TMUXHS4212双通道差分 2:1 多路复用器/1:2 多路信号分离器

1 特性

- 提供双向 2:1 多路复用器/1:2 多路信号分离器
- 支持 USB 3.2，速率高达 10Gbps (Gen 2.0)；支持 PCI Express，速率高达 16Gbps (Gen 4.0)
- 还支持 SATA、SAS、MIPI DSI/CSI、FPD-Link III、LVDS、SFI 和以太网接口
- 13GHz 的 -3dB 差分带宽
- 动态特性
  - 插入损耗 = –1.3/-1.8dB（5/8GHz 时）
  - 回波损耗 = –13/-12dB（5/8GHz 时）
  - 关断隔离 = –22/-20dB（5/8GHz 时）
- 较低的差分对内延迟差/差分对间延迟差：8/20ps（最大值）
- 自适应共模电压跟踪
- 支持高达 0V 至 1.8V 的共模电压
- 单电源电压 V_{CC} 为 3.3 V
- 超低有效 (180µA) 和待机功耗 (<2µA)
- –40° 至 105°C 的工业温度选项
- 采用 2.5mm x 4.5mm QFN 封装

2 应用

- PC 和笔记本电脑
- 智能手机、平板电脑和电视
- 游戏机及家庭影院和娱乐
- 数据中心和企业级计算
- 医疗 应用
- 测试和测量
- 工厂自动化和控制
- 航天和国防
- 电子销售终端 (EPOS)
- 无线基础设施

3 说明

TMUXHS4212 是一款采用多路复用器或多路信号分离器配置的高速双向无源开关。它适用于许多 应用 包括 USB Type-C®和 PCI Express。TMUXHS4212 是一款通用模拟差分无源多路复用器或多路信号分离器，适用于许多高速差分接口，其数据速率高达 16Gbps。该器件可用于电气通道具有信号完整性裕量的更高数据速率。TMUXHS4212 支持差分信号，其共模电压范围 (CMV) 为 0 至 1.8V，差分振幅高达 1800mVpp。自适应 CMV 跟踪可确保通过器件的通道在整个共模电压范围内保持不变。

TMUXHS4212 的动态特性允许进行高速开关，使信号眼图具有最小的衰减，并且几乎不会增加抖动。该器件的芯片设计经过优化，可在较高信号频谱上实现出色的频率响应。其芯片信号布线和开关网络相匹配，以实现最佳的差分对内延迟差性能。

TMUXHS4212 具有扩展的工业温度范围，适合许多严苛 应用， 包括工业和高可靠性用例。

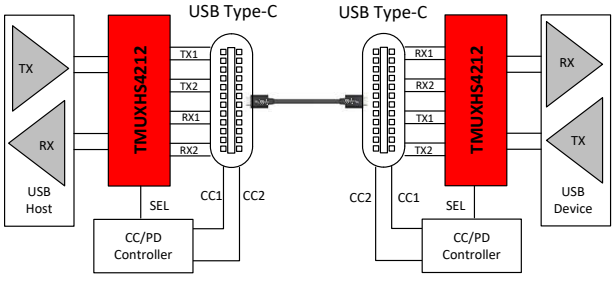
器件信息(1)

器件型号	封装	封装尺寸（标称值）
TMUXHS4212	VQFN (20)	2.50mm × 4.50mm × 0.5mm 间距
TMUXHS4212I		

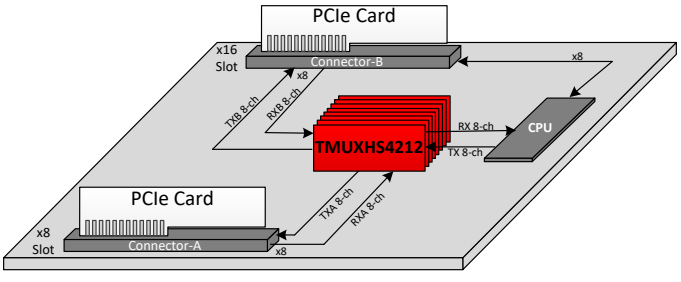
(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

ADVANCE INFORMATION

应用用例



USB-C DFP Port with USB 3.2　　USB-C UFP Port with USB 3.2



PCIe 3.0/4.0 Lane Switching

目录

ADVANCE INFORMATION

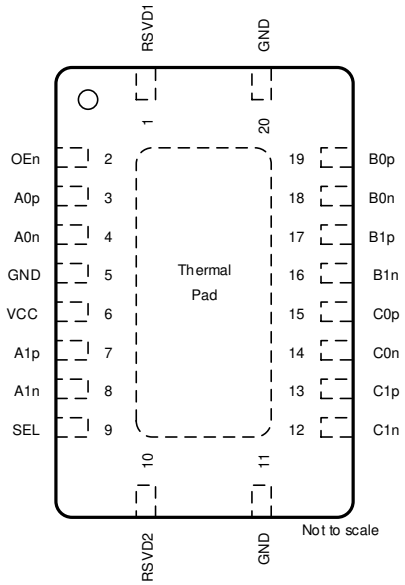
4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

日期	修订版本	说明
2020 年 1 月	*	初始发行版

5 Pin Configuration and Functions

RKS Package
20-Pin VQFN
Top View



Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
A0n	4	I/O	Port A, channel 0, high-speed negative signal
A0p	3	I/O	Port A, channel 0, high-speed positive signal
A1n	8	I/O	Port A, channel 1, high-speed negative signal
A1p	7	I/O	Port A, channel 1, high-speed positive signal
B0n	18	I/O	Port B, channel 0, high-speed negative signal (connector side)
B0p	19	I/O	Port B, channel 0, high-speed positive signal (connector side)
B1n	16	I/O	Port B, channel 1, high-speed negative signal
B1p	17	I/O	Port B, channel 1, high-speed positive signal
C0n	14	I/O	Port C, channel 0, high-speed negative signal
C0p	15	I/O	Port C, channel 0, high-speed positive signal
C1n	12	I/O	Port C, channel 1, high-speed negative signal
C1p	13	I/O	Port C, channel 1, high-speed positive signal
GND	5, 11, 20	G	Ground
OEn	2	I	Active-low chip enable. The pin can be connected to GND if always on functional behaviour is desired. L: Normal operation, H: Shutdown. If always ON behavior of the device is desired the pin can be permanently connected to GND.
RSVD1	1	NA	Reserved pins. Connect both pins to V_{CC} or leave both of them open (no connect).
RSVD2	10	NA	
SEL	9	I	Port select pin. L: Port A to Port B, H: Port A to Port C
V_{CC}	6	P	3.3 V power

ADVANCE INFORMATION

6 Specifications

6.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
$V_{CC-ABSMAX}$	Supply voltage		–0.5	4	V
$V_{HS-ABSMAX}$	Voltage	Differential I/O	–0.5	2.4	V
$V_{CTR-ABSMAX}$	Voltage	Control pins	–0.5	V_{CC}+0.4	V
T_{STG}	Storage temperature		–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. Theseare stress ratings only, which do not imply functional operation of the device at these or anyother conditions beyond those indicated under *Recommended OperatingConditions*. Exposure to absolute-maximum-rated conditions for extended periods mayaffect device reliability.

6.2 ESD Ratings

			VALUE	UNIT
V_{ESD}	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±500	

(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 Recommended Operating Conditions

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

			MIN	TYP	MAX	UNIT
V_{CC}	Supply voltage		3.0	3.3	3.6	V
$V_{CC-RAMP}$	Supply voltage ramp time		0.1		100	ms
V_{IH}	Input high voltage	SEL, OEn pins	$0.75V_{CC}$			V
V_{IL}	Input low voltage	SEL, OEn pins			$0.25V_{CC}$	V
V_{DIFF}	High-speed signal pins differential voltage		0		1.8	V_{pp}
V_{CM}	High speed signal pins common mode voltage		0		1.8	V
T_A	Operating free-air/ambient temperature	TMUXHS4212	0		70	°C
		TMUXHS4212I	-40		105	°C

6.4 Thermal Information

THERMAL METRIC(1)		TMUXHS4212 RKS (WQFN) 20 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance - High K	53.0	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	52.3	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	27.1	°C/W
ψ_{JT}	Junction-to-top characterization parameter	2.9	°C/W
ψ_{JB}	Junction-to-board characterization parameter	26.9	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	11.1	°C/W

(1) For more information about traditional and new thermalmetrics, see the Semiconductor and IC Package ThermalMetrics application report.

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6.5 Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{CC}	Device active current	OEn = 0; 0 V ≤ V_{CM} ≤ 1.8		180	250	µA
I_{STDN}	Device shutdown current	OEn = V_{CC}		2	5	µA
C_{ON}	Output ON capacitance to GND	OEn = 0		0.4		pF
C_{OFF}	Output OFF capacitance to GND	OEn = V_{CC}		0.6		pF
R_{ON}	Output ON resistance	0 V ≤ V_{CM} ≤ 1.8 V; I_O = –8 mA		5	9	Ω
ΔR_{ON}	On-resistance match between pairs for the same channel at same V_{CM}, V_{CC} and T_A				0.5	Ω
R_{FLAT_ON}	On-resistance flatness R_{ON}(MAX) – R_{ON}(MIN) over V_{CM} range for the same channel at same V_{CC} and T_A				0.75	Ω
$I_{IH,CTRL}$	Input high current, control pins (SEL, OEn)	V_{IN} = 3.6 V			2	µA
$I_{IL,CTRL}$	Input low current, control pins (SEL, OEn)	V_{IN} = 0 V			1	µA
$R_{CM,HS}$	Common mode resistance to ground on Ax pins	Each pin to GND		1.0	1.6	MΩ
$I_{IH,HS,SEL}$	Input high current, high-speed pins [Ax/Bx/Cx][p/n]	V_{IN} = 1.8 V for selected port, A and B with SEL = 0, and A and C with SEL = V_{CC}			5	µA
$I_{IH,HS,NSEL}$	Input high current, high-speed pins [Ax/Bx/Cx][p/n]	V_{IN} = 1.8 V for non-selected port, C with SEL = 0, and B with SEL = V_{CC} (1)			150	µA
$I_{HIZ,HS}$	Leakage current through turned off switch between Ax[p/n] and [B/C]x[p/n]	OEn = VCC; Ax[p/n] = 1.8 V, [B/C]x[p/n] = 0 V and Ax[p/n] = 0 V, [B/C]x[p/n] = 1.8 V			2	µA
$R_{A,p2n}$	DC Impedance between p and n for Ax pins	OEn = 0 and VCC		20		KΩ

(1) There is a 20-kΩ pull-down in non-selected port.

6.6 High-Speed Performance Parameters

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
I_L	Differential insertion loss	f = 10 MHz		-0.4		dB
		f = 2.5 GHz		-0.8		
		f = 4 GHz		-1.1		
		f = 5 GHz		-1.3		
		f = 8 GHz		-1.8		
		f = 10 GHz		-2.1		
BW	–3-dB bandwidth			13		GHz
R_L	Differential return loss	f = 10 MHz		-28		dB
		f = 2.5 GHz		-16		
		f = 4 GHz		-13		
		f = 5 GHz		-13		
		f = 8 GHz		-12		
		f = 10 GHz		-12		
O_{IRR}	Differential OFF isolation	f = 10 MHz		-60		dB
		f = 2.5 GHz		-27		
		f = 4 GHz		-23		
		f = 5 GHz		-22		
		f = 8 GHz		-20		
		f = 10 GHz		-18		
X_{TALK}	Differential crosstalk	f = 10 MHz		-65		dB
		f = 2.5 GHz		-40		
		f = 4 GHz		-35		
		f = 5 GHz		-32		
		f = 8 GHz		-29		
		f = 10 GHz		-26		

ADVANCE INFORMATION

6.7 Switching Characteristics

PARAMETER			MIN	TYP	MAX	UNIT
t_{PD}	Switch propagation delay	f = 1 Ghz			70	ps
t_{SW_ON}	Switching time SEL-to-Switch ON	Biased from Bx/Cx side with CMV difference is <100mV, Bx/Cx pins at 90% of final value,		300	500	ns
t_{SW_OFF}	Switching time SEL-to-Switch OFF	Biased from Bx/Cx side with CMV difference is <100mV, Bx/Cx pins at 90% of final value,		300	500	ns
t_{SK_INTRA}	Intra-pair output skew between P and N pins for same channel	f = 1 Ghz		2	8	ps
t_{SK_INTER}	Inter-pair output skew between channels	f = 1 Ghz		5	20	ps

ADVANCE INFORMATION

6.8 Typical Characteristics

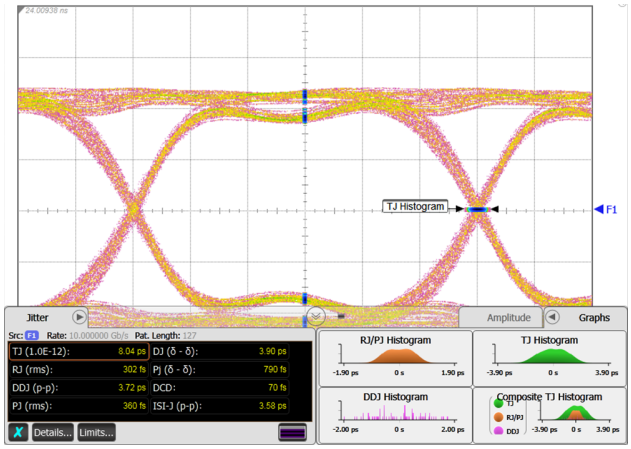


图 1. Jitter Decomposition of 10Gbps PRBS-7 signals through Calibration Traces in TI Evaluation Board

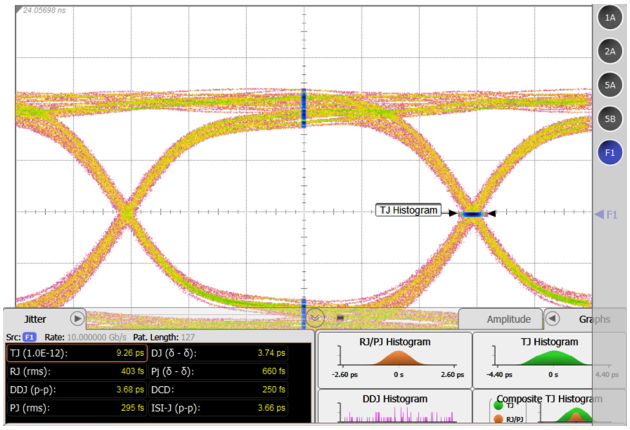


图 2. Jitter Decomposition of 10Gbps PRBS-7 signals through a Typical TMUXHS4212 channel in TI Evaluation Board

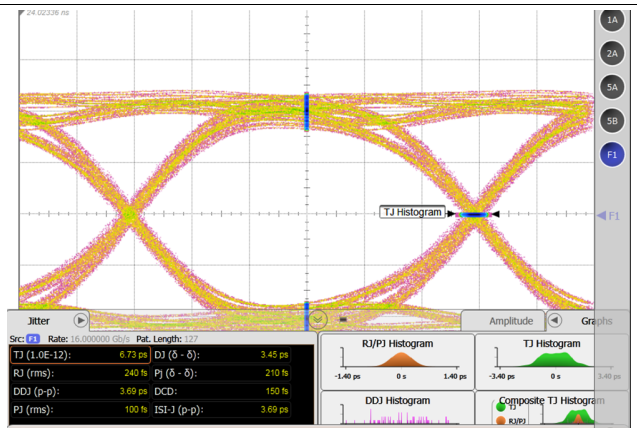


图 3. Jitter Decomposition of 16Gbps PRBS-7 signals through Calibration Traces in TI Evaluation Board

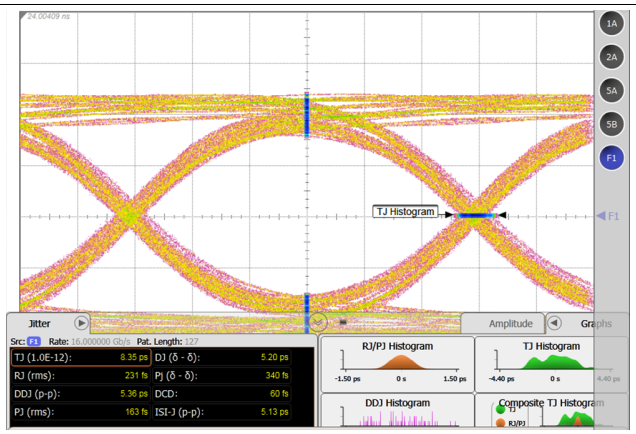


图 4. Jitter Decomposition of 16Gbps PRBS-7 signals through a Typical TMUXHS4212 channel in TI Evaluation Board

ADVANCE INFORMATION

7 Parameter Measurement Information

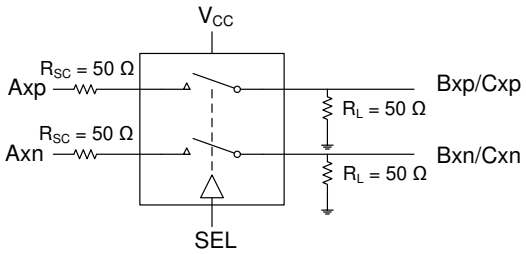


图 5. Test Setup

Parameter Measurement Information (接下页)

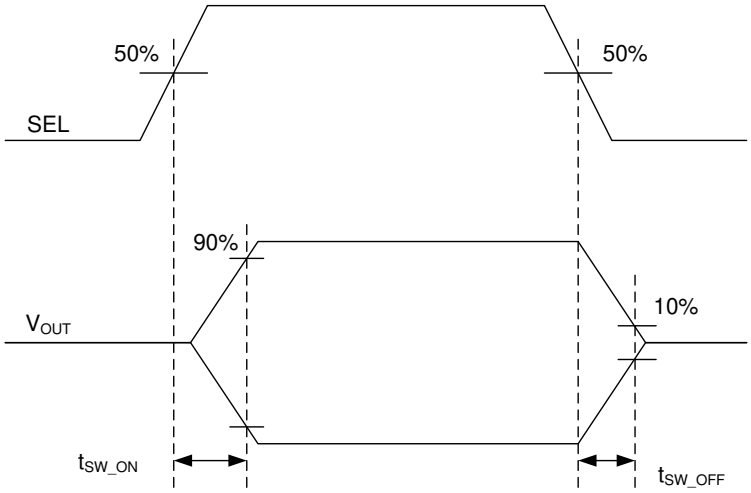


图 6. Switch On and Off Timing Diagram

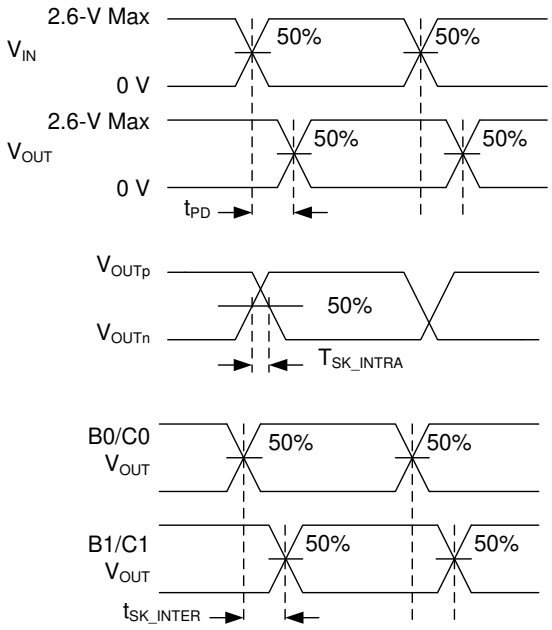


图 7. Timing Diagrams and Test Setup

ADVANCE INFORMATION

8 Detailed Description

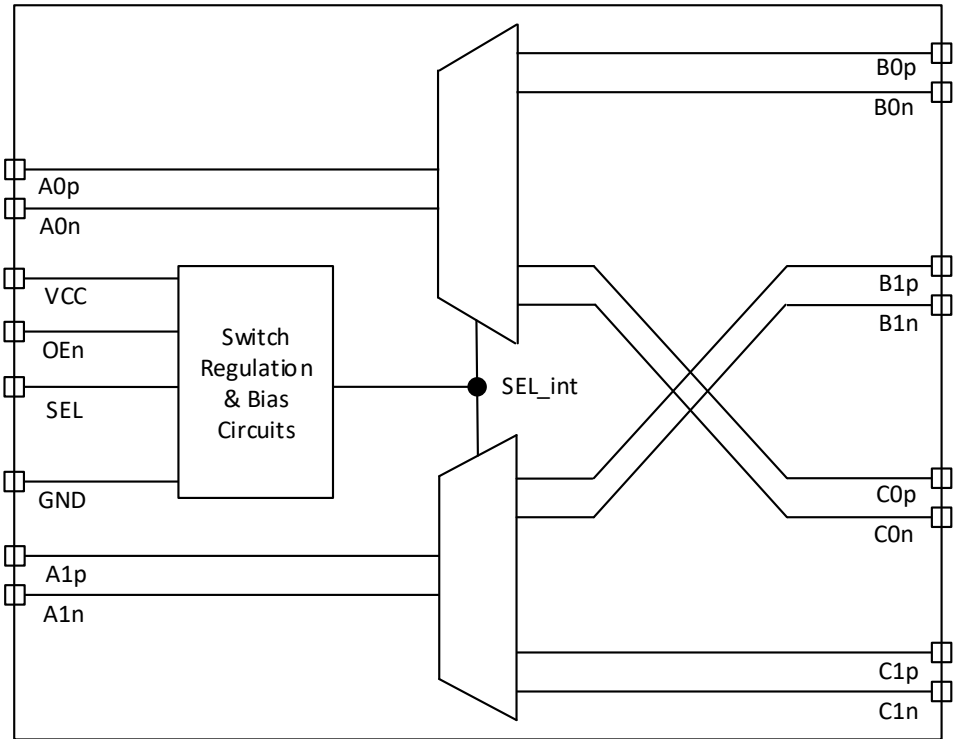
8.1 Overview

The TMUXHS4212 is a generic analog differential passive mux/demux that can work for any high-speed interface applications requiring a common mode voltage (CMV) range of 0 to 1.8 V and differential signaling with differential amplitude up to 1800 mVpp. It employs adaptive input voltage tracking that ensures the channel remains unchanged for the entire common mode voltage range. Two channels of the device can be used for electrical signals that have different CMV between them. Two channels can also be used such a way that the device switches two different interface signals with different data and electrical characteristics.

Excellent dynamic characteristics of the device allow high speed switching with minimum attenuation to the signal eye diagram with very little added jitter. While the device is recommended for the interfaces up to 16 Gbps, actual data rate where the device can be used highly depends on the electrical channels. For low loss channels where adequate margin is maintained the device can potentially be used for higher data rates.

The TMUXHS4212 is only recommended for differential signaling. However certain low voltage single ended signaling such as Mipi DPHY LP signaling can pass through the device. It is recommended to analyze the data line biasing of the device for such single ended use cases.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 Output Enable and Power Savings

The TMUXHS4212 has two power modes, active/normal operating mode and standby/shutdown mode. During standby mode, the device consumes very-little current to achieve ultra low power in systems where power saving is critical. To enter standby mode, the OEn control pin is pulled high through a resistor and must remain high. For active/normal operation, the OEn control pin should be pulled low to GND or dynamically controlled to switch between H or L.

The TMUXHS4212 consumes 180 μA of power when operational and has a shutdown mode exercisable by the OEn pin resulting < 2 μA.

Feature Description (接下页)

8.3.2 Data Line Biasing

The TMUXHS4212 has a weak pull-down of 1MΩ from A[0/1][p/n] pins to GND. While these resistors biases the device data channels to common mode voltage (CMV) of 0 V with very weak strength, it is recommended that the device is biased by a stronger impedance from either side of the device to a valid value in the range of 0 - 1.8 V. To avoid double biasing appropriate AC coupling capacitors should be ensured on either side of the device.

In certain use cases if both side of the TMUXHS4212 is ac coupled, it is recommended that appropriate CMV biasing is used for the device. 10 kΩ to GND or any other bias voltage in the range of 0 - 1.8 V for each A[0/1][p/n] pin will suffice for most use cases.

The high-speed data ports incorporate 20 kΩ pull-down resistors that are switched in when a port is not selected and switched out when the port is selected. For example when SEL = L, the C[0/1][p/n] pins have 20 kΩ resistors to GND. The feature ensures that unselected port is always biased to a known voltage for long term reliability of the device and the electrical channel.

The positive and negative terminals of data pins A[0/1] have a weak (20 kΩ) differential resistor for device switch regulation operation. This does not impact signal integrity or functionality of high speed differential signaling that typically has much stronger differential impedance (such as 100 Ω).

8.4 Device Functional Modes

表 1. Port Select Control Logic(1)

PORT A CHANNEL	PORT B OR PORT C CHANNEL CONNECTED TO PORT A CHANNEL	
	SEL = L	SEL = H
A0p	B0p	C0p
A0n	B0n	C0n
A1p	B1p	C1p
A1n	B1n	C1n

(1) The TMUXHS4212 can tolerate polarity inversions for all differential signals on Ports A, B, and C. In such flexible implementation one must ensure that the same polarity is maintained on Port A versus Ports B/C.

ADVANCE INFORMATION

9 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.

9.1 Application Information

The TMUXHS4212 is a generic 2-channel high-speed mux/demux type of switch that can be used for routing high-speed signals between two different locations on a circuit board. The TMUXHS4212 supports many high-speed data protocols provided the signals' differential amplitude is within <1800 mVpp and a common mode voltage is <1.8 V. The TMUXHS4212 can be used for many high speed interfaces including:

- Universal Serial Bus (USB) 3.2 Gen 1.0, 2.0
- USB Type-C
- Peripheral Component Interconnect Express (PCIe) Gen 1.0, 2.0, 3.0, 4.0
- Serial ATA (SATA/eSATA)
- Serial Attached SCSI (SAS)
- Display Port (DP) 1.4, 2.0
- Thunderbolt (TBT) 3.0
- Mipi Camera Serial Interface (CSI-2), Display Serial Interface (DSI)
- Low Voltage Differential Signalling (LVDS)
- Serdes Framer Interface (SFI)
- Ethenet Interfaces

The device's mux/demux selection pin SEL can easily be controlled by an available GPIO pin of a controller or hard tie to voltage level H or L as an application requires.

The TMUXHS4212 with adaptive voltage tracking technology can support applications where the common mode is different between the RX and TX pair. The switch paths of the TMUXHS4212 have internal weak pull-down resistors of 1 MΩ on the A port pins. While these resistors biases the device data channels to common mode voltage (CMV) of 0 V with a weak strength, it is recommended that the device is biased from either side of the device to a valid value in the range of 0 - 1.8 V. It is expected that the system/host controller and Device/End point common mode bias impedances are much stronger (smaller) than the TMUXHS4212 internal pull-down resistors; therefore, they are not impacted.

Many interfaces require AC coupling between the transmitter and receiver. The 0201 or 0402 capacitors are the preferred option to provide AC coupling. Avoid the 0603, 0805 size capacitors and C-packs. When placing AC coupling capacitors, symmetric placement is best. The capacitor value must be chosen according to the specific interface the device is being used. The value of the capacitor should match for the positive and negative signal pair. For many interfaces such as USB 3.2 and PCIe, the designer should place them along the TX pairs on the system board, which are usually routed on the top layer of the board. Depending upon the application and interface specifications, use the appropriate value for AC coupling capacitors.

The AC coupling capacitors have several placement options. Typical use cases warrant that the capacitors are placed on one side of the TMUXHS4212. In certain use cases, if both side of the TMUXHS4212 is ac coupled, it is recommended that appropriate CMV biasing is used for the device. 10 kΩ to GND or any other bias voltage in the range of 0 - 1.8 V for each A[0/1][p/n] pin suffice for most use cases.图 8 shows a few placement options. Some interfaces such as USB SS and PCIe recommends AC coupling capacitors on the TX signals before it goes to a connector. Option (a) features TX AC coupling capacitors on the connector side of the TMUXHS4212. Option (b) illustrates the capacitors on the host of the TMUXHS4212. Option (c) showcases where the TMUXHS4212 is ac coupled on both sides. Range for V_{BIAS} is 0 to 1.8 V.

ADVANCE INFORMATION

Application Information (接下页)

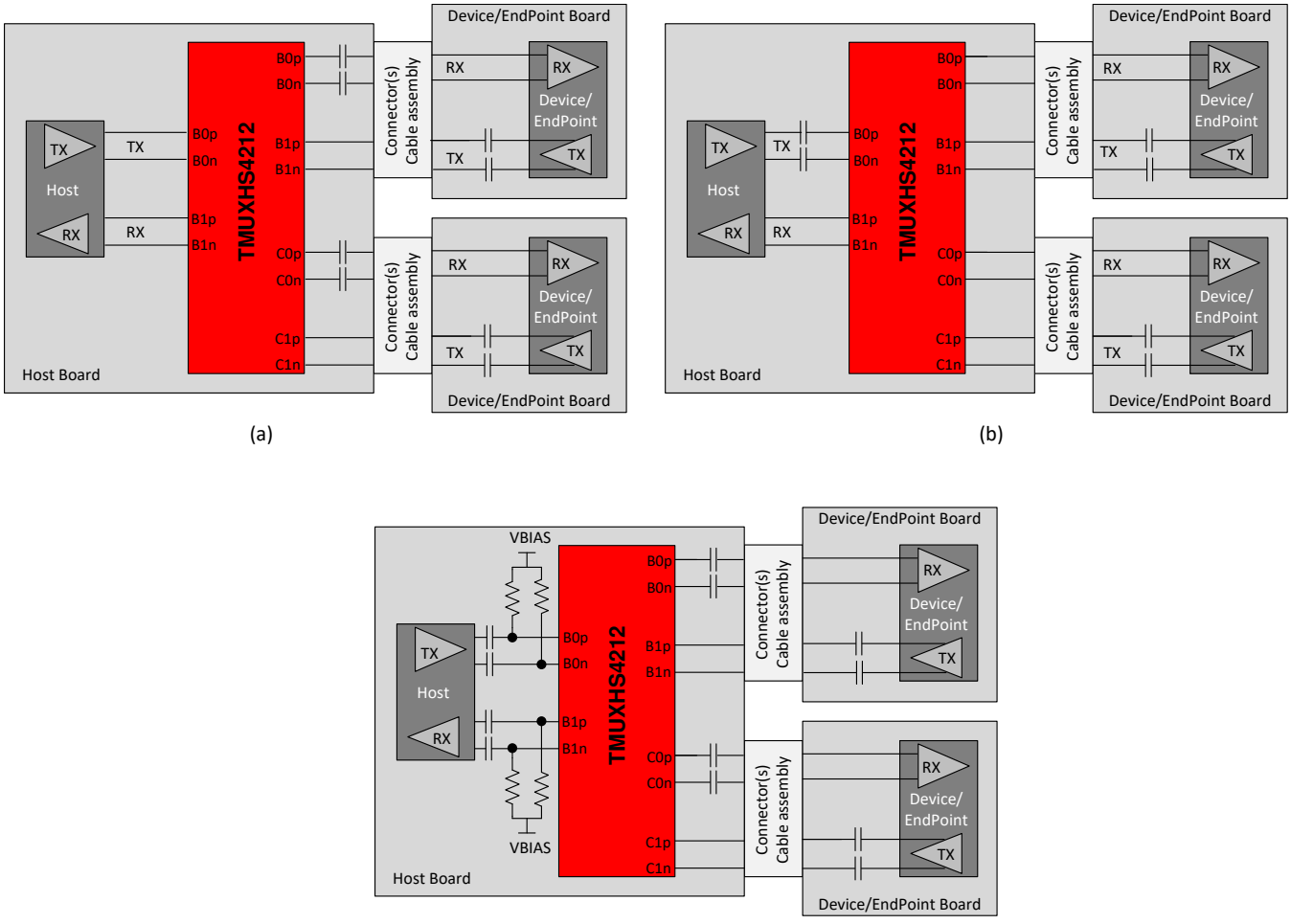


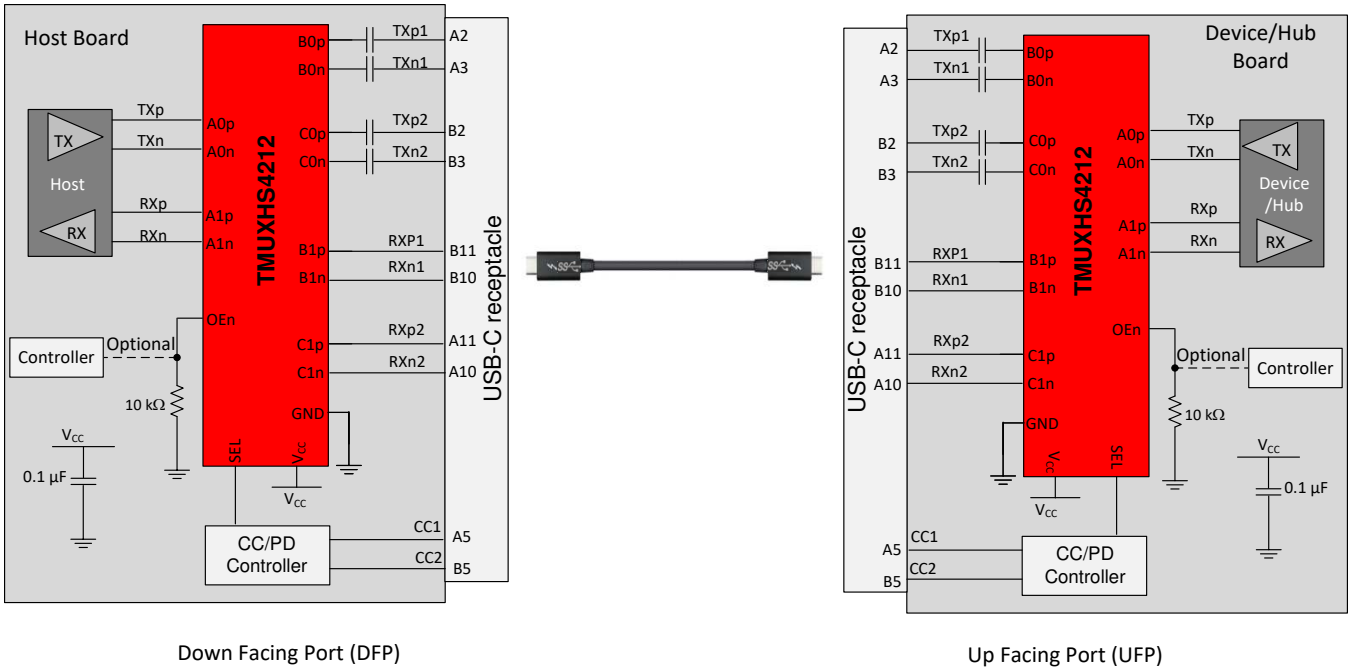
图 8. AC Coupling Capacitors Placement Options between Host and Device / Endpoint through TMUXHS4212

ADVANCE INFORMATION

9.2 Typical Applications

9.2.1 USB3.2 implementation for USB Type-C

The TMUXHS4212 can be used in USB Type-C implementation to mux USB 3.2 superspeed signals (TX1, RX1 pairs versus TX2, RX2 pairs) to accommodate plug flips. In typical use cases, the mux selection is done by a USB Type-C Channel Configuration (CC) or Power Delivery (PD) controller. The device can used on a USB Type-C DFP, UFP or DRP port. The two USB Type-C connector applications show both a host and device side. The cable between the two connectors swivels the pairs to properly route the signals to the correct pin. The other applications are more generic because different connectors can be used.



Down Facing Port (DFP) Up Facing Port (UFP)

图 9. USB 3.2 Implementation for USB Type-C™ Connector

9.2.1.1 Design Requirements

The TMUXHS4212 can be designed into many different applications. All the applications have certain requirements for the system to work properly. The TMUXHS4212 requires 3.3 V ±10% V_{CC} rail. The OEn pin must be low for device to work; otherwise, it disables the outputs. This pin can be driven by a processor. The expectation is that one side of the device has AC coupling capacitors. 表 2 provides information on expected values to perform properly.

表 2. Design Parameters

DESIGN PARAMETER	VALUE
V_{CC}	3.3 V
AXp/n, BXp/n, CXp/n CM input voltage	0 V to 1.8 V
Control/OEn pin max voltage for low	0.5 V
Control/OEn pin min voltage for high	1.42 V
AC coupling capacitor	75 nF to 265 nF
R_{BIAS} (图 9) when needed	1 kΩ to 100 kΩ

ADVANCE INFORMATION

9.2.1.2 Detailed Design Procedure

The TMUXHS4212 is a high-speed passive switch device that can behave as a mux or demux. Because this is a passive switch, signal integrity is important because the device provides no signal conditioning capability. The device can support 2 to 3 inches of board trace and a connector on either end.

To design in the TMUXHS4212, the designer needs to understand the following.

- Determine the loss profile between circuits that are to be muxed or demuxed.
- Provide clean impedance and electrical length matched board traces.
- Provide a control signal for the SEL and OEn pins.
- The thermal pad must be connected to ground.
- See the application schematics on recommended decouple capacitors from V_{CC} pins to ground

9.2.1.3 Application Curves

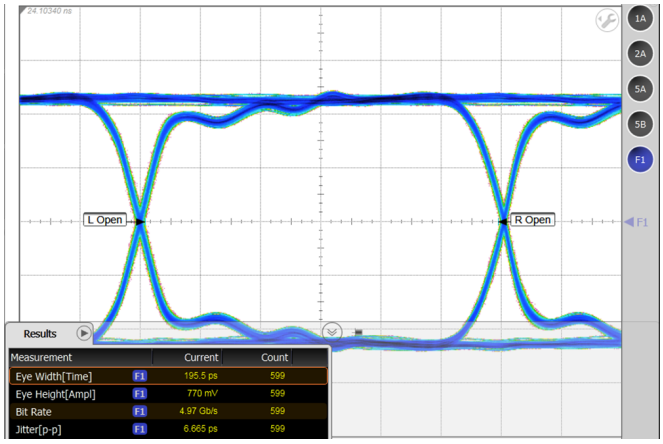


图 10. 5 Gbps PRBS-7 signals through Calibration Traces in TI Evaluation Board

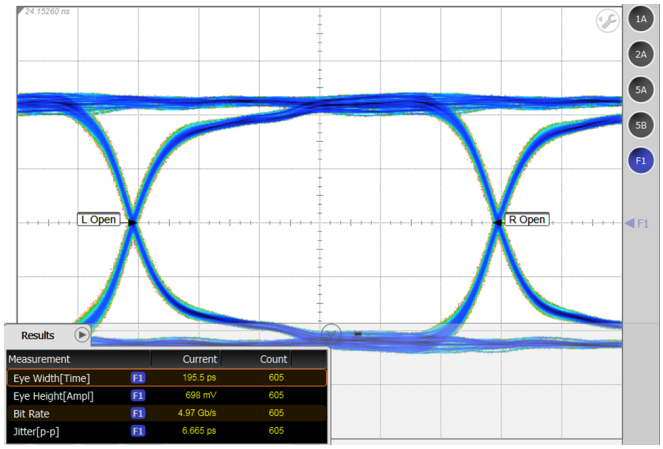


图 11. 5 Gbps PRBS-7 signals through a Typical TMUXHS4212 channel in TI Evaluation Board

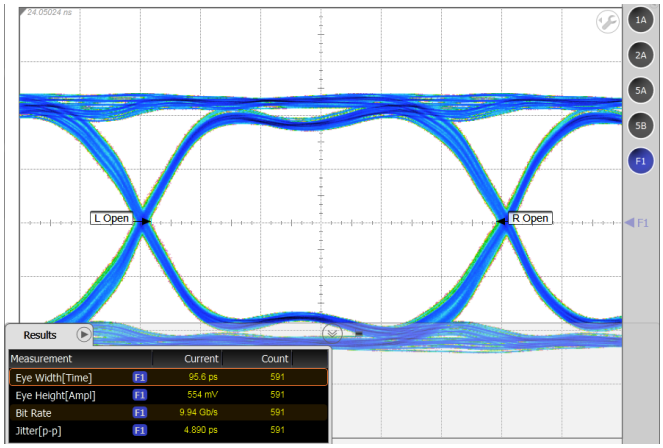


图 12. 10 Gbps PRBS-7 signals through Calibration Traces in TI Evaluation Board

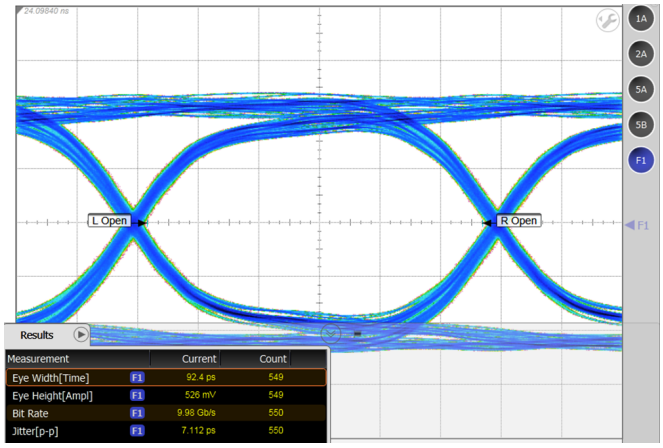


图 13. 10Gbps PRBS-7 signals through a Typical TMUXHS4212 channel in TI Evaluation Board

ADVANCE INFORMATION

9.2.2 PCIe Lane Muxing

The TMUXHS4212 can be used to switch PCIe lanes between two slots. In many PC and server motherboards, the CPU does not have enough PCIe lanes to provide desired system flexibility for end customers. In such applications, the TMUXHS4212 can be used to switch PCIe TX and RX lanes between two slots. 图 14 provides a schematic where eight TMUXHS4212 are used to switch eight PCIe TX and eight RX lanes. Note the common mode voltage (CMV) bias for the TMUXHS4212 must be within the range of 0 to 1.8 V. In implementations where receiver CMV bias of a PCIe root complex or an end point can not be ensured within the CMV range, additional DC blocking capacitors and appropriate CMV biasing must be implemented.

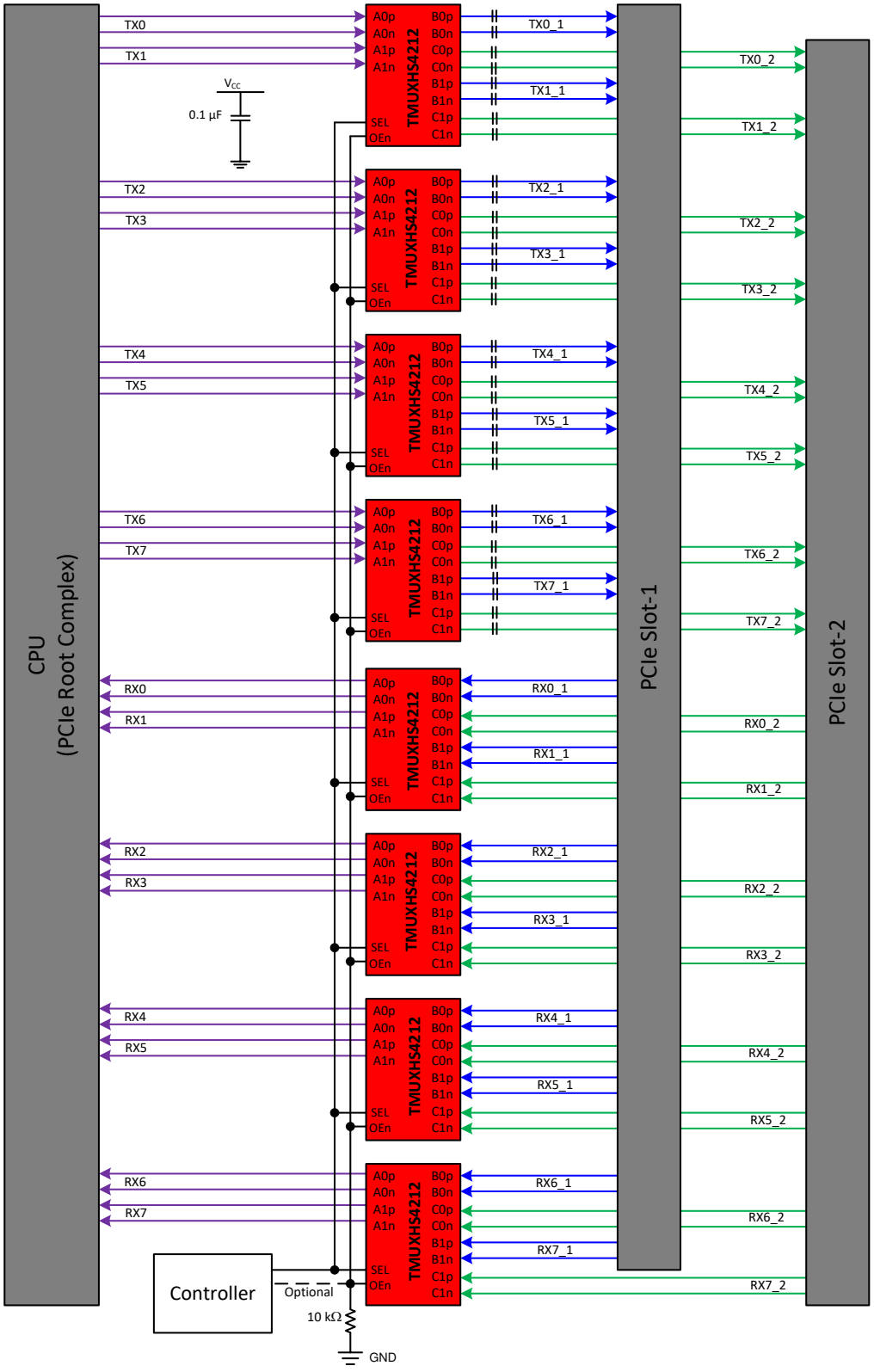


图 14. PCIe Lane Muxing

9.2.2.1 Application Curves

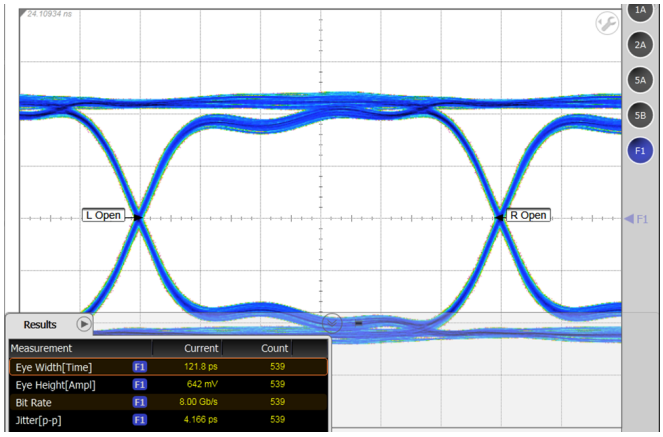


图 15. 8 Gbps PRBS-7 signals through Calibration Traces in TI Evaluation Board

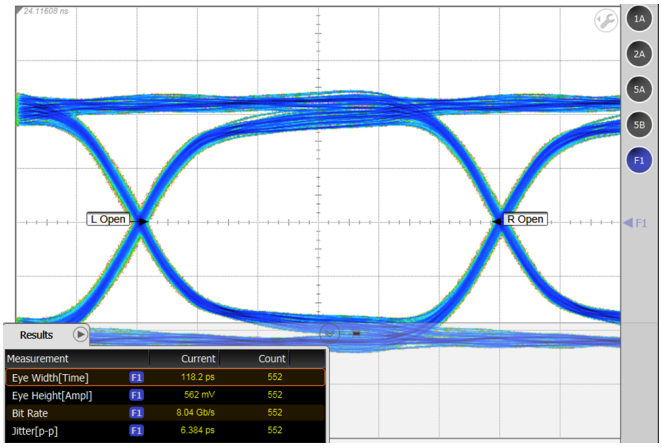


图 16. 8 Gbps PRBS-7 signals through a Typical TMUXHS4212 channel in TI Evaluation Board

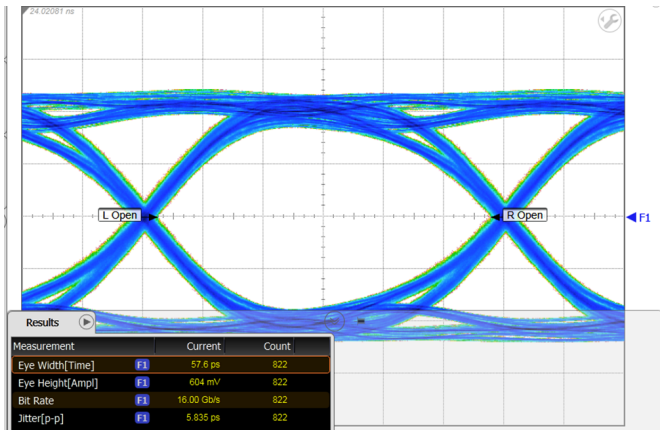


图 17. 16Gbps PRBS-7 signals through Calibration Traces in TI Evaluation Board

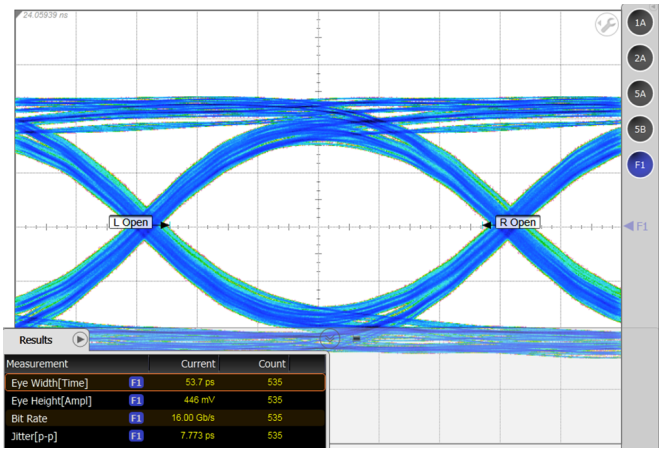


图 18. 16Gbps PRBS-7 signals through a Typical TMUXHS4212 channel in TI Evaluation Board

ADVANCE INFORMATION

9.3 Systems Examples

9.3.1 USB/eSATA

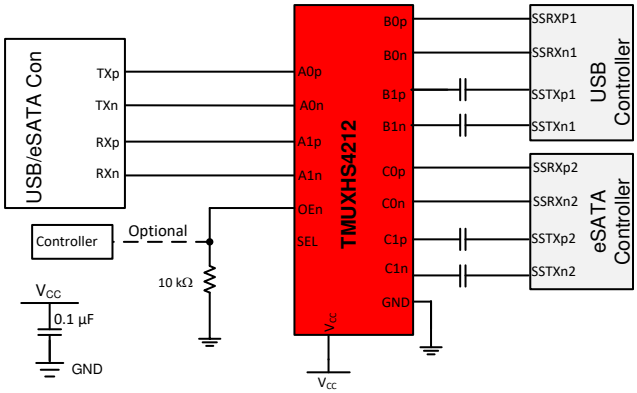


图 19. eSATA and USB 3.2 Combo Connector

Systems Examples (接下页)

9.3.2 MIPI Camera Serial Interface

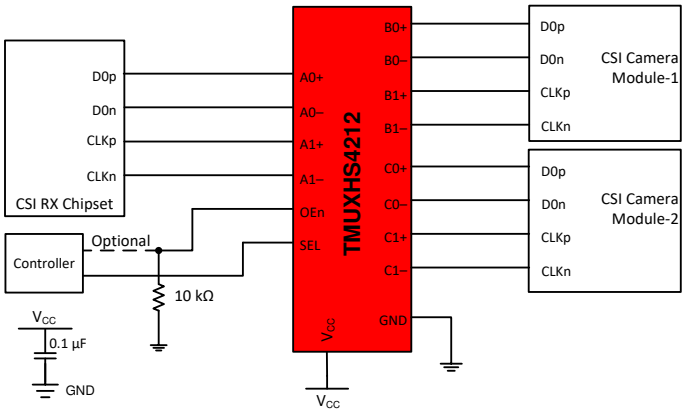


图 20. CSI Camera Selection

ADVANCE INFORMATION

10 Power Supply Recommendations

The TMUXHS4212 does not require a power supply sequence. However, TI recommends that OEn is asserted low after device supply V_{CC} is stable and in specification. TI also recommends to place ample decoupling capacitors at the device V_{CC} near the pin.

11 Layout

11.1 Layout Guidelines

On a high-K board, TI always recommends to solder the Power-pad™ onto the thermal land. A thermal land is the area of solder-tinned-copper underneath the Power-pad package. On a high-K board, the TMUXHS4212 can operate over the full temperature range by soldering the Power-pad onto the thermal land without vias.

For high speed layout guidelines refer to *High-Speed Layout Guidelines for Signal Conditioners and USB Hubs*, SLLA414.

On a low-K board, for the device to operate across the temperature range, the designer must use a 1-oz Cu trace connecting the GND pins to the thermal land. A general PCB design guide for Power-pad packages is provided in *Power-pad Thermally-Enhanced Package*, SLMA002.

11.2 Layout Example

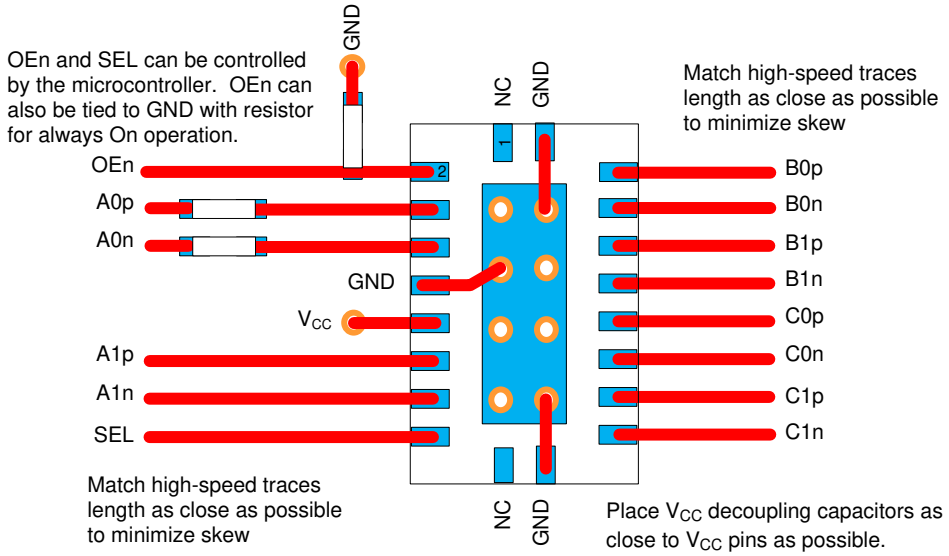


图 21. TMUXHS4212 Basic Layout Example for Application Shown in *USB3.2 implementation for USB Type-C*

ADVANCE INFORMATION

12 器件和文档支持

12.1 接收文档更新通知

要接收文档更新通知，请转至 TI.com.cn 上您的器件的产品文件夹。请在右上角单击*通知我* 按钮进行注册，即可收到产品信息更改每周摘要（如有）。有关更改的详细信息，请查看任意已修订文档的修订历史记录。

12.2 支持资源

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.

12.3 商标

USB Type-C, Power-pad, E2E are trademarks of Texas Instruments.
USB Type-C is a registered trademark of USB Implementation Forum.

12.4 静电放电警告

这些装置包含有限的内置 ESD 保护。 存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

12.5 Glossary

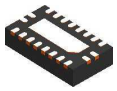
SLYZ022 — *TI Glossary*.

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

ADVANCE INFORMATION

13 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请查阅左侧的导航栏。

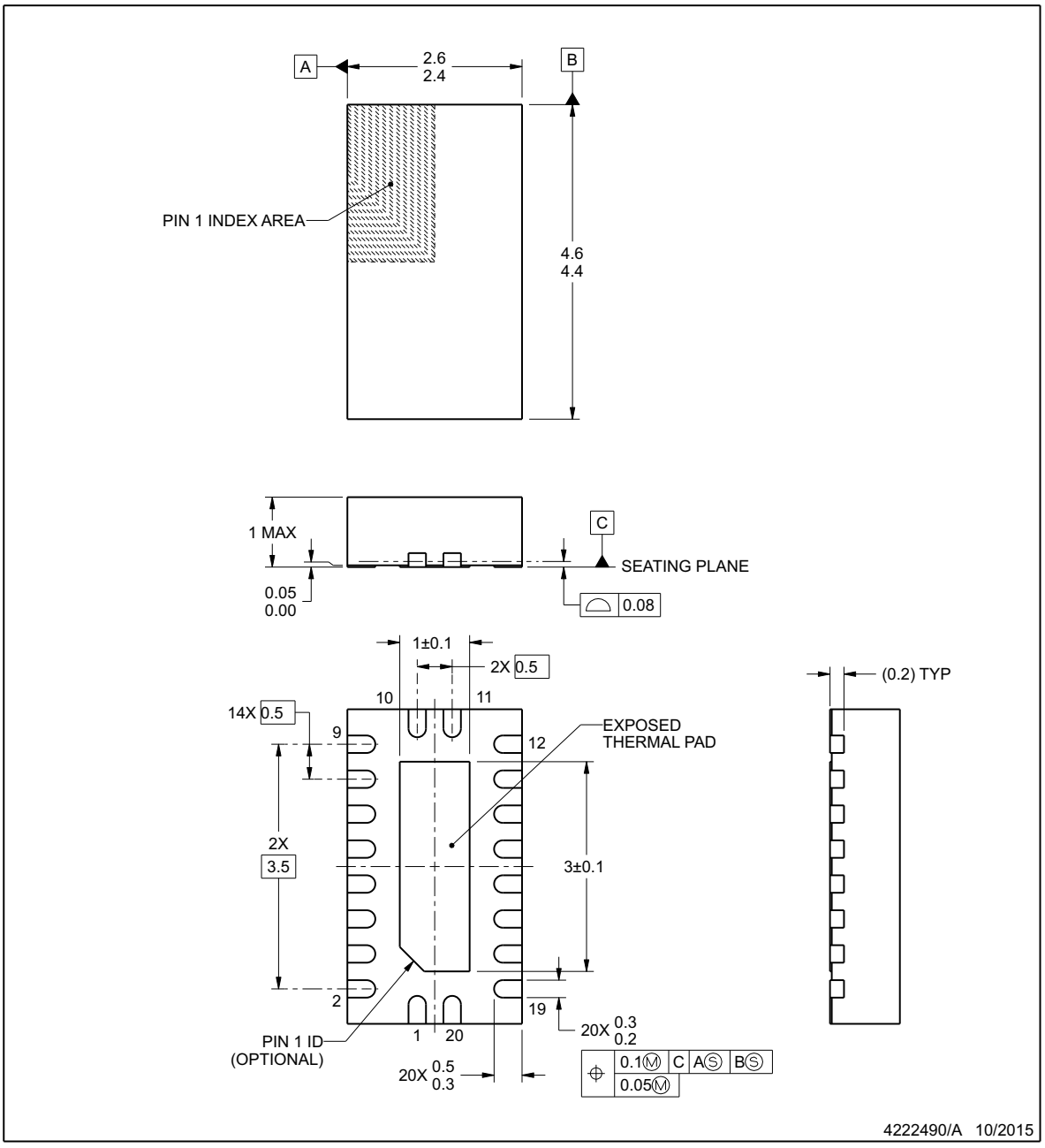


PACKAGE OUTLINE

RKS0020A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



NOTES:

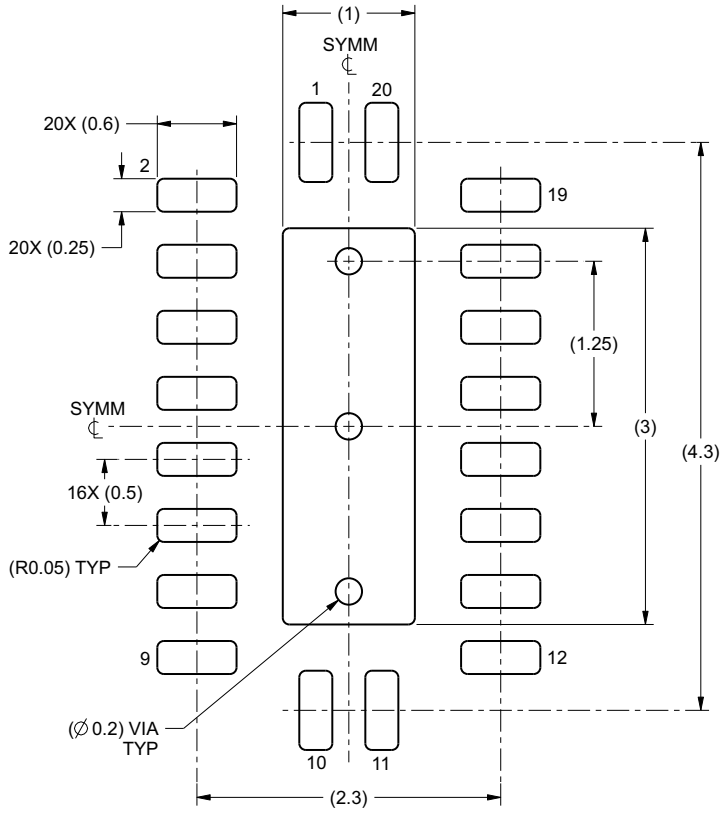
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

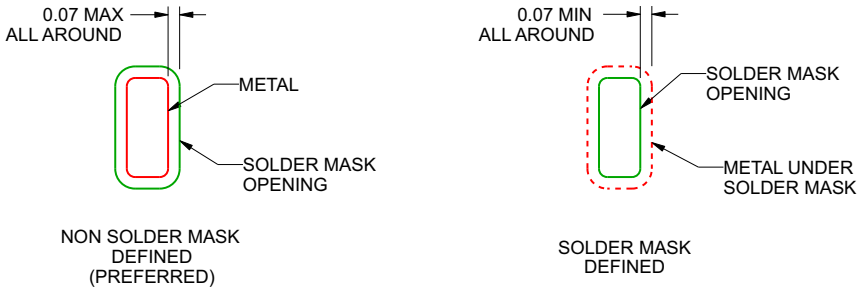
RKS0020A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
SCALE:20X



SOLDER MASK DETAILS

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NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.

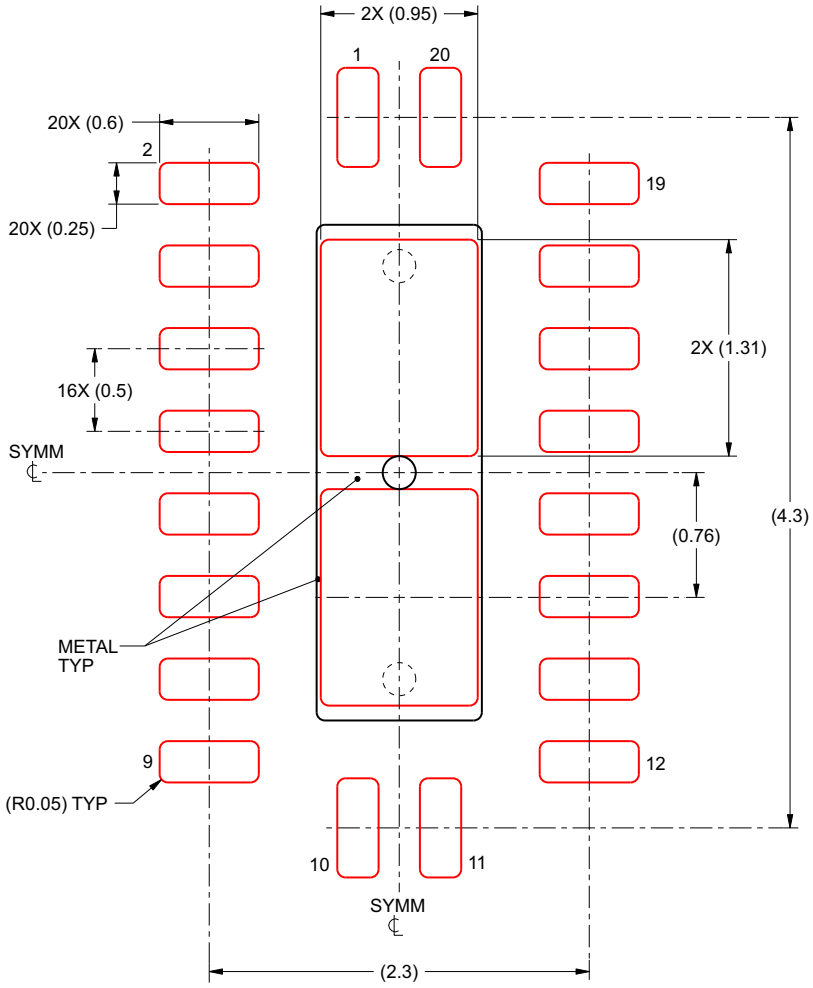
ADVANCE INFORMATION

ADVANCE INFORMATION

EXAMPLE STENCIL DESIGN

RKS0020A — **VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD
83% PRINTED SOLDER COVERAGE BY AREA
SCALE:25X

4222490/A 10/2015

NOTES: (continued)

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

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
TMUXHS4212IRKSR	ACTIVE	VQFN	RKS	20	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 105	HS4212	Samples
TMUXHS4212IRKST	ACTIVE	VQFN	RKS	20	250	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 105	HS4212	Samples
TMUXHS4212RKSR	ACTIVE	VQFN	RKS	20	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	0 to 70	HS4212	Samples
TMUXHS4212RKST	ACTIVE	VQFN	RKS	20	250	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	0 to 70	HS4212	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.

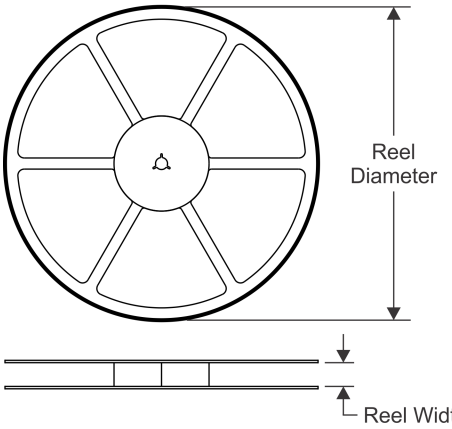
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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.

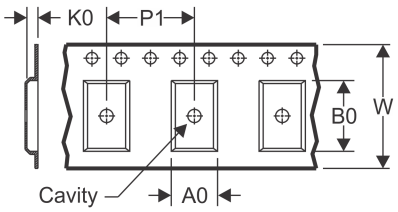
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

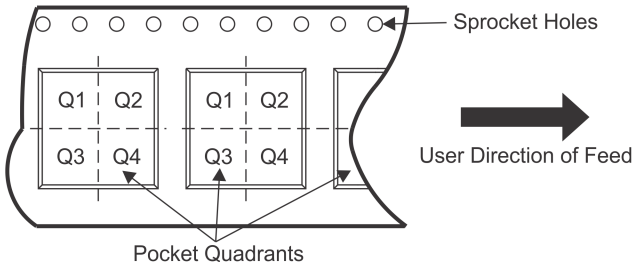


TAPE DIMENSIONS



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

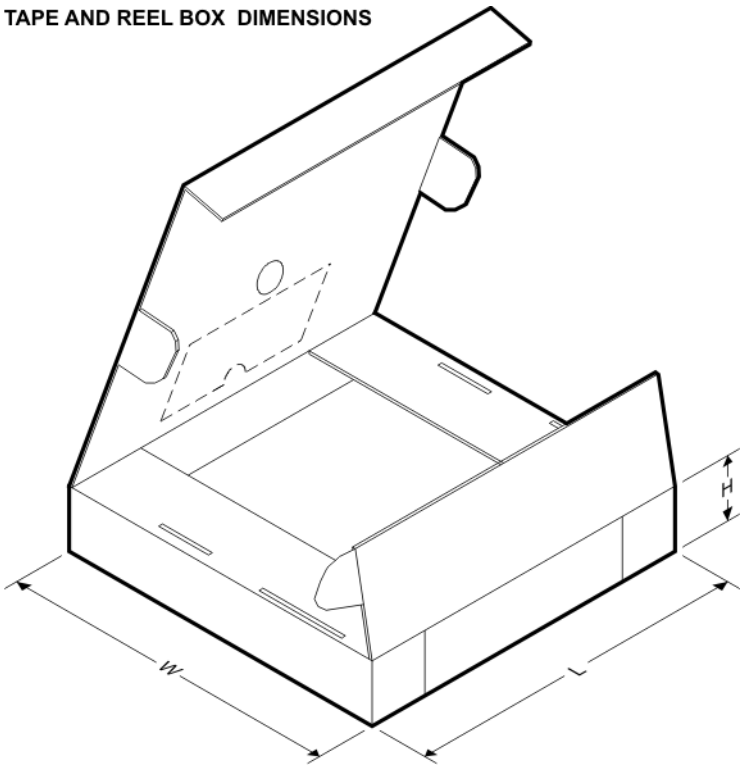
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TMUXHS4212IRKSR	VQFN	RKS	20	3000	180.0	12.4	2.8	4.8	1.2	4.0	12.0	Q1
TMUXHS4212IRKST	VQFN	RKS	20	250	180.0	12.4	2.8	4.8	1.2	4.0	12.0	Q1
TMUXHS4212RKSR	VQFN	RKS	20	3000	180.0	12.4	2.8	4.8	1.2	4.0	12.0	Q1
TMUXHS4212RKST	VQFN	RKS	20	250	180.0	12.4	2.8	4.8	1.2	4.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TMUXHS4212IRKSR	VQFN	RKS	20	3000	210.0	185.0	35.0
TMUXHS4212IRKST	VQFN	RKS	20	250	210.0	185.0	35.0
TMUXHS4212RKSR	VQFN	RKS	20	3000	210.0	185.0	35.0
TMUXHS4212RKST	VQFN	RKS	20	250	210.0	185.0	35.0

GENERIC PACKAGE VIEW

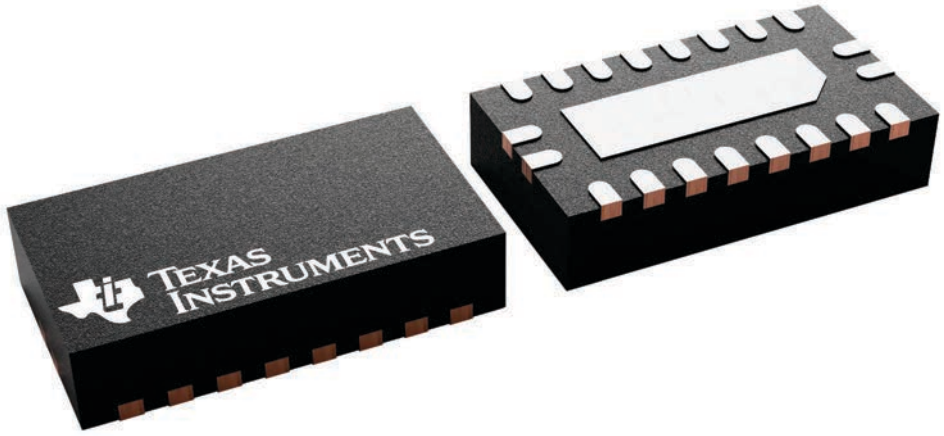
RKS 20

VQFN - 1 mm max height

2.5 x 4.5, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

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

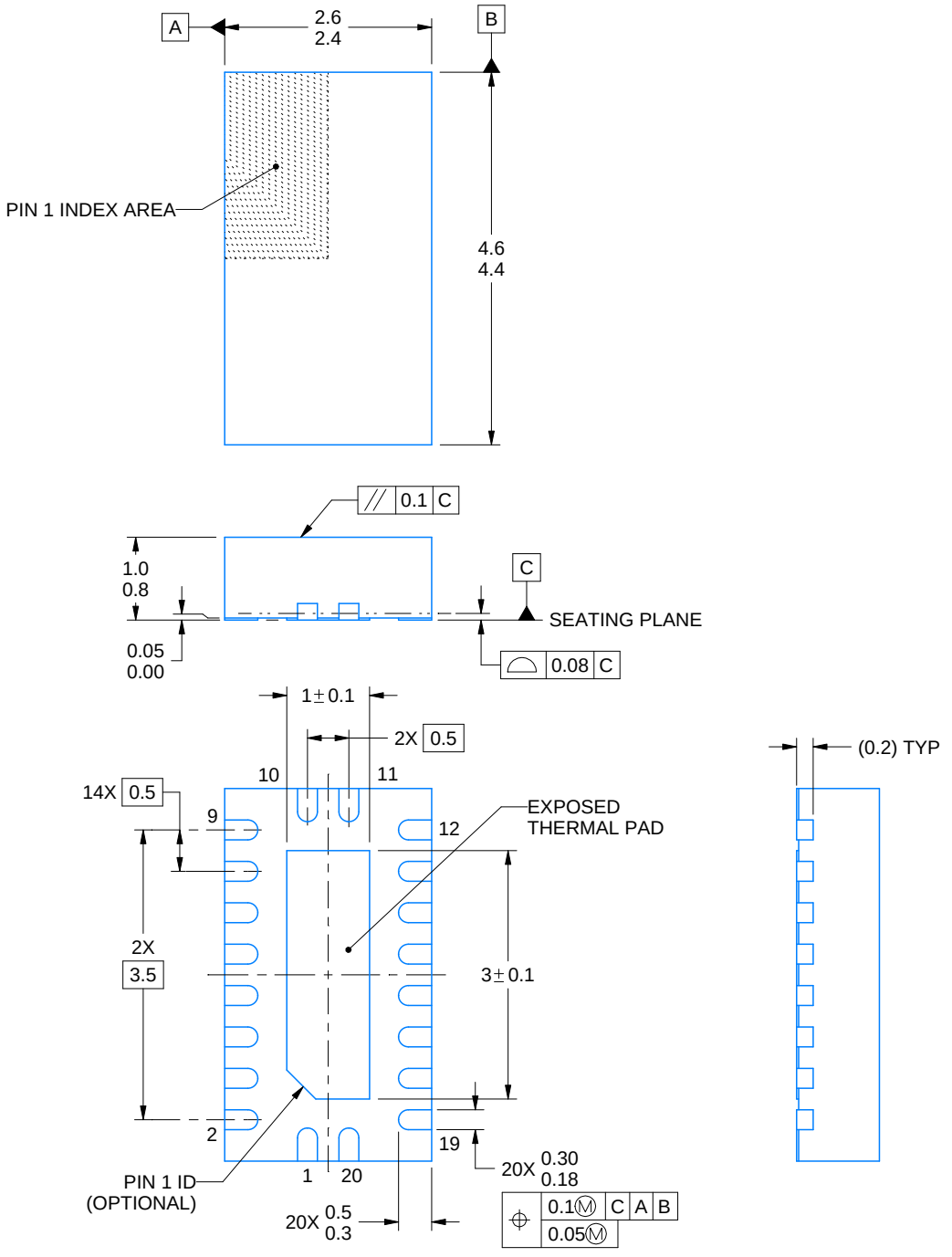


PACKAGE OUTLINE

RKS0020A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



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.
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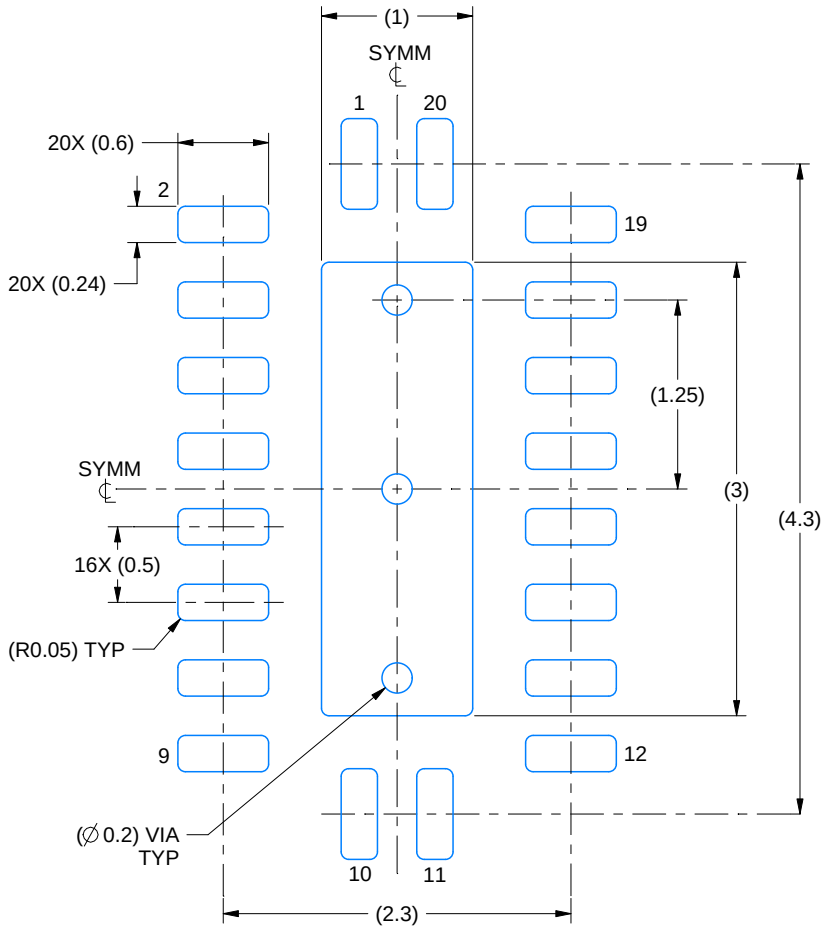
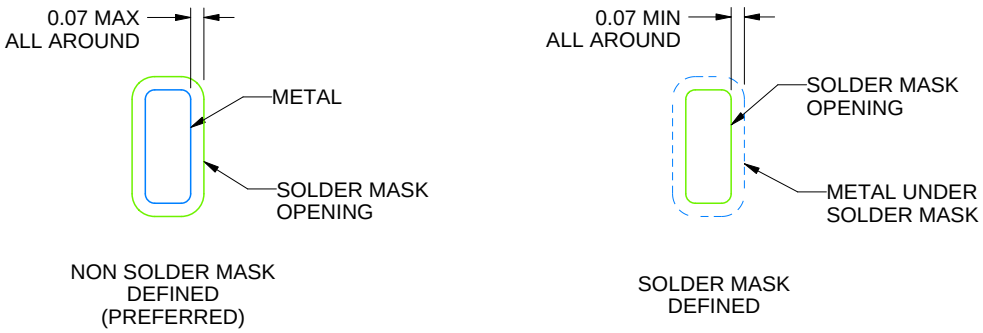


LAND PATTERN EXAMPLE
SCALE:20X

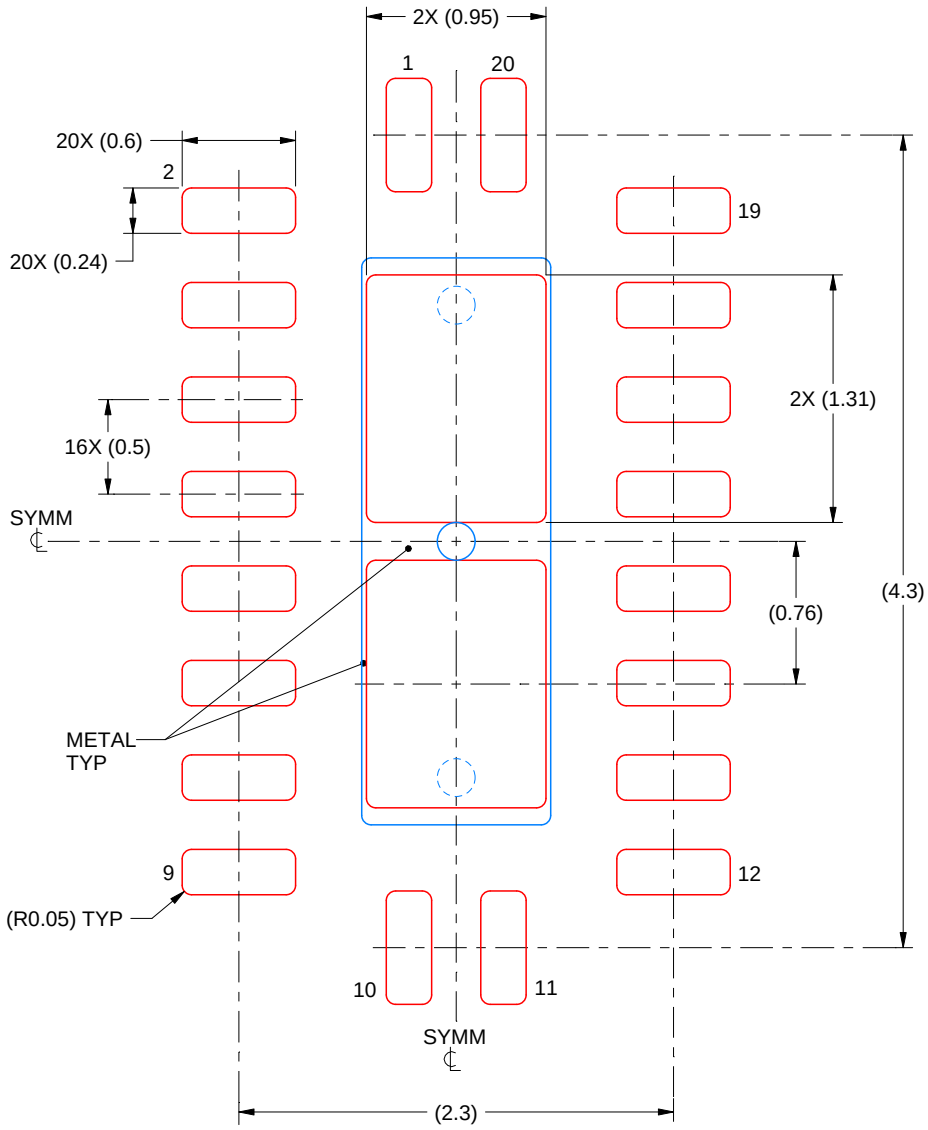


SOLDER MASK DETAILS

4222490/B 02/2021

NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD
83% PRINTED SOLDER COVERAGE BY AREA
SCALE:25X

4222490/B 02/2021

NOTES: (continued)

6. 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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