EMI2121, SZEMI2121

Single Pair Common Mode Filter with ESD Protection

ON Semiconductor®

http://onsemi.com

Description

The EMI2121 is an integrated common mode filter providing both ESD protection and EMI filtering for high speed serial digital interfaces such as USB2.0.

The EMI2121 provides EMI filtering for one differential data line pair and ESD protection for one data pair plus a supply input such as USB2.0 Vbus or USB ID pin. It is supplied in a small RoHS−compliant WDFN8 package.

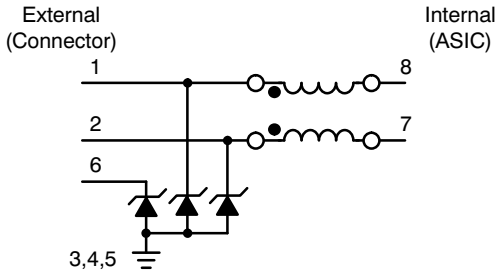
Features

- Highly Integrated Common Mode Filter (CMF) with ESD Protection provides protection and EMI Reduction for systems using high speed Serial Data Lines with cost and space savings over Discrete Solutions
- Large Differential Mode Bandwidth with Cutoff Frequency > 2 GHz
- High Common Mode Stop Band Attenuation: >25 dB at 700 MHz, >30 dB at 800 MHz Typical
- Provides ESD Protection to IEC61000−4−2 Level 4, ±12 kV Contact Discharge
- Low Channel Input Capacitance provides Superior Impedance Matching Performance
- Low Profile Package with Small Footprint in WDFN8 2.0 mm length x 2.2 mm width x 0.75 mm height Pb−Free Package
- 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

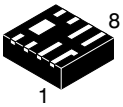
Applications

- USB2.0 and other High Speed Differential Data Lines in Mobile Phones, Digital Still Cameras, and Automotive interfaces
- MIPI D−PHY

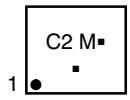
SIMPLIFIED SCHEMATIC



MARKING DIAGRAM



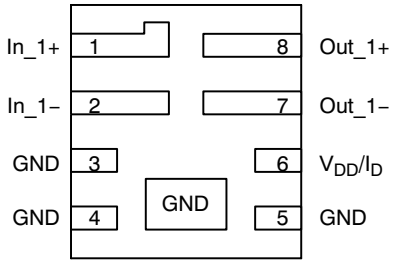
WDFN8
CASE 511BN



C2 = Specific Device Code
M = Date Code
▪ = Pb−Free Device

(*Note: Microdot may be in either location)

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

Device	Package	Shipping†
EMI2121MTTAG	WDFN8 (Pb−Free)	3000/Tape & Reel
SZEMI2121MTTAG	WDFN8 (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 Specification Brochure, BRD8011/D.

PIN DESCRIPTION

Pin No.	Pin Name	Type	Description
1	In_1+	I/O	CMF Channel 1+ to Connector (External)
2	In_1−	I/O	CMF Channel 1− to Connector (External)
8	Out_1+	I/O	CMF Channel 1+ to ASIC (Internal)
7	Out_1−	I/O	CMF Channel 1− to ASIC (Internal)
6	V_{DD}/I_D	I/O	Supply Protection to Connector (External)
3,4,5	GND	GND	Ground

MAXIMUM RATINGS (T_A = 25°C unless otherwise stated)

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

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Channel Leakage Current	I_{LEAK}	T_A = 25°C, V_{IN} = 5 V, GND = 0 V			1.0	μA
Channel Negative Voltage	V_F	T_A = 25°C, I_F = 10 mA	0.1		1.5	V
Channel Input Capacitance to ground (Pins 1,2,4,5 to Pins 3,8)	C_{IN}	T_A = 25°C, At 1 MHz, GND = 0 V, V_{IN} = 1.65 V		0.8	1.3	pF
Channel Resistance (Pins 1−16, 2−15, 4−13, 5−12, 7−10 and 9−9)	Rch			8.0		Ω
Differential Mode Cut − Off Frequency	f_{3dB}	50 Ω source and load termination		2.0		GHz
Common Mode Stop Band Attenuation	F_{atten}	@ 800 MHz		30		dB
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)**	V_{ESD}	(Notes 1 and 2)	 ±12 ±2			kV
TLP Clamping Voltage (See Figure 9)	V_{CL}	Forward I_{PP} = 8 A Forward I_{PP} = 12 A Reverse I_{PP} = −8 A Reverse I_{PP} = −12 A		13 16 −6 −8.5		V V V V
Reverse Working Voltage	V_{RWM}	(Note 3)			5.0	V
Breakdown Voltage	V_{BR}	I_T = 1 mA; (Note 4)	5.5		9.0	V
Maximum Peak Pulse Current (Pin 6 to GND)	I_{PP}	8x20 μs Waveform			12	A
Clamping Voltage (Pin 6 to GND)	V_C	I_{PP} = 5 A			10	V
Dynamic Resistance Positive Transients Negative Transients	R_{DYN}	T_A = 25C, I_{PP}=1 A, t_P= 8/20 us, Any I/O to GND		 0.67 0.59		 Ω Ω

1. Standard IEC 61000−4−2 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 or greater than the DC or continuous peak operating voltage level.
4. V_{BR} is measured at pulse test current I_T.

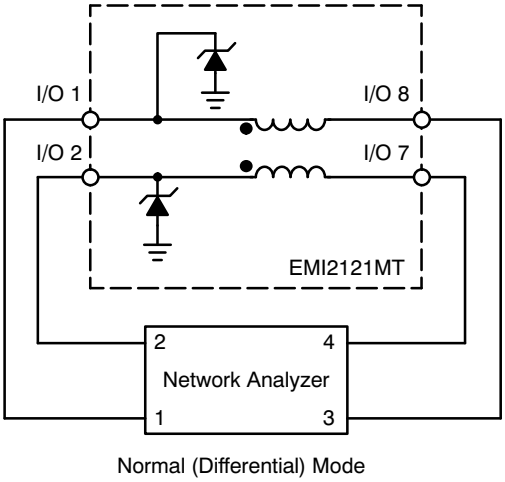


Figure 1. Normal (Differential) Mode Test Configuration

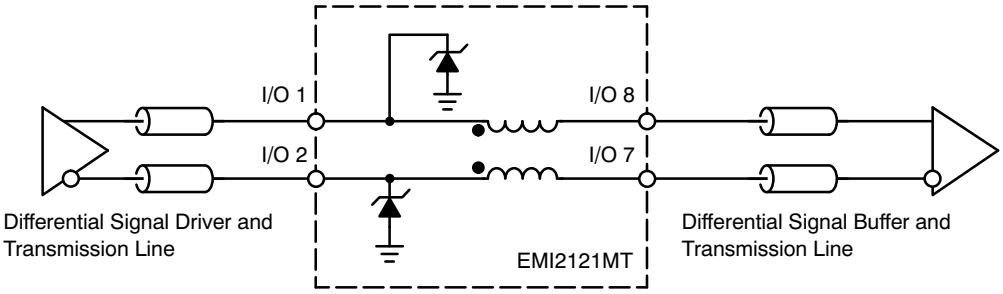


Figure 2. Application Circuit

TYPICAL CHARACTERISTICS

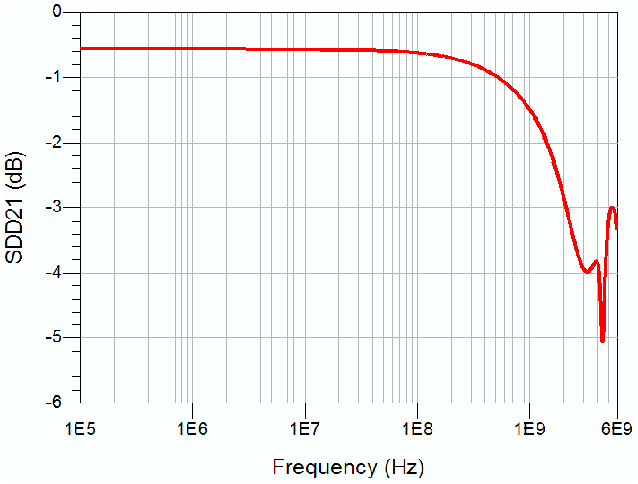


Figure 3. Differential Mode Attenuation vs. Frequency (Zdiff = 100 Ω)

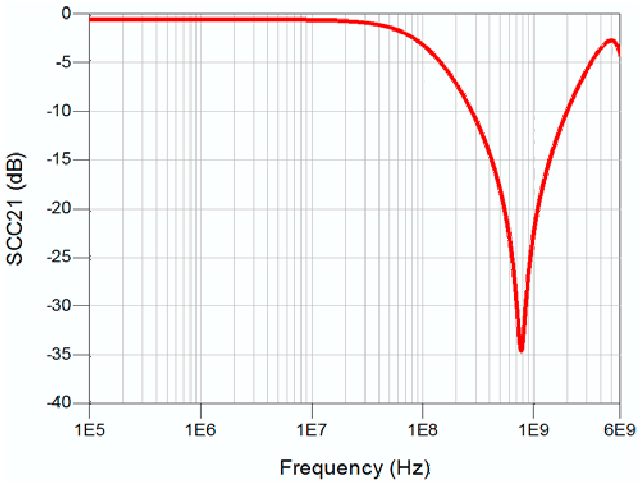


Figure 4. Common Mode Attenuation vs. Frequency (Zcomm = 50 Ω)

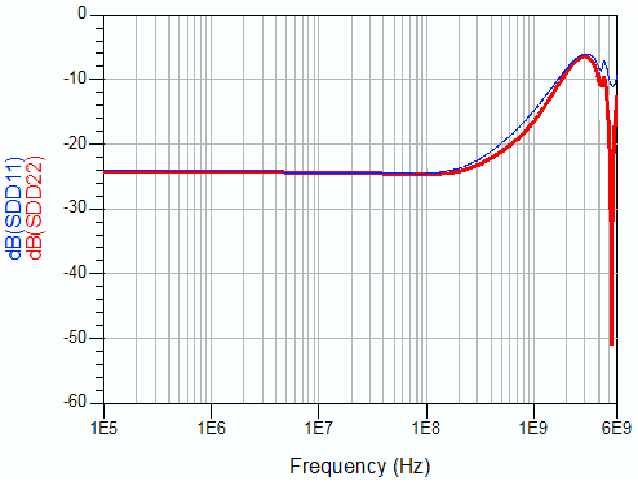


Figure 5. Differential Return Loss vs. Frequency (Zdiff=100 Ω)

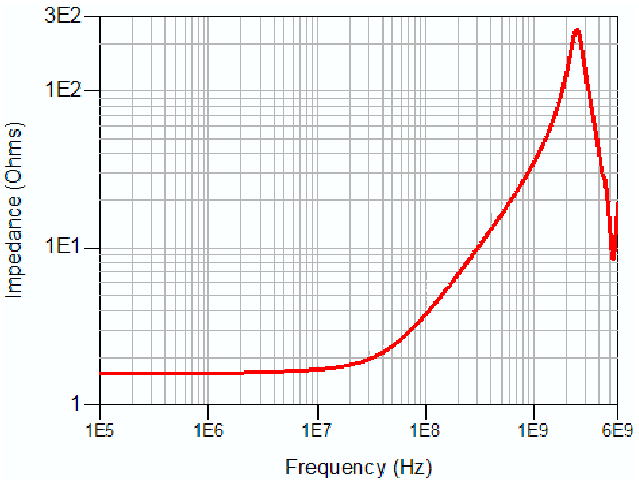


Figure 6. Differential Impedance vs. Frequency (Zdiff=100 Ω)

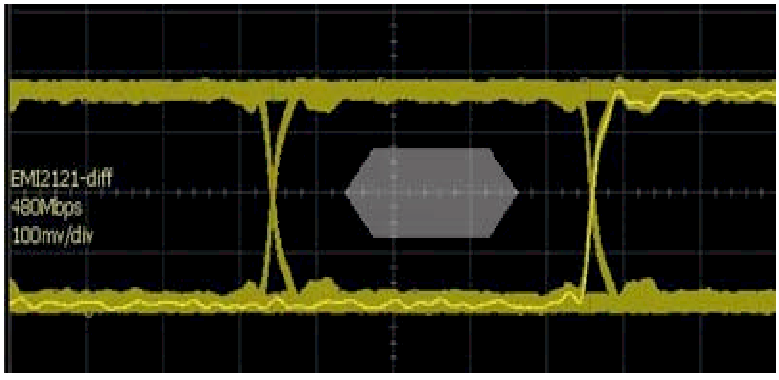


Figure 7. EMI2121 Measured Eye Diagram @ 480 Mbps

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 8. 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 9 where an 8 kV IEC61000−4−2 current waveform is compared with TLP current pulses at 8 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 EMI2121 are shown in Figure 10.

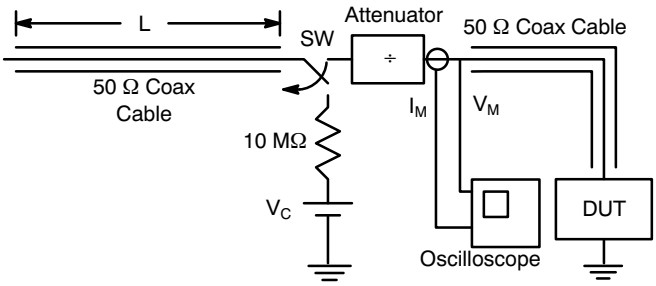


Figure 8. Simplified Schematic of a Typical TLP System

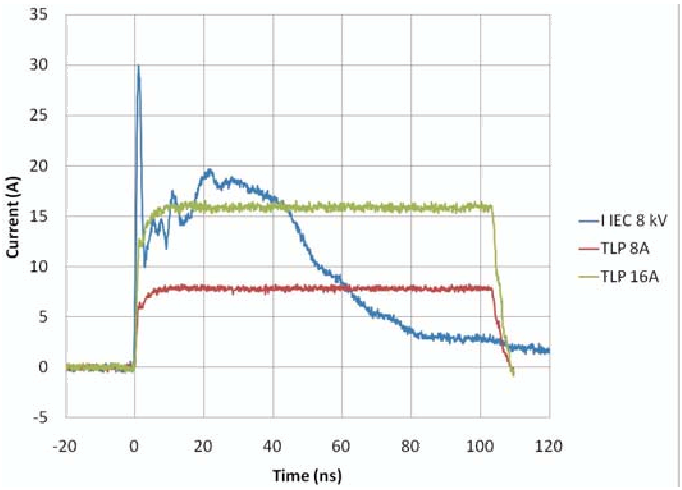


Figure 9. Comparison Between 8 kV IEC61000−4−2 and 8 A and 16 A TLP Waveforms

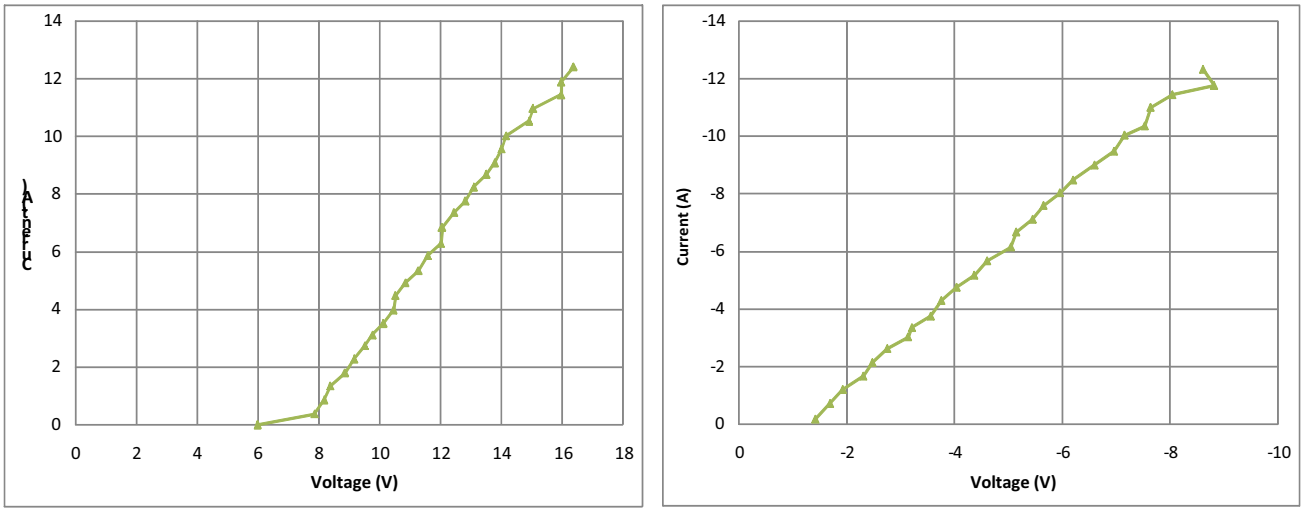


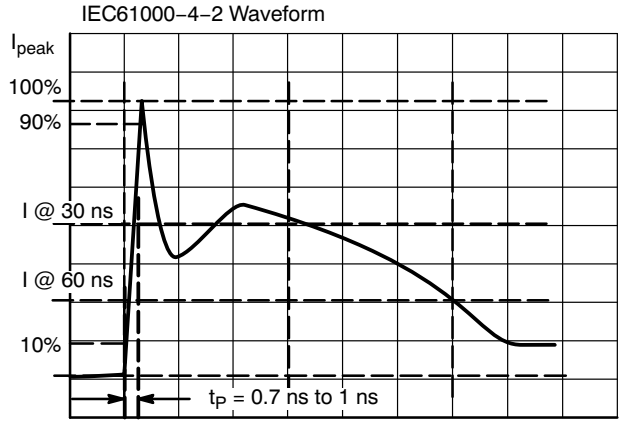
Figure 10. Positive and Negative TLP Waveforms

ESD Voltage Clamping

For sensitive circuit elements it is important to limit the voltage that an IC will be exposed to during an ESD event to as low a voltage as possible. The ESD clamping voltage is the voltage drop across the ESD protection diode during an ESD event per the IEC61000−4−2 waveform. Since the IEC61000−4−2 was written as a pass/fail spec for larger systems such as cell phones or laptop computers it is not clearly defined in the spec how to specify a clamping voltage at the device level. ON Semiconductor has developed a way to examine the entire voltage waveform across the ESD protection diode over the time domain of an ESD pulse in the form of an oscilloscope screenshot, which can be found on the datasheets for all ESD protection diodes. For more information on how ON Semiconductor creates these screenshots and how to interpret them please refer to On Semiconductor Application Notes AND8307/D and AND8308/D.

IEC61000−4−2 Spec.

Level	Test Voltage (kV)	First Peak Current (A)	Current at 30 ns (A)	Current at 60 ns (A)
1	2	7.5	4	2
2	4	15	8	4
3	6	22.5	12	6
4	8	30	16	8



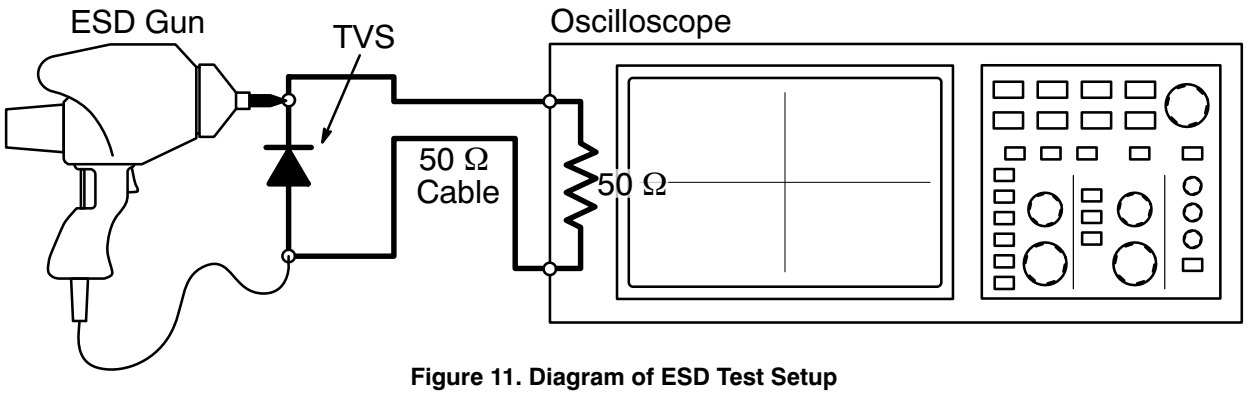


Figure 11. Diagram of ESD Test Setup

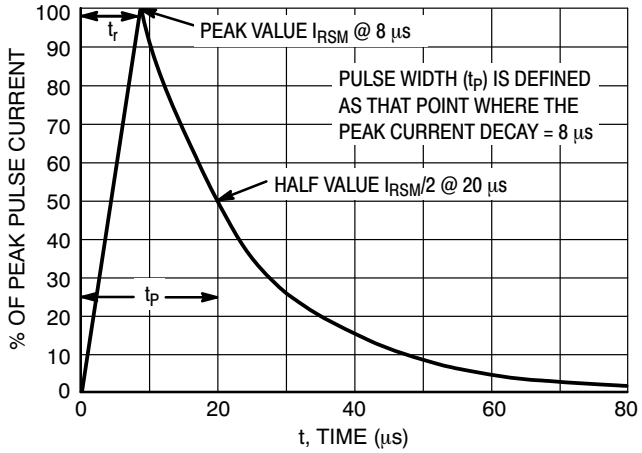


Figure 12. 8 x 20 μs Pulse Waveform

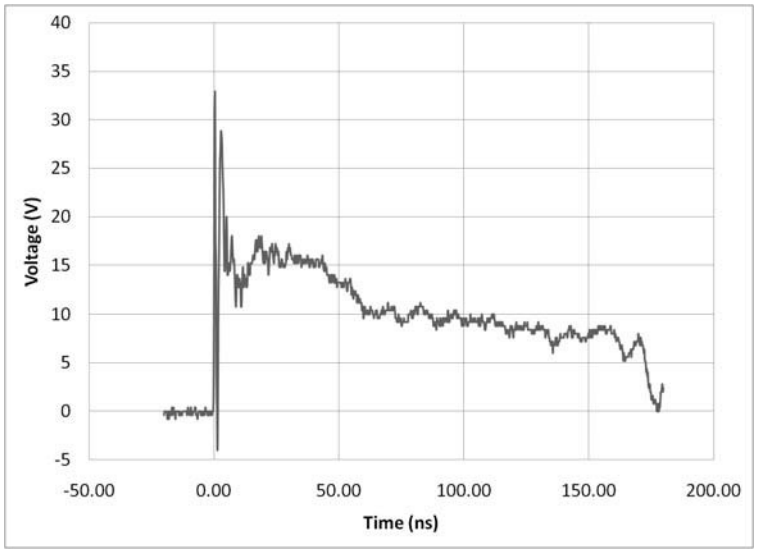


Figure 13. ESD Clamping Voltage +8 kV per IEC6100−4−2 (external to internal pin)

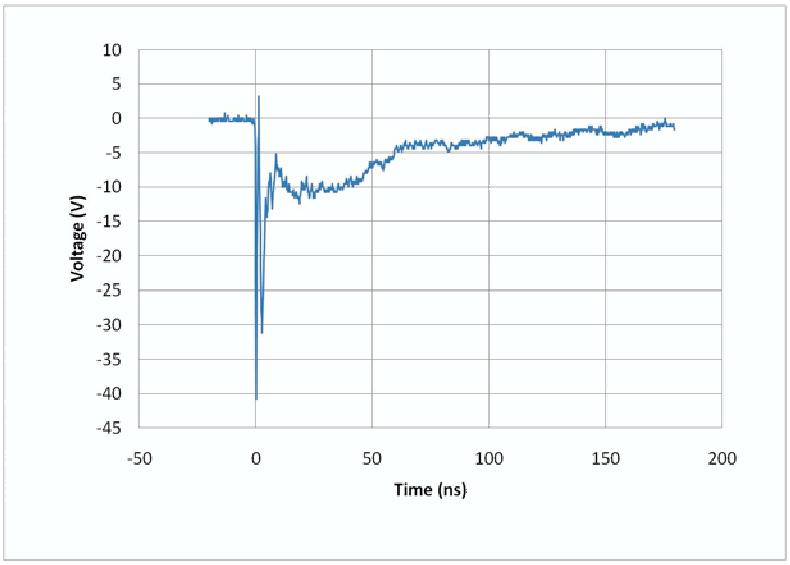


Figure 14. ESD Clamping Voltage −8 kV per IEC6100−4−2 (external to internal pin)

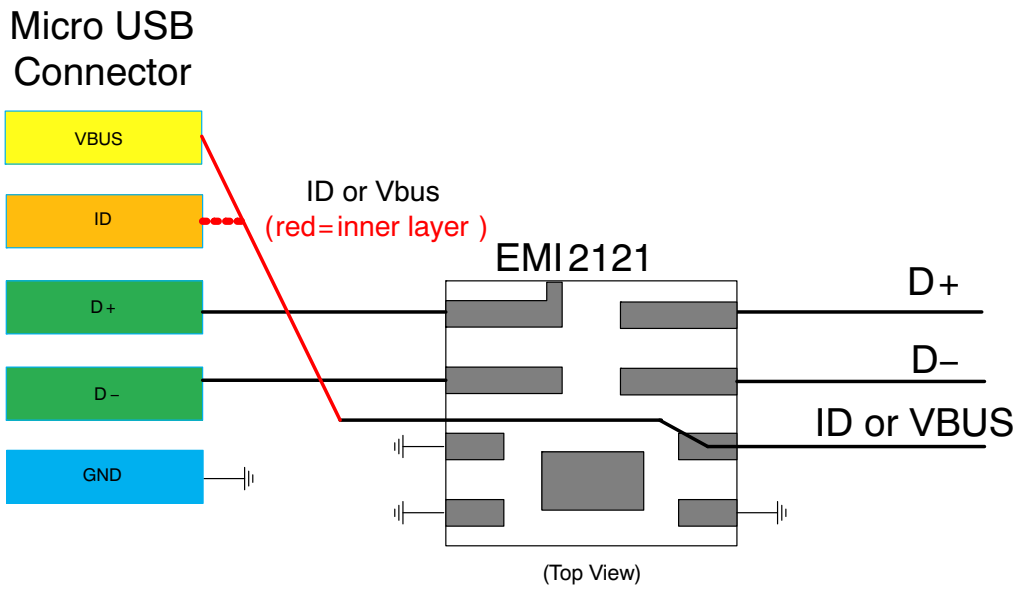
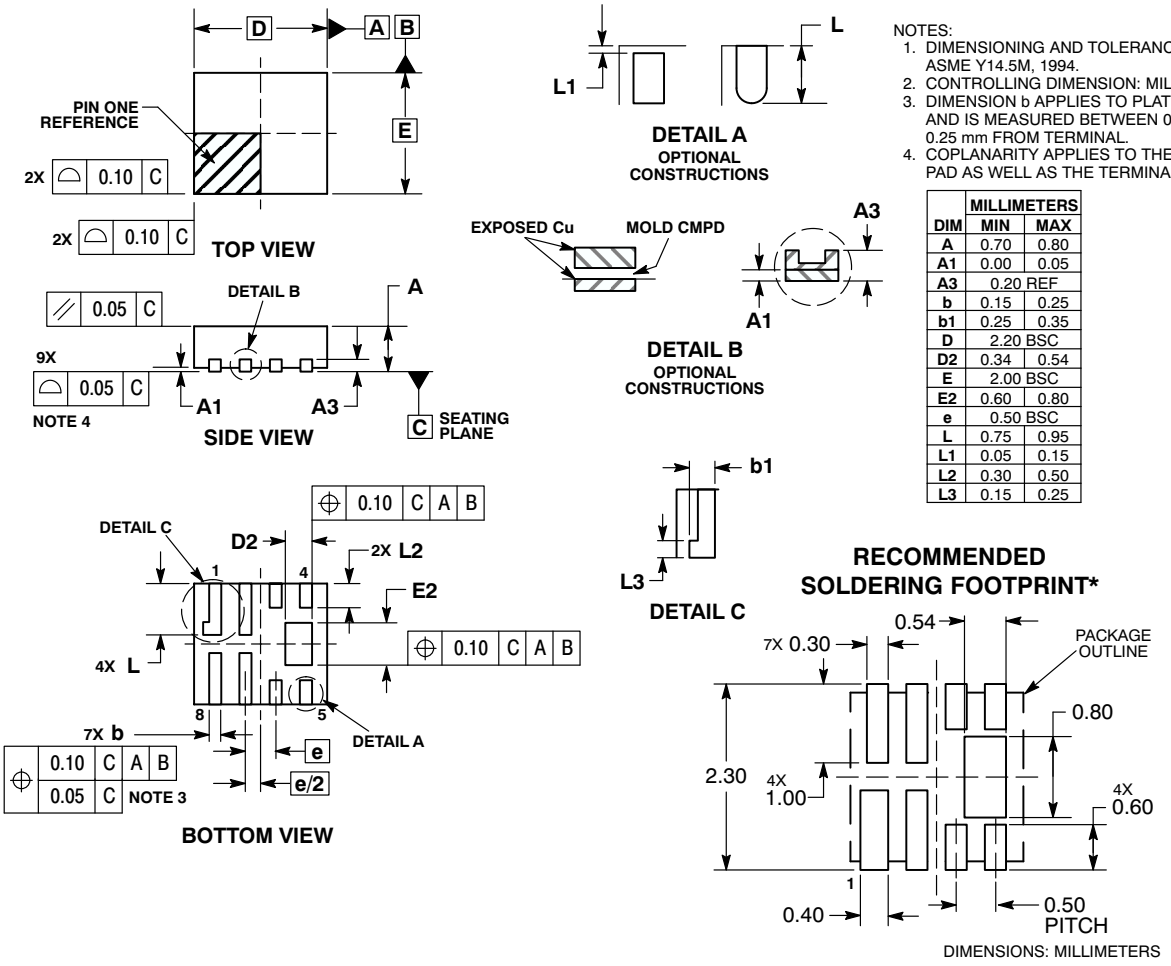


Figure 15. EMI2121 Micro − USB Connector Application Diagram

PACKAGE DIMENSIONS

WDFN8, 2.2x2, 0.5P
CASE 511BN
ISSUE A



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 0.25 mm FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

	MILLIMETERS	
DIM	MIN	MAX
A	0.70	0.80
A1	0.00	0.05
A3	0.20 REF	
b	0.15	0.25
b1	0.25	0.35
D	2.20 BSC	
D2	0.34	0.54
E	2.00 BSC	
E2	0.60	0.80
e	0.50 BSC	
L	0.75	0.95
L1	0.05	0.15
L2	0.30	0.50
L3	0.15	0.25

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.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5817−1050

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative

EMI2121MT/D