

ESD204 4チャンネル、低容量のサージおよびESD保護ダイオード

1 特長

- IEC 61000-4-2 レベル4 ESD保護
 - 接触放電 $\pm 30\text{kV}$
 - 空気ギャップ放電 $\pm 30\text{kV}$
- IEC 61000-4-4 EFT保護
 - 80A (5/50ns)
- IEC 61000-4-5 サージ保護
 - 5.5A (8/20 μs)
 - 低いサージ・クランピング電圧
5.5A I_{PP} で8.5V
- IO容量
 - 0.55pF (標準値)
- HDMI 2.0準拠
- DC降伏電圧: 5.5V (最小値)
- 非常に低いリーク電流: 10nA (最大値)
- 最大6Gbpsの高速インターフェイスをサポート
- 工業用温度範囲: $-40^{\circ}\text{C} \sim +125^{\circ}\text{C}$
- 使いやすいフロースルー配線パッケージ

2 アプリケーション

- 最終製品
 - IPネットワーク・カメラ
 - DVRおよびNVR
 - イーサネット・スイッチおよびルータ
 - ラップトップおよびデスクトップPC
 - セットトップ・ボックス
 - TVおよびモニタ
 - モバイルおよびタブレット
- インターフェイス
 - HDMI 2.0
 - HDMI 1.4
 - USB 3.0
 - DisplayPort 1.3
 - PCI Express 3.0
 - イーサネット10/100/1000Mbps

3 概要

ESD204は双方向のTVS ESD保護ダイオード・アレイで、最大5.5A (8/20 μs)のHDMIおよびUSBサージ保護に対応しています。ESD204は、IEC 61000-4-2国際規格で規定されている最大レベル(レベル4)のESD耐性を備えています。

ESD204は、低いクランピングおよび高い差動帯域幅により、高速の信号をクリーンに通過させながら、下流のデバイスを堅牢に保護できます。このデバイスはチャンネルごとの容量が0.55pFと低く、HDMI 2.0、HDMI 1.4、USB 3.0、イーサネット1Gなど、最高6Gbpsの高速インターフェイスを保護するために適しています。動的抵抗とクランピング電圧が低いため、過渡事象に対してシステム・レベルの保護が保証されます。

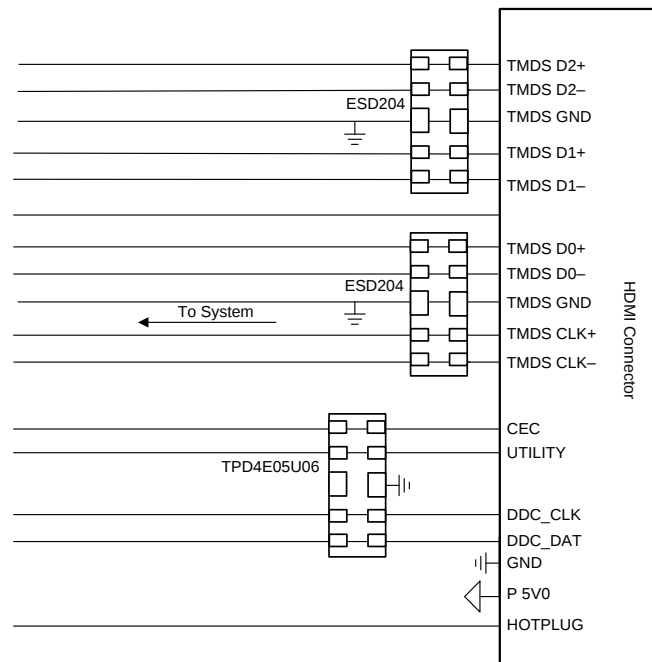
ESD204は、業界標準のUSON-10 (DQA)パッケージで供給されます。このパッケージはフロースルー配線と0.5mmピン・ピッチを採用しているため、実装が容易で、設計時間を短縮できます。

製品情報⁽¹⁾

型番	パッケージ	本体サイズ(公称)
ESD204	USON (10)	2.50mm×1.00mm

(1) 提供されているすべてのパッケージについては、データシートの末尾にある注文情報を参照してください。

代表的なアプリケーションの回路図



目次

1	特長	1	7.3	Feature Description	8
2	アプリケーション	1	7.4	Device Functional Modes	8
3	概要	1	8	Application and Implementation	8
4	改訂履歴	2	8.1	Application Information	8
5	Pin Configuration and Functions	3	8.2	Typical Application	9
6	Specifications	4	9	Power Supply Recommendations	10
6.1	Absolute Maximum Ratings	4	10	Layout	10
6.2	ESD Ratings - JEDEC Specifications	4	10.1	Layout Guidelines	10
6.3	ESD Ratings - IEC Specifications	4	10.2	Layout Examples	11
6.4	Recommended Operating Conditions	4	11	デバイスおよびドキュメントのサポート	12
6.5	Thermal Information	4	11.1	ドキュメントの更新通知を受け取る方法	12
6.6	Electrical Characteristics	5	11.2	コミュニティ・リソース	12
6.7	Typical Characteristics	6	11.3	商標	12
7	Detailed Description	8	11.4	静電気放電に関する注意事項	12
7.1	Overview	8	11.5	Glossary	12
7.2	Functional Block Diagram	8	12	メカニカル、パッケージ、および注文情報	12

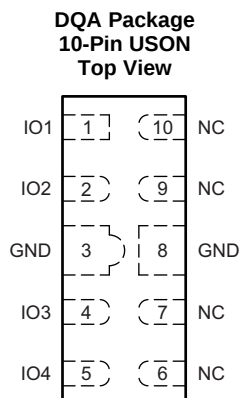
4 改訂履歴

2018年2月発行のものから更新

Page

•	事前情報から量産データに変更	1
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5 Pin Configuration and Functions



Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
GND	3	Ground	Ground. Connect to ground
GND	8		
IO1	1	I/O	ESD protected channel. Connect to the line being protected.
IO2	2		
IO3	4		
IO4	5		
NC	6	NC	Not connected internally; Can be connected to line being protected for optional flow-through routing. Can also be left floating or grounded
NC	7		
NC	9		
NC	10		

6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Electrical Fast Transient	IEC 61000-4-4 Peak Current at 25°C		80	A
Peak Pulse	IEC 61000-4-5 Surge (t_p 8/20 μ s) Peak Power at 25°C		50	W
	IEC 61000-4-5 Surge (t_p 8/20 μ s) Peak Current at 25°C		5.5	A
T_A	Operating free-air temperature	-40	125	°C
T_{stg}	Storage temperature	-65	155	°C

- (1) Stresses beyond those listed under *Absolute Maximum Rating* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Condition*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings -JEDEC Specifications

		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 JESD22-C101, 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

		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	-3.6		3.6	V
T_A	Operating Free Air Temperature	-40		125	°C

6.5 Thermal Information

THERMAL METRIC ⁽¹⁾		ESD204	UNIT
		DQA (USON)	
		10 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	262.1	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	184.6	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	138.2	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	41.8	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	137.8	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	

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

6.6 Electrical Characteristics

At $T_A = 25^\circ\text{C}$ unless otherwise noted

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{RWM}	Reverse stand-off voltage	$I_{IO} < 10\text{ nA}$, across operating temperature range	-3.6		3.6	V
V_{BRF}	Positive Breakdown Voltage, Each IO Pin to GND ⁽¹⁾	$I_{IO} = 1\text{ mA}$	5		7.9	V
V_{BRR}	Negative Breakdown Voltage, Each IO Pin to GND ⁽¹⁾	$I_{IO} = -1\text{ mA}$,	-7.9		-5	V
V_{HOLD}	Positive Holding Voltage, Each IO pin to GND ⁽²⁾	$I_{IO} = 1\text{ mA}$		6.2		V
$V_{HOLD-NEG}$	Negative Holding Voltage, Each IO pin to GND ⁽²⁾	$I_{IO} = -1\text{ mA}$		-6.2		V
V_{CLAMP}	Clamping voltage	Surge $I_{PP} = 5.5\text{ A}$, Each IO pin to GND, GND to Each IO pin, $t_p=8/20\text{ }\mu\text{s}$		8.5		V
		TLP $I_{PP} = 5\text{ A}$, Each IO pin to GND, GND to Each IO pin, $t_p=10/100\text{ ns}$		8.2		V
		TLP $I_{PP} = 16\text{ A}$, Each IO pin to GND, GND to Each IO pin, $t_p=10/100\text{ ns}$		11.5		V
R_{DYN}	Dynamic resistance	Each IO Pin to GND, TLP $t_p=10/100\text{ ns}$		0.3		Ω
		GND to Each IO Pin, TLP $t_p=10/100\text{ ns}$		0.3		
C_{LINE}	Line capacitance, any IO to GND	$V_{IO} = 0\text{ V}$, $V_{p-p} = 30\text{ mV}$, $f = 1\text{ MHz}$		0.55	0.65	pF
ΔC_{LINE}	Variation of line capacitance	$C_{LINE1} - C_{LINE2}$, $V_{IO} = 0\text{ V}$, $V_{p-p} = 30\text{ mV}$, $f = 1\text{ MHz}$		0.02	0.07	pF
C_{CROSS}	Line-to-line capacitance	$V_{IO} = 0\text{ V}$, $V_{rms} = 30\text{ mV}$, $f = 1\text{ MHz}$		0.25	0.35	pF

(1) V_{BRF} and V_{BRR} are defined as the voltage obtained at 1 mA when sweeping the voltage up, before the device latches into the snapback state

(2) V_{HOLD} is defined as the voltage when 1 mA is applied, after the device has successfully latched into the snapback state.

6.7 Typical Characteristics

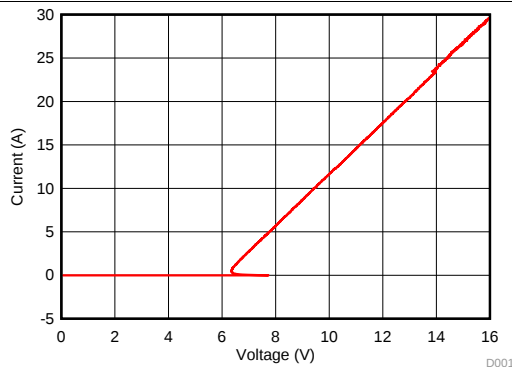


图 1. Positive TLP Curve, IO pin to GND ($t_p = 100$ ns)

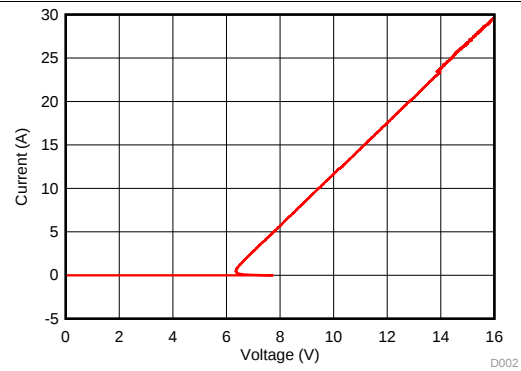


图 2. Negative TLP Curve, GND to IO pin ($t_p=100$ ns; Plotted as Positive TLP Curve from GND to IO pin)

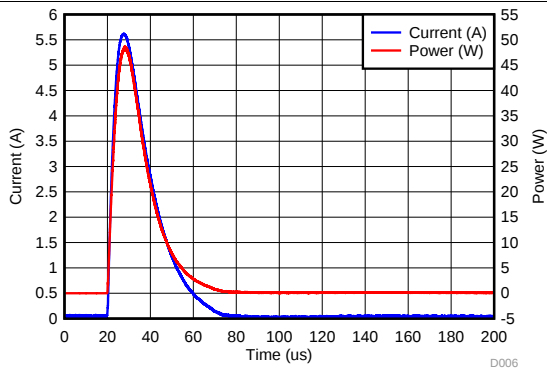


图 3. Surge Curve ($t_p = 8/20$ μ s), any IO pin to GND

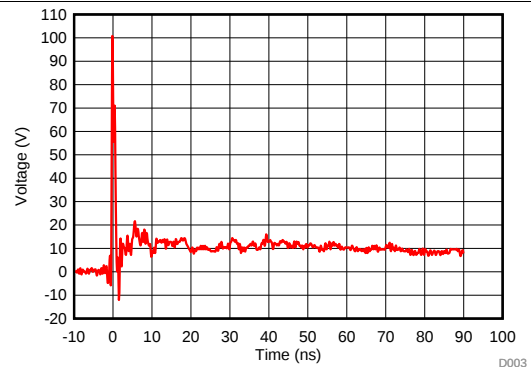


图 4. 8-kV IEC 61000-4-2 Clamping Voltage Waveform, IO pin to GND

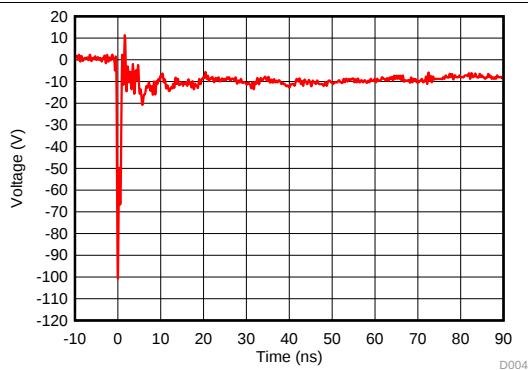


图 5. -8-kV IEC 61000-4-2 Clamping Voltage Waveform, GND pin to IO

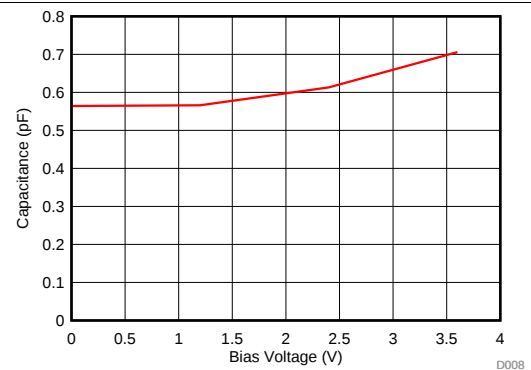


图 6. Capacitance vs Bias Voltage

Typical Characteristics (continued)

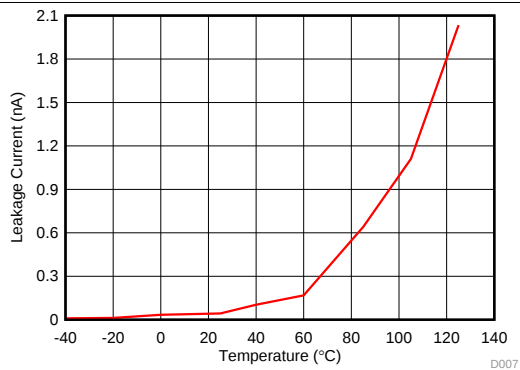


Fig. 7. Leakage Current vs Temperature, IO pin to GND at 3.6 V Bias

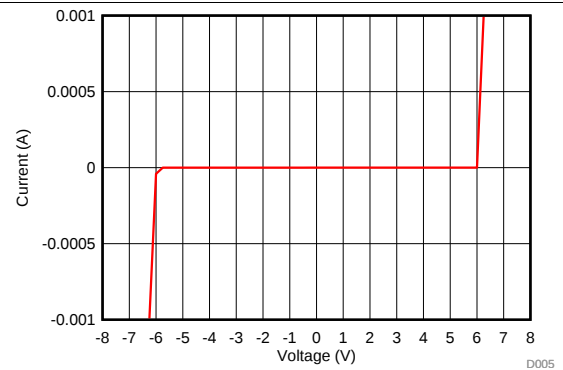


Fig. 8. DC Voltage Sweep I-V Curve, IO pin to GND

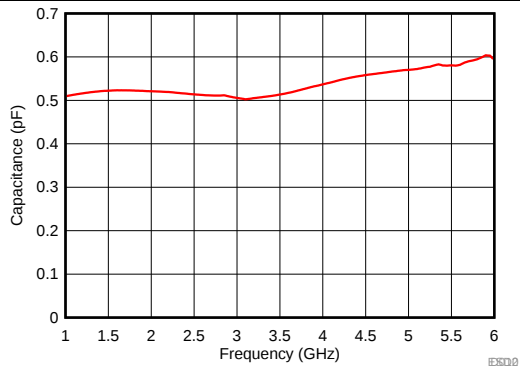


Fig. 9. Capacitance vs Frequency

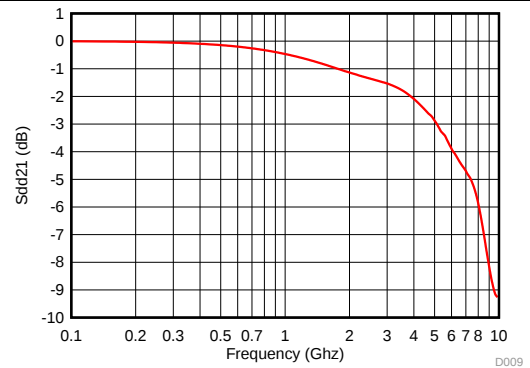


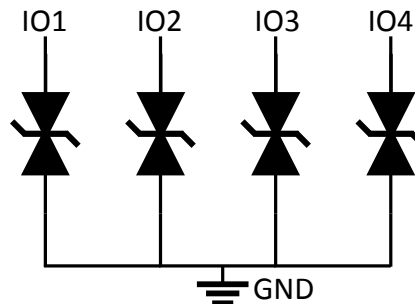
Fig. 10. Differential Insertion Loss

7 Detailed Description

7.1 Overview

The ESD204 is a bidirectional ESD Protection Diode with ultra-low capacitance. This device can dissipate ESD strikes up to 30kV (Contact/Air) level specified by the IEC 61000-4-2 International Standard. Additionally, ESD204 dissipates 5.5 A of surge current (8/20 μ s waveform) per IEC 61000-4-5 standard. The ultra-low capacitance makes this device capable of supporting any super high-speed signal pins.

7.2 Functional Block Diagram



7.3 Feature Description

ESD204 provides ESD protection up to ± 30 -kV contact and ± 30 -kV air gap per IEC61000-4-2 standard. During an ESD event, ESD diode connected to the IO pin turns on and diverts the ESD current to ground. Additionally, ESD204 also provides protection against IEC 61000-4-5 surge currents up to 5.5 A (8/20 μ s waveform) and up to 80 A per IEC 61000-4-4 electrical fast transient (EFT) standard. Please see the [Application Note](#) on IEC61000-4-x standard based tests. ESD204 provides a very low clamping voltage of 11.5 V at 16 A 100 ns TLP current and 8.5 V at 5.5 A surge current (8/20 μ s waveform).

The capacitance between each I/O pin to ground is 0.55 pF (typical) and 0.65 pF (maximum). This device supports data rates up to 6 Gbps. The DC breakdown voltage of each I/O pin is a minimum of ± 5 V. This ensures that sensitive equipment is protected from surges above the reverse standoff voltage of ± 3.6 V. The I/O pins feature an ultra-low leakage current of 10 nA (maximum) with a bias of ± 3.6 V.

7.4 Device Functional Modes

The ESD204 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 (contact/air) can be directed to ground via the internal diode network. When the voltages on the protected line fall below the trigger levels of ESD204 (usually within 10s of nano-seconds) the device reverts to passive.

8 Application and Implementation

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. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

The ESD204 is a diode type TVS array which is used to provide a path to ground for dissipating ESD events on high-speed signal lines between an 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

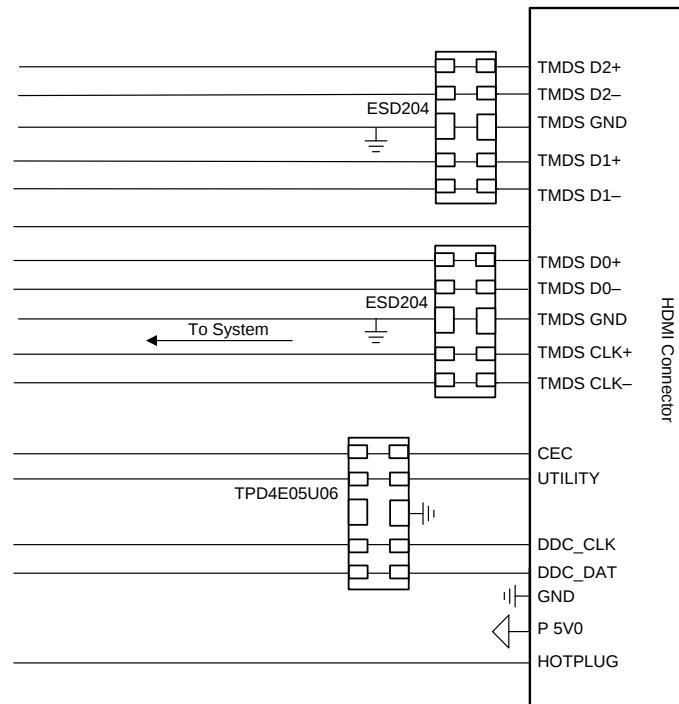


图 11. ESD204 Protecting the HDMI Interface

8.2.1 Design Requirements

In this design example, two ESD204 devices and one TPD4E05U06 device are used to protect an HDMI 2.0 interface. For HDMI 2.0 application design parameters listed in 表 1 are known.

表 1. Design Parameters

DESIGN PARAMETER	VALUE
Signal range on high speed differential data lines	0 to 3.6 V
Operating frequency of high speed data lines	3 GHz (First Harmonic)
Signal range on control lines (CEC, UTILITY, DDC_CLK and DDC_DAT)	0 to 5 V

8.2.2 Detailed Design Procedure

8.2.2.1 Signal Range

ESD204 supports signal ranges between -3.6 V and 3.6 V , which supports the high-speed lines on the HDMI 2.0 application. The TPD4E05U06 supports signal ranges between 0 V and 5.5 V , which supports the HDMI control lines.

8.2.2.2 Operating Frequency

The ESD204 has a 0.55 pF (typical) capacitance, which supports the HDMI 2.0 rate of 6 Gbps . The TPD4E05U06 has a typical capacitance of 0.5 pF , which easily support the control lines. The ESD204 has 4 identical protection channels for the differential HDMI high-speed signal lines. The symmetrical pin out of the device with a ground pin between the two differential signal pins makes it suitable for this application.

8.2.3 Application Curves

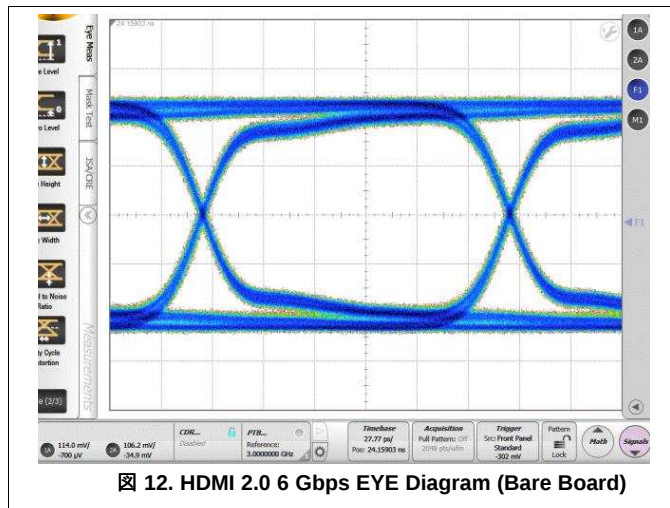


FIG 12. HDMI 2.0 6 Gbps EYE Diagram (Bare Board)

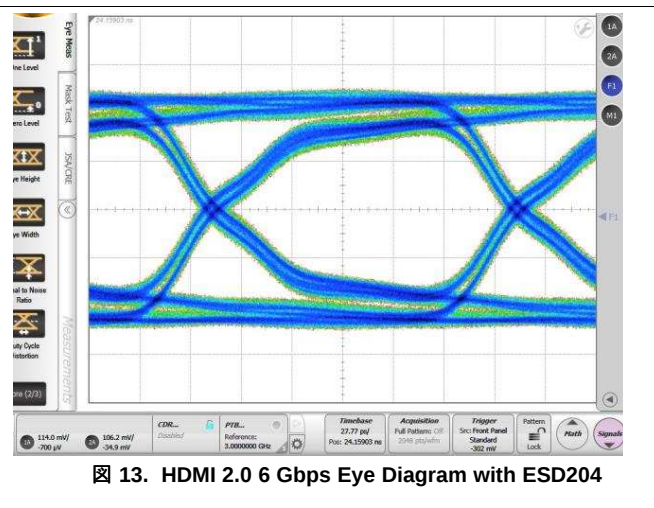


FIG 13. HDMI 2.0 6 Gbps Eye Diagram with ESD204

9 Power Supply Recommendations

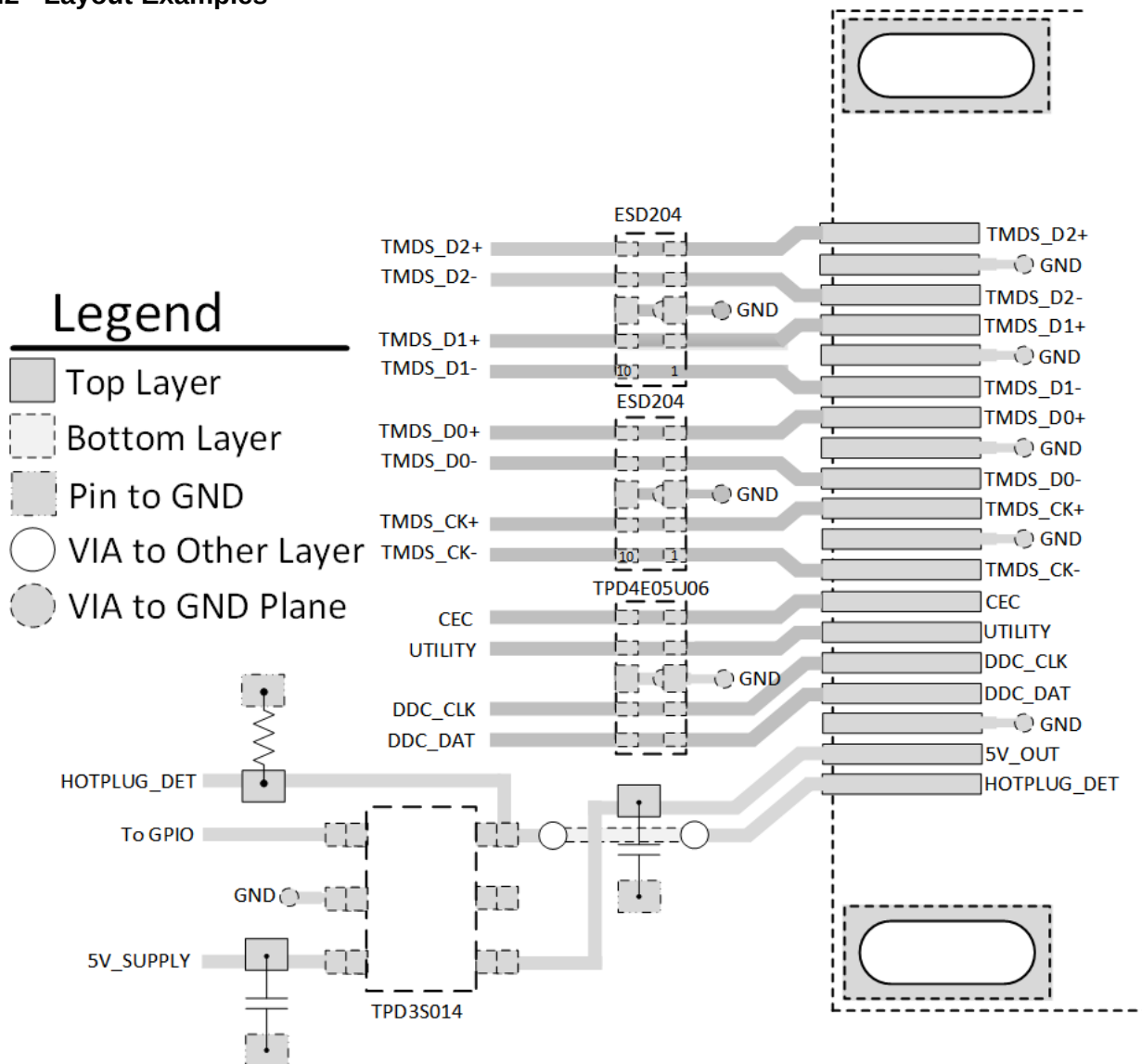
This device is a passive ESD device so there is no need to power it. Take care not to violate the recommended I/O specification (-3.6 V to 3.6 V) to ensure the device functions properly.

10 Layout

10.1 Layout Guidelines

- The optimum placement 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.

10.2 Layout Examples



14. HDMI Type-A Transmitter Port Layout

11 デバイスおよびドキュメントのサポート

11.1 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.comのデバイス製品フォルダを開いてください。右上の隅にある「通知を受け取る」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

11.2 コミュニティ・リソース

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11.4 静電気放電に関する注意事項



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静電気放電はわずかな性能の低下から完全なデバイスの故障に至るまで、様々な損傷を与えます。高精度の集積回路は、損傷に対して敏感であり、極めてわずかなパラメータの変化により、デバイスに規定された仕様に適合しなくなる場合があります。

11.5 Glossary

SLYZ022 — *TI Glossary*.

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

12 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

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)
ESD204DQAR	Active	Production	USON (DQA) 10	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(CE5, CEG) CEY
ESD204DQAR.B	Active	Production	USON (DQA) 10	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(CE5, CEG) CEY
ESD204DQARG4.B	Active	Production	USON (DQA) 10	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	CE5

(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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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
ESD204DQAR	USON	DQA	10	3000	180.0	9.5	1.18	2.68	0.72	4.0	8.0	Q1
ESD204DQAR	USON	DQA	10	3000	180.0	8.4	1.2	2.7	0.63	4.0	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)
ESD204DQAR	USON	DQA	10	3000	189.0	185.0	36.0
ESD204DQAR	USON	DQA	10	3000	210.0	185.0	35.0

GENERIC PACKAGE VIEW

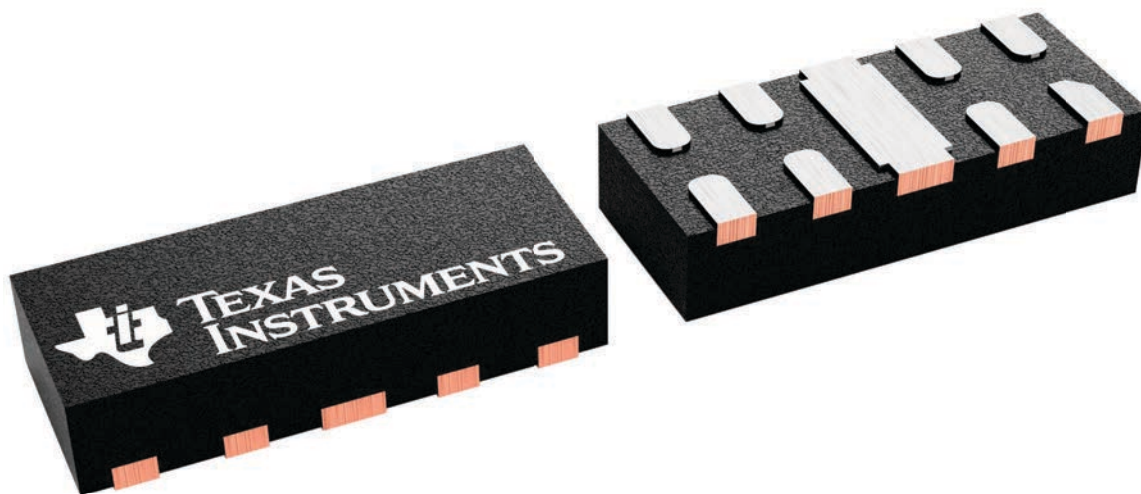
DQA 10

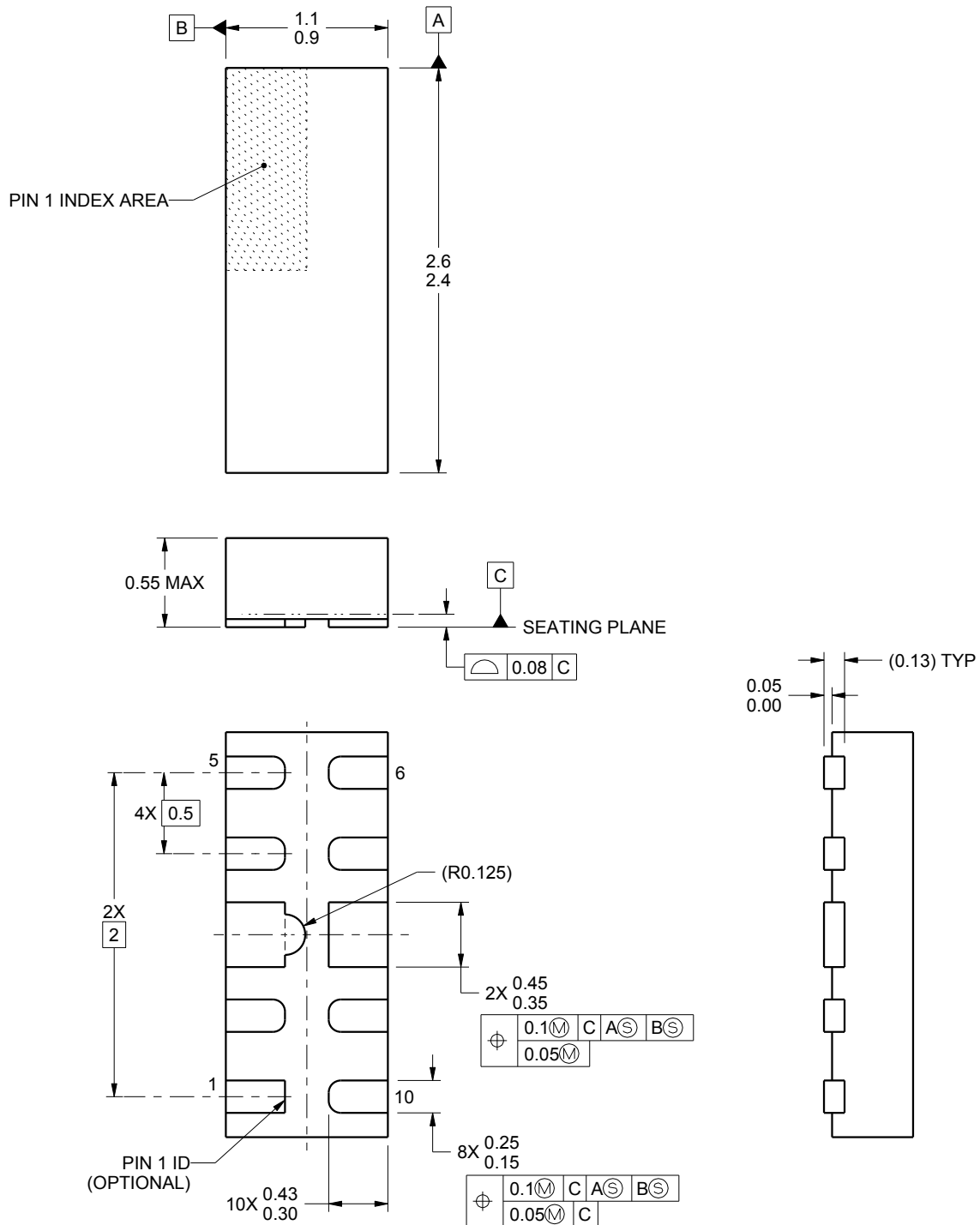
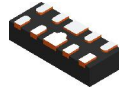
USON - 0.55 mm max height

1 x 2.5, 0.5 mm pitch

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.





4220328/A 12/2015

NOTES:

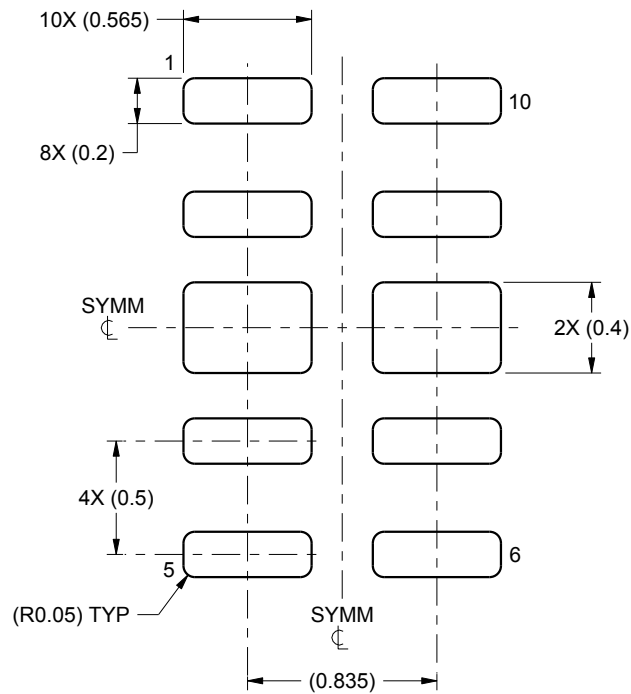
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

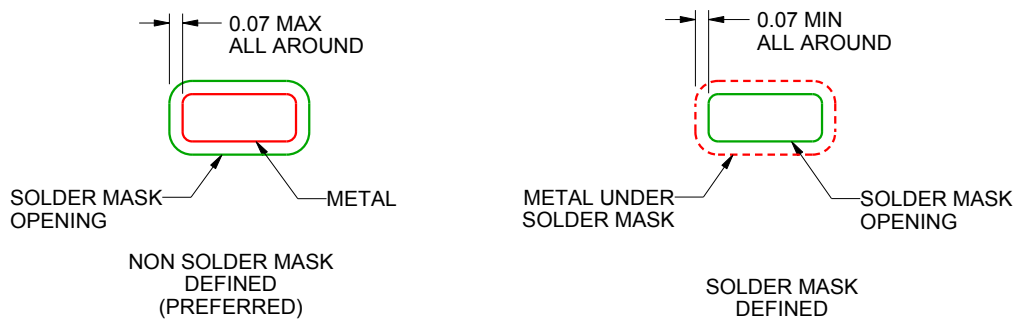
DQA0010A

USON - 0.55 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE
SCALE:30X



SOLDER MASK DETAILS

4220328/A 12/2015

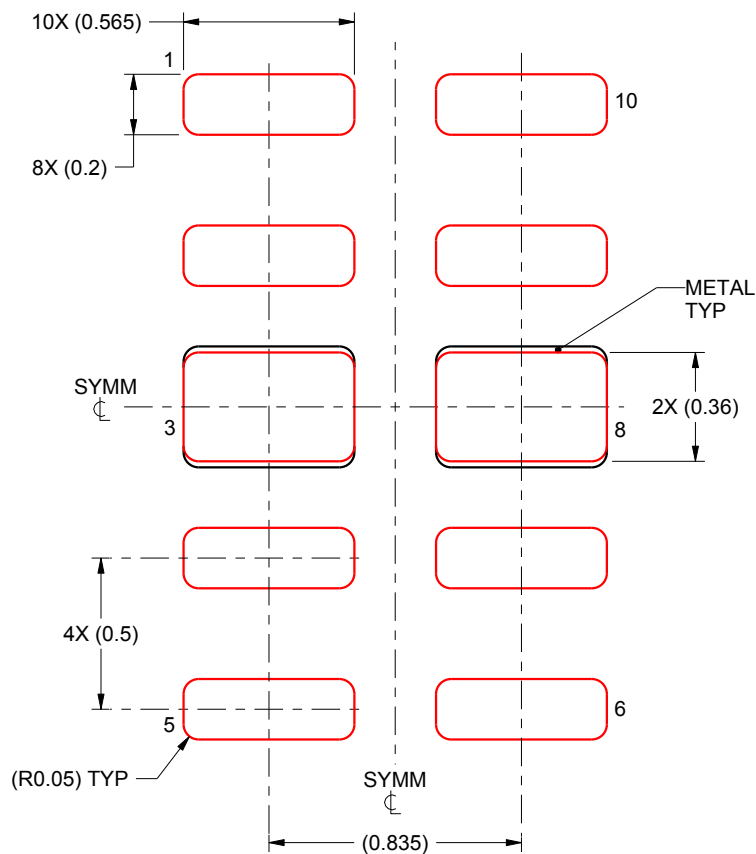
NOTES: (continued)

3. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).

DQA0010A

USON - 0.55 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



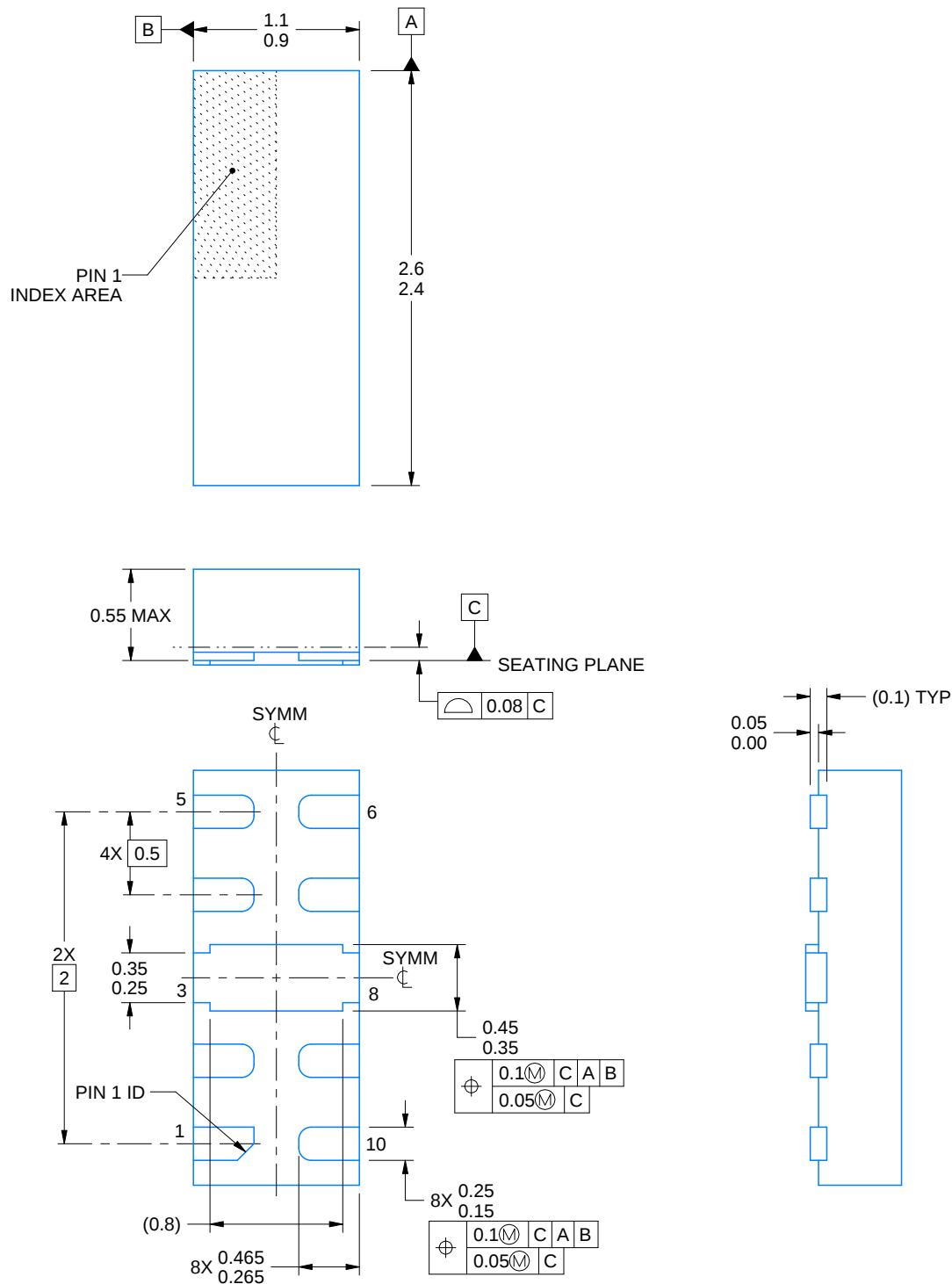
SOLDER PASTE EXAMPLE BASED ON 0.1 mm THICK STENCIL

EXPOSED PADS 3 & 8:
90% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:40X

4220328/A 12/2015

NOTES: (continued)

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



4230307/A 12/2023

NOTES:

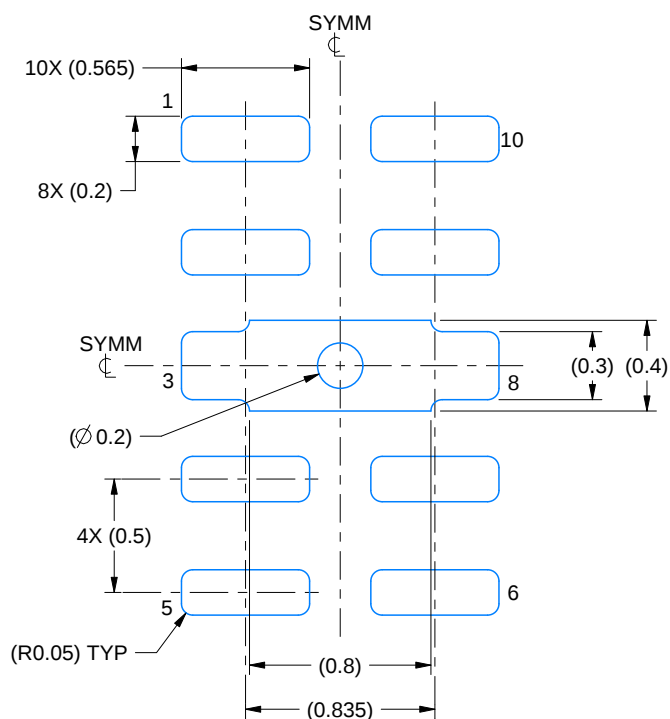
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

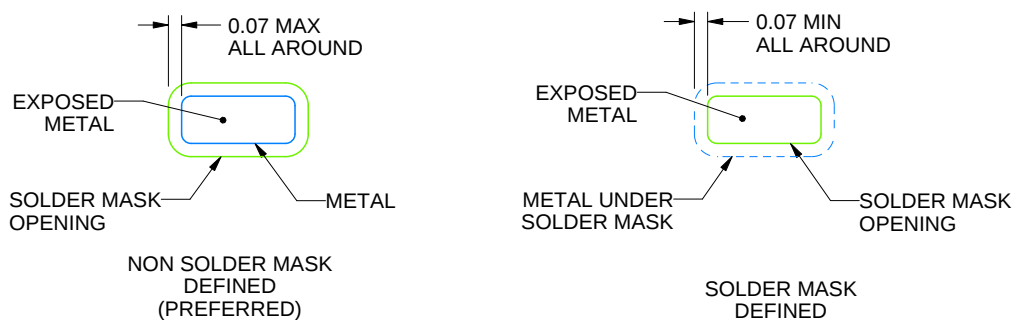
DQA0010B

USON - 0.55 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:30X



SOLDER MASK DETAILS

4230307/A 12/2023

NOTES: (continued)

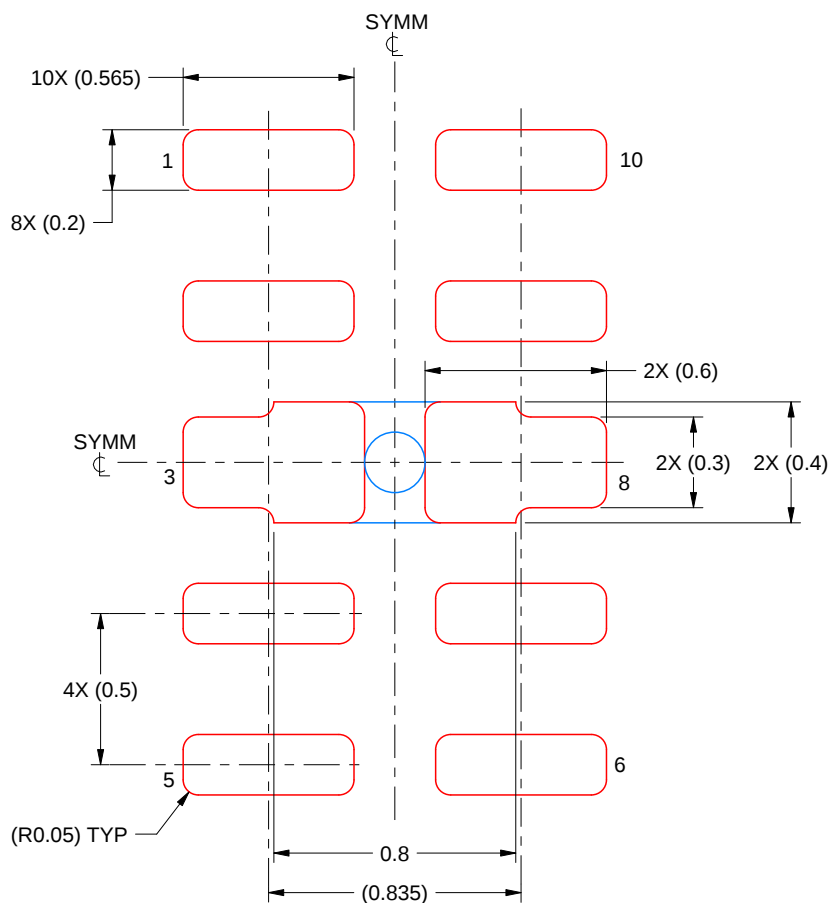
3. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).

EXAMPLE STENCIL DESIGN

DQA0010B

USON - 0.55 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:40X

4230307/A 12/2023

NOTES: (continued)

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

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