

ESD652-Q1 采用 SOT-23 封装且适用于车载网络的汽车类 18V 双向 ESD 保护

1 特性

- IEC 61000-4-5 浪涌保护：
 - 5.5A (8/20 μ s)
- IEC 61000-4-2 ESD 保护：
 - ± 30 kV 接触放电
 - ± 30 kV 空气间隙放电
- 18V 工作电压
- I/O 电容：
 - 4pF (典型值)
- 双向极性，支持正负电压摆幅
- 双通道器件通过单个元件提供全面的 ESD 保护
- 温度范围：-55°C 至 +150°C
- 小型引线式 SOT-23 可实现低成本的自动光学检测 (AOI)
- 符合 AEC-Q101 标准

2 应用

- 汽车车载网络：
 - 汽车混合动力和电动动力总成系统
 - 储能系统
 - 汽车电池管理系统

3 说明

ESD652-Q1 是一款双向 ESD 保护二极管，用于电池管理系统和其他汽车应用。ESD652-Q1 的额定 ESD 冲击消散值超出了 IEC 61000-4-2 国际标准所规定的最高水平 (± 30 kV 接触放电, ± 30 kV 空气间隙放电)。根据 IEC 61000-4-5 标准，该器件可以钳制峰值脉冲电流高达 5.5A 的 8/20 μ s 浪涌。

该器件具有 4pF (典型值) 的 IO 电容，可实现高速接口保护。低动态电阻和低钳位电压有助于保护系统免受瞬态事件的影响。这种保护很关键，因为汽车系统在控制安全设备时需要高度的稳健性和可靠性。

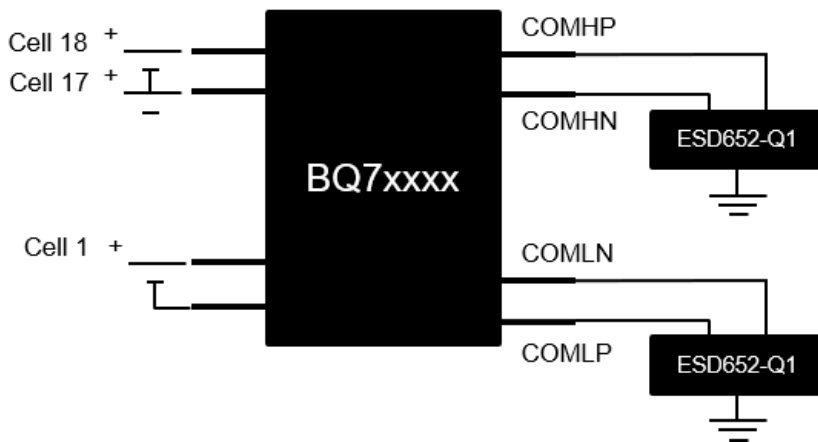
ESD652-Q1 采用小型引线式 SOT-23 (DBZ) 封装。

封装信息

器件型号	封装 ⁽¹⁾	封装尺寸 ⁽²⁾
ESD652-Q1	DBZ (SOT-23, 3)	2.92mm x 2.37mm

(1) 有关更多信息，请参阅节 9。

(2) 封装尺寸 (长 × 宽) 为标称值，并包括引脚 (如适用)。



典型应用原理图



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4 Pin Configuration and Functions

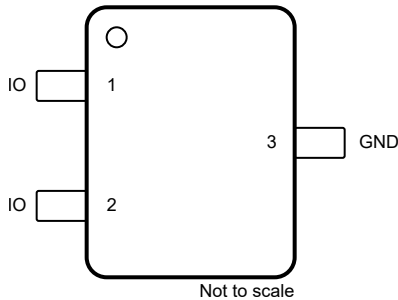


图 4-1. ESD652-Q1 DBZ Package, 3-Pin SOT-23 (Top View)

表 4-1. Pin Functions for ESD652-Q1

PIN		TYPE ⁽¹⁾	DESCRIPTION
NAME	NO.		
IO	1, 2	I/O	Surge and ESD protected IO
GND	3	GND	Ground. Connect to ground

(1) I = Input, O = Output, I/O = Input or Output, GND = ground

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 ⁽²⁾		176	W
I _{PPM}	IEC 61000-4-5 Surge (t _p = 8/20 μs) Peak Pulse Current at 25 °C ⁽²⁾		5.5	A
T _A	Operating free-air temperature	– 55	150	°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.

5.2 ESD Ratings - AEC Specifications

Parameter		Test Conditions	VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per AEC Q101-001 ⁽¹⁾	±2500	V
		Charged device model (CDM), per AEC Q101-005 ⁽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.

5.3 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	

5.4 ESD Ratings - ISO Specifications

Parameter		Test Conditions		VALUE	UNIT
V _(ESD)	ISO 10605 Electrostatic Discharge	C = 150pF; R = 330Ω	Contact Discharge, all pins	±30000	V
			Air-gap Discharge, all pins	±30000	
		C = 330pF; R = 330Ω	Contact Discharge, all pins	±30000	
			Air-gap Discharge, all pins	±30000	

5.5 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V _{IN}	Input voltage between any 2 pins	– 18		18	V
T _A	Operating Free Air Temperature	– 55		150	°C

5.6 Thermal Information

THERMAL METRIC ⁽¹⁾		ESD652(Q1)	UNIT
		DBZ (SOT-23)	
		3 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	249.2	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	129.7	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	83.1	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	24.2	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	82.5	°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 report.

5.7 Electrical Characteristics

At TA = 25°C unless otherwise noted

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{RWM}	Reverse stand-off voltage	$I_{IO} < 50\text{nA}$	-18		18	V
I_{LEAK}	Leakage current at V_{RWM}	$V_{IO} = \pm 18\text{V}$, I/O to GND		1	50	nA
V_{BR}	Breakdown voltage, I/O to GND ⁽¹⁾	$I_{IO} = \pm 10\text{mA}$	19		25	V
V_{CLAMP}	Surge clamping voltage, $t_p = 8/20 \mu\text{s}$ ⁽²⁾	$I_{PP} = \pm 1\text{A}$, I/O to GND		22	25	V
		$I_{PP} = \pm 5.5\text{A}$, I/O to GND		25	32	V
V_{CLAMP}	TLP clamping voltage, $t_p = 100 \text{ ns}$ ⁽³⁾	$I_{PP} = \pm 16\text{A}$ TLP, I/O to GND		28		V
R_{DYN}	Dynamic resistance ⁽⁴⁾	I/O to GND		0.32		Ω
		GND to I/O		0.32		
C_{LINE}	Line capacitance, IO to GND	$V_{IO} = 0\text{V}$, $f = 1\text{MHz}$		4		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 $I = 10\text{A}$ and $I = 20\text{A}$

5.8 Typical Characteristics

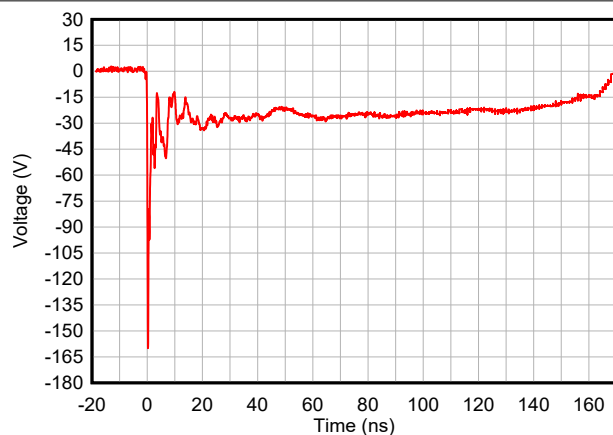


图 5-1. -8kV Clamped IEC Waveform

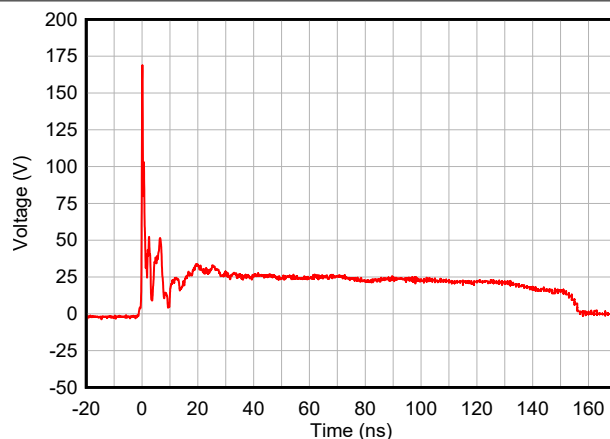


图 5-2. +8kV Clamped IEC Waveform

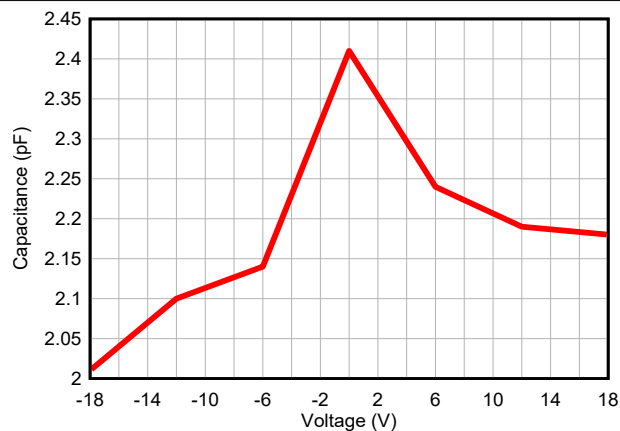


图 5-3. Capacitance vs. Bias Voltage

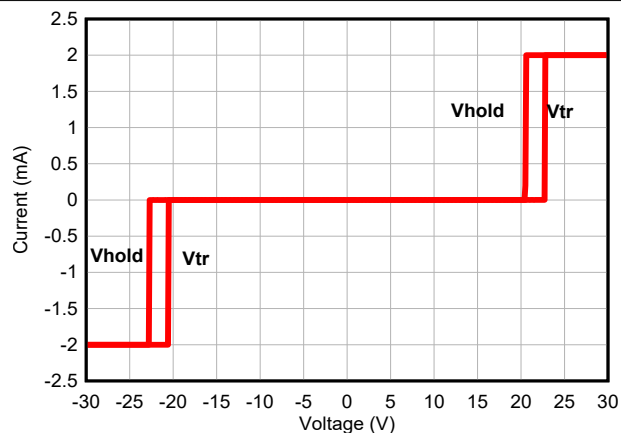


图 5-4. DC Voltage Sweep I-V Curve

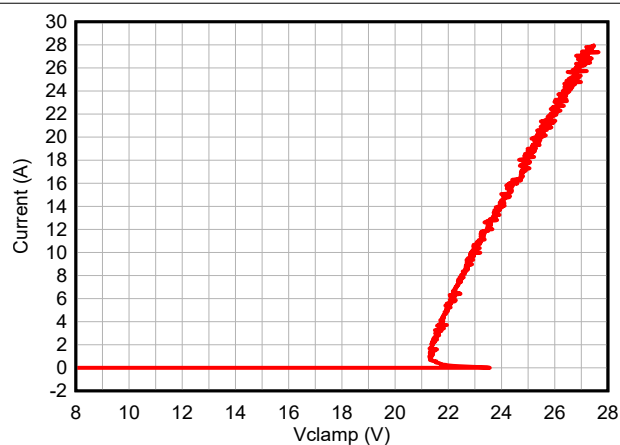


图 5-5. Negative TLP Curve

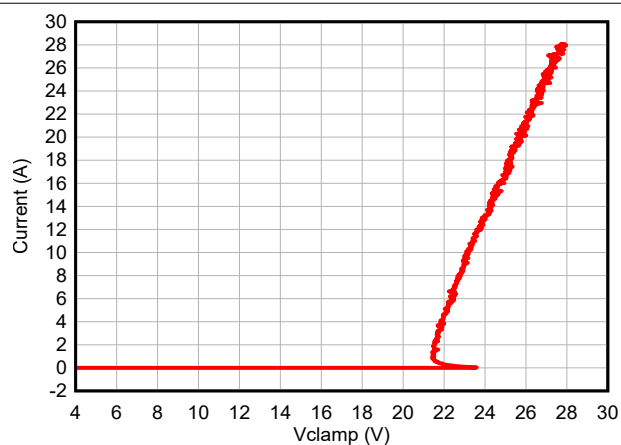
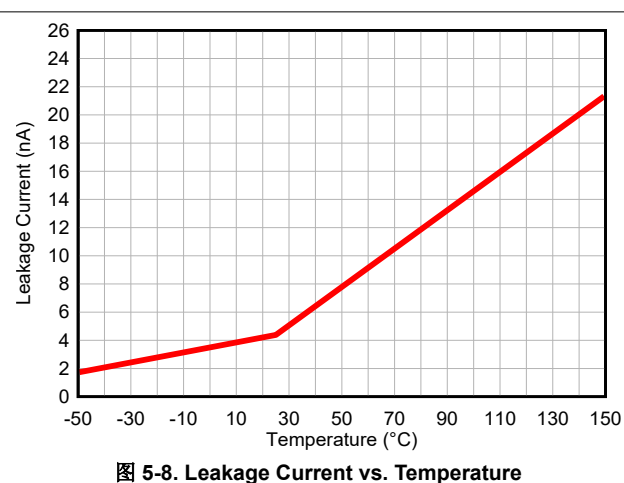
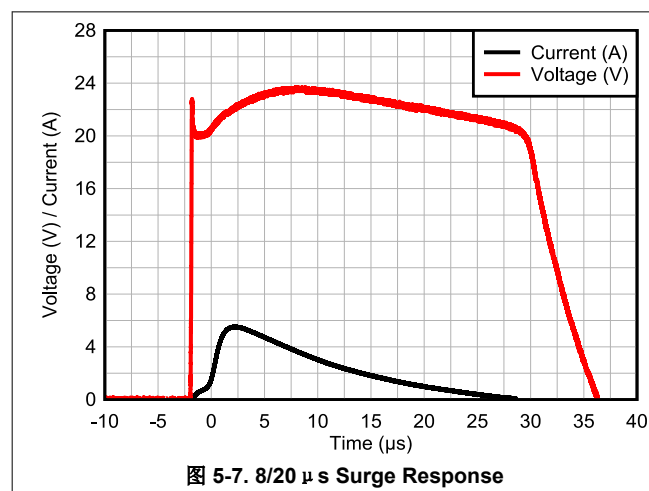


图 5-6. Positive TLP Curve

5.8 Typical Characteristics (continued)



6 Application and Implementation

备注

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 ESD652-Q1 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. Connect the device in parallel to the down stream circuitry for protection. As the current from the transient passes through the device, 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](#) for details.

7 Device and Documentation Support

7.1 Documentation Support

7.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [ESD Packaging and Layout Guide](#)
- 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](#)

7.2 接收文档更新通知

要接收文档更新通知，请导航至 [ti.com](https://www.ti.com) 上的器件产品文件夹。点击 [通知](#) 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

7.3 支持资源

[TI E2E™ 中文支持论坛](#) 是工程师的重要参考资料，可直接从专家处获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题，获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 [使用条款](#)。

7.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.

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7.5 静电放电警告



静电放电 (ESD) 会损坏这个集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

7.6 术语表

[TI 术语表](#) 本术语表列出并解释了术语、首字母缩略词和定义。

8 Revision History

DATE	REVISION	NOTES
February 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)
ESD652DBZRQ1	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 150	37M8
ESD652DBZRQ1.B	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 150	37M8

⁽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.

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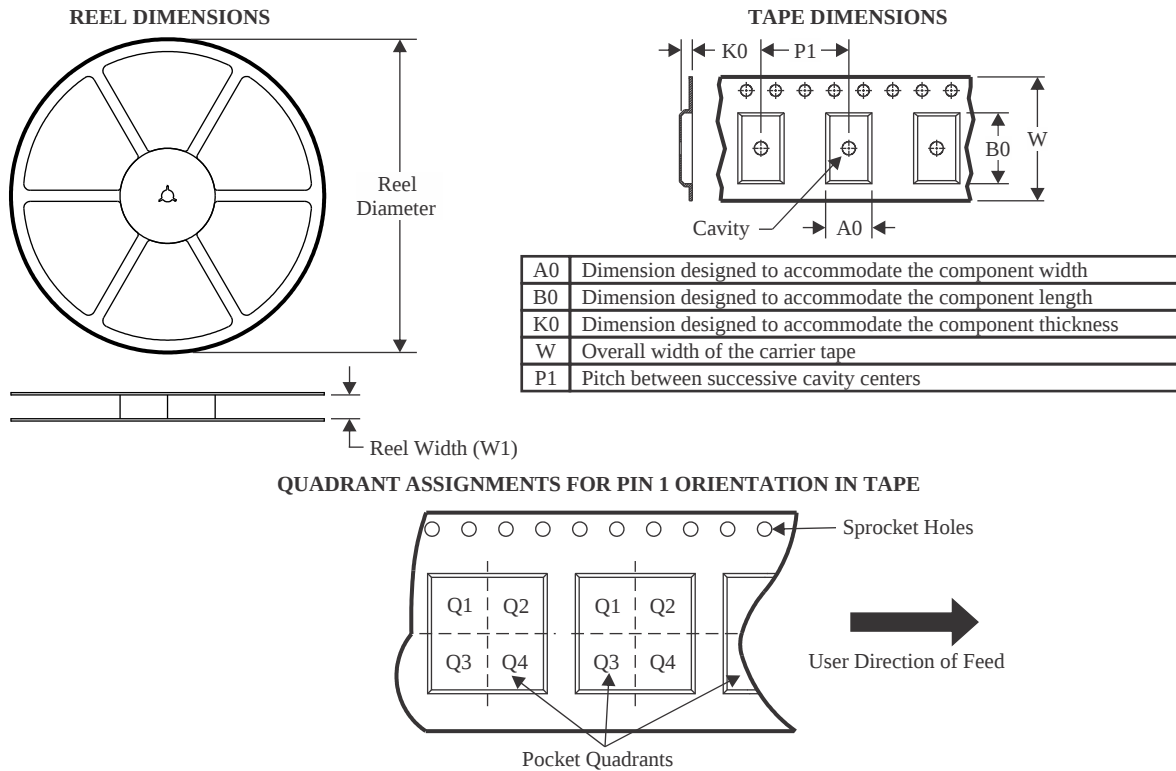
OTHER QUALIFIED VERSIONS OF ESD652-Q1 :

- Catalog : [ESD652](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

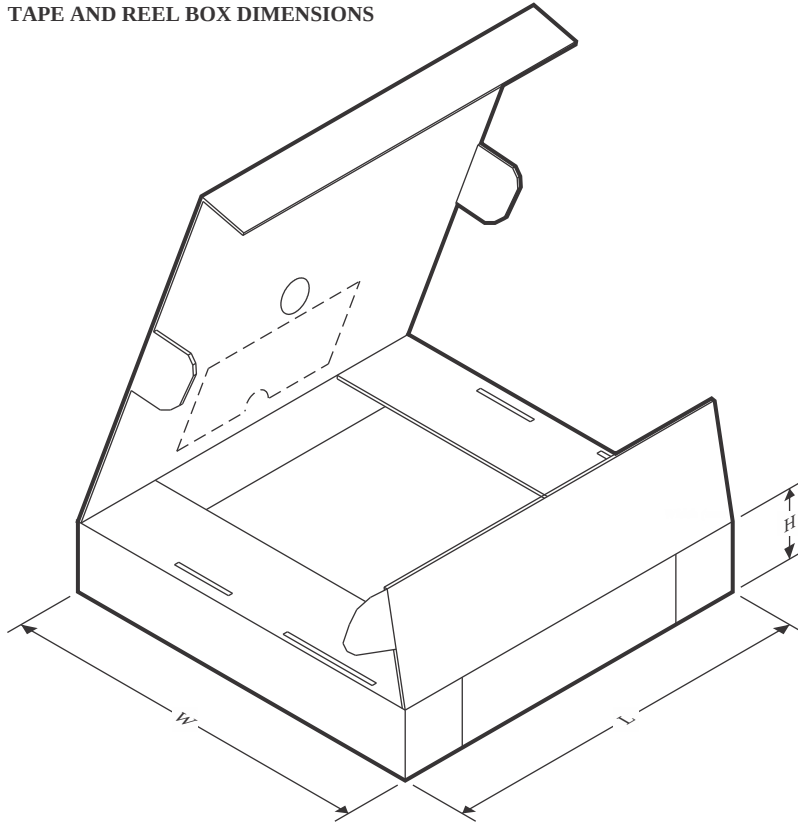
TAPE AND REEL INFORMATION



*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
ESD652DBZRQ1	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

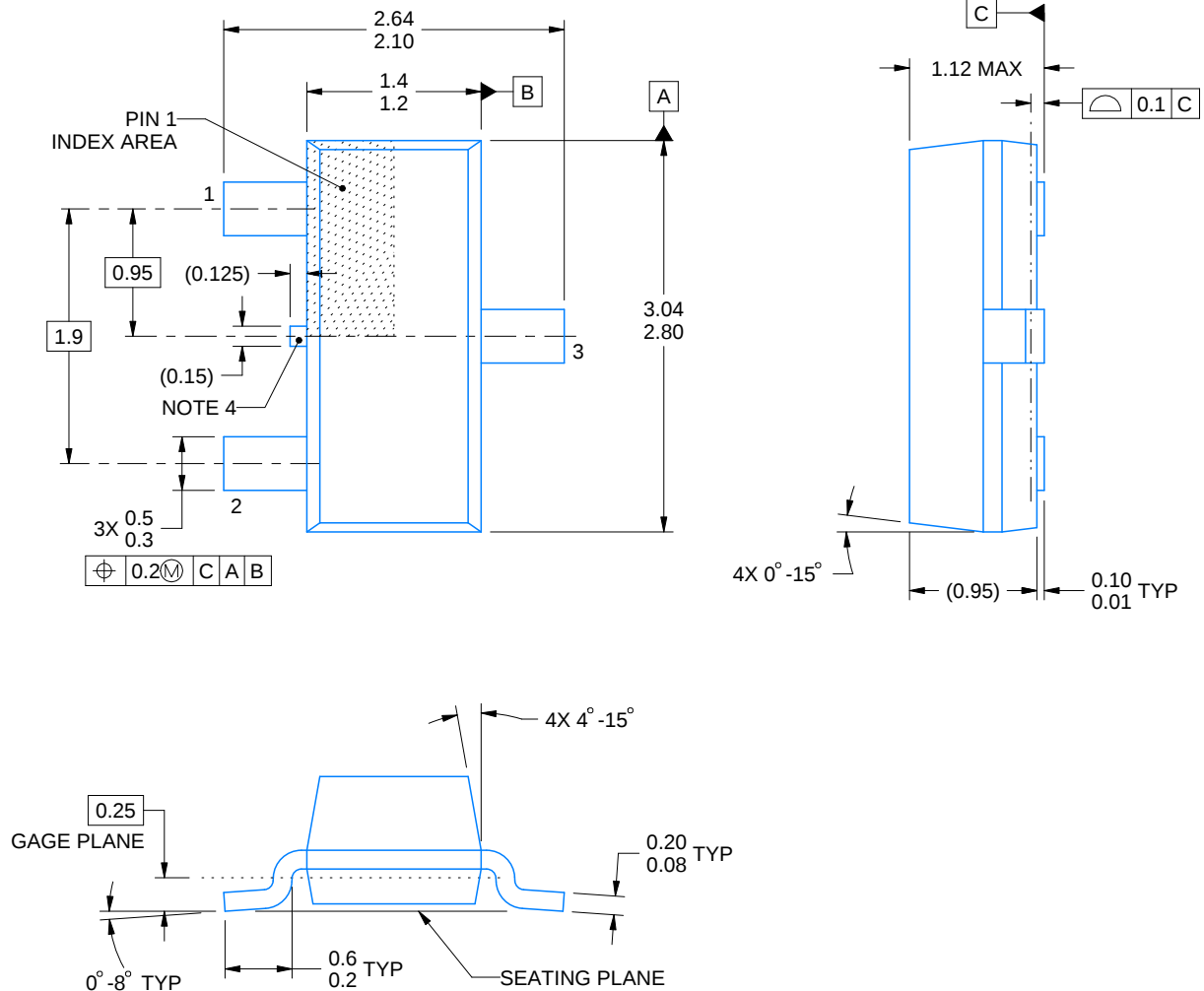


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
ESD652DBZRQ1	SOT-23	DBZ	3	3000	210.0	185.0	35.0

DBZ0003A**PACKAGE OUTLINE****SOT-23 - 1.12 mm max height**

SMALL OUTLINE TRANSISTOR



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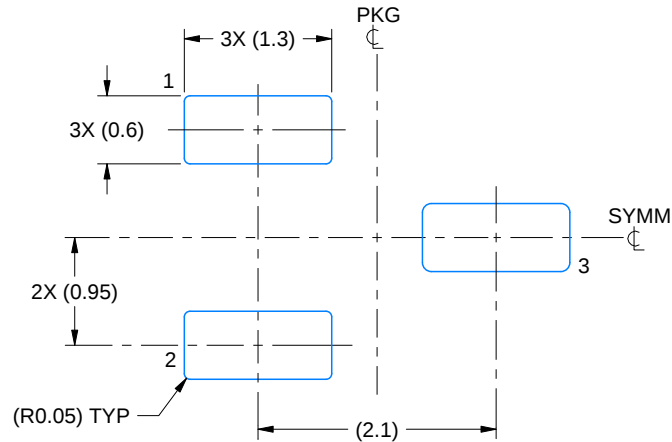
NOTES:

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

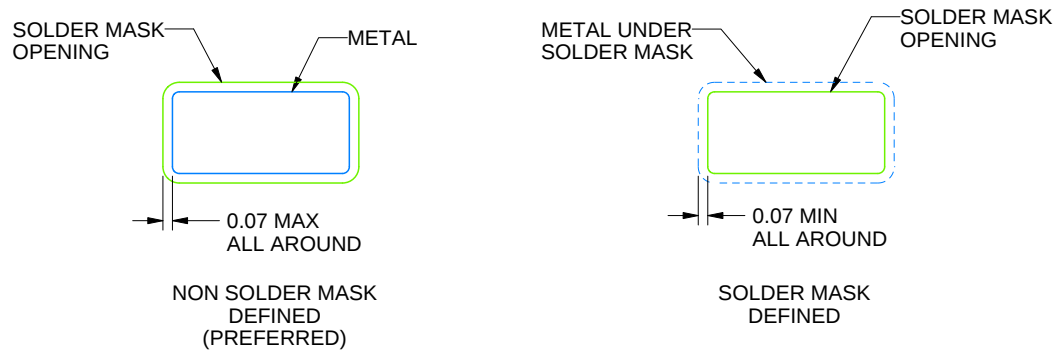
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

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NOTES: (continued)

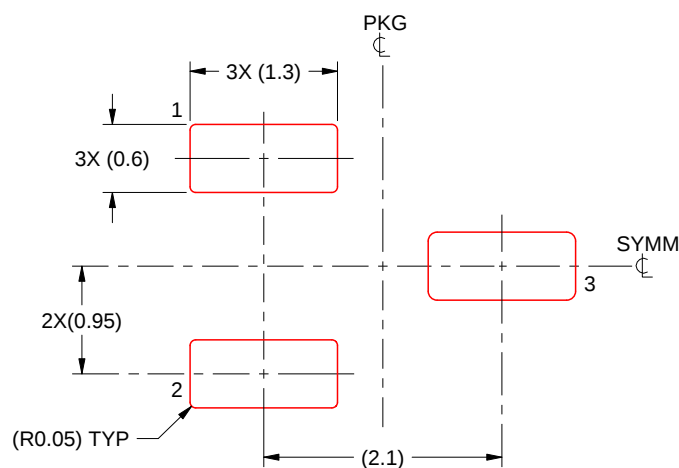
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



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.

重要通知和免责声明

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