DPDT USB 2.0 High-Speed (480Mbps) and Mobile High-Definition Link (MHL) Switch with ID Select and Flexible Power Control

Check for Samples: TS3USB3200

FEATURES

- **V_{CC} Range: 2.7V to 4.3V**
- **Mobile High-definition Link (MHL) Switch**
  - **Bandwidth (–3dB): 6 GHz**
  - **Ron (Typ): 5.7Ω**
  - **Con (Typ): 2.5pF**
- **USB Switch**
  - **Bandwidth (–3dB): 6 GHz**
  - **Ron (Typ): 4.6Ω**
  - **Con (Typ): 2.5pF**
- **Current Consumption: 40µA Typ**
- **Special Features**
  - **Flexible Power Control: Device can be Powered by V_{BUS} Without V_{CC} or by V_{CC} Alone**
  - **I_{OFF} Protection Prevents Current Leakage in Powered Down State (V_{CC} and V_{BUS}= 0 V)**
  - **1.8-V Compatible Control Inputs (SEL1, SEL2, and PSEL)**
  - **Over-Voltage Tolerance (OVT) on all I/O Pins up to 5.5V Without External Components**
- **ESD Performance:**
  - **3.5kV Human Body Model (A114B, Class II)**
  - **1kV Charged Device Model (C101)**
- **Package:**
  - **16-pin QFN Package (2.6 x 1.8 mm, 0.4 mm Pitch)**

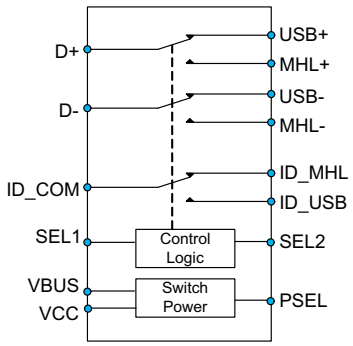
DESCRIPTION

The TS3USB3200 is a double-pole, double throw (DPDT) multiplexer that includes a high speed Mobile High-Definition Link (MHL) switch and a USB 2.0 High-Speed (480Mbps) switch in the same package. Additionally included is a single-pole, double throw (SPDT) USB/MHL ID switch for easy information control. These configurations allow the system designer to use a common USB or Mico-USB connector for both MHL video signals and USB data.

The TS3USB3200 has a V_{CC} range of 2.7V to 4.3V and also has the option to be powered by V_{BUS} without V_{CC}. The device supports a over-voltage tolerance (OVT) feature which allows the I/O pins to withstand over-voltage conditions (up to 5.5V). The power-off protection feature forces all I/O pins to be in high impedance mode when power is not present. This allows full isolation of the signals lines without excessive leakage current. The select pins of TS3USB3200 are compatible with 1.8V control voltage, allowing them to be directly interfaced with the General Purpose I/O (GPIO) from a mobile processor.

The TS3USB3200 comes with a small 16-pin QFN package (2.6mm x 1.8mm in size), which makes it a perfect candidate for mobile applications.

SWITCH DIAGRAM



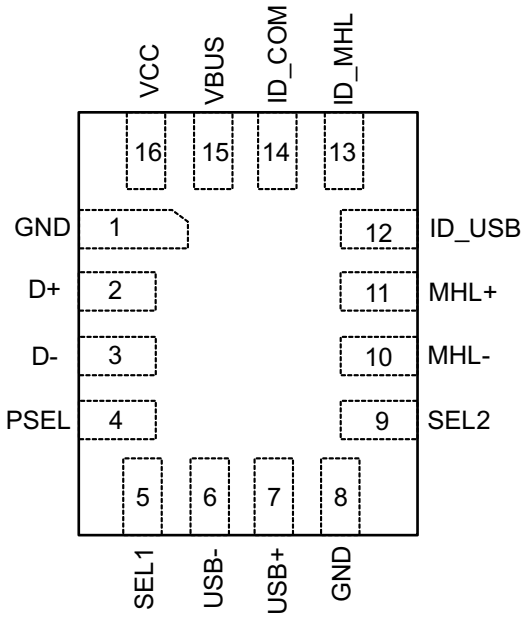
ORDERING INFORMATION

T_A	PACKAGE		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	QFN– RSV	Tape and reel	TS3USB3200RSVR	ZTO

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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.

PIN DESCRIPTION



PIN FUNCTIONS

PIN			DESCRIPTION
NO.	NAME	TYPE	
1	GND	Ground	Ground
2	D+	I/O	Data Switch Output (Differential +)
3	D–	I/O	Data Switch Output (Differential –)
4	PSEL	Input	Power Source Select Line
5	SEL1	Input	Control Input Select Line 1
6	USB–	I/O	USB Data (Differential –)
7	USB+	I/O	USB Data (Differential +)
8	GND	Ground	Ground
9	SEL2	Input	Control Input Select Line 2
10	MHL–	I/O	MHL Data (Differential–)
11	MHL+	I/O	MHL Data (Differential +)
12	ID_USB	I/O	ID Output for USB
13	ID_MHL	I/O	ID Output for MHL
14	ID_COM	I/O	ID Common
15	V_{BUS}	Power	Alternative Device Power
16	V_{CC}	Power	Power supply

Table 1. Function Table (Power Source)

V_{CC}	V_{BUS}	PSEL(1)	POWER SOURCE
L	L	X	No Power. All I/O in High-Z
L	H	X	V_{BUS}
H	L	X	V_{CC}
H	H	L	V_{CC}
H	H	H	V_{BUS}

(1) The PSEL pin has 6MΩ weak pull-down resistor to GND to make its default value to be LOW.

Table 2. Function Table (Signal and ID Select)

SEL1(1)	SEL2(1)	CONNECTION	High-Z
L	L	D+/D– to USB+/USB–, ID_COM to ID_USB	MHL+/MHL–, ID_MHL
L	H	D+/D– to USB+/USB–, ID_COM to ID_MHL	MHL+/MHL–, ID_USB
H	L	D+/D– to MHL+/MHL–, ID_COM to ID_USB	USB+/USB–, ID_MHL
H	H	D+/D– to MHL+/MHL–, ID_COM to ID_MHL	USB+/USB–, ID_USB

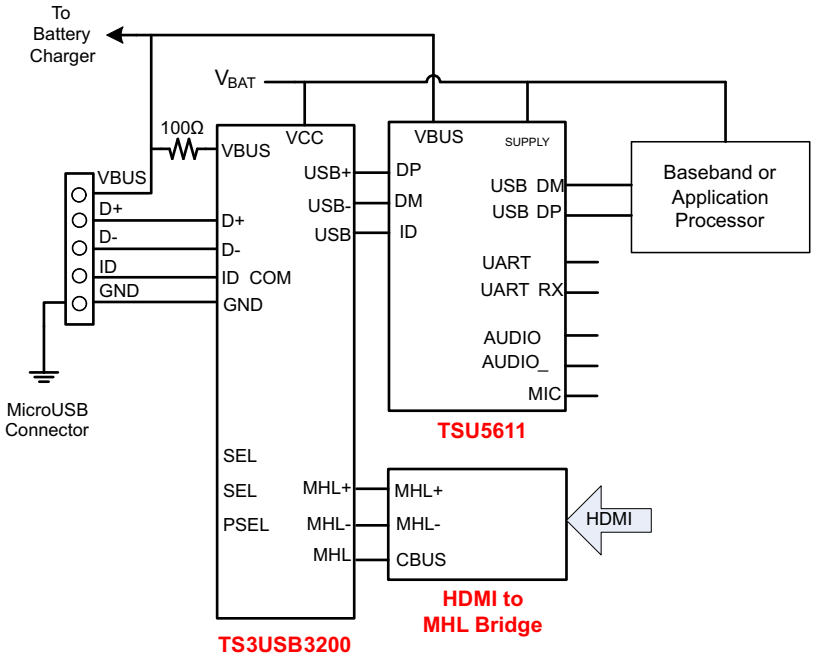
(1) The SEL1 and SEL2 pins have 6MΩ weak pull-down resistor to GND to make their default value to be LOW.

Table 3. Summary of Typical Characteristics

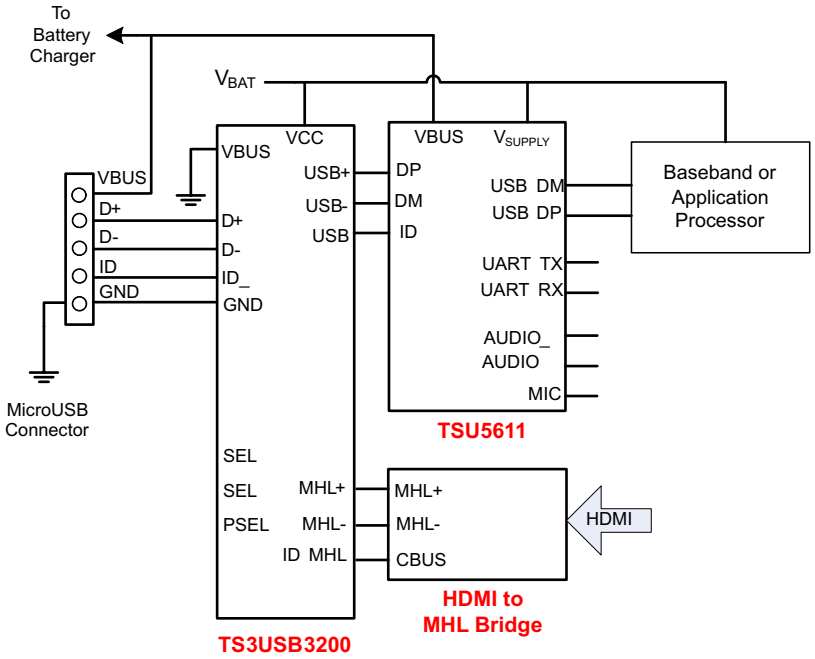
	MHL PATH	USB PATH	ID PATH
Number of switches	2	2	2
ON-state resistance (r_{on})	5.7 Ω	4.6 Ω	6.5 Ω
ON-state resistance match (Δr_{on})	<0.4 Ω	<0.4 Ω	<0.4 Ω
ON-state capacitance ($C_{I/O}$,on)	2.5 pF	2.5 pF	3.0 pF
Bandwidth (BW)	6 GHz	6 GHz	2.2 GHz

TYPICAL APPLICATION

During manufacturing test when battery power is not available, the TS3USB3200 can be configured, as shown in the figure below, to be powered by VBUS through the microUSB connector. The control pins (SEL1 and SEL2) have built-in 6MΩ pull-down resistors to ensure the USB paths are enabled for TS3USB3200 and allow connectivity to the TSU5611 USB accessory switch.



The TS3USB3200 can also be powered by the mobile device's standalone battery. The diagram below shows a typical implementation. The VBUS pin of the TS3USB3200 can simply be grounded under such conditions.



ABSOLUTE MAXIMUM RATINGS(1)(2)

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

			MIN	MAX	UNIT
V_{CC} ,V_{BUS}	Supply voltage range(3)		–0.3	5.5	V
$V_{I/O}$	Input/Output DC voltage Range(3)		–0.3	5.5	V
I_K	Input/Output port diode current	$V_{I/O}$ < 0	–50		mA
V_I	Digital input voltage range (SEL1, SEL2, PSEL)		–0.3	5.5	V
I_{IK}	Digital logic input clamp current(3)	V_I < 0	–50		mA
I_{CC}	Continuous current through V_{CC}			100	mA
I_{GND}	Continuous current through GND		–100		mA
T_{stg}	Storage temperature range		–65	150	°C

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
(2) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum.
(3) All voltages are with respect to ground, unless otherwise specified.

PACKAGE THERMAL IMPEDANCE(1)

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

			TYP	UNIT
θ_{JA}	Package thermal impedance	RSV package	184	°C/W

(1) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V_{CC}	Supply voltage range	2.7	4.3	V
V_{BUS}	V_{BUS} Supply voltage range	4.3	5.5	V
$V_{I/O\ (USB)}$ $V_{I/O\ (ID)}$	Analog voltage range	0	3.6	V
$V_{I/O\ (MHL)}$		1.6	3.4	V
V_I	Digital input voltage range (SEL1, SEL2, PSEL)	0	V_{CC}	V
$T_{RAMP\ (VCC)}$	Power supply ramp time requirement (V_{CC})	100	1000	µs/V
$T_{RAMP\ (VBUS)}$	Power supply ramp time requirement (V_{BUS})	100	1000	µs/V
T_A	Operating free-air temperature	–40	85	ºC

ELECTRICAL CHARACTERISTICS

T_A =–40°C to 85°C, Typical values are at V_{CC} = 3.3V, T_A=25°C, (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
MHL SWITCH							
R_{ON}	ON-state resistance	V_{CC} = 2.7V	$V_{I/O}$ = 1.6V, I_{ON} = –8mA		5.7		Ω
ΔR_{ON}	ON-state resistance match between + and –paths	V_{CC} = 2.7V	$V_{I/O}$ = 1.6V, I_{ON} = –8mA		0.4		Ω
$R_{ON\ (FLAT)}$	ON-state resistance flatness	V_{CC} = 2.7V	$V_{I/O}$ = 1.6V to 3.4V, I_{ON} = –8mA		1		Ω
I_{OZ}	OFF leakage current	V_{CC} = 4.3V	Switch OFF, $V_{MHL+/MHL–}$ = 1.6V to 3.4V, $V_{D+/D–}$ = 0 V	–2		2	µA
I_{OFF}	Power-off leakage current	V_{CC} = 0V	Switch ON or OFF, $V_{MHL+/MHL–}$ = 1.6V to 3.4V, $V_{D+/D–}$ = NC	–10		10	µA
I_{ON}	ON leakage current	V_{CC} = 4.3V	Switch ON, $V_{MHL+/MHL–}$ = 1.6V to 3.4V, $V_{D+/D–}$ = NC	–2		2	µA
USB SWITCH							
R_{ON}	ON-state resistance	V_{CC} = 2.7V	$V_{I/O}$ = 0.4V, I_{ON} = –8mA		4.6		Ω
ΔR_{ON}	ON-state resistance match between + and - paths	V_{CC} = 2.7V	$V_{I/O}$ = 0.4V, I_{ON} = –8mA		0.4		Ω

ELECTRICAL CHARACTERISTICS (continued)

T_A =–40°C to 85°C, Typical values are at V_{CC} = 3.3V, T_A=25°C, (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$R_{ON\ (FLAT)}$	ON-state resistance flatness	V_{CC} = 2.7V	$V_{I/O}$ = 0V to 0.4V, I_{ON} = –8mA		1		Ω
I_{OZ}	OFF leakage current	V_{CC} = 4.3V	Switch OFF, $V_{USB+/USB–}$ = 0V to 4.3V, $V_{D+/D–}$ = 0V	–2		2	µA
I_{OFF}	Power-off leakage current	V_{CC} = 0V	Switch ON or OFF, $V_{USB+/USB–}$ = 0V to 4.3V, $V_{D+/D–}$ = NC	–10		10	µA
I_{ON}	ON leakage current	V_{CC} = 4.3V	Switch ON, $V_{USB+/USB–}$ = 0V to 4.3V, $V_{D+/D–}$ = NC	–2		2	µA
ID SWITCH							
R_{ON}	ON-state resistance	V_{CC} = 2.7V	$V_{I/O}$ = 3.3V, I_{ON} = –8mA		6.5		Ω
ΔR_{ON}	ON-state resistance match between + and - paths	V_{CC} = 2.7V	$V_{I/O}$ = 3.3V, I_{ON} = –8mA		0.4		Ω
I_{OZ}	OFF leakage current	V_{CC} = 4.3V	Switch OFF, V_{ID_MHL/ID_USB} = 0V to 4.3V, V_{ID_COM} = 0V	–1		1	µA
I_{OFF}	Power-off leakage current	V_{CC} = 0V	Switch ON or OFF, V_{ID_MHL/ID_USB} = 0V to 4.3V, V_{ID_COM} = NC	–10		10	µA
I_{ON}	ON leakage current	V_{CC} = 4.3V	Switch ON, V_{ID_MHL/ID_USB} = 0V to 4.3V, V_{ID_COM} = 0V	–1		1	µA
DIGITAL CONTROL INPUTS (SEL1, SEL2, PSEL)							
V_{IH}	Input logic high	V_{CC} = 2.7V to 4.3V		1.3			V
V_{IL}	Input logic low	V_{CC} = 2.7V to 4.3V				0.6	V
I_{IN}	Input leakage current	V_{CC} = 4.3V, $V_{I/O}$ = 0V to 4.3V, V_{IN} = 0 to 2V		–10		10	µA

DYNAMIC CHARACTERISTICS

T_A = –40°C to 85°C, Typical values are at V_{CC} = 3.3V, T_A=25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
MHL(1)/USB/ ID SWITCH							
t_{pd}	Propagation Delay	R_L = 50 Ω, C_L = 5 pF	V_{CC} = 2.7V to 4.3V		0.1		ns
t_{ON}	Turn-on time	R_L = 50 Ω, C_L = 5 pF	V_{CC} = 2.7V to 4.3V			400	ns
t_{OFF}	Turn-off time	R_L = 50 Ω, C_L = 5 pF	V_{CC} = 2.7V to 4.3V			400	ns
$t_{SK(P)}$	Skew of opposite transitions of same output	V_{CC} = 2.7 V or 3.3V	V_{CC} = 2.7V to 4.3V		0.1	0.2	ns
$C_{ON(MHL)}$	MHL path ON capacitance	V_{CC} = 3.3 V, $V_{I/O}$ = 0 or 3.3 V, f = 240 MHz	Switch ON		1.6		pF
$C_{ON(USB)}$	USB path ON capacitance	V_{CC} = 3.3 V, $V_{I/O}$ = 0 or 3.3 V, f = 240 MHz	Switch ON		1.4		pF
$C_{OFF(MHL)}$	MHL path OFF capacitance	V_{CC} = 3.3 V, $V_{I/O}$ = 0 or 3.3 V, f = 240 MHz	Switch OFF		1.4		pF
$C_{OFF(USB)}$	USB path OFF capacitance	V_{CC} = 3.3 V, $V_{I/O}$ = 0 or 3.3 V, f = 240 MHz	Switch OFF		1.6		pF
C_I	Digital input capacitance	V_{CC} = 3.3 V, V_I = 0 or 2V			2.2		pF
O_{ISO}	OFF Isolation	V_{CC} = 2.7 V to 4.3 V, R_L = 50 Ω, f = 240 MHz	Switch OFF		–35		dB
X_{TALK}	Crosstalk	V_{CC} = 2.7 V to 4.3 V, R_L = 50 Ω, f = 240 MHz	Switch ON		–35		dB
$BW_{(MHL)}$	MHL path –3dB bandwidth	V_{CC} = 2.7 V to 4.3 V, R_L = 50 Ω	Switch ON		6.0(1)		GHz
$BW_{(USB)}$	USB path –3dB bandwidth	V_{CC} = 2.7 V to 4.3 V, R_L = 50 Ω	Switch ON		6.0(1)		GHz
$BW_{(ID)}$	ID path –3dB bandwidth	V_{CC} = 2.7 V to 4.3 V, R_L = 50 Ω	Switch ON		4.0		GHz
SUPPLY							
V_{BUS}	V_{BUS} Power supply voltage			4.3		5.5	V
V_{CC}	Power supply voltage			2.7		4.3	V
I_{CC}	Positive supply current	V_{CC} = 4.3 V, V_{IN} = V_{CC} or GND, $V_{I/O}$ = 0 V	Switch ON or OFF		40	70	µA
$I_{CC,\ VBUS}$	Positive supply current (V_{BUS} Mode)	V_{CC} = 0 V, V_{BUS} = 5.5 V, V_{IN} = V_{CC} or GND, $V_{I/O}$ = 0 V	Switch ON or OFF			50	µA

(1) Specified by Design

TYPICAL CHARACTERISTICS

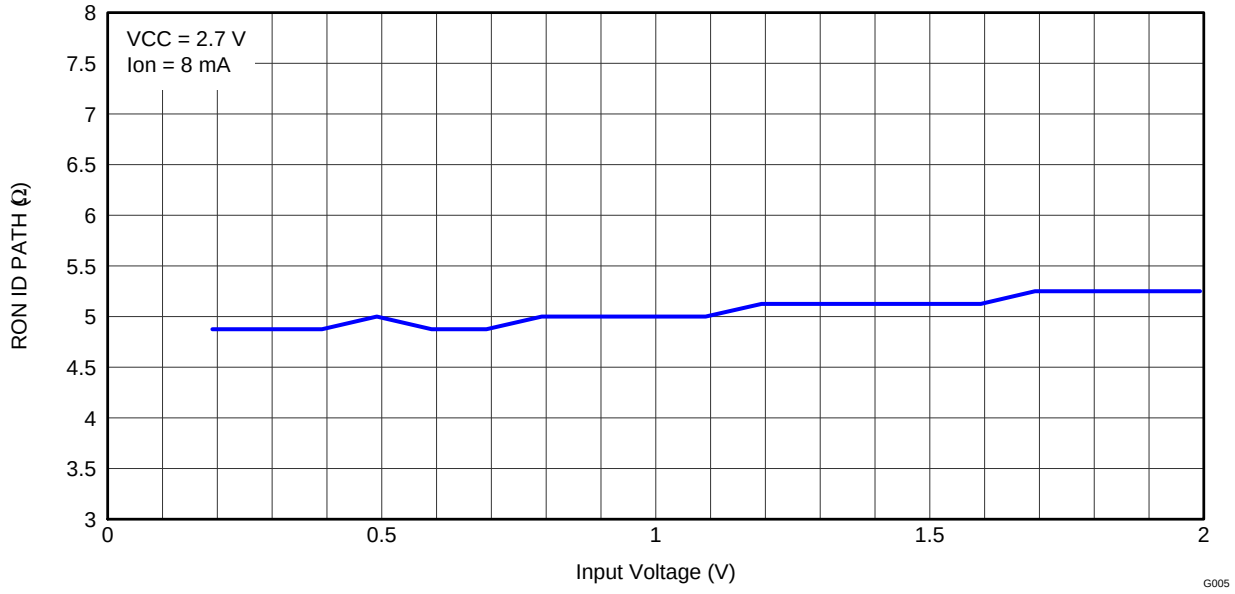


Figure 1. ON-Resistance vs. VI for MHL Switch

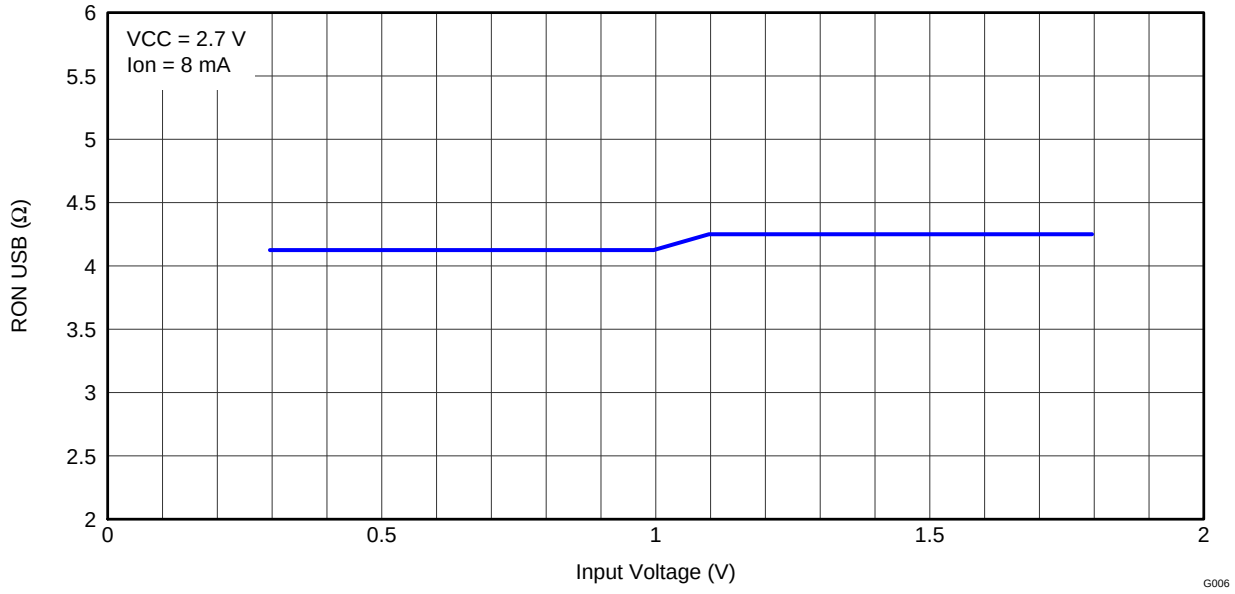


Figure 2. ON-Resistance vs. VI for USB Switch

TYPICAL CHARACTERISTICS (continued)

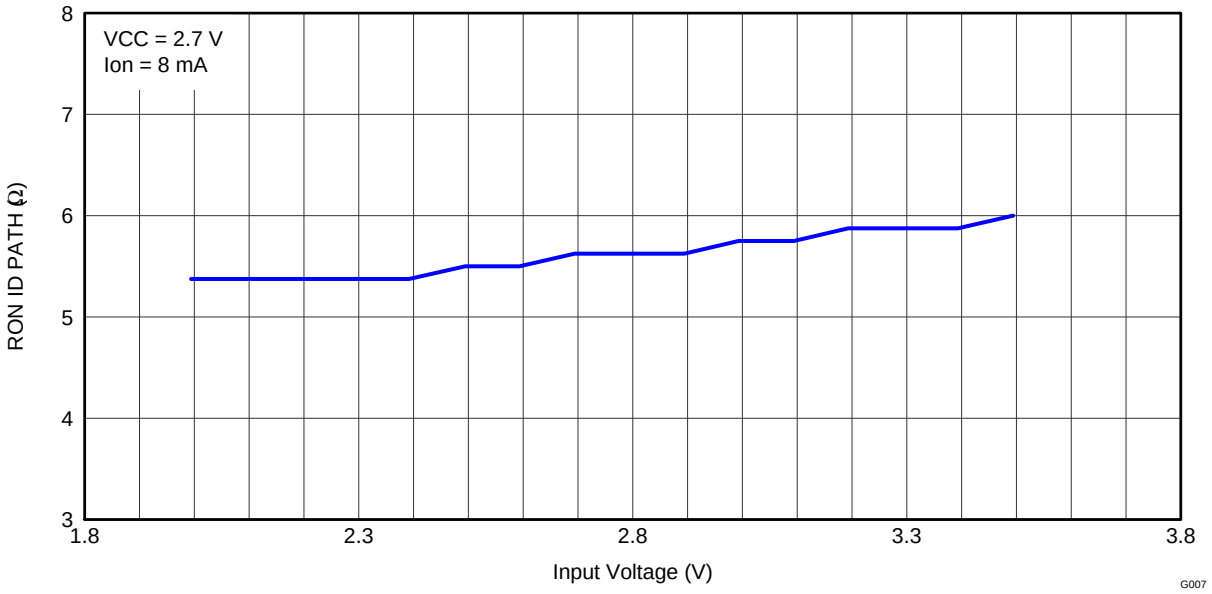
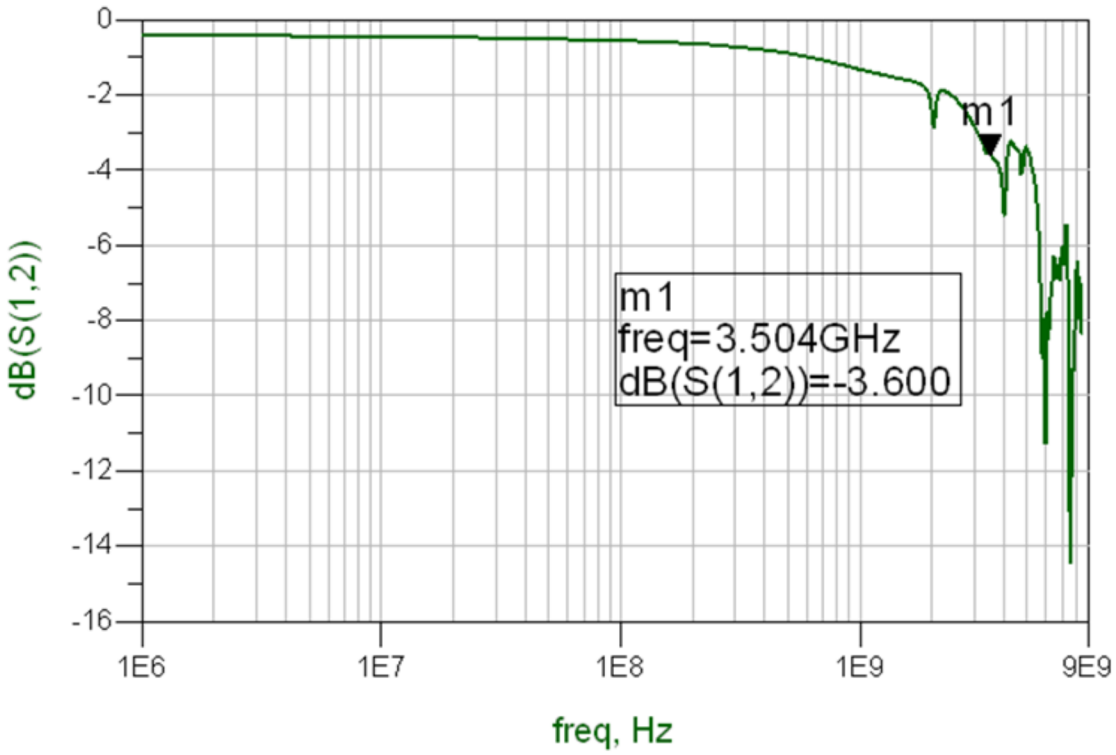


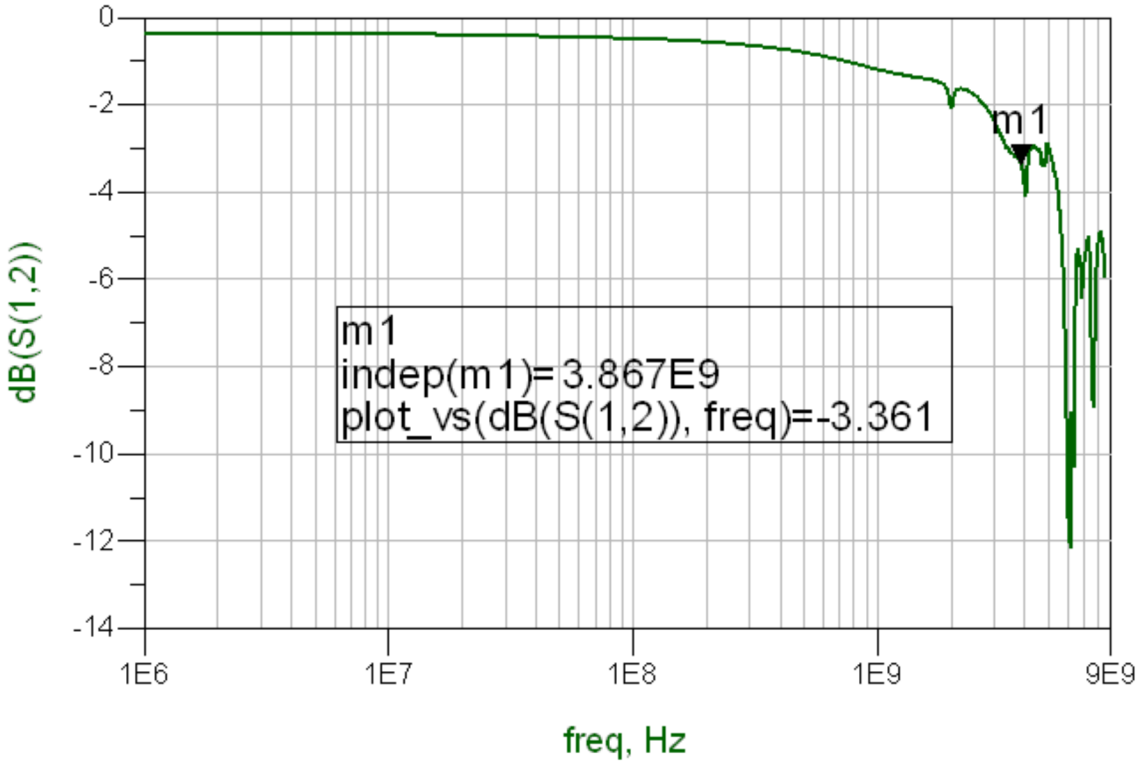
Figure 3. ON-Resistance vs. VI for ID Switch



*Gain vs. Frequency plot will be updated by July, 2012 when new characterization hardware becomes available

Figure 4. Gain vs. Frequency for MHL Switch*

TYPICAL CHARACTERISTICS (continued)



*Gain vs. Frequency plot will be updated by July, 2012 when new characterization board becomes available

Figure 5. Gain vs. Frequency for USB Switch*

TYPICAL CHARACTERISTICS (continued)

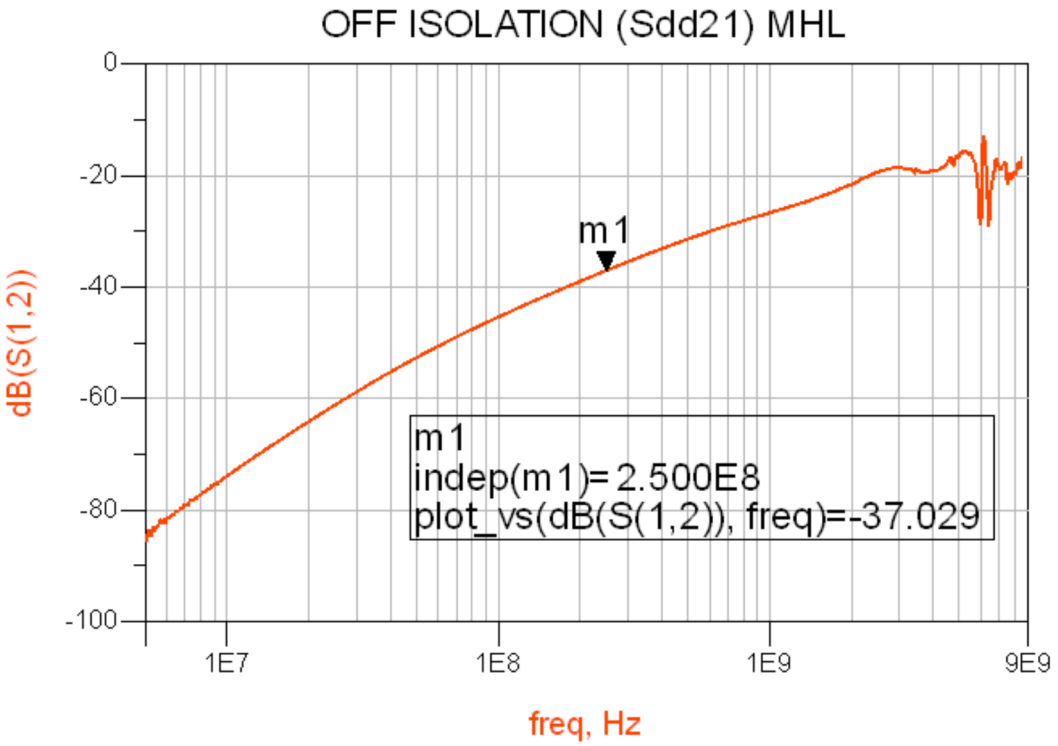


Figure 6. Off Isolation vs. Frequency for MHL Path

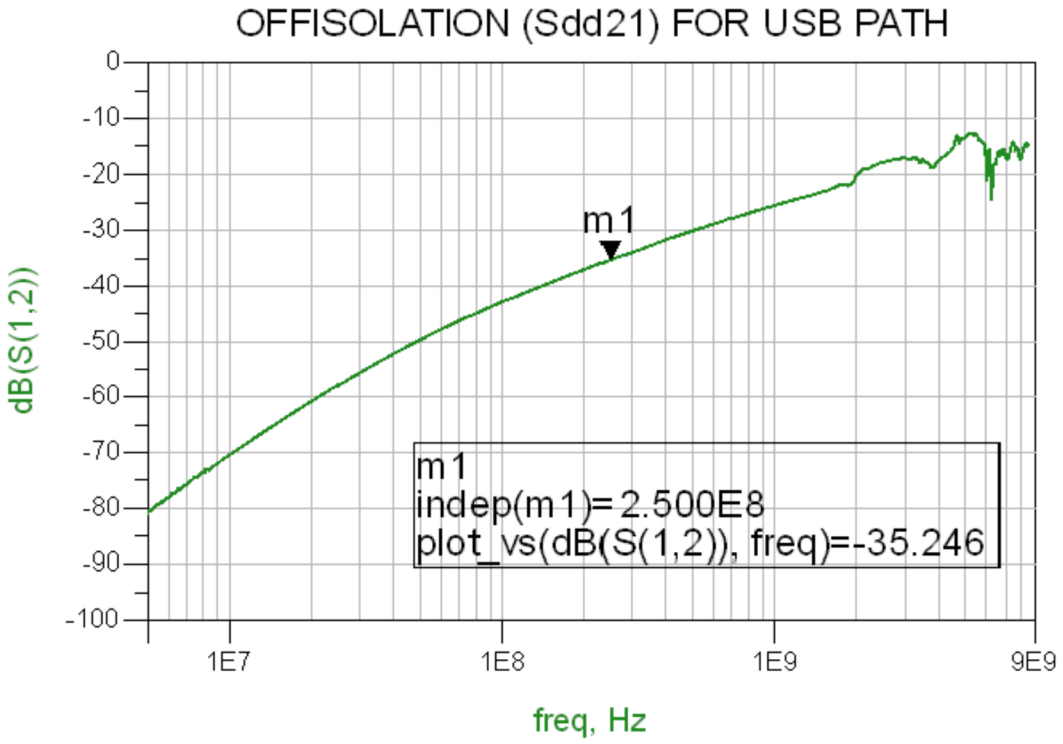


Figure 7. Off Isolation vs. Frequency for USB Path

TYPICAL CHARACTERISTICS (continued)

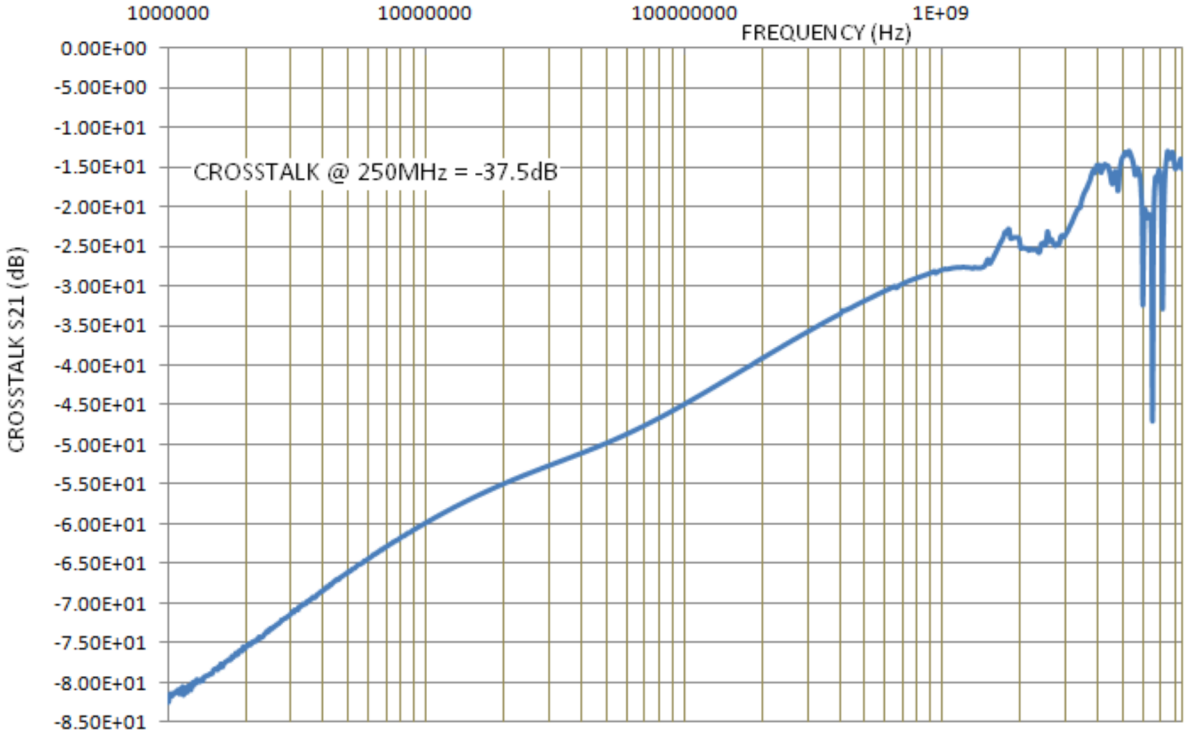


Figure 8. Cross talk vs. Frequency for MHL Path

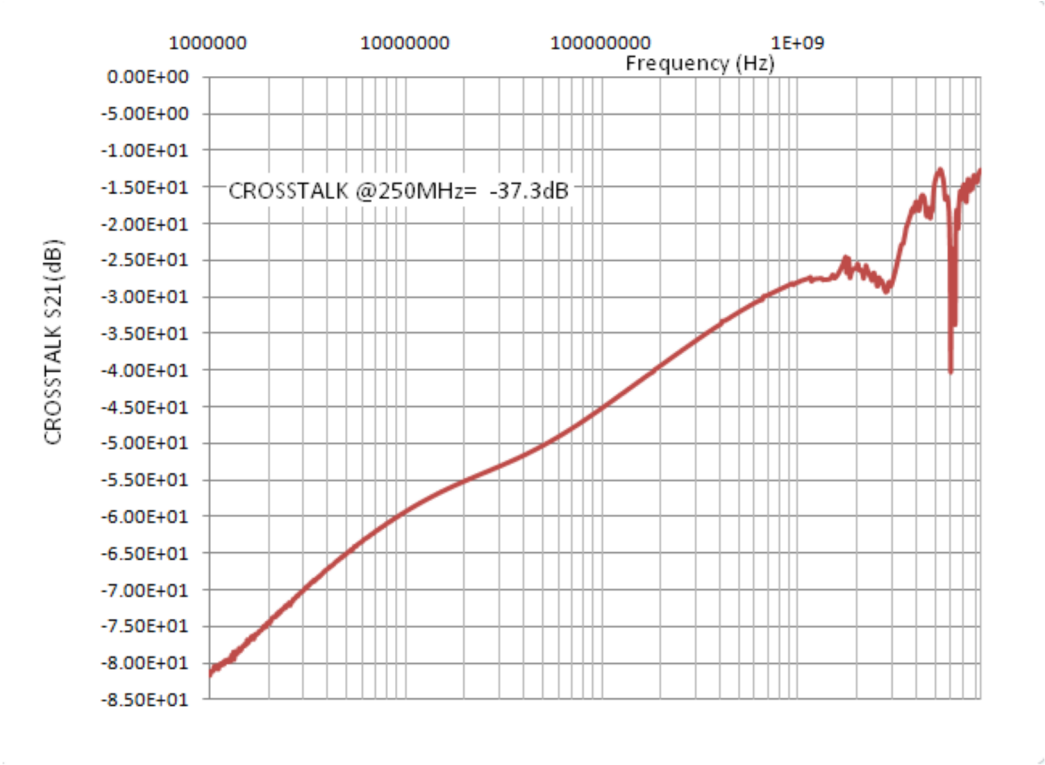


Figure 9. Cross talk vs. Frequency for USB Path

TYPICAL CHARACTERISTICS (continued)

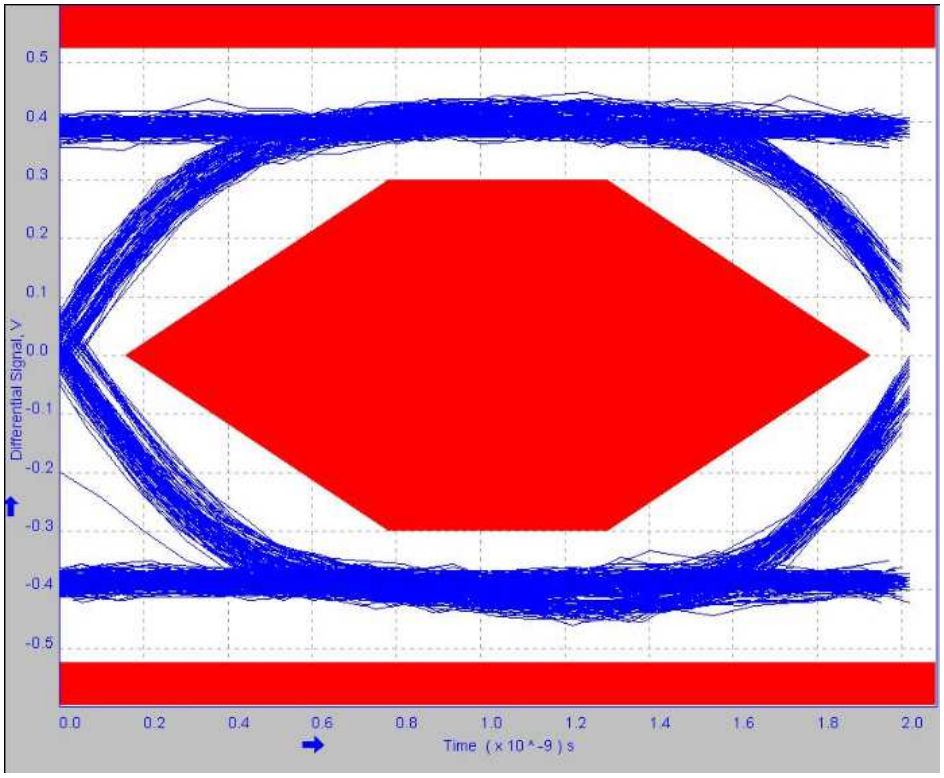


Figure 10. 480-Mbps USB 2.0 Eye Pattern with No Device

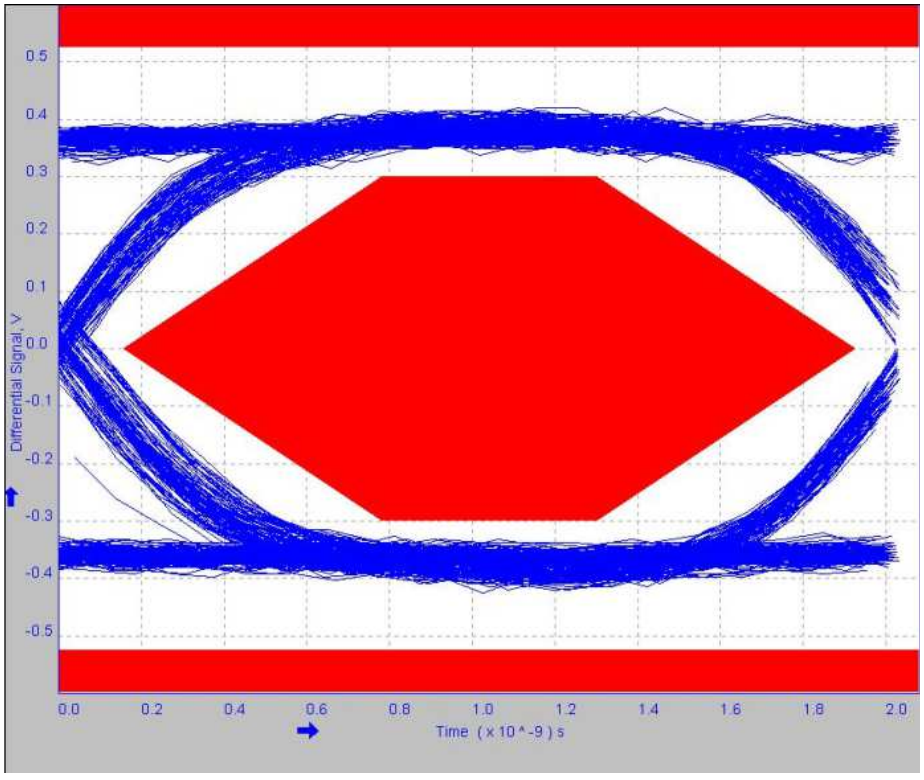


Figure 11. 480-Mbps USB 2.0 Eye Pattern for USB Switch

TYPICAL CHARACTERISTICS (continued)

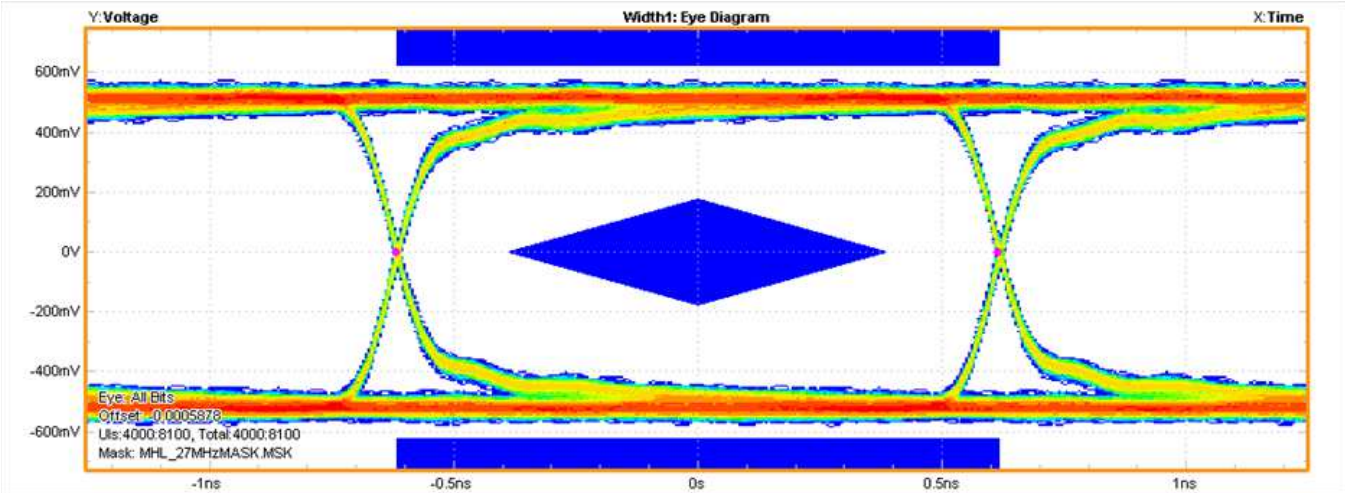


Figure 12. Eye Pattern: 0.7 Gbps MHL Eye Pattern for With No Device

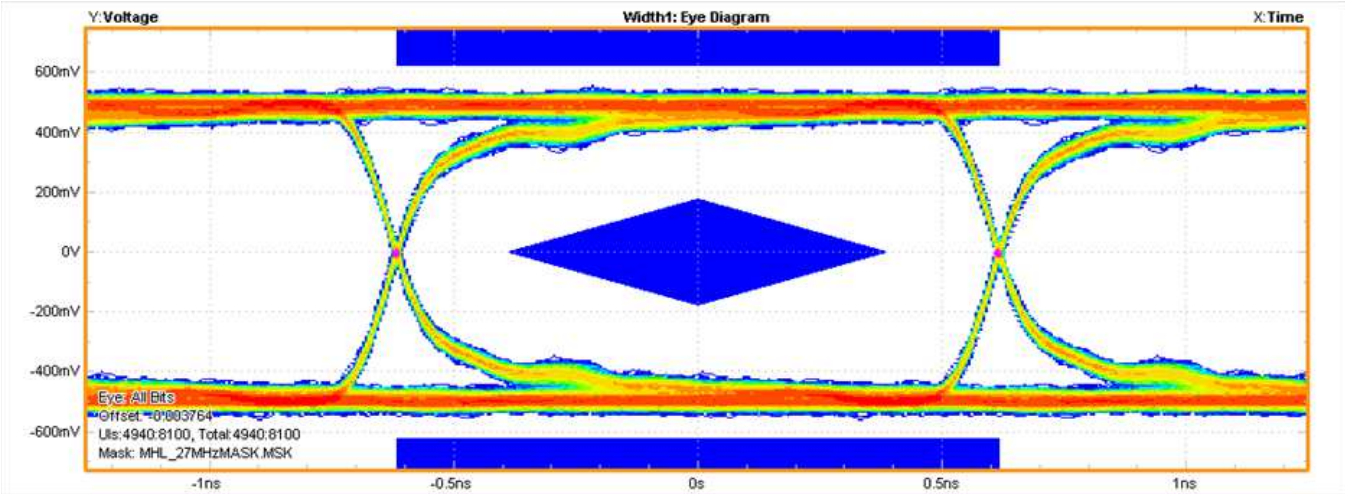


Figure 13. Eye Pattern: 0.7 Gbps MHL Eye Pattern for MHL Switch

TYPICAL CHARACTERISTICS (continued)

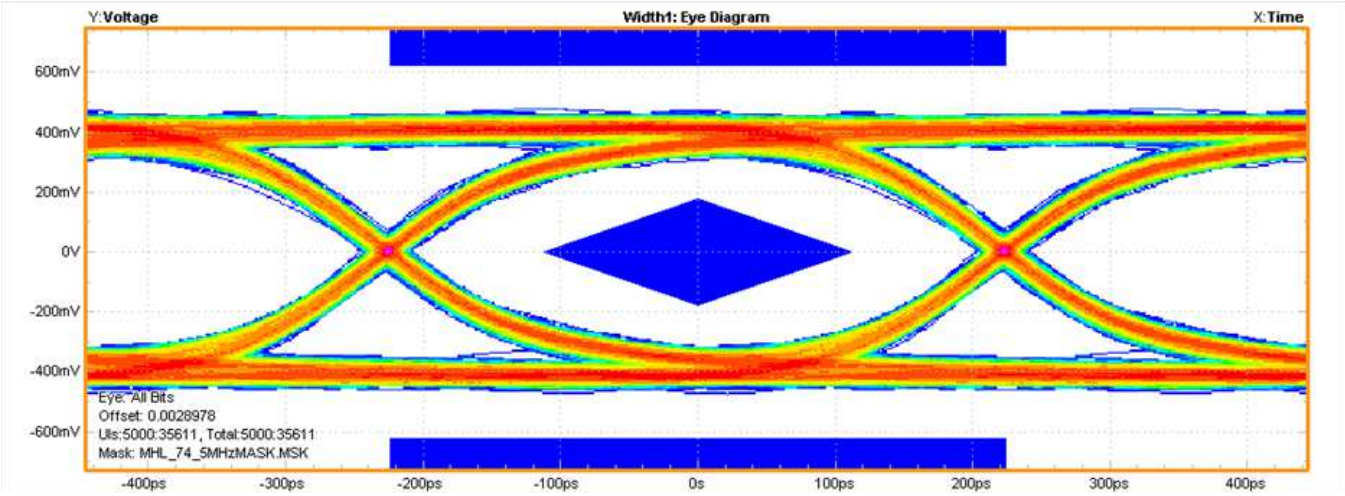


Figure 14. Eye Pattern: 2.2 Gbps MHL Eye Pattern for With No Device

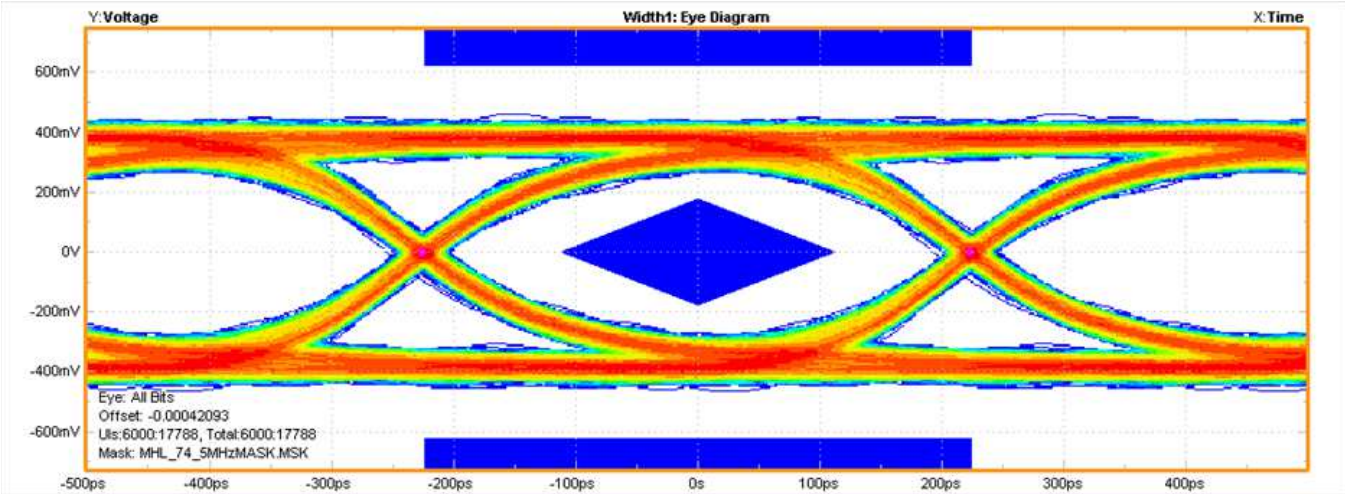


Figure 15. Eye Pattern: 2.2 Gbps MHL Eye Pattern for MHL Switch

TYPICAL CHARACTERISTICS (continued)

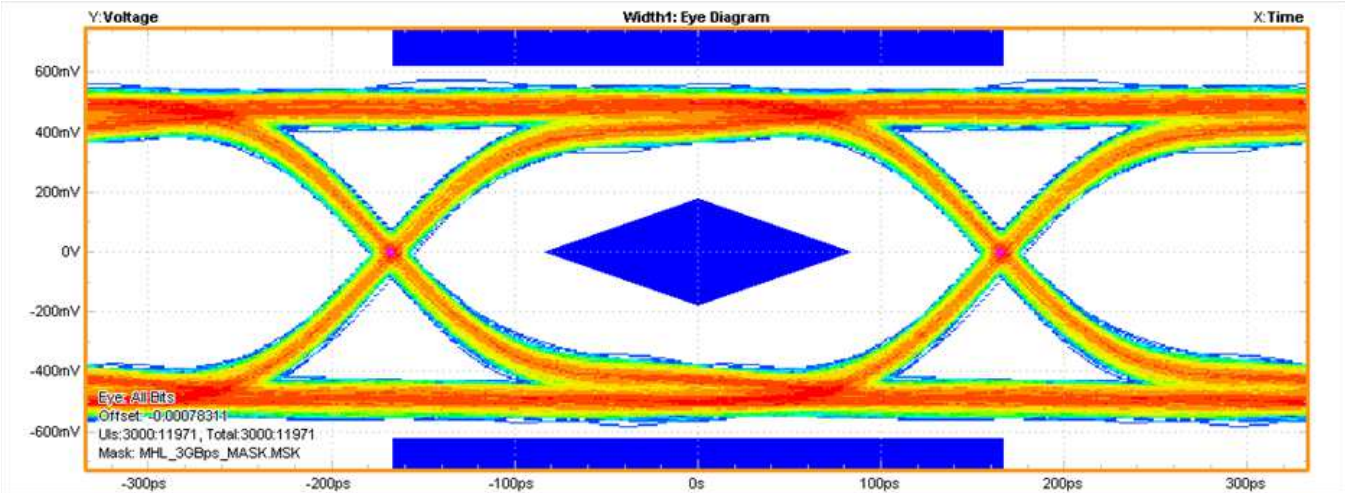


Figure 16. Eye Pattern: 3.0 Gbps MHL Eye Pattern for With No Device

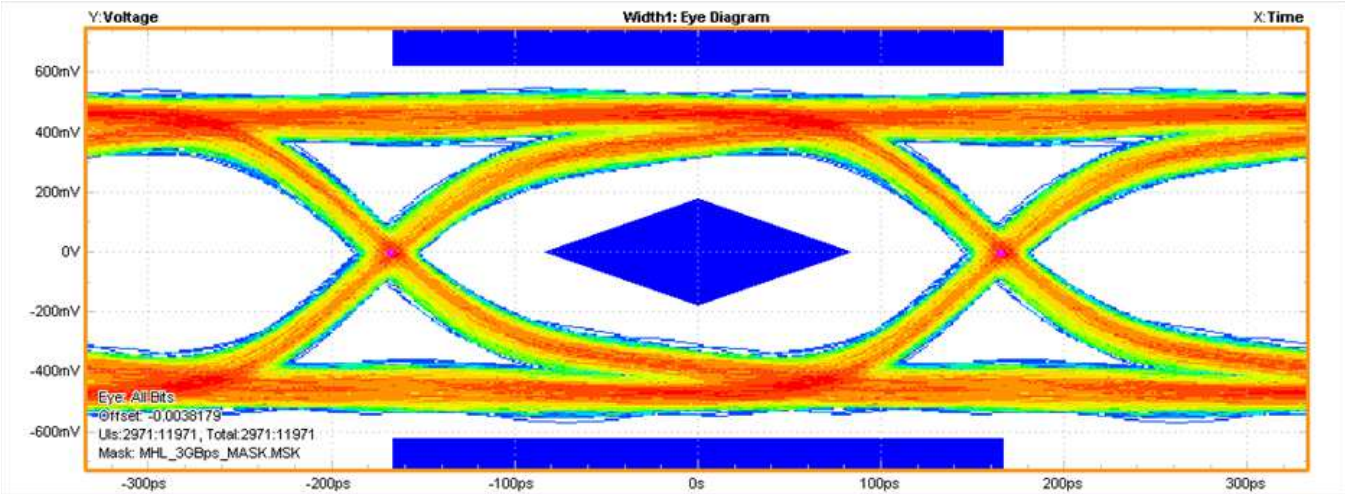


Figure 17. Eye Pattern: 3.0 Gbps MHL Eye Pattern for MHL Switch

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TS3USB32008RSVR	PREVIEW	UQFN	RSV	16		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ZTV	
TS3USB3200RSVR	ACTIVE	UQFN	RSV	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ZTO	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) 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)

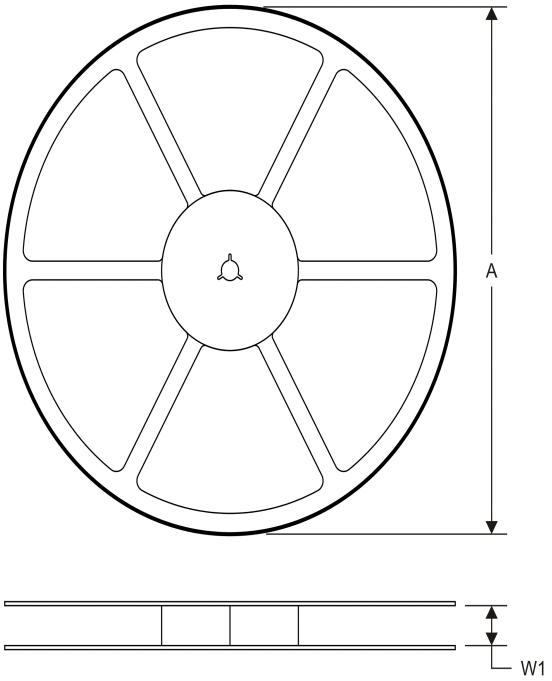
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

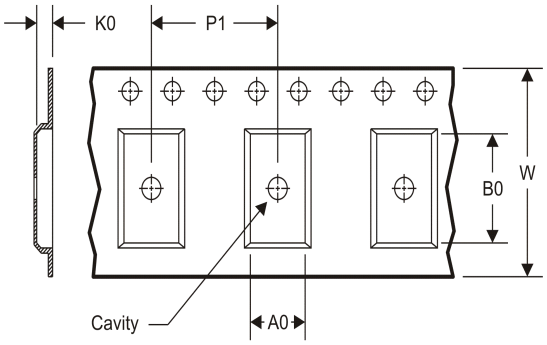
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



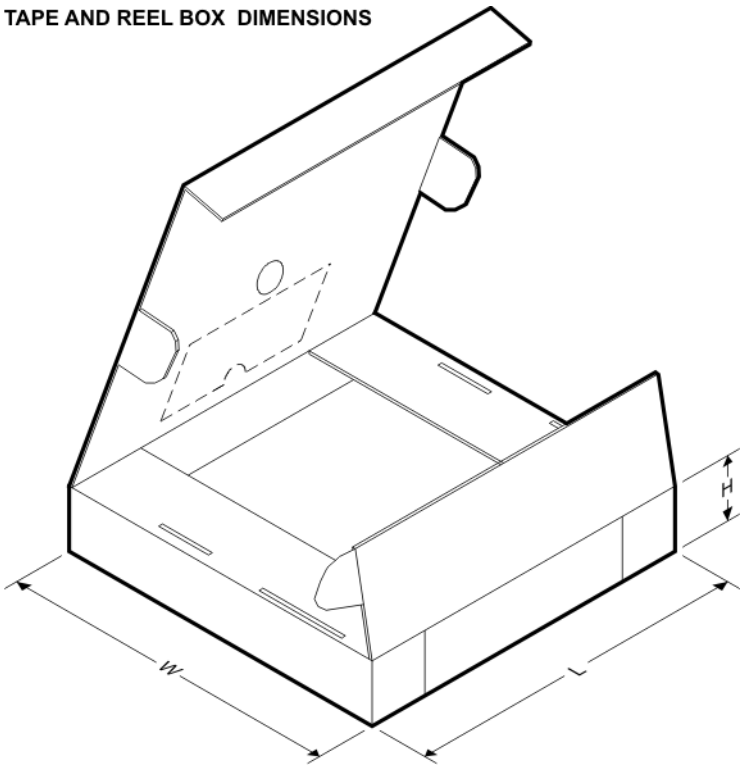
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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
TS3USB3200RSVR	UQFN	RSV	16	3000	180.0	12.4	2.1	2.9	0.75	4.0	12.0	Q1

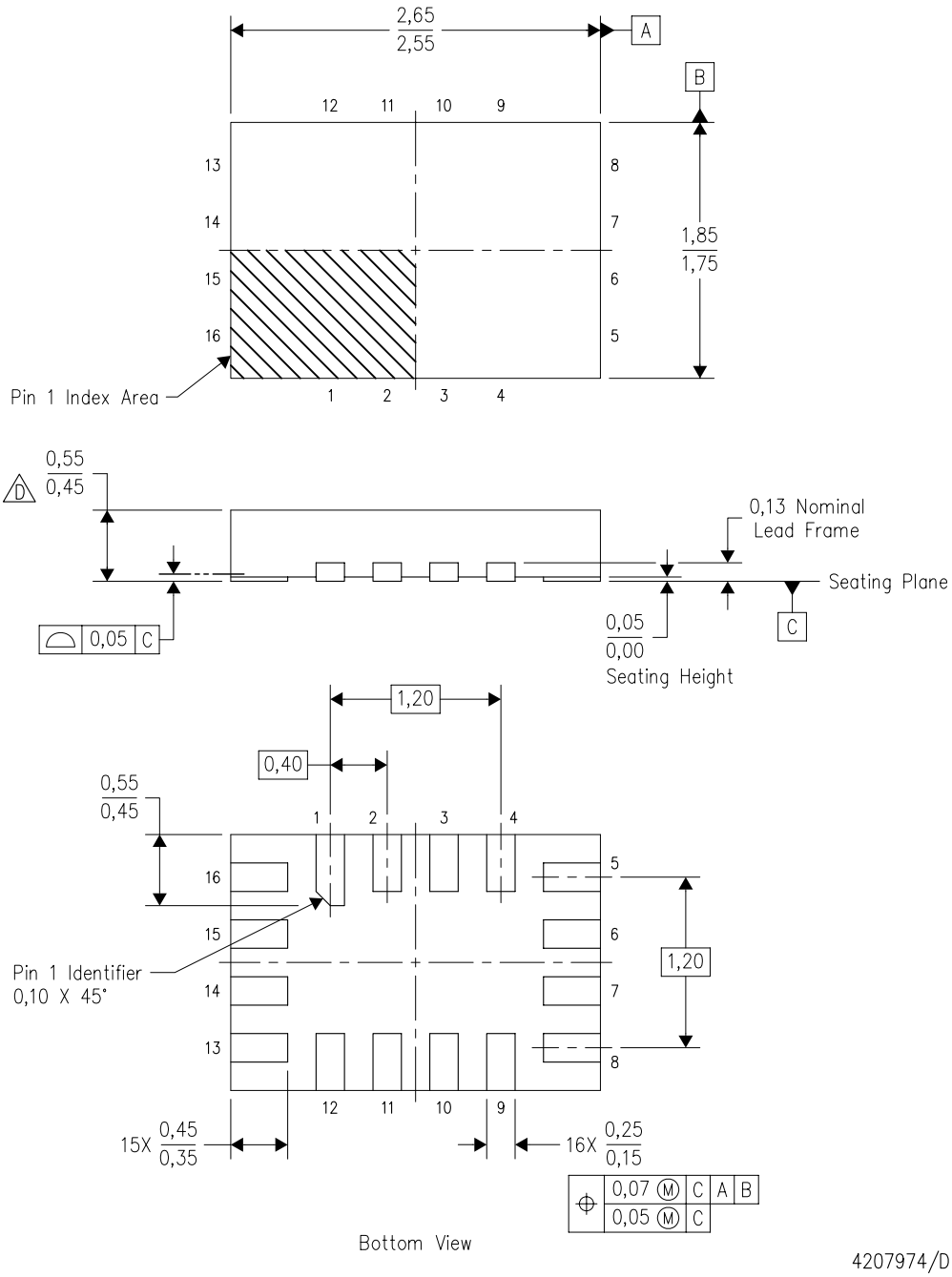
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

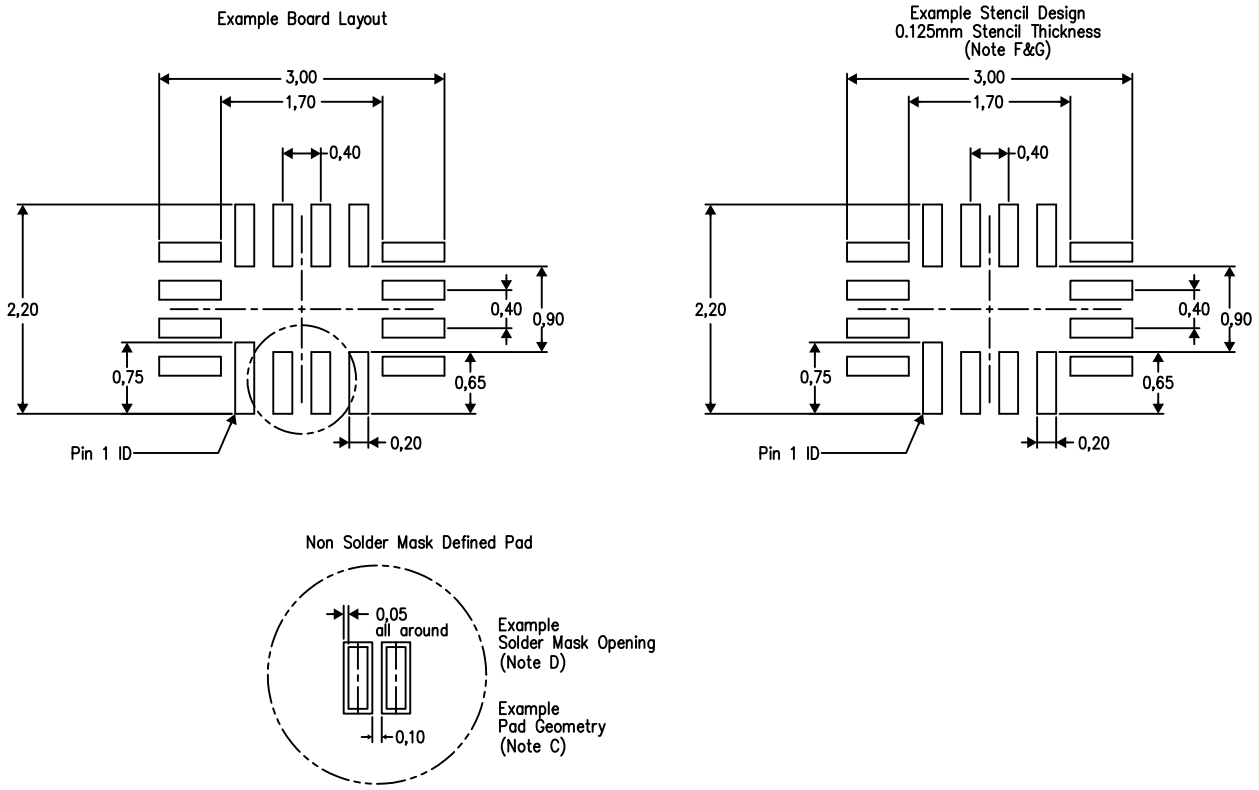
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS3USB3200RSVR	UQFN	RSV	16	3000	203.0	203.0	35.0

RSV (R–PUQFN–N16) PLASTIC QUAD FLATPACK NO–LEAD



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. QFN (Quad Flatpack No–Lead) package configuration.
D. This package complies to JEDEC MO–288 variation UFHE, except minimum package thickness.

RSV (R–PUQFN–N16) PLASTIC QUAD FLATPACK NO–LEAD



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NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.
E. Maximum stencil thickness 0,127 mm (5 mils). All linear dimensions are in millimeters.
F. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
G. Side aperture dimensions over–print land for acceptable area ratio > 0.66. Customer may reduce side aperture dimensions if stencil manufacturing process allows for sufficient release at smaller opening.

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