Dual Line CAN/CAN-FD Bus Protector

SZNUP2124

The SZNUP2124 has been designed to protect both CAN and CAN−FD transceivers from ESD and other harmful transient voltage events. This device provides two channels of bidirectional protection in a single, ultra−compact XDFNW3 1x1 mm package. The combination of low turn−on voltage and low dynamic resistance (R_{dyn}) gives the system designer a low cost option for improving system reliability by working in conjunction with transceivers utilizing advanced internal ESD structures.

Features

- Low Reverse Leakage Current (< 100 nA)
- Low Parasitic Capacitance (< 6 pF) for High Signal Integrity of CAN−FD Data Rates
- 175°C $T_{J(max)}$ − Rated for High Temperature, Mission Critical Applications
- IEC Compatibility:
  - IEC 61000−4−2 (ESD): Level 4
  - IEC 61000−4−4 (EFT): 50 A (5/50 ns)
  - IEC 61000−4−5 (Lighting) 3.0 A (8/20 μs)
- ISO 7637−1, Nonrepetitive EMI Surge Pulse 2, 8.0 A (1/50 μs)
- ISO 7637−3, Repetitive Electrical Fast Transient (EFT) EMI Surge Pulses, 50 A (5/50 ns)
- Flammability Rating UL 94 V−0
- Wettable Flank Package for optimal Automated Optical Inspection (AOI)
- 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

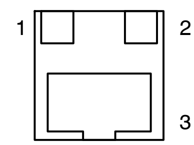
Applications

- Automotive Networks
  - CAN / CAN−FD
  - Low and High−Speed CAN
  - Fault Tolerant CAN
  - LIN

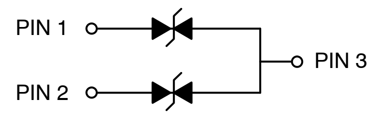
ON Semiconductor®

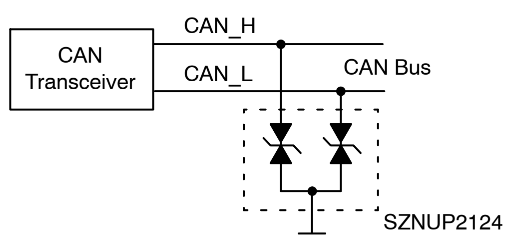
www.onsemi.com

**XDFNW3
DUAL BIDIRECTIONAL
VOLTAGE SUPPRESSOR**

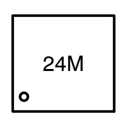


**XDFNW3
CASE 521AC**





MARKING DIAGRAM



24 = Specific Device Code
M = Month Code

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

MAXIMUM RATINGS (T_J = 25°C, unless otherwise specified)

Symbol	Rating	Value	Unit
PPK	Peak Power Dissipation 8/20 μs Double Exponential Waveform (Note 1)	120	W
T_J	Operating Junction Temperature Range	−55 to 175	°C
T_J	Storage Temperature Range	−55 to 175	°C
T_L	Lead Solder Temperature (10 s)	260	°C
ESD	Human Body Model (HBM) IEC 61000−4−2 Specification (Contact)	16 28	kV kV

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.

1. Non−repetitive current pulse per Figure 1.

ELECTRICAL CHARACTERISTICS (T_J = 25°C, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{RWM}	Reverse Working Voltage	(Note 2)			24	V
V_{BR}	Breakdown Voltage	I_T = 1 mA (Note 3)	26	27	33	V
I_R	Reverse Leakage Current	V_{RWM} = 24 V			100	nA
V_C	Clamping Voltage	I_{PP} = 1 A (8/20 μs Waveform), (Note 4)			40	V
I_{PP}	Maximum Peak Pulse Current	8/20 μs Waveform (Note 4)			3.0	A
CJ	Capacitance	V_R = 0 V, f = 1 MHz (Line to GND) V_R = 5 V, f = 1 MHz (Line to GND)			10 6.0	pF
ΔC	Diode Capacitance Matching	V_R = 0 V, f = 1 MHz (Note 5)			0.25	pF

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.

2. Surge protection 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.
3. V_{BR} is measured at pulse test current I_T.
4. Pulse waveform per Figure 1.
5. ΔC is the percentage difference between C_J of lines 1 and 2 measured according to the test condition given in the electrical characteristics table.

ORDERING INFORMATION

Device	Part Orientation†	Package	Shipping†
SZNUP2124MXWTAG*	Pin 1 – Upper Left	XDFNW3 (Pb−Free)	10,000 / Tape & Reel
SZNUP2124MXWTBG*	Pin 1 – Upper Right		

†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

TYPICAL PERFORMANCE CURVES

(T_J = 25°C unless otherwise noted)

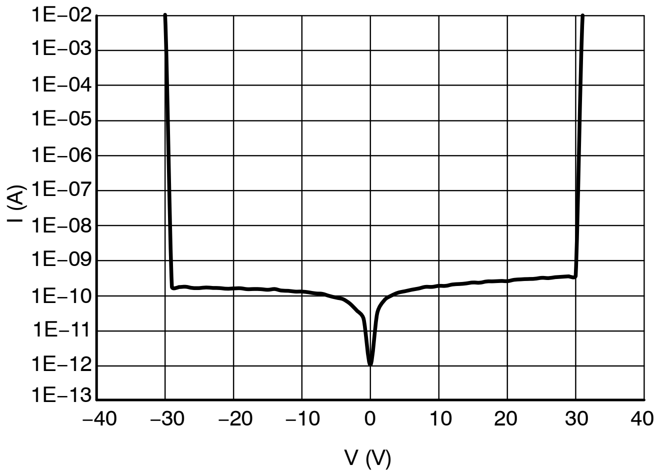


Figure 1. IV Characteristics

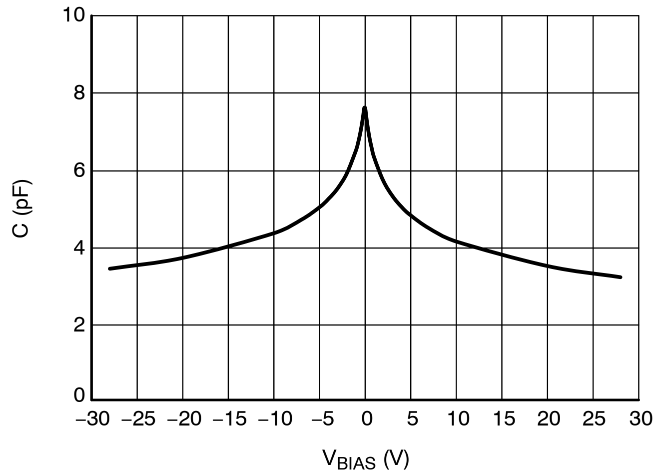


Figure 2. CV Characteristics

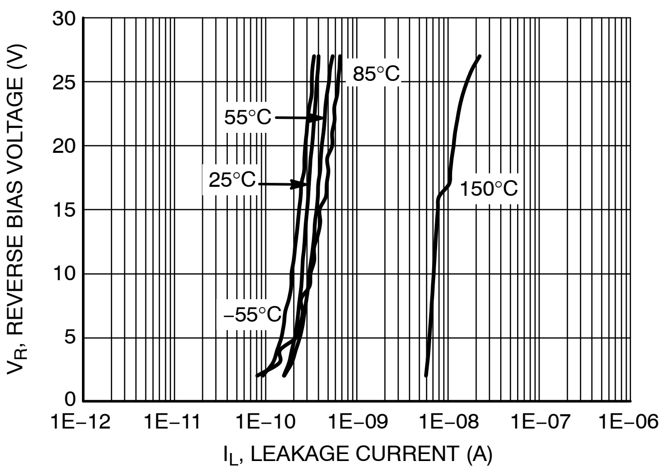


Figure 3. I_R vs. Temperature Characteristics

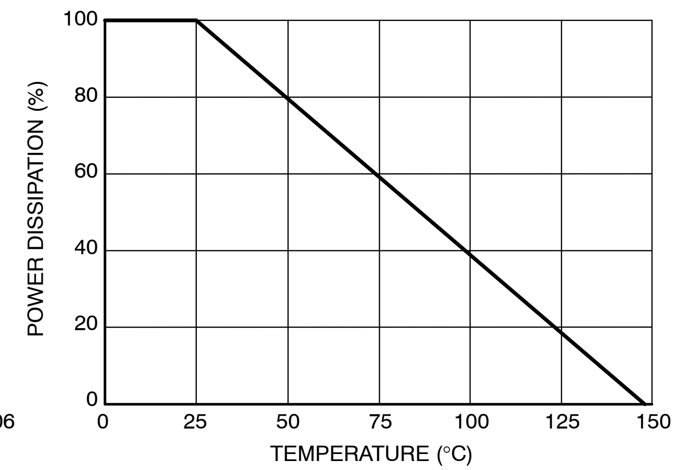


Figure 4. Steady State Power Derating

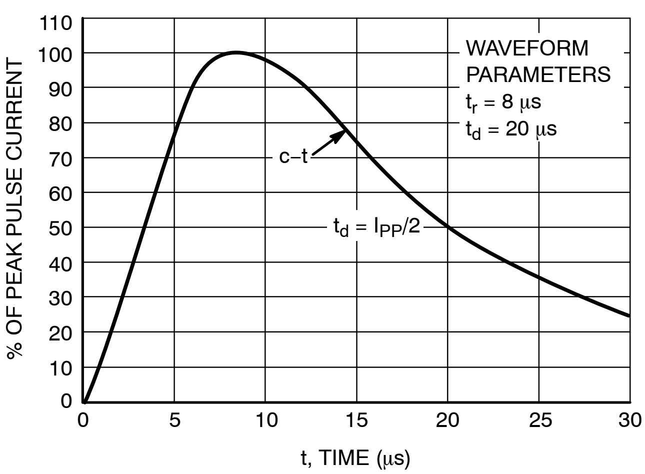


Figure 5. Pulse Waveform (8/20 μs)

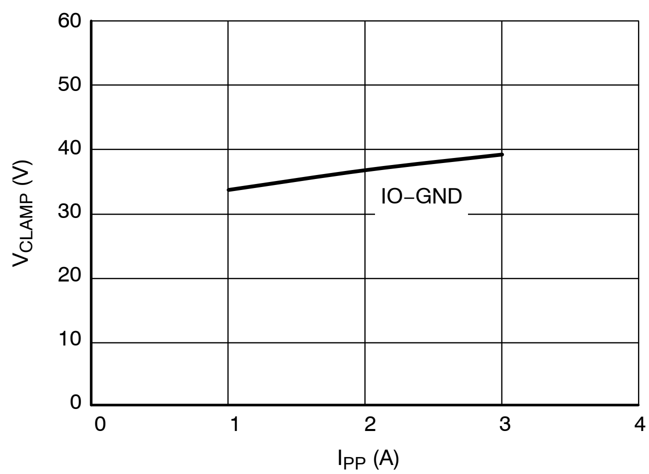


Figure 6. Clamping Voltage vs. Peak Pulse Current (8/20 μs)

TYPICAL PERFORMANCE CURVES

(T_J = 25°C unless otherwise noted)

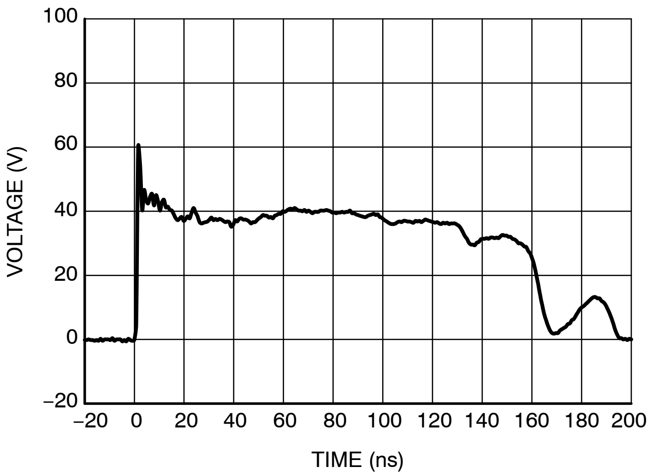


Figure 7. IEC61000−4−2 +8 kV Contact ESD Clamping Voltage

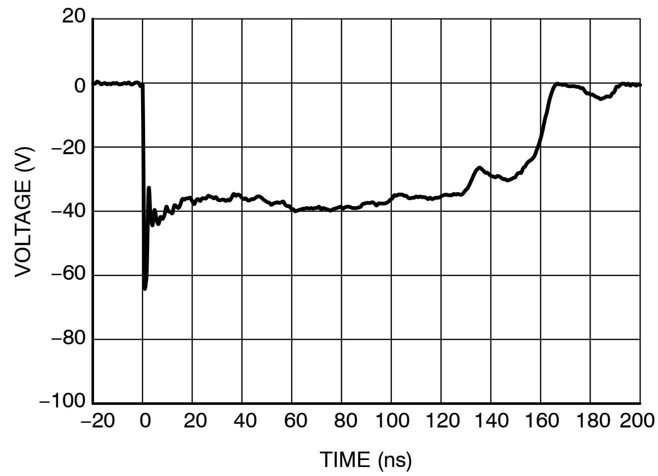


Figure 8. IEC61000−4−2 −8 kV Contact ESD Clamping Voltage

IEC 61000−4−2 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

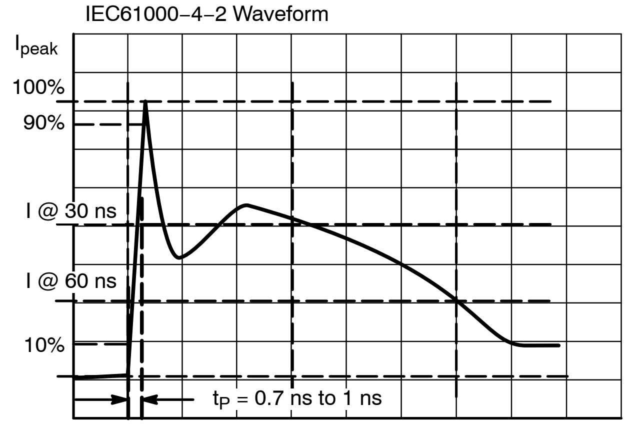


Figure 9. IEC61000−4−2 Spec

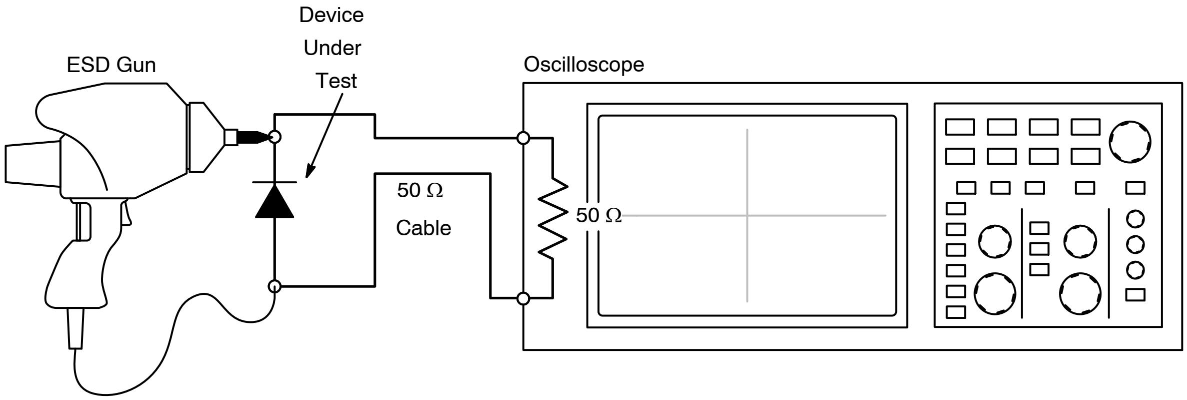


Figure 10. Diagram of ESD Clamping Voltage Test Setup

The following is taken from Application Note AND8308/D − Interpretation of Datasheet Parameters for ESD Devices.

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 AND8307/D.

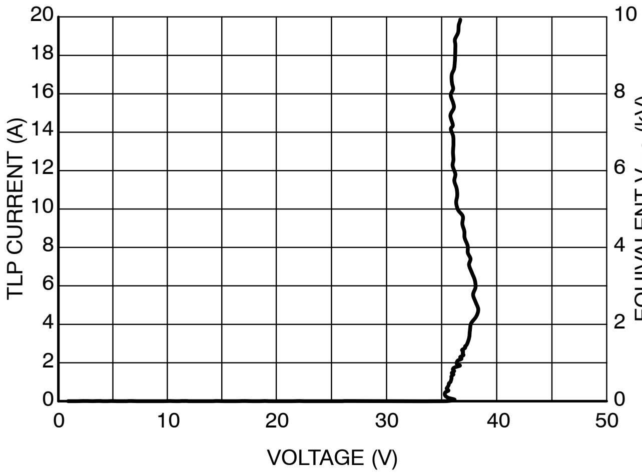


Figure 11. Positive TLP IV Curve

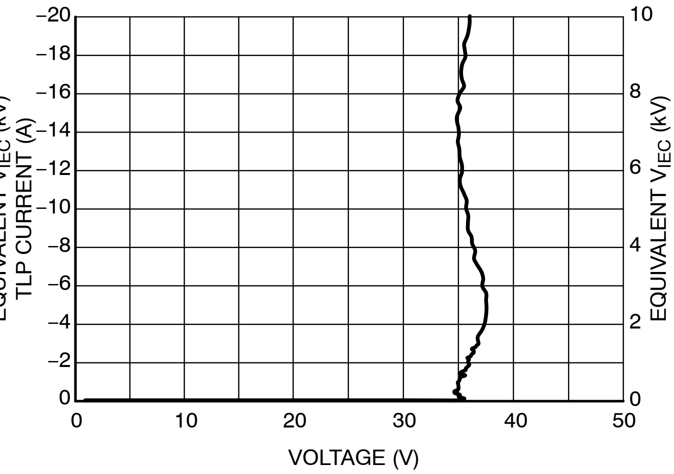


Figure 12. Negative TLP IV Curve

NOTE: TLP parameter: Z_0 = 50 Ω, t_p = 100 ns, t_r = 300 ps, averaging window: t_1 = 30 ns to t_2 = 60 ns.

Transmission Line Pulse (TLP) Measurement

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 13. TLP I−V curves of ESD protection devices accurately demonstrate the product's ESD capability because the 10s of amps current levels and under 100 ns time scale match those of an ESD event. This is illustrated in Figure 14 where an 8 kV IEC 61000−4−2 current waveform is compared with TLP current pulses at 8 A and 16 A. A TLP I−V 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.

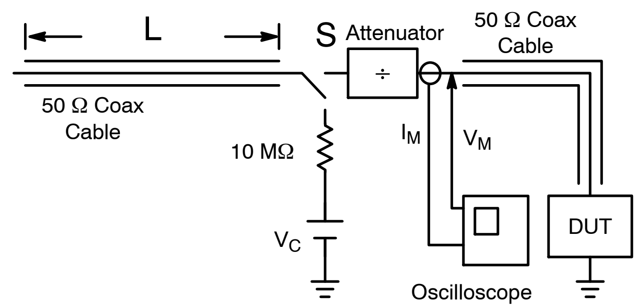


Figure 13. Simplified Schematic of a Typical TLP System

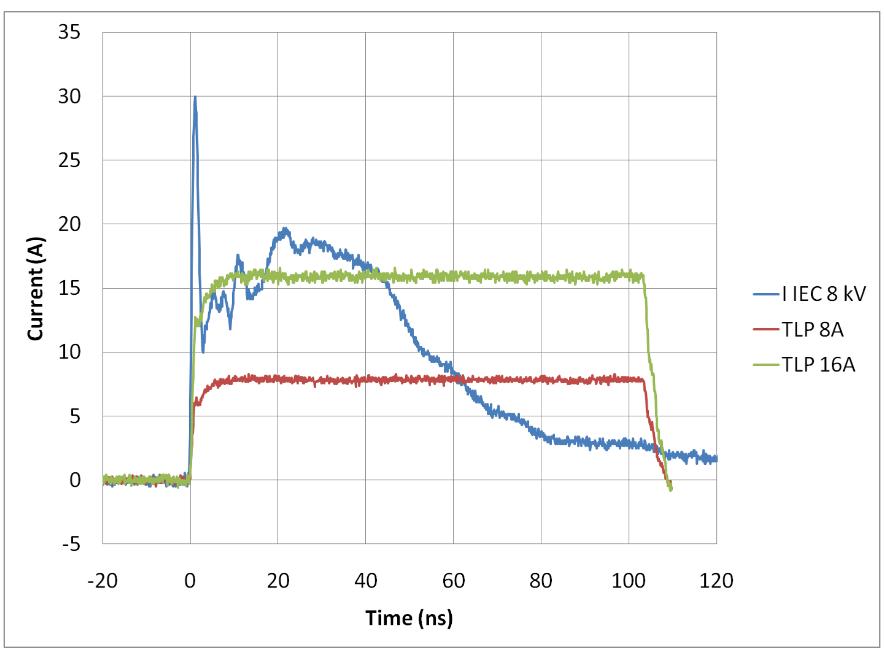


Figure 14. Comparison Between 8 kV IEC 61000−4−2 and 8 A and 16 A TLP Waveforms

APPLICATIONS

Background

The Controller Area Network (CAN) is a serial communication protocol designed for providing reliable high speed data transmission in harsh environments. surge protection diodes provide a low cost solution to conducted and radiated Electromagnetic Interference (EMI) and Electrostatic Discharge (ESD) noise problems. The noise immunity level and reliability of CAN transceivers can be easily increased by adding external surge protection diodes to prevent transient voltage failures.

The SZNUP2124 provides a surge protection solution for CAN data communication lines. The SZNUP2124 is a dual bidirectional surge protection device in a compact XDFNW3 package. This device is based on Zener technology that optimizes the active area of a PN junction to provide robust protection against transient EMI surge voltage and ESD. The SZNUP2124 has been tested to EMI and ESD levels that exceed the specifications of popular high speed CAN and CAN−FD networks.

CAN Physical Layer Requirements

Table 1 provides a summary of the system requirements for a CAN transceiver. The ISO 11898−2 physical layer specification forms the baseline for most CAN systems.

Table 1. Transceiver Requirements for High−Speed CAN Networks

Parameter	ISO 11898−2
Min / Max Bus Voltage (12 V System)	−3.0 V / 16 V
Common Mode Bus Voltage	CAN_L: −2.0 V (min) 2.5 V (nom) CAN_H: 2.5 V (nom) 7.0 V (max)
Transmission Speed	1.0 Mb/s @ 40 m 125 kb/s @ 500 m
ESD	Not specified, recommended ≥ ±8.0 kV (contact)
EMI Immunity	ISO 7637−3, pulses ‘a’ and ‘b’
Popular Applications	Automotive, Truck, Medical and Marine Systems

EMI Specifications

The EMI protection level provided by the surge protection device can be measured using the International Organization for Standardization (ISO) 7637−2 and −3 specifications that are representative of various noise sources. The ISO 7637−2 specification is used to define the susceptibility to coupled transient noise on a 12 V power supply, while ISO 7637−3 defines the noise immunity tests for data lines. The ISO 7637 tests also verify the robustness and reliability of a design by applying the surge voltage for extended durations.

The IEC 61000−4−X specifications can also be used to quantify the EMI immunity level of a CAN system. The IEC 61000−4 and ISO 7637 tests are similar; however, the IEC standard was created as a generic test for any electronic system, while the ISO 7637 standard was designed for vehicular applications. The IEC61000−4−4 Electrical Fast Transient (EFT) specification is similar to the ISO 7637−3 pulse 3a and b tests and is a requirement of SDS CAN systems. The IEC 61000−4−5 test is used to define the power absorption capacity of a surge protection device and long duration voltage transients such as lightning. Table 2 provides a summary of the ISO 7637 and IEC 61000−4−X test specifications. Table 3 provides the SZNUP2124's ESD test results.

Table 2. ISO 7637 and IEC 61000−4−X Test Specifications

Test	Waveform	Test Specifications	SZNUP2124 Results	Simulated Noise Source
ISO 7637−2 12 V Power Supply Lines (Note 2)	Pulse 1	V_s = 0 to −100 V I_{max} = 10 A $t_{duration}$ = 5000 pulses	I_{max} = 1.75 A V_{clamp_max} = TBD V $t_{duration}$ = 5000 pulses R_i = 10 Ω, t_r = 1.0 μs, $t_{d\_10\%}$ = 2000 μs, t_1 = 2.5 s, t_2 = 200 ms, t_3 = 100 μs	DUT (Note 1) in parallel with inductive load that is disconnected from power supply.
	Pulse 2a	V_s = 0 to +50 V coupled onto 14 V battery I_{max} = 10 A $t_{duration}$ = 5000 pulses	I_{max} = 9.5 A V_{clamp_max} = TBD V $t_{duration}$ = 5000 pulses Ri = 2 Ω, t_r = 1.0 μs, $t_{d\_10\%}$ = 50 μs, t_1 = 2.5 s, t_2 = 200 ms	DUT in series with inductor (wire harness) that is disconnected from load.
ISO 7637−3 Repetitive data line fast transients (Note 3)	Pulse 'a'	V_s = −60 V I_{max} = 1.2 A $t_{duration}$ = 10 minutes	I_{max} = 50 A (Note 4) V_{clamp_max} = TBD V $t_{duration}$ = 60 minutes R_i = 50 Ω, t_r = 5.0 ns, $t_{d\_10\%}$ = 100 ns, t_1 = 100 μs, t_2 = 10 ms, t_3 = 90 ms	Switching noise of inductive loads.
	Pulse 'b'	V_s = +40 V I_{max} = 0.8 A $t_{duration}$ = 10 minutes		
IEC 61000−4−4 Data Line EFT		$V_{open\ circuit}$ = 2.0 kV $I_{short\ circuit}$ = 40 A (Level 4 = Severe Industrial Environment) R_i = 50 Ω, t_r < 5.0 ns, $t_{d\_50\%}$ = 50 ns, t_{burst} = 15 ms, f_{burst} = 2.0 to 5.0 kHz, t_{repeat} = 300 ms $t_{duration}$ = 1 minute	(Note 5)	Switching noise of inductive loads.
IEC 61000−4−5		$V_{open\ circuit}$ = 1.2/50 μs, $I_{short\ circuit}$ = 8/20 μs R_i = 50 Ω	I_{max} = 8.0 A	Lightning, nonrepetitive power line and load switching

1. DUT = device under test.
2. Test specifications were taken from ISO7637−2: 2004 version.
3. Test specifications were taken from ISO7637−3: 1995 version.
4. DUT was tested to ISO7637−2: 2004 pulse 3a,b specification for more rigorous test.
5. The EFT immunity level was measured with test limits beyond the IEC 61000−4−4 test, but with the more severe test conditions of ISO 7637−3.

Table 3. SZNUP2124 ESD Test Results

ESD Specification	Test	Test Level	Pass / Fail
Human Body Model	Contact	8 kV	Pass
IEC 61000−4−2	Contact	12.5 kV	Pass
	Non−contact (Air Discharge)	12.5 kV	Pass

Surge protection Diode Protection Circuit

ESD diodes provide protection to a transceiver by clamping a surge voltage to a safe level. ESD diodes have high impedance below and low impedance above their breakdown voltage. An ESD diode has its junction optimized to absorb the high peak energy of a transient event, while a standard diode is designed and specified to clamp a steady state voltage.

Figure 15 provides an example of a dual bidirectional ESD diode array that can be used for protection with the high−speed CAN network. The clamping voltage of the composite device is equal to the breakdown voltage of the diode that is reversed biased, plus the diode drop of the second diode that is forwarded biased.

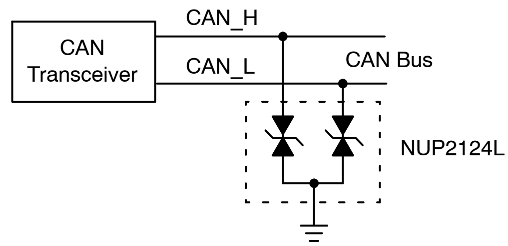
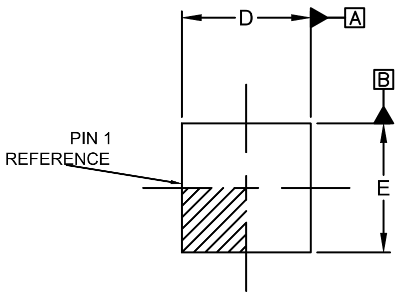


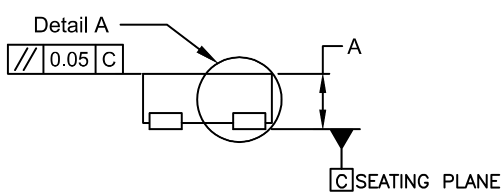
Figure 15. CAN ESD Circuit

PACKAGE DIMENSIONS

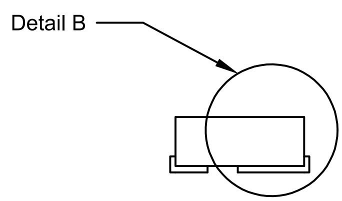
XDFNW3 1x1, 0.65P
CASE 521AC
ISSUE O



TOP VIEW



SIDE VIEW

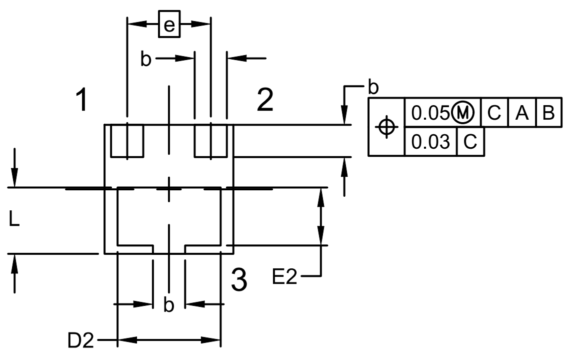


END VIEW

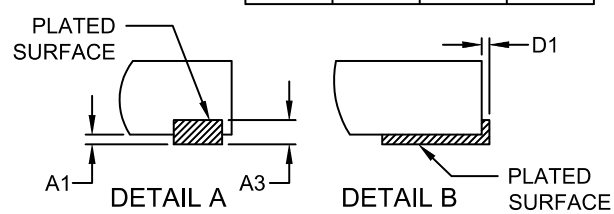
NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS

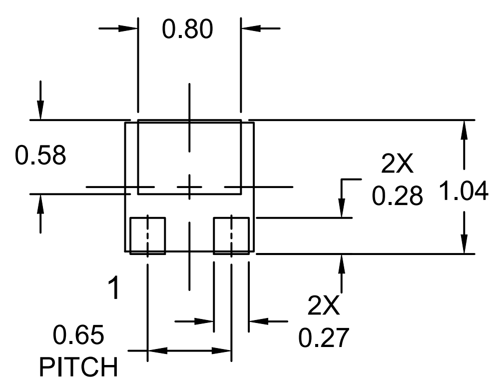
DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.32	0.38	0.44
A1	0.00	---	0.04
A3	0.125 REF		
b	0.20	0.25	0.30
D	0.90	1.00	1.10
D1	0.00	---	0.04
D2	0.75	0.80	0.85
E	0.90	1.00	1.10
E2	0.40	0.45	0.50
e	0.65 BSC		
L	0.465	0.515	0.565



BOTTOM VIEW



DETAIL A DETAIL B



RECOMMENDED
MOUNTING FOOTPRINT*

* 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
19521 E. 32nd Pkwy, Aurora, Colorado 80011 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

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

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

For additional information, please contact your local Sales Representative