
**SCALE 4:1**

**XDFN6 1.40x1.35, 0.4P**
CASE 711AV
ISSUE A

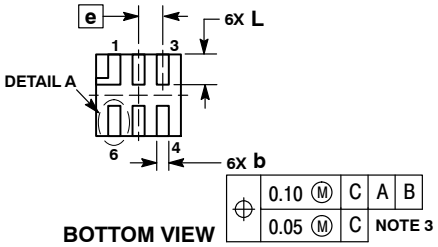
DATE 04 JUN 2014



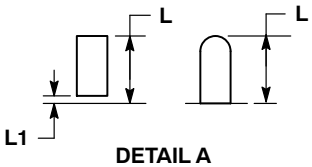

TOP VIEW



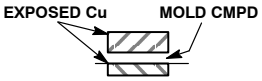

SIDE VIEW




BOTTOM VIEW




**DETAIL A**
ALTERNATE TERMINAL CONSTRUCTIONS




**DETAIL B**
ALTERNATE CONSTRUCTION

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.

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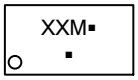
| A1 | 0.00 | 0.05 |
| A3 | 0.15 REF | |
| b | 0.15 | 0.25 |
| D | 1.40 BSC | |
| E | 1.35 BSC | |
| e | 0.40 BSC | |
| L | 0.40 | 0.60 |
| L1 | --- | 0.15 |

## GENERIC MARKING DIAGRAM*

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▪ = 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.

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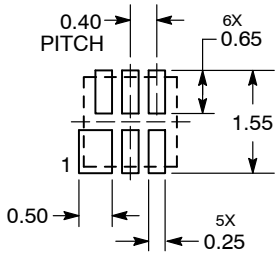


DIMENSIONS: MILLIMETERS

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|---|---|---|
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| **DESCRIPTION:** | **XDFN6 1.40X1.35, 0.4P** | **PAGE 1 OF 1** |

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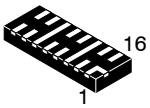
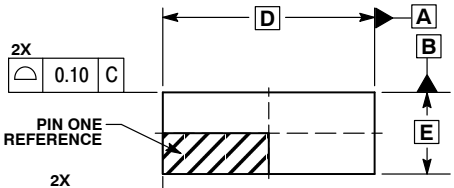


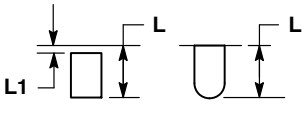

**SCALE 4:1**

**XDFN16 3.5x1.35, 0.4P**
CASE 711AW
ISSUE A

DATE 17 JUN 2014




TOP VIEW

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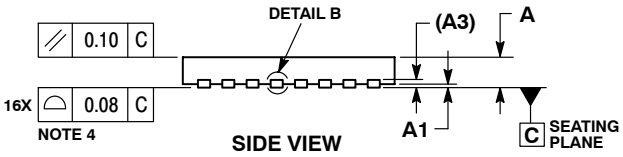
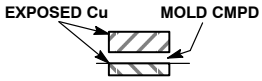
ALTERNATE TERMINAL CONSTRUCTIONS



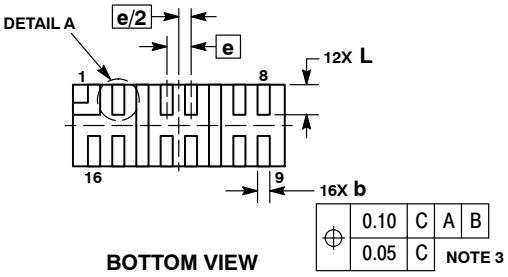

SIDE VIEW




**DETAIL B**
ALTERNATE CONSTRUCTION

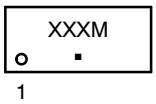
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 mm FROM THE TERMINAL TIP.

| | MILLIMETERS | |
|---|---|---|
| DIM | MIN | MAX |
| A | 0.40 | 0.50 |
| A1 | 0.00 | 0.05 |
| A3 | 0.15 REF | |
| b | 0.15 | 0.25 |
| D | 3.50 BSC | |
| E | 1.35 BSC | |
| e | 0.40 BSC | |
| L | 0.40 | 0.60 |
| L1 | --- | 0.15 |




BOTTOM VIEW

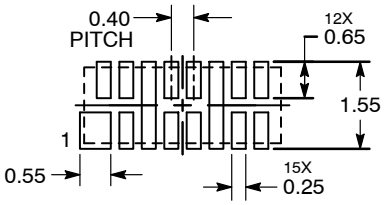
## GENERIC MARKING DIAGRAM*




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 **onsemi** Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

| | | | |
|---|---|---|---|
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| **DESCRIPTION:** | **XDFN16 3.5X1.35, 0.4P** | | **PAGE 1 OF 1** |

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