ESD601 Low Capacitance ESD Diode for RF and ADAS Signal Protection

1 Features

- IEC 61000-4-2 ESD Protection:
  - ±15kV contact discharge
  - ±15kV air gap discharge
- IEC 61000-4-5 surge protection:
  - 2.7A (8/20µs)
- I/O capacitance: 0.3pF (typical)
- Ultra low leakage current: 1nA (typical)
- Low dynamic resistance 0.9Ω (typical)
- Industry standard 0402 package

2 Applications

- Automotive Antenna ESD Protection
- RF Signal ESD Protection
- Near Field Communications (NFC)
- Automotive SerDes w/Power over Coax
- USB Type-C (short-to-Vbus tolerant)

3 Description

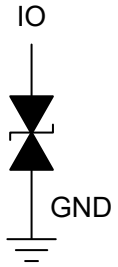
The ESD601 is a bidirectional ESD protection diode. The ESD601 is offered in the industry standard 0402 (DPY) package, and offers an IEC 61000-4-2 protection level of 15kV. The device can clamp 8/20µs surges with peak pulse currents up to 2.7A in accordance with the IEC 61000-4-5 standard.

The low capacitance and low leakage current provide protection against transient events in a variety of systems and applications. This protection is key for many applications, such as smaller form factors and faster data speeds, which are becoming more popular over time.

Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)
ESD601	DPY (X1SON, 2)	1mm × 0.6mm

(1) For more information, see Section 9.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.



Functional Block Diagram

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

Table of Contents

1 Features.....1
2 Applications.....1
3 Description.....1
4 Pin Configuration and Functions.....3
5 Specifications.....4
5.1 Absolute Maximum Ratings.....4
5.2 ESD Ratings - JEDEC Specifications.....4
5.3 ESD Ratings - IEC Specifications.....4
5.4 Recommended Operating Conditions.....4
5.5 Thermal Information.....5
5.6 Electrical Characteristics.....5
5.7 Typical Characteristics.....6
6 Application and Implementation.....8
6.1 Application Information.....8
7 Device and Documentation Support.....9
7.1 Receiving Notification of Documentation Updates.....9
7.2 Support Resources.....9
7.3 Trademarks.....9
7.4 Electrostatic Discharge Caution.....9
7.5 Glossary.....9
8 Revision History.....9
9 Mechanical, Packaging, and Orderable Information.....9

Copyright © 2026 Texas Instruments Incorporated

4 Pin Configuration and Functions

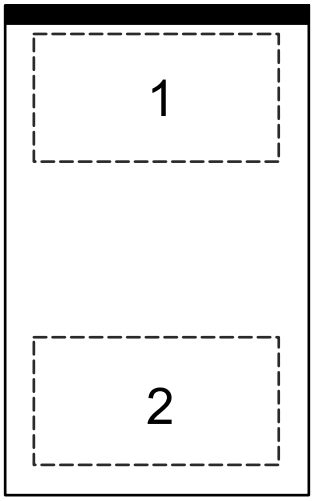


Figure 4-1. DPY Package, 2-Pin X1SON (Top View)

Table 4-1. Pin Functions

PIN		TYPE[(1)]	DESCRIPTION
NAME	NO.		
IO	1	I/O	ESD Protected Channel. If used as ESD I/O, connect pin 2 to ground
IO	2	I/O	ESD Protected Channel. If used as ESD I/O, connect pin 1 to ground

(1) I = input, O = output

5 Specifications

5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)[1]

Parameter		MIN	MAX	UNIT
P_{PPM}	IEC 61000-4-5 Surge (t_p = 8/20 µs) Peak Pulse Power at 25 °C		75	W
I_{PPM}	IEC 61000-4-5 Surge (t_p = 8/20 µs) Peak Pulse Current at 25 °C		2.7	A
T_A	Operating free-air temperature	–40	125	°C
T_{stg}	Storage temperature	–65	155	°C

(1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. Absolute maximum ratings do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If briefly operating outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not sustain damage, but it may not be fully functional. Operating the device in this manner may affect device reliability, functionality, performance, and shorten the device lifetime.

5.2 ESD Ratings - JEDEC Specifications

Parameter		Test Conditions	VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins[1]	±2500	V
		Charged device model (CDM), per JEDEC specification JS-002, all pins[2]	±1000	

(1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

5.3 ESD Ratings - IEC Specifications

Parameter		Test Conditions	VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	IEC 61000-4-2 Contact Discharge, all pins	±15000	V
		IEC 61000-4-2 Air Discharge, all pins	±15000	

5.4 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
V_{IN}	Input voltage	-18		18	V
T_A	Operating Free Air Temperature	–40		125	°C

Copyright © 2026 Texas Instruments Incorporated

5.5 Thermal Information

THERMAL METRIC[1]		ESD601 DPY (X1SON) 2 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	284.4	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	150.5	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	100.6	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	10.1	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	99.8	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	NA	°C/W

(1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application note.

5.6 Electrical Characteristics

At TA = 25°C unless otherwise noted

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{RWM}	Reverse stand-off voltage	I_{IO} < 10nA	-18		18	V
I_{LEAK}	Leakage current at V_{RWM}	V_{IO} = ±18V, I/O to GND		1	10	nA
V_{BR}	Breakdown voltage, I/O to GND [1]	I_{IO} = ±10mA	19	21		V
V_{CLAMP}	Surge clamping voltage, t_p = 8/20µs [2]	I_{PP} = 2.7A, I/O to GND		33		V
		I_{PP} = 2.7A, GND to I/O		33		V
	TLP clamping voltage, t_p = 100ns [3]	I_{PP} = ±8A (100ns TLP), I/O to GND		29		V
		I_{PP} = ±16A (100ns TLP), I/O to GND		36		V
R_{DYN}	Dynamic resistance [4]	I/O to GND		0.9		Ω
		GND to I/O		0.9		
C_{LINE}	Line capacitance, IO to GND	V_{IO} = 0V, f = 1MHz		0.3	0.5	pF

(1) V_{BR} is defined as the voltage obtained at 10mA when sweeping the voltage up, before the device latches into the snapback state
(2) Device stressed with 8/20 µs exponential decay waveform according to IEC 61000-4-5
(3) Non-repetitive square wave current pulse, Transmission Line Pulse (TLP); ANSI / ESD STM5.5.1-2008
(4) Extraction of R_{DYN} using least squares fit of TLP characteristics between I = 10A and I = 20A

Copyright © 2026 Texas Instruments Incorporated

5.7 Typical Characteristics

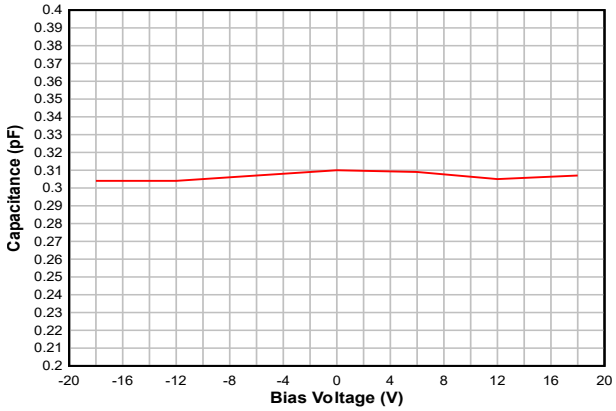


Figure 5-1. Bias Voltage vs. Capacitance

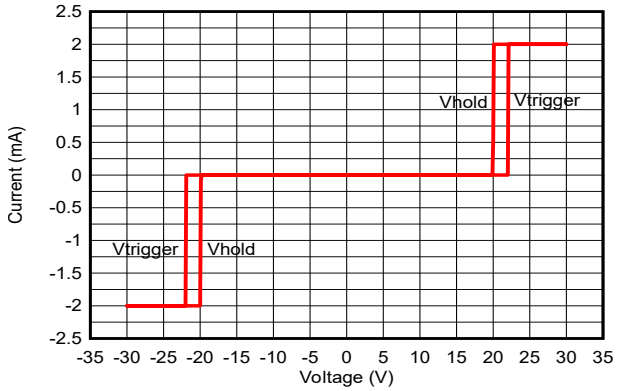


Figure 5-2. DC I-V Curve

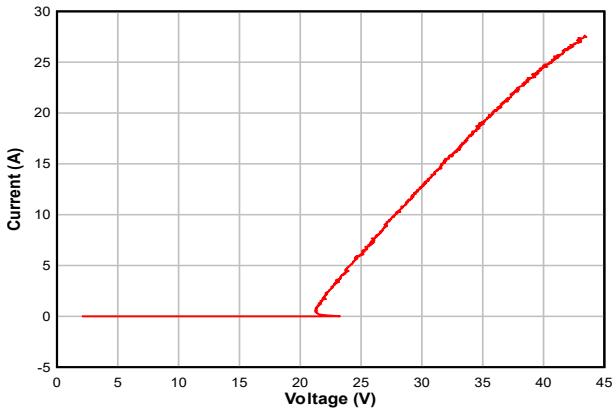


Figure 5-3. Positive TLP Curve

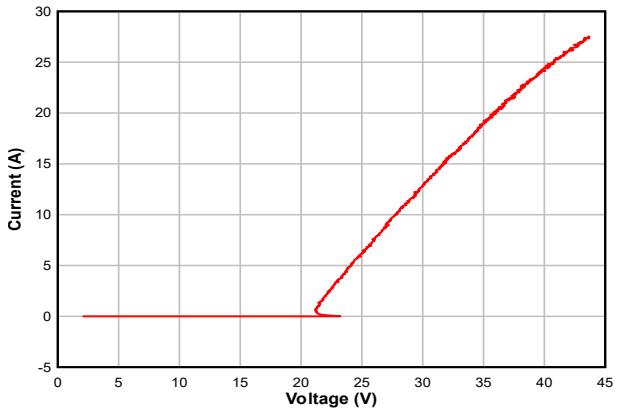


Figure 5-4. Negative TLP Curve

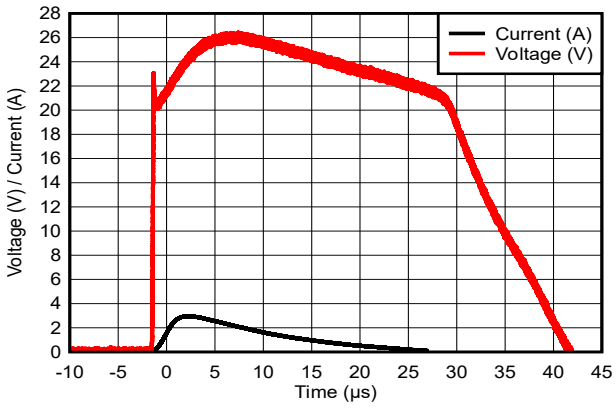


Figure 5-5. 8/20 µs Surge Response

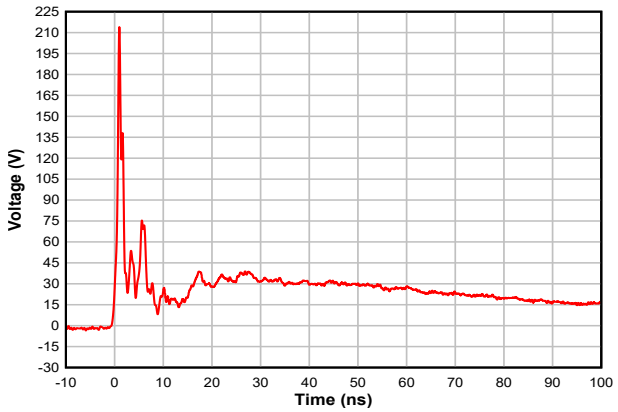


Figure 5-6. +8kV Clamped IEC Waveform

Copyright © 2026 Texas Instruments Incorporated

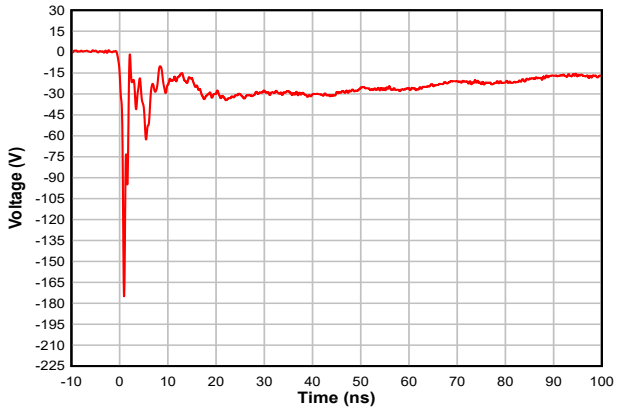


Figure 5-7. -8kV Clamped IEC Waveform

6 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

6.1 Application Information

The ESD601 is a diode type TVS which is used to provide a path to ground for dissipating ESD events on high-speed signal lines between a human interface connector and a system.

Copyright © 2026 Texas Instruments Incorporated

7 Device and Documentation Support

7.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

7.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

7.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

7.4 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

7.5 Glossary

TI Glossary — This glossary lists and explains terms, acronyms, and definitions.

8 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (August 2024) to Revision A (January 2026) — **Page**

- Removed Insertion Loss graph.....6

DATE	REVISION	NOTES
August 2024	*	Initial Release

9 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
ESD601DPYR	Active	Production	X1SON (DPY) | 2	10000 | LARGE T&R	Yes	NIPDAUAG	Level-1-260C-UNLIM	-40 to 125	P8
ESD601DPYR.B	Active	Production	X1SON (DPY) | 2	10000 | LARGE T&R	Yes	NIPDAUAG	Level-1-260C-UNLIM	-40 to 125	P8

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF ESD601 :

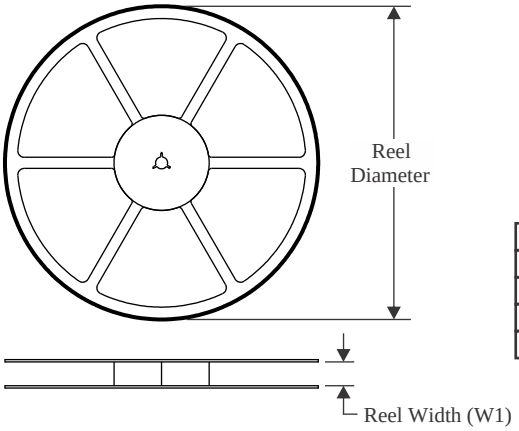
- Automotive : ESD601-Q1

NOTE: Qualified Version Definitions:

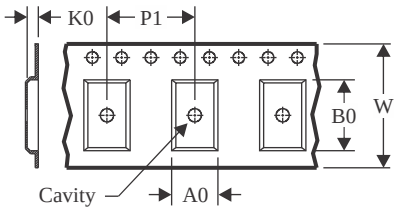
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

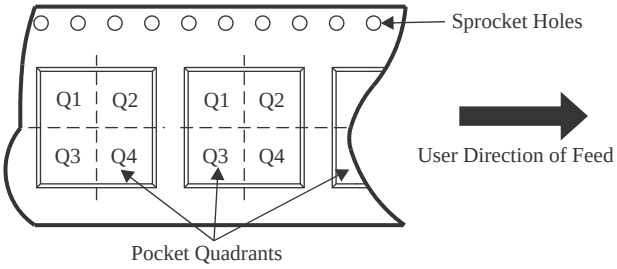


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

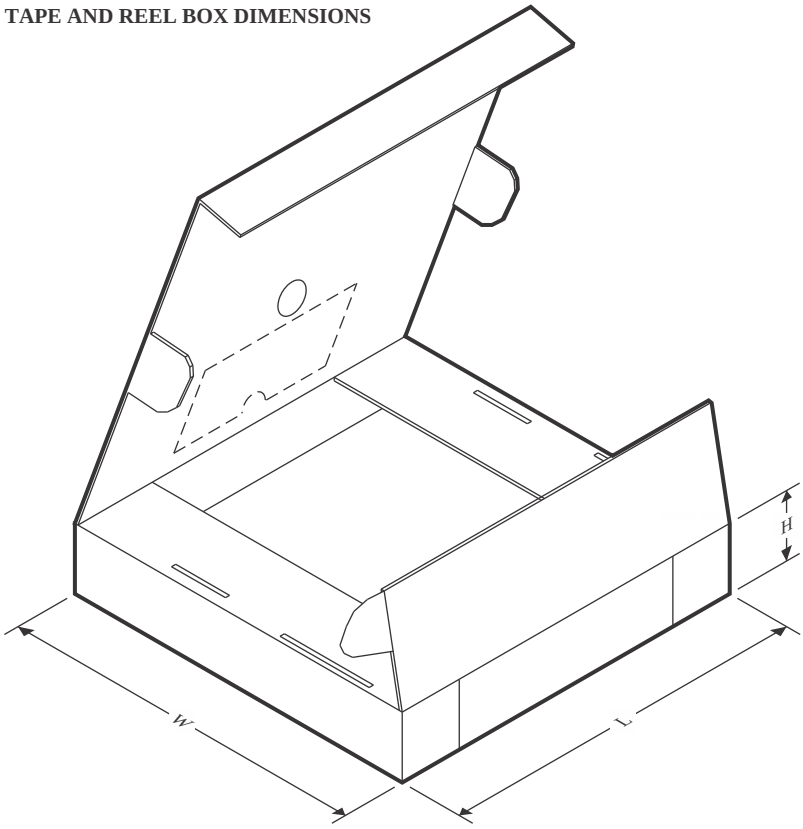
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
ESD601DPYR	X1SON	DPY	2	10000	178.0	8.4	0.7	1.15	0.47	2.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
ESD601DPYR	X1SON	DPY	2	10000	205.0	200.0	33.0

GENERIC PACKAGE VIEW

DPY 2

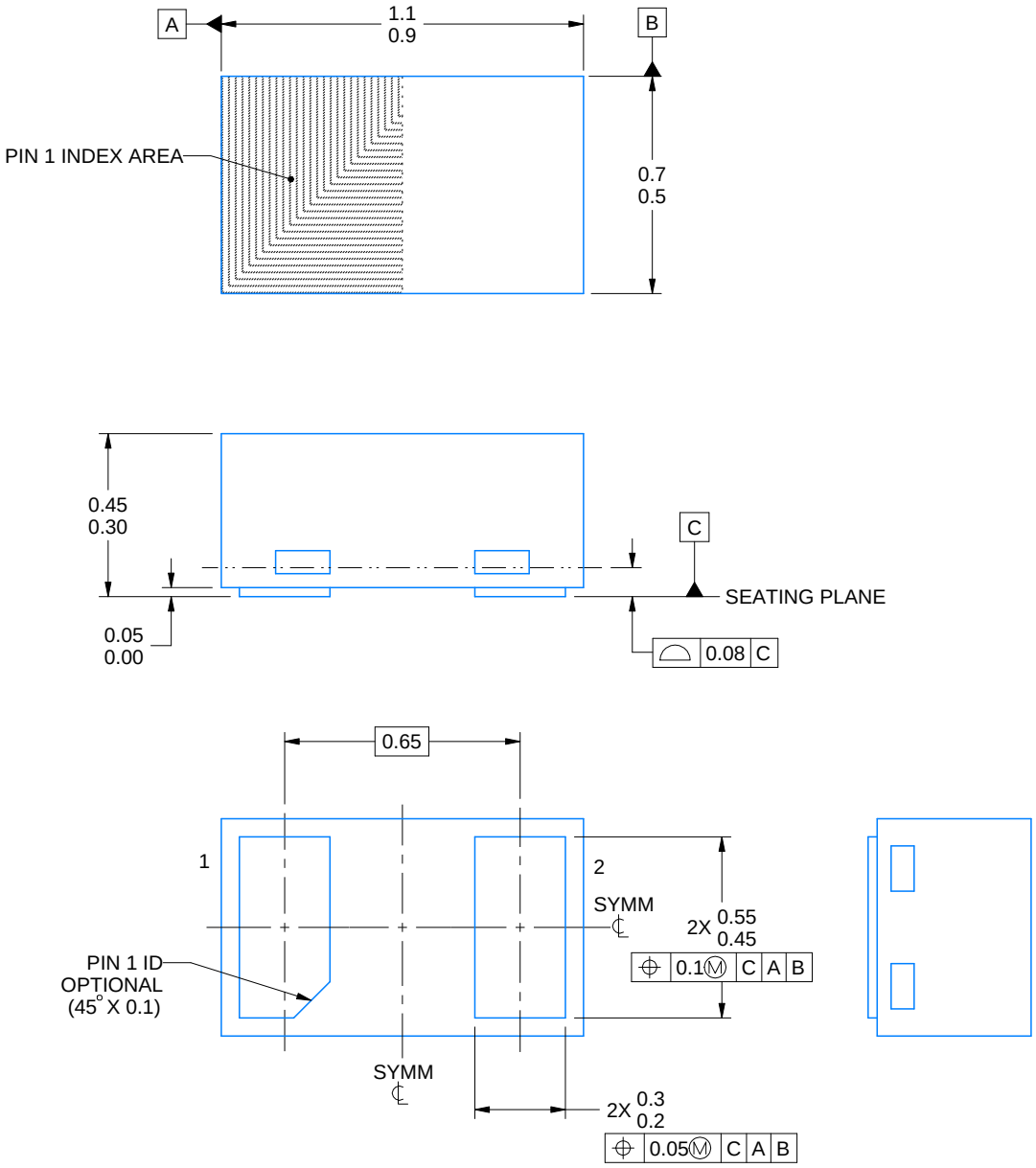
X1SON - 0.45 mm max height

1 x 0.6 mm

PLASTIC SMALL OUTLINE - NO LEAD

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

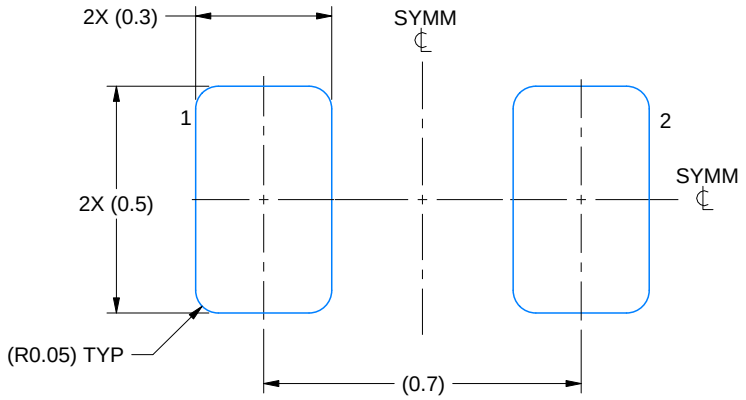
4231484/A



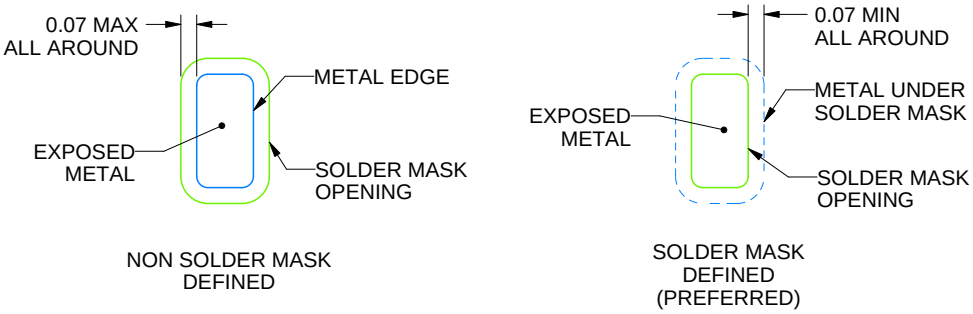
4224561/C 07/2024

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M
2. This drawing is subject to change without notice.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:60X

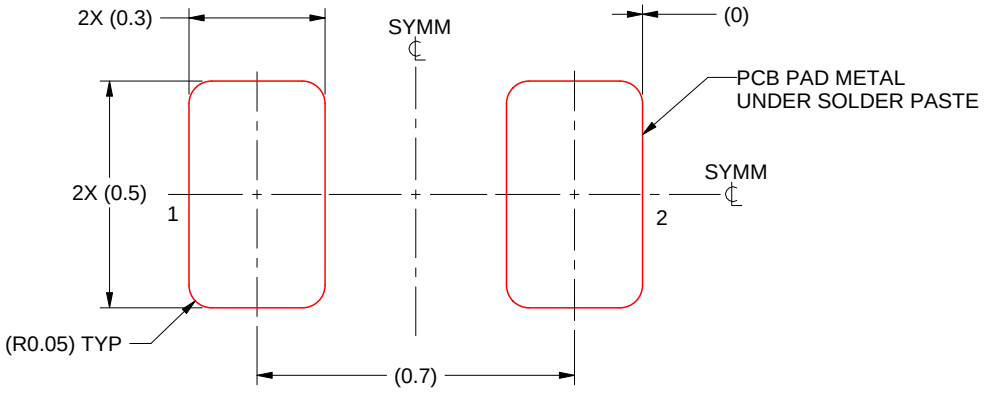


SOLDER MASK DETAILS

4224561/C 07/2024

NOTES: (continued)

3. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
4. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:60X

4224561/C 07/2024

NOTES: (continued)

5. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you fully indemnify TI and its representatives against any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale, TI’s General Quality Guidelines, or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products. Unless TI explicitly designates a product as custom or customer-specified, TI products are standard, catalog, general purpose devices.

TI objects to and rejects any additional or different terms you may propose.

Copyright © 2026, Texas Instruments Incorporated

Last updated 10/2025