

采用 0201 封装的 ESD341 单通道 ± 30 kV ESD 保护二极管

1 特性

- IEC 61000-4-2 4 级 ESD 保护
 - 30kV 接触放电
 - 30kV 空气间隙放电
- IEC 61000-4-5 浪涌保护
 - 5.4 A (8 μ s/20 μ s)
- IO 电容：
 - 0.66pF (典型值)
- 直流击穿电压： ± 6.2 V (典型值)
- 超低漏电流：100nA (最大值)
- 低 ESD 钳位电压：16A TLP 时为 10.2V
- 低插入损耗：5GHz (- 3dB 带宽, DPL)
- 支持速率高达 3.4Gbps 的高速接口
- 工业温度范围：- 40°C 至 +125°C
- 节省空间的行业标准 0201 尺寸 (0.6mm $\times$ 0.3mm $\times$ 0.3mm)

2 应用

- 终端设备：
 - 可穿戴设备
 - 智能扬声器
 - 便携式电子产品
 - 小型电器
 - 便携式计算机和台式机
 - 电视和监视器
 - 音响主机
 - 后座娱乐系统
 - 扩展坞
- 接口：
 - USB 2.0
 - USB 3.0
 - HDMI 1.4 和 2.0
 - LVDS
 - DisplayPort
 - SIM 卡

3 说明

ESD341 是一款双向瞬态电压抑制器 (TVS) ESD 保护二极管，用于为 HDMI 1.4 电路提供保护。ESD341 的额定 ESD 冲击消散值等于 IEC 61000-4-2 国际标准 (4 级) 规定的最高水平。

该器件采用一个 0.66pF (典型值) 的 IO 电容，可保护速率高达 3.4Gbps 的高速接口，包括支持 HDMI 1.4b 之类的协议。低动态电阻和低钳位电压可针对瞬变事件提供系统级保护。

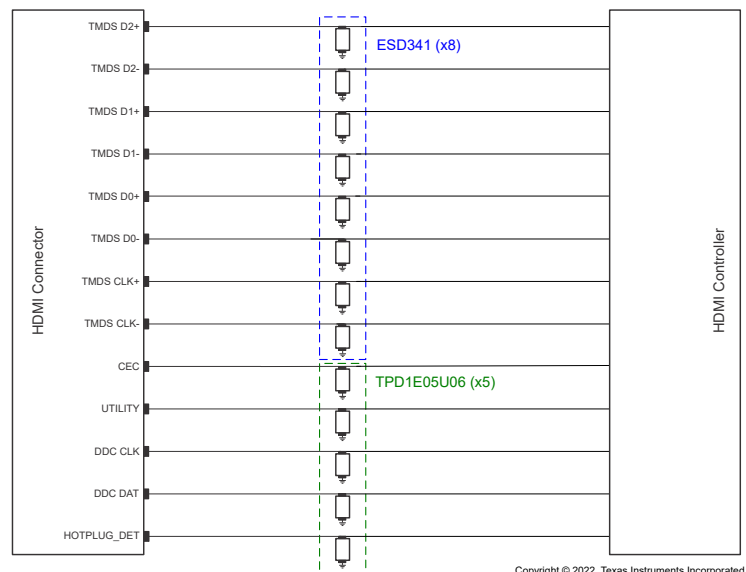
30kV ESD 等级和 5.4A 浪涌采用微型封装，可提供强大的瞬态保护，用于保护便携式电子产品和其他空间狭小应用 (如可穿戴设备) 中的 3.6V 电源轨。

ESD341 采用行业标准的 0201 (DPL) 封装。

器件信息⁽¹⁾

器件型号	封装	封装尺寸 (标称值)
ESD341	X2SON (2)	0.60mm x 0.30mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。



Copyright © 2022, Texas Instruments Incorporated

典型应用



Table of Contents

1 特性	1	8 Application and Implementation	9
2 应用	1	8.1 Application Information.....	9
3 说明	1	8.2 Typical Application.....	9
4 Revision History	2	9 Power Supply Recommendations	11
5 Pin Configuration and Functions	3	10 Layout	11
6 Specifications	4	10.1 Layout Guidelines.....	11
Absolute Maximum Ratings.....	4	10.2 Layout Example.....	11
6.1 ESD Ratings—JEDEC Specification.....	4	11 Device and Documentation Support	12
6.2 ESD Ratings—IEC Specification.....	4	11.1 Documentation Support.....	12
Recommended Operating Conditions.....	4	11.2 接收文档更新通知.....	12
6.3 Thermal Information.....	4	11.3 支持资源.....	12
6.4 Electrical Characteristics.....	5	11.4 Trademarks.....	12
6.5 Typical Characteristics.....	6	11.5 Electrostatic Discharge Caution.....	12
7 Detailed Description	8	11.6 术语表.....	12
7.1 Overview.....	8	12 Mechanical, Packaging, and Orderable Information	12
7.2 Functional Block Diagram.....	8	12.1 Tape and Reel Information.....	14
7.3 Feature Description.....	8		
7.4 Device Functional Modes.....	8		

4 Revision History

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision * (April 2022) to Revision A (July 2022)	Page
• 将数据表的状态从 <i>预告信息</i> 更改为 <i>量产数据</i>	1

5 Pin Configuration and Functions

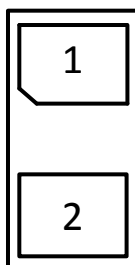


图 5-1. DPL Package, 2-Pin X2SON (Top View)

表 5-1. Pin Functions

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

(1) I = input, O = output

6 Specifications

Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Peak Pulse ^{(2) (3)}	IEC 61000-4-5 power (t_p - 8/20 μ s)		54	W
	IEC 61000-4-5 Current (t_p - 8/20 μ s)		5.4	A
T_A	Ambient Operating Temperature	-40	125	°C
T_J	Junction 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.
- (2) Voltages are with respect to GND unless otherwise noted.
- (3) Measured at 25°C

6.1 ESD Ratings—JEDEC Specification

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001	±2500	V
		Charged device model (CDM), per JEDEC specification JS-002	±1000	V

6.2 ESD Ratings—IEC Specification

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	IEC 61000-4-2 contact discharge	±30000	V
		IEC 61000-4-2 air-gap discharge	±30000	

Recommended Operating Conditions

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

			MIN	NOM	MAX	UNIT
V_{IO}	Input pin voltage	Pin 1 to 2 or Pin 2 to 1	-3.6		3.6	V
T_A	Operating free-air temperature		-40		125	°C

6.3 Thermal Information

THERMAL METRIC ⁽¹⁾		ESD341	UNIT
		DPL (X2SON)	
		2 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	356.8	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	208.8	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	136.2	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	3.0	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	135.7	°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.

6.4 Electrical Characteristics

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

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
V _{RWM}	Reverse stand-off voltage	Pin 1 to Pin 2 or Pin 2 to Pin 1	-3.6		3.6	V
V _{BRF}	Break-down voltage	I _{IO} = 1 mA, Pin 1 to Pin 2	5	6.2	7.2	V
V _{BRR}	Break-down voltage	I _{IO} = -1 mA, Pin 2 to Pin 1	-7.2	-6.2	-5	V
V _{HOLD}	Holding voltage ⁽²⁾	TLP, Pin 1 to Pin 2 or Pin 2 to Pin 1		6.2		V
V _{Clamp_TLP}	Clamp voltage with TLP ⁽²⁾	I _{PP} = 1 A, TLP, Pin 1 to Pin 2		6.3		V
		I _{PP} = 5 A, TLP, Pin 1 to Pin 2		7.4		
		I _{PP} = 16 A, TLP, Pin 1 to Pin 2		10.2		
		I _{PP} = 1 A, TLP, Pin 2 to Pin 1		6.3		
		I _{PP} = 5 A, TLP, Pin 2 to Pin 1		7.4		
		I _{PP} = 16 A, TLP, Pin 2 to Pin 1		10.2		
V _{Clamp_Surge}	Clamp voltage with surge strike ⁽⁴⁾	I _{PP} = 5.4 A, t _p = 8/20 μs, Pin 1 to Pin 2 or Pin 2 to Pin 1		8.8		V
I _{LEAK}	Leakage current	V _{IO} = 3.6 V, Pin 1 to Pin 2 or Pin 2 to Pin 1		5	100	nA
R _{DYN}	Dynamic resistance ⁽³⁾	Pin 1 to Pin 2		0.25		Ω
		Pin 2 to Pin 1				
C _L	Line capacitance	V _{IO} = 0 V; f = 1 MHz, Pin 1 to Pin 2, T _A = 25°C		0.66		pF

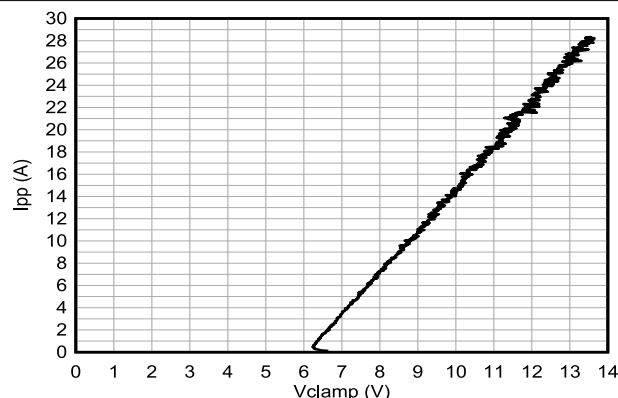
(1) Typical parameters are measured at 25°C

(2) Transition line pulse with 100 ns width and 10 ns rise and fall time

(3) Extraction of R_{DYN} using least squares fit of TLP characteristics between I = 10 A and I = 20 A

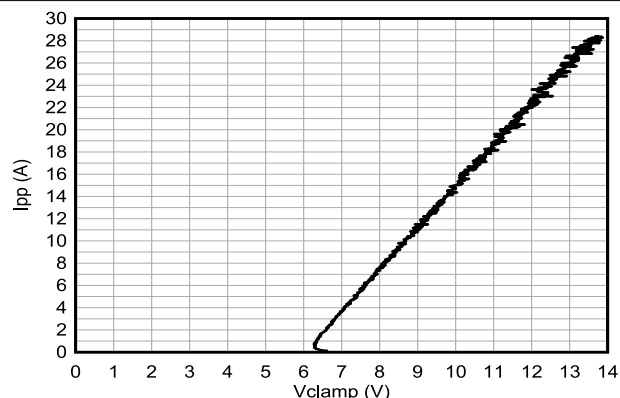
(4) Nonrepetitive current pulse 8 to 20 μs exponentially decaying waveform according to IEC 61000-4-5

6.5 Typical Characteristics



tp = 100 ns, Transmission Line Pulse (TLP)

图 6-1. Positive TLP Curve



tp = 100 ns, Transmission Line Pulse (TLP)

图 6-2. Negative TLP Curve

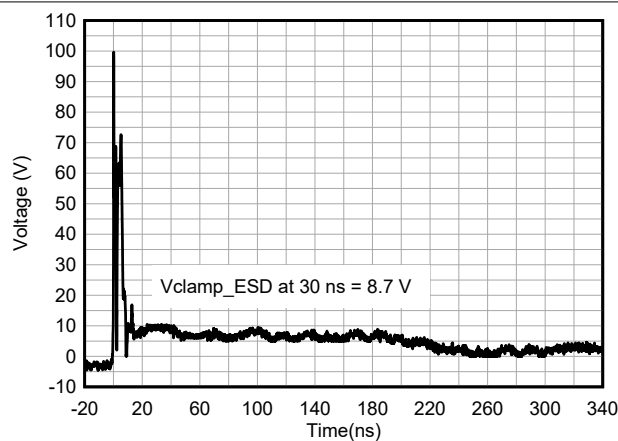


图 6-3. +8-kV Clamped IEC Waveform

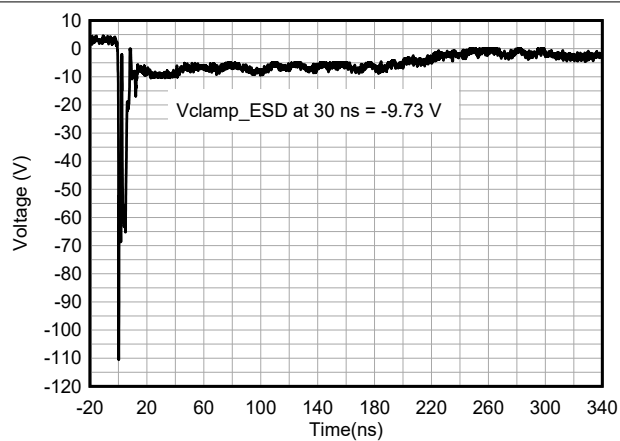


图 6-4. -8-kV Clamped IEC Waveform

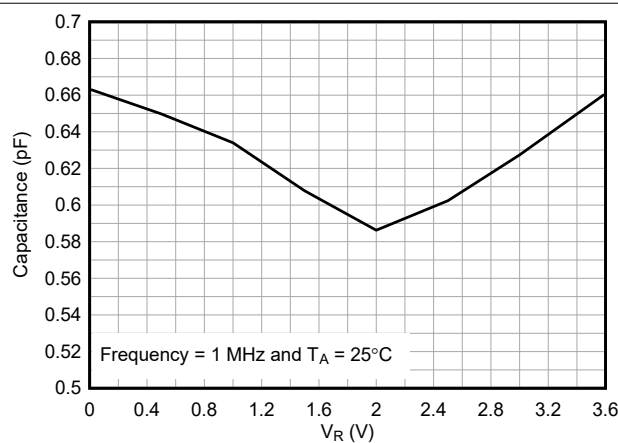


图 6-5. Bias Voltage vs. Capacitance

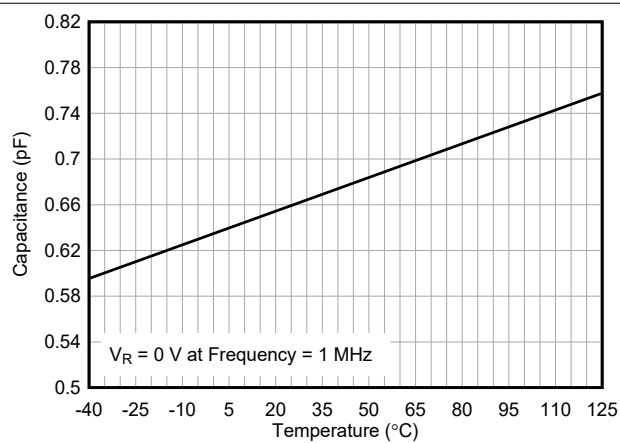


图 6-6. Temperature vs. Capacitance

6.5 Typical Characteristics (continued)

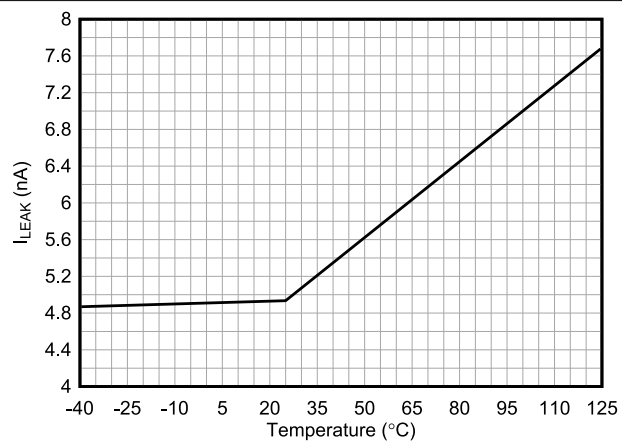


图 6-7. Temperature vs. Leakage Current

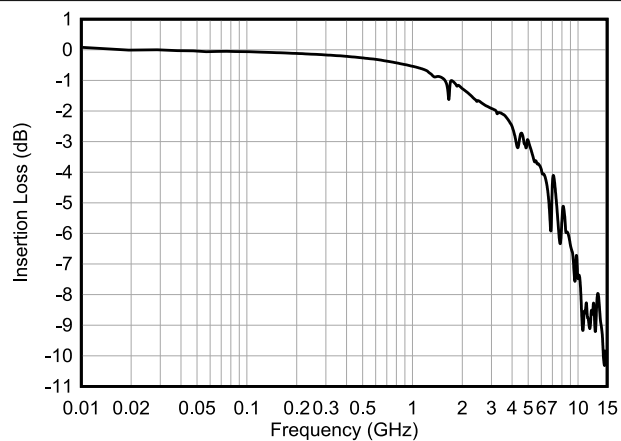


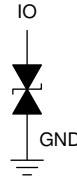
图 6-8. Insertion Loss

7 Detailed Description

7.1 Overview

The ESD341 device is a bidirectional ESD Protection Diode with ultra-low capacitance. This device can dissipate ESD strikes above the maximum level specified by the IEC 61000-4-2 International Standard. The ultra-low capacitance allows this device to protect high-speed signal pins including HDMI 1.4b.

7.2 Functional Block Diagram



Copyright © 2016, Texas Instruments Incorporated

7.3 Feature Description

7.3.1 IEC 61000-4-2 ESD Protection

The I/O pins can withstand ESD events up to ± 30 kV contact and ± 30 kV air gap. An ESD-surge clamp diverts the current to ground.

7.3.2 IEC 61000-4-5 Surge Protection

The I/O pins can withstand surge events up to 5.4 A and 54 W (8/20 μ s waveform). An ESD-surge clamp diverts this current to ground.

7.3.3 IO Capacitance

The capacitance between each I/O pin to ground is 0.66 pF (typical). This device supports data rates up to 3.4 Gbps.

7.3.4 DC Breakdown Voltage

The DC breakdown voltage of each I/O pin is ± 6.2 V (typical). This DC breakdown voltage ensures that sensitive equipment is protected from surges above the reverse standoff voltage of ± 3.6 V.

7.3.5 Ultra Low Leakage Current

The I/O pins feature an ultra-low leakage current of 100 nA (maximum) with a bias of ± 3.6 V.

7.3.6 Low ESD Clamping Voltage

The I/O pins feature an ESD clamp that is capable of clamping the voltage to 7.4 V ($I_{PP} = 5$ A, TLP).

7.3.7 Supports High Speed Interfaces

This device is capable of supporting high speed interfaces up to 3.4 Gbps, because of the extremely low IO capacitance.

7.3.8 Industrial Temperature Range

This device features an industrial operating range of -40°C to $+125^{\circ}\text{C}$.

7.4 Device Functional Modes

The ESD341 device is a passive integrated circuit that triggers when voltages are above V_{BRF} or below V_{BRR} . During ESD events, voltages as high as ± 30 kV (air or contact) can be directed to ground through the internal diode network. When the voltages on the protected line fall below the V_{HOLD} of ESD341 (usually within 10s of nano-seconds) the device reverts to passive.

8 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.

8.1 Application Information

The ESD341 is a diode type TVS which provides a path to ground for dissipating ESD events on high-speed signal lines between a human interface connector and a system. As the current from ESD 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.

8.2 Typical Application



Copyright © 2022, Texas Instruments Incorporated

图 8-1. HDMI 1.4 Application

8.2.1 Design Requirements

For this design example, 8 ESD341 devices and 5 TPD1E05U06 devices are being used in an HDMI 1.4 application, which provides a complete port protection scheme.

表 8-1 lists the parameters for the HDMI 1.4 application.

表 8-1. Design Parameters

DESIGN PARAMETER	VALUE
TMDS signal range on pins	0 V to 3.6 V
Other signal range on pins	0 V to 5 V
Operating frequency	1.7 GHz

8.2.2 Detailed Design Procedure

8.2.2.1 Signal Range

The ESD341 supports signal ranges between -3.6 V and 3.6 V, which supports the TMDS signals. The TPD1E05U06 supports signal ranges between 0 V and 5.5 V, which supports the other signals (CEC, UTILITY, DDC CLK, DDC DAT, and HOTPLUG_DET) in the HDMI 1.4 application.

8.2.2.2 Operating Frequency

The ESD341 has a 0.66 pF (typical) capacitance, which supports the 3.4 Gbps data rate needed for the HDMI 1.4 application.

8.2.3 Application Curves

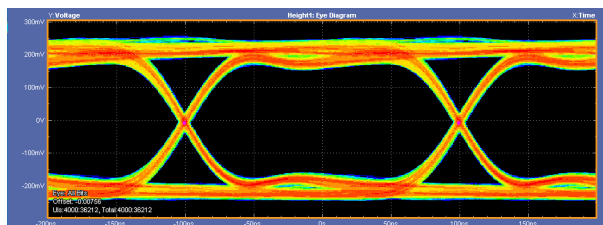


图 8-2. Data Rate > 3.4 Gbps Eye Diagram (Bare Board)

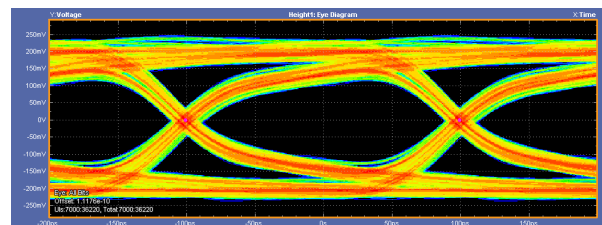


图 8-3. Data Rate > 3.4 Gbps Eye Diagram (with ESD341)

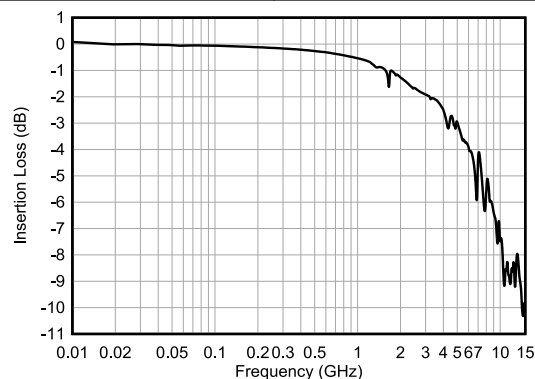


图 8-4. Insertion Loss

9 Power Supply Recommendations

This is a passive TVS diode-based ESD protection device, therefore there is no need to power it. Take care that the maximum voltage specifications for each pin are not violated.

10 Layout

10.1 Layout Guidelines

- The optimum placement of the ESD protection device is as close to the connector as possible
 - EMI during an ESD event can couple from the trace being struck to other nearby unprotected traces, resulting in early system failures
 - The PCB designer must minimize the possibility of EMI coupling by keeping any unprotected traces away from the protected traces which are between the TVS and the connector
- Route the protected traces as straight as possible
- Eliminate any sharp corners on the protected traces between the TVS and the connector by using rounded corners with the largest radii possible
 - Electric fields tend to build up on corners, increasing EMI coupling
- If pin 1 or pin 2 is connected to ground, use a thick and short trace for this return path

10.2 Layout Example

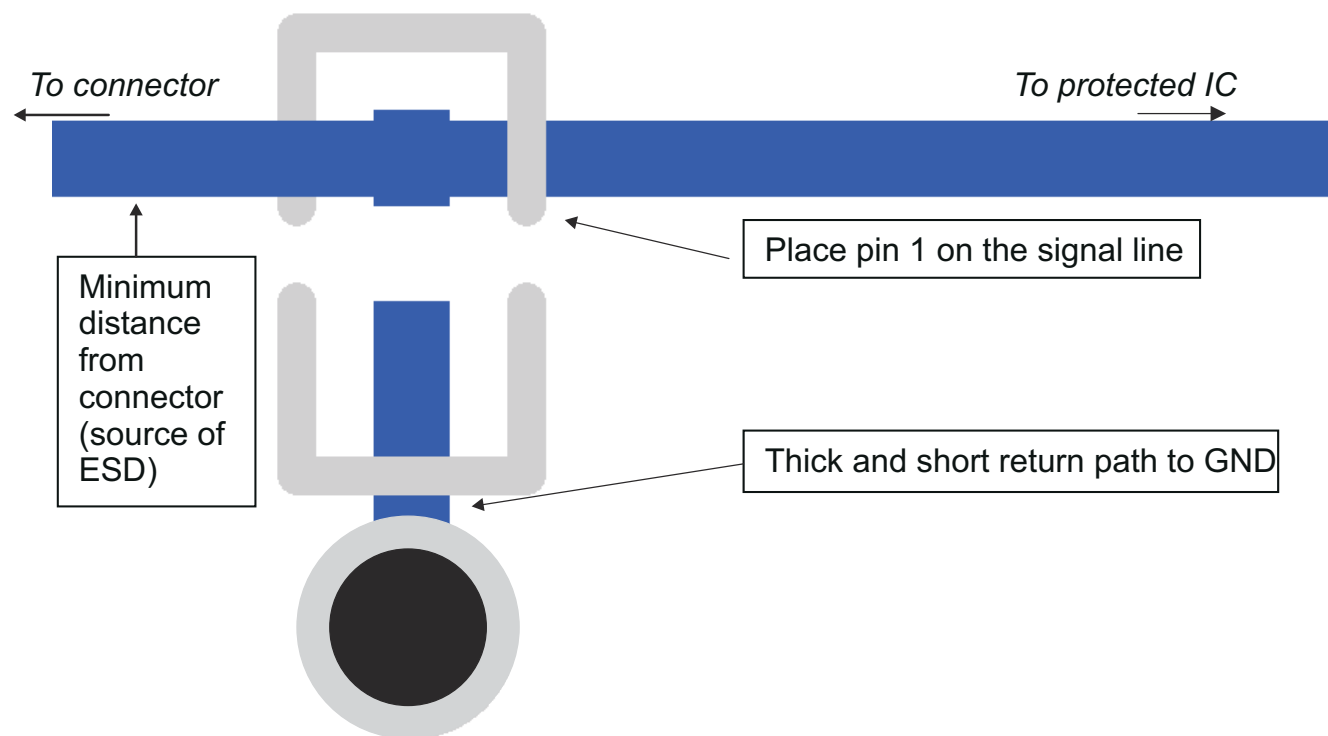


图 10-1. Layout Recommendation

11 Device and Documentation Support

11.1 Documentation Support

11.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [ESD Layout Guide application reports](#)
- Texas Instruments, [Generic ESD Evaluation Module user's guide](#)
- Texas Instruments, [Picking ESD Diodes for Ultra High-Speed Data Lines application reports](#)
- Texas Instruments, [Reading and Understanding an ESD Protection data sheet](#)

11.2 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 [订阅更新](#) 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。

11.3 支持资源

[TI E2E™ 支持论坛](#) 是工程师的重要参考资料，可直接从专家获得快速、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可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》](#)。

11.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.

所有商标均为其各自所有者的财产。

11.5 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.

11.6 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。

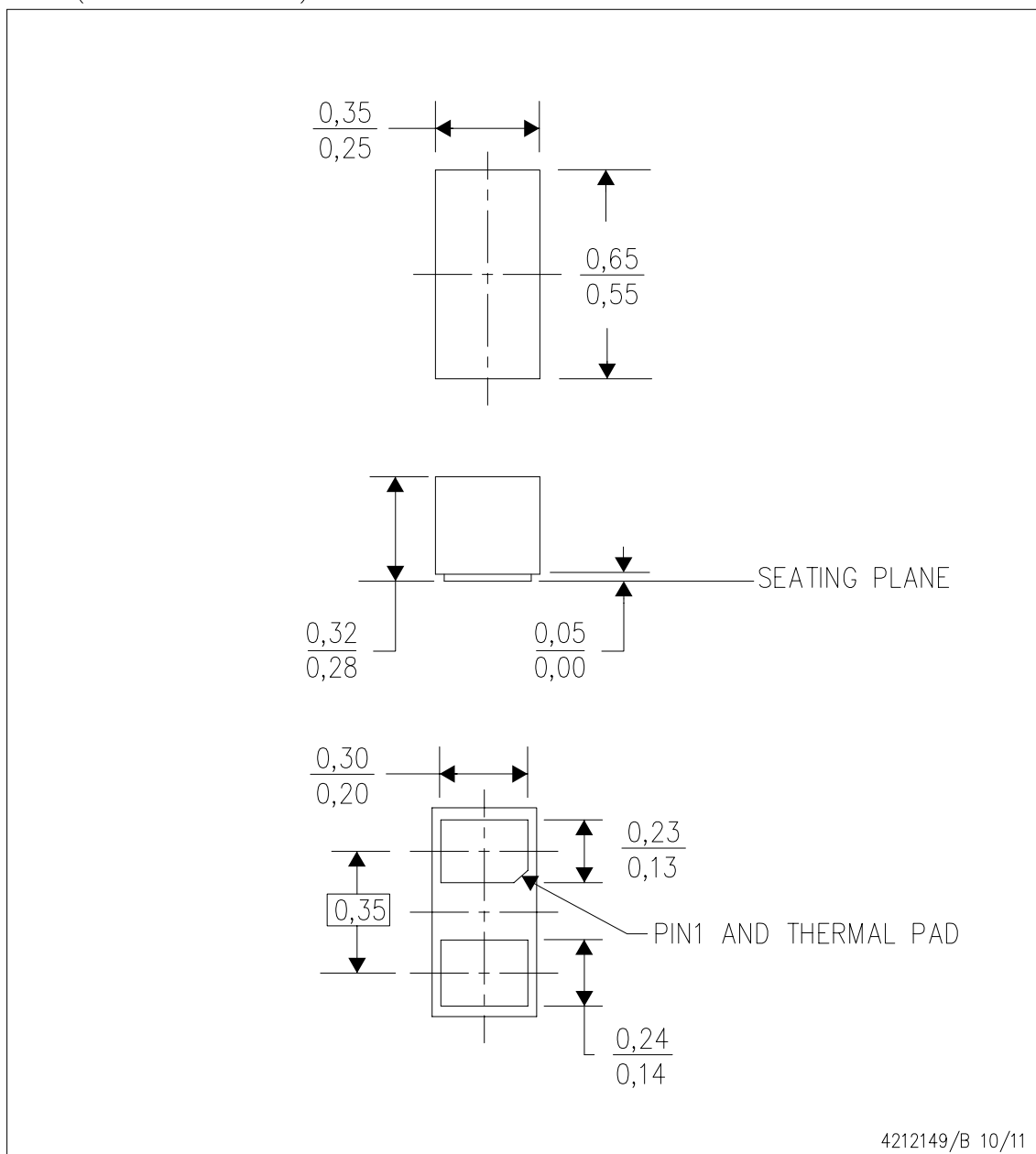
12 Mechanical, Packaging, and Orderable Information

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.

MECHANICAL DATA

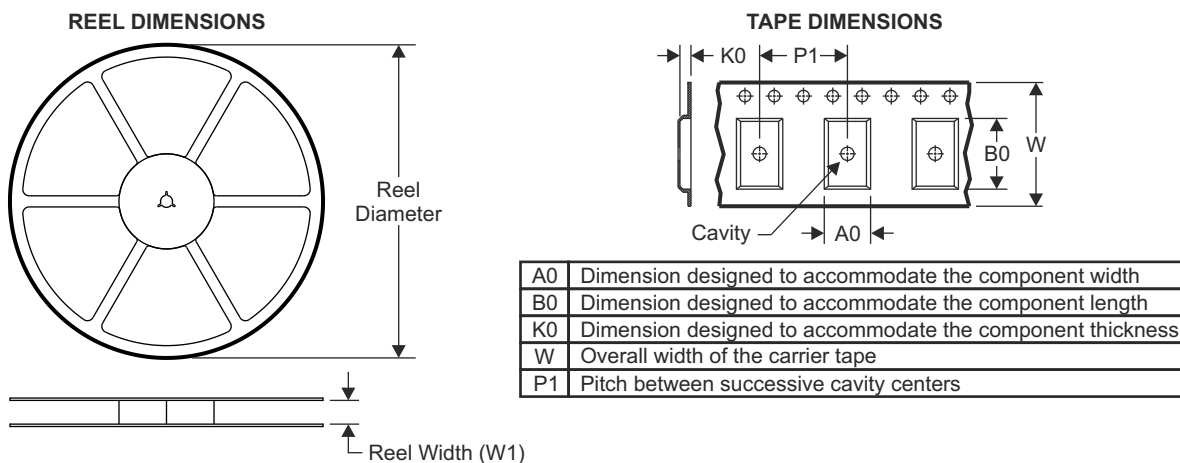
DPL (R-PX2SON-N2)

PLASTIC SMALL OUTLINE NO-LEAD

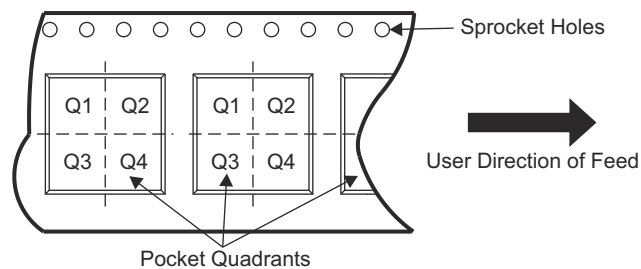


- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Small Outline No-Lead (SON) package configuration.
 - D. The package thermal pad must be soldered to the board for thermal and mechanical performance.

12.1 Tape and Reel Information

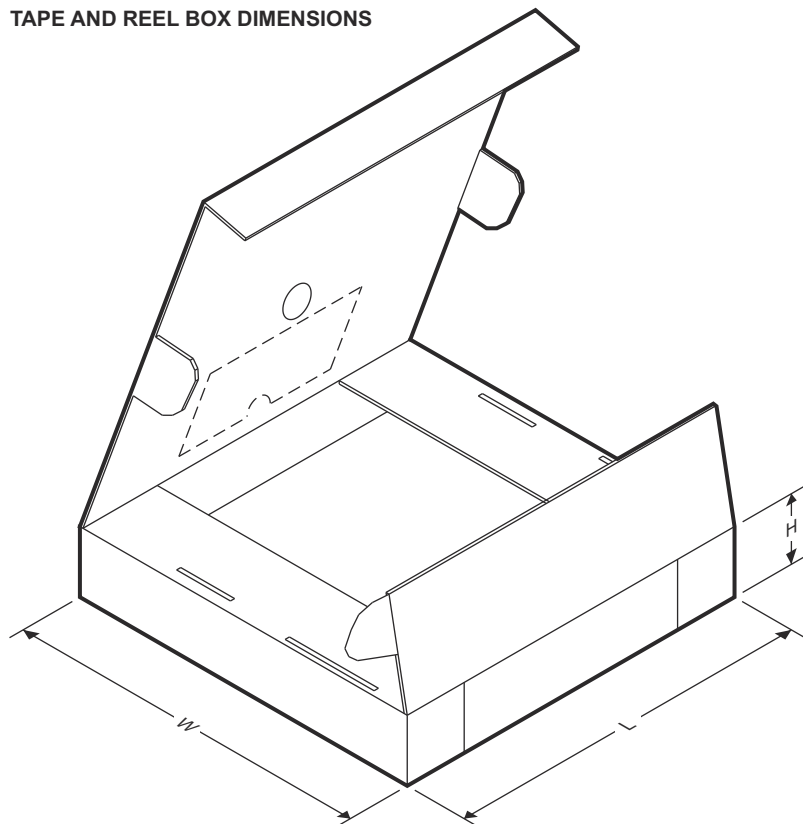


QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



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
ESD341DPLR	X2SON	DPL	2	15000	178	8.4	0.36	0.66	0.33	0.2	8	Q1

TAPE AND REEL BOX DIMENSIONS



Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
ESD341DPLR	X2SON	DPL	2	15000	205	200	33

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)
ESD341DPLR	Active	Production	X2SON (DPL) 2	15000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3
ESD341DPLR.B	Active	Production	X2SON (DPL) 2	15000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3

⁽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.

重要通知和免责声明

TI“按原样”提供技术和可靠性数据（包括数据表）、设计资源（包括参考设计）、应用或其他设计建议、网络工具、安全信息和其他资源，不保证没有瑕疵且不做任何明示或暗示的担保，包括但不限于对适销性、与某特定用途的适用性或不侵犯任何第三方知识产权的暗示担保。

这些资源可供使用 TI 产品进行设计的熟练开发人员使用。您将自行承担以下全部责任：(1) 针对您的应用选择合适的 TI 产品，(2) 设计、验证并测试您的应用，(3) 确保您的应用满足相应标准以及任何其他安全、安保法规或其他要求。

这些资源如有变更，恕不另行通知。TI 授权您仅可将这些资源用于研发本资源所述的 TI 产品的相关应用。严禁以其他方式对这些资源进行复制或展示。您无权使用任何其他 TI 知识产权或任何第三方知识产权。对于因您对这些资源的使用而对 TI 及其代表造成的任何索赔、损害、成本、损失和债务，您将全额赔偿，TI 对此概不负责。

TI 提供的产品受 [TI 销售条款](#)、[TI 通用质量指南](#) 或 [ti.com](#) 上其他适用条款或 TI 产品随附的其他适用条款的约束。TI 提供这些资源并不会扩展或以其他方式更改 TI 针对 TI 产品发布的适用的担保或担保免责声明。除非德州仪器 (TI) 明确将某产品指定为定制产品或客户特定产品，否则其产品均为按确定价格收入目录的标准通用器件。

TI 反对并拒绝您可能提出的任何其他或不同的条款。

版权所有 © 2025，德州仪器 (TI) 公司

最后更新日期：2025 年 10 月