TSM24B Unidirectional Surge Protection Device in SOT-23

1 Features

- Robust surge protection:
  - IEC61000-4-5 (8/20 µs): 20 A
- Low clamping voltage of 33 V (typical) at 20 A for 8/20 µs surge current protects downstream components
- Unidirectional polarity for optimized clamping performance on single ended data lines and power rails
- 24 V working voltage for protecting signals on 12 V systems
- Low leakage current of 75 nA (maximum)
- Low I/O capacitance of 24 pF (typical)
- Integrated IEC 61000-4-2 ESD protection
  - ±30-kV contact discharge
  - ±30-kV air-gap discharge
- Small SOT-23 leaded package to minimize board space and allow for automatic optical inspection (AOI)

2 Applications

- Industrial sensors
- Controller area network (CAN)
- PLC I/O modules
- 24-V power lines or digital inputs or output lines
- Appliances
- Medical equipment
- Motor drivers

3 Description

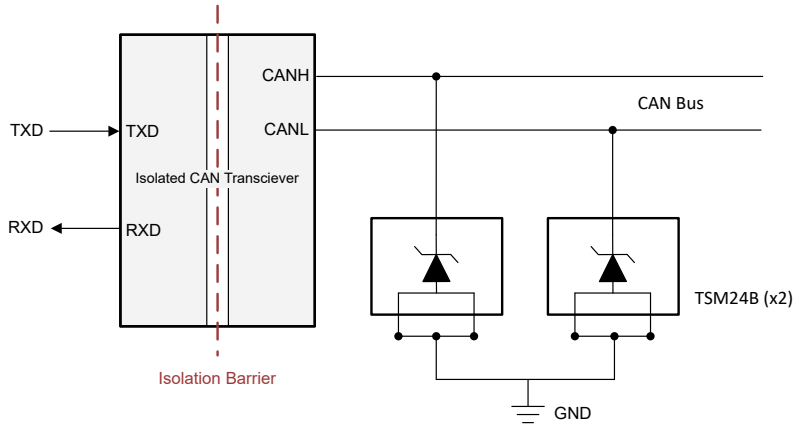
The TSM24B is a part of TI's surge protection device family. The TSM24B robustly shunts up to 20 A of IEC 61000-4-5 fault current to protect systems from high power transients or lightning strikes. The TSM24B is rated to dissipate ESD strikes beyond the maximum level specified in the IEC 61000-4-2 international standard (±30-kV contact, ±30-kV air-gap). The TSM24B clamps during a surge event, keeping system exposure below 33 V (typical) at I_{PP} = 20 A.

Additionally, the TSM24B is available in a small leaded SOT-23 (DBZ) package, which is reduced in size by approximately 50 percent compared to the industry standard SMA package. The device is designed to have a minimal effect on the protected line due to extremely low device leakage.

Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)
TSM24B	DBZ (SOT-23, 3)	2.92 mm × 2.37 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.
(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 Revision History....2
5 Pin Configuration and Functions....3
6 Specifications....4
6.1 Absolute Maximum Ratings....4
6.2 ESD Ratings -JEDEC Specifications....4
6.3 ESD Ratings - IEC Specifications....4
6.4 Recommended Operating Conditions....4
6.5 Thermal Information....4
6.6 Electrical Characteristics....5
6.7 Typical Characteristics....5
7 Application and Implementation....6
7.1 Application Information....6
8 Device and Documentation Support....7
8.1 Documentation Support....7
8.2 Receiving Notification of Documentation Updates....7
8.3 Support Resources....7
8.4 Trademarks....7
8.5 Electrostatic Discharge Caution....7
8.6 Glossary....7
9 Mechanical, Packaging, and Orderable Information....7

4 Revision History

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

Changes from Revision * (October 2023) to Revision A (October 2023)	Page
• Changed I_{LEAK} typ value from: *50 nA* to: *25 nA* and max value from: *100 nA* to: *75 nA*	5
• Changed V_{BR} min value from: *24.8 V* to: *26.5 V*	5
• Changed V_{CLAMP} typ value from: *37 V* to: *33 V* and deleted the max value	5

Copyright © 2023 Texas Instruments Incorporated

5 Pin Configuration and Functions

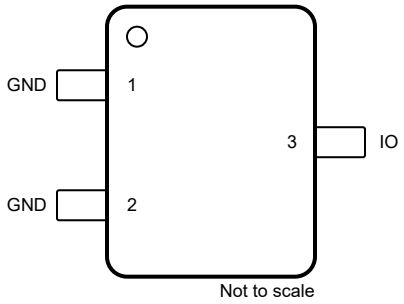


Figure 5-1. DBZ Package, 3-Pin SOT-23 (Top View)

Table 5-1. Pin Functions

PIN		TYPE[1]	DESCRIPTION
NAME	NO.		
IO	3	I/O	Surge and ESD protected IO
GND	1, 2	G	Connect to ground. To achieve the rated performance, connect pin 1 and 2 together on the PCB as close to the device as possible.

(1) I = Input, O = Output, I/O = Input or Output, G = Ground

Copyright © 2023 Texas Instruments Incorporated

6 Specifications

6.1 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 (2)		800	W
I_{PPM}	IEC 61000-4-5 Surge (t_p = 8/20 µs) Peak Pulse Current at 25 °C (2)		20	A
T_A	Operating free-air temperature	-40	125	°C
T_{stg}	Storage temperature	–65	155	°C

(1) Operation outside the *Absolute Maximum Rating* may cause permanent device damage. *Absolute Maximum Rating* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Condition*. If used outside the *Recommended Operating Condition* but within the *Absolute Maximum Rating*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
(2) Voltages are with respect to GND unless otherwise noted.

6.2 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 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 ESD Ratings - IEC Specifications

Parameter		Test Conditions	VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	IEC 61000-4-2 Contact Discharge, all pins	±30000	V
		IEC 61000-4-2 Air Discharge, all pins	±30000	

6.4 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V_{IN}	Input voltage	0		24	V
T_A	Operating free-air temperature	-40		125	°C

6.5 Thermal Information

THERMAL METRIC(1)		TSM24B DBZ (SOT-23) 3 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	220.6	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	122.8	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	54.1	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	16.6	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	53.7	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	°C/W

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

Copyright © 2023 Texas Instruments Incorporated

6.6 Electrical Characteristics

At T_A = 25°C unless otherwise noted

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{RWM}	Reverse stand-off voltage	I_{IO} < 100 nA			24	V
I_{LEAK}	Leakage current at V_{RWM}	V_{IO} = 24 V, I/O to GND		25	75	nA
V_{BR}	Breakdown voltage, I/O to GND (1)	I_{IO} = 10 mA	26.5			V
V_{FWD}	Forward Voltage, GND to I/O (1)	I_{IO} = 10 mA		0.7		V
V_{CLAMP}	Surge clamping voltage, t_p = 8/20 µs (2)	I_{PP} = 20 A, I/O to GND		33		V
V_{CLAMP}	Surge clamping voltage, t_p = 8/20 µs (2)	I_{PP} = 20 A, GND to I/O		6	8	V
C_{LINE}	Line capacitance, IO to GND	V_{IO} = 0 V, f = 1 MHz		24	37.5	pF

(1) V_{BR} is defined as the voltage when 10 mA is applied in the positive-going direction.
(2) Device stressed with 8/20 µs exponential decay waveform according to IEC 61000-4-5.

6.7 Typical Characteristics

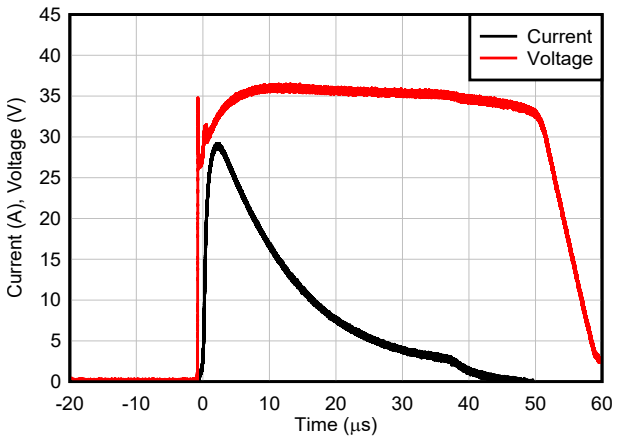


Figure 6-1. 8/20 µs Surge Response

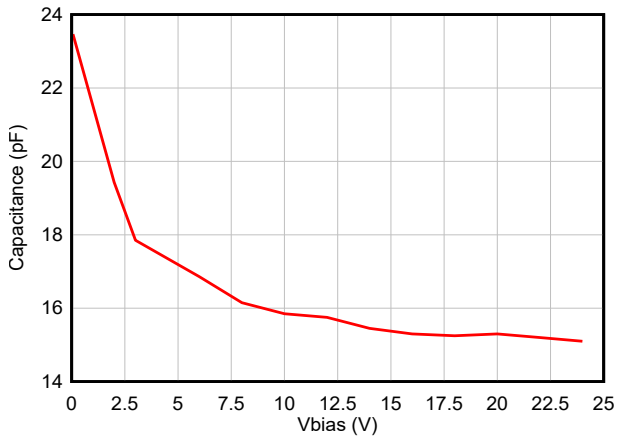


Figure 6-2. Capacitance vs Bias Voltage

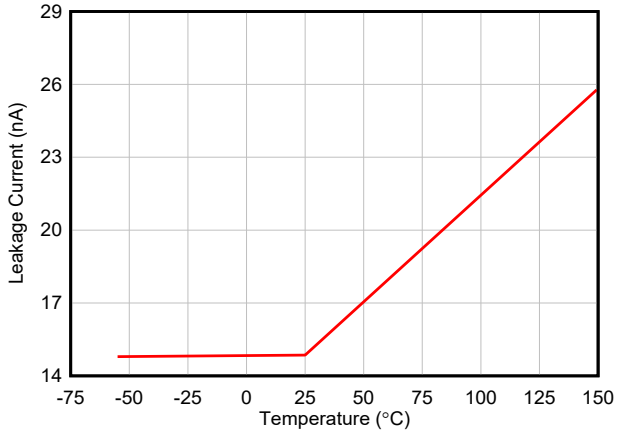


Figure 6-3. Leakage vs Temperature

7 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.

7.1 Application Information

The TSM24B is a diode type TVS that provides a path to ground for dissipating transient voltage spikes (such as ESD or surge) on signal lines and power lines. The device should be connected in parallel to the down stream circuitry it is protecting. As the current from the transient passes through the TVS, only a small voltage drop is present across the diode. This is the voltage presented to the protected IC. The low R_{DYN} of the triggered TVS holds this voltage (V_{CLAMP}) to a safe level for the protected IC. For more information on how to properly use this device, refer to the *ESD Packaging and Layout Guide*.

Copyright © 2023 Texas Instruments Incorporated

8 Device and Documentation Support

8.1 Documentation Support

8.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, *TI's IEC 61000-4-x Testing* application note
- Texas Instruments, *ESD Layout Guide* user's guide
- Texas Instruments, *ESD Protection Diodes EVM* user's guide
- Texas Instruments, *Generic ESD Evaluation Module* user's guide
- Texas Instruments, *Reading and Understanding an ESD Protection Data Sheet* user's guide

8.2 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.

8.3 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.

8.4 Trademarks

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

8.5 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.

8.6 Glossary

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

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.

Copyright © 2023 Texas Instruments Incorporated

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TSM24BDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 150	35H8	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

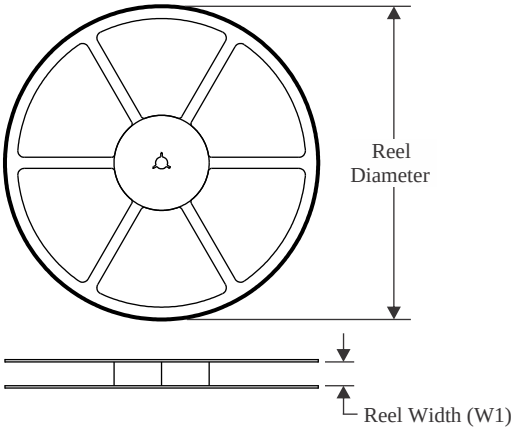
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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.

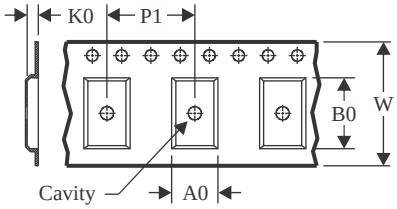
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

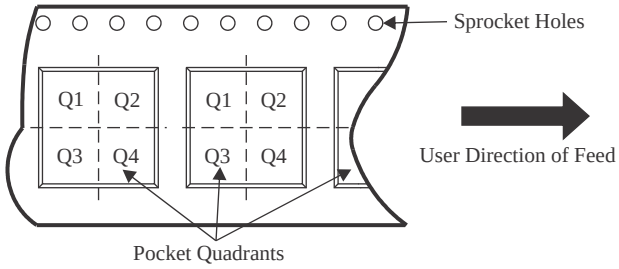


TAPE DIMENSIONS



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

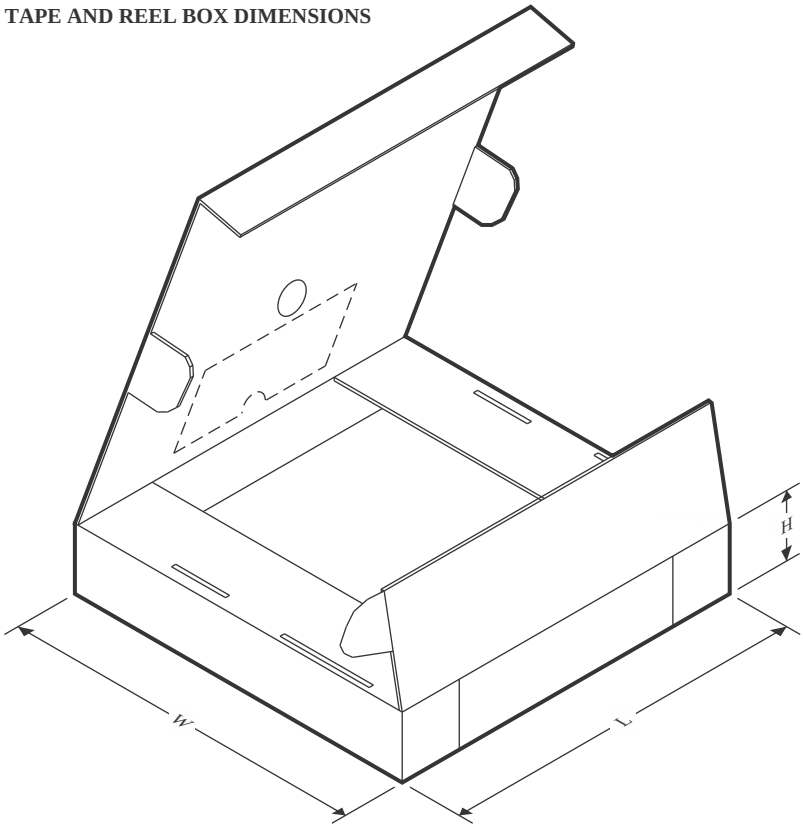
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TSM24BDBZR	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TSM24BDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0

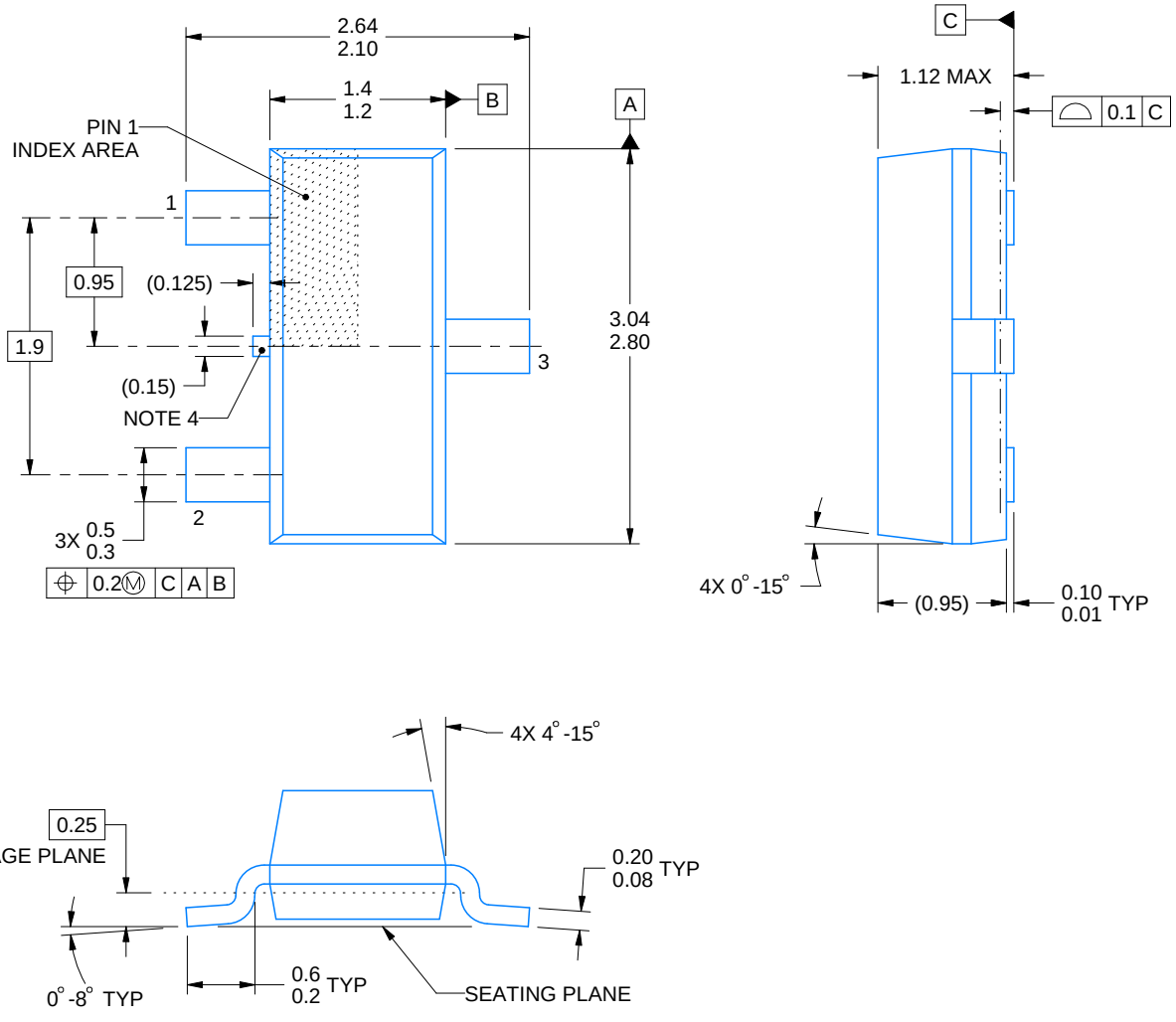
PACKAGE OUTLINE

DBZ0003A



SOT-23 - 1.12 mm max height

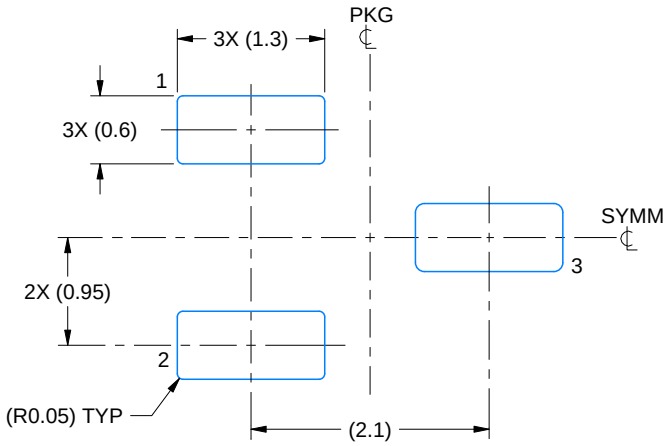
SMALL OUTLINE TRANSISTOR



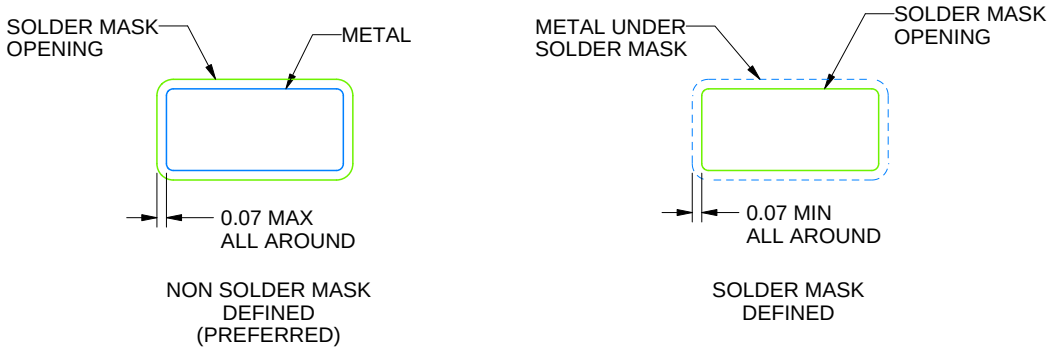
4214838/F 08/2024

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.
3. Reference JEDEC registration TO-236, except minimum foot length.
4. Support pin may differ or may not be present.
5. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25mm per side



LAND PATTERN EXAMPLE
SCALE:15X

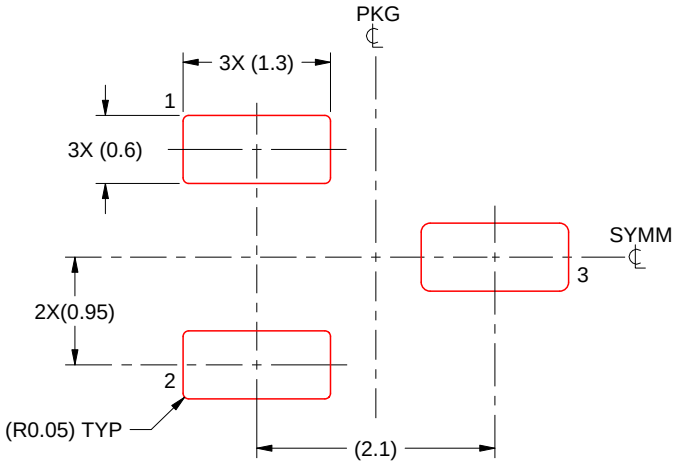


SOLDER MASK DETAILS

4214838/F 08/2024

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:15X

4214838/F 08/2024

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), 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 will 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 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.

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

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2024, Texas Instruments Incorporated

Unikeyic Electronics

Global Electronic Components Distributor

Click to view pricing, inventory, delivery, and lifecycle information:

Texas Instruments:

DRV8821DCA SN74ALS257AD TPS3307-25DGNR TPS3809I50DBVR SN74ACT7807-20FN
SN74ALVC244PWE4 SN74AS1034ANSR SN74AS832BDW TL750L12CP SN74ALS1640AN
LM5110-2M/NOPB TVP5150AM1PBSR UCC3752D SN74ALS258ADR TPA005D14DCA RI-I02-114B-01
BQ25616RTWR MSP430F5438AIPZR OPA2330AIDRBT ISO124U/1K LM4050CEM3-5.0 TLV2451IDBVR
TPS2835PWPR INA228AIDGSR LM311PW OPA643P THMC50DBQR TPS25200DRVR
SN74ACT3631-15PQ TL074IDR