

PI3USB102 PI3USB102 Demo Board Rev.A User Manual

Introduction

This user manual describes the components and operation of the PI3USB102 Demo Board. USB2.0 high-speed, full-speed and low speed signal quality measurement setup will also be described in the user guide and result for this demo board using High Speed USB device. TDR measurement result will also be shown in this user guide.



Figure 1. Top view of PI3USB102

Board Operation

The PI3USB102 is a single differential channel 2:1 multiplexer or demultiplexer. Figure 2 shows the logical block diagram of PI3USB102.

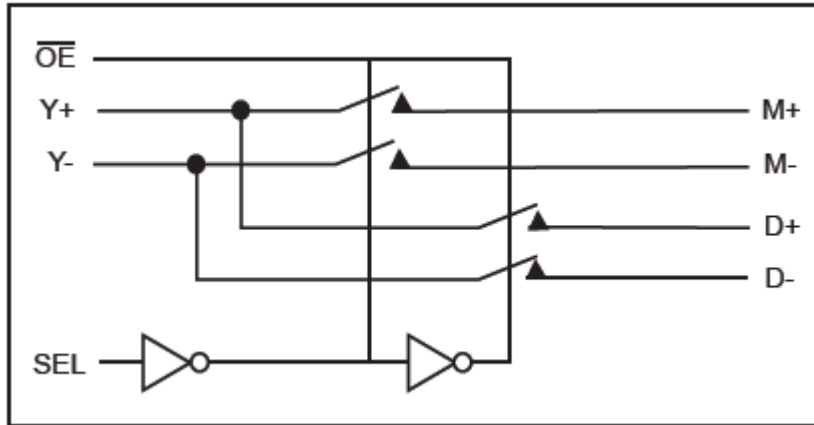


Figure 2. Logical Block Diagram of PI3USB102

In order to choose which output the Y+/Y- connects to, two header pins are provided on the demo board for user to choose the desired signal path. Table 1 shows the truth table of the device.

SEL	nOE	Y+	Y-
X	H	Hi-Z	Hi-Z
L	L	M+	M-
H	L	D+	D-

Table 1. Truth Table of PI3USB102

If nOE is connected to “L” and SEL is connected to “L”, Y+/Y- will connect to M+/M-. Figure 3 shows the signal path of this connection.

SEL	nOE	Y+	Y-
X	H	Hi-Z	Hi-Z
L	L	M+	M-
H	L	D+	D-

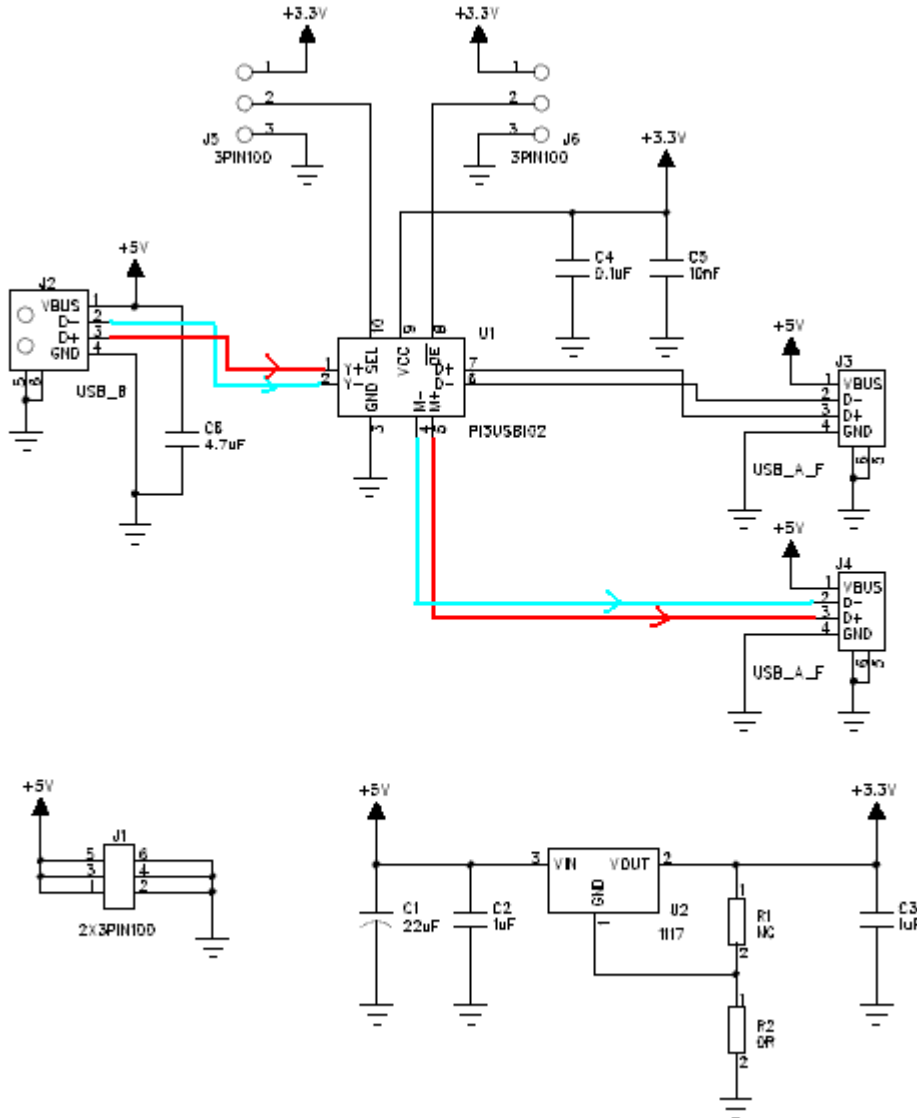


Figure 3. Signal path of connection to M+/M-

If nOE is connected to “L” and SEL is connected to “H”, Y+/Y- will connect to M+/M-. Figure 4 shows the signal path of this connection.

SEL	nOE	Y+	Y-
X	H	Hi-Z	Hi-Z
L	L	M+	M-
H	L	D+	D-

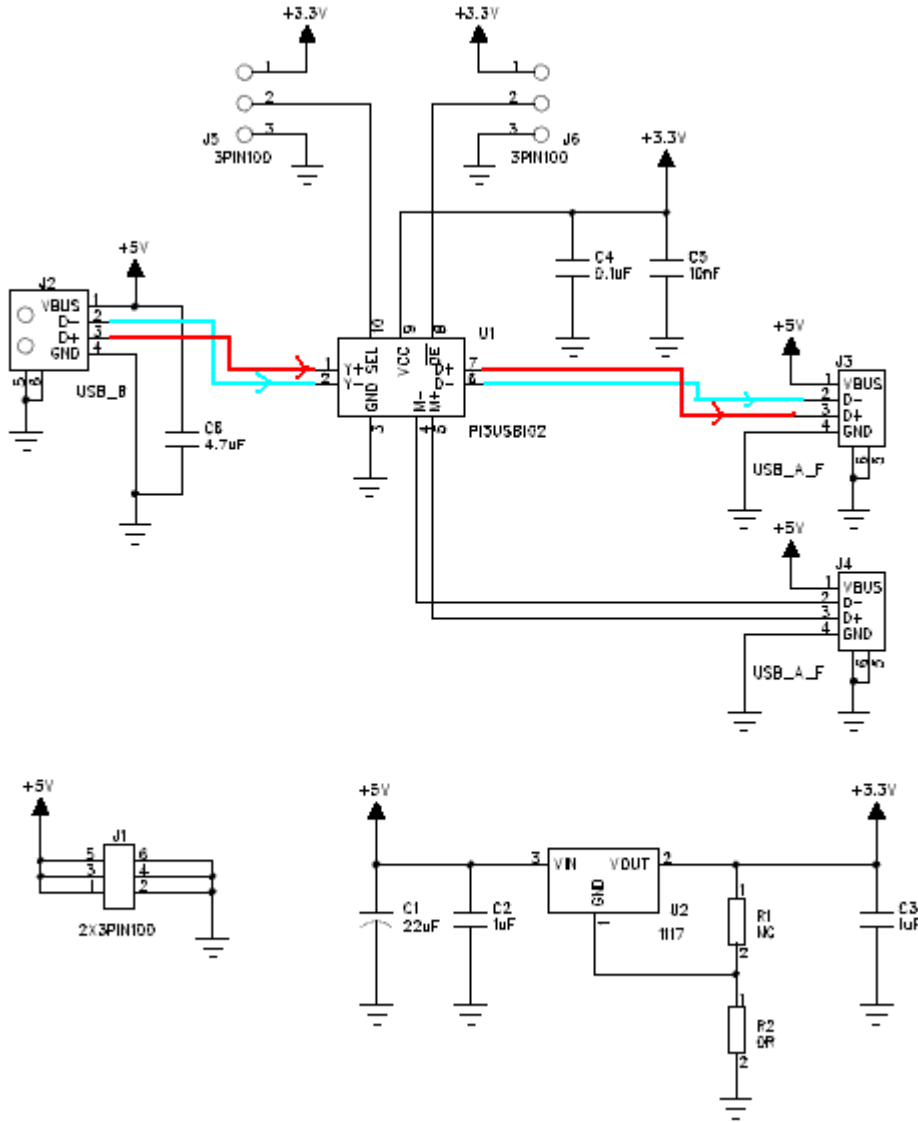


Figure 4. Signal path of connection to D+/D-

Signal Quality Measurement

Tektronix TDS7404 is used to measure Signal Quality of PI3USB102. The USB signal from High-Speed USB device through PI3USB102 is compared with USB 2.0 High Speed UPSTREAM – NEAR END eye mask. Figure 5 shows the test setup of USB 2.0 High Speed test.

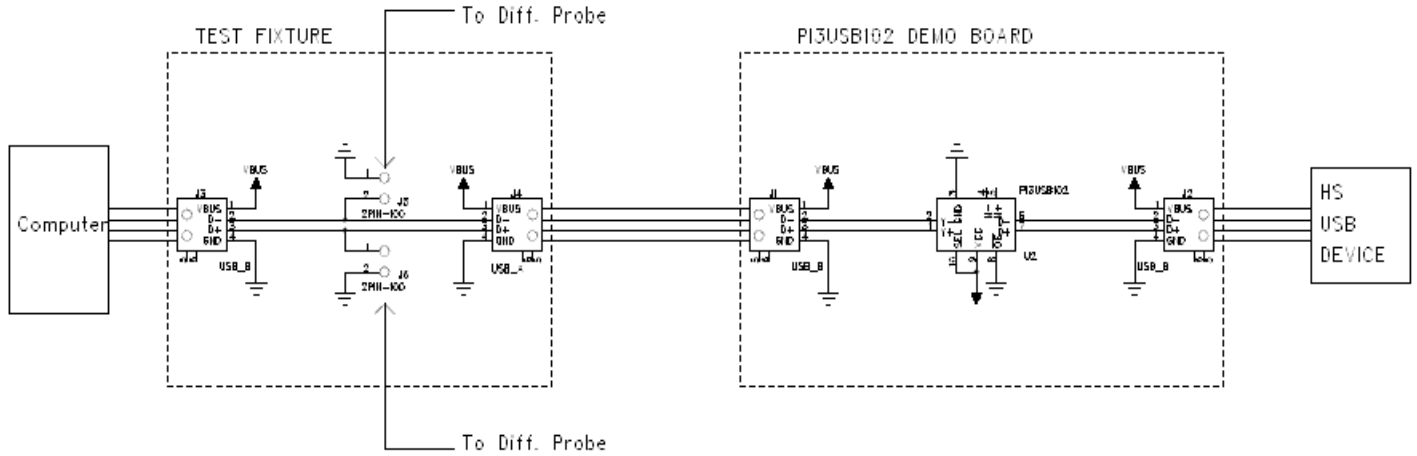


Figure 5. USB 2.0 High Speed Test Setup

Figure 6a and Figure 6b show the PASSING eye-diagram of which the USB 2.0 High Speed signal passing through PI3USB102. Figure 6c shows the eye-diagram of which the PI3USB102 is not used.

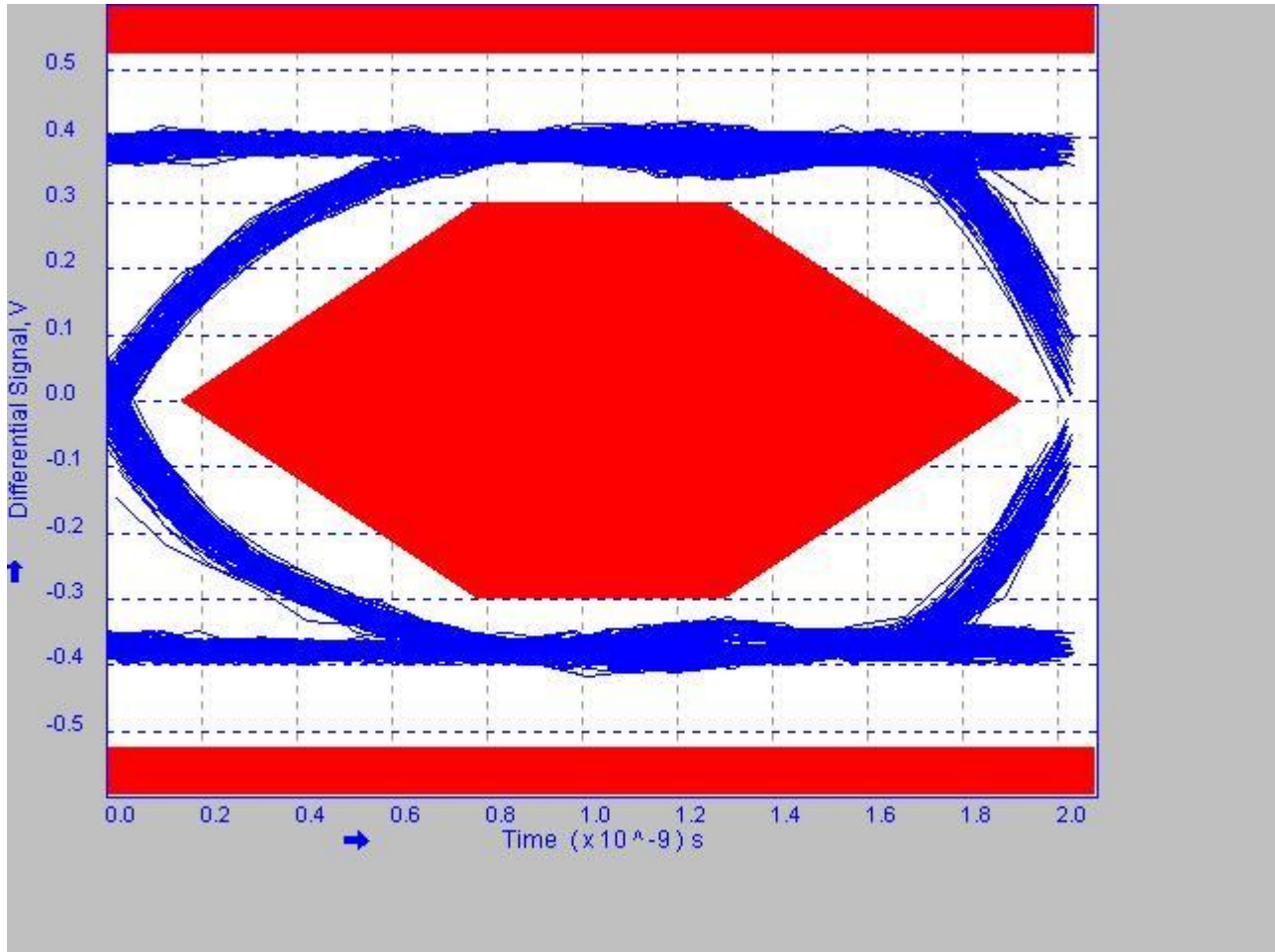


Figure 6a. High Speed Eye-Diagram of connection to M+/M-

Measurement Name	Minimum	Maximum	Mean	pk-pk	Standard Deviation	RMS	Population	Status
Monotonic Property	-	-	-	-	-	-	0	Pass
Eye Diagram Test	-	-	-	-	-	-	-	Pass
Signal Rate	470.1142Mbps	494.4532Mbps	480.0265Mbps	0.0000bps	4.089580Mbps	480.7090Mbps	513	Pass
EOP Width	-	-	16.66155ns	-	-	-	1	Pass
EOP Width (Bits)	-	-	7.997988	-	-	-	1	Pass
Rise Time	739.5680ps	896.1289ps	807.2906ps	156.5609ps	34.96188ps	808.0402ps	107	Pass
Fall Time	735.7871ps	861.8438ps	797.0221ps	126.0568ps	31.65904ps	797.6448ps	107	Pass

Table 2. High Speed Signal Quality Measurement of connection to M+/M-

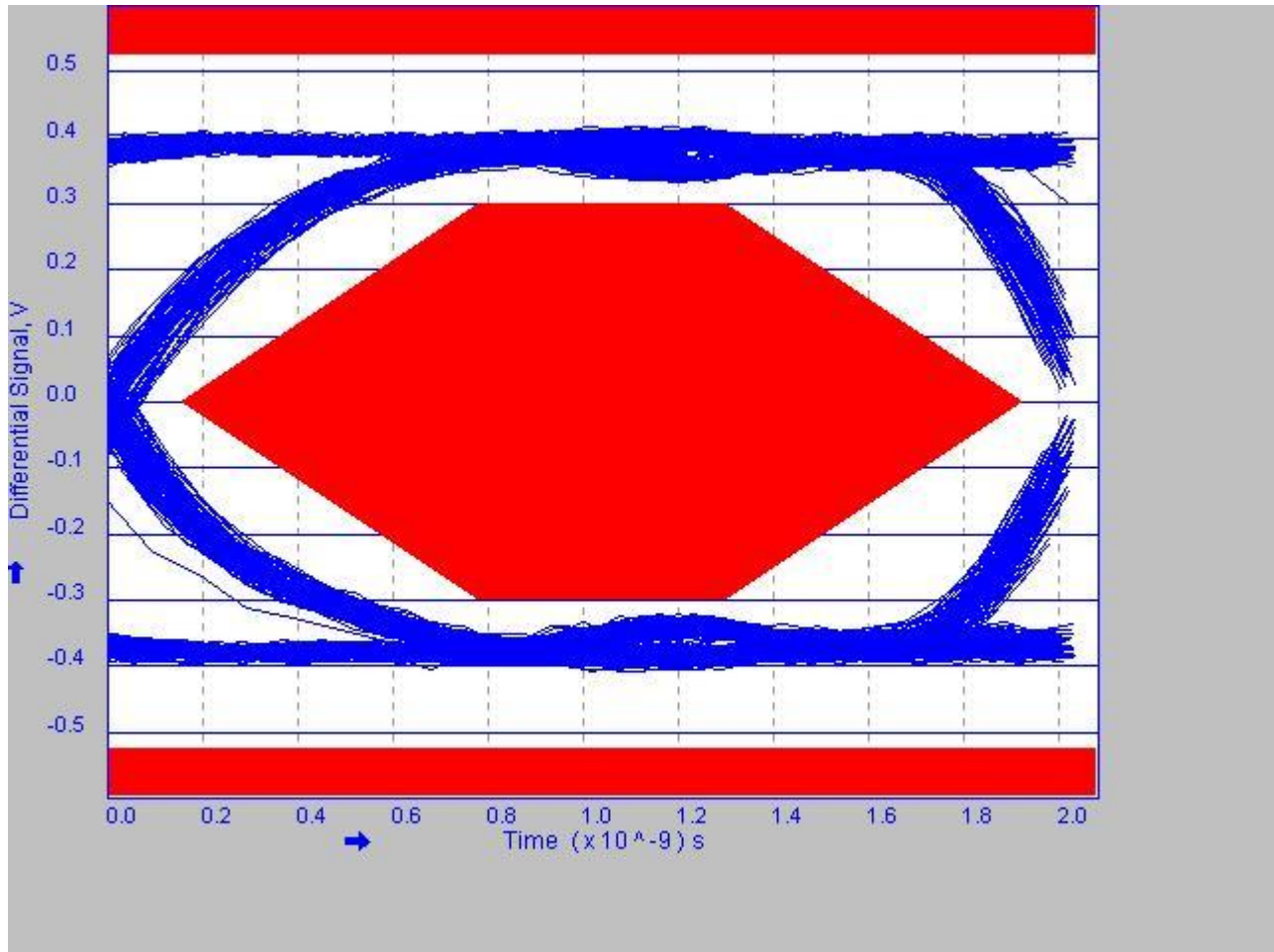


Figure 6b. High Speed Eye-Diagram of connection to D+/D-

Measurement Name	Minimum	Maximum	Mean	pk-pk	Standard Deviation	RMS	Population	Status
Monotonic Property	-	-	-	-	-	-	0	Pass
Eye Diagram Test	-	-	-	-	-	-	-	Pass
Signal Rate	473.5376Mbps	492.7479Mbps	480.0623Mbps	0.0000bps	3.670153Mbps	480.6329Mbps	513	Pass
EOP Width	-	-	16.70019ns	-	-	-	1	Pass
EOP Width (Bits)	-	-	8.017130	-	-	-	1	Pass
Rise Time	696.8445ps	840.6004ps	770.7400ps	143.7559ps	25.85369ps	771.1695ps	107	Pass
Fall Time	707.7780ps	843.9054ps	772.5156ps	136.1273ps	28.84574ps	773.0489ps	107	Pass

Table 3. High Speed Signal Quality Measurement of connection to D+/D-

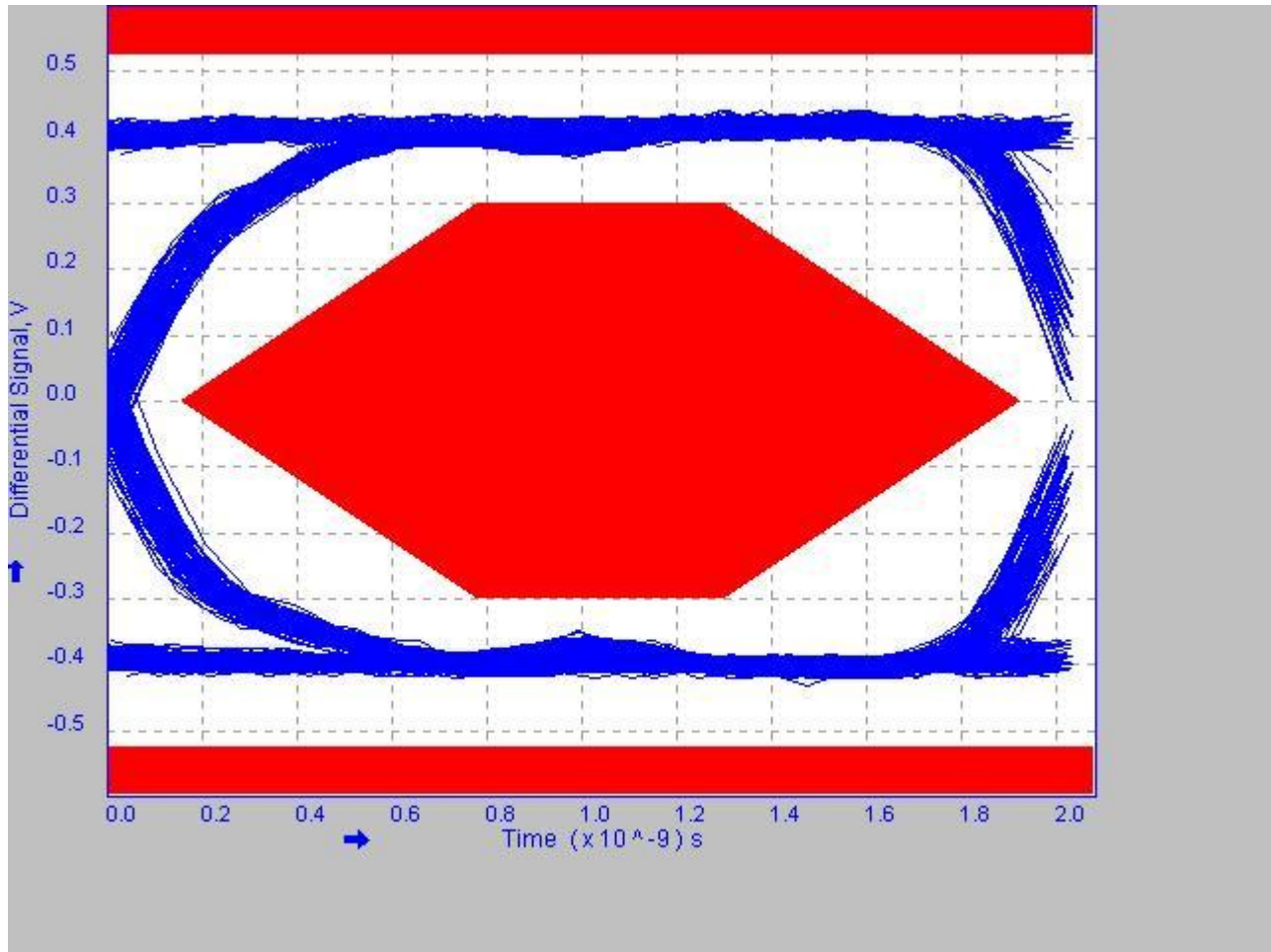


Figure 6c. High Speed Signal Quality Measurement without PI3USB102

Measurement Name	Minimum	Maximum	Mean	pk-pk	Standard Deviation	RMS	Population	Status
Monotonic Property	-	-	-	-	-	-	0	Pass
Eye Diagram Test	-	-	-	-	-	-	-	Pass
Signal Rate	473.1907Mbps	489.3789Mbps	480.0545Mbps	0.0000bps	2.961996Mbps	480.4405Mbps	513	Pass
EOP Width	-	-	16.70521ns	-	-	-	1	Pass
EOP Width (Bits)	-	-	8.019411	-	-	-	1	Pass
Rise Time	566.0808ps	658.6335ps	605.0194ps	92.55269ps	19.01294ps	605.3152ps	107	Pass
Fall Time	478.2657ps	671.5919ps	565.0937ps	193.3262ps	38.96274ps	566.4229ps	107	Pass

Table 4. High Speed Signal Quality Measurement without PI3USB102

The USB signal from Full-Speed USB device through PI3USB102 is compared with USB 2.0 Full Speed DOWNSTREAM – FAR END eye mask. Figure 7 shows the test setup of USB 2.0 Full Speed and Low Speed test setup.

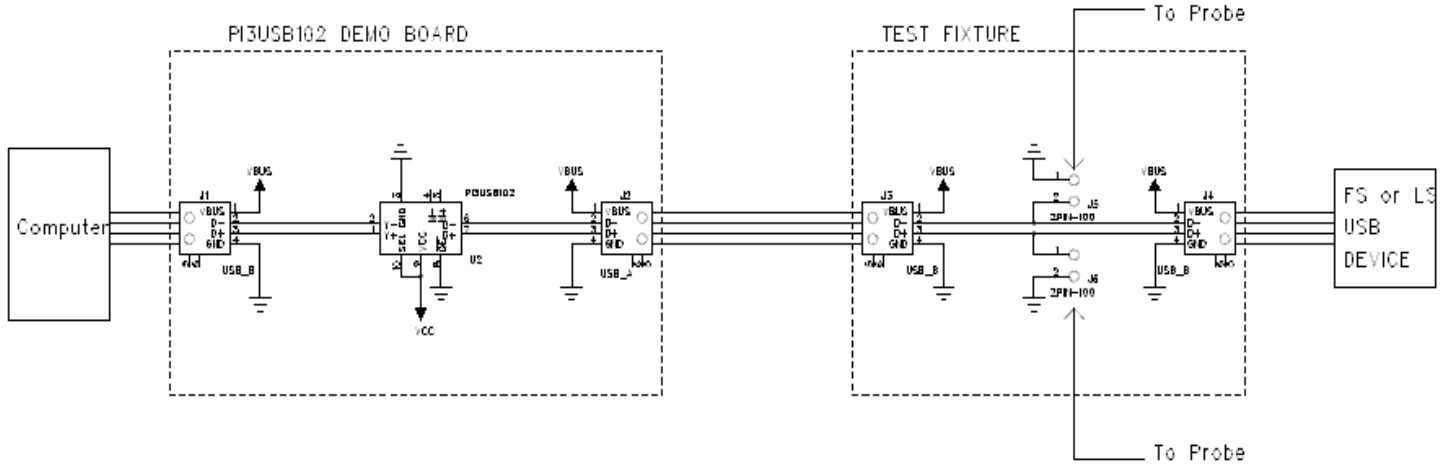


Figure 5. USB 2.0 Full Speed and Low Speed Test Setup

Figure 8a and Figure 8b show the PASSING eye-diagram of which the USB 2.0 Full Speed signal passing through PI3USB102.

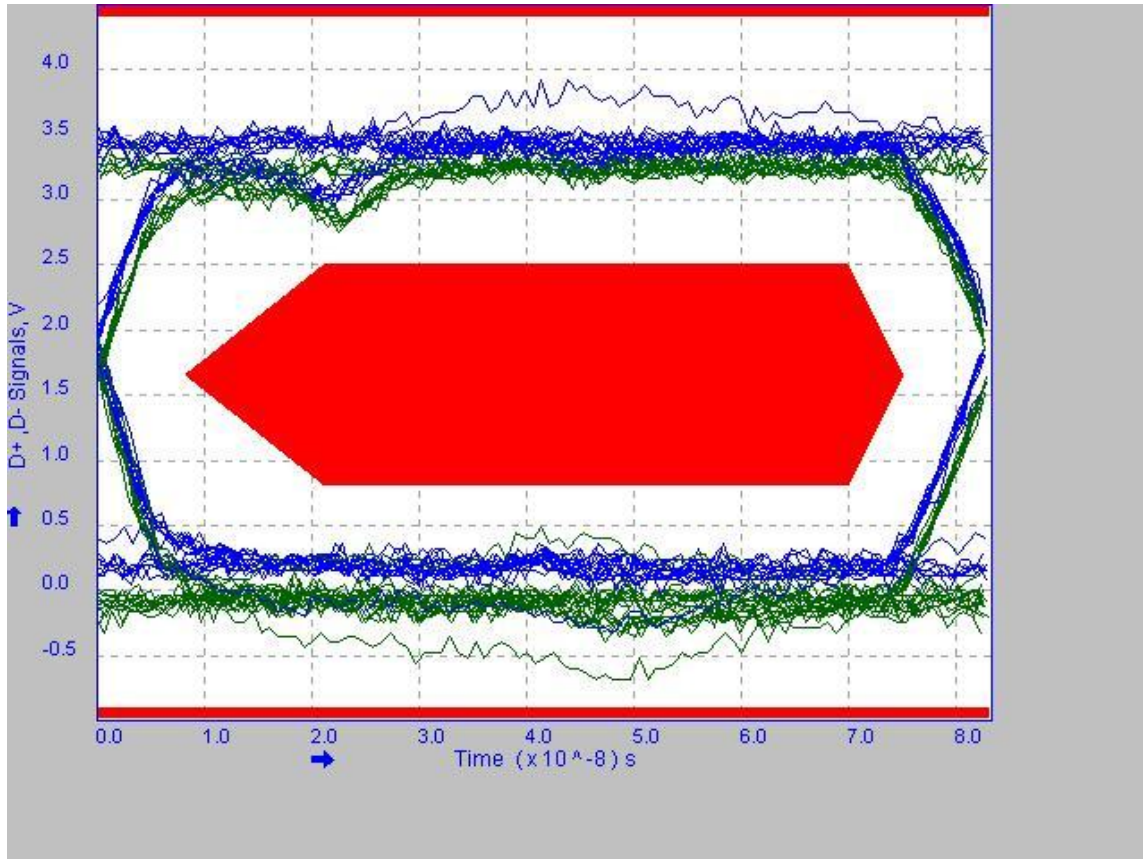


Figure 8a. Full Speed Eye-Diagram of connection to M+/M-

Measurement Name	Minimum	Maximum	Mean	pk-pk	Standard Deviation	RMS	Population	Status
Eye Diagram Test	-	-	-	-	-	-	-	Pass
Signal Rate	11.82033Mbps	12.19512Mbps	11.99872Mbps	0.0000bps	117.2124kbps	12.00201Mbps	30	Pass
Crossover Voltage	1.700000 V	1.960000 V	1.821494 V	260.0000mV	64.66396mV	1.822574 V	17	Pass
EOP Width	-	-	165.8083ns	-	-	-	1	Pass
Consecutive Jitter	-692.1122ps	863.4434ps	0.0000s	1.555556ns	524.1401ps	507.4965ps	16	Pass
Paired JK Jitter	-400.0000ps	276.8254ps	-2.539683ps	676.8254ps	211.5925ps	195.9130ps	7	Pass
Paired KJ Jitter	-204.4444ps	417.7778ps	30.36075ps	622.2222ps	217.9307ps	204.0361ps	7	Pass

Table 5. Full Speed Signal Quality Measurement of connection to M+/M-

Additional Information :

Rise Time: Min: 12.739ns Max: 15.468ns Mean: 13.801ns Std: 781.27ps RMS: 13.820ns Population: 8
 Fall Time: Min: 13.362ns Max: 14.530ns Mean: 13.840ns Std: 426.35ps RMS: 13.846ns Population: 8

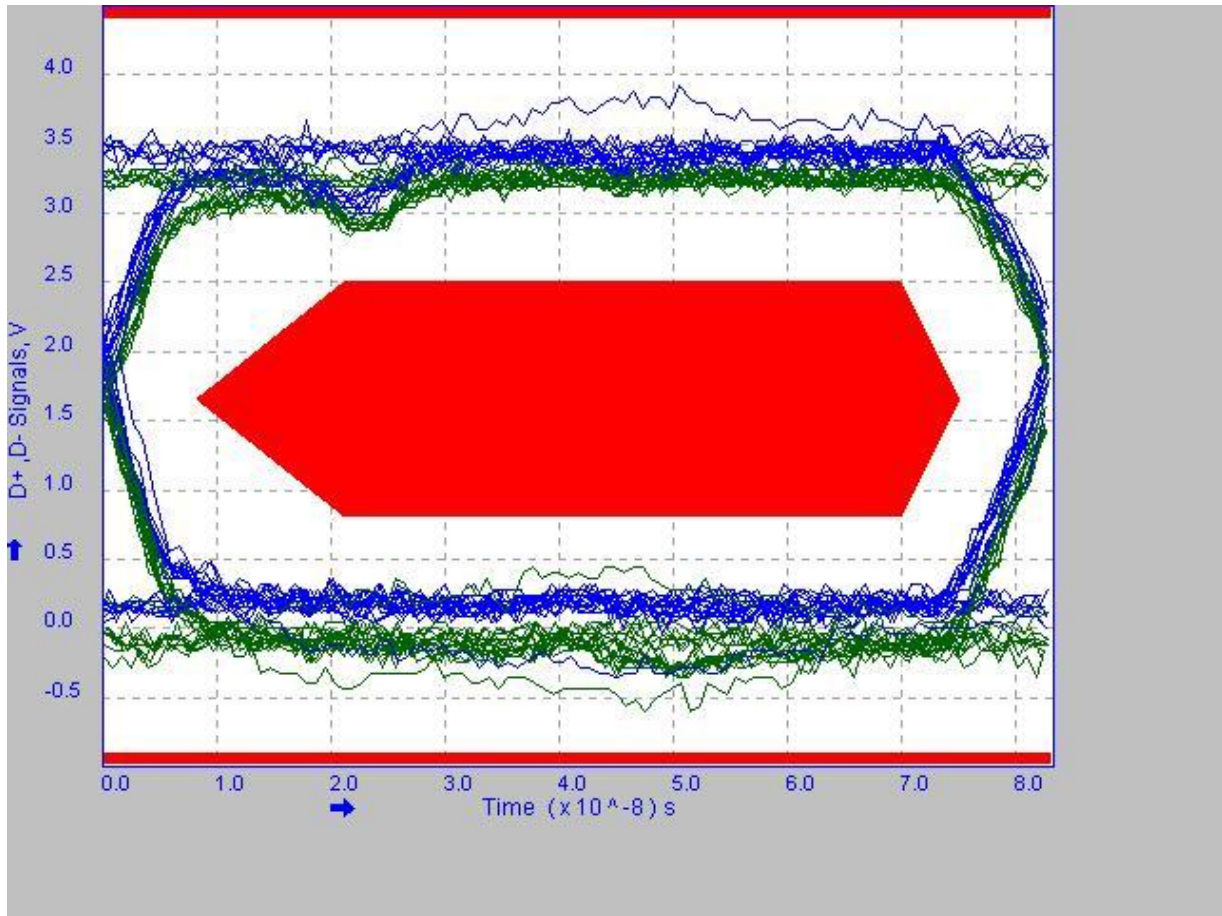


Figure 8b. Full Speed Eye-Diagram of connection to D+/D-

Measurement Name	Minimum	Maximum	Mean	pk-pk	Standard Deviation	RMS	Population	Status
Eye Diagram Test	-	-	-	-	-	-	-	Pass
Signal Rate	11.81723Mbps	12.16887Mbps	12.00424Mbps	0.0000bps	124.9426kbps	11.99716Mbps	29	Pass
Crossover Voltage	1.752727 V	1.963636 V	1.848974 V	210.9091mV	57.64284mV	1.849827 V	20	Pass
EOP Width	-	-	165.7698ns	-	-	-	1	Pass
Consecutive Jitter	-978.1878ps	1.082909ns	0.0000s	2.061096ns	618.8819ps	602.3755ps	19	Pass
Paired JK Jitter	-320.5691ps	276.1086ps	-68.33082ps	596.6777ps	181.1687ps	183.9682ps	9	Pass
Paired KJ Jitter	-380.6688ps	207.7325ps	-99.02908ps	588.4013ps	187.7591ps	201.6272ps	8	Pass

Table 6. Full Speed Signal Quality Measurement of connection to D+/D-

Additional Information :

Rise Time: Min: 12.582ns Max: 13.672ns Mean: 13.161ns Std: 377.84ps RMS: 13.165ns Population: 9
 Fall Time: Min: 12.117ns Max: 14.446ns Mean: 13.423ns Std: 680.41ps RMS: 13.438ns Population: 10

The USB signal from Low-Speed USB device through PI3USB102 is compared with USB 2.0 Low Speed DOWNSTREAM – NEAR END eye mask. Figure 9a and Figure 9b show the PASSING eye-diagram of which the USB 2.0 Full Speed signal passing through PI3USB102.

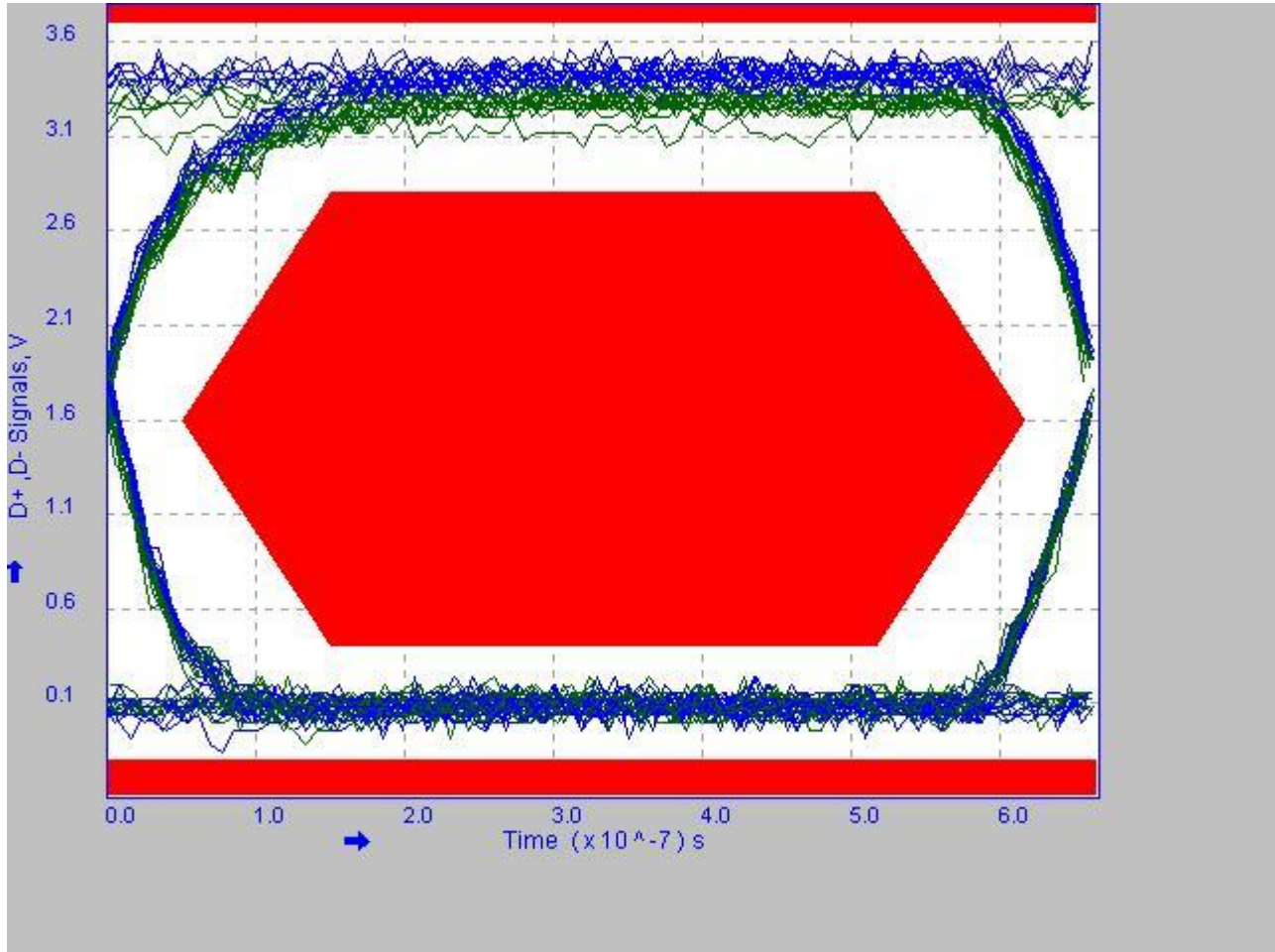


Figure 9a. Low Speed Eye-Diagram of connection to M+/M-

Measurement Name	Minimum	Maximum	Mean	pk-pk	Standard Deviation	RMS	Population	Status
Eye Diagram Test	-	-	-	-	-	-	-	Pass
Signal Rate	1.493664Mbps	1.509021Mbps	1.499836Mbps	0.0000bps	4.024761kbps	1.500093Mbps	31	Pass
Crossover Voltage	1.706667 V	1.856364 V	1.796314 V	149.6970mV	34.28785mV	1.796626 V	22	Pass
EOP Width	-	-	1.339729us	-	-	-	1	Pass
Consecutive Jitter	-2.837954ns	3.262011ns	0.0000s	6.099965ns	1.466047ns	1.430715ns	21	Pass
Paired JK Jitter	-1.321092ns	2.050337ns	275.5051ps	3.371429ns	1.160625ns	1.135010ns	10	Pass
Paired KJ Jitter	-4.145274ns	2.336051ns	152.1313ps	6.481325ns	2.299580ns	2.173396ns	9	Pass

Table 7. Low Speed Signal Quality Measurement of connection to M+/M-

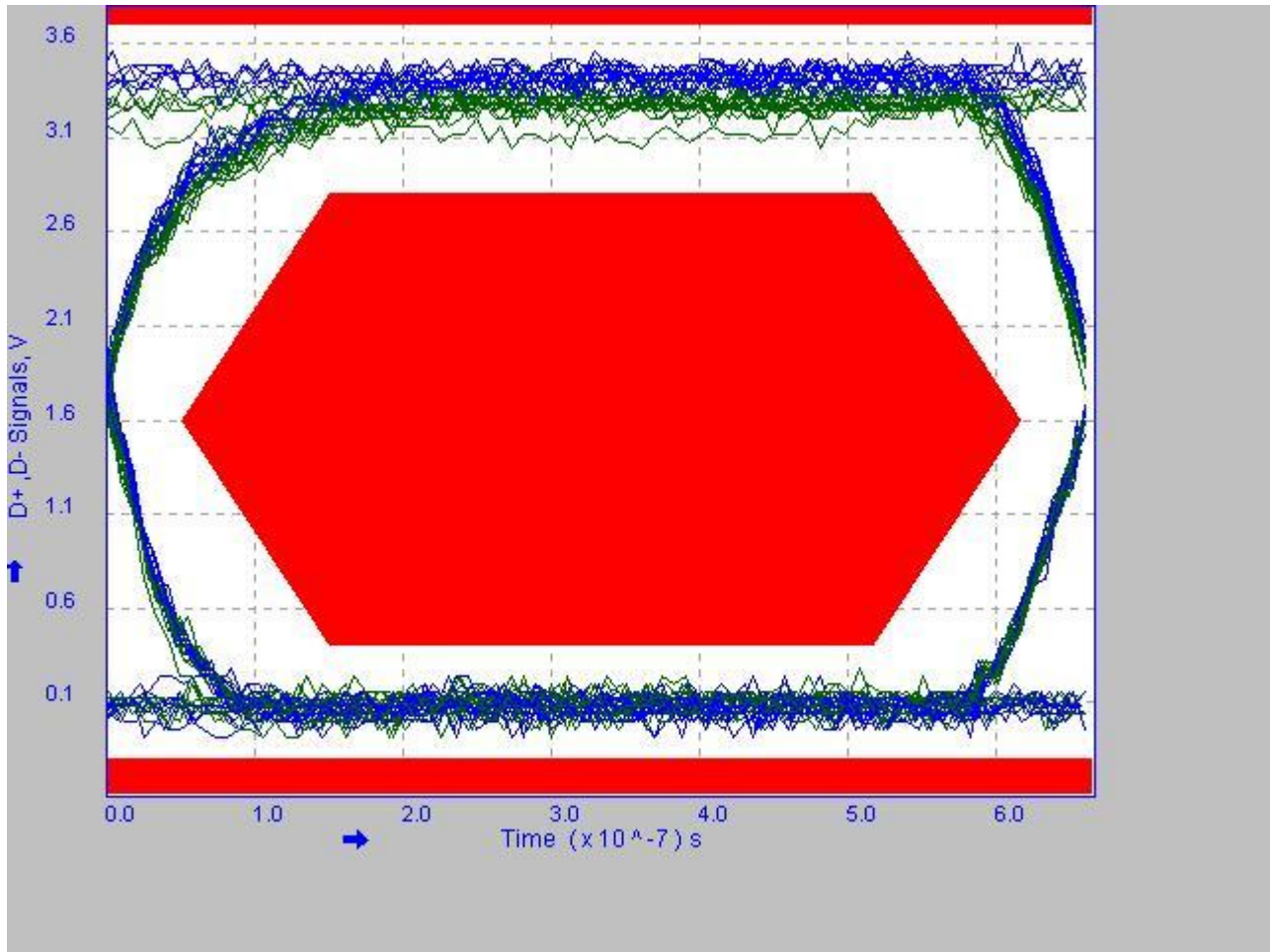


Figure 9b. Low Speed Eye-Diagram of connection to D+/D-

Measurement Name	Minimum	Maximum	Mean	pk-pk	Standard Deviation	RMS	Population	Status
Eye Diagram Test	-	-	-	-	-	-	-	Pass
Signal Rate	1.485653Mbps	1.513186Mbps	1.499986Mbps	0.0000bps	6.258799kbps	1.500167Mbps	31	Pass
Crossover Voltage	1.709333 V	1.846154 V	1.795022 V	136.8205mV	40.85973mV	1.795465 V	22	Pass
EOP Width	-	-	1.339144us	-	-	-	1	Pass
Consecutive Jitter	-2.944317ns	3.638171ns	0.0000s	6.582488ns	1.831335ns	1.787200ns	21	Pass
Paired JK Jitter	-3.493088ns	4.884084ns	132.7189ps	8.377171ns	2.885336ns	2.740486ns	10	Pass
Paired KJ Jitter	-4.197235ns	4.061412ns	-92.67793ps	8.258647ns	2.620899ns	2.472745ns	9	Pass

Table 8. Low Speed Signal Quality Measurement of connection to D+/D-

TDR Measurement

Differential impedance of PI3USB102 on a demo board is measured to confirm the trace impedance is within the requirement described in USB 2.0 TDR Loading specification in Section 7.1.6.2.

Section	Reference	Requirement
7.1.6.2	TDR Loading Specification	Through Impedance: $70\Omega \leq Z_{HSTRHU} \leq 110\Omega$ * At Termination Impedance: $80\Omega \leq Z_{HSTERM} \leq 100\Omega$ * In the Exception Window (a sliding 1.4 ns window inside the Through Impedance time window), the differential impedance may exceed the Through limits. No single excursion, however, may exceed the Through limits for more than twice the TDR rise time (400 ps)

Filter Rise Time = 380ps

Through Impedance		D+/D-	Spec		Units
			Min	Max	
J3	Min	75.14	70	110	Ω
	Max	101.4	70	110	Ω
J4	Min	75.14	70	110	Ω
	Max	101.4	70	110	Ω

Table 9. TDR Through Impedance Result of PI3USB102

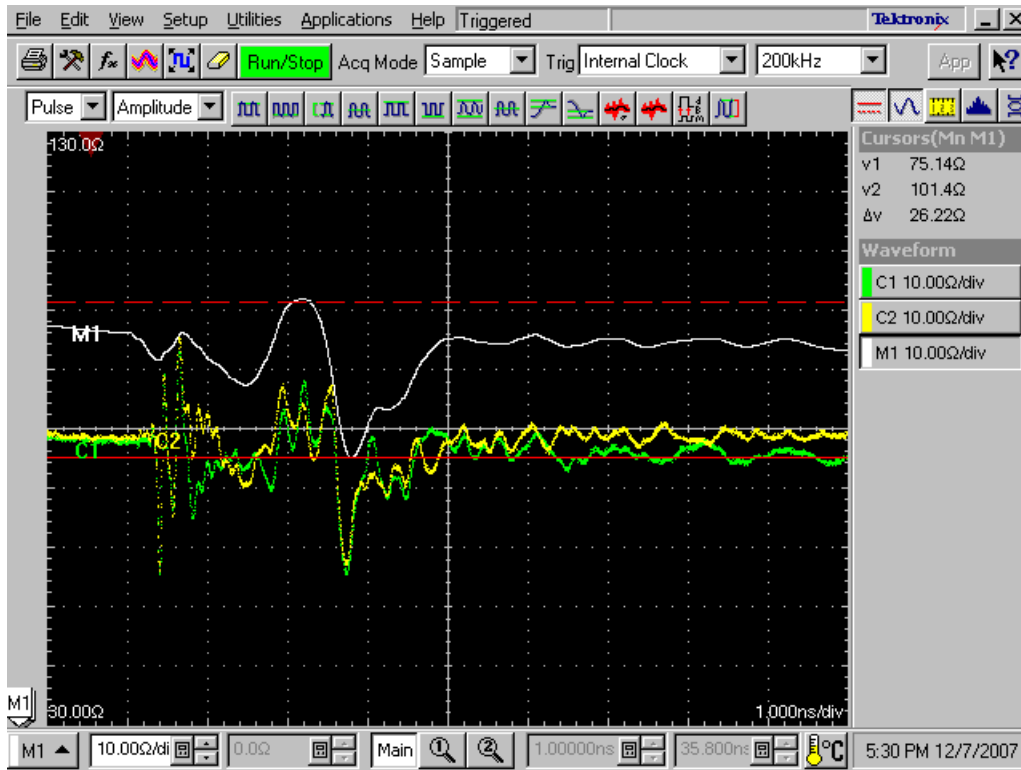
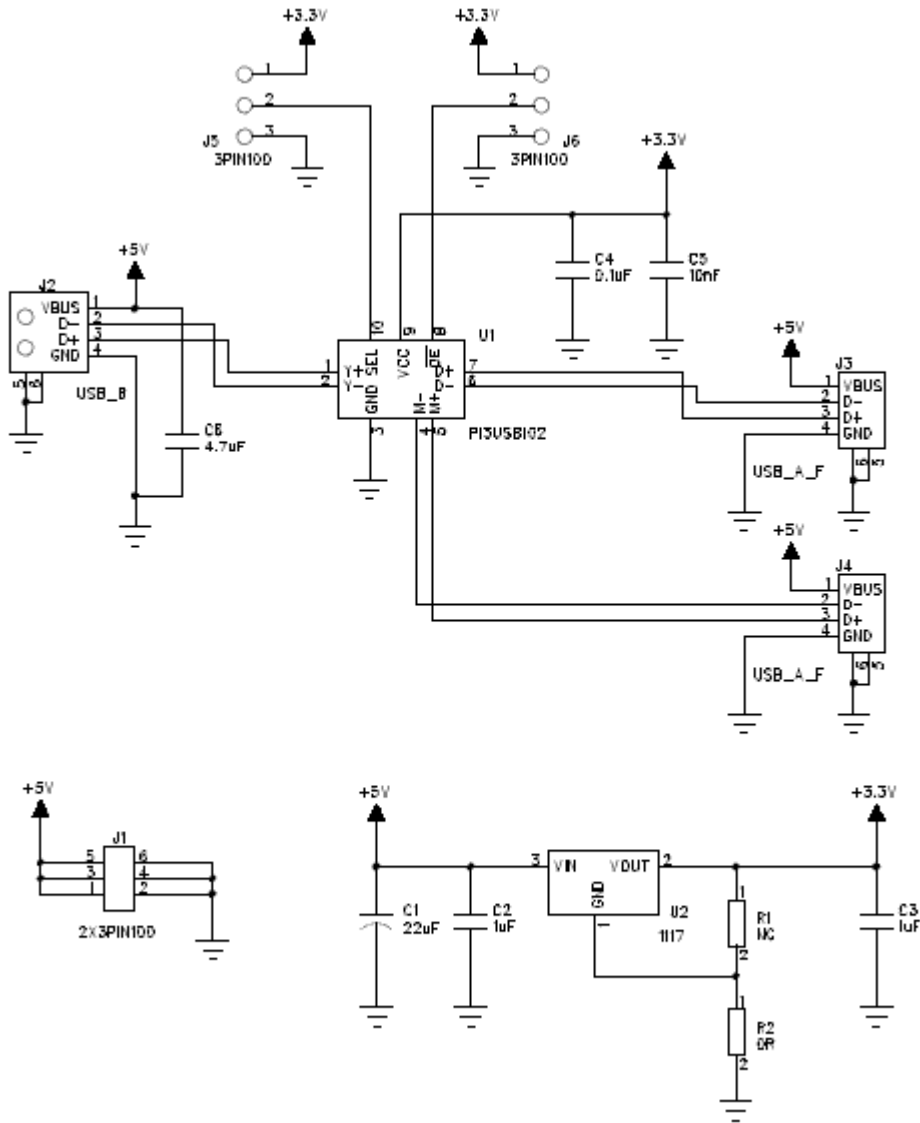


Figure 10a. TDR at D+/D- of J3



Figure 10b. TDR at D+/D- of J4

Appendix A: PCB Schematic



Appendix B: PCB Layout Requirements

a. Stack Up:

Layer #	Plane	Material type	mil
	Solder Mask		0.4
Layer 1	Signal		1.9
	Prepreg	Prepreg 1080 Prepreg 2116	7.3
Layer 2	Gnd		1.2
	Core		44
Layer 3	Power		1.2
	Prepreg	Prepreg 2116 Prepreg 1080	7.3
Layer 4	Signal		1.9
	Solder Mask		0.4

b. Isolation Spacing = 30 mil

c. Width & Spacing (W/S) of 90Ω Differential Trace = 11 / 10 mil

Appendix C: BOM List

Reference	Description	Package	Value	Qty
U2	3.3V Regulator	SOT89		1
J1	2x3pin connector, 2.54mm			1
J5-6	3pin 2.54mm Pin Header			2
C4	Ceramic Capacitor	0402	0.1uF	1
C5	Ceramic Capacitor	0402	10nF	1
C2-3	Ceramic Capacitor	0805	1uF	2
C6	Ceramic Capacitor	0805	4.7uF	1
C1	Tan Cap	B-Size	22uF	1
U1	USB2.0 High-Speed(480Mbps) Signal Switch	TQFN10		1
R2	Resistor	0402	0R	1
R1	Resistor	0402	NC	1
J3-4	USB Type-A Receptacle			2
J2	USB Type-B Receptacle			1

History

Version 1.0
Version 1.1

Original Version
Eye Diagram is added

December 12, 2007
December 20, 2007