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 ±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 Ω
- Provides ESD Protection to IEC61000−4−2 Level 4, ±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

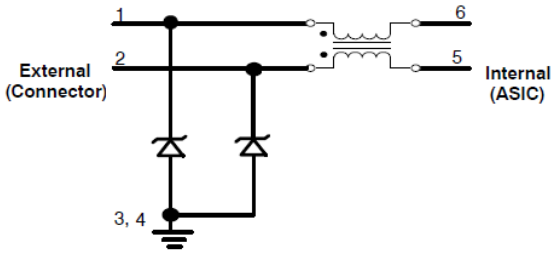

Figure 1. EMI8041 Electrical Schematic

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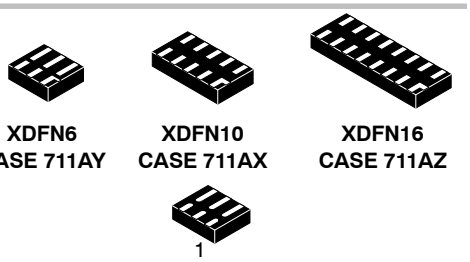


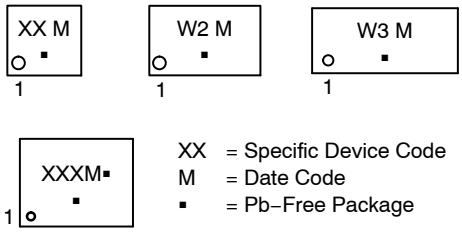
XDFN6
CASE 711AY

XDFN10
CASE 711AX

XDFN16
CASE 711AZ

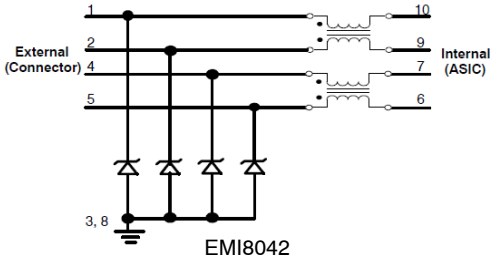
UDFN6
CASE 517DG

MARKING DIAGRAMS

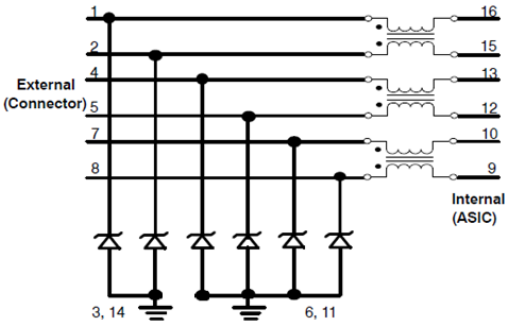


XX = Specific Device Code
M = Date Code
▪ = Pb−Free Package

ELECTRICAL SCHEMATICS



EMI8042



EMI8043

ORDERING INFORMATION

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

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)
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 (Pins 1−6, 2−5) − EMI8041 (Pins 1−10, 2−9, 4−7 and 5−6) − EMI8042 (Pins 1−16, 2−15, 4−13, 5−12, 7−10 and 8−9) − EMI8043			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 a) Contact discharge per IEC 61000-4-2 standard, Level 4 **(External Pins)** b) Contact discharge per IEC 61000-4-2 standard, Level 1 **(Internal Pins)**	(Notes 1 and 2)	 ±15 ±2			kV
V_{CL}	TLP Clamping Voltage	Forward I_{PP} = 8 A Forward I_{PP} = 16 A Forward I_{PP} = −8 A Forward I_{PP} = −16 A		7.26 11.8 −3.5 −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

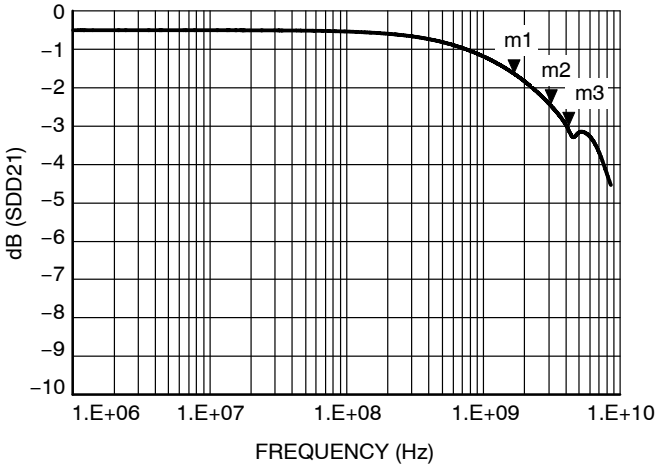


Figure 2. Typical Differential Mode Attenuation vs. Frequency

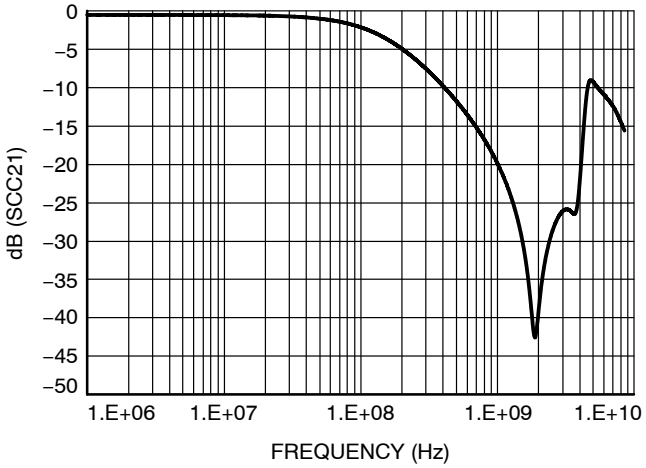


Figure 3. Typical Common Mode Attenuation vs. Frequency

Interface	Data Rate (Gb/s)	Fundamental Frequency (GHz)	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.

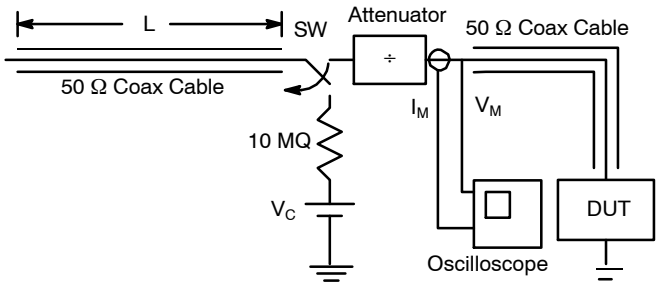


Figure 4. Simplified Schematic of a Typical TLP System

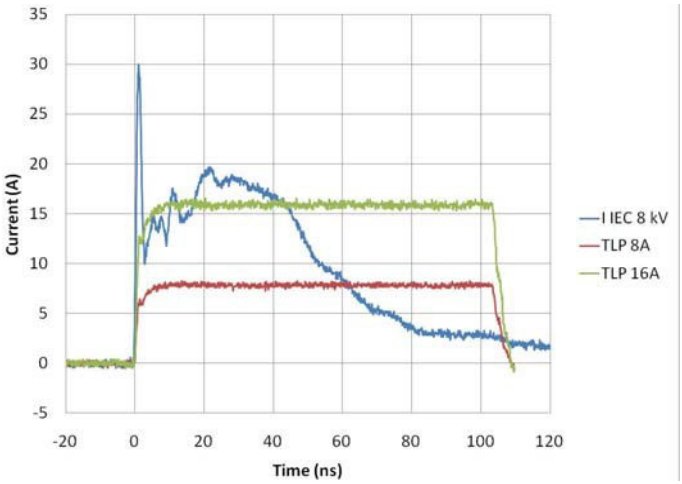


Figure 5. Comparison Between 8 kV IEC61000-4-2 and 8 A and 16 A TLP Waveforms

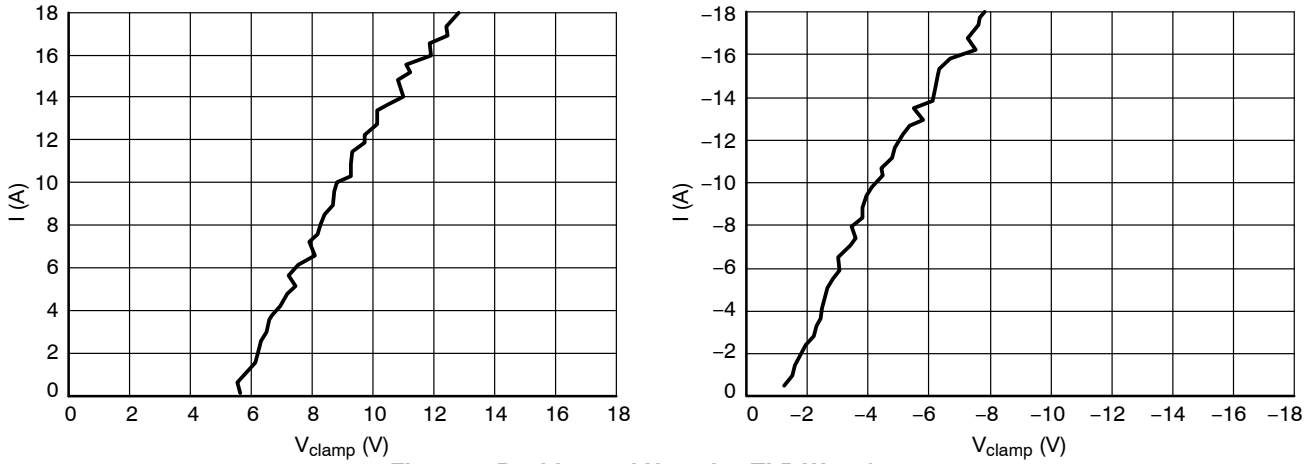


Figure 6. Positive and Negative TLP Waveforms

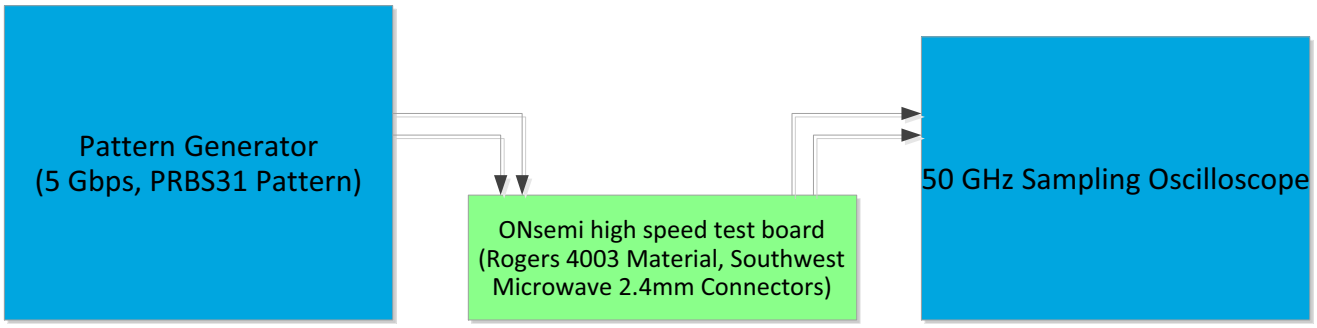


Figure 7. Eye Diagram Test Setup for 5Gbps Data Rate

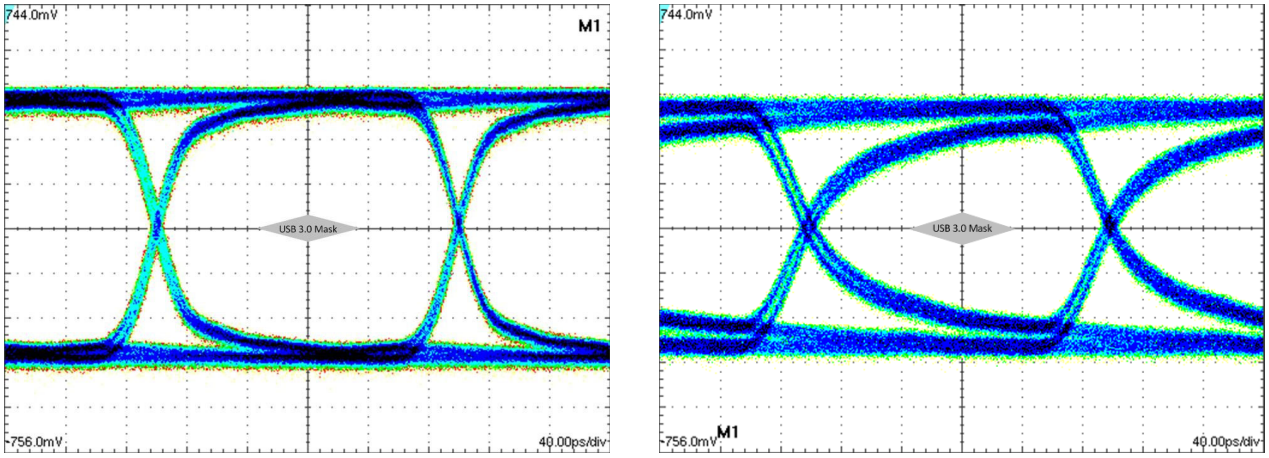


Figure 8. Eye Diagram 5Gbps with and without EMI804x

	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, SZEMI8041MUTAG*	WA	XDFN6 (Pb−Free)	3000 / Tape & Reel
EMI8042MUTAG, SZEMI8042MUTAG*	W2	XDFN10 (Pb−Free)	3000 / Tape & Reel
EMI8043MUTAG, SZEMI8043MUTAG*	W3	XDFN16 (Pb−Free)	3000 / Tape & Reel
EMI8041BMUTAG	MA	UDFN6 (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.

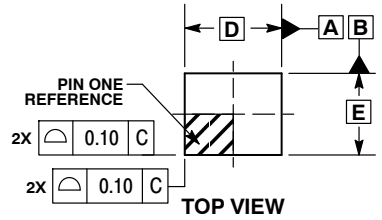
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

ON Semiconductor®

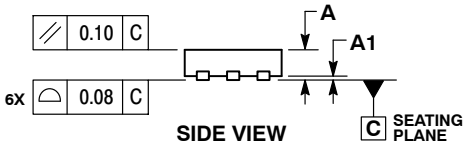
1
SCALE 4:1

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

DATE 21 SEP 2015

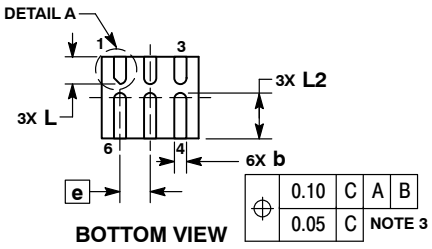


TOP VIEW



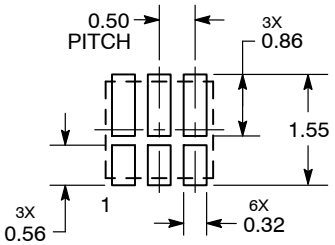
SIDE VIEW

DETAIL A



BOTTOM VIEW

RECOMMENDED MOUNTING FOOTPRINT



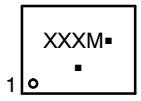
DIMENSIONS: MILLIMETERS

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

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.

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DESCRIPTION:	**UDFN6, 1.6X1.35, 0.5P**	**PAGE 1 OF 1**

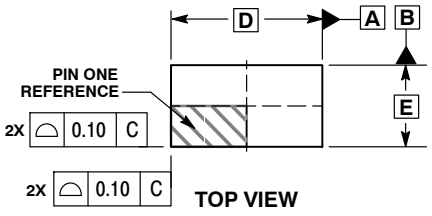
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

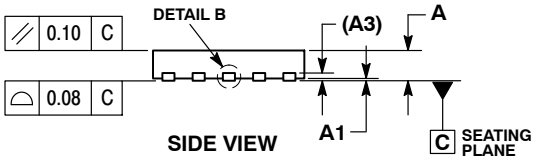
ON Semiconductor®

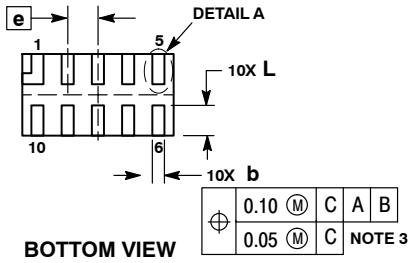
SCALE 4:1

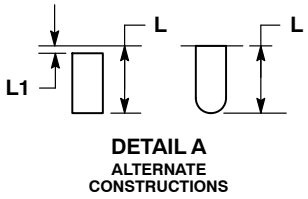
XDFN10 2.50x1.35, 0.5P
CASE 711AX
ISSUE A

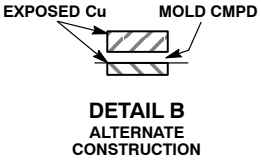
DATE 12 APR 2016







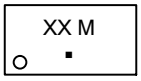




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSIONS b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM THE TERMINAL TIP.

	MILLIMETERS	
DIM	MIN	MAX
A	0.40	0.50
A1	0.00	0.05
A3	0.15 REF	
b	0.15	0.25
D	2.50 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

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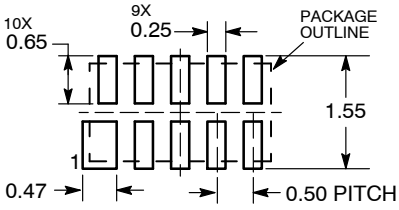
RECOMMENDED MOUNTING FOOTPRINT



DIMENSIONS: MILLIMETERS

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DESCRIPTION:	XDFN10 2.50X1.35, 0.5P	PAGE 1 OF 1

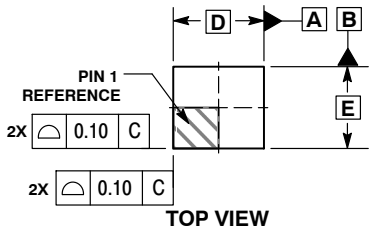
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

ON Semiconductor®

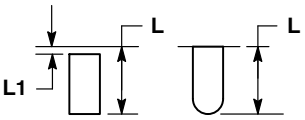
XDFN6 1.50x1.35, 0.5P
CASE 711AY
ISSUE O

DATE 09 SEP 2014

SCALE 4:1



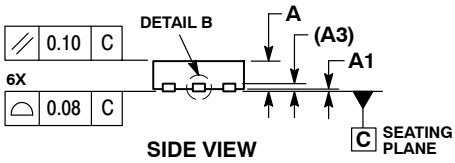
TOP VIEW



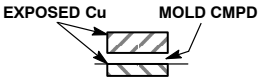
DETAIL A
ALTERNATE CONSTRUCTIONS

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.

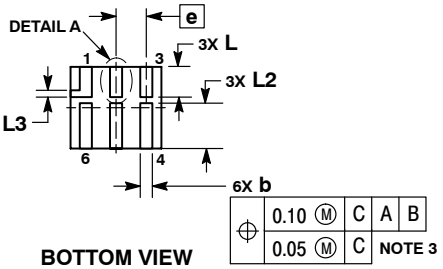
	MILLIMETERS	
DIM	MIN	MAX
A	0.40	0.50
A1	0.00	0.05
A3	0.15 REF	
b	0.15	0.25
D	1.50 BSC	
E	1.35 BSC	
e	0.50 BSC	
L	0.35	0.55
L1	---	0.15
L2	0.65	0.85
L3	0.15 REF	



SIDE VIEW

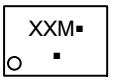


DETAIL B
ALTERNATE CONSTRUCTION



BOTTOM VIEW

GENERIC MARKING DIAGRAM*



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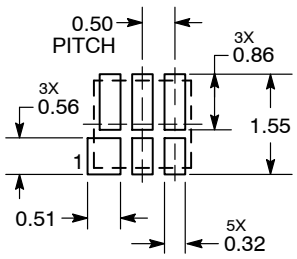
RECOMMENDED MOUNTING FOOTPRINT



DIMENSIONS: MILLIMETERS

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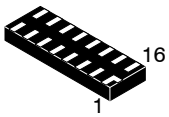
DESCRIPTION:	**XDFN6 1.50X1.35, 0.5P**		**PAGE 1 OF 1**

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

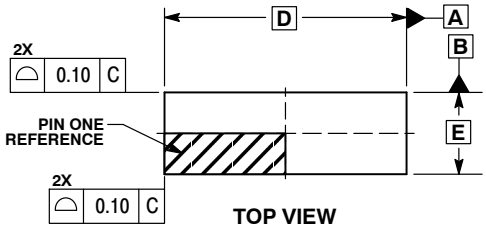
ON Semiconductor®



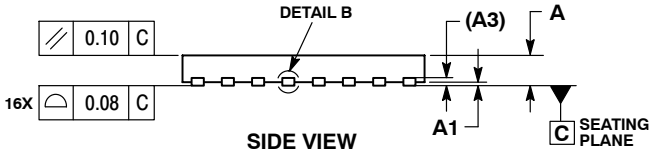
SCALE 4:1

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

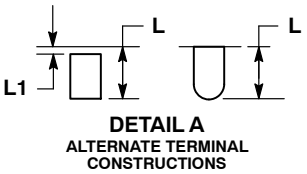
DATE 09 SEP 2014



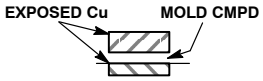
TOP VIEW



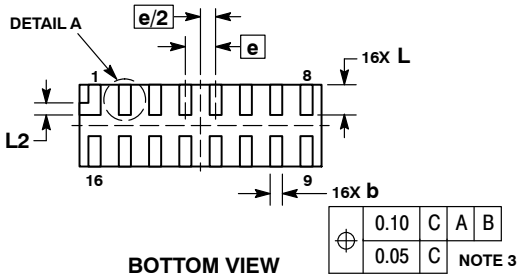
SIDE VIEW



DETAIL A
ALTERNATE TERMINAL CONSTRUCTIONS



DETAIL B
ALTERNATE CONSTRUCTION



BOTTOM VIEW

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	4.00 BSC	
E	1.35 BSC	
e	0.50 BSC	
L	0.40	0.60
L1	---	0.15
L2	0.20 REF	

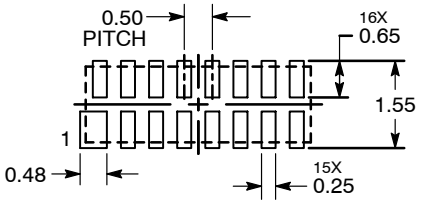
GENERIC MARKING DIAGRAM*

1

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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