HD3SS3212x Two-Channel Differential 2:1/1:2 USB3.1 Mux/Demux

1 Features

- Provides MUX/DEMUX Solution for USB Type-C™ Ecosystem for USB 3.1 Gen 1 and Gen 2 Data Rates
- Compatible With MIPI DSI/CSI, FPDLinkIII, LVDS, and PCIE Gen II, III
- Operates up to 10 Gbps
- Wide –3-dB Differential BW of over 8 GHz
- Excellent Dynamic Characteristics (at 5 GHz)
  - Crosstalk = –32 dB
  - Off Isolation = –19 dB
  - Insertion Loss = –1.6 dB
  - Return Loss = –12 dB
- Bidirectional "Mux/De-Mux" Differential Switch
- Supports Common Mode Voltage 0 to 2 V
- Single Supply Voltage V_{CC} of 3.3 V ±10%
- Commercial Temperature Range of 0°C to 70°C (HD3SS3212RKS)
- Industrial Temperature Range of –40°C to 85°C (HD3SS3212IRKS)

2 Applications

- USB Type-C™ Ecosystem
- Desktop and Notebook PCs
- Server/Storage Area Networks
- PCI Express Backplanes
- Shared I/O Ports
- FPDLinkII and FPDLinkIII Switching

3 Description

The HD3SS3212 is a high-speed bidirectional passive switch in mux or demux configurations suited for USB Type-C™ application supporting USB 3.1 Gen 1 and Gen 2 data rates. Based on control pin SEL, the device provides switching on differential channels between Port B or Port C to Port A.

The HD3SS3212 is a generic analog differential passive switch that can work for any high-speed interface applications requiring a common mode voltage range of 0 to 2 V and differential signaling with differential amplitude up to 1800 mVpp. It employs adaptive tracking that ensures the channel remains unchanged for the entire common mode voltage range.

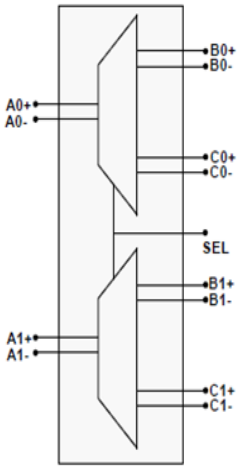
Excellent dynamic characteristics of the device allow high-speed switching with minimum attenuation to the signal eye diagram with very little added jitter. It consumes <2 mW of power when operational and has a shutdown mode exercisable by OEn pin resulting <20 µW.

Device Information(1)

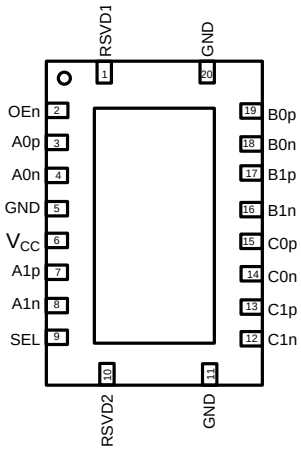
PART NUMBER	PACKAGE	BODY SIZE (NOM)
HD3SS3212	VQFN (20)	2.50 mm × 4.50 mm × 0.5-mm pitch
HD3SS3212I		

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Simplified Schematic



Pinout



An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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4 Revision History

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

Changes from Revision B (January 2016) to Revision C — **Page**

- Changed the PINOUT image - pin 1 From: NC To: RSVD1 and pin 10 From: NC To: RSVD2 ... 1
- Changed pin 1 From: NC To: RSVD1 , changed pin 10 From: NC To: RSVD2, and updated the Description in the *Pin Functions* table ... 4

Changes from Revision A (August 2015) to Revision B — **Page**

- Changed the V_{ih} MIN value From: 2 V To: 1.7 V in *Recommended Operating Conditions* ... 4

Changes from Original (May 2015) to Revision A — **Page**

- . Removed "or GND" from NC pin description ... 4
- Updated Figure 16 ... 17

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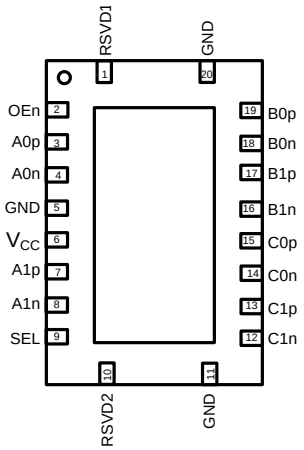
5 Device Comparison Table

OPERATING TEMPERATURE (°C)	PACKAGE(1)(2)		ORDERABLE PART NUMBER
0 to 70	RKS	20 pins	HD3SS3212RKSR
–40 to 85	RKS	20 pins	HD3SS3212IRKSR

(1) For the most current package and ordering information, see *Mechanical, Packaging, and Orderable Information*.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

6 Pin Configuration and Functions

RKS Package
20-Pin VQFN
Top View



Pin Functions

PIN		TYPE(1)	DESCRIPTION
NAME	NO.		
V_{CC}	6	P	3.3-V power
OEn	2	I	Active-low chip enable L: Normal operation H: Shutdown
A0p	3	I/O	Port A, channel 0, high-speed positive signal
A0n	4	I/O	Port A, channel 0, high-speed negative signal
GND	5, 11, 20	G	Ground
A1p	7	I/O	Port A, channel 1, high-speed positive signal
A1n	8	I/O	Port A, channel 1, high-speed negative signal
SEL	9	I	Port select pin. Internally tied to GND via 100-kΩ resistor. L: Port A to Port B H: Port A to Port C
C1n	12	I/O	Port C, channel 1, high-speed negative signal (connector side)
C1p	13	I/O	Port C, channel 1, high-speed positive signal (connector side)
C0n	14	I/O	Port C, channel 0, high-speed negative signal (connector side)
C0p	15	I/O	Port C, channel 0, high-speed positive signal (connector side)
B1n	16	I/O	Port B, channel 1, high-speed negative signal (connector side)
B1p	17	I/O	Port B, channel 1, high-speed positive signal (connector side)
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)

(1) The high-speed data ports incorporate 20-kΩ pulldown resistors that are switched in when a port is not selected and switched out when the port is selected.

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Pin Functions (continued)

PIN		TYPE(1)	DESCRIPTION
NAME	NO.		
RSVD1	1	O	Can be left not connected or can be fed to V_{CC}
RSVD2	10	O	

7 Specifications

7.1 Absolute Maximum Ratings

see (1)

			MIN	MAX	UNIT
V_{CC}	Supply voltage		–0.5	4	V
	Voltage	Differential I/O	–0.5	2.5	V
		Control pins	–0.5	V_{CC}+ 0.5	
T_{stg}	Storage temperature		–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* 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 Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

7.2 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.

7.3 Recommended Operating Conditions

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage		3	3.6	V
V_{ih}	Input high voltage (SEL, OEn pins)		1.7	V_{CC}	V
V_{il}	Input low voltage (SEL, OEn pins)		–0.1	0.8	V
V_{diff}	High-speed signal pins differential voltage		0	1.8	V_{pp}
V_{cm}	High speed signal pins common mode voltage		0	2	V
T_A	Operating free-air/ambient temperature	HD3SS3212RKS	0	70	°C
		HD3SS3212IRKS	–40	85	

7.4 Thermal Information

THERMAL METRIC(1)		HD3SS3212 RKS (VQFN) 20 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	46.6	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	41.8	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	4.4	°C/W
ψ_{JT}	Junction-to-top characterization parameter	17.6	°C/W
ψ_{JB}	Junction-to-board characterization parameter	1.6	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	17.6	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

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7.5 Electrical Characteristics

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{CC}	Device active current	V_{CC} = 3.3 V, OEn = 0		0.6	0.8	mA
I_{STDN}	Device shutdown current	V_{CC} = 3.3 V, OEn = V_{CC}		5	20	µA
C_{ON}	Output ON capacitance			0.6		pF
C_{OFF}	Output OFF capacitance			0.8		pF
R_{ON}	Output ON resistance	V_{CC} = 3.3 V; V_{CM} = 0 to 2 V; IO = –8 mA		5	8	Ω
ΔR_{ON}	On-resistance match between pairs of the same channel	V_{CC} = 3.3 V; –0.35 V ≤ V_{IN} ≤ 2.35 V; IO = –8 mA			0.5	Ω
R_{FLAT_ON}	On-resistance flatness RON(MAX) – RON(MAIN)	V_{CC} = 3.3 V; –0.35 V ≤ V_{IN} ≤ 2.35 V			1	Ω
$I_{IH,CTRL}$	Input high current, control pins (SEL, OEn)				1	µA
$I_{IL,CTRL}$	Input low current, control pins (SEL, OEn)				1	µA
$I_{IH,HS}$	Input high current, high-speed pins [Ax/Bx/Cx][p/n]	V_{IN} = 2 V for selected port, A and B with SEL = 0, and A and C with SEL = V_{CC}			1	µA
$I_{IH,HS}$	Input high current, high-speed pins [Ax/Bx/Cx][p/n]	V_{IN} = 2 V for non-selected port, C with SEL = 0, and B with SEL = V_{CC} (1)		100	140	µA
$I_{IL,HS}$	Input low current, high-speed pins [Ax/Bx/Cx][p/n]				1	µA

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

7.6 High-Speed Performance Parameters

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
I_L	Differential insertion loss	f = 0.3 MHz		–0.5		dB
		f = 0.625 MHz		-0.55		
		f = 2.5 GHz		–0.8		
		f = 4 GHz		–1.4		
		f = 5 GHz		–1.6		
BW	–3-dB bandwidth			8		GHz
R_L	Differential return loss	f = 0.3 MHz		–25		dB
		f = 2.5 GHz		–13		
		f = 4 GHz		–13		
		f = 5 GHz		– 12		
O_{IRR}	Differential OFF isolation	f = 0.3 MHz		–75		dB
		f = 2.5 GHz		–23		
		f = 4 GHz		–19		
		f = 5 GHz		–19		
X_{TALK}	Differential crosstalk	f = 0.3 MHz		–90		dB
		f = 2.5 GHz		–35		
		f = 4 GHz		–32.5		
		f = 5 GHz		–32		

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7.7 Switching Characteristics

PARAMETER		MIN	TYP	MAX	UNIT
t_{PD}	Switch propagation delay (see Figure 3)			80	ps
t_{SW_ON}	Switching time SEL-to-Switch ON (see Figure 2)			0.5	µs
t_{SW_OFF}	Switching time SEL-to-Switch OFF (see Figure 2)			0.5	µs
t_{SK_INTRA}	Intra-pair output skew (see Figure 3)			6	ps
t_{SK_INTER}	Inter-pair output skew (see Figure 3)			20	ps

8 Parameter Measurement Information

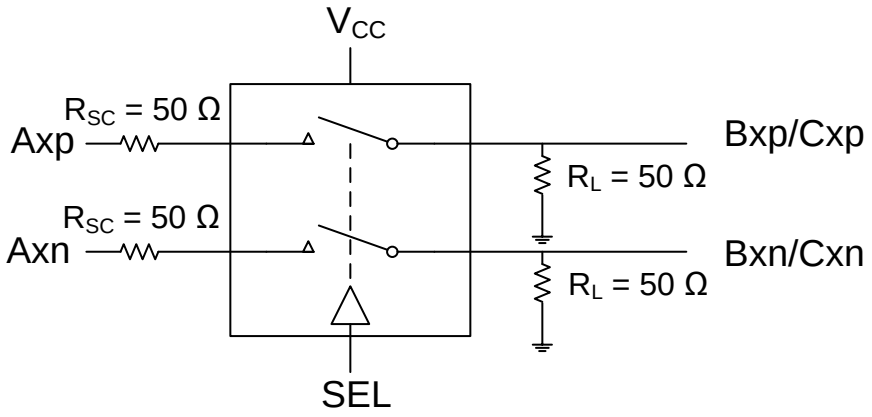


Figure 1. Test Setup

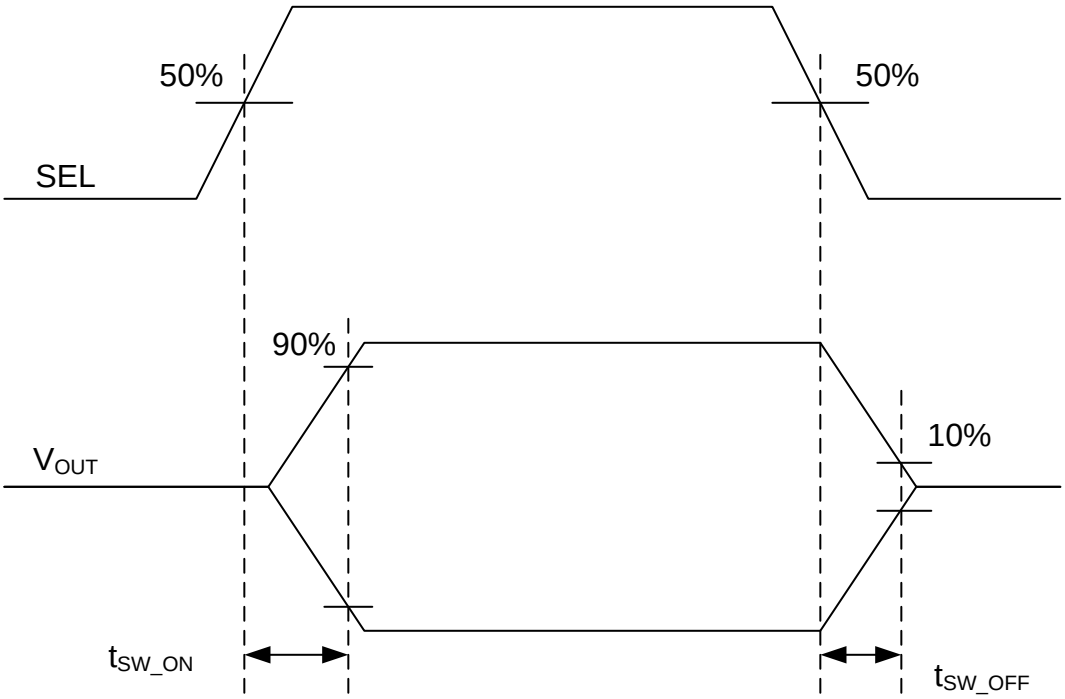


Figure 2. Switch On and Off Timing Diagram

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Parameter Measurement Information (continued)

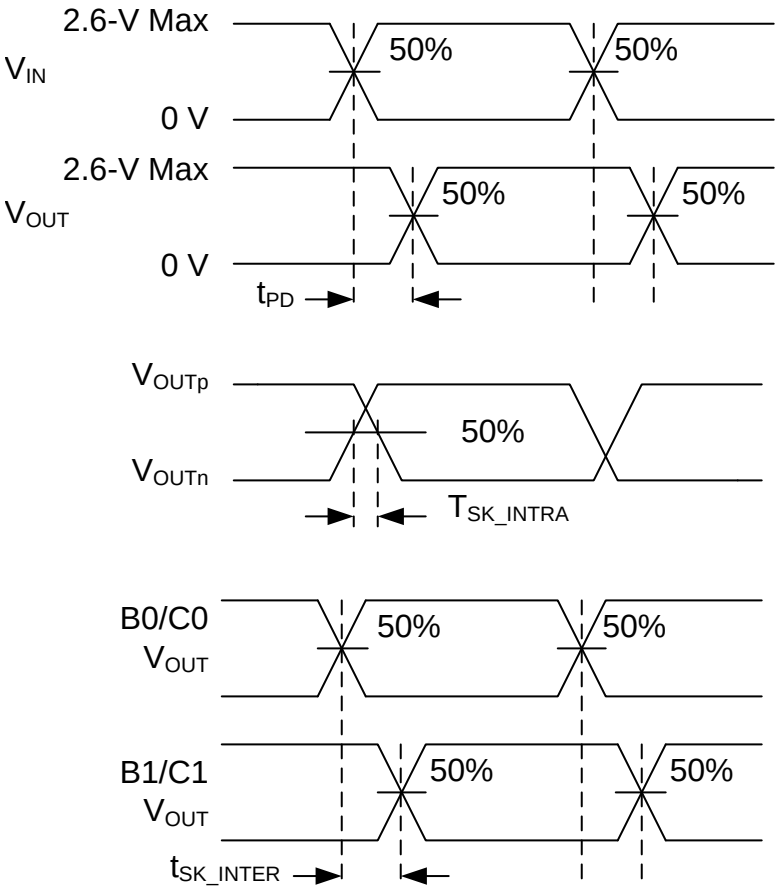


Figure 3. Timing Diagrams and Test Setup

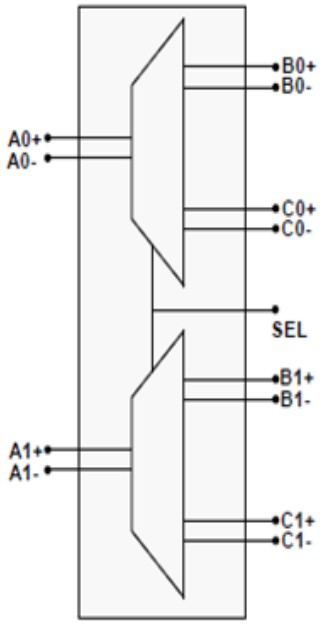
9 Detailed Description

9.1 Overview

The HD3SS3212 is a generic analog differential passive switch that can work for any high-speed interface applications requiring a common mode voltage range of 0 to 2 V and differential signaling with differential amplitude up to 1800 mVpp. It employs adaptive tracking that ensures the channel remains unchanged for the entire common mode voltage range.

Excellent dynamic characteristics of the device allow high-speed switching with minimum attenuation to the signal eye diagram with very little added jitter. It consumes <2 mW of power when operational and has a shutdown mode exercisable by OEn pin resulting <20 µW.

9.2 Functional Block Diagram



9.3 Feature Description

9.3.1 Output Enable and Power Savings

The HD3SS3212 has two power modes, active/normal operating mode and standby/shutdown mode. During standby mode, the device consumes very-little current to save the maximum power. 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.

HD3SS3212 consumes <2 mW of power when operational and has a shutdown mode exercisable by the EN pin resulting <20 µW.

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9.4 Device Functional Modes

Table 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 HD3SS3212 can tolerate polarity inversions for all differential signals on Ports A, B, and C. Take care to ensure the same polarity is maintained on Port A versus Ports B/C.

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10 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

10.1 Application Information

The HD3SS3212 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 HD3SS3212 supports several high-speed data protocols with a differential amplitude of <1800 mVpp and a common mode voltage of <2.0 V, as with USB 3.0 and DisplayPort 1.2. The device's one select input (SEL) pin can easily be controlled by an available GPIO pin within a system or from a microcontroller.

The HD3SS3212 with its adaptive common mode tracking technology can support applications where the common mode is different between the RX and TX pair. The two USB3.1 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.

Many interfaces require AC coupling between the transmitter and receiver. The 0402 capacitors are the preferred option to provide AC coupling; 0603 size capacitors also work. Avoid the 0805 size capacitors and C-packs. When placing AC coupling capacitors, symmetric placement is best. A capacitor value of 0.1 µF is best, and the value should match for the ±signal pair. The designer should place them along the TX pairs on the system board, which are usually routed on the top layer of the board.

The AC coupling capacitors have several placement options. Because the switch requires a bias voltage, the designer must place the capacitors on one side of the switch. If they are placed on both sides of the switch, a biasing voltage should be provided. Figure 4 shows a few placement options. The coupling capacitors are placed between the switch and endpoint. In this situation, the switch is biased by the system/host controller.

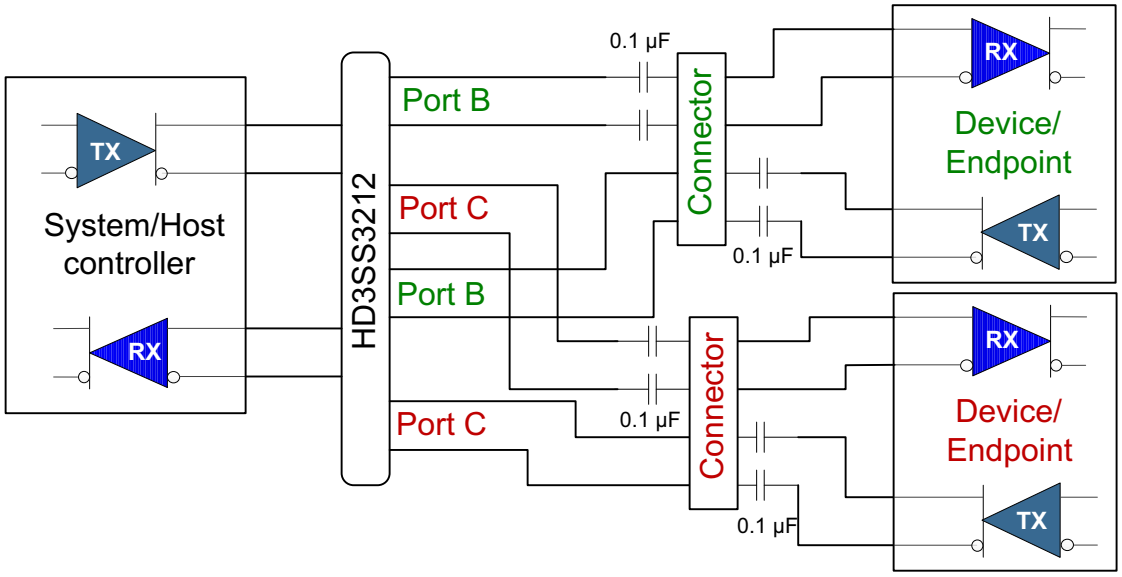


Figure 4. AC Coupling Capacitors between Switch TX and Endpoint TX

In Figure 5, the coupling capacitors are placed on the host transmit pair and endpoint transmit pair. In this situation, the switch on top is biased by the endpoint and the lower switch is biased by the host controller.

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Application Information (continued)

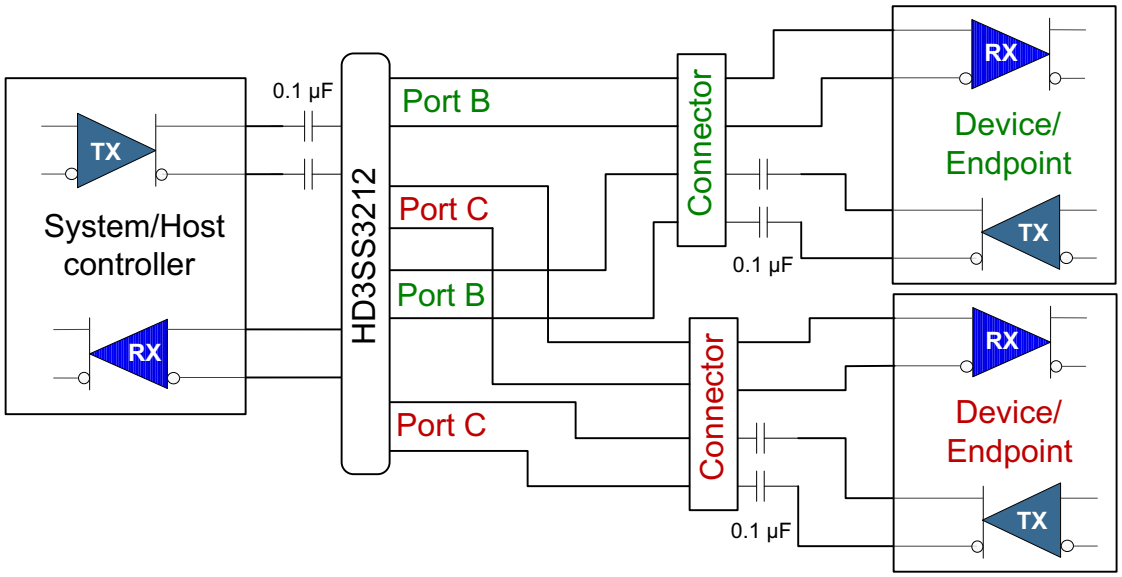
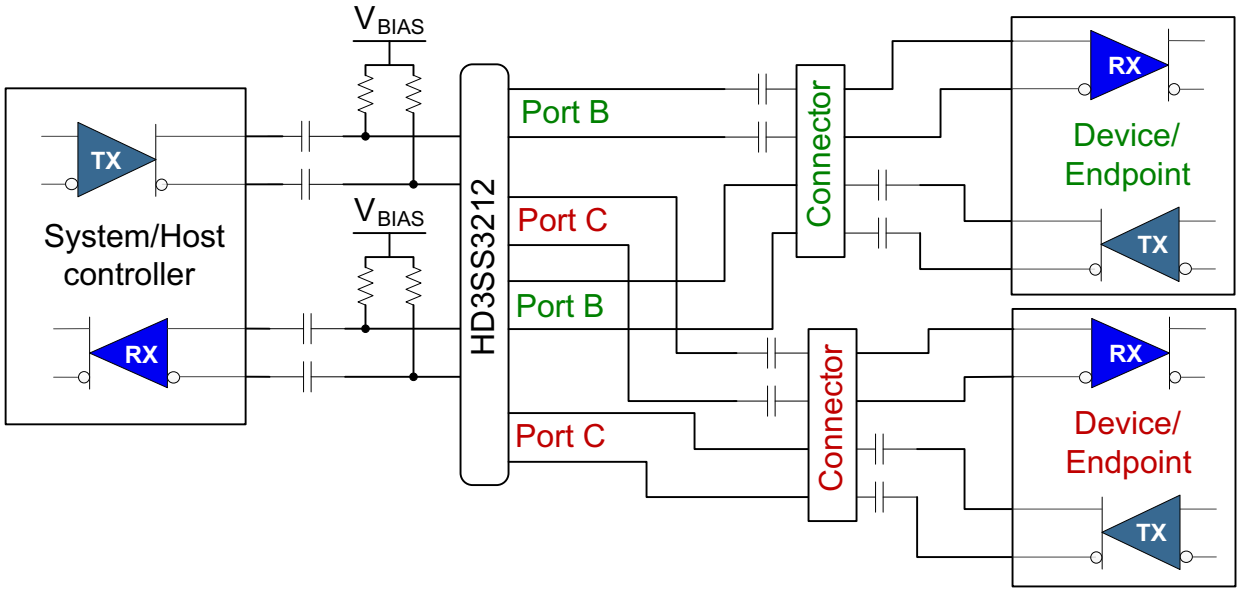


Figure 5. AC Coupling Capacitors on Host TX and Endpoint TX

In the case where the common mode voltage in the system is higher than 2 V, the coupling capacitors are placed on both sides of the switch (shown in Figure 6). A biasing voltage of <2 V is required in this case.



V_{BIAS} can be GND

Capacitor and resistor values depend upon application

Figure 6. AC Coupling Capacitors on Both Sides of Switch

The HD3SS3212 can be used with the USB Type C connector to support the connector's flip ability. Figure 7 provides the generic location for the AC coupling capacitors for this application.

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Application Information (continued)

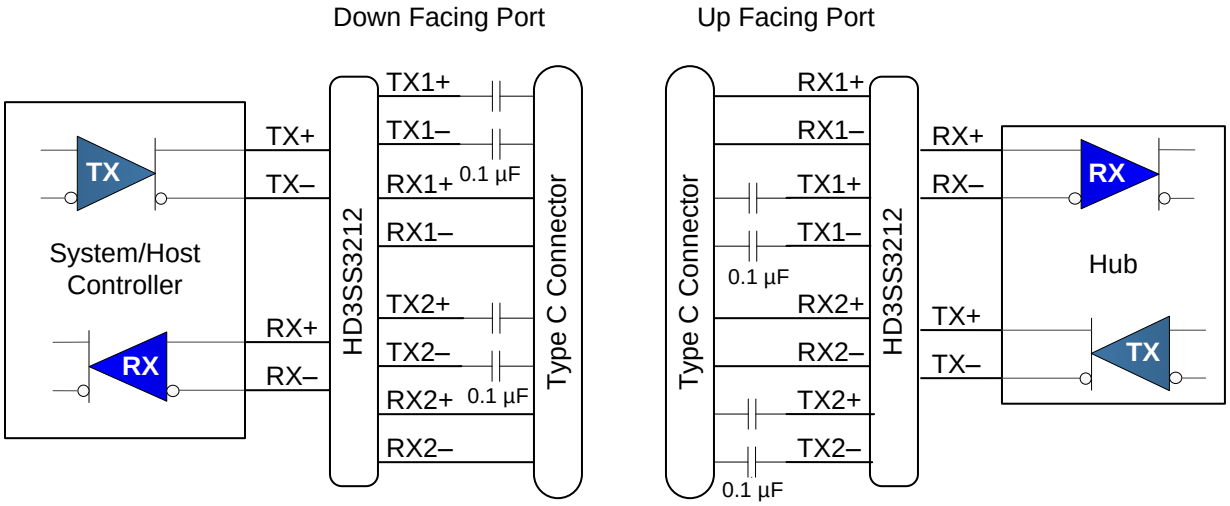


Figure 7. AC Coupling Capacitors for USB Type C

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10.2 Typical Applications

10.2.1 Down Facing Port for USB3.1 Type C

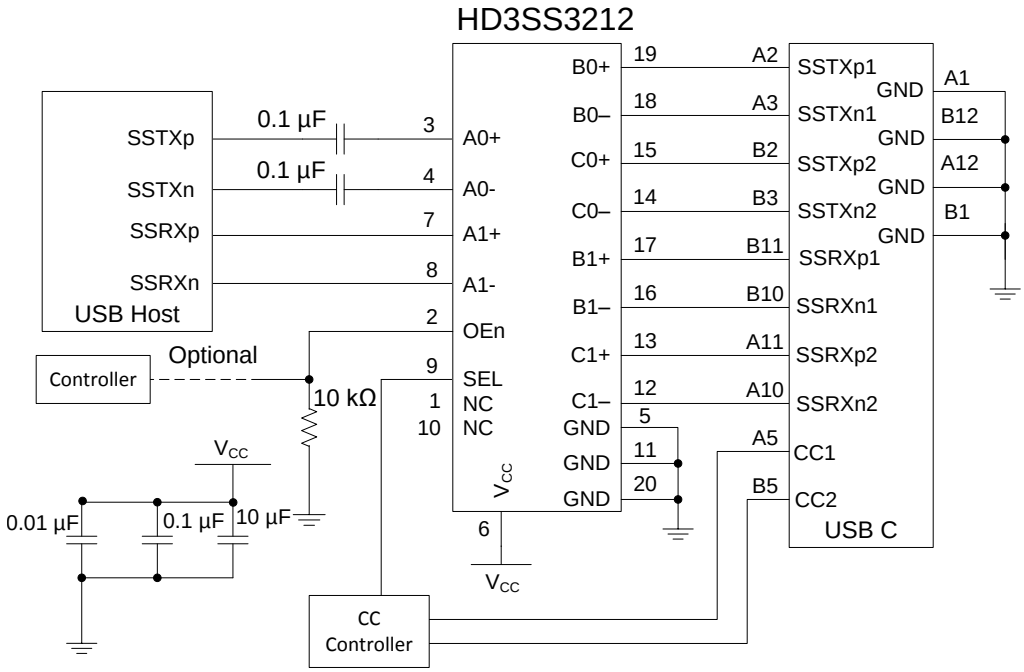


Figure 8. Down Facing Port for USB3.1 Type C Connector

10.2.1.1 Design Requirements

The HD3SS3212 can be designed into many different applications. All the applications have certain requirements for the system to work properly. The HD3SS3212 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. Table 2 provides information on expected values to perform properly.

Table 2. Design Parameters

DESIGN PARAMETER	VALUE
V_{CC}	3.3 V
AXp/n, BXp/n, CXp/n CM input voltage	0 to 2 V
Control/OEn pin max voltage for low	0.8 V
Control/OEn pin min voltage for high	2.0 V
AC coupling capacitor	100 nF
R_{BIAS} (Figure 8) when needed	1 kΩ

10.2.1.2 Detailed Design Procedure

The HD3SS3212 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 HD3SS3212, 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.
- Depending upon the application, determine the best place to put the 100-nF coupling capacitor.
- Provide a control signal for the SEL and OEn pins.
- The thermal pad must be connected to ground.

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- See the application schematics on recommended decouple capacitors from V_{CC} pins to ground

10.2.1.3 Application Curves

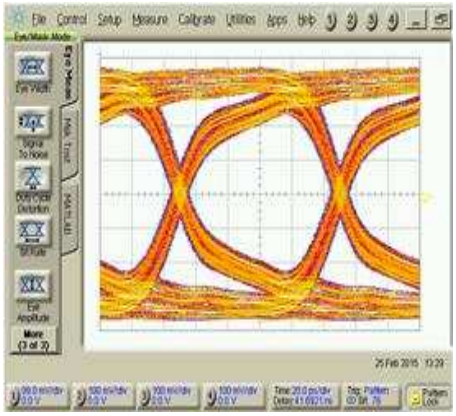


Figure 9. 10 Gbps Source Eye Diagram

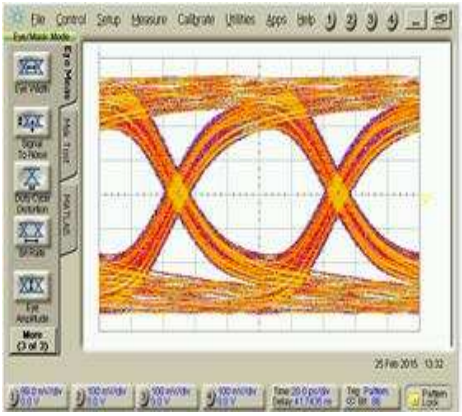


Figure 10. 10 Gbps Output Eye Diagram

10.2.2 Up Facing Port for USB3.1 Type C

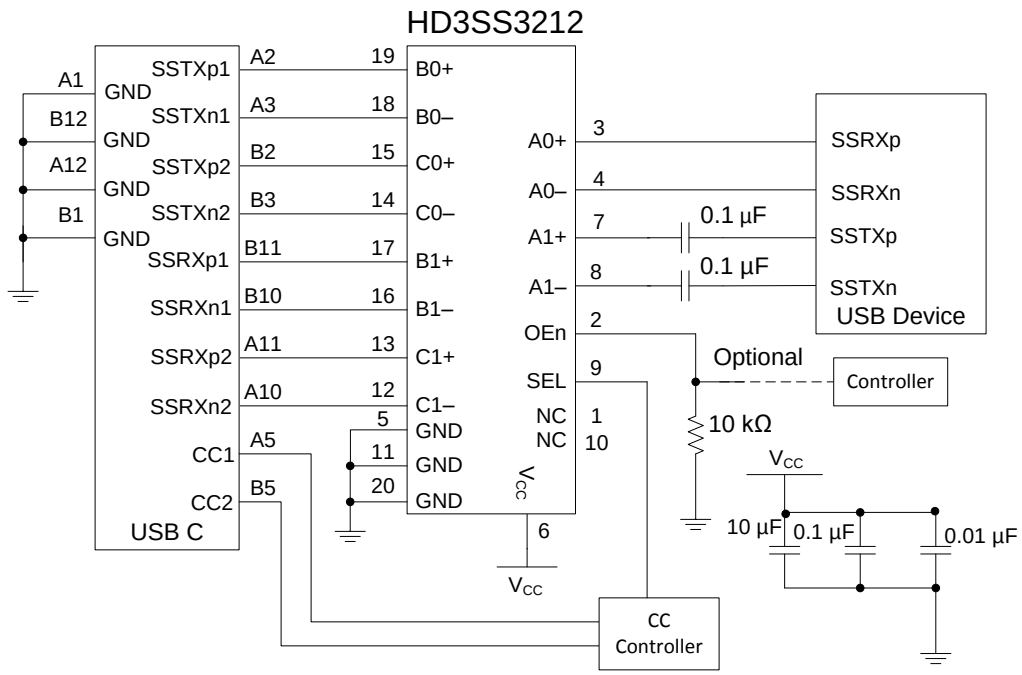


Figure 11. Up Facing Port for USB3.1 USB Type-C Connector

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10.2.3 PCIE/SATA/USB

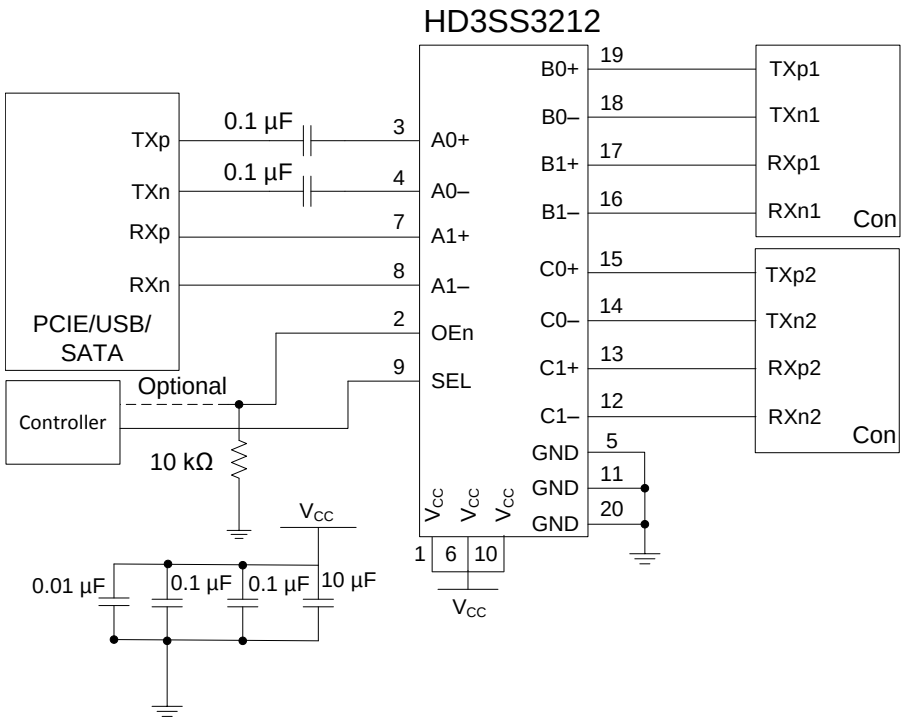


Figure 12. PCIE Motherboard

10.2.4 PCIE/eSATA

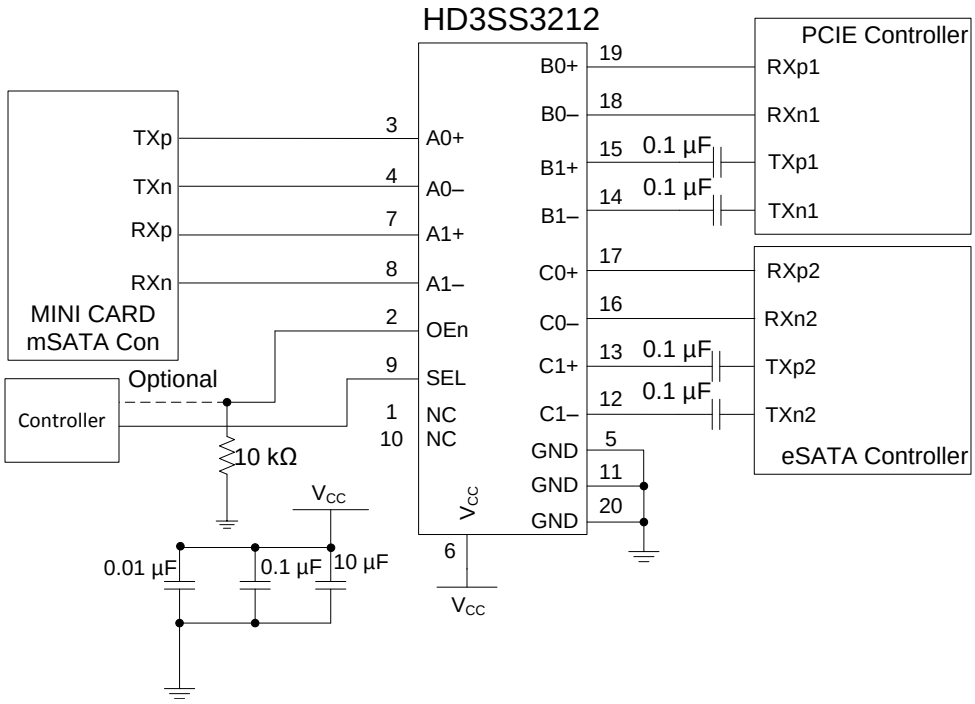


Figure 13. PCIE and eSATA Combo

10.2.5 USB/eSATA

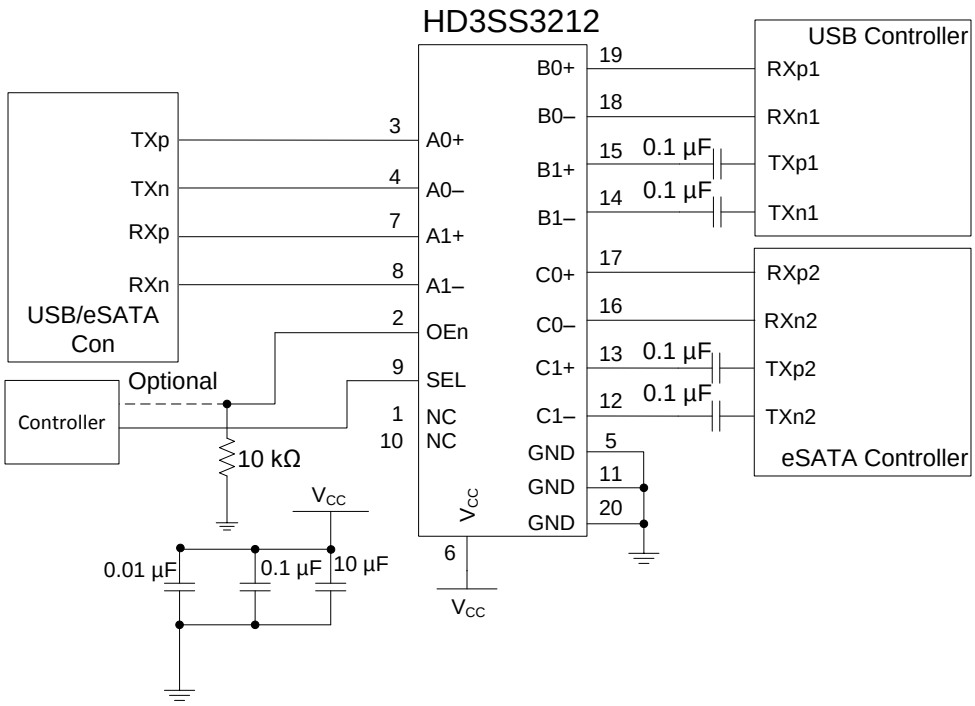


Figure 14. eSATA and USB 3.0 Combo Connector

10.2.6 MIPI Camera Serial Interface

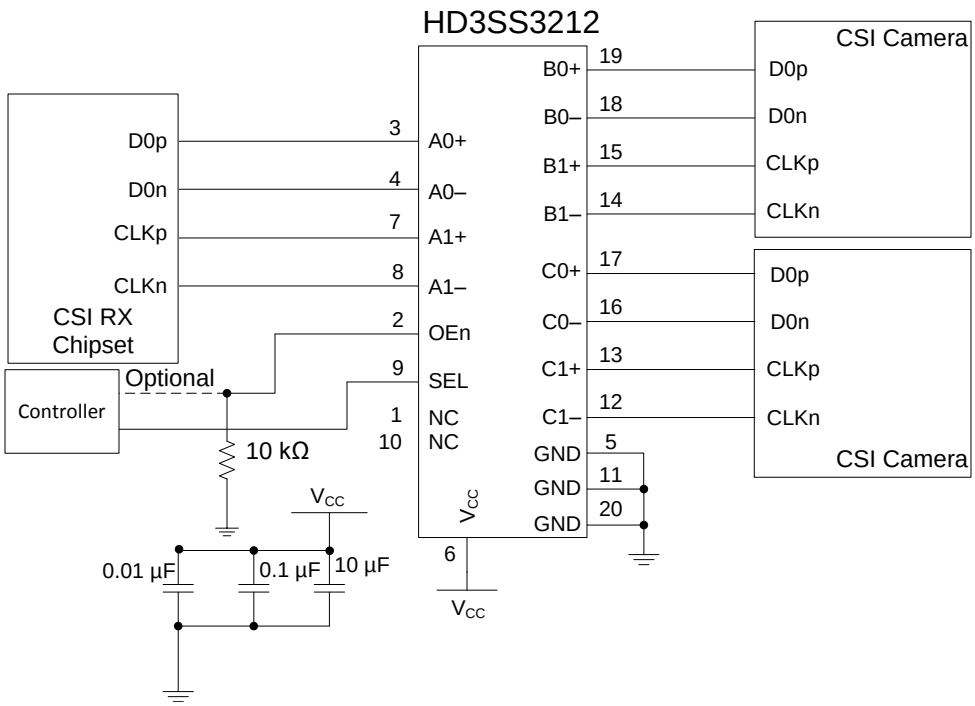


Figure 15. CSI Camera Array

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11 Power Supply Recommendations

The HD3SS3212 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.

12 Layout

12.1 Layout Guidelines

On a high-K board, TI always recommends to solder the PowerPAD™ onto the thermal land. A thermal land is the area of solder-tinned-copper underneath the PowerPAD package. On a high-K board, the HD3SS3212 can operate over the full temperature range by soldering the PowerPAD onto the thermal land without vias.

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 PowerPAD packages is provided in *PowerPAD Thermally-Enhanced Package*, SLMA002.

12.2 Layout Example

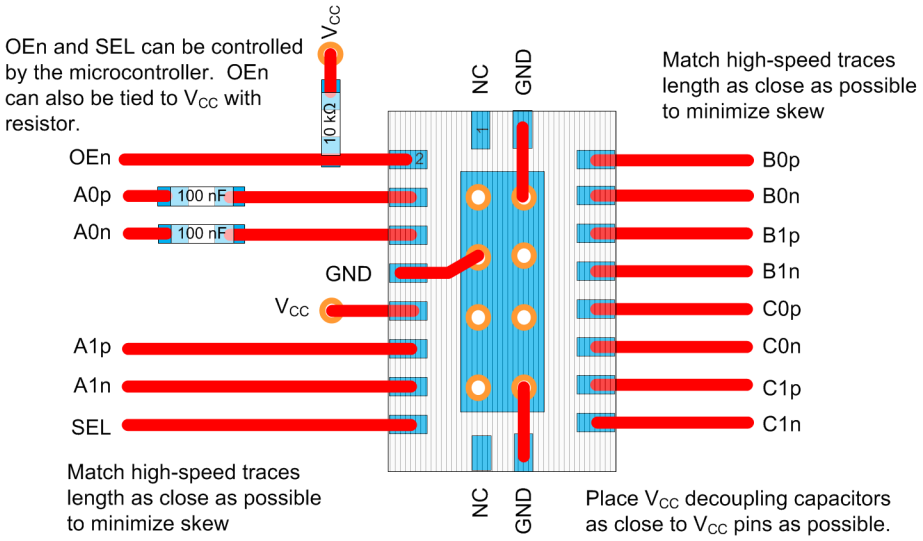


Figure 16. HD3SS3212 Basic Layout Example for Application Shown in *Down Facing Port for USB3.1 Type C*

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13 Device and Documentation Support

13.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 3. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
HD3SS3212	Click here	Click here	Click here	Click here	Click here
HD3SS3212I	Click here	Click here	Click here	Click here	Click here

13.2 Community Resources

The following links connect to TI community resources. Linked contents are 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.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

13.3 Trademarks

PowerPAD, E2E are trademarks of Texas Instruments.
All other trademarks are the property of their respective owners.

13.4 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

13.5 Glossary

SLYZ022 — *TI Glossary*.

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

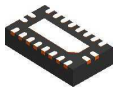
14 Mechanical, Packaging, and Orderable Information

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.

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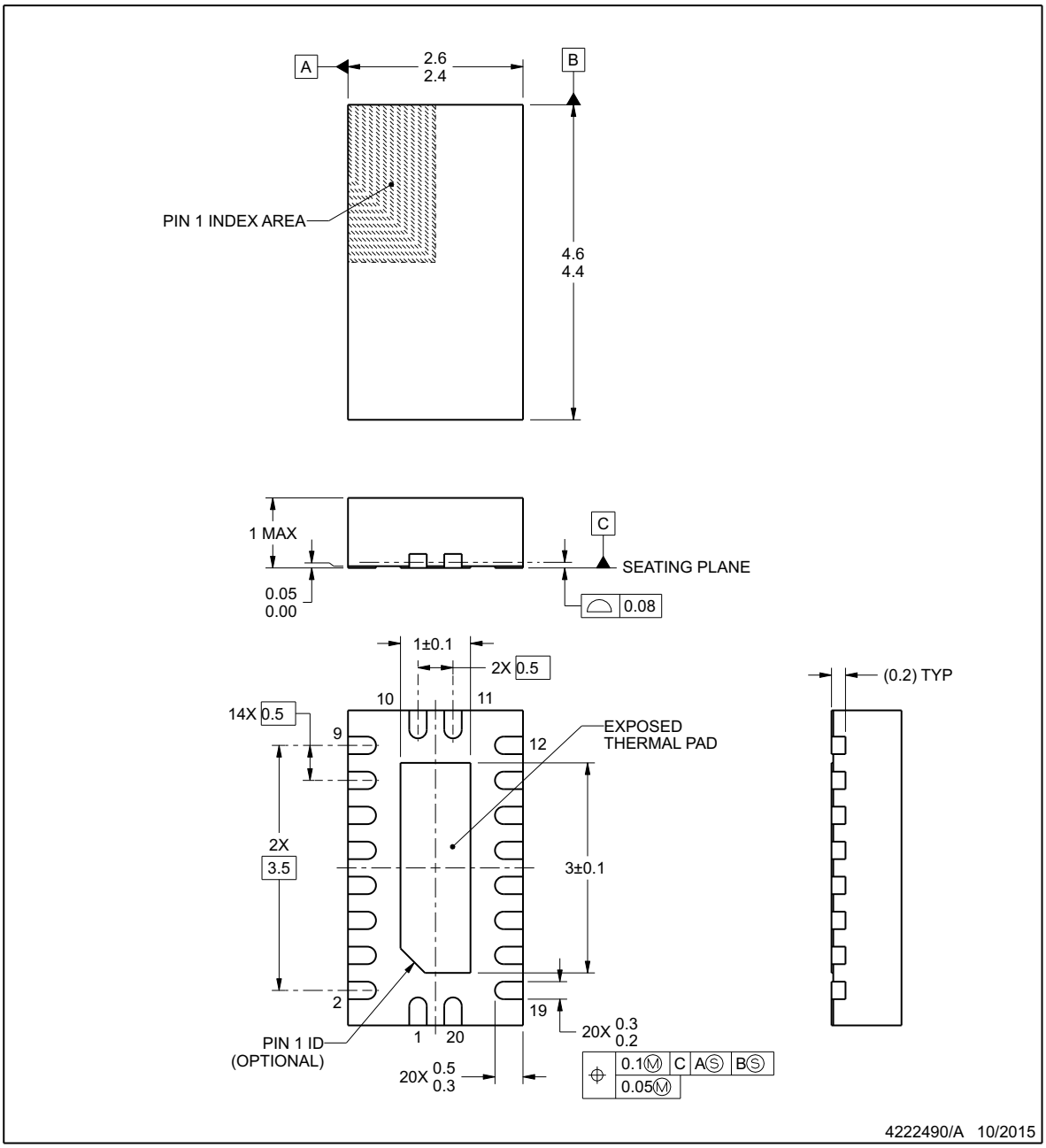
PACKAGE OUTLINE

RKS0020A



VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



NOTES:

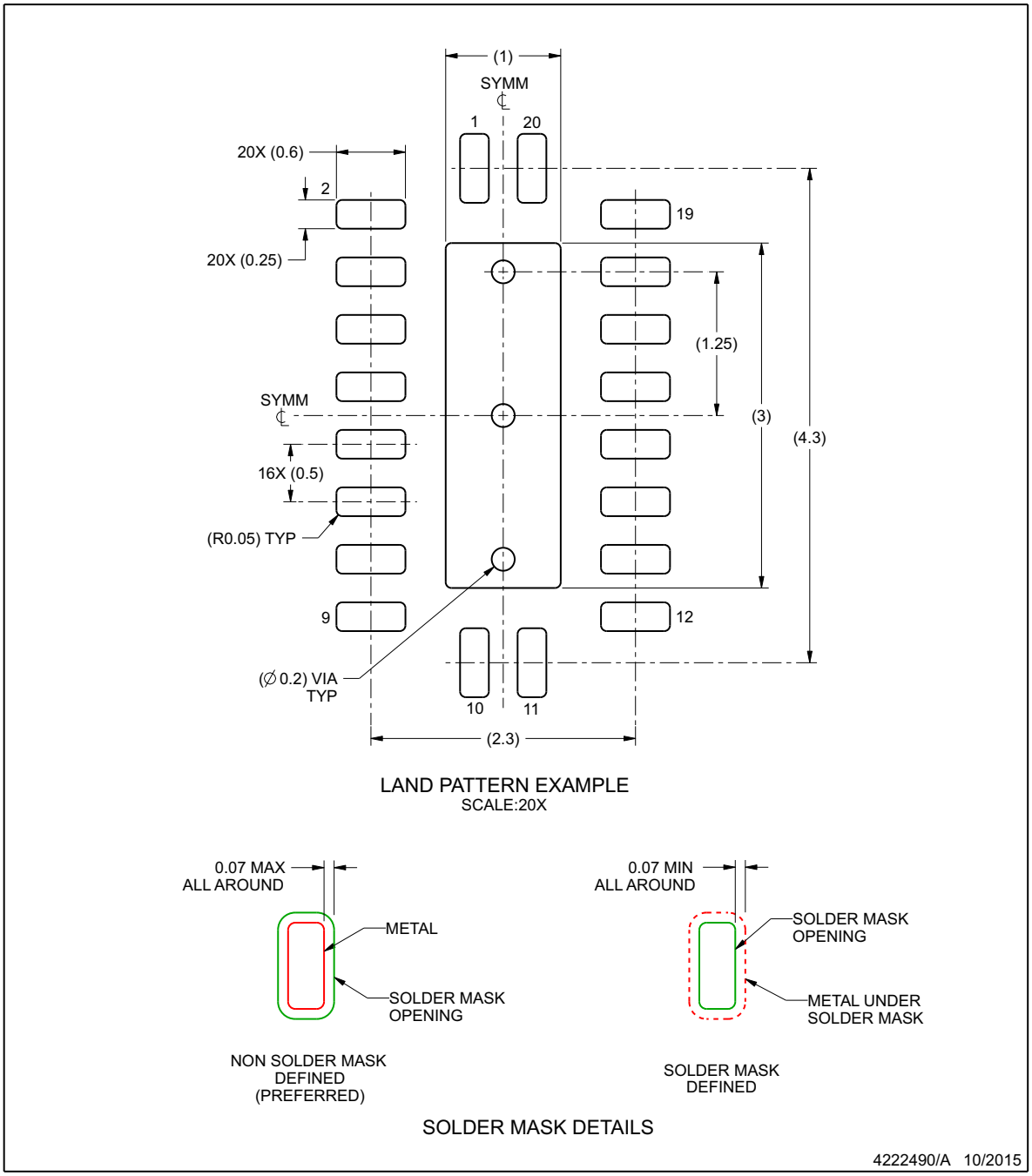
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

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EXAMPLE BOARD LAYOUT

RKS0020A — **VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



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.

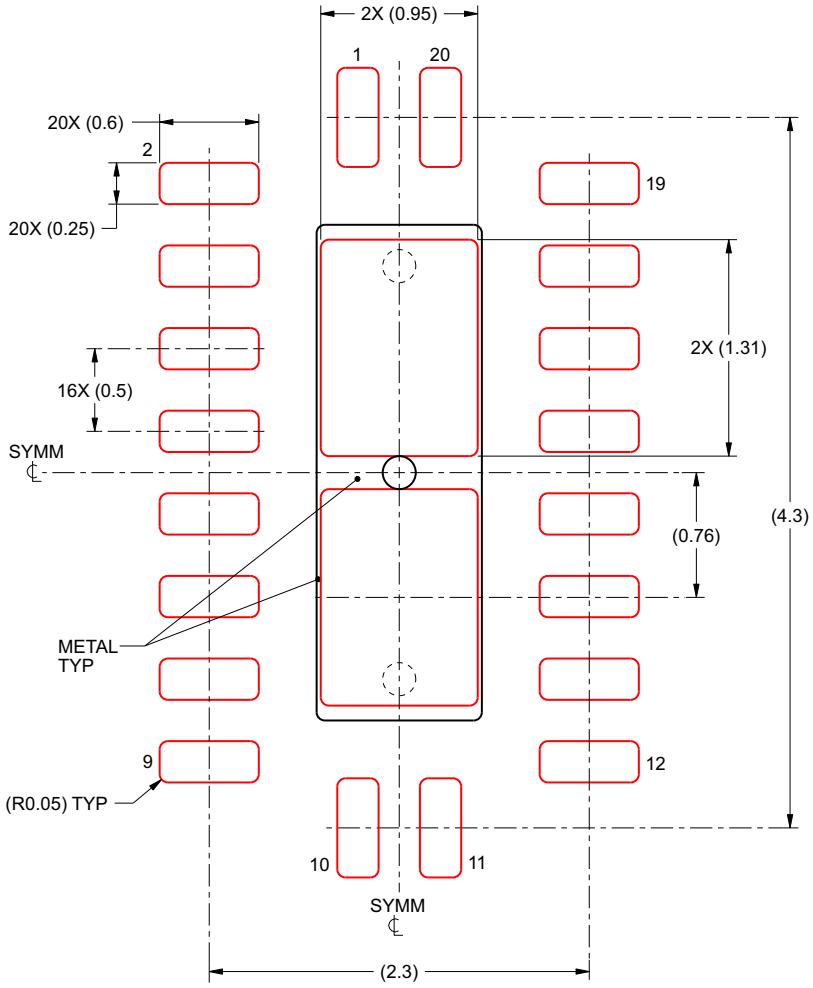
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EXAMPLE STENCIL DESIGN

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.

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
HD3SS3212IRKSR	ACTIVE	VQFN	RKS	20	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	HD3212I	Samples
HD3SS3212IRKST	PREVIEW	VQFN	RKS	20	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	HD3212I	
HD3SS3212RKSR	ACTIVE	VQFN	RKS	20	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	0 to 70	HDS3212	Samples
HD3SS3212RKST	PREVIEW	VQFN	RKS	20	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	0 to 70	HDS3212	

(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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(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.

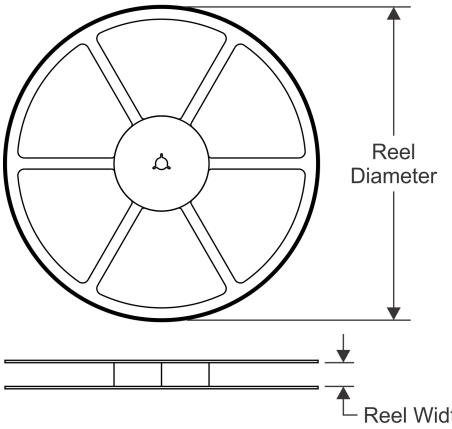
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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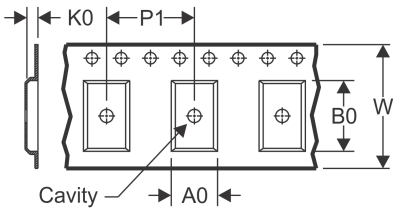
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TAPE AND REEL INFORMATION

REEL DIMENSIONS

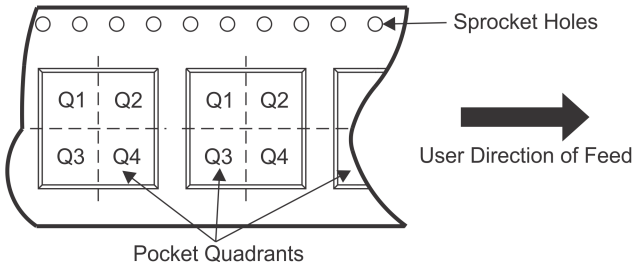


TAPE DIMENSIONS



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

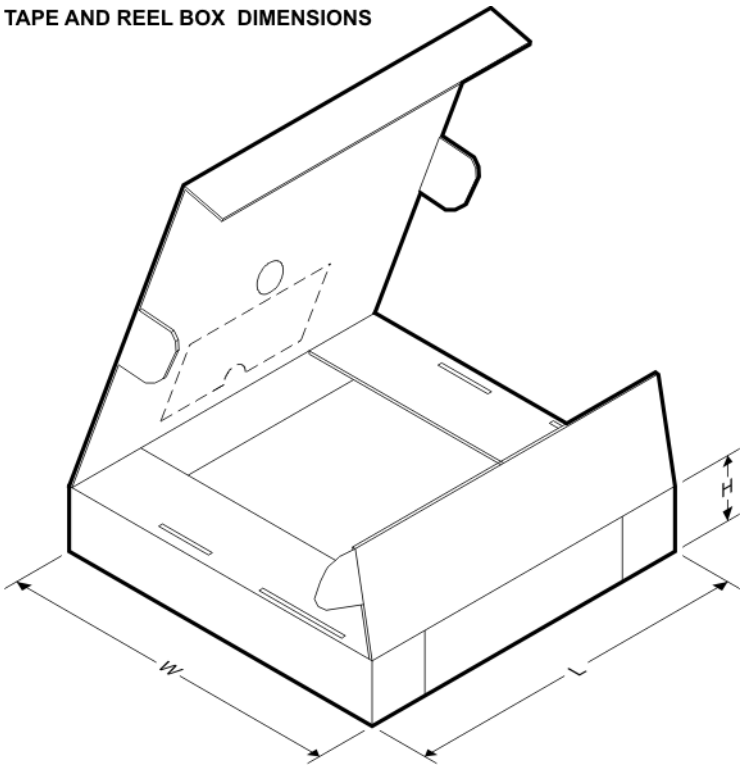
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
HD3SS3212IRKSR	VQFN	RKS	20	3000	177.8	12.4	2.73	4.85	1.03	4.0	12.0	Q1
HD3SS3212RKSR	VQFN	RKS	20	3000	177.8	12.4	2.73	4.85	1.03	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)
HD3SS3212IRKSR	VQFN	RKS	20	3000	223.0	270.0	35.0
HD3SS3212RKSR	VQFN	RKS	20	3000	223.0	270.0	35.0

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Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
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