USB 3.1 Cable Compliance Test Method of Implementation (MOI) Using Tektronix DSA8300 Series Sampling Oscilloscope

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Index

1.	Ove	rview	4
2.	Tes	t Equipment Requirements	4
	2.1.	Required Equipment	4
	2.2.	Oscilloscope	5
	2.1.	USB 3.1 Test Fixture	5
3.	Get	ting Started	6
	3.1.	Equipment Calibration and Fixture setup	6
4.	USI	3 Type-C to Type-C Cable Assembly	9
	4.1.	Normative Measurements	9
	4.2.	Informative Measurements	19
5.	USI	3 Standard A to Type-C Cable Assembly	
	5.1.	Normative Measurements	20
	5.2.	Informative Measurements	28
6.	USI	3 Type-C to Legacy Cable Assembly	
	6.1.	Normative Measurements	29
	6.2.	Informative Measurements	37
7.	Lov	v Speed Signal	
	7.1.	Single Ended Coupling between Vbus to SBU_A/SBU_B	
	7.2.	Single Ended Coupling between Vbus to CC	
	7.3.	Single Ended Coupling between SBU_A/SBU_B to CC.	
,	7.4.	Differential Coupling between CC and D+/D	38
	7.5.	Differential Coupling between Vbus and D+/D	
	7.6.	USB D+/D- Signal Integrity.	
8.	App	endix A: Tips to reduce time and connections	
1	8.1.	Reducing the number connections made during testing	

Revision History

Version	Date	Summary of Change(s)	Contributors
.5	12/17/2014	Initial Document	Steve Bright
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1. Overview

The cable test for USB 3.1 standards are far different then the testing requirements for any earlier USB cables. This testing requires the use of s-parameters of the cable to calculate integrated values. This test procedure is designed to assist the end user in capturing the required s-parameters and use them in the USB compliance tool to generate the integrated values and validate that the cable is acceptable for use with the USB 3.1 standard.

The following list summarizes the cable tests required for USB 3.1 compliant cables and adapters.

- 1. Differential Insertion Loss Fit
- 2. Integrated Differential Multi-reflections
- 3. Integrated Differential Crosstalk on SuperSpeed
- 4. Integrated Return Loss
- 5. Differential to Common Mode Conversion
- 6. CC to USB D+/D- Differential Coupling
- 7. Vbus to SBU_A/SBU_B Single ended
- 8. SBU_A/SBU_B to D+/D- Differential Coupling

This MOI contains the procedure for testing electrical requirements for Enhanced SuperSpeed USB Cables and adapters as descripted in Universal Serial Bus (USB) 3.1 specifications Revision 1.0 dated July 26, 2013.

2. Test Equipment Requirements

In this MOI, the test are grouped by cable type. Within each cable type there is a subsection for normative and informative measurements. Each cable type can be performed without any previous cable setups.

2.1. Required Equipment

The following equipment is required for USB 3.1 cable tests

- 1. 1 ea. Tektronix DSA8300
 - Tektronix Option 80SSPAR, 80SICON, or 80SICMX (IConnect® S-parameters Software)

- 2. 2 ea. 80E08B, 80E10B, OR $80E04^1$ sampling module
- 3. 1 ea. set of approved text fixture adapters
- 4. 4 ea. SMA male to male barrel adapters
- 5. 16 ea. SMA male 50 Ohm terminators
- 6. USB Analysis software tool (available from USB-IF)
- 7. 1 ea. SMA cable
- 8. 1 ea. 5/16 torque wrench
- 9. 1 ea. 5/16 wrench (optional, highly recommended)
- 10. 1 each ¼ wrench (optional, useful when torqueing the SMA Male to Male adapter)
- 11. External Monitor (optional, highly recommended)

2.2. Oscilloscope

This document is developed using the Tektronix sampling oscilloscope, Model# DSA8300 with 80E10B modules. Any Tektronix Sampling oscilloscope capable of supporting the TDR Modules offered by Tektronix and able to support the use of the IConnect S-parameter Wizard will work. This includes the 80E04 TDR modules with some limitations.

2.1. USB 3.1 Test Fixture

For cable testing, a LUXSHARE-ICT set of adapters and four male to male SMA barrel adapters are used.



Figure 1: LUXSHAREICT USB3.1 Test Fixture

¹ The 80E04 has not been tested with this process because of it limited frequency response and reduce accuracy. For this reason the 80E04 is not recommended. However, all tools and process in this document will work with the 80E04. If the 80E04 is used, 18 GHz matched cable will be required.

3. Getting Started

3.1. Equipment Calibration and Fixture setup

Before starting the DSA8300 and associate module needs to have a 20 minute warm-up period for best results. After the warm-up verify that the mainframe and modules do not require compensation. This can be verify by viewing the temp gauge at the lower right side of the gratitude display. If the gauge is yellow or red compensation is required.



Figure 2 Screen shot of the calibration indicator

To run compensation click on the temp gauge. A menu will appear that will show what the temp drift from the last compensation. The mainframe is compensated separately from the modules. Select either Mainframe or all modules (One module can be compensated but it is recommended to compensate all modules) then click on Execute and follow the prompts on the display. When finished with compensation click on close.

urre	nt Date/Time:	06 Ja	n 15 15:05			
Aainf	frame					
	Model	Serial #	Date / Time	Status	ΔΤΕΜΡ	Select Action
	DSA8300	C050085	06 Jan 15 10:14	Pass	-1.3°C	© Save
Jppe	r Modules					© Recall
СН	Model	Serial #	Date / Time	Status	ΔΤΕΜΡ	© Compensate
1 2 3						Compensate and Save
4						\frown
owe	r Modules					Mainframe
СН	Model	Serial #	Date / Time	Status	ΔΤΕΜΡ	Mainframe
1	80E10B	B020171	06 Jan 15 10:16	Pass	+1.0°C	All Modules Module
2	80E10B	B020171	06 Jan 15 10:16	Pass	+0.9°C	Wodule
3	80E10B	B020188	06 Jan 15 10:16	Pass	+3.6°C	Storage
4 5	80E10B	B020188	06 Jan 15 10:16	Pass	+0.8°C	User
6						Factory
7						a torati
						Execute
Con	npensation India	ator Button				
alle a	Displ	ay 🔽 🗸	nimate			Help Close

Figure 3 Screen that allows compensation to be run

Note when using the DSA8300 and modules it is very important to always use a grounding strap. When the instrument is not in use make sure that the termination caps are placed on the module inputs.

Next is to identify which side of the cable will be Host and which will be the Device. For Type-C to Type-C cables the user will need to identify and mark each side. In this procedure for Standard A to Type-C legacy cables the Type-C will be referred to as the Device side and the Standard A legacy side will be referred to the Host side. Additionally for Type-C to Type-C cables the end user needs to determine the orientation of the cable as it plugs into the fixture. For this procedure it is assumed that TX1+/- will connect to RX1+/- and the same holds true for TX2 and RX2.

To determine the orientation of the cables with the test fixtures, it is best to associate the USB logo on the top of the cable connector with the fixture that has top side printed on it. Refer to figure 4.



Figure 4: USB Type-C cable associated with USB Fixture

4. USB Type-C to Type-C Cable Assembly

4.1. Normative Measurements

Main Setup:

- 4.1.1. From the DSA8300 pull down application menu select IConnect S-parameter Wizard. A popup window about resuming measurements will show up click OK.
- 4.1.2. From the top menu in the Wizard select 4 port Single Ended refer to figure 5

IConnect S-param	eter Wizard	
Calibration	4 Port Single Ended 1 Port Single Ended 2 Port Single Ended 4 Port Single Ended 4 Port Single Ended 1 Port Differential 2 Port Differential 1 Port Mixed Mode 2 Port Mixed Mode Thru + Open + Load Thru + Open + Load	3
Timebase Auto 💌	RL Auto - Avg 250 -	
Frequency Autoset	∆f MHz F _{max} GHz	
Connect ↓ Z-Line	Z-Line Threshold 35 %	
Start	Cancel Help Close	
Select channels and setting	ps, then click Start.	

Figure 5: Setting the Wizard for s4p file

4.1.3. In the Wizard Calibration menu select Thru +Open +Load from the pull down. Refer to figure 6.



Figure 6: Selecting Calibration Method

4.1.4. In the Frequency menu uncheck the Auto and set the Delta Frequency to 10MHz and the max Frequency to 15 GHz. Refer to Figure 7.

ICon	nect S-parameter Wi	zard
ø	4 Port Single Ended 💌	8
CH1 - Port 1	DUT	Port 2 CH3 •
CH2 V Port 3		Port 4
Calibration	Thru + Open + Load 💌	
Timebase Auto 💌	RL Auto 👻	Avg 250 💌
Autoset	Δf 010.000 MHz	F max 15. GHz
Z-Line	Z-Line Threshold 35 %	
Start	ancel Help	Close
Running in Demomode. Clic	sk Start to restart Wizard.	

Figure 7: Setting the Delta Frequency and Max Frequency Range

- 4.1.5. Verify Port setting are as follows: Ch1 = Port 1, Ch2 = Port 3, Ch3 = Port 2, and Ch4 = Port 4 (This is important for the compliance tool set to work correctly).
- 4.1.6. Click on the Start Button. Next create or select a folder for the measurement data to go to.

Insertion Loss and Return Loss data acquisition:

4.1.7. Input the following file name **ID#_Host_TX1_Thru**. Replace the #with a unique identifier. Then click OK. Refer to Figure 8.

IConnect S-parameter Wizard	
4 Port Single Ended 💌	8
Port 1 DUT Port 2	
CH2 → DUT #1	
Ci Filename ID001_Host_TX1_Thru _11.WFM	
Fr OK Cancel	
IConnect ✓ Z-Line Z-Line Threshold 35 %	
Start Cancel Help Close	
Choose filename prefix for this DUT.	

Figure 8: File naming step

- 4.1.8. If a pop window appears asking to use previous measured Deskews, select No if there has been any change in the setup since the last time testing was performed. Then follow promotes to remove terminators and cables and connect to the TDR clock output.
- 4.1.9. Make the following connections using the male to male barrel adapters to the USB Fixtures: Ch1 to Host TX1+, Ch2 to Host TX1-, Ch3 to Device RX1+, and Ch4 Device to RX1-. Install 50 ohm terminators on all unused connectors. Do not

connect any cables between fixtures. Click OK. Refer to Figure 9 for fixture markings.



Figure 9: Identifying fixture inputs

- 4.1.10. Connect the first cable to be tested. Note if more than one cable is being tested start with the longest cable. This will set the time base correctly for test all other cables. Click OK
- 4.1.11. Disconnect the test fixture from the barrel adapter. Then connect Ch1 to the open reference on the USB calibration test fixture. Then Click OK. Repeat the step for remaining channels.
- 4.1.12. Connect Ch 1 to one side of the 2X thru on the Calibration test fixture and Ch3 to the other side of the same 2X thru. Click OK. When prompted by the application repeat for the following connections: Ch2 to Ch4, Ch1 to Ch4, Ch3 to Ch2, Ch1 to Ch2, Ch3 to Ch4,.
- 4.1.13. Connect Ch1 to Load_1 on the calibration test fixture, then click OK. Repeat for the remaining channels when promoted by the application.
- 4.1.14. Input the following file name **ID#_Host_RX1_Thru**. Replace the # with a unique identifier. Then click OK.
- 4.1.15. Make the following connections using the male to male barrel adapters: Ch1 to Host RX1+, Ch2 to Host RX1-, Ch3 to Device TX1+, and Ch4 to Device TX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 4.1.16. Input the following file name **ID#_Host_D+_D-_Thru**. Replace the # with a unique identifier. Then click OK.
- 4.1.17. Make the following connections using the male to male barrel adapters: Ch1 to Host D+, Ch2 to Host D-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

Near End Cross Talk Data acquisitions:

- 4.1.18. Input the following file name **ID#_Host_TX1RX1_NEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.19. Make the following connections using the male to male barrel adapters: Ch1 to Host TX1+, Ch2 to Host TX1-, Ch3 to Host RX1+, and Ch4 to Host RX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 4.1.20. Input the following file name **ID#_Device_TX1RX1_NEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.21. Make the following connections using the male to male barrel adapters: Ch1 to Device TX1+, Ch2 to Device TX1-, Ch3 to Device RX1+, and Ch4 to Device RX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 4.1.22. Input the following file name **ID#_Host_TX1D+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.23. Make the following connections using the male to male barrel adapters: Ch1 to Host TX1+, Ch2 to Host TX1-, Ch3 to Host D+, and Ch4 to Host D-. Install 50 ohm

terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

- 4.1.24. Input the following file name **ID#_Host_RX1D+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.25. Make the following connections using the male to male barrel adapters: Ch1 to Host RX1+, Ch2 to Host RX1-, Ch3 to Host D+, and Ch4 to Host D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 4.1.26. Input the following file name **ID#_ Device_TX1D+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.27. Make the following connections using the male to male barrel adapters: Ch1 to Device TX1+, Ch2 to Device TX1-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 4.1.28. Input the following file name **ID#_ Device_RX1D+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.29. Make the following connections using the male to male barrel adapters: Ch1 to Device RX1+, Ch2 to Device RX1-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

Far End Cross Talk data Acquisitions:

- 4.1.30. Input the following file name **ID#_ HostRX1_DeviceRX1_FEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.31. Make the following connections using the male to male barrel adapters: Ch1 to Host RX1+, Ch2 to Host RX1-, Ch3 to Device RX1+, and Ch4 to Device RX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 4.1.32. Input the following file name **ID#_ HostTX1_DeviceTX1_FEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.33. Make the following connections using the male to male barrel adapters: Ch1 to Host TX1+, Ch2 to Host TX1-, Ch3 to Device TX1+, and Ch4 to Device TX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 4.1.34. Input the following file name **ID#_ HostD+D-_DeviceTX1_FEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.35. Make the following connections using the male to male barrel adapters: Ch1 to Host D+, Ch2 to Host D-, Ch3 to Device TX1+, and Ch4 to Device TX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 4.1.36. Input the following file name **ID#_ HostD+D-_DeviceRX1_FEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.37. Make the following connections using the male to male barrel adapters: Ch1 to Host D+, Ch2 to Host D-, Ch3 to Device RX1, and Ch4 to Device RX1. Install 50

ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

- 4.1.38. Input the following file name **ID#_ HostTX1_DeviceD+D-_FEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.39. Make the following connections using the male to male barrel adapters: Ch1 to Host TX1+, Ch2 to Host TX1-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 4.1.40. Input the following file name **ID#_ HostRX1_DeviceD+D-_FEXT**. Replace the # with a unique identifier. Then click OK.
- 4.1.41. Make the following connections using the male to male barrel adapters: Ch1 to Host RX1+, Ch2 to Host RX1-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

Analyzing the Capture Data with USB Compliance Software Tool

- 4.1.42. Start the USB Compliance Tool IntePar by Double clicking on
- C:\IntePar\IntePar_v0p7\IntePar_v0p7_x86.exe (or equivalent application)
- 4.1.43. Select 4 port VNA
- 4.1.44. Select Cable Type Type-C to Type-C, Gen 2. Refer to Figure 10.

- 3		IntePar	×
Load Config Spreadsheet coming Spreadsheet Select Oxde Type and VNA Type Select Cable Type Type-C to Type-C, Gen 2 Type-C to Type-C, Gen 2	-Port VNA 🗹 4-Port VNA	Raw S-Parameters Empty v 1,1 v fmin: 50 MHz fmax 15 GHz fstep: 10 MHz	Select Spec Items Empty V
Type-C to Type-C, Gen 1 Type-C to Legacy me Standard-A to Type-C me Type-C to Legacy Adaptor > "Chru: Rx == Rx, SDD(3:4,3:4) > Thru: Dafter _ Dafter _ SDD(5:6:5:6)	Port Definition [Tx Tx] [Rx Rx]	Type-C Side	Type-C Side or Legacy Side
NEXT: Tx == Rx, SDD13/SDD31 NEXT: Tx == Rx, SDD24/SDD42	[Tx Rx]	Rx 3	4
>> NEXT: Tx == D+/D-, SDD15/SDD51	[Tx D+/D-]	D+/D- 5	6
>> NEXT: Rx == D+/D-, SDD35/SDD53	[Rx D+/D-]		
>> NEXT: Rx == D+/D-, SDD46/SDD64	[Rx D+/D-]		
>> FEXT: Tx == Rx, SDD14/SDD41	[Rx Tx]		
>> FEXT: Tx == Rx, SDD23/SDD32 >> FEXT: Tx == D+/D-, SDD52/SDD25	[Tx Rx] [D+/D- Tx]	Value, Pass/Fail	Pass/Fail Criteria Check Compliance
>> FEXT: Rx == D+/D-, SDD54/SDD45	[D+/D- Rx]	ILfit@5.0 GHz	Generate Report
>> FEXT: Tx == D+/D-, SDD61/SDD16	[Tx D+/D-]	IMR	Help
>> FEXT: Rx == D+/D-, SDD63/SDD36	[Rx D+/D-]	IRL INEXT	Exit
ļ	Import	IFEXT SCD12/SCD21	Revision 0.7 By Yun Ling Intel Corp, July, 2014

Figure 10: Selecting USB cable Type with s4p files

4.1.45. In the Load/Show S-parameter Files Names select the file to be loaded by clicking beside file name. As shown in figure 11.

		1.0	Raw S-Parameters		Select Spec Iter	ms
Load Config Spreadsheet	Config Spreadsheet	*	Empty	v 1,1 v	Empty	
Select Cable Type and VNA T Select Cable Type Type-C to Type-C, Gen 2	Type	8-Port VNA 🗹 4-Port VNA	fmin: 50 MHz fmax 15 GH	z fstep: 10 MHz		
Load/Show S-Parameters Fil S-Parameter Fil	e Names	Port Definition	Type-C	Side	Tupo C Sido	er Lemay Side
>> Thru: Tx == Tx, SDD(1:2,	,1:2)	[Tx Tx]			Type-C side	or Legacy Side
>> Thru: Rx == Rx, SDD(3:4	,3:4)	[Rx Rx]	Tx 1			2
>> Thru: D+/D- == D+/D-, SD	DD(5:6,5:6)	[D+/D- D+/D-]				
>> NEXT: Tx == Rx, SDD13/	SDD31	[Tx Rx]	Rx 3			4
>> NEXT: Tx == Rx, SDD24/	SDD42	[Tx Rx]				
>> NEXT: Tx == D+/D-, SDD	15/SDD51	[T× D+/D-]	D+/D-			б
>> NEXT: Rx == D+/D-, SDD	35/SDD53	[Rx D+/D-]	2.,0			
>> NEXT: Tx == D+/D-, SDD	26/SDD62	[Tx D+/D-]				
>> NEXT: Rx == D+/D-, SDD	46/SDD64	[Rx D+/D-]				
>> FEXT: Tx Rx, SDD14/	SDD41	[Rx Tx]				
>> FEXT: Tx == Rx, SDD23/	SDD32	[Tx Rx]	ſ	N.L. D. (5.3)		-
>> FEXT: Tx == D+/D-, SDD	52/SDD25	[D+/D- Tx]	ILfit@2.5GHz	Value, Pass/Fail	Pass/Fail Criteria	Check Compliance
>> FEXT: Rx == D+/D-, SDD	54/SDD45	[D+/D- Rx]	ILfit@5.0 GHz			Generate Report
>> FEXT: Tx == D+/D-, SDD	61/SDD16	[Tx D+/D-]	ILfit@10.0GHz IMR			Help
>> FEXT: Rx == D+/D-, SDD	XT: Rx == D+/D-, SDD63/SDD36 [Rx D+/D-]		IRL	_		Ext
			INEXT			Revision 0.7
				-		

Figure 11: Loading associated s4p files

Load all files as associated in table below:

Thru: Tx==Tx, SDD(1:2, 1:2)	ID#_Host_TX1_Thru
Thru: Rx==Rx, SDD(3:4, 3:4)	ID#_Host_RX1_Thru
Thru: D+/D-==D+/D-, SDD(5:6, 5:6)	ID#_Host_D+_DThru
NEXT: $Tx == Rx$, SDD13/SDD31	ID#_Host_TX1RX1_NEXT
NEXT: $Tx == Rx$, SDD24/SDD42	ID#_Device_TX1RX1_NEXT
NEXT: $Tx == D+/D-$, $SDD15/SDD51$	ID#_Host_TX1D+DNEXT
NEXT: $Rx == D+/D-$, SDD35/SDD53	ID#_Host_RX1D+DNEXT

NEXT: $Tx == D + D$ -, $SDD26/SDD62$	ID#_ Device_TX1D+DNEXT
NEXT: $Rx == D+/D-$, SDD46/SDD64	ID#_ Device_RX1D+DNEXT
FEXT: $Tx == Rx$, SDD14/SDD41	ID#_HostRX1_DeviceRX1_FEXT
FEXT: $Tx == Rx$, SDD23/SDD32	ID#_HostTX1_DeviceTX1_FEXT
FEXT: $Tx == D+/D-$, SDD52/SDD25	ID#_ HostD+DDeviceTX1_FEXT
FEXT: $Rx == D+/D-$, SDD54/SDD45	ID#_ HostD+DDeviceRX1_FEXT
FEXT: $Tx == D+/D-$, SDD61/SDD16	ID#_HostTX1_DeviceD+DFEXT
FEXT: $Rx == D + /D$ -, SDD63/SDD36	ID#_HostRX1_DeviceD+DFEXT

4.1.46. Click on the Import button

4.1.47. Click on the Check Compliance, verify that results are with in Specifications from the generated report. Refer to figure 12.

			[DetailRepo	ort				_ □
			Insertion F	it at Nyquist Fr	requency				
	ILfit@2.5GF	lz ILfit@2.5G	Hz Limit	Lfit@5GHz	ILfit@5GH	lz Limit	ILfit@10GH	lz ILfit@10)GHz Limit
Pair 1-2	-3.71	42	-4	-5.8424			6 -8.65	515	-1
Pair 3-4	-3.70	40	-4	-5.6332			6 -8.33	337	-1
	г			IMR and IRL					
			IMR	IMR Limi	t IRL		RL Limit		
	Ļ	Pair 1-2	-33.565	59 -42.71	95 -22.	2106	-24.8412		
	Ļ	Pair 3-4	-38.330	03 -42.38	395 -21.	6653	-24.5727		
	L								
	Integrated	I Near-End Cross	stalk			Int	egrated Far-End	d Crosstalk IFEXT Limit	
Vic = 1	Integrated	d Near-End Cross INEXT Limit -40	stalk		Vic	Int = 1	egrated Far-End IFEXT -40.2068	d Crosstalk IFEXT Limit -40)
Vic = 1 Vic = 3	Integrated INEXT -39.8365 -40.4599	d Near-End Cross INEXT Limit -40 -40	stalk		Vic Vic	Int = 1 = 3	egrated Far-End IFEXT -40.2068 -43.8423	d Crosstalk IFEXT Limit -40 -40)
Vic = 1 Vic = 3 Vic = 2	Integrated INEXT -39.8365 -40.4599 -40.2971	d Near-End Cross INEXT Limit -40 -40 -40	stalk		Vic Vic Vic	Int = 1 = 3 = 2	egrated Far-End IFEXT -40.2068 -43.8423 -42.8448	d Crosstalk IFEXT Limit -40 -40)))
Vic = 1 Vic = 3 Vic = 2 Vic = 4	Integrated INEXT -39.8365 -40.4599 -40.2971 -40.8975	d Near-End Cross INEXT Limit -40 -40 -40	stalk		Vic Vic Vic	Int = 1 = 3 = 2 = 4	egrated Far-End IFEXT -40.2068 -43.8423 -42.8448 -40.9652	d Crosstalk IFEXT Limit -40 -40 -40	
Vic = 1 Vic = 3 Vic = 2 Vic = 4	Integrated INEXT -39.8365 -40.4599 -40.2971 -40.8975	d Near-End Cross INEXT Limit -40 -40 -40 -40	stalk		Vic Vic Vic	Int = 1 = 3 = 2 = 4	egrated Far-End IFEXT -40.2068 -43.8423 -42.8448 -40.9652	d Crosstalk IFEXT Limit -40 -40 -40)
Vic = 1 Vic = 3 Vic = 2 Vic = 4	Integrated INEXT -39.8365 -40.4599 -40.2971 -40.8975	d Near-End Cross INEXT Limit -40 -40 -40 -40	stalk		Vic Vic Vic Vic	Int = 1 = 3 = 2 = 4	egrated Far-End IFEXT -40.2068 -43.8423 -42.8448 -40.9652	d Crosstalk IFEXT Limit -40 -40 -40 -40	
Vic = 1 Vic = 3 Vic = 2 Vic = 4	Integrated INEXT -39.8365 -40.4599 -40.2971 -40.8975	d Near-End Cross INEXT Limit -40 -40 -40	stalk Commor	n-to-Differentia	Vic Vic Vic Vic	Int = 1 = 3 = 2 = 4	egrated Far-End IFEXT -40.2068 -43.8423 -42.8448 -40.9652	d Crosstalk IFEXT Limit -40 -40 -40 -40	
Vic = 1 Vic = 3 Vic = 2 Vic = 4	Integrated INEXT -39.8365 -40.4599 -40.2971 -40.8975	d Near-End Cross INEXT Limit -40 -40 -40	stalk Common Max Mode C	n-to-Differentia	Vic Vic Vic Vic al Mode Conve Limit	Int = 1 = 3 = 2 = 4	egrated Far-End IFEXT -40.2068 -43.8423 -42.8448 -40.9652	d Crosstalk IFEXT Limit -40 -40 -40 -40	
Vic = 1 Vic = 3 Vic = 2 Vic = 4	Integrated INEXT -39.8365 -40.4599 -40.2971 -40.8975	d Near-End Cross INEXT Limit -40 -40 -40 -40	Stalk Common Max Mode Co	n-to-Differentia onversion -21.0248	Vic Vic Vic Vic al Mode Conve Limit -20	Int = 1 = 3 = 2 = 4	egrated Far-End -40.2068 -43.8423 -42.8448 -40.9652	d Crosstalk IFEXT Limit -40 -40 -40 -40	
Vic = 1 Vic = 3 Vic = 2 Vic = 4	Integrated INEXT -39.8365 -40.4599 -40.2971 -40.8975	d Near-End Cross INEXT Limit -40 -40 -40 -40 SCD12 SCD12 SCD21	stalk Common Max Mode Co	n-to-Differentia onversion -21.0248 -18.9846 -24.7000	Vic Vic Vic Vic Linit -20 -20	Int = 1 = 3 = 2 = 4	egrated Far-End -40.2068 -43.8423 -42.8448 -40.9652	d Crosstalk IFEXT Limit -40 -40 -40	
Vic = 1 Vic = 3 Vic = 2 Vic = 4	Integrated INEXT -39.8365 -40.4599 -40.2971 -40.8975	d Near-End Cross INEXT Limit -40 -40 -40 -40 -40 SCD12 SCD12 SCD21 SCD21 SCD34 SCD42	stalk Common Max Mode Cr	n-to-Differentia onversion -21.0248 -18.9846 -24.7960 25.5100	Vic Vic Vic Vic Limit Limit -20 -20 -20	Int = 1 = 3 = 2 = 4	egrated Far-End -40.2068 -43.8423 -42.8448 -40.9652	d Crosstalk IFEXT Limit -40 -40 -40	

Figure 12: IntePar report

4.1.48. Repeat process for TX2 and RX2.

4.2. Informative Measurements

To be completed in a future revision

5. USB Standard A to Type-C Cable Assembly

5.1. Normative Measurements <u>Main Setup:</u>

- 5.1.1. From the DSA8300 pull down application menu select IConnect S-parameter Wizard. A popup window about resuming measurements will show up click OK.
- 5.1.2. From the top menu in the Wizard select 4 port Single Ended refer to figure 13.

IConnect S-param	neter Wizerd
CH1 Port CH1 Port CH2 Port 3 Calibration	4 Port Single Ended ▼ 1 Port Single Ended Port 2 2 Port Single Ended Port 2 4 Port Single Ended Port 2 1 Port Differential Port 4 2 Port Mixed Mode Port 4 2 Port Mixed Mode ● Thru + Open + Load ▼
Timebase	
Auto	RL Auto VI Avg 250 V
Frequency Autoset	Δf MHz F _{max} GHz
Connect I Z-Line	Z-Line Threshold 35 %
Start	Cancel Help Close
Select channels and setting	gs, then click Start.

Figure 13: Setting the Wizard for s4p file

5.1.3. In the Wizard Calibration menu select Thru +Open +Load from the pull down. Refer to figure 14.



Figure 14: Selecting Calibration Method

5.1.4. In the Frequency menu uncheck the Auto and set the Delta Frequency to 10 MHz and the max Frequency to 15 GHz. Refer to figure 15



Figure 15: Setting the Delta Frequency and Max Frequency Range

- 5.1.5. Verify Port setting are as follows: Ch1 = Port 1, Ch2 = Port 3, Ch3 = Port 2, and Ch4 = Port 4 (This is important for the compliance tool set to work correctly).
- 5.1.6. Click on the Start Button. Next create or select a folder for where the measurement data will be stored.

Insertion Loss and Return Loss data acquisition:

5.1.7. Input the following file name **ID#_Host_TX_Thru**. Replace the # with a unique identifier. Then click OK. Refer to figure 16

IConnect S-pa	rameter Wiza	ard	
9	4 Port Sing	le Ended 💌	a
	ort 1 DI	JT Por	t2
• DUT #1			
Ct Filename	ID001_Host_TX	1_Thru _11.	WFM
-Fr	ок	Cancel	
- IConnect I Z-Line	Z-Line Thr	eshold 35 %	
Start	Cancel	Help	Close
Choose filename prefi	x for this DUT.		
	Figure 16	: File naming step	

- 5.1.8. If a pop window appears asking to use previous measured Deskews, select No if there has been any change in the setup since the last time testing was performed. Then follow promotes to remove terminators and cables and connect to the TDR clock output.
- 5.1.9. Make the following connections using the male to male barrel adapters to the Host Standard A fixture and the Device Type-C fixture: Ch1 to Host TX+, Ch2 to Host TX-, Ch3 to Device RX1+, and Ch4 Device to RX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

- 5.1.10. Connect the First cable to be tested. Note if more than one cable is being tested start with the longest cable. This will set the time base correctly for test all other cables. Click Okay
- 5.1.11. Disconnect the test fixture from the barrel adapter. Then connect Ch1 to the open reference on the USB calibration test fixture. Then Click OK. Repeat the step for remaining channels.
- 5.1.12. Connect Ch 1 to one side of the 2X thru on the Calibration test fixture and Ch3 to the other side of the same 2X thru. Click OK. When prompted by the application repeat for the following connections: Ch2 to Ch4, Ch1 to Ch4, Ch3 to Ch2, Ch1 to Ch2, Ch3 to Ch4,.
- 5.1.13. Connect Ch1 to Load_1 on the calibration test fixture, then click OK. Repeat for the remaining channels when promoted by the application.
- 5.1.14. Input the following file name **ID#_Host_RX_Thru**. Replace the # with a unique identifier. Then click OK.
- 5.1.15. Make the following connections using the male to male barrel adapters: Ch1 to Host RX+, Ch2 to Host RX-, Ch3 to Device TX1+, and Ch4 to Device TX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 5.1.16. Input the following file name **ID#_Host_D+D-_Thru**. Replace the # with a unique identifier. Then click OK.
- 5.1.17. Make the following connections using the male to male barrel adapters: Ch1 to Host D+, Ch2 to Host D-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

Near End Cross Talk Data acquisitions:

- 5.1.18. Input the following file name **ID#_Host_TXRX_NEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.19. Make the following connections using the male to male barrel adapters: Ch1 to Host TX+, Ch2 to Host TX-, Ch3 to Host RX+, and Ch4 to Host RX-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 5.1.20. Input the following file name **ID#_Device_TX1RX1_NEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.21. Make the following connections using the male to male barrel adapters: Ch1 to Device TX1+, Ch2 to Device TX1-, Ch3 to Device RX1+, and Ch4 to Device RX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 5.1.22. Input the following file name **ID#_Host_TXD+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.23. Make the following connections using the male to male barrel adapters: Ch1 to Host TX+, Ch2 to Host TX-, Ch3 to Host D+, and Ch4 to Host D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

- 5.1.24. Input the following file name **ID#_Host_RXD+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.25. Make the following connections using the male to male barrel adapters: Ch1 to Host RX+, Ch2 to Host RX-, Ch3 to Host D+, and Ch4 to Host D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 5.1.26. Input the following file name **ID#_ Device_TX1D+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.27. Make the following connections using the male to male barrel adapters: Ch1 to Device TX1+, Ch2 to Device TX1-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 5.1.28. Input the following file name **ID#_ Device_RX1D+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.29. Make the following connections using the male to male barrel adapters: Ch1 to Device RX1+, Ch2 to Device RX1-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

Far End Crosstalk data Acquisitions:

- 5.1.30. Input the following file name **ID#_ HostRX_DeviceRX1_FEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.31. Make the following connections using the male to male barrel adapters: Ch1 to Host RX+, Ch2 to Host RX-, Ch3 to Device RX1+, and Ch4 to Device RX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 5.1.32. Input the following file name **ID#_ HostTX_DeviceTX1_FEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.33. Make the following connections using the male to male barrel adapters: Ch1 to Host TX+, Ch2 to Host TX-, Ch3 to Device TX1+, and Ch4 to Device TX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 5.1.34. Input the following file name **ID#_ HostD+D-_DeviceTX1_FEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.35. Make the following connections using the male to male barrel adapters: Ch1 to Host D+, Ch2 to Host D-, Ch3 to Device TX1+, and Ch4 to Device TX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 5.1.36. Input the following file name **ID#_ HostD+D-_DeviceRX1_FEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.37. Make the following connections using the male to male barrel adapters: Ch1 to Host D+, Ch2 to Host D-, Ch3 to Device RX1+, and Ch4 to Device RX1-. Install 50

ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

- 5.1.38. Input the following file name **ID#_ HostTX_DeviceD+D-_FEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.39. Make the following connections using the male to male barrel adapters: Ch1 to Host TX+, Ch2 to Host TX-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 5.1.40. Input the following file name **ID#_ HostRX_DeviceD+D-_FEXT**. Replace the # with a unique identifier. Then click OK.
- 5.1.41. Make the following connections using the male to male barrel adapters: Ch1 to Host RX+, Ch2 to Host RX-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

Analyzing the Capture Data with USB Compliance Software Tool

- 5.1.42. Start the USB Compliance Tool IntePar by Double clicking on
- C:\IntePar\IntePar_v0p7\IntePar_v0p7_x86.exe (or equivalent application)
- 5.1.43. Select Cable Type as Standard A to Type-C
- 5.1.44. Select 4 port VNA. Refer to figure 17

.		IntePar	- 🗆 🗙
Load Config Stratusheet Config Spreadsheet Select Cable Type and VNA Type Select Cable Type Standard-A to Type-C Type-C to Type-C Config Can 2	S-Port VNA 🗹 4-Port VNA	Raw S-Parameters Empty v 1,1 v fmin: 50 MHz fmax 15 GHz fstep: 10 MHz	Select Spec Items Empty
Type-C to Type-C, Gen 1 Type-C to Legacy me Standard-A to Type-C me Type C to Legacy Adaptor >> Thru: Rx == Rx, =SP(3:4:3:4)	Port Definition [Tx Tx] [Rx Rx]	Type-C Side	Type-C Side or Legacy Side
>> Thru: D+/D- == D+/D-, SDD(5:6,5:6) >> NEXT: Tx == Rx, SDD13/SDD31	[D+/D- D+/D-] [Tx Rx]	Rx 3	4
>> NEXT: Tx == Rx, SDD24/SDD42 >> NEXT: Tx == D+/D-, SDD15/SDD51	[Tx Rx]	D+/D- 5	6
>> NEXT: Rx == D+/D-, SDD35/SDD53 >> NEXT: Tx == D+/D-, SDD26/SDD62	[Rx D+/D-]		
>> NEXT: Rx == D+/D-, SDD46/SDD64 >> FEXT: Tx == Rx, SDD14/SDD41	[Rx D+/D-] [Rx Tx]		
>> FEXT: Tx == Rx, SDD23/SDD32 >> FEXT: Tx == D+/D-, SDD52/SDD25	[Tx Rx] [D+/D- Tx]	Value, Pass/Fail	Pass/Fail Criteria Check Compliance
>> FEXT: Rx == D+/D-, SDD54/SDD45	[D+/D- Rx]	ILfit@5.0 GHz IMR	Generate Report
>> FEXT: Tx == D+/D-, SDD61/SDD16 >> FEXT: Rx == D+/D-, SDD63/SDD36	[Tx D+/D-]	IRL ISSXT IDDXT	Help Exit
	Import	SCD12/SCD21	Revision 0.7 By Yun Ling Intel Corp. July, 2014

Figure 17: Selecting USB cable Type with s4p files

5.1.45. In the Load/Show S-parameter Files Names select the file to be loaded by clicking beside file name. As show in figure 18

		IntePar – C	
Load Config Spreadsheet Config Spreadsheet - Select Cable Type and VNA Type Select Cable Type Standard-A to Type-C V 12-Port VNA	S-Port VNA 🗹 4-Port VNA	Raw S-Parameters Select Spec Items Empty v 1,1 v fmin: 50 MHz fmax 15 GHz fstep: 10 MHz	~
– Load/Show S-Parameters File Names	Port Definition	Tura C Sida	
>> Thru: Tx == Tx, SDD(1:2,1:2)	[Tx Tx]	Type-C Side or Legacy Side	
>> Thru: Rx == Rx, SDD(3:4,3:4)	[Rx Rx]	Tx 1 2	
>> Thru: D+/D- == D+/D-, SDD(5:6,5:6)	[D+/D- D+/D-]		
>> NEXT: Tx == Rx, SDD13/SDD31	[Tx Rx]	Rx 3 4	
>> NEXT: Tx == Rx, SDD24/SDD42	[Tx Rx]		
>> NEXT: Tx == D+/D-, SDD15/SDD51	[Tx D+/D-]		
>> NEXT: Rx == D+/D-, SDD35/SDD53	[Rx D+/D-]		
>> NEXT: Tx == D+/D-, SDD26/SDD62	[Tx D+/D-]		
>> NEXT: Rx == D+/D-, SDD46/SDD64	[Rx D+/D-]		
>> FEXT: Tx == Rx, SDD14/SDD41	[Rx Tx]		
>> FEXT: Tx == Rx, SDD23/SDD32	[Tx Rx]		
>> FEXT: Tx == D+/D-, SDD52/SDD25	[D+/D- Tx]	Value, Pass/Fail Pass/Fail Criteria Check Complian	nce
>> FEXT: Rx == D+/D-, SDD54/SDD45	[D+/D- Rx]	ILfit@5.0 GHz Generate Rep	ort
>> FEXT: Tx == D+/D-, SDD61/SDD16	[Tx D+/D-]	IMR Help	
>> FEXT: Rx == D+/D-, SDD63/SDD36	[Rx D+/D-1	ISSXT Exit	
	Import	Beyind J. A Beyind J. A Beyind J. By Yun Ling Intel Corp. July, 2014	

Figure 18: Loading associated s4p files

Load all files as associated in table below:

Thru: Tx==Tx, SDD(1:2, 1:2)	ID#_Host_TX_Thru
Thru: Rx==Rx, SDD(3:4, 3:4)	ID#_Host_RX_Thru
Thru: D+/D-==D+/D-, SDD(5:6, 5:6)	ID#_Host_D+DThru
NEXT: $Tx == Rx$, SDD13/SDD31	ID#_Host_TXRX_NEXT
NEXT: $Tx == Rx$, SDD24/SDD42	ID#_Device_TX1RX1_NEXT
NEXT: $Tx == D+/D-$, SDD15/SDD51	ID#_Host_TXD+DNEXT
NEXT: $Rx == D+/D-$, SDD35/SDD53	ID#_Host_RXD+DNEXT
NEXT: $Tx == D + D$ -, $SDD26/SDD62$	ID#_ Device_TX1D+DNEXT
NEXT: $Rx == D + D$ -, SDD46/SDD64	ID#_ Device_RX1D+DNEXT
FEXT: $Tx == Rx$, SDD14/SDD41	ID#_ HostRX_DeviceRX1_FEXT

FEXT: Tx == Rx, SDD23/SDD32	ID#_ HostTX_DeviceTX1_FEXT
FEXT: $Tx == D+/D-$, SDD52/SDD25	ID#_HostD+DDeviceTX1_FEXT
FEXT: $Rx == D+/D-$, SDD54/SDD45	ID#_HostD+DDeviceRX1_FEXT
FEXT: $Tx == D+/D-$, SDD61/SDD16	ID#_ HostTX_DeviceD+DFEXT
FEXT: $Rx == D+/D-$, SDD63/SDD36	ID#_ HostRX_DeviceD+DFEXT

- 5.1.46. Click on the Import button
- 5.1.47. Click on the Check Compliance, verify that results are with in Specifications from the generated report. Refer to figure 19

			Insertion I	Fit at Nyquist Fr	equency				
	ILfit@2.5GHz	ILfit@2.5G	iHz Limit	ILfit@5GHz	ILfit@5GI	Hz Limit			
Pair 1-2	-6.9169		-3.5000	-10.6618		-6			
Pair 3-4	-7.0524		-3.5000	-10.9855		-6			
				IMR and IRL					
			IMR	IMR Limi	t IRL	. IR	L Limit		
		Pair 1-2	-41.87	43 -45.27	/14 -25	.8690	-28.9152	2	
		Pair 3-4	-42.77	29 -45.36	73 -26	.9290	-29.1794	4	
Int	egrated Crossta	lk on SuperS	peed Pair			Integra	ted Crosst	talk on D+/	/D- Pair IDDXT Limit
Int Left Side	egrated Crossta	lk on SuperS	imit -38			Integra Left Side	ted Crosst	talk on D+/ DDXT -27.7701	/D- Pair IDDXT Limit -34
Int Left Side Right Side	egrated Crossta ISSXT -38.69 -38.75	Ik on SuperS ISSXT L 32 39	ipeed Pair imit -38 -38		I R	Integra Left Side ight Side	ted Crosst	talk on D+/ DDXT -27.7701 -42.8011	/D- Pair IDDXT Limit -34 -34
Int Left Side Right Side	egrated Crossta ISSXT -38.69 -38.75	Ik on SuperS ISSXT L 32 39	ipeed Pair imit -38 -38		I	Integra Left Side ight Side	ted Crosst	talk on D+/ DDXT -27.7701 -42.8011	/D- Pair IDDXT Limit -34 -34
Int Left Side Right Side	egrated Crossta ISSXT -38.69 -38.75	lk on SuperS ISSXT L 32 39	ipeed Pair imit -38 -38		I R	Integra Left Side ight Side	ted Crosst	talk on D+/ DDXT -27.7701 -42.8011	/D- Pair IDDXT Limit -34 -34
Int Left Side Right Side	egrated Crossta ISSXT -38.69 -38.75	lk on SuperS ISSXT L 32 39	ipeed Pair imit -38 -38		R	Integra Left Side ight Side	ted Crosst	talk on D+/ DDXT -27.7701 -42.8011	ID- Pair IDDXT Limit -34 -34
Int Left Side Right Side	egrated Crossta ISSXT -38.69 -38.75	lk on SuperS ISSXT L 32 39	ipeed Pair imit -38 -38			Integra Left Side ight Side	ted Crosst	talk on D+/ DDXT -27.7701 -42.8011	ID- Pair IDDXT Limit -34 -34
Int Left Side Right Side	egrated Crossta ISSXT -38.69 -38.75	Ik on SuperS ISSXT L 39	ipeed Pair imit -38 -38 Commo	Dn-to-Differentia	Il Mode Conv	Integra Left Side ight Side ersion	ted Crosst	talk on D+/ DDXT -27.7701 -42.8011	ID- Pair IDDXT Limit -34 -34
Int Left Side Right Side	egrated Crossta	Ik on SuperS ISSXT L 32 39	ipeed Pair imit -38 -38 Commo Max Mode C	on-to-Differentia	Il Mode Conv Limit	Integra Left Side ight Side ersion	Ited Crosst	talk on D+/ DDXT -27.7701 -42.8011	ID- Pair IDDXT Limit -34 -34
Int Left Side Right Side	egrated Crossta ISSXT -38.69 -38.75	Ik on SuperS ISSXT L 32 39 SCD12 SCD12 SCD21	ipeed Pair imit -38 -38 Commo Max Mode C	on-to-Differentia Conversion -24.1075 -27 4657	Il Mode Conv Limit -20 -20	Integra Left Side ight Side ersion	IEd Crosst	talk on D+/ DDXT -27.7701 -42.8011	ID- Pair IDDXT Limit -34 -34
Int Left Side Right Side	egrated Crossta ISSXT -38.69 -38.75	Ik on SuperS ISSXT L 32 39 SCD12 SCD12 SCD21 SCD34	ipeed Pair imit -38 -38 Commo Max Mode C	on-to-Differentia Conversion -24.1075 -27.4657 -22.5180	Il Mode Conv Limit -20 -20 -20	Integra Left Side ight Side	ted Crosst	talk on D+/ DDXT -27.7701 -42.8011	ID- Pair IDDXT Limit -34 -34

Figure 19: IntePar report

5.1.48. Repeat process for TX2 and RX2 by flipping the Type C connector 180 degrees and plug into the fixture so that the USB logo is associated to the bottom side of the test fixture.

5.2. Informative Measurements

To be completed in a future revision

6. USB Type-C to Legacy Cable Assembly

6.1. Normative Measurements <u>Main Setup:</u>

- 6.1.1. From the DSA8300 pull down application menu select IConnect S-parameter Wizard. A popup window about resuming measurements will show up click OK.
- 6.1.2. From the top menu in the Wizard select 4 port Single Ended refer to figure 20.

IConnect S-parar	neter Wizerd
CHI - Port	4 Port Single Ended ▼ 1 Port Single Ended 2 Port Single Ended 4 Port Single Ended 1 Port Differential 2 Port Differential 1 Port Mixed Mode 2 Port Mixed Mode 2 Port Mixed Mode 7 Port 4
Timebase	
Auto 💌	RL Auto V Avg 250 V
Frequency Autoset	Δf MHz F _{max} GHz
Connect I⊂ Z-Line	Z-Line Threshold 35 %
Start	Cancel Help Close
Select channels and settin	igs, then click Start.

Figure 20: Setting the Wizard for s4p file

IConnect S-param	neter Wizard	
9	4 Port Single Ended	8
CH1 - Port 1	DUT Port 2	CH3 -
CH2 - Port 3	Port 4	CH4 → ● ●
Calibration	Thru + Open + Load 💽	
Timebase Auto 👻	Thru Open + Load Short + Load Thru + Load	250 💌
Frequency Autoset	Thru + Open + Load Thru + Short	GHz
IConnect ↓ Z·Line	Cline Threshold 35 。	
Start	Cancel Help	Close
Select channels and setting	gs, then click Start.	

6.1.3. In the Wizard Calibration menu select Thru +Open +Load from the pull down. Refer to figure 21.

Figure 21: Selecting Calibration Method

ICon	nect S-parameter Wi	zard
9	4 Port Single Ended 💌	8
CH1 V Port 1	DUT	Port 2 CH3 v
CH2 - Port 3		Port 4
Calibration	Thru + Open + Load 💌	
Timebase Auto 🖵	RL Auto 👻	Avg 250 💌
Autoset	Δf 010.000 MHz	F _{max} 15. GHz
Connect IConnect I Z-Line	Z-Line Threshold 35 %	
Start	ancel Help	Close
Running in Demomode. Cli	ck Start to restart Wizard.	

6.1.4. In the Frequency menu uncheck the Auto and set the Delta Frequency to 10 MHz and the max Frequency to 15 GHz. Refer to figure 22

Figure 22: Setting the Delta Frequency and Max Frequency Range

- 6.1.5. Verify Port setting are as follows: Ch1 = Port 1, Ch2 = Port 3, Ch3 = Port 2, and Ch4 = Port 4 (This is important for the compliance tool set to work correctly).
- 6.1.6. Click on the Start Button. Next create or select a folder for the measurement data to go to.

Insertion Loss and Return Loss data acquisition:

6.1.7. Input the following file name **ID#_Host_TX1_Thru**. Replace the # with a unique identifier. Then click OK. Refer to figure 23.

IConnect S-parameter Wizard	
Ø 4 Port Single Ended ▼	8
Port 1 DUT Port 2	•
CH2 • DUT #1	
Ti Comment DUT ID or comment	
Fr OK Cancel	2
IConnect Z-Line Z-Line Threshold 35 %	
Start Cancel Help C	lose
Choose filename prefix for this DUT.	

Figure 23: File naming step

- 6.1.8. If a pop window appears asking to use previous measured Deskews, select No if there has been any change in the setup since the last time testing was performed. Then follow promotes to remove terminators and cables and connect to the TDR clock output.
- 6.1.9. Make the following connections using the male to male barrel adapters to the Host Type-C fixture and the Device Legacy fixture: Ch1 to Host TX1+, Ch2 to Host TX1-, Ch3 to Device RX+, and Ch4 Device to RX-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

- 6.1.10. Connect the First cable to be tested. Note if more than one cable is being tested start with the longest cable. This will set the time base correctly for test all other cables. Click Okay
- 6.1.11. Disconnect the test fixture from the barrel adapter. Then connect Ch1 to the open reference on the USB calibration test fixture. Then Click OK. Repeat the step for remaining channels.
- 6.1.12. Connect Ch 1 to one side of the 2X thru on the Calibration test fixture and Ch3 to the other side of the same 2X thru. Click OK. When prompted by the application repeat for the following connections: Ch2 to Ch4, Ch1 to Ch4, Ch3 to Ch2, Ch1 to Ch2, Ch3 to Ch4,.
- 6.1.13. Connect Ch1 to Load_1 on the calibration test fixture, then click OK. Repeat for the remaining channels when promoted by the application.
- 6.1.14. Input the following file name **ID#_Host_RX1_Thru**. Replace the # with a unique identifier. Then click OK.
- 6.1.15. Make the following connections using the male to male barrel adapters: Ch1 to Host RX1+, Ch2 to Host RX1-, Ch3 to Device TX+, and Ch4 to Device TX-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 6.1.16. Input the following file name **ID#_Host_D+D-_Thru**. Replace the # with a unique identifier. Then click OK.
- 6.1.17. Make the following connections using the male to male barrel adapters: Ch1 to Host D+, Ch2 to Host D-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

Near End Cross Talk Data acquisitions:

- 6.1.18. Input the following file name **ID#_Host_TX1RX1_NEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.19. Make the following connections using the male to male barrel adapters: Ch1 to Host TX1+, Ch2 to Host TX1-, Ch3 to Host RX1+, and Ch4 to Host RX1-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 6.1.20. Input the following file name **ID#_Device_TXRX_NEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.21. Make the following connections using the male to male barrel adapters: Ch1 to Device TX+, Ch2 to Device TX-, Ch3 to Device RX+, and Ch4 to Device RX-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 6.1.22. Input the following file name **ID#_Host_TX1D+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.23. Make the following connections using the male to male barrel adapters: Ch1 to Host TX1+, Ch2 to Host TX1-, Ch3 to Host D+, and Ch4 to Host D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

- 6.1.24. Input the following file name **ID#_Host_RX1D+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.25. Make the following connections using the male to male barrel adapters: Ch1 to Host RX1+, Ch2 to Host RX1-, Ch3 to Host D+, and Ch4 to Host D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 6.1.26. Input the following file name **ID#_ Device_TXD+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.27. Make the following connections using the male to male barrel adapters: Ch1 to Device TX+, Ch2 to Device TX-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 6.1.28. Input the following file name **ID#_ Device_RXD+D-_NEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.29. Make the following connections using the male to male barrel adapters: Ch1 to Device RX+, Ch2 to Device RX-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

Far End Crosstalk data Acquisitions:

- 6.1.30. Input the following file name **ID#_ HostRX1_DeviceRX_FEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.31. Make the following connections using the male to male barrel adapters: Ch1 to Host RX1+, Ch2 to Host RX1-, Ch3 to Device RX+, and Ch4 to Device RX-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 6.1.32. Input the following file name **ID#_ HostTX1_DeviceTX_FEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.33. Make the following connections using the male to male barrel adapters: Ch1 to Host TX1+, Ch2 to Host TX1-, Ch3 to Device TX+, and Ch4 to Device TX-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 6.1.34. Input the following file name **ID#_ HostD+D-_DeviceTX_FEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.35. Make the following connections using the male to male barrel adapters: Ch1 to Host D+, Ch2 to Host D-, Ch3 to Device TX+, and Ch4 to Device TX-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 6.1.36. Input the following file name **ID#_ HostD+D-_DeviceRX_FEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.37. Make the following connections using the male to male barrel adapters: Ch1 to Host D+, Ch2 to Host D-, Ch3 to Device RX+, and Ch4 to Device RX-. Install 50

ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

- 6.1.38. Input the following file name **ID#_ HostTX1_DeviceD+D-_FEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.39. Make the following connections using the male to male barrel adapters: Ch1 to Host TX1+, Ch2 to Host TX1-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.
- 6.1.40. Input the following file name **ID#_ HostRX1_DeviceD+D-_FEXT**. Replace the # with a unique identifier. Then click OK.
- 6.1.41. Make the following connections using the male to male barrel adapters: Ch1 to Host RX1+, Ch2 to Host RX1-, Ch3 to Device D+, and Ch4 to Device D-. Install 50 ohm terminators on all unused connectors. Do not connect any cables between fixtures. Click OK.

Analyzing the Capture Data with USB Compliance Software Tool

- 6.1.42. Start the USB Compliance Tool IntePar by Double clicking on
 - C:\IntePar_v0p7\IntePar_v0p7_x86.exe (or equivalent application)
- 6.1.43. Select Cable Type as Standard A to Type-C
- 6.1.44. Select 4 port VNA Refer to figure 24.

51		IntePar	- 🗆 🗙
Load Cooling Spreadsheet Config Spreadsheet Felect Cable Type and VNA Type Select Cable Type Type-C to Legacy Adaptor V 12-Port VNA	S-Port VNA VA-Port VNA	Raw S-Parameters Empty v 1,1 v fmin: 50 MHz fmax 15 GHz fstep: 10 MH;	Select Spec Items Empty v
Type-C to Type-C, Gen 1 Type-C to Type-C, Gen 1 Type-C to Legacy me Type-C to Legacy Adaptor >> Top: Rx == Rx, SDD(3:4,3:4)	Port Definition [Tx Tx] [Rx Rx]	Type-C Side	Type-C Side or Legacy Side
>> Thru: D+ID== 0+ID_, SDD(5:6,5:6) >> NEXT: Tx == Rx, SDD13/SDD31	(8+/D- D+/D-) [Tx Rx]	Rx 3	4
>> NEXT: Tx == Rx, SDD24/SDD42 >> NEXT: Tx == D+/D-, SDD15/SDD51	[Tx Rx] [Tx D+/D-]	D+/D- 5	6
>> NEXT: RX == 0+10-, SU035/SU033 >> NEXT: Tx == 0+10-, SD026/SD062 >> NEXT: Rx == 0+10-, SD046/SD064	[FX D+/D-] [Tx D+/D-] [Rx D+/D-]		_
>> FEXT: Tx == Rx, SDD14/SDD41 >> FEXT: Tx == Rx, SDD23/SDD32	[Rx Tx] [Tx Rx]	Value Dare	
>> FEXT: Tx == D+/D-, SDD52/SDD25 >> FEXT: Rx == D+/D-, SDD54/SDD45	[D+/D- Tx] [D+/D- Rx]	ILfit@2.5GHz IMR IRL	Generate Report
>> FEXT: Tx == D+/D-, SDD61/SDD16 >> FEXT: Rx == D+/D-, SDD63/SDD36	[Tx D+/D-] [Rx D+/D-]	ISSXT IDDXT SCD12/SCD21	Help Exit
	Import		Revision 0.7 By Yun Ling Intel Corp. July, 2014

Figure 24: Selecting USB cable Type with s4p files

		IntePar	
Load Config Spreadsheet Config Spreadsheet	۷	Raw S-Parameters	Select Spec Items Empty
Select Cable Type and VNA Type Select Cable Type Type-C to Leoacy Adaptor VI 12-Port VNA	8-Port VNA 🔽 4-Port VNA	fmin:50 MHz fmax 15 GHz fstep: 10 MHz	
- Load/Show S-Parameters File Names			
S-Parameter File Name	Port Definition	Type-C Side	Type-C Side or Legacy Side
>> Thru: Tx == Tx, SDD(1:2,1:2)	[Tx Tx]		
>> Thru: Rx == Rx, SDD(3:4,3:4)	[Rx Rx]	Tx 1	2
>> Thru: D+/D- == D+/D-, SDD(5:6,5:6)	[D+/D- D+/D-]		
>> NEXT: Tx == Rx, SDD13/SDD31	[Tx Rx]	Rx 3	4
>> NEXT: Tx == Rx, SDD24/SDD42	[Tx Rx]		
>> NEXT: Tx == D+/D-, SDD15/SDD51	[Tx D+/D-]	D+/D- 5	6
>> NEXT: Rx == D+/D-, SDD35/SDD53	[Rx D+/D-]		
>> NEXT: Tx == D+/D-, SDD26/SDD62	[Tx D+/D-]		
>> NEXT: Rx == D+/D-, SDD46/SDD64	[Rx D+/D-]		
>> FEXT: Tx == Rx, SDD14/SDD41	[Rx Tx]		
>> FEXT: Tx == Rx, SDD23/SDD32	[Tx Rx]		
>> FEXT: Tx == D+/D-, SDD52/SDD25	[D+/D- Tx]	ILfit@2.5GHz	Pass/Fail Criteria Check Compliance
>> FEXT: Rx == D+/D-, SDD54/SDD45	[D+/D- Rx]	IMR	Generate Report
>> FEXT: Tx == D+/D-, SDD61/SDD16	[Tx D+/D-]	ISSXT	Help
>> FEXT: Rx == D+/D-, SDD63/SDD36	[Rx D+/D-]	IDDXT SCD12/SCD21	Exit
	Import	50012/30021	Revision 0.7 By Yun Ling Intel Corp. July, 2014

6.1.45. In the Load/Show S-parameter Files Names select the file to be loaded by clicking beside file name. As shown in figure 25

Figure 25: Loading associated s4p files

Load all files as associated in table below:

Thru: Tx==Tx, SDD(1:2, 1:2)	ID#_Host_TX1_Thru
Thru: Rx==Rx, SDD(3:4, 3:4)	ID#_Host_RX1_Thru
Thru: D+/D-==D+/D-, SDD(5:6, 5:6)	ID#_Host_D+DThru
NEXT: $Tx == Rx$, SDD13/SDD31	ID#_Host_TX1RX1_NEXT
NEXT: $Tx == Rx$, SDD24/SDD42	ID#_Device_TXRX_NEXT
NEXT: $Tx == D + D$ -, $SDD15/SDD51$	ID#_Host_TX1D+DNEXT
NEXT: Rx == D+/D-, SDD35/SDD53	ID#_Host_RX1D+DNEXT
NEXT: $Tx == D + D$ -, $SDD26/SDD62$	ID#_ Device_TXD+DNEXT
NEXT: $Rx == D+/D-$, SDD46/SDD64	ID#_ Device_RXD+DNEXT
FEXT: $Tx == Rx$, SDD14/SDD41	ID#_ HostRX1_DeviceRX_FEXT
FEXT: Tx == Rx, SDD23/SDD32	ID# HostTX1 DeviceTX FEXT

FEXT: $Tx == D+/D-$, SDD52/SDD25	ID#_ HostD+DDeviceTX_FEXT
FEXT: $Rx == D+/D-$, SDD54/SDD45	ID#_ HostD+DDeviceRX_FEXT
FEXT: $Tx == D+/D-$, SDD61/SDD16	ID#_HostTX1_DeviceD+DFEXT
FEXT: $Rx == D + /D - , SDD63 / SDD36$	ID#_HostRX1_DeviceD+DFEXT

- 6.1.46. Click on the Import button
- 6.1.47. Click on the Check Compliance, verify that results are with in Specifications from the generated report. Refer to figure 26

				De	etailRepor	t					- 🗆	×
			Ir	Isertion Fit a	at Nyquist Fre	quency						
	ILfit@2.5G	Hz ILf	it@2.5GHz Li	mit								
Pair 1-2	-6.91	169		-2								
Pair 3-4	-7.05	524		-2								
	ſ				IMR and IRL			101.1.1.1.1.				
		D :	1.0	IMR 40.0077	IMR Limit		L 0005	IRL Limit				
		Pair	1-2	-43.3077	-3	o -2	0.9225	-24				
		Pair	5-4	-44.0920	-3	0 -2	1.5591	-24	•			
	ISS)	(T	ISSXT Limit]				DDXT	IDDXT Limi	:	
Left Side	-4	1.8982	-38				Left Side	e	-27.7165	i -3	2	
Right Side	-4	3.7227	-38			F	Right Sid	le	-43.0810) -3	2	
				Common t	o Differential I	Mode Con	varaiaa					
				Common-t	0-Differentian	NOUE COIL	Version		7			
			Maria	Mada Car	version	Linnit						
			Max	Mode Con	version	Limit						
		SC	Max 2012	Mode Con -	version 26.7727 27.6521	Limit -20 -20						
		SC SC	Max 2012 2021 2034	Mode Con - -	version 26.7727 27.6521 22.5180	Limit -20 -20 -20						
		50 50 50 50	Max 2D12 2D21 2D34 2D43	Mode Con - - -	version 26.7727 27.6521 22.5180 23.1389	Limit -20 -20 -20 -20						
		50 50 50	Max D12 D21 D34 D43	Mode Con - - -	version 26.7727 27.6521 22.5180 23.1389	Limit -20 -20 -20 -20						



6.1.48. Repeat process for TX2 and RX2 by flipping the Type C connector 180 degrees and plug into the fixture so that the USB logo is associated to the bottom side of the test fixture.

6.2. Informative Measurements

To be completed in a future revision

7. Low Speed Signal

7.1. Single Ended Coupling between Vbus to SBU_A/SBU_B. <i>To be completed in a future revision</i>
7.2. Single Ended Coupling between Vbus to CC. <i>To be completed in a future revision</i>
7.3. Single Ended Coupling between SBU_A/SBU_B to CC. <i>To be completed in a future revision</i>
7.4. Differential Coupling between CC and D+/D To be completed on a Future Revision
7.5. Differential Coupling between Vbus and D+/D To be completed on a future revision
7.6. USB D+/D- Signal Integrity. To be completed on a future revision

8. Appendix A: Tips to reduce time and connections

8.1. Reducing the number connections made during testing

When testing the Type-C to Type-C cable with a 4 port VNA or TDR type of instrument, there are many files to save as well as may connections that have to be made during the process. This can slow the process greatly and create opportunity for the end user to make errors during the acquisition capturing process. To assist in reducing the number of connections that need to be made during the testing process, there is a simple step that could be added to the process that would allow for the capture of two s-parameter files with one connection instead of a single sparameter file. After the user has captured the first s-parameter file, they can unplug the cable and rotate it 180 degrees at both ends of the cable, this will associate the USB logo on the cable with the bottom side of the test fixture instead of the top side of the fixture. This will allow the user to capture the data for the second pair of lanes in the cable. The user will need replace the 1 in the file name with a 2, since now the user is capturing data for either TX2 or RX2. For example if the file name for the data is ID001_Host_TX1RX1_NEXT the new file name will be ID001_Host_TX2RX2_NEXT. This process will allow the user to capture all the data require to be used with the USB compliance tool for both pairs of lanes without needing to repeat the data acquisition process. This process also assumes that the test equipment and fixtures have equal performance on all lanes connecting to the USB cable. If the test equipment and fixtures

including cabling to the fixture do not have equal performance then this process is not recommended.

More tips to be added in future revisions of this document.