PESD2ETH1G-T

ESD protection for In-vehicle networks

6 October 2022 **Product data sheet**

1. General description

Fully OPEN Alliance 100BASE-T1 and 1000BASE-T1 compliant Electrostatic discharge (ESD) protection device in a small SOT23 surface-mounted plastic package designed to protect two automotive in-vehicle network bus lines from the damage caused by ESD and other transients.

2. Features and benefits

- Fully OPEN Alliance 100BASE-T1 and 1000BASE-T1 compliant
- High trigger voltage: V_{t1} = 100 V min.
- Low capacitance: C_d < 2 pF
- ESD protection up to 30 kV (IEC 61000-4-2)
- 1000 contact discharges (OPEN Alliance specification) with 15 kV (IEC 61000-4-2)
- AEC-Q101 qualified / automotive grade

3. Applications

ESD protection for in-vehicle network lines In-automotive environments

- OPEN Alliance 100/1000BASE-T1 Ethernet
- Low-Voltage Differential Signaling (LVDS) automotive

4. Quick reference data

Table 1. Quick reference data

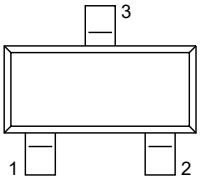
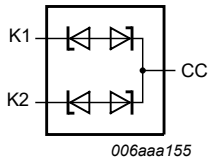
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{RWM}	reverse standoff voltage	T_{amb} = 25 °C		-	-	24	V
C_d	diode capacitance	f = 1 MHz; V_R = 0 V; T_{amb} = 25 °C		-	1.8	2	pF
V_{t1}	trigger voltage	t_p = 100 ns; T_{amb} = 25 °C	[1]	100	130	-	V
V_{ESD}	electrostatic discharge voltage	IEC 61000-4-2; contact discharge	[2] [3]	30	-	-	kV
		1000 contact discharges (IEC 61000-4-2); OPEN Alliance specification	[3]	15	-	-	kV

[1] Non-repetitive current pulse, Transmission Line Pulse (TLP); square pulse; ANSI / ESD STM5.5.1-2008
[2] Device stressed with ten non-repetitive ESD pulses.
[3] Measured from pin 1 or 2 to pin 3.

nexperia

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	K	cathode	 SOT23	
2	K	cathode		
3	CC	common cathode		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PESD2ETH1G-T	SOT23	plastic, surface-mounted package; 3 terminals; 1.9 mm pitch; 2.9 mm x 1.3 mm x 1 mm body	SOT23

7. Marking

Table 4. Marking codes

Type number	Marking code[1]
PESD2ETH1G-T	%HK

[1] % = placeholder for manufacturing site code

8. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC60134)

Symbol	Parameter	Conditions		Min	Max	Unit
I_{PPM}	rated peak pulse current	t_p = 8/20 µs	[1] [2]	-	2.3	A
T_j	junction temperature			-	150	°C
T_{amb}	ambient temperature			-55	150	°C
T_{stg}	storage temperature			-65	150	°C
V_{ESD}	electrostatic discharge voltage	IEC 61000-4-2; contact discharge	[3] [2]	30	-	kV
		ISO 10605; contact discharge; C = 150 pF; R = 330 Ω	[3] [2]	30	-	kV
		ISO 10605; contact discharge; C = 330 pF; R = 330 Ω	[3] [2]	30	-	kV
		1000 contact discharges (IEC 61000-4-2); OPEN Alliance specification	[2]	15	-	kV

[1] Device stressed with 8/20 µs exponential decay waveform according to IEC 61000-4-5.
[2] Measured from pin 1 or 2 to pin 3.
[3] Device stressed with ten non-repetitive ESD pulses.

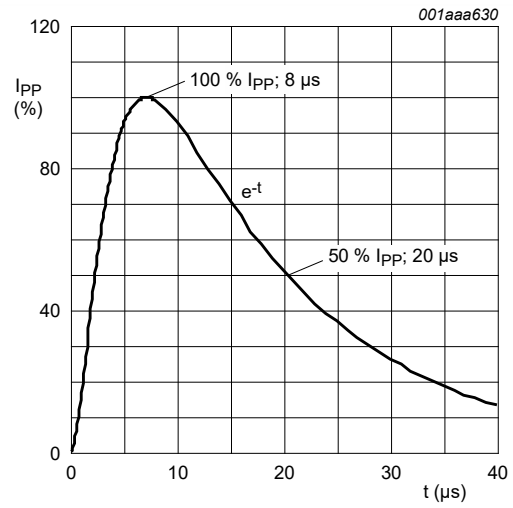


Fig. 1. 8/20 µs pulse waveform according to IEC 61000-4-5

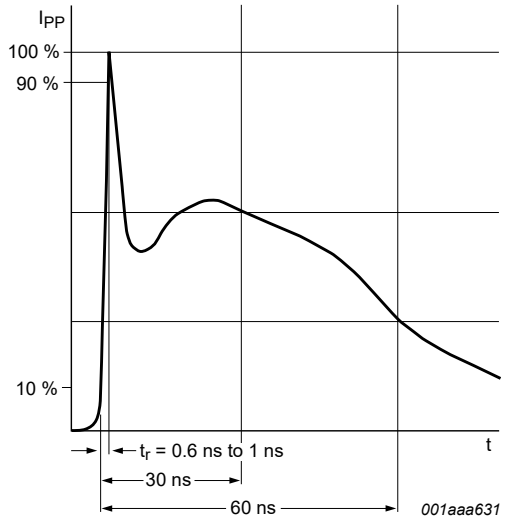


Fig. 2. ESD pulse waveform according to IEC 61000-4-2

9. Characteristics

Table 6. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{RWM}	reverse standoff voltage	T_{amb} = 25 °C		-	-	24	V
V_h	holding voltage	t_p = 100 ns; T_{amb} = 25 °C	[1]	28	-	-	V
V_{t1}	trigger voltage		[1]	100	130	-	V
I_{RM}	reverse leakage current	V_{RWM} = 24 V; V_R = 0 V; T_{amb} = 25 °C		-	1	100	nA
C_d	diode capacitance	f = 1 MHz; V_R = 0 V; T_{amb} = 25 °C		-	1.8	2	pF
$\Delta C_d/C_d$	diode capacitance matching		[2]	-	0.5	-	%
		f = 1 MHz; V_R = 2.5 V; T_{amb} = 25 °C	[2]	-	0.5	-	%
R_{dyn}	dynamic resistance	I_R = 40 A; t_p = 100 ns; T_{amb} = 25 °C	[1]	-	0.6	-	Ω

[1] Non-repetitive current pulse, Transmission Line Pulse (TLP); square pulse; ANSI / ESD STM5.5.1-2008
[2] ΔC_d is the difference of the capacitance measured between pin 1 and pin 3 and the capacitance measured between pin 2 and pin 3.

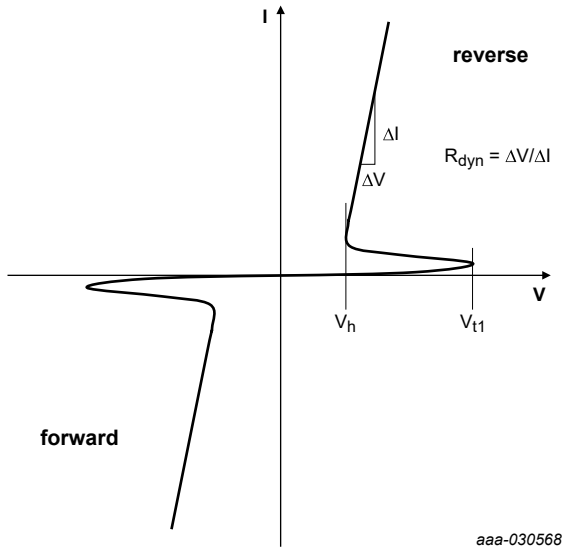


Fig. 3. V-I characteristics for a bidirectional ESD protection diode

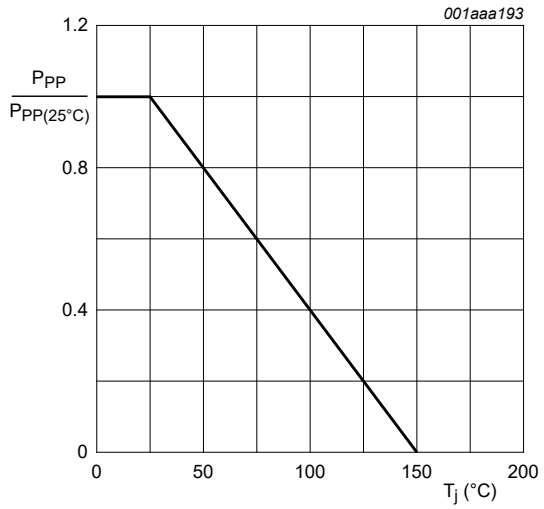
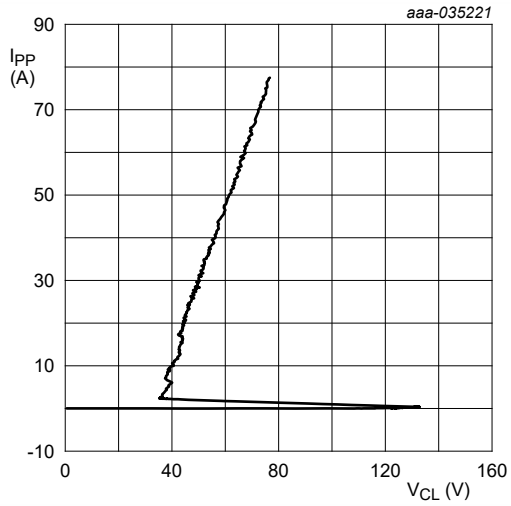
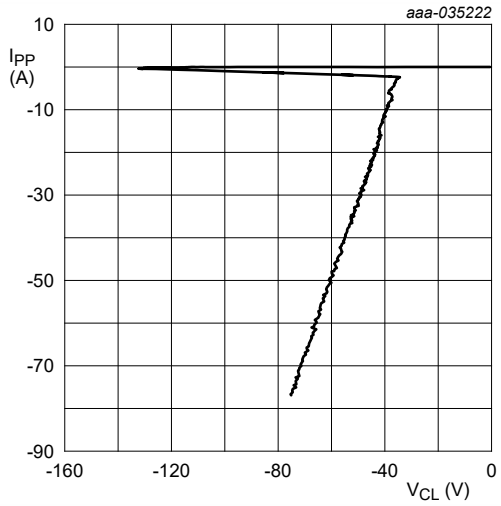


Fig. 4. Relative variation of peak pulse power as a function of junction temperature; typical values



Transmission Line Pulse (TLP);
t_p = 100 ns; t_r = 1 ns

Fig. 5. Dynamic resistance with positive clamping; typical values



Transmission Line Pulse (TLP);
t_p = 100 ns; t_r = 1 ns

Fig. 6. Dynamic resistance with negative clamping; typical values

10. Application information

In the „*IEEE 100BASE-T1 EMC Test Specification for ESD suppression devices*“ [1] document (further referred as OPEN Alliance 100BASE-T1 specification), the OPEN Alliance describes four different tests to ensure compliance of ESD suppressor devices and PHYs which are compliant according to the document “*Transceiver EMC Test Specification*”. The PESD2ETH1G-T passes all tests as shown on figures 6 to 16. Furthermore, it complies with the requirements mentioned in Section 2.2. of „*IEEE 100BASE-T1 EMC Test Specification for ESD suppression devices*“.

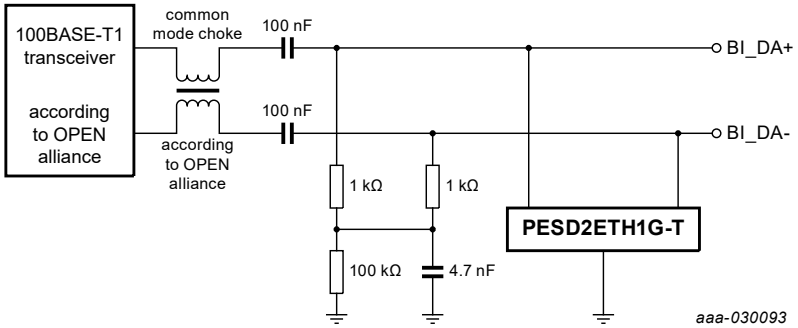
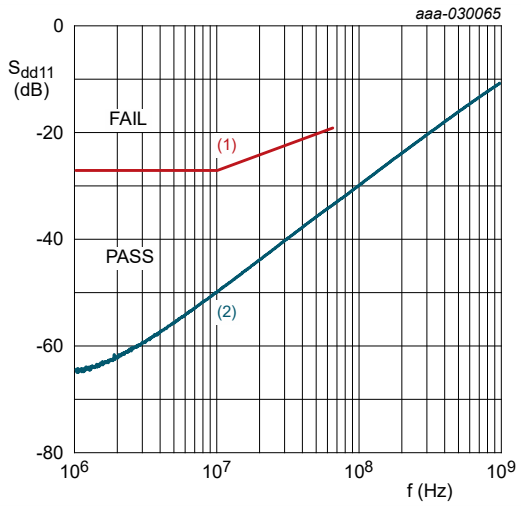


Fig. 7. Application diagram

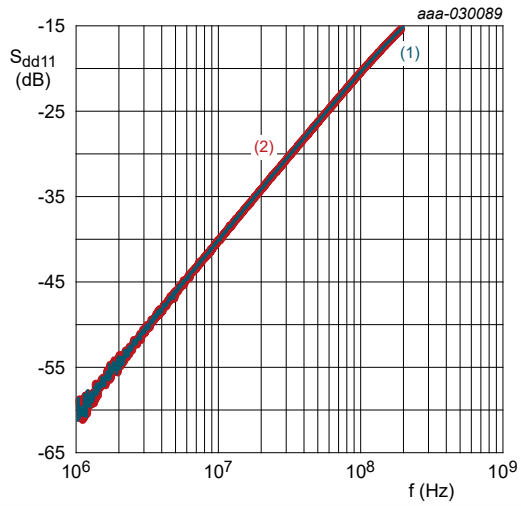
The return loss and insertion loss are evaluated using the differential S-parameters S_{dd11} and S_{dd21}. These measurements replace the requirement for a certain capacitance value. To ensure symmetry, the differential to common mode rejection is evaluated using the S-parameter S_{sd21}. This measurement replaces the requirement for a matching of the capacitances per line. To ensure that the device does not degrade and changes behavior after repetitive ESD events, the S-parameter measurements are repeated after discharging 20 times ±8 kV ESD on signal lines 1 and 2, with C = 150 pF, R = 330 Ω according to ISO 10605. Subsequently, the S-parameters are measured again and compared to the original data.



(1) limit according to OPEN Alliance 100BASE-T1 specification

(2) PESD2ETH1G-T

Fig. 8. Return loss



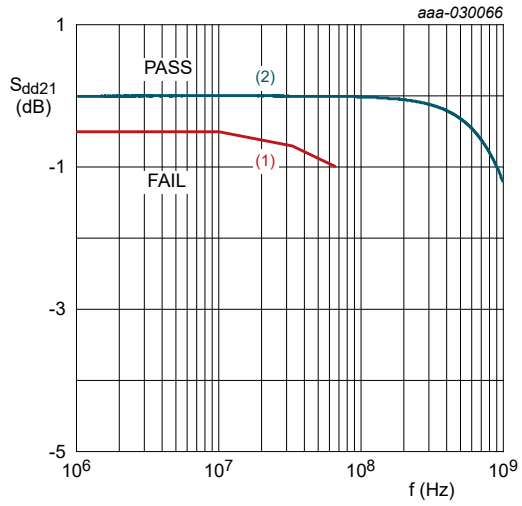
PESD2ETH1G-T

(1) before repetitive ESD event

(2) after 20 times ±8 kV ESD

Fig. 9. Return loss

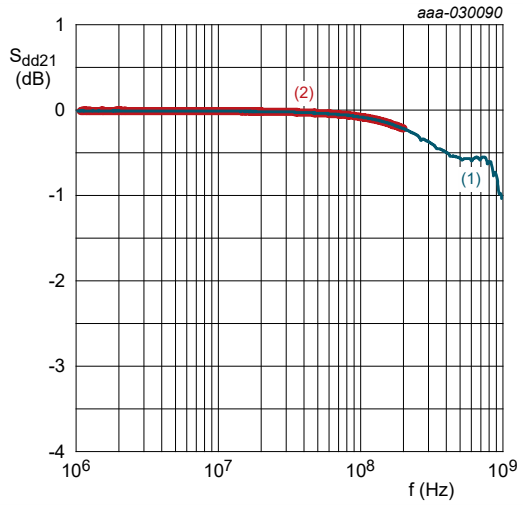
1 *OPEN Alliance: "IEEE 100BASE-T1 EMC Test Specification for ESD suppression devices"*, version 1.0 rev. draft, December 10, 2018



(1) limit according to OPEN Alliance 100BASE-T1 specification

(2) PESD2ETH1G-T

Fig. 10. Insertion loss

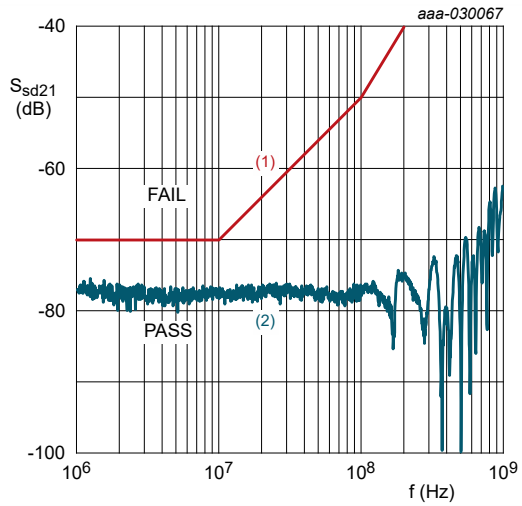


PESD2ETH1G-T

(1) before repetitive ESD event

(2) after 20 times ±8 kV ESD

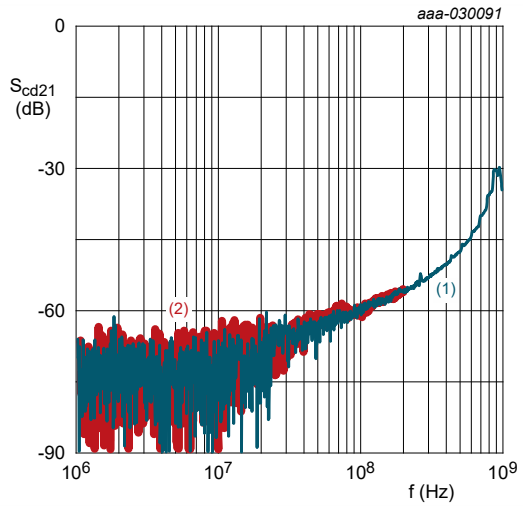
Fig. 11. Insertion loss



(1) limit according to OPEN Alliance 100BASE-T1 specification

(2) PESD2ETH1G-T

Fig. 12. Differential to common mode rejection



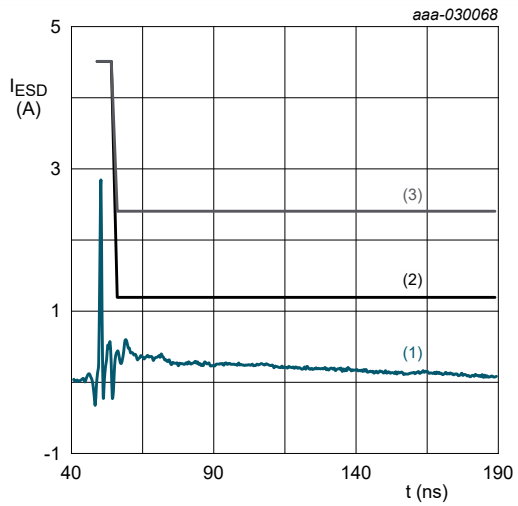
PESD2ETH1G-T

(1) before repetitive ESD event

(2) after 20 times ±8 kV ESD

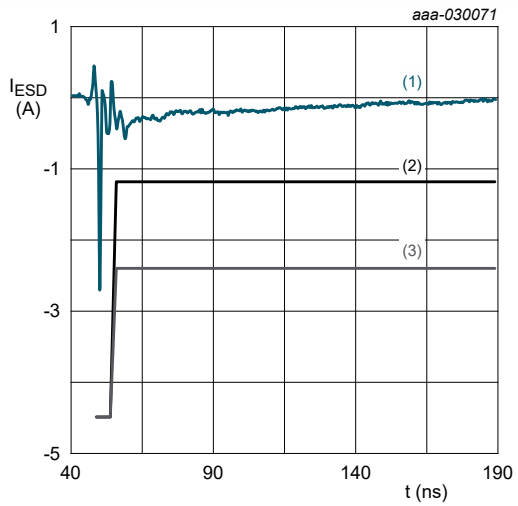
Fig. 13. Differential to common mode rejection

To predict if the ESD suppressor device would protect a PHY of a certain robustness class (Class I (JEDEC-HBM 4 kV) and Class II (JEDEC-HBM 2 kV)), the ESD discharge current is measured in a reference circuit according to OPEN Alliance 100BASE-T1 specification for ±4 kV and ±6 kV according to IEC 61000-4-2 with C = 150 pF and R = 330 Ω. Unlike in the OPEN Alliance 100BASE-T1 specification of October 29 2017, the „Transceiver Simulation network“ is implemented with 2 Ω and 50 Ω resistors.



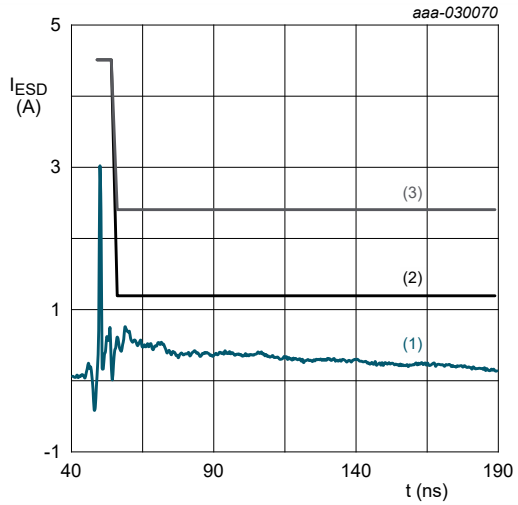
(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

Fig. 14. ESD discharge current at +4 kV



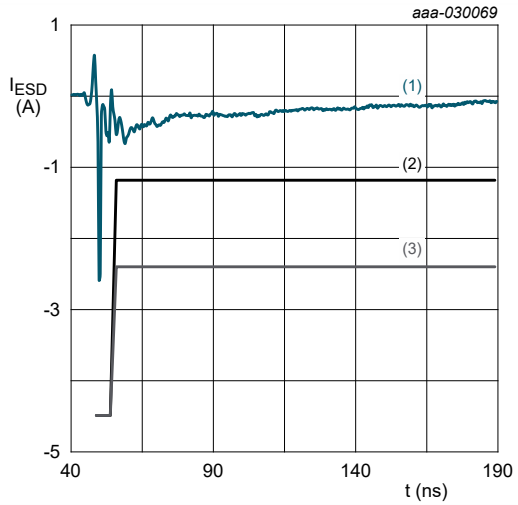
(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

Fig. 15. ESD discharge current at -4 kV



(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

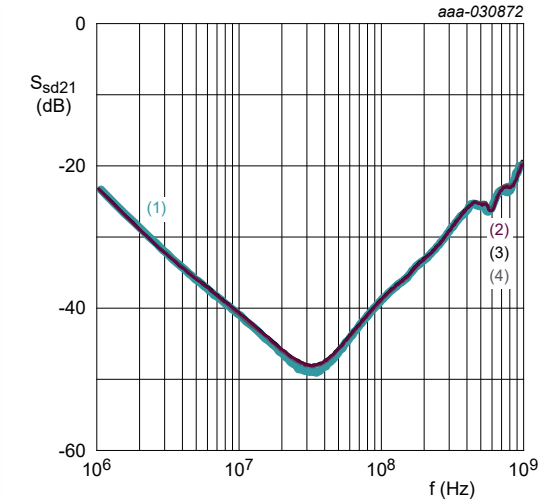
Fig. 16. ESD discharge current at +6 kV



(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

Fig. 17. ESD discharge current at -6 kV

To ensure that the ESD suppressor device is not impacting the EMC performance of the complete module, the RF clamping test as defined in the OPEN Alliance specification is applied. First a measurement at a reference power level of 25 dBm is conducted in an environment defined by the OPEN Alliance 100BASE-T1 specification. Next, the power is increased to 33 dBm (Class I), 36 dBm (Class II), and 39 dBm (Class III). No change in the measured common mode rejection indicates that the ESD suppressor device is not impacting the modules EMC performance.

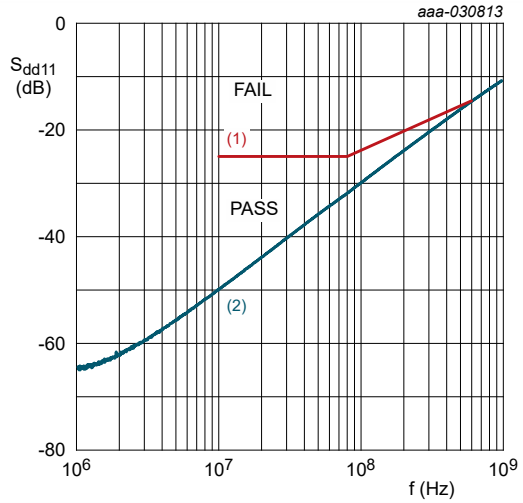


According to OPEN Alliance 100BASE-T1 specification
Common mode rejection for:
(1) reference
(2) Class I
(3) Class II
(4) Class III

Fig. 18. RF Clamping Test

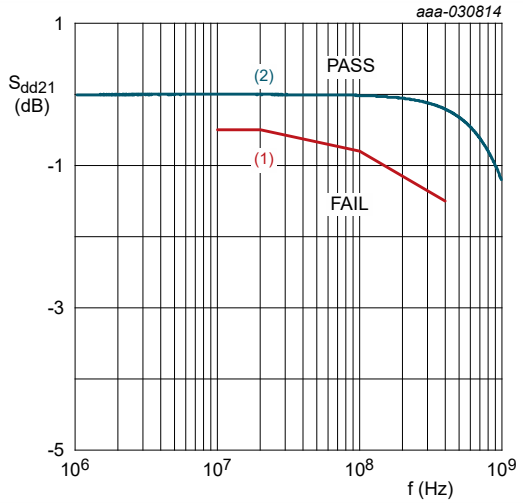
For 1000BASE-T1, there is no published document on the requirements for external ESD suppressor devices. However, a similar requirement specification is in preparation at the time the present document is created. To support the conformity of PESD2ETH1G-T with the to-be-published requirement specification of OPEN Alliance for 1000BASE-T1, results of tests adapted from OPEN Alliance specification for 100BASE-T1 are shown. In this tests, limits are adapted to the current state of the art and the common-mode choke is selected in compliance with the published OPEN Alliance document “IEEE 1000BASE-T1 EMC Test Specification for Common Mode Chokes Version 1.0” as of January 16, 2018.

The following graphs show the S-parameters with adapted limit lines. ESD damage test results of 100BASE-T1 are also valid for 1000BASE-T1.



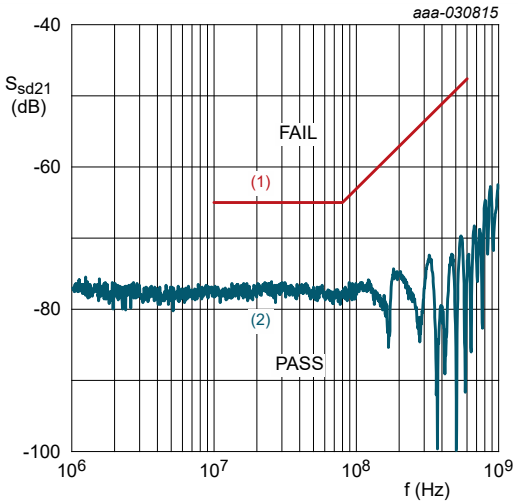
(1) limit according to state of the art for 1000BASE-T1
(2) PESD2ETH1G-T

Fig. 19. Return loss



(1) limit according to state of the art for 1000BASE-T1
(2) PESD2ETH1G-T

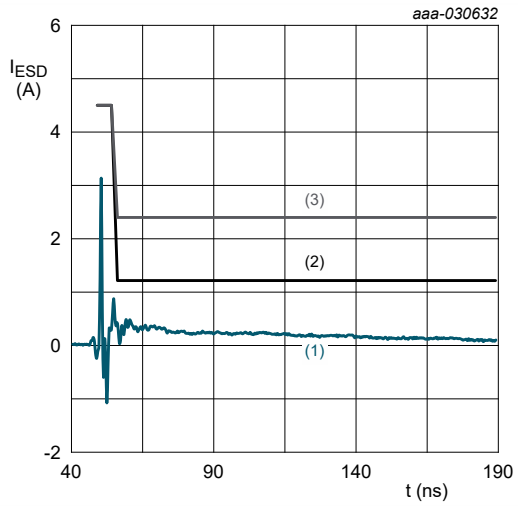
Fig. 20. Insertion loss



(1) limit according to state of the art for 1000BASE-T1
(2) PESD2ETH1G-T

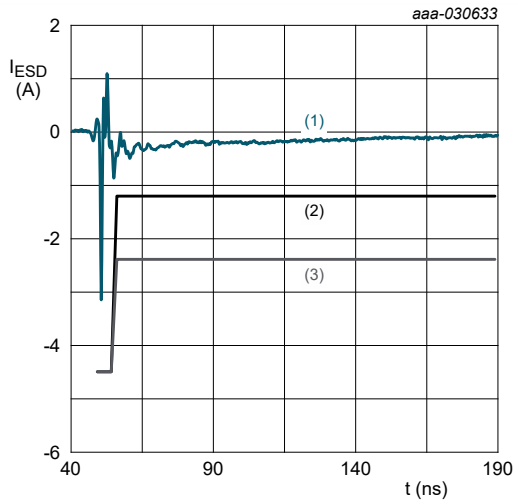
Fig. 21. Differential to common mode rejection

The following graphs show the discharge current measurements, with a 1000BASE-T1 compliant common-mode choke.



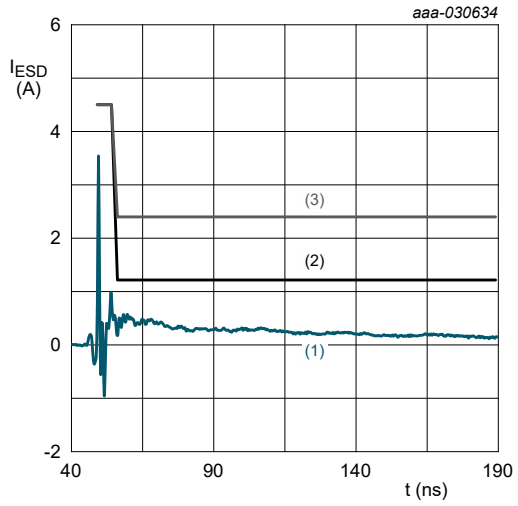
(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

Fig. 22. ESD discharge current at +4 kV



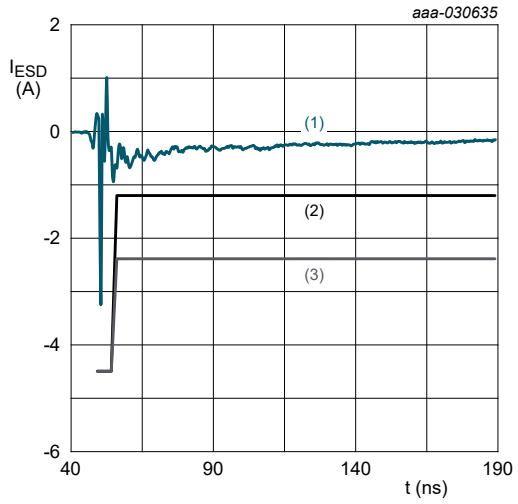
(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

Fig. 23. ESD discharge current at -4 kV



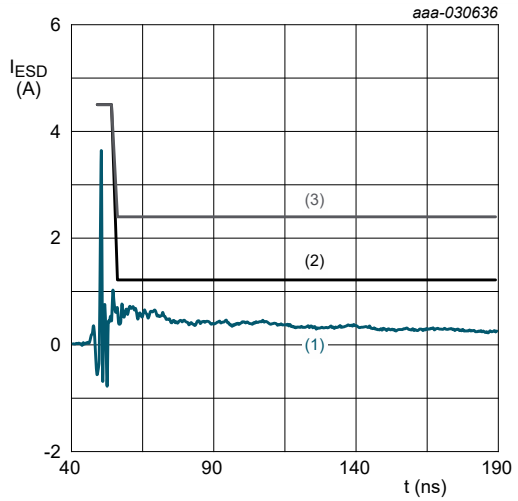
(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

Fig. 24. ESD discharge current at +6 kV



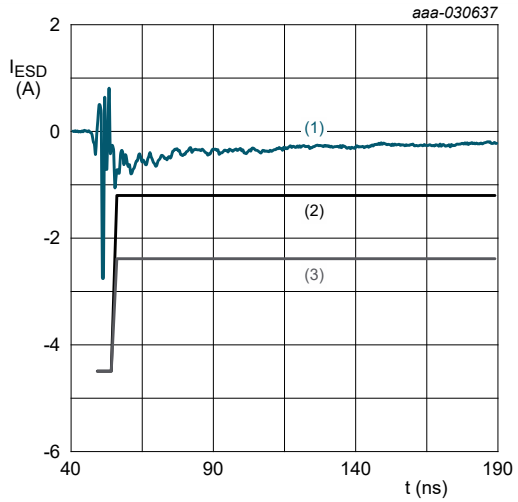
(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

Fig. 25. ESD discharge current at -6 kV



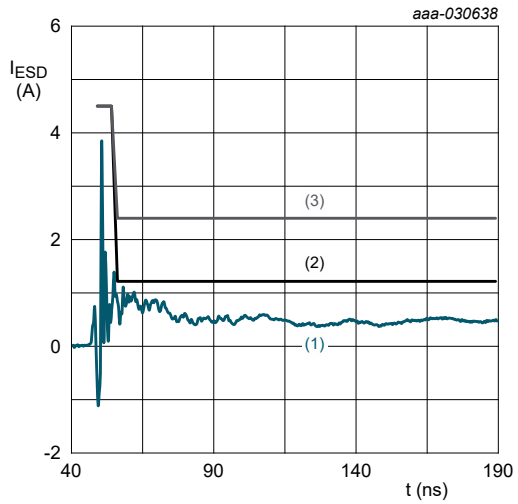
(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

Fig. 26. ESD discharge current at +8 kV



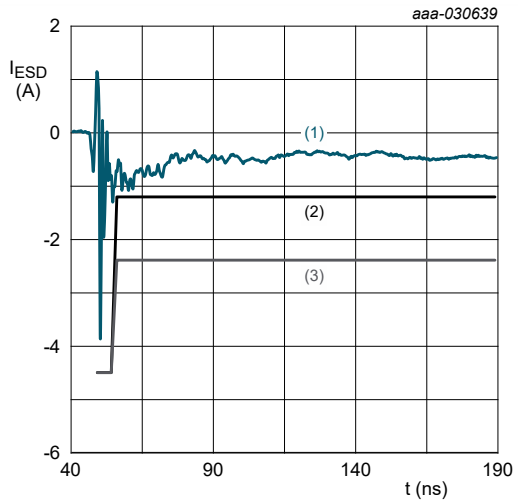
(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

Fig. 27. ESD discharge current at -8 kV



(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

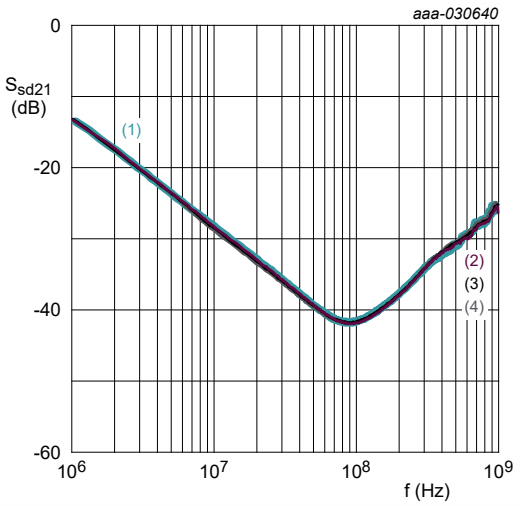
Fig. 28. ESD discharge current at +15 kV



(1) PESD2ETH1G-T
(2) limit Class II
(3) limit Class I

Fig. 29. ESD discharge current at -15 kV

The following graph shows the RF clamping test with a 1000BASE-T1 compliant common-mode choke.

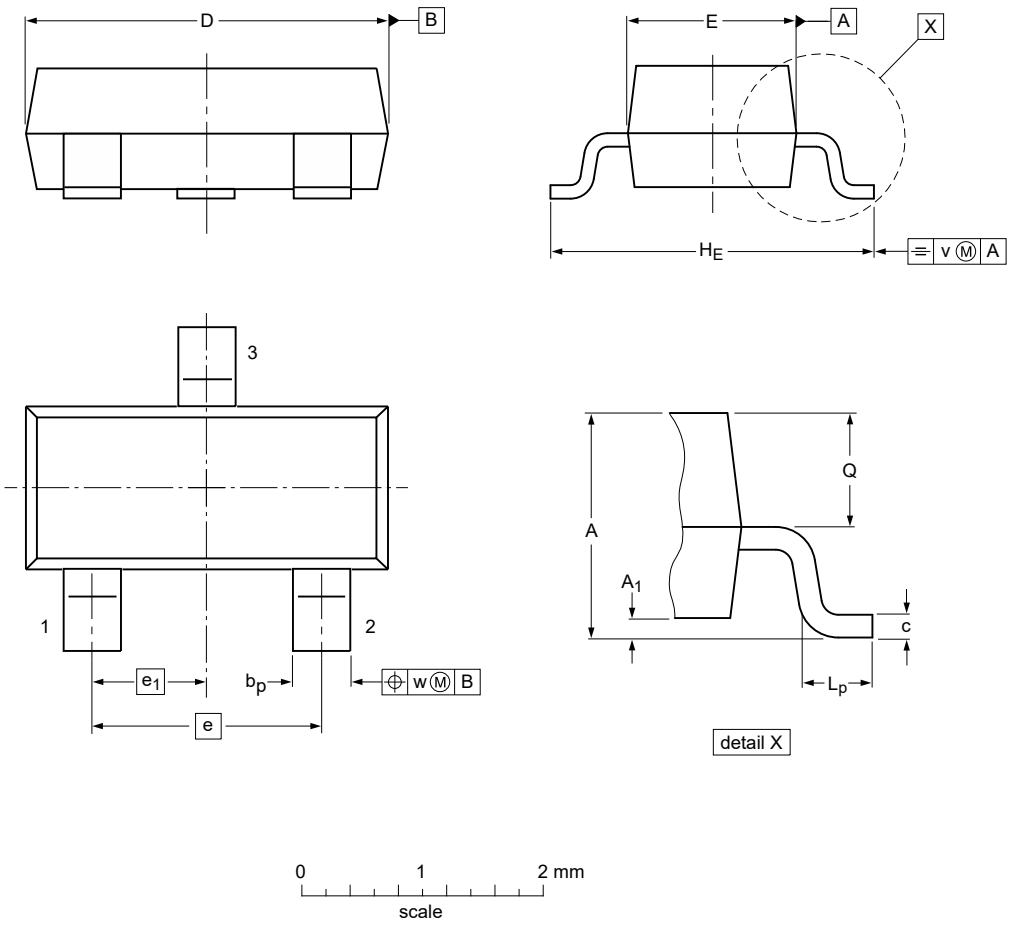


According to state of the art for 1000BASE-T1
Common mode rejection for:
(1) reference
(2) Class I
(3) Class II
(4) Class III

Fig. 30. RF Clamping Test

11. Package outline

Plastic surface-mounted package; 3 leads **SOT23**



Dimensions (mm are the original dimensions)

Unit		A	A_1	b_p	c	D	E	e	e_1	H_E	L_p	Q	v	w
mm	max	1.1	0.1	0.48	0.15	3.0	1.4			2.5	0.45	0.55		
	nom							1.9	0.95				0.2	0.1
	min	0.9		0.38	0.09	2.8	1.2			2.1	0.15	0.45		

sot023_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT23		TO-236AB				~~14-06-19~~ 14-09-22

Fig. 31. Package outline SOT23

12. Soldering

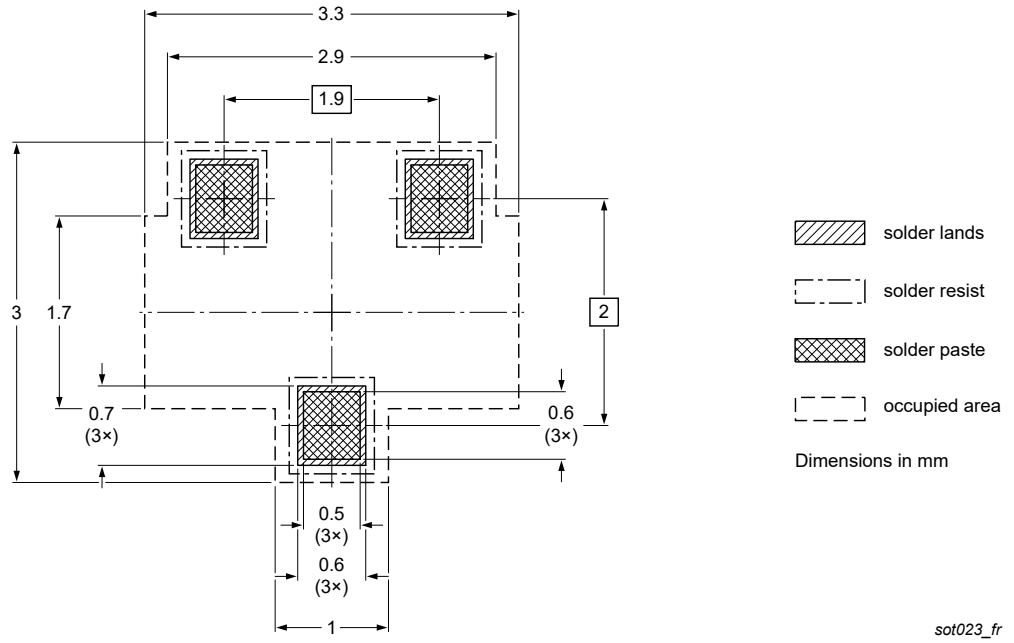


Fig. 32. Reflow soldering footprint for SOT23

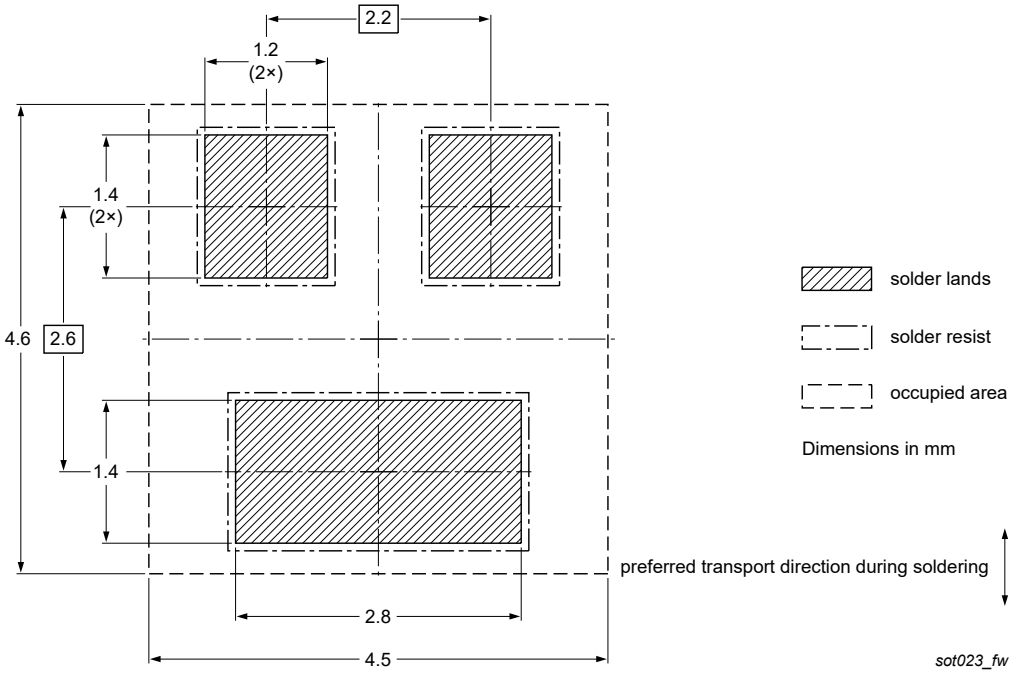


Fig. 33. Wave soldering footprint for SOT23

13. Revision history

Table 7. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PESD2ETH1G-T v.3	20221006	Product data sheet	-	PESD2ETH1G-T v.2
Modifications:	• Parameter V_{t1} (trigger voltage): typical value changed • Figures 5 and 6 (dynamic resistance): update with latest test results			
PESD2ETH1G-T v.2	20200207	Product data sheet	-	PESD2ETH1G-T v.1
PESD2ETH1G-T v.1	20190708	Objective data sheet	-	-

14. Legal information

Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at https://www.nexperia.com.

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