

Mobile HDMI™ Link (MHL) & USB 2.0 High-speed Signal Switch

Features

- USB 2.0 compliant (high-speed and full-speed)
 - 1080p, 24-bit mode support with -1.35dB insertion loss
 - 1080p, PackedPixel mode support with -1.5dB insertion loss
 - Low R_{ON}, 3ohm, for USB-HS signaling
 - Low bit-to-bit skew
 - Low Crosstalk: -33dB @ 480 Mbps
 - Off Isolation: -30dB @ 480 Mbps
 - Near-Zero propagation delay: 250ps
 - Low C_{ON}, ~4.5pF, for MHL signaling
 - Dual Power Supply capable
 - V_{DD}, 2.7V to 4.2V
 - V_{bus}, 5V +/-5%
 - Integrated ESD protection
 - pins D+, D-, and ID support up to +/-3kV contact per IEC61000-4-2 spec
 - all other pins support up to 2kV HBM per JEDEC standard
- Integrated ESD protection
- ~ 2.4GHz for MHL
 - ~ 2.0GHz for USB
 - Packaging (Pb-free & Green):
 - 16-contact TQFN, 2.5 x 2.5 x 0.8 mm (ZL16)

Description

The PI3USBH22 is a single differential channel 2:1 multiplexer/demultiplexer for USB 2.0 and MHL signaling standards. Industry leading advantages include a propagation delay of less than 250ps, resulting from its low channel resistance and I/O capacitance. The device allows the user to pass both USB data and HDMI™ video stream across the same pins. The switch is bidirectional and offers little or no attenuation of the high-speed signals at the outputs. It is designed for low bit-to-bit skew, high channel-to-channel noise isolation.

The PI3USBH22 offers over voltage protection per the USB 2.0 specification. With the chip powered on or off, all I/O pins can withstand a short to V_{bus}. If V_{DD} = 0V, the I/Os can still have signals present, and the signal will NOT leak through to V_{DD}.

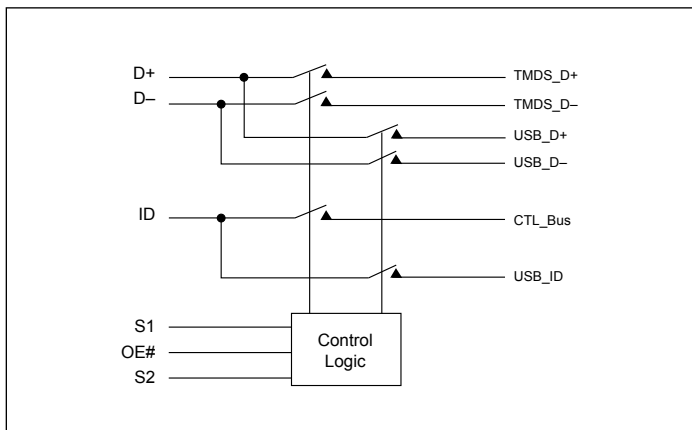
Application

- Routes signals for USB 2.0
- Hand-held devices

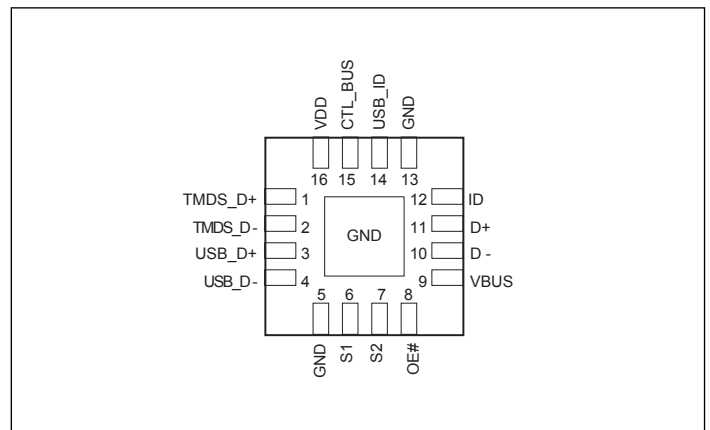
Truth Table

OE#	S1	D+	D-
1	x	Hi-Z	Hi-Z
0	1	TMDS_D+	TMDS_D-
0	0	USB_D+	USB_D-
OE#	S2	ID	
1	x	Hi-Z	
0	1	CTL_bus	
0	0	USB_ID	

Block Diagram



Pin Description



Maximum Ratings

(Above which useful life may be impaired. For user guidelines, not tested.)

Storage Temperature.....	-65°C to +150°C
Supply Voltage to Ground Potential, V _{DD}	-0.5V to +4.6V
Supply Voltage to Ground Potential, V _{BUS}	-0.5V to 5.5V
DC Input Voltage	-0.5V to +5.25V
DC Output Current	120mA
Power Dissipation	0.5W

Note: Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

V _{DD}	V _{bus}	Result
present	present	V _{DD} powers IC ONLY
Present	not present	V _{DD} powers IC ONLY
not present	present	V _{BUS} powers IC ONLY
not present	not present	IC is powered off

DC Electrical Characteristics for USB 2.0 Switching over Operating Range

(T_A = -40°C to +85°C, V_{DD} = 2.7V to 4.2V)

Parameter	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽²⁾	Max.	Units	
V _{DD}	3.3V Main power supply		3.0	3.3	3.6	V	
V _{bus}	5V secondary power supply		4.75	5.0	5.25		
V _{IH}	Input HIGH Voltage for S1, S2, & \overline{OE}	Guaranteed HIGH level	V _{DD} = 4.2V, V _{bus} = x	1.8			
			V _{DD} = 3.3V, V _{bus} = x	1.6			
			V _{DD} = 0V, V _{bus} = 5V	1.6			
V _{IL}	Input LOW Voltage for S1, S2, and \overline{OE}	Guaranteed HIGH level	V _{DD} = 2.7V to 4.2V, V _{bus} = x				0.8
			V _{DD} = 0V, V _{bus} = 5V				0.6
V _{IK_OE}	Clamp Diode Voltage for OE# pin	V _{DD} = Max., I _{IK} = -18mA			-1.2		
V _{IK_I/O}	Clamp Diode Voltage for I/O pin	V _{DD} = Max., I _{IK} = -18mA			-1.2		
V _{IK_SEL}	Clamp Diode Voltage for select IN pins (S1 and S2)	V _{DD} = Max., I _{IK} = -18mA			-1.2		
I _{IH}	Input HIGH Current	V _{DD} = Max., V _{IH} = V _{DD}			±5	μA	
I _{IL}	Input LOW Current	V _{DD} = Max., V _{IL} = GND			±5		

DC Electrical Characteristics for USB 2.0 Switching over Operating Range (Cont..)

Parameter	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽²⁾	Max.	Units
R _{ON}	Switch On-Resistance for USB 2.0 HS signal ⁽³⁾	V _{DD} = Min., -0.4V ≤ V _{input} ≤ 0.4V, I _{ON} = -40mA		3.0	5.0	Ohm
R _{ON}	Switch On-Resistance for USB FS signal	V _{DD} = min., 0V ≤ V _{input} ≤ 3.3V		5	7	
R _{ON}	Switch On-Resistance for MHL signal	V _{DD} = min. 2V ≤ V _{input} ≤ 3.3V		7.7		
R _{ON(flat)}	On-resistance flatness	V _{DD} = min. -0.4V ≤ V _{input} ≤ 1.0V		0.5		
DR _{ON}	On-Resistance match from center ports to any other port(3)	V _{DD} = Min., -0.4V ≤ V _{input} ≤ 0.4V, I _{ON} = -40mA		0.9	2.0	
I _{OZ_D+/D-}	I/O leakage current when port is off (TMDS D+/D- and MHL D+/D- path)	V _{DD} = 4.3V, V _{input} = 0 to 3.6V, switch = off, OE# = LOW			±2	μA
I _{OFF}	Signal leakage when chip is off	V _{DD} = 0V, V _{input} = 0 to 5.25V, T _A = 25°C			±10	
I _{OZ_ID}	I/O leakage current when port is off (for USB_ID, CTL_Bus path only)	V _{DD} = 2.7V to 4.2V, V _{input} = 0V to 3.6V, USB_ID switch = off, OE# = LOW			±0.5	

Notes:

1. For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
2. V_{DD} = 3.0 - 4.4V, T_A = 25°C ambient and maximum loading.
3. Measured by the voltage drop between D I/O pin at indicated current through the Switch On-Resistance is determined by the lower of the voltages on the two (D, Dn) pins.

Power Supply Characteristics (V_{DD} = 2.7V to 4.2V)

Parameters	Description	Test Conditions ⁽¹⁾	Min.	Typ.	Max.	Units
I _{CC}	V _{DD} Power Supply Current	V _{DD} = 4.2V, VS _x = GND (USB mode enabled), OE# = LOW		38	60	μA
		V _{DD} = 3.0V		20	30	
		V _{DD} = 4.2V, VS _x = V _{DD} (MHL mode enabled), OE# = LOW		60	80	
		V _{DD} = 3.0V		40	60	
I _{CC_off}	Power Down current consumption	V _{DD} = 3.3V, VS _x = GND, OE# = HIGH		5	11	
I _{cc_Vbus}	Vbus power supply current	Vbus = 5V±5%, V _{DD} = 0V		120	300	

Notes:

1. For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.

Capacitance (T_A = 25°C, f = 1MHz)

Parameters ⁽³⁾	Description	Test Conditions ⁽¹⁾	Typ. ⁽²⁾	Max.	Units
C _{IN}	Input Capacitance		1.5	2.35	pF
C _{OFF_USB}	Switch Off-Capacitance, USB Path	VS _x = 0V, OE/ = HIGH	1.8	2.55	
C _{ON_USB}	Switch On- Capacitance, USB Path	VS _x = 0V, OE/ = LOW	5.0	5.5	
C _{off_MHL}	Switch Off-Capacitance, MHL Path	VS _x = 3.3V, OE/ = High	1.8	2.0	
C _{on_MHL}	Switch On-Capacitance, MHL Path	VS _x = 3.3V, OE/ = LOW	5.0	5.5	

Dynamic Electrical Characteristics Over the Operating Range

Parameters	Description	Test Conditions	Min.	Typ. ⁽²⁾	Max.	Units
X _{TALK}	Crosstalk	R _L = 50-Ohm	f = 240 MHz	-40		dB
			f = 825 MHz	-25		
O _{IRR}	OFF Isolation		f = 240 MHz	-39		
			f = 825 MHz	-25		
BW_MHL	-3dB Bandwidth	R _{TX} = 50Ohm, R _{TX} = 50Ohm,		2400		MHz
-0.5dB BW_USB	-0.5dB Bandwidth	R _L = 50Ohm		400		MHz
-3dB BW_USB	-3dB Bandwidth for USB path	R _L = 50Ohm		2000		MHz
IN_MHL	Insertion Loss for MHL path	f = 825 MHz (1.65Gbps) f = 1.0 GHz (2.0Gbps) f = 1.125 GHz (2.25Gbps) f = 1.5GHz (3.0Gbps)		-1.1 -1.15 -1.35 -1.5		dB

Notes:

- For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
- Typical values are at VDD = 3.3V, Ta = 25°C ambient and maximum loading.
This parameter is determined by device characterization but is not production tested.

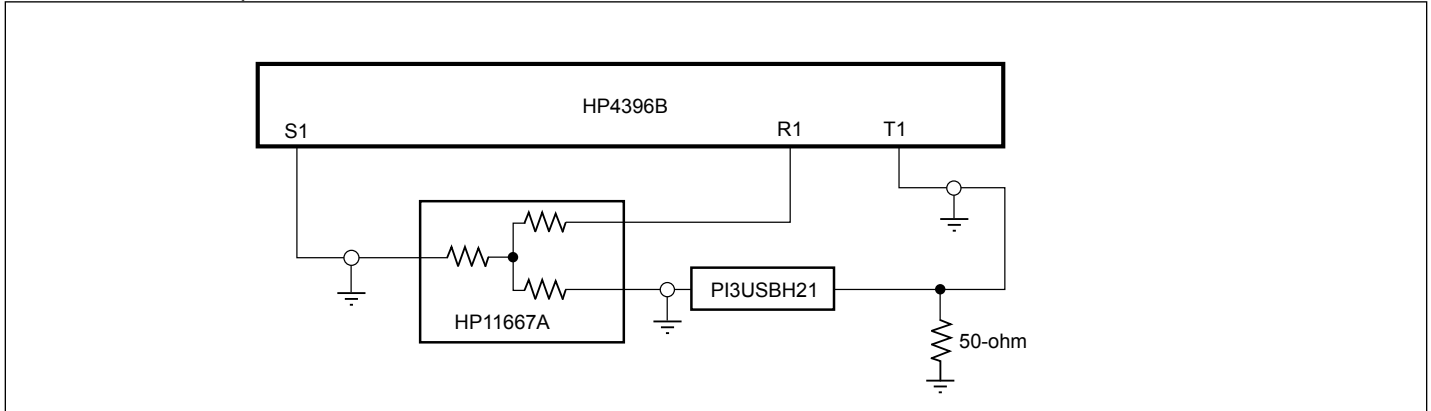
Switching Characteristics

Parameters	Description	Test Conditions ⁽¹⁾	Min.	Typ.	Max.	Units
t _{PD}	Propagation Delay ^(2,3)	See Test Circuit for Electrical Characteristics		0.25		ns
t _{PZH} , t _{PZL}	Line Enable Time - S, OE# to D(+/-)		3		2K	ns
t _{PHZ} , t _{PLZ}	Line Disable Time - S, OE# to D(+/-)		3		2K	
t _{SKC-C}	Output skew, channel-to-channel ⁽²⁾			3.5	14	ps

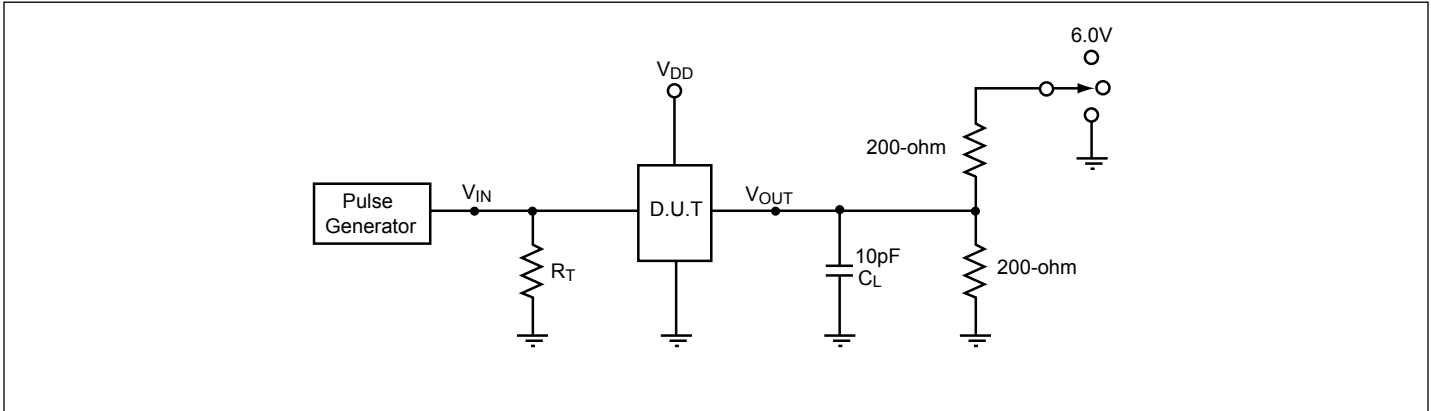
Notes:

- For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
- Guaranteed by design.
- The switch contributes no propagational delay other than the RC delay of the On-Resistance of the switch and the load capacitance. The time constant for the switch alone is of the order of 0.25ns for 10pF load. Since this time constant is much smaller than the rise/fall times of typical driving signals, it adds very little propagational delay to the system. Propagational delay of the switch when used in a system is determined by the driving circuit on the driving side of the switch and its interactions with the load on the driven side.

Test Circuit for Dynamic Electrical Characteristics



Test Circuit for Electrical Characteristics



Notes:

C_L = Load capacitance: includes jig and probe capacitance.

R_T = Termination resistance: should be equal to Z_{OUT} of the Pulse Generator

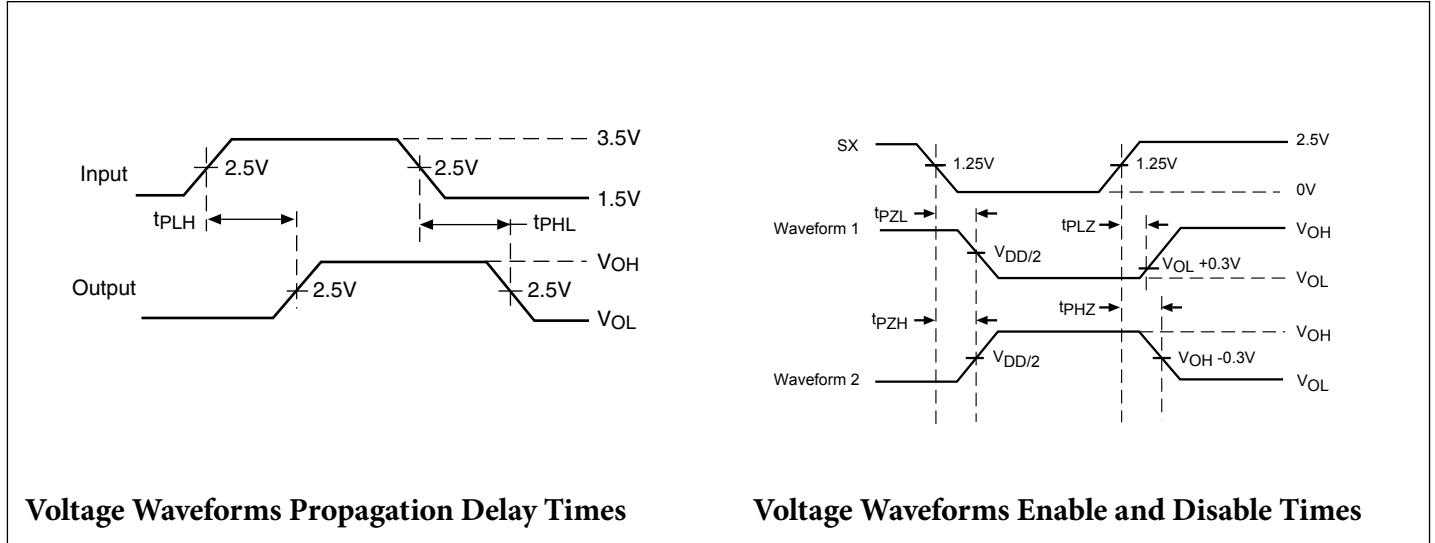
All input impulses are supplied by generators having the following characteristics: $PRR \leq$ MHz, $Z_O = 50\text{-}\Omega$, $t_R \leq 2.5\text{ns}$, $t_F \leq 2.5\text{ns}$.

The outputs are measured one at a time with on transition per measurement.

Switch Positions

Test	Switch
t_{PLZ} , t_{PZL}	6.0V
t_{PHZ} , t_{PZH}	GND
Prop Delay	Open

Switching Waveforms



Applications Information

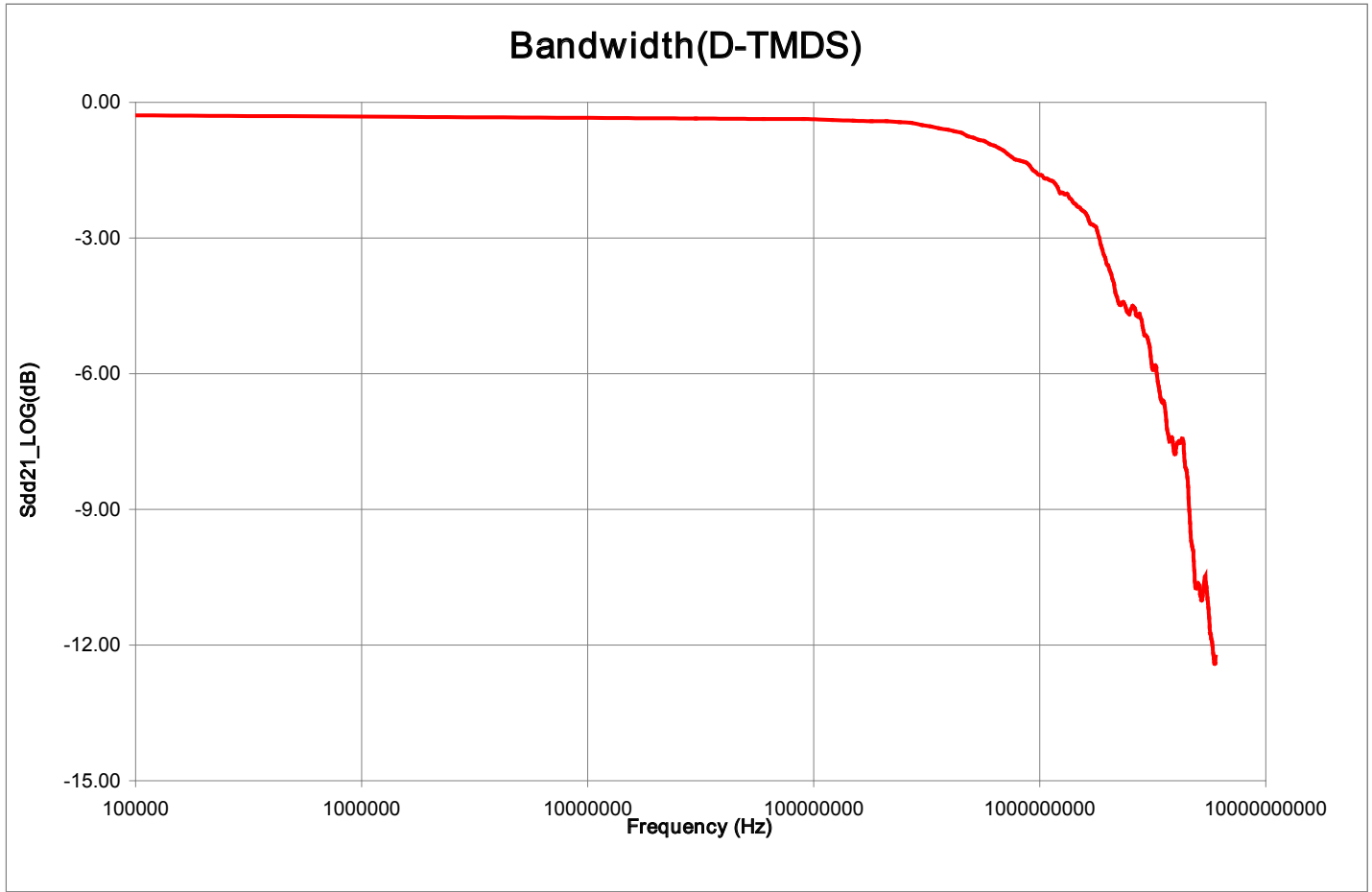
Logic Inputs

The logic control inputs can be driven up to +3.6V regardless of the supply voltage. For example, given a +3.3V supply, the output enables or select pins may be driven low to 0V and high to 3.6V. Driving IN Rail-to-Rail® minimizes power consumption.

Power Supply Sequencing

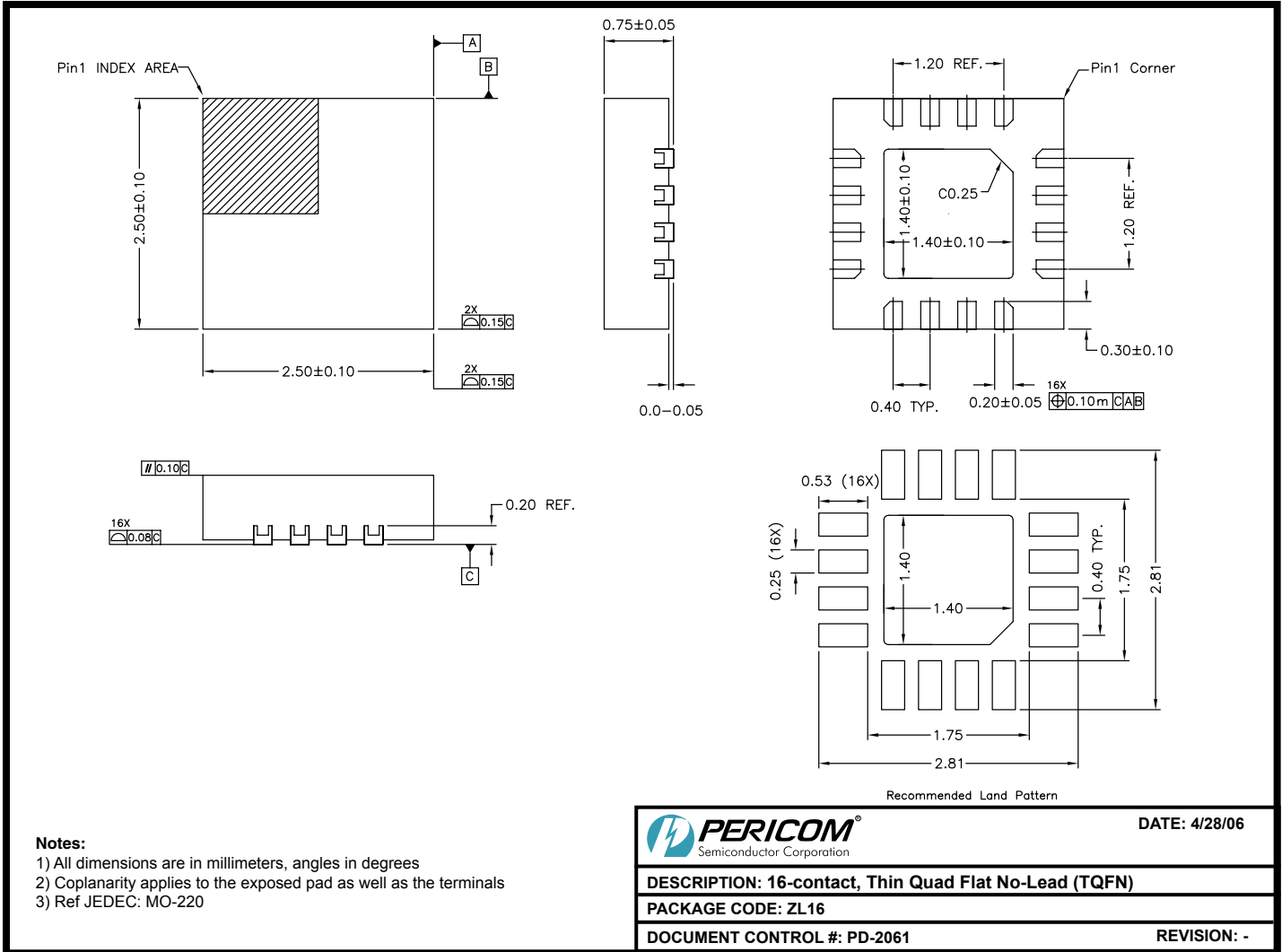
Since this product does not contain any PMOS parasitic at the I/O pins, proper supply sequencing is not required.

Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.



Differential Insertion loss, $V_{DD} = 3.3V$

Packaging Mechanicals: 16-Contact TQFN (ZL16)



- Notes:**
- 1) All dimensions are in millimeters, angles in degrees
 - 2) Coplanarity applies to the exposed pad as well as the terminals
 - 3) Ref JEDEC: MO-220

06-0393 Note: For latest package info, please check: <http://www.pericom.com/products/packaging/mechanicals.php>

Ordering Information

Ordering Code	Package Code	Package Description
PI3USBH22ZLE	ZL	Pb-free & Green, 16-contact TQFN

Notes:

- Thermal characteristics can be found on the company web site at www.pericom.com/packaging/
- E = Pb-free and Green
- Adding X suffix = Tape/Reel