Application Note

METHOD OF IMPLEMENTATION (MOI) FOR USB TYPE-C TO TYPE-C CABLE ASSEMBLY

Products:

► R&S®ZNB

Curtis Donahue | 1SL405 | Version 1e | 08.2023

Find the most up-to-date document on our homepage https://www.rohde-schwarz.com/appnote/1SL408.

This document is complemented by configuration files. The configuration files may be updated even if the version of the document remains unchanged.

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1 Introduction

The purpose of this document is to provide a step-by-step guidance on how to perform USB-IF compliance testing on a USB Type-C cable assembly.

Throughout this Method of Implementation (MOI), procedures will detail how to perform such USB-IF compliance testing using the R&S® ZNB lineup of Network Analyzers.

2 Required equipment

2.1 R&S®ZNB20 configuration

Description	Equipment	Quantity
Network analyzer	R&S®ZNB20 vector network analyzer, 4 ports, 100kHz - 20GHz, PC3.5 connectors with: – R&S®ZNB-K2, time domain (TDR) analysis (software license) – R&S®ZNB-K20, extended time domain (TDR) analysis (software license) – R&S®ZNB-K210, eazy de-embedding (EZD) (software license)	1
RF cable	R&S®ZV-Z193 var60, 50 Ohm, DC to 26.5GHz, 3.5mm(f)-3.5mm(m), flexible, phase stable, 60 inch (1520mm)	4
Calibration unit/kit	One of the following: – R&S®ZN-Z52 var30 calibration unit, 100kHz to 26.5 GHz, 4 ports, 3.5mm(f) – R&S®ZN-Z53 var32 calibration unit, 100 kHz to 26.5 GHz, 2 ports, 3.5mm(f) – R&S®ZN-Z135 var03 calibration kit, 50 Ohm, 0Hz to 26.5 GHz, 3.5mm(f)	1
Type-C Super Speed receptacle test fixture	Type-C test fixture: Luxshare-ICT TFU-49R38	2
Type-C Low Speed receptacle test fixture	Type-C test fixture: Luxshare-ICT TFU-59R18	2
RFI test fixture	Luxshare-ICT MEU-28R2-041 (100 cm)	1
50 Ohm terminator	One of the following: – Hirose HRM-601A(52) – XMA 2003-6110-00 – P1dB P1TR-SAM-26G2W	16

3 Test overview and preparation

3.1 Measurement scope

This document focusses on how to perform normative compliance measurements for USB Type-C to Type-C passive cable assemblies with USB4 Gen3, USB4 Gen2, USB3.2 Gen2, USB3.2 Gen1, and USB2.0 capabilities. Test requirements for other types of cables are not described in this document. However, the requirements might be a subset of measurements described in this document.

Normative compliance requirements are categorized into three measurement groups:

► High speed – Frequency Domain
  – Insertion Loss Fit at Nyquist Frequencies (ILfitatNq)
  – Integrated Multi-reflection (IMR)
  – Integrated Crosstalk between SuperSpeed Pairs (IXT_USB and IXT_DP)
  – Integrated Return Loss (IRL)
  – Differential-to-Common-Mode Conversion (Scd)
  – Channel Operation Margin (COM)

► High Speed – Time Domain
  – Differential Impedance
  – Propagation Delay
  – Intra-pair Skew

► Low speed – Frequency Domain
  – Differential Insertion Loss (D+/D- attenuation)
  – Coupling between CC and differential USB D+/D-
  – Coupling between VBUS and differential USB D+/D-
  – Single- ended Coupling between SBU_A and CC, SBU_B and CC
  – Single- ended Coupling between CC and D-
  – Single- ended Coupling between SBU_A and SBU_B
  – Coupling between SBU_A /SBU_B and differential USB D+/D-

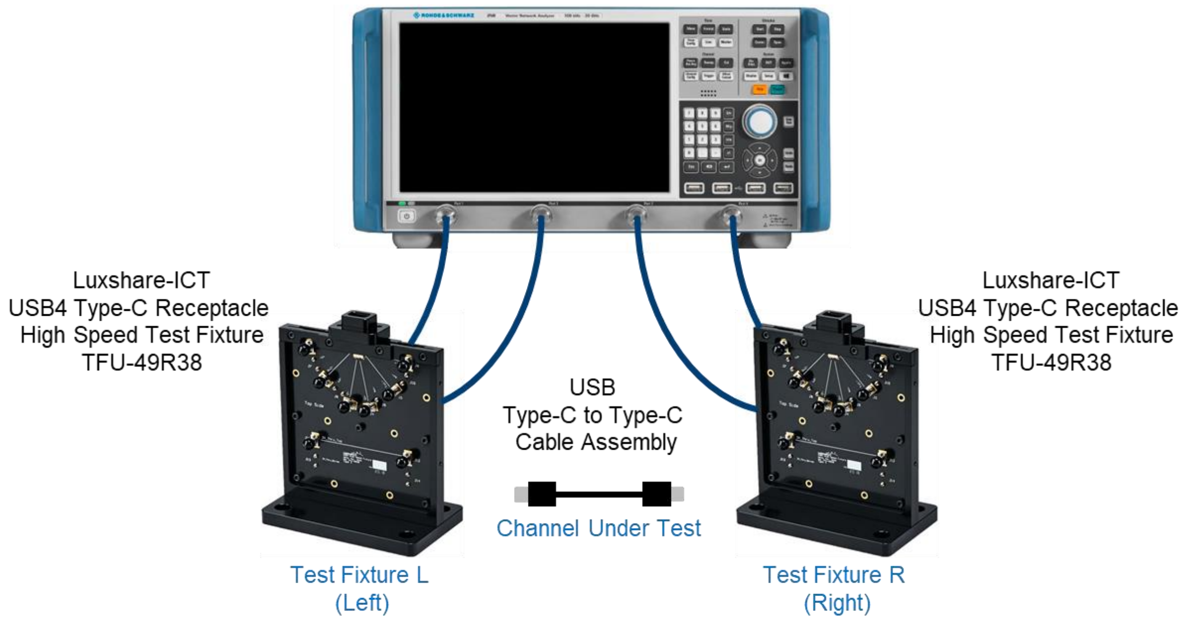
► Low Speed – Time Domain
  – D+/D-Pair Attenuation
  – Differential impedance
  – Propagation delay
  – Intra-pair skew

► Shielding effectiveness
  – Differential mode
  – Common mode

3.2 Test setup

3.2.1 R&S®ZNB20 test setup

Equipment needed for testing is listed in R&S ZNB20 Configuration. Below is an example setup using the R&S®ZNB20.



To avoid confusion, throughout the document the test fixtures are referred to by their orientation in this diagram (left, right), or simply by an "L" or "R" subscript when appropriate.

3.3 Necessary software tools

3.3.1 Get_iPar

Several high-speed channel parameters are figures of merit that are calculated from S-parameter data but are not easily determined directly in the VNA firmware interface. The USB-IF provides the Get_iPar software tool to perform such calculations and provide values for compliance evaluation.

The Get_iPar tool is freely available at https://compliance.usb.org/files/

1. Download the latest Get_iPar files.

   At the time of this document's creation, the latest file version is 'Get_iPar_v1p1_release.zip'

2. Export the contents of the .zip file.

   Examples in this MOI assume the files are exported to the following directory:

   C:\USB-IF_SW\Get_iPar_v1p1_release\

3. Install Matlab Runtime Library R2016a (9.0.1).

3.3.2 IntePar

The USB-IF provides the IntePar software tool to perform compliance verification for the USB2.0, USB3.2 Gen1, USB3.2 Gen2, and USB4 Gen2.

The IntePar tool is freely available at https://compliance.usb.org/files/.

1. Download the latest IntePar files.

   At the time of this document's creation, the latest file version is 'IntePar_1p6.zip'.

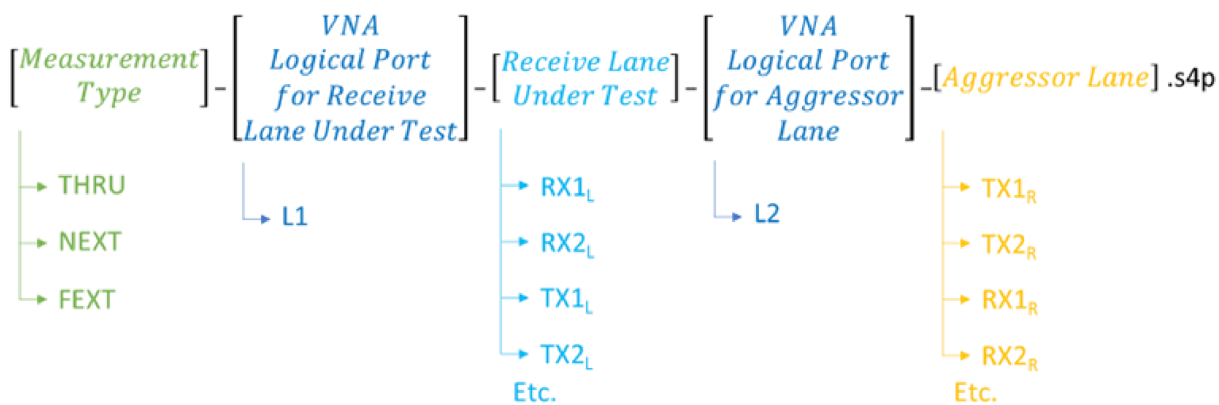
2. Export the contents of the .zip file.

   Examples in this MOI assume the files are exported to the following directory:

   C:\USB-IF_SW\IntePar_1p6\

3.4 Touchstone file naming convention

When saving touchstone files (*.s4p for R&S®ZNB20) to be used with the USB-IF compliance tools, the following naming convention is recommended:



For example, when collecting the touchstone file which includes the differential insertion loss and differential return loss of TX1, or the TX1 "Thru" file, the file name would be:

THRU_L1_ TX1L_L2_RX1R.s4p

3.5 Recall setup files

There are recall files delivered together with this document which makes it more convenient to perform the required measurements. There is one recall file for each group of measurements, one additional one for the calibration procedure, and three files for the shielding effectiveness test, e.g., 7 files.

Recalling the setup files

1. On the front panel of the instruments, click the green “PRESET” button.
2. Press “FILE” > “Open Recall...”.
3. Open the recall files (*.znx) for the desired tests.

   In total there are 6 recall files for the different test groups and another one dedicated for the calibration procedure:

   – USB4Gen3_High_Speed_Frequency_Domain.znx

– USB4Gen2_High_Speed_Frequency_Domain.znx
– High_Speed_Time_Domain.znx
– Low_Speed_Frequency_Domain.znx
– Low_Speed_Time_Domain.znx
– RFI_Type-C_to_Type-C_Cable_Assembly.znx
– Calibration.znx

Overview about the setting in the different recall files:

Recall file	Start	Stop	Step size	IFBW	Power
USB4Gen3_High_Speed_Frequency_Domain.znx	10 MHz	20 GHz	10 MHz	1 kHz	-10 dBm
USB4Gen2_High_Speed_Frequency_Domain.znx	10 MHz	20 GHz	10 MHz	1 kHz	-10 dBm
High_Speed_Time_Domain.znx	10 MHz	16.5 GHz	10 MHz	1 kHz	-10 dBm
Low_Speed_Frequency_Domain.znx	300 KHz	100 MHz	100 KHz	1 kHz	-10 dBm
Low_Speed_Time_Domain.znx	10 MHz	1.65 GHz *	10 MHz	1 kHz	-10 dBm
RFI_Type-C_to_Type-C_Cable_Assembly.znx	10 MHz * *	6 GHz	10 MHz	1 kHz	-10 dBm
Calibration.znx	300 kHz	20 GHz	100 KHz	1 kHz	-10 dBm

* Stop frequency selected to achieve requested rise time of 40 ps or 400 ps (20% - 80%).

* * Start frequency 10 MHz selected; Test requirement start from 500 MHz

3.6 Calibration and de-embedding

Calibration of the VNA and RF cables, as well as de-embedding of the USB test fixtures, is necessary to accurately measure the USB cable assembly characteristics at the proper test points.

This is accomplished by performing a coaxial calibration until the end of the RF cables, extract the test fixture S-parameter files using EAZY De-embedding (EZD) technique, and then import de-embedding files in the VNA which removes the effect of the test fixture. Alternative de-embedding techniques, such In-Situ De-embedding (ISD), are also supported by R&S®ZNB20.

The five different test groups use different frequency ranges. The calibration recall file includes all the required frequency ranges needed for each test group. This allows for all required frequency ranges to be calibrated in a single step.

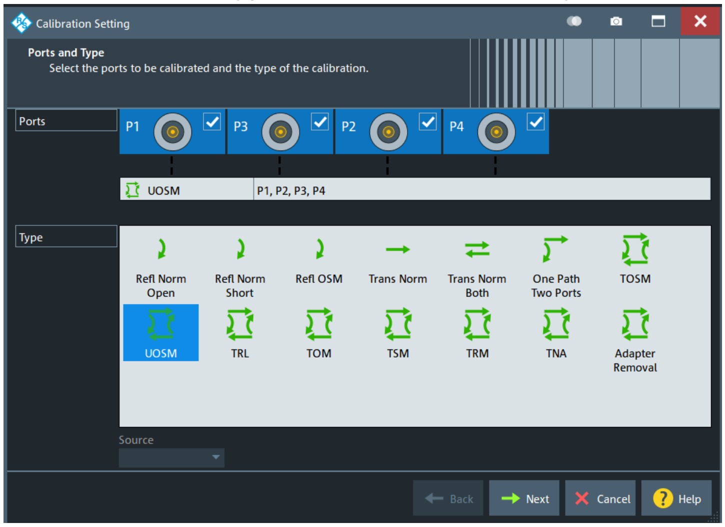
3.6.1 Coaxial calibration

3.6.1.1 Calibration with automated calibration unit

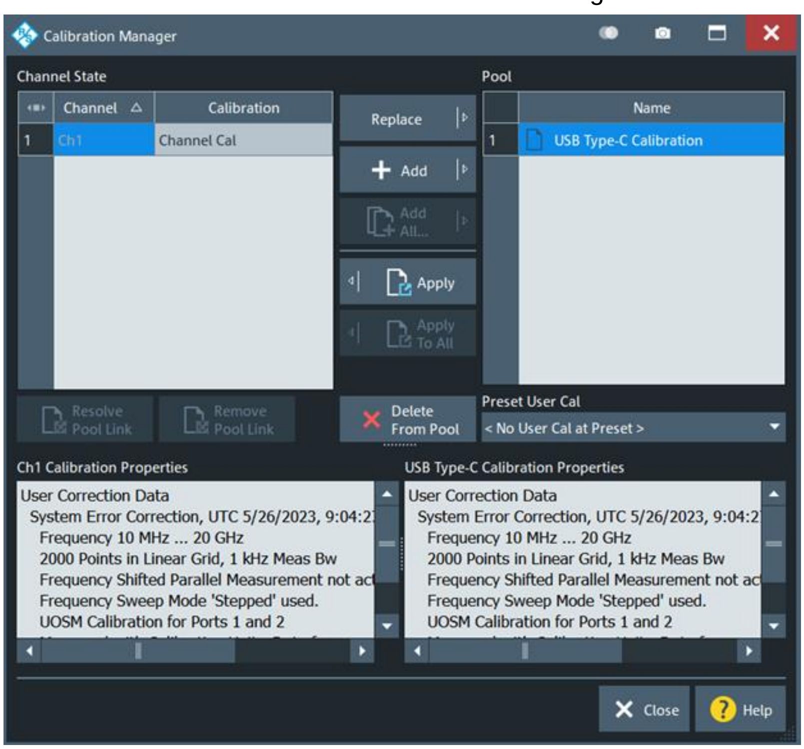
The most convenient method to perform coaxial calibration is to use an automated calibration unit. Doing so will complete calibration faster and more efficiently.

1. Make sure the active setup is the “Calibration” setup.
2. On the front panel, press “CAL”
3. Select “Start… (Cal Unit)”

4. Select Calibration Type UOSM for best accuracy.



5. Follow the calibration wizard during the whole process.
6. After the calibration is completed, select “Cal” > “Use Cal”.
7. Enter the “Cal Manager…”.
8. Add the calibration to the Pool and enter a meaningful name for the calibration.

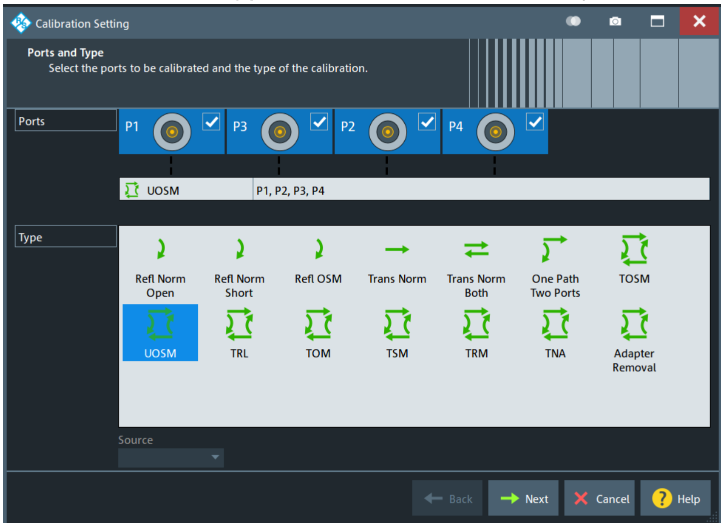


3.6.1.2 Manual calibration with calibration kit

Alternatively, if an automated calibration unit is not available, then a manual calibration kit can be used instead.

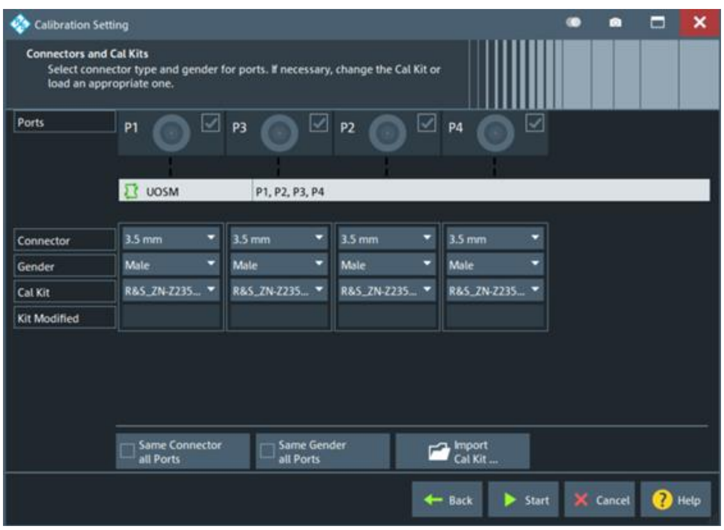
1. Make sure the active setup is the “Calibration” setup.
2. On the front panel, press “CAL” > “Start… (Manual)”

3. Select Calibration Type “UOSM” for best accuracy.

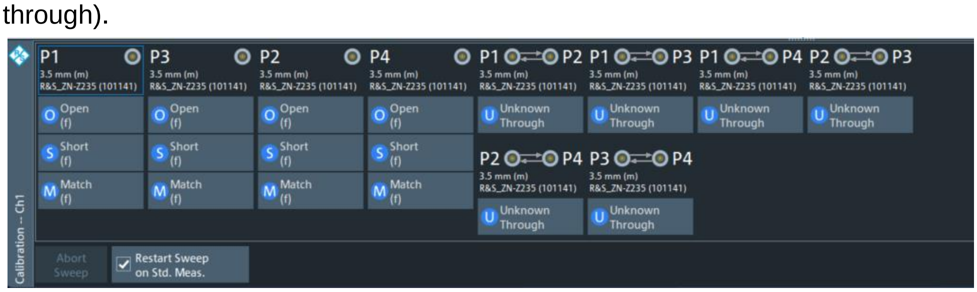


4. Open dialog “Calibration Setting”.

Check connector (e.g. 3.5 mm), gender (e.g. male) and used CalKit.



5. Start calibration and connect all required calibration standards (open, short, match and unknown through).



It is required to measure at least 3 unknown through connections, however further measured connections will increase the accuracy.

6. After the calibration is completed, select “Cal” > “Use Cal”.

7. Enter the “Cal Manager…”.

8. Add the calibration to the pool and enter a meaningful name for the calibration.

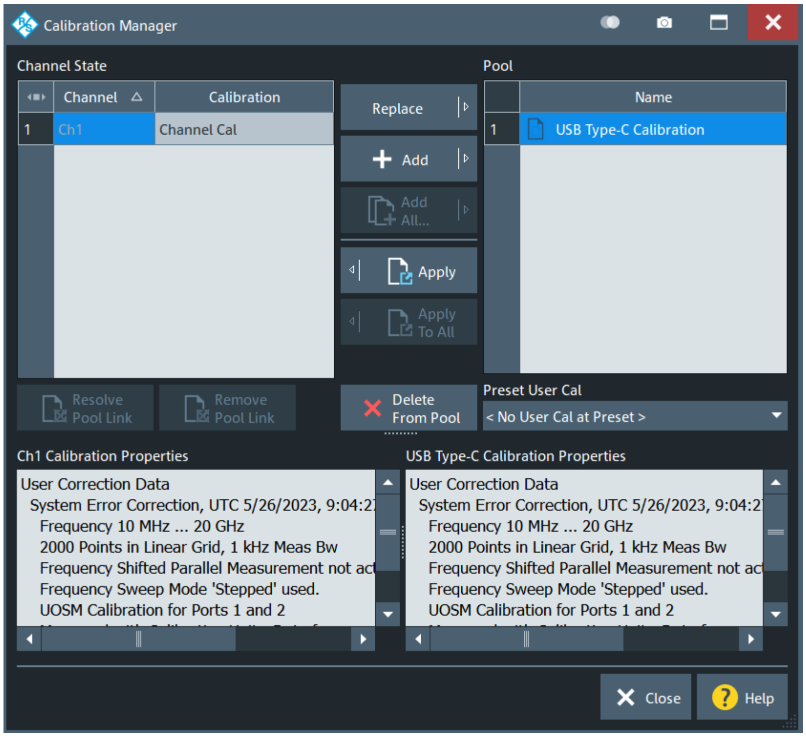
3.6.1.3 Recalling coaxial calibration

After calibrating to the end of the RF cables and storing the calibration data, select the measurement group preset where measurements should be performed. Then recall the calibration in the selected measurement group:

1. On the front panel, press “CAL” > “Use Cal”.
2. Open the “Cal manager …”.
3. Click “Apply” to make it active for the current measurement group.

   Note: The

Recalling coaxial calibration procedure must be performed on each measurement group and channel after a firmware preset. Otherwise, measurements will be collected without proper calibration applied, resulting in inaccurate results.



3.6.2 De-embedding USB test fixtures

After coaxial calibration is completed, the next step is to remove the effect of the test fixtures that will be used during testing. This is accomplished by using files provided by the test fixture supplier or collecting de-embedding files from the fixtures manually. This section describes both methods of de-embedding.

The user should verify that the de-embedding files are applied before collecting DUT measurement data. This is especially true after a measurement group preset has been issued. Otherwise, measurements will be collected without proper de-embedding applied, resulting in inaccurate results.

3.6.2.1 Using de-embedding files provided by test fixture supplier

The most convenient de-embedding method is to use files provided by the test fixture vendor.

1. On the front panel, press “Offset Embed”.
2. Select “Single Ended”.
3. Import the 2-port Touchstone files (*.s2p) which are delivered together with the test fixtures of Luxshare-ICT (except for RFI test which requires no de-embedding files)

Single Ended				
Deembedding		Active	File Name 1	Swap Gates
P1	L1	☑	USB4 HS-TFU-49R38-099_POINT2000_10MHZ_TO_20GHZ_CAL_2X_THRU_TOP_1.s2p	☐
P2	L2	☑	USB4 HS-TFU-49R38-099_POINT2000_10MHZ_TO_20GHZ_CAL_2X_THRU_BOTTOM_1.s2p	☐
P3	L3	☑	USB4 HS-TFU-49R38-099_POINT2000_10MHZ_TO_20GHZ_CAL_2X_THRU_TOP_1.s2p	☐
P4	L4	☑	USB4 HS-TFU-49R38-094_POINT2000_10MHZ_TO_20GHZ_CAL_2X_THRU_BOTTOM_1.s2p	☐

3.6.2.2 Measuring and generating de-embedding files

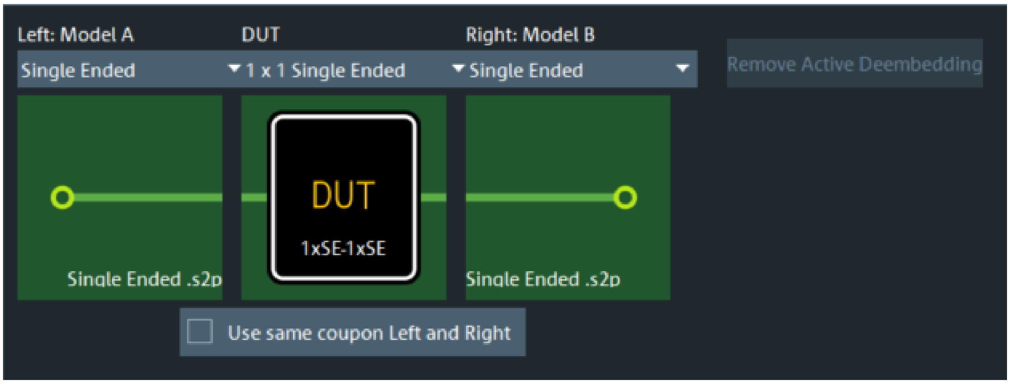
In case the test fixture vendor could not supply the necessary files for de-embedding, or there is a concern regarding accuracy of such files (from fixture aging/use due to cable insertion over time), the user creates new de-embedding files by making measurements in the VNA firmware. This procedure will be using the EAZY De-embedding (EZD) tool which requires the R&S®ZNB-K210 software option. This De-embedding algorithm is based upon the IEEE 370 specification.

3.6.2.2.1 Performing EZD De-embedding

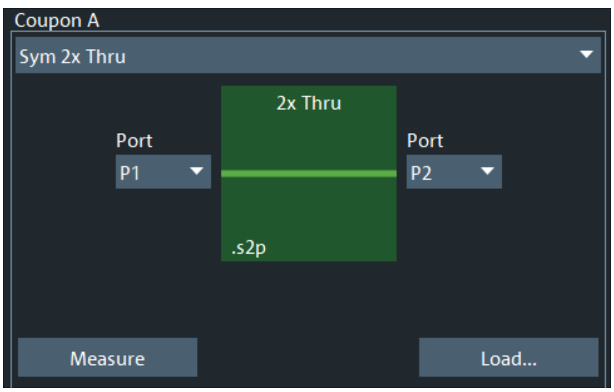
This section describes how to de-embed the test fixtures from the setup. Since this is for Type-C to Type-C cable testing, Test Fixture L and Test Fixture R will be identical. The following procedure describes how to perform de-embedding of a symmetrical test setup.

EZD de-embedding requires the test fixtures to include a "2x Thru" trace, referred to as a “Coupon”. When distinguishing between the coupons on the left and right test fixtures, the R&S®ZNB Deembed Assistant refers to the coupons as "Coupon A" and "Coupon B"; where Coupon A is measured from Test Fixture L, and Coupon B is measured from Test Fixture R.

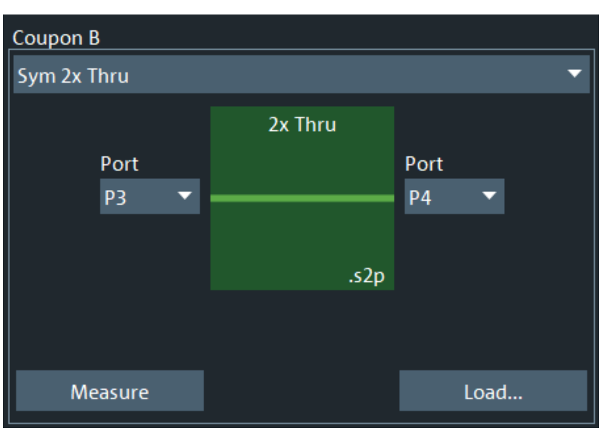
1. On the front panel, press “Offset Embed”.
2. Select “Deembed Assistant”.
3. Select “Fixture Tool” > “EZD”.
4. In the “Deembed Assistant” dialog, select “Remove Active Deembedding” to remove any residual deembeding files.
5. Use the following configuration:
   a) “Use same coupon Left and Right = Off”.
   b) “Left: Model A = Single Ended”
   c) “Right: Model B = Single Ended”
   d) “DUT = 1x1 Single Ended”



6. Select “Next”.
7. Measure the test fixture coupon for the Top Left Fixture:
   a) For “Coupon A”, select “Sym 2x Thru”. Map the left side to Port 1 and the right side to Port 2.



   b) Connect Port 1 and Port 2 of the VNA to each side of the 2x_Thru_Top calibration trace on the left fixture board.
   c) Select “Measure”.
8. Measure the test fixture coupon for the Top Right Fixture:
   a) For “Coupon B”, select “Sym 2x Thru”. Map the left side to Port 3 and the right side to Port 4.



   b) Connect Port 3 and Port 4 of the VNA to each side of the 2x_Thru_Top calibration trace on the right fixture board.
   c) Select “Measure”.
9. Generate the de-embedding model for the top layer fixtures for both the left and right sides:
   a) Uncheck the “Impedance Correction” box.

b) Select “Apply”.

c) Once completed, close the “Deembed Assistant”.

10. The main firmware interface is now present.

The test fixture files for the left-side and right-side, top-layer fixtures have been created.

a) Press the Windows button ( ) on the tool bar to access the Windows Start Menu and start the Windows File Browser.

b) Navigate to the following directory: “C:\Users\Public\Documents\Rohde-Schwarz\VNA\Embedding\”.

c) Verify that the files "A1_left_DUT.s2p" and “B1_right_DUT.s2p” exist, and that the timestamp matches the expected time of the de-embedding operation just completed.

d) Since the EZD de-embedding process will overwrite existing files when performed, rename the fixture files. The preconfigured R&S®ZNB state files are populated with a default file name.

Thus, rename the files as follows:

"A1_left_DUT" to "USBHS_top_left_fixture.s2p" and “B1_right_DUT” to “USBHS_top_right_fixture.s2p”.

The left-side and right-side, top layer fixtures have been completed.

11. De-embed the left-side and right-side bottom layer fixtures:

a) On the front panel, select “Offset Embed”.

b) Select “Deembed Assistant”.

c) Select “Remove Active Deembedding” to remove any residual deembedding files.

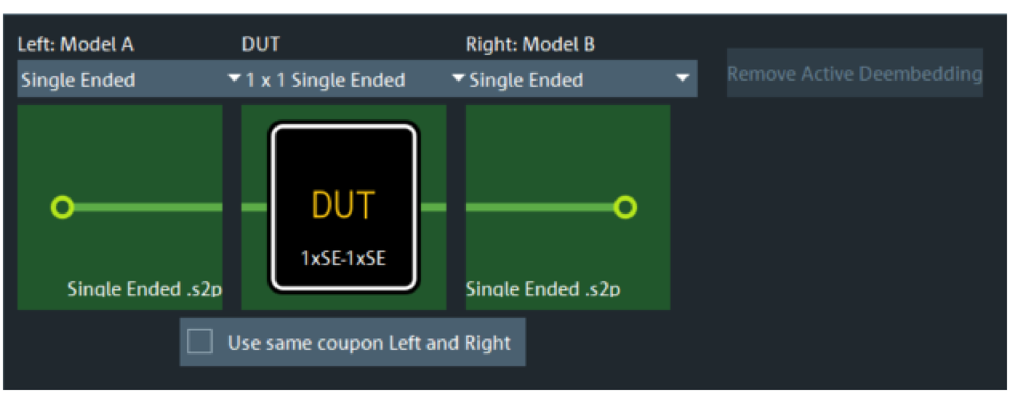
12. Use the following configuration:

a) “Use same coupon Left and Right = Off”.

b) “Left: Model A = Single Ended”

c) “Right: Model B = Single Ended”

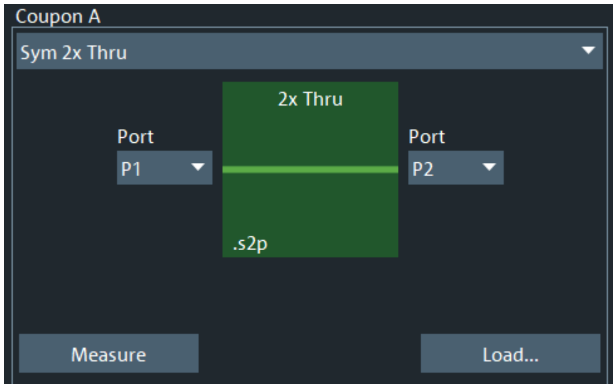
d) “DUT = 1x1 Sigle Ended”



13. Select “Next”.

14. Measure the test fixture coupon for the Bottom Left Fixture:

a) For “Coupon A”, select “Sym 2x Thru”. Map the left side to Port 1 and the right side to Port 2.

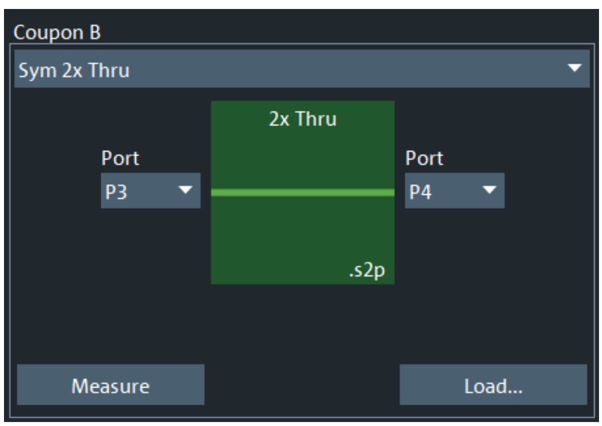


b) Connect Port 1 and Port 2 of the VNA to each side of the 2x_Thru_Bottom calibration trace on the left fixture board.

c) Click the “Measure”.

15. Measure the test fixture coupon for the bottom right fixture:

a) For “Coupon B”, select “Sym 2x Thru”. Map the left side to Port 3 and the right side to Port 4.



b) Connect Port 3 and Port 4 of the VNA to each side of the 2x_Thru_Bottom calibration trace on the right fixture board.

c) Click the “Measure”.

16. Generate the de-embedding model for the bottom layer fixtures for both the left and right sides:

a) Uncheck the “Impedance Correction”.

b) Click “Apply”.

c) Once completed, close the de-embedding assistant.

17. The main firmware interface is now present.

The test fixture files for the left-side and right-side, bottom-layer fixtures have been created.

a) Press the Windows button (⊞) on the tool bar to access the Windows Start Menu and open the Windows File Browser.

b) Navigate to the following directory: “C:\Users\Public\Documents\Rohde-Schwarz\VNA\Embedding\”.

c) Verify that the files "A1_left_DUT.s2p" and “B1_right_DUT.s2p” exist, and that the timestamp matches the expected time of the de-embedding operation just completed.

d) Since the EZD de-embedding process will overwrite existing files when performed, rename the fixture files. The preconfigured R&S®ZNB state files are populated with a default file name.

Thus, rename the files as follows:

"A1_left_DUT" to "USBHS_bottom_left_fixture.s2p" and “B1_right_DUT” to “USBHS_bottom_right_fixture.s2p”.

18. Load the 4 fixture files that were created into the single-ended de-embedding dock widget dialog.

Configure as following. Check the “Swap Gates” settings.

Deembedding	Active	File Name 1	Swap Gates
P1	✔	USBHS_top_left_fixture.s2p •••	☐
P2	✔	USBHS_bottom_right_fixture.s2p •••	☐
P3	✔	USBHS_top_left_fixture.s2p •••	☐
P4	✔	USBHS_bottom_right_fixture.s2p •••	☐

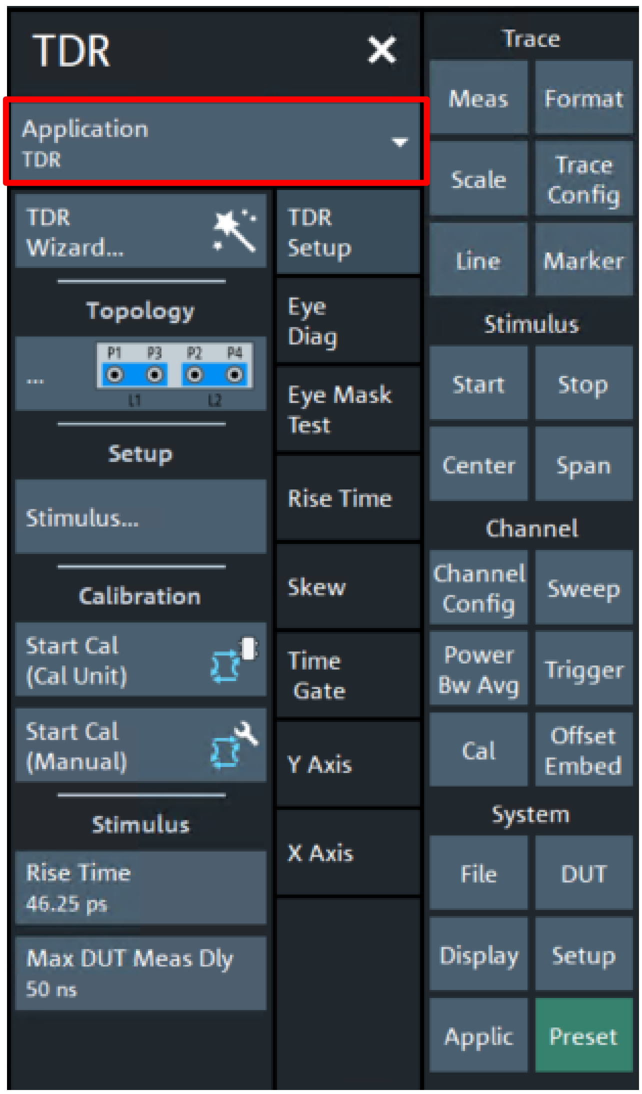
EZD De-embedding is now completed, and the measurements can be started.

3.7 Stimulus rise time adjustment

This section demonstrates how the stimulus rise time of the R&S®ZNB is adjusted. This is necessary, when performing the time domain measurements (such as propagation delay), as the USB-IF requires different rise times be used in each of these scenarios.

Note: Licenses for the additional R&S®ZNB-K2 and R&S®ZNB-K20 options will be required for this functionality.

1. On the front panel, select “APPLIC”.
2. In the “Application” dialog, select “TDR”.



At the bottom of the “TDR” dialog, you find the “Rise Time” button.

3. Select “Rise Time” to adjust the rise time.

   The rise time value can be defined to 10%/90% or 20%/80%.

3.8 USB Type-C receptacle orientation

The USB Type-C form factor was designed to be reversible, meaning the end of a cable assembly (plug) can be inserted into a host receptacle in either upside-up or upside-down orientation. To ensure successful operation in either orientation, a configuration channel (or CC pin) is used to automatically detect the cable orientation.

However, since adapter testing utilizes test fixtures to connect the cable to the measurement equipment, and does not utilize a host, the test setup is an entirely passive connection and does not include an automated means of verifying the cable assembly plug to test fixture receptacle orientation is correct. There are also no markings on the adapter to assist in this. So, it is up to the user to verify the correct lanes are being measured.

For example, when measuring the insertion loss (Sdd21) of the TX1/RX1 path through the cable assembly, it is possible for the adapter to be connected to the test fixture receptacle in a means that would be measuring the electrical characteristics of TX1/RX2 (a crosstalk parameter).

4 Compliance measurements with R&S®ZNB20

This section describes how to perform the compliance measurements with the R&S®ZNB20 4-port vector network analyzer.

4.1 High speed adapter testing

Several Type-C cable assemblies support the high-speed data lane required to achieve ≥5 Gbps throughput. This section covers the related compliance measurements for those cable assemblies.

4.1.1 High speed channel frequency domain requirements

As mentioned in the electrical requirements summary table shown in Measurement scope, all cable assemblies supporting high speed data rates share common electrical requirements; albeit with different frequency ranges and limits respective to the specific technology supported. The frequency ranges specified for USB3.2 Gen1, USB3.2 Gen2, and USB4 Gen2 measurements, respectively, are a subset of the USB4 Gen3 requirements. For this reason, both the USB4Gen3_High_Speed_Frequency_Domain.znx and USB4Gen2_High_Speed_Frequency_Domain.znx state files will configure the R&S©ZNB20 for measurements out to 20 GHz (USB4 Gen3 F_{max}), allowing data necessary for all the aforementioned standards to be collected with either setup.

However, the required *.s4p files differ between USB specifications that use the Get_iPar or Intepar compliance tools.

4.1.1.1 USB4 Gen3

In this group the following normative tests will be performed:

- Insertion Loss Fit at Nyquist Frequencies (ILfitatNq)
- Integrated Multi-reflection (IMR)
- Integrated Crosstalk between SuperSpeed Pairs (IXT_USB and IXT_DP)
- Integrated Return Loss (IRL)
- Differential-to-Common-Mode Conversion (S_{cd})
- Channel Operation Margin (COM)

These values are calculated or checked based on Touchstone files. This test group requires 44 4-port Touchstone files (*.s4p) to be measured.

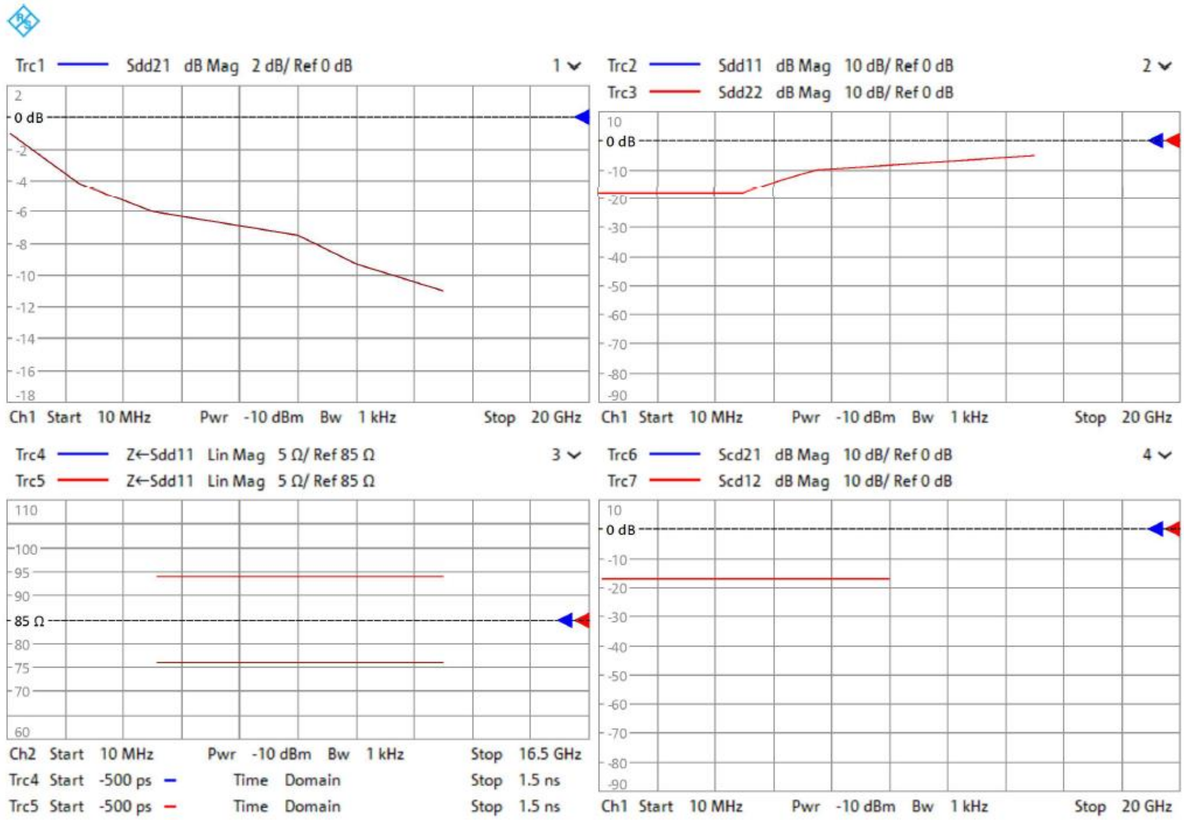
4.1.1.1.1 Test Procedure

For this test the Type-C cable will be connected to a high-speed Type-C test fixture on each side.

Note: The Luxshare ICT test fixtures described in this MOI uses 3.5mm ports as the RF interface. For this reason, it's very important that a 8-lb torque wrench is used, when tightening cables or connectors to the fixtures.

Note: Make sure to terminate all unused 3.5mm ports with 50Ω loads/matches.

1. Recall the USB4Gen3_High_Speed_Frequency_Domain.znx state file, if not already performed.



Note: The normative parameters of interest (ILfitatNq, IMR, etc.) cannot be processed natively in the network analyzer firmware. In addition to these normative requirements, the USB-IF also defines informative limits for several common frequency domain S-parameters and time domain impedance parameters. These informative limits are meant to be used as recommended guidelines for cable assembly design only, and not substitute the normative limits listed above. However, since the normative limits are derived from an external software the user can have limited feedback when measuring the necessary Touchstone files, to increase visibility into cable assembly performance the USB4Gen3_High_Speed_Frequency_Domain.znx recall file will display the informative limit lines when performing measurements. The displayed S-parameters will be checked against the included informative limit and presented with a 'pass' or 'fail' result; but these are only informative and not indicative of results generated from the normative Get_iPar results.

Additionally, the displayed limit lines will only be applicable to the high-speed data lanes (TX1/RX1, TX2/RX2) when measuring the through parameters. When measuring other data lanes, or any respective crosstalk parameters the limit lines should be ignored.

2. Verify that the calibration and de-embedding data is recalled and enabled.
3. Perform the measurement and export the Touchstone file.
   a) Using the port mapping defined in the below table, connect Port 1, Port 2, Port 3, and Port 4 to the respective test fixture pins.

For Insertion Loss (IL) part: Connect the port 1 to 4 to the test fixture according to #1 ~ #4 of the following table:

#	Test Item	Port 1	Port 3	Port 2	Port 4	Filename	Port No.
1	Thru, TX1	TX1+ (Left TF)	TX1- (Left TF)	RX1+ (Right TF)	RX1- (Right TF)	Thru_L1_TX1L_L2_RX1R.s4p	sp_port_1
2	Thru, RX1	RX1+ (Left TF)	RX1- (Left TF)	TX1+ (Right TF)	TX1- (Right TF)	Thru_L1_RX1L_L2_TX1R.s4p	sp_port_14
3	Thru, TX2	TX2+ (Left TF)	TX2- (Left TF)	RX2+ (Right TF)	RX2- (Right TF)	Thru_L1_TX2L_L2_RX2R.s4p	sp_port_23
4	Thru, RX2	RX2+ (Left TF)	RX2- (Left TF)	TX2+ (Right TF)	TX2- (Right TF)	Thru_L1_RX2L_L2_TX2R.s4p	sp_port_28

For high speed crosstalk-1 part: Connect the port 1 to 4 to the test fixture according to #5 ~ #12 of the following table:

#	Test Item	Port 1	Port 3	Port 2	Port 4	Filename	Port No.
5	Next Tx1(L)-Rx1(L)	TX1+ (Left TF)	TX1- (Left TF)	RX1+ (Left TF)	RX1- (Left TF)	Next_L1_TX1L_L2_RX1L.s4p	sp_port_5
6	Next Tx1(R)-RX1(R)	TX1+ (Right TF)	TX1- (Right TF)	RX1+ (Right TF)	RX1- (Right TF)	Next_L1_TX1R_L2_RX1R.s4p	sp_port_11
7	Fext Tx1(L)-Tx1(R)	TX1+ (Left TF)	TX1- (Left TF)	TX1+ (Right TF)	TX1- (Right TF)	Fext_L1_TX1L_L2_TX1R.s4p	sp_port_2
8	Fext Tx1(R)-Tx1(L)	TX1+ (Right TF)	TX1- (Right TF)	TX1+ (Left TF)	TX1- (Left TF)	Fext_L1_TX1R_L2_TX1L.s4p	sp_port_8
9	Next Tx2(L)-Rx2(L)	TX2+ (Left TF)	TX2- (Left TF)	RX2+ (Left TF)	RX2- (Left TF)	Next_L1_TX2L_L2_RX2L.s4p	sp_port_25
10	Next Tx2(R)-RX2(R)	TX2+ (Right TF)	TX2- (Right TF)	RX2+ (Right TF)	RX2- (Right TF)	Next_L1_TX2R_L2_RX2R.s4p	sp_port_27
11	Fext Tx2(L)-Tx2(R)	TX2+ (Left TF)	TX2- (Left TF)	TX2+ (Right TF)	TX2- (Right TF)	Fext_L1_TX2L_L2_TX2R.s4p	sp_port_24
12	Fext Tx2(R)-Tx2(L)	TX2+ (Right TF)	TX2- (Right TF)	TX2+ (Left TF)	TX2- (Left TF)	Fext_L1_TX2R_L2_TX2L.s4p	sp_port_26

For high speed crosstalk-2 part: Connect the port 1 to 4 to the test fixture according to #13 ~ #20 of the following table:

#	Test Item	Port 1	Port 3	Port 2	Port 4	Filename	Port No.
13	Next Tx1(L)-Tx2(L)	TX1+ (Left TF)	TX1- (Left TF)	TX2+ (Left TF)	TX2- (Left TF)	Next_L1_TX1L_L2_TX2L.s4p	sp_port_6
14	Next Tx1(R)-TX2(R)	TX1+ (Right TF)	TX1- (Right TF)	TX2+ (Right TF)	TX2- (Right TF)	Next_L1_TX1R_L2_TX2R.s4p	sp_port_12
15	Next Tx1(L)-Rx2(L)	TX1+ (Left TF)	TX1- (Left TF)	RX2+ (Left TF)	RX2- (Left TF)	Next_L1_TX1L_L2_RX2L.s4p	sp_port_7
16	Next Tx1(R)-RX2(R)	TX1+ (Right TF)	TX1- (Right TF)	RX2+ (Right TF)	RX2- (Right TF)	Next_L1_TX1R_L2_RX2R.s4p	sp_port_13
17	Fext Tx1(L)-Tx2(R)	TX1+ (Left TF)	TX1- (Left TF)	TX2+ (Right TF)	TX2- (Right TF)	Fext_L1_TX1L_L2_TX2R.s4p	sp_port_3
18	Fext Tx1(R)-Tx2(L)	TX1+ (Right TF)	TX1- (Right TF)	TX2+ (Left TF)	TX2- (Left TF)	Fext_L1_TX1R_L2_TX2L.s4p	sp_port_9
19	Fext Tx1(L)-Rx2(R))	TX1+ (Left TF)	TX1- (Left TF)	RX2+ (Right TF)	RX2- (Right TF)	Fext_L1_TX1L_L2_RX2R.s4p	sp_port_4
20	Fext Tx1(R)-Rx2(L)	TX1+ (Right TF)	TX1- (Right TF)	RX2+ (Left TF)	RX2- (Left TF)	Fext_L1_TX1R_L2_RX2L.s4p	sp_port_10

For high speed crosstalk-3 part: Connect the port 1 to 4 to the test fixture according to #21 ~ #28 of the following table:

#	Test Item	Port 1	Port 3	Port 2	Port 4	Filename	Port No.
21	Next Rx1(L)-Tx2(L)	RX1+ (Left TF)	RX1+ (Left TF)	TX2+ (Left TF)	TX2- (Left TF)	Next_L1_RX1L_L2_TX2L.s4p	sp_port_17
22	Next Rx1(R)-TX2(R)	RX1+ (Right TF)	RX1- (Right TF)	TX2+ (Right TF)	TX2- (Right TF)	Next_L1_RX1R_L2_TX2R.s4p	sp_port_21
23	Next Rx1(L)-Rx2(L)	RX1+ (Left TF)	RX1+ (Left TF)	RX2+ (Left TF)	RX2- (Left TF)	Next_L1_RX1L_L2_RX2L.s4p	sp_port_18
24	Next Rx1(R)-RX2(R)	RX1+ (Right TF)	RX1- (Right TF)	RX2+ (Right TF)	RX2- (Right TF)	Next_L1_RX1R_L2_RX2R.s4p	sp_port_22
25	Fext Rx1(L)-Tx2(R)	RX1+ (Left TF)	RX1+ (Left TF)	TX2+ (Right TF)	TX2- (Right TF)	Fext_L1_RX1L_L2_TX2R.s4p	sp_port_15
26	Fext Rx1(R)-Tx2(L)	RX1+ (Right TF)	RX1- (Right TF)	TX2+ (Left TF)	TX2- (Left TF)	Fext_L1_RX1R_L2_TX2L.s4p	sp_port_19
27	Fext Rx1(L)-Rx2(R)	RX1+ (Left TF)	RX1- (Left TF)	RX2+ (Right TF)	RX2- (Right TF)	Fext_L1_RX1L_L2_RX2R.s4p	sp_port_16
28	Fext Rx1(R)-Rx2(L)	RX1+ (Right TF)	RX1- (Right TF)	RX2+ (Left TF)	RX2- (Left TF)	Fext_L1_RX1R_L2_RX2L.s4p	sp_port_20

For low speed crosstalk-4 part: Connect the port 1 to 4 to the test fixture according to #29 ~ #44 of the following table:

#	Test Item	Port 1	Port 3	Port 2	Port 4	Filename	Port No.
29	Next DD(L)-Tx1(L)	DD+ (Left TF)	DD- (Left TF)	TX1+ (Left TF)	TX1- (Left TF)	Next_L1_DDL_L2_TX1L.s4p	usb2_port_1
30	Fext DD(L)-Tx1(R)	DD+ (Left TF)	DD- (Left TF)	TX1+ (Right TF)	TX1- (Right TF)	Fext_L1_ DDL _L2_TX1R.s4p	usb2_port_2
31	Next DD(L)-Rx1(L)	DD+ (Left TF)	DD- (Left TF)	RX1+ (Left TF)	RX1- (Left TF)	Next_L1_ DDL _L2_RX1L.s4p	usb2_port_3
32	Fext DD(L)-Rx1(R)	DD+ (Left TF)	DD- (Left TF)	RX1+ (Right TF)	RX1- (Right TF)	Fext_L1_ DDL _L2_RX1R.s4p	usb2_port_4
33	Next DD(L)-Tx2(L)	DD+ (Left TF)	DD- (Left TF)	TX2+ (Left TF)	TX2- (Left TF)	Next_L1_ DDL _L2_TX2L.s4p	usb2_port_5
34	Fext DD(L)-Tx2(R)	DD+ (Left TF)	DD- (Left TF)	TX2+ (Right TF)	TX2- (Right TF)	Fext_L1_ DDL _L2_TX2R.s4p	usb2_port_6
35	Next DD(L)-Rx2(L)	DD+ (Left TF)	DD- (Left TF)	RX2+ (Left TF)	RX2- (Left TF)	Next_L1_ DDL _L2_RX2L.s4p	usb2_port_7
36	Fext DD(L)-Rx2(R)	DD+ (Left TF)	DD- (Left TF)	RX2+ (Right TF)	RX2- (Right TF)	Fext_L1_ DDL _L2_RX2R.s4p	usb2_port_8
37	Fext DD(R)-Tx1(L)	DD+ (Right TF)	DD- (Right TF)	TX1+ (Left TF)	TX1- (Left TF)	Fext_L1_DDR_L2_TX1L.s4p	usb2_port_9
38	Next DD(R)-Tx1(R)	DD+ (Right TF)	DD- (Right TF)	TX1+ (Right TF)	TX1- (Right TF)	Next_L1_ DDR_L2_TX1R.s4p	usb2_port_10
39	Fext DD(R)-Rx1(L)	DD+ (Right TF)	DD- (Right TF)	RX1+ (Left TF)	RX1- (Left TF)	Fext_L1_ DDR_L2_RX1L.s4p	usb2_port_11
40	Next DD(R)-Rx1(R)	DD+ (Right TF)	DD- (Right TF)	RX1+ (Right TF)	RX1- (Right TF)	Next_L1_ DDR_L2_RX1R.s4p	usb2_port_12
41	Fext DD(R)-Tx2(L)	DD+ (Right TF)	DD- (Right TF)	TX2+ (Left TF)	TX2- (Left TF)	Fext_L1_ DDR_L2_TX2L.s4p	usb2_port_13
42	Next DD(R)-Tx2(R)	DD+ (Right TF)	DD- (Right TF)	TX2+ (Right TF)	TX2- (Right TF)	Next_L1_ DDR_L2_TX2R.s4p	usb2_port_14
43	Fext DD(R)-Rx2(L)	DD+ (Right TF)	DD- (Right TF)	RX2+ (Left TF)	RX2- (Left TF)	Fext_L1_ DDR_L2_RX2L.s4p	usb2_port_15
44	Next DD(R)-Rx2(R)	DD+ (Right TF)	DD- (Right TF)	RX2+ (Right TF)	RX2- (Right TF)	Next_L1_ DDR_L2_RX2R.s4p	usb2_port_16

b) After an acquisition is complete, select “FILE” on the front panel then Select “Trace Data” > “s4p Port 1,2,3,4...”.

c) Use the name listed in the ‘Filename’ column (based on the naming described in 3.4 Touchstone file naming convention) in the above table for the file name of the exported Touchstone file.

4. Repeat step 3.a through 3.c for all 44 measurements.

5. Import the 44 4-port Touchstone files (*.s4p) to the "Get_iPar" software.

The Get_iPar software can be used for the evaluation of several different compliance requirements. Due to its flexibility, there are configuration files (*.xlsx) used to automate the post-processing and evaluation of the cable assembly data. These files needed to be edited to properly perform the interested analysis.

a) After downloading the latest Get_iPar files, described in 3.3.1 Get_iPar, extract the content of the .zip file.

b) In the extracted content, there is a folder called 'Templates'. Copy the provided 'R&S_ZNB20_s4p_template.xlsx' into this folder.

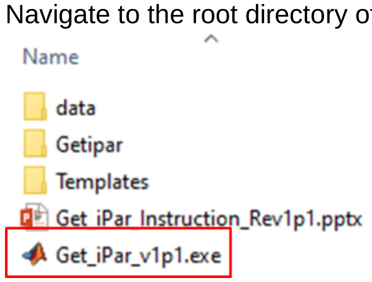
c) Within the 'Templates' folder there is a file called 'USB4_Gen3_CableCom_Config_Example.xlsx'. This file will be used in the following steps, but must first be modified to reflect the settings necessary for USB4 Gen3 passive cable assembly testing. Modify the file as shown below:

USB4 Gen3 Cable Complaince Check Configuration File Example		
comp_check_type	1	1=iPar+COM; 2=iPar only; 3=COM only; 4=Connector
result_folder	.\Templates\	
cable_type	0	0= passive cable; 1=active cable (only used for cable)
eta_0	5.67E-08	only use for active cable
save_assembled_cable_sp	0	
plot_cable_sp	1	
case_number	[1]	
case_1	.\Templates\R&S_ZNB20_s4p_template.xlsx	
case_2	.\Templates\s8p_example_0p91a.xlsx	
case_3	.\Templates\s16p_example_0p91a.xlsx	
case_4	.\Templates\s20p_example_0p91a.xlsx	

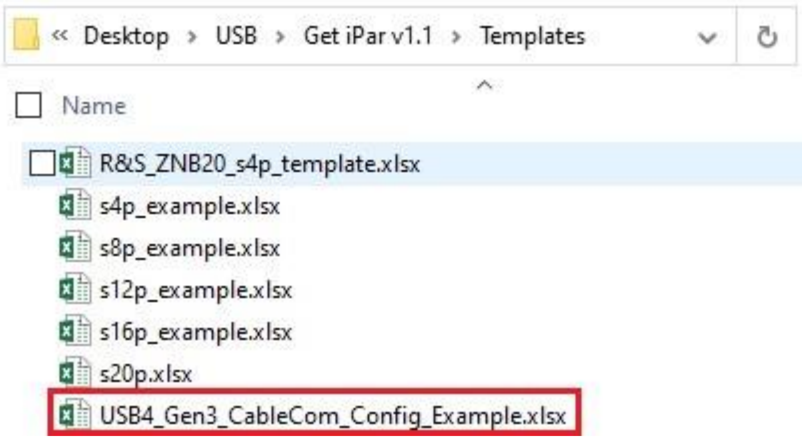
d) After editing 'USB4_Gen3_CableCom_Config_Example.xlsx' is completed. The provided 'R&S_ZNB20_s4p_template.xlsx' (previously copied into the 'Templates' folder in step 5.b) must be edited to properly reflect the directory that the 44 Touchstone files are stored.

folder	C:\USB-IF_SW\Ger_iPar_v0p91a_release\s4p\	
VNA_port	4	
sp_file_1	Thru_L1_TX1L_L2_RX1R.s4p	sp_port_1
sp_file_2	Fext_L1_TX1L_L2_TX1R.s4p	sp_port_2
sp_file_3	Fext_L1_TX1L_L2_TX2R.s4p	sp_port_3
sp_file_4	Fext_L1_TX1L_L2_RX2R.s4p	sp_port_4
sp_file_5	Next_L1_TX1L_L2_RX1L.s4p	sp_port_5
sp_file_6	Next_L1_TX1L_L2_TX2L.s4p	sp_port_6
sp_file_7	Next_L1_TX1L_L2_RX2L.s4p	sp_port_7
sp_file_8	Fext_L1_TX1R_L2_TX1L.s4p	sp_port_8
sp_file_9	Fext_L1_TX1R_L2_TX2L.s4p	sp_port_9
sp_file_10	Fext_L1_TX1R_L2_RX2L.s4p	sp_port_10

e) Navigate to the root directory of the extracted Get_iPar files, and run the *.exe file



f) Next, a pop-up window will appear, titled “INPUT CONFIG FILE”. Select the ‘USB4_Gen3_CableCom_Config_Example.xlsx” file in the ‘Templates’ folder.



g) The Get_iPar software will begin processing the 44 Touchstone files. This process may take several minutes. Plots will appear on the screen, but will automatically close.

6. Retrieve the analysis results from the software.

Once the Get_iPar software has completed it’s analysis, the compliance results will be stored in two spreadsheets within the ‘Templates’ folder. The spreadsheets include numerical values as well as pass or fail judgement against the respective limit.

	A	B	C	D	E	F	G	H	I	J	K
1	Passive ca	TX1(L)	TX1(R)	RX1(L)	RX1(R)	TX2(L)	TX2(R)	RX2(L)	RX2(R)	Limit	Pass/Fail
2	ILfit@0.1G	-0.48	-0.48	-0.47	-0.47	-0.5	-0.5	-0.48	-0.48	1	Pass
3	ILfit@2.5G	-2.77	-2.77	-2.65	-2.65	-2.78	-2.78	-2.71	-2.71	-4.2	Pass
4	ILfit@5GH:	-4.3	-4.3	-4.01	-4.01	-4.32	-4.32	-4.1	-4.1	6	Pass
5	ILfit@10GH	-6.61	-6.61	-6.07	-6.07	-6.69	-6.69	-6.14	-6.14	-7.5	Pass
6	ILfit@12.5(	-7.33	-7.33	-6.86	-6.86	-7.51	-7.51	-6.91	-6.91	-9.3	Pass
7	ILfit@15GH	-7.72	-7.72	-7.5	-7.5	-8.05	-8.05	-7.54	-7.54	-11	Pass
8	IMR, dB	-37.09	-37.09	-40.06	-40.06	-39.08	-39.08	-38.55	-38.55	-36.47	Pass
9	IRL, dB	-19.61	-19.61	-20.82	-20.82	-19.97	-19.97	-19.44	-19.44	-18.61	Pass
10	C2D, dB	-32.25	-37.9	-35.94	-31.4	-34.85	-34.68	-27.49	-26.9	-17	Pass
11	D2C, dB	-32.12	-38	-35.51	-31.5	-34.93	-34.86	-27.22	-26.6	-17	Pass
12	IXT_DP, dE	-46.94	-47.23	-47.1	-46.81	-47.65	-48.31	-48.53	-47.85	-40.49	Pass
13	IXT_USB, (	-47.01	-46.97	-46.48	-47.01	-46.12	-46.77	-46.63	-46.77	-40.54	Pass
14											
15	Detailed crosstalk between each pair in dB										
16	Vic/Agg P(	TX1(L)	TX1(R)	RX1(L)	RX1(R)	TX2(L)	TX2(R)	RX2(L)	RX2(R)		
17	TX1(L)			-47.53	-47.58	-56.58	-58.83	-60.21	-58.39		
18	TX1(R)			-47.93	-47.62	-58.33	-59.79	-58.73	-58.76		
19	RX1(L)	-47.53	-47.93			-54.71	-57.19	-59.04	-58.36		
20	RX1(R)	-47.58	-47.62			-56.59	-58.33	-59.32	-58.59		
21	TX2(L)	-56.58	-58.33	-54.71	-56.59			-47.08	-48.7		
22	TX2(R)	-58.83	-59.79	-57.19	-58.33			-49.38	-47.39		
23	RX2(L)	-60.21	-58.73	-59.04	-59.32	-47.08	-49.38				
24	RX2(R)	-58.39	-58.76	-58.36	-58.59	-48.7	-47.39				
25											
26		Tx1/RX1	Tx2/Rx2	Limit	Pass/Fail						
27	USB2(L):IL	-58.05	-58.01	-34.5	Pass						
28	USB2(R):IL	-60.71	-56.52	-34.5	Pass						
29	USB2(L):2	-57.48	-55.75	-33	Pass						
30	USB2(R):2	-57.9	-56.16	-33	Pass						
31											
32	USB4 Gen3 Get_iPar Revision 1.1										
33	Report Time: 25-Oct-2023 23:11:03										

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Host#	Device#	Cable#	Victim	ILfitatNq	Signal_mV	ISI_mV	Crosstalk_	FFE	CTEL Gair	DFE	COM	COM Limit	Pass/Fail
2	1	1	s20p	Tx1	-21.7215	59.87516	26.02	6.18	-0.17	-8	0.36896	3.628398	3	Pass
3	1	1	s20p	Rx1	-21.597	60.42059	26.08	5.02	-0.17	-8	0.36257	3.709367	3	Pass
4	1	1	s20p	Tx2	-22.4267	57.88651	26.53	6.32	-0.17	-8	0.39251	3.219038	3	Pass
5	1	1	s20p	Rx2	-21.1118	62.08529	25.44	5.16	-0.17	-8	0.32748	4.134782	3	Pass
6	1	2	s20p	Tx1	-17.3831	85.89427	28.75	9.09	-0.17	-5	0.29115	5.352669	3	Pass
7	1	2	s20p	Rx1	-17.2379	84.60408	29.22	7.16	-0.17	-6	0.22232	5.288894	3	Pass
8	1	2	s20p	Tx2	-18.066	80.57759	28.24	8.58	-0.17	-6	0.2716	4.916463	3	Pass
9	1	2	s20p	Rx2	-16.7528	89.09432	27.39	7.93	-0.17	-5	0.24704	5.907694	3	Pass
10	2	1	s20p	Tx1	-17.4082	85.86788	30.12	6.46	-0.17	-5	0.29447	5.288418	3	Pass
11	2	1	s20p	Rx1	-17.2816	84.54819	29.27	5.26	-0.17	-6	0.22486	5.429714	3	Pass
12	2	1	s20p	Tx2	-18.1227	80.52843	28.21	6.22	-0.17	-6	0.27543	5.08761	3	Pass
13	2	1	s20p	Rx2	-16.7659	89.15134	29.14	5.34	-0.17	-5	0.24919	5.798533	3	Pass
14	2	2	s20p	Tx1	-13.0835	133.2535	44.95	8.21	-0.09	-3	0.30028	5.57921	3	Pass
15	2	2	s20p	Rx1	-12.9496	119.084	36.39	8.29	-0.17	-4	0.11365	5.993218	3	Pass
16	2	2	s20p	Tx2	-13.7976	113.3293	37.87	8.03	-0.17	-4	0.16763	5.53831	3	Pass
17	2	2	s20p	Rx2	-12.4239	136.851	42.88	8.38	-0.09	-3	0.27283	5.809363	3	Pass

4.1.1.2 USB4 Gen2 and USB3.2 Gen2/Gen1

In this group the following normative tests will be performed:

► Insertion Loss Fit at Nyquist Frequencies (ILfitatNq)

► Integrated Multi-reflection (IMR)

► Integrated Crosstalk between SuperSpeed Pairs (IXT_USB and IXT_DP)

► Integrated Return Loss (IRL)

► Differential-to-Common-Mode Conversion (S_{cd})

These values are calculated or checked based on Touchstone files. This test group requires 15 4-port Touchstone files (*.s4p) to be measured.

Cable assemblies supporting USB3.2 Gen2 or USB3.2 Gen1 capabilities have unique normative compliance limits, but the procedure to perform testing for each respective type is nearly identical. The procedure defined in this section will be applicable to both, and identify the differences when necessary.

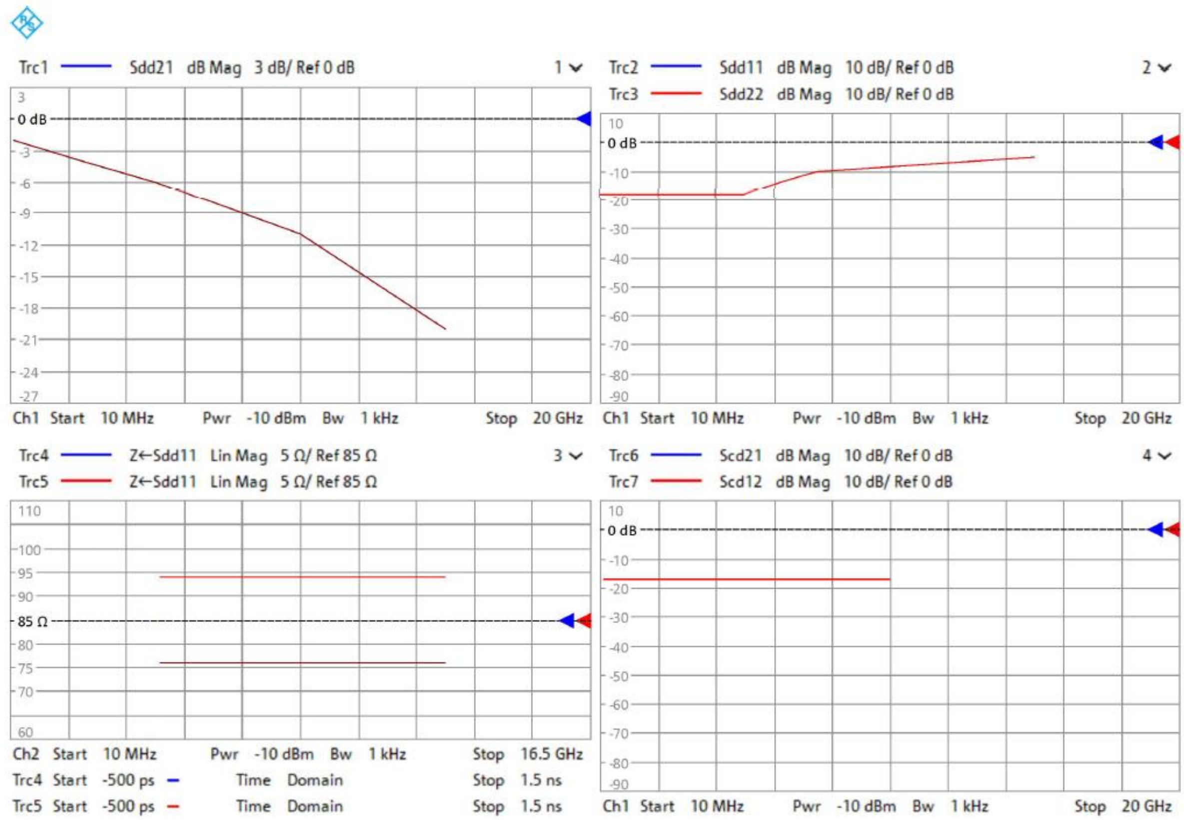
4.1.1.2.1 Test Procedure

For this test the Type-C cable will be connected to a high-speed Type-C test fixture on each side.

Note: The Luxshare ICT test fixtures described in this MOI uses 3.5mm ports as the RF interface. For this reason, it's very important that a 8-lb torque wrench is used, when tightening cables or connectors to the fixtures.

Note: Make sure to terminate all unused 3.5mm ports with 50Ω loads/matches.

1. Recall the USB4Gen2_High_Speed_Frequency_Domain.znx state file, if not already performed.



Note: The normative parameters of interest (ILfitatNq, IMR, etc.) cannot be processed natively in the network analyzer firmware. In addition to these normative requirements, the USB-IF also defines informative limits for several common frequency domain S-parameters and time domain impedance parameters. These informative limits are meant to be used as recommended guidelines for cable assembly design only, and not substitute the normative limits listed above. However, since the normative limits are derived from an external software the user can have limited feedback when measuring the necessary Touchstone files, to increase visibility into cable assembly performance the USB4Gen2_High_Speed_Frequency_Domain.znx recall file will display the informative limit lines when performing measurements. The displayed S-parameters will be checked against the included informative limit and presented with a 'pass' or 'fail' result; but these are only informative and not indicative of results generated from the normative Get_iPar results.

Additionally, the displayed limit lines will only be applicable to the high-speed data lanes (TX1/RX1, TX2/RX2) when measuring the through parameters. When measuring other data lanes, or any respective crosstalk parameters the limit lines should be ignored

Lastly, USB3.2 Gen1 does not define informative limits, only normative requirements. For this reason, the same recall file ("USB4Gen2_High_Speed_Frequency_Domain.znx") will be used for testing both cable assembly types.

2. Verify that the calibration and de-embedding data is recalled and enabled.

3. Perform the measurement and export the Touchstone file.

   a) Using the port mapping defined in the below table, connect Port 1, Port 2, Port 3, and Port 4 to the respective test fixture pins.

For Insertion Loss (IL) part: Connect the port 1 to 4 to the test fixture according to #1 ~ #3 of the following table:

#	Test Item	Port 1	Port 3	Port 2	Port 4	Filename
1	Thru, TX1	TX1+ (Left TF)	TX1- (Left TF)	RX1+ (Right TF)	RX1- (Right TF)	Thru_L1_TX1L_L2_RX1R.s4p
2	Thru, RX1	RX1+ (Left TF)	RX1- (Left TF)	TX1+ (Right TF)	TX1- (Right TF)	Thru_L1_RX1L_L2_TX1R.s4p
3	Thru, DD	D+ (Left TF)	D- (Left TF)	D+ (Right TF)	D- (Right TF)	Thru_L1_DDL_L2_DDR.s4p

For crosstalk part: Connect the port 1 to 4 to the test fixture according to #4 ~ #15 of the following table:

#	Test Item	Port 1	Port 3	Port 2	Port 4	Filename
4	Next Tx1(L)-Rx1(L)	TX1+ (Left TF)	TX1- (Left TF)	RX1+ (Left TF)	RX1- (Left TF)	Next_L1_TX1L_L2_RX1L.s4p
5	Next Tx1(L)-DD(L)	TX1+ (Left TF)	TX1- (Left TF)	D+ (Left TF)	D- (Left TF)	Next_L1_TX1L_L2_DDL.s4p
6	Fext Tx1(L)-Tx1(R)	TX1+ (Left TF)	TX1- (Left TF)	TX1+ (Right TF)	TX1- (Right TF)	Fext_L1_TX1L_L2_TX1R.s4p
7	Fext Tx1(L)-Rx1(R)	TX1+ (Left TF)	TX1- (Left TF)	D+ (Right TF)	D- (Right TF)	Fext_L1_TX1L_L2_DDR.s4p
8	Next Rx1(L)-Tx1(L)	RX1+ (Left TF)	RX1- (Left TF)	TX1+ (Left TF)	TX1- (Left TF)	Next_L1_RX1L_L2_TX1L.s4p
9	Next Rx1(L)-DD(L)	RX1+ (Left TF)	RX1- (Left TF)	D+ (Left TF)	D- (Left TF)	Next_L1_RX1L_L2_DDL.s4p
10	Fext Rx1(L)-Rx1(R)	RX1+ (Left TF)	RX1- (Left TF)	RX1+ (Right TF)	RX1- (Right TF)	Fext_L1_RX1L_L2_RX1R.s4p
11	Fext Rx1(L)-DD(R)	RX1+ (Left TF)	RX1- (Left TF)	D+ (Right TF)	D- (Right TF)	Fext_L1_RX1L_L2_DDR.s4p
12	Next DD(L)-Tx1(L)	D+ (Left TF)	D- (Left TF)	TX1+ (Left TF)	TX1- (Left TF)	Next_L1_DDL_L2_TX1L.s4p
13	Next DD(L)-RX1(L)	D+ (Left TF)	D- (Left TF)	RX1+ (Left TF)	RX1- (Left TF)	Next_L1_DDL_L2_RX1L.s4p
14	Fext DD(L)-Tx1(R)	D+ (Left TF)	D- (Left TF)	TX1+ (Right TF)	TX1- (Right TF)	Fext_L1_DDL_L2_TX1R.s4p
15	Fext DD(L)-Rx1(R)	D+ (Left TF)	D- (Left TF)	RX1+ (Right TF)	RX1- (Right TF)	Fext_L1_DDL_L2_RX1R.s4p

b) After an acquisition is complete, select “FILE” on the front panel then Select “Trace Data” > “s4p Port 1,2,3,4...”.

c) Use the name listed in the ‘Filename’ column (based on the naming described in 3.4 Touchstone file naming convention) in the above table for the file name of the exported Touchstone file.

4. Repeat step 3.a through 3.c for all 15 measurements.

5. Import the 15 4-port Touchstone files (*.s4p) to the “InterPar" software.

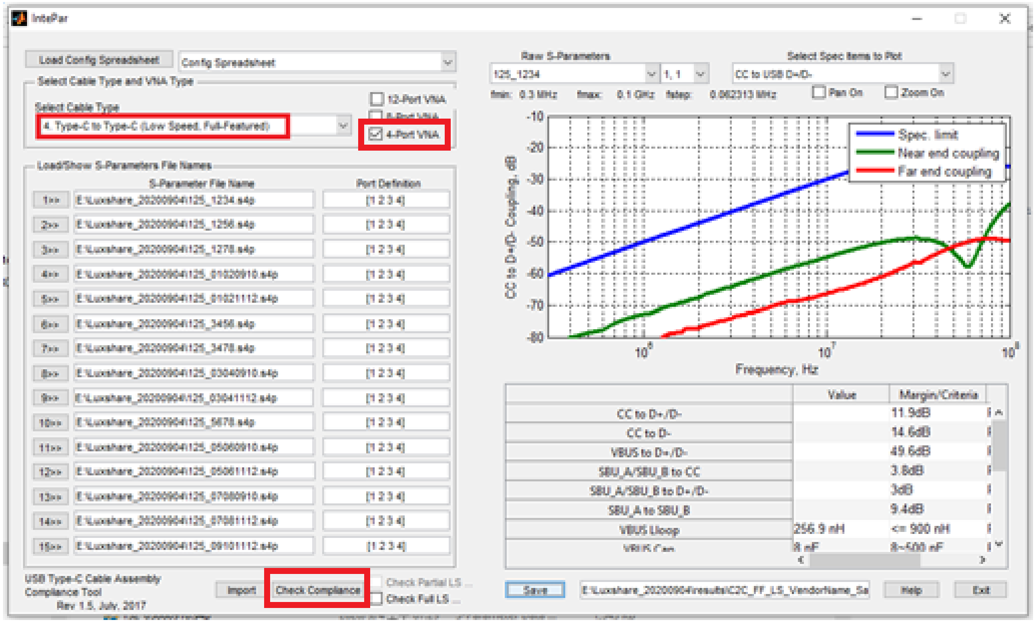
   a) After downloading the latest Intepar files, described in 3.3.2 IntePar, extract the content of the .zip file.

   b) In the extracted content, run the executable file called ‘Intepar.exe’.

   c) In the Select Cable Type dropdown menu, choose either
   "1. Type-C to Type-C, Gen 2 (high Speed)" (for USB3.2 Gen2), or
   "2. Type-C to Type-C, Gen 1 (high Speed)" (for USB3.2 Gen1), depending on the compliance testing being performed.

   d) Select the ‘4-port VNA’ checkbox

e) Run the IntePar tool by clicking the 'Check Compliance' button at the bottom of the IntePar user interface.



6. Retrieve the analysis results from the table in the bottom right corner Intepar user interface.
7. Now the S-parameters of the data lanes on the Right Test Fixture need to be measured.

   a) Using the port mapping defined in the below table, connect Port 1, Port 2, Port 3, and Port 4 to the respective test fixture pins.

   For Insertion Loss (IL) part: Connect the port 1 to 4 to the test fixture according to #1 ~ #3 of the following table:

#	Test Item	Port 1	Port 3	Port 2	Port 4	Filename
1	Thru, TX1	TX1+ (Right TF)	TX1- (Right TF)	RX1+ (Left TF)	RX1- (Left TF)	Thru_L1_TX1R_L2_RX1L.s4p
2	Thru, RX1	RX1+ (Right TF)	RX1- (Right TF)	TX1+ (Left TF)	TX1- (Left TF)	Thru_L1_RX1R_L2_TX1L.s4p
3	Thru, DD	D+ (Right TF)	D- (Right TF)	D+ (Left TF)	D- (Left TF)	Thru_L1_DDR_L2_DDL.s4p

   For crosstalk part: Connect the port 1 to 4 to the test fixture according to #4 ~ #15 of the following table:

#	Test Item	Port 1	Port 3	Port 2	Port 4	Filename
4	Next Tx1(R)-Rx1(R)	TX1+ (Right TF)	TX1- (Right TF)	RX1+ (Right TF)	RX1- (Right TF)	Next_L1_TX1R_L2_RX1R.s4p
5	Next Tx1(R)-DD(R)	TX1+ (Right TF)	TX1- (Right TF)	D+ (Right TF)	D- (Right TF)	Next_L1_TX1R_L2_DDR.s4p
6	Fext Tx1(R)-Tx1(L)	TX1+ (Right TF)	TX1- (Right TF)	TX1+ (Left TF)	TX1- (Left TF)	Fext_L1_TX1R_L2_TX1L.s4p
7	Fext Tx1(R)-Rx1(L)	TX1+ (Right TF)	TX1- (Right TF)	D+ (Left TF)	D- (Left TF)	Fext_L1_TX1R_L2_DDL.s4p
8	Next Rx1(R)-Tx1(R)	RX1+ (Right TF)	RX1- (Right TF)	TX1+ (Right TF)	TX1- (Right TF)	Next_L1_RX1R_L2_TX1R.s4p
9	Next Rx1(R)-DD(R)	RX1+ (Right TF)	RX1- (Right TF)	D+ (Right TF)	D- (Right TF)	Next_L1_RX1R_L2_DDR.s4p
10	Fext Rx1(R)-Rx1(L)	RX1+ (Right TF)	RX1- (Right TF)	RX1+ (Left TF)	RX1- (Left TF)	Fext_L1_RX1R_L2_RX1L.s4p
11	Fext Rx1(R)-DD(L)	RX1+ (Right TF)	RX1- (Right TF)	D+ (Left TF)	D- (Left t TF)	Fext_L1_RX1R_L2_DDL.s4p

#	Test Item	Port 1	Port 3	Port 2	Port 4	Filename
12	Next DD(R)-Tx1(R)	D+ (Right TF)	D- (Right TF)	TX1+ (Right TF)	TX1- (Right TF)	Next_L1_DDR_L2_TX1R.s4p
13	Next DD(R)-RX1(R)	D+ (Right TF)	D- (Right TF)	RX1+ (Right TF)	RX1- (Right TF)	Next_L1_DDR_L2_RX1R.s4p
14	Fext DD(R)-Tx1(L)	D+ (Right TF)	D- (Right TF)	TX1+ (Left TF)	TX1- (Left TF)	Fext_L1_DDR_L2_TX1L.s4p
15	Fext DD(R)-Rx1(L)	D+ (Right TF)	D- (Right TF)	RX1+ (Left TF)	RX1- (Left TF)	Fext_L1_DDR_L2_RX1L.s4p

b) After an acquisition is complete, select “FILE” on the front panel then Select “Trace Data” > “s4p Port 1,2,3,4...”.

c) Use the name listed in the ‘Filename’ column (based on the naming described in 3.4 Touchstone file naming convention) in the above table for the file name of the exported Touchstone file.

8. Repeat step 7.a through 7.c for all 15 measurements.
9. Repeat the procedure from step 5 for all the Right Test Fixture files.
10. Retrieve the analysis results from the table in the bottom right corner Intepar user interface.

4.1.2 High speed channel time domain requirements

Time domain measurements are directly performed on the R&S®ZNB20 vector network analyzer. Only for this section the R&S®ZNB-K2 time domain option is required:

In this group following coupling tests will be performed:

- ► Intra-pair skew
- ► Propagation delay
- ► Differential impedance

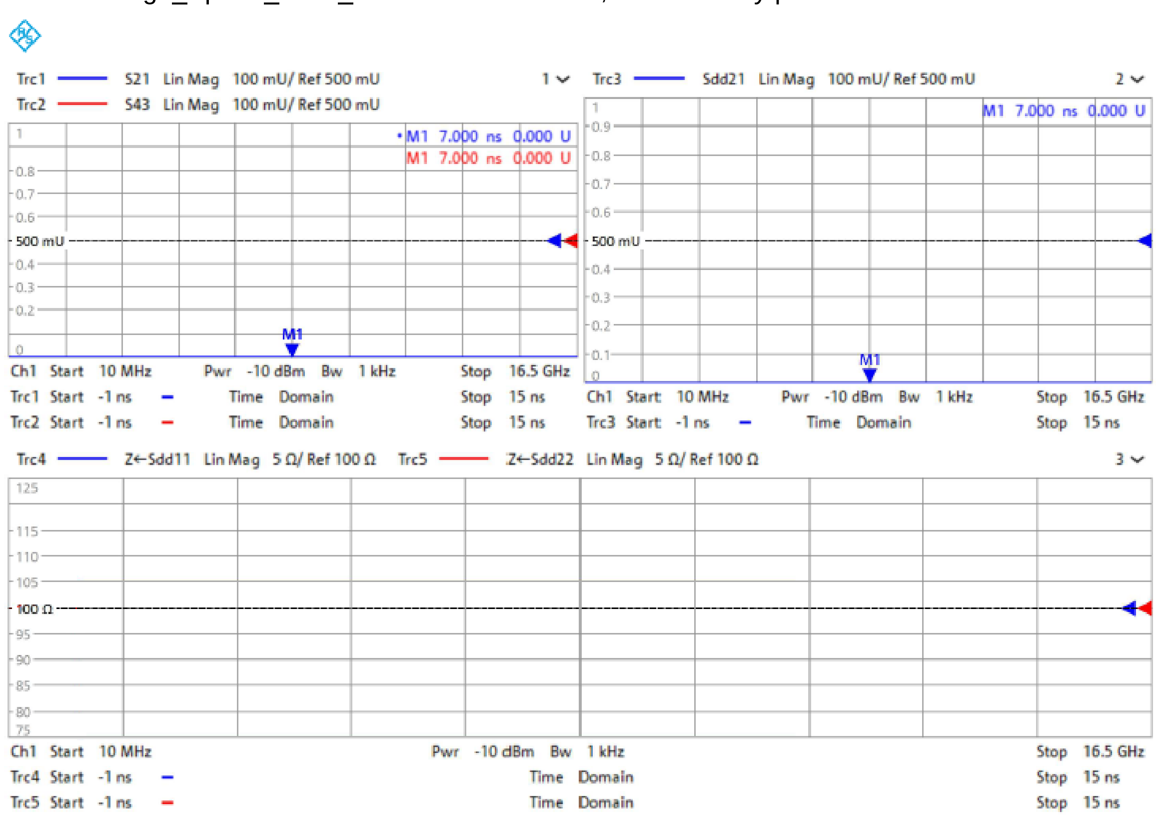
4.1.2.1 Test Procedure

For this test the Type-C cable can be connected to either the low speed Type-C test fixture or the super speed Type-C test fixture.

Note: The Luxshare ICT test fixtures described in this MOI uses 3.5mm ports as the RF interface. For this reason, it's very important that a 8-lb torque wrench is used, when tightening cables or connectors to the fixtures.

Note: Terminate all unused 3.5mm ports with 50Ω loads/matches.

1. Recall the High_Speed_Time_Domain.znx state file, if not already performed.



2. Verify that the calibration and de-embedding data is recalled and enabled.
3. Adjust the ZNB20 rise time as needed, using the procedure described in 3.7 Stimulus rise time adjustment, to target 40 ps.
4. Perform the measurements.

a) Using the port mapping defined in the below table, connect Port 1, Port 2, Port 3, and Port 4 to the respective test fixture pins.

#	Test Item	Port 1	Port 3	Port 2	Port 4
1	TX Time Domain	TX1+ (Left TF)	TX1- (Left TF)	RX1+ (Right TF)	RX1- (Right TF)
2	RX Time Domain	RX1+ (Left TF)	RX1- (Left TF)	TX1+ (Right TF)	TX1- (Right TF)

b) Intra-pair skew can be verified using trace1 (S21) and trace2 (S43) in the top left window.

The two marker values are used to measure the difference in skew between positive and negative polarities. To pass, the difference must be ≤ 100 ps.

c) Propagation delay can be verified using trace3 (Sdd21) in the top right window.

The marker value is used to measure the delay. To pass, the difference must be ≤ 20 ps.

d) Differential impedance can be verified using trace4 (Z ← $S_{dd}11$) and trace5 (Z ← $S_{dd}22$) in the bottom window.

The two red lines in the window are representing the limits defined by USB-IF for differential impedance. Both traces shall be within the limit lines of 75 and 105 Ω.

5. Repeat steps 4.b through 4.d for both measurements.
6. Export the Touchstone file.

a) After an acquisition is complete, select “FILE” on the front panel then Select “Trace Data” > “s4p Port 1,2,3,4...”.

4.2 Low speed cable assembly testing

This section covers the frequency domain and time domain related compliance measurements for the low-speed lanes in cable assemblies.

4.2.1 Low speed channel frequency domain requirements

In this group following coupling tests will be performed:

- ► Differential Insertion Loss (D+/D- attenuation)
- ► Coupling between CC and differential USB D+/D-
- ► Coupling between VBUS and differential USB D+/D-
- ► Single- ended Coupling between SBU_A and CC, SBU_B and CC
- ► Single- ended Coupling between CC and D-
- ► Single- ended Coupling between SBU_A and SBU_B
- ► Coupling between SBU_A /SBU_B and differential USB D+/D-

These values are calculated or checked based on Touchstone files. This test group requires 15 4-port Touchstone files (*.s4p) to be measured.

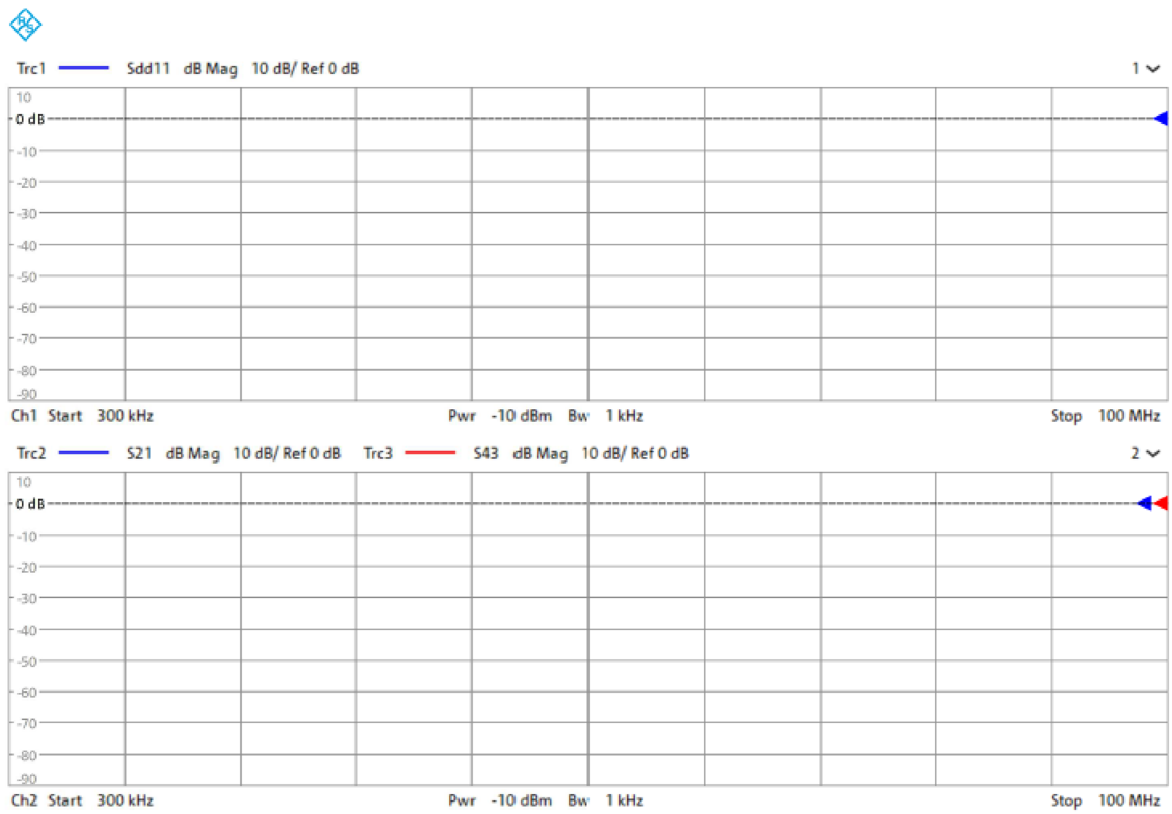
4.2.1.1 Test Procedure

For this test the Type-C cable will be connected to a low-speed Type-C test fixture on each side.

Note: The Luxshare ICT test fixtures described in this MOI uses 3.5mm ports as the RF interface. For this reason, it's very important that a 8-lb torque wrench is used, when tightening cables or connectors to the fixtures.

Note: Make sure to terminate all unused 3.5mm ports with 50Ω loads/matches.

1. Recall the Low_Speed_Frequency_Domain.znx state file, if not already performed.



2. Verify that the calibration and de-embedding data is recalled and enabled.
3. Perform the measurement and export the Touchstone file.
   a) Using the port mapping defined in the below table, connect Port 1, Port 2, Port 3, and Port 4 to the respective test fixture pins.

#	Test Item	Port 1	Port 3	Port 2	Port 4
1	D+(L), D+(R), D-(L), D-(R)	D+ (Left TF)	D- (Left TF)	D+ (Right TF)	D- (Right TF)
2	D+(L), D+(R), VBUS(L), VBUS(R)	D+ (Left TF)	VBUS (Left TF)	D+ (Right TF)	VBUS (Right TF)
3	D+(L), D+(R), CC(L), CC(R)	D+ (Left TF)	CC (Left TF)	D+ (Right TF)	CC (Right TF)
4	D+(L), D+(R), SBU_A(L), SBU_A(R)	D+ (Left TF)	SBU_A (Left TF)	D+ (Right TF)	SBU_B (Right TF)
5	D+(L), D+(R), SBU_B(L), SBU_B(R)	D+ (Left TF)	SBU_B (Left TF)	D+ (Right TF)	SBU_A (Right TF)
6	D-(L), D-(R), VBUS(L), VBUS(R),	D- (Left TF)	VBUS (Left TF)	D- (Right TF)	VBUS (Right TF)
7	D-(L), D-(R), CC(L), CC(R)	D- (Left TF)	CC (Left TF)	D- (Right TF)	CC (Right TF)
8	D-(L), D-(R), SBU_A(L), SBU_A(R)	D- (Left TF)	SBU_A (Left TF)	D- (Right TF)	SBU_B (Right TF)
9	D-(L), D-(R), SBU_B(L), SBU_B(R)	D- (Left TF)	SBU_B (Left TF)	D- (Right TF)	SBU_A (Right TF)
10	VBUS(L), VBUS(R), CC(L), CC(R)	VBUS (Left TF)	CC (Left TF)	VBUS (Right TF)	CC (Right TF)
11	VBUS(L), VBUS(R), SBU_A(L), SBU_A(R)	VBUS (Left TF)	SBU_A (Left TF)	VBUS (Right TF)	SBU_B (Right TF)

#	Test Item	Port 1	Port 3	Port 2	Port 4
12	VBUS(L), VBUS(R), SBU_B(L), SBU_B(R)	VBUS (Left TF)	SBU_B (Left TF)	VBUS (Right TF)	SBU_A (Right TF)
13	CC(L), CC(R), SBU_A(L), SBU_A(R)	CC (Left TF)	SBU_A (Left TF)	CC (Right TF)	SBU_B (Right TF)
14	CC(L), CC(R), SBU_B(L), SBU_B(R)	CC (Left TF)	SBU_B (Left TF)	CC (Right TF)	SBU_A (Right TF)
15	SBU_A(L), SBU_A(R), SBU_B(L), SBU_B(R)	SBU_A (Left TF)	SBU_B (Left TF)	SBU_B (Right TF)	SBU_A (Right TF)

b) After an acquisition is complete, select “FILE” on the front panel then Select “Trace Data” > “s4p Port 1,2,3,4...”.

c) Use the name listed in the ‘Filename’ column (based on the naming described in 3.4 Touchstone file naming convention) in the above table for the file name of the exported Touchstone file.

4. Repeat step 3.a through 3.c for all 15 measurements.

5. Import the 15 4-port Touchstone files (*.s4p) to the “InterPar" software.

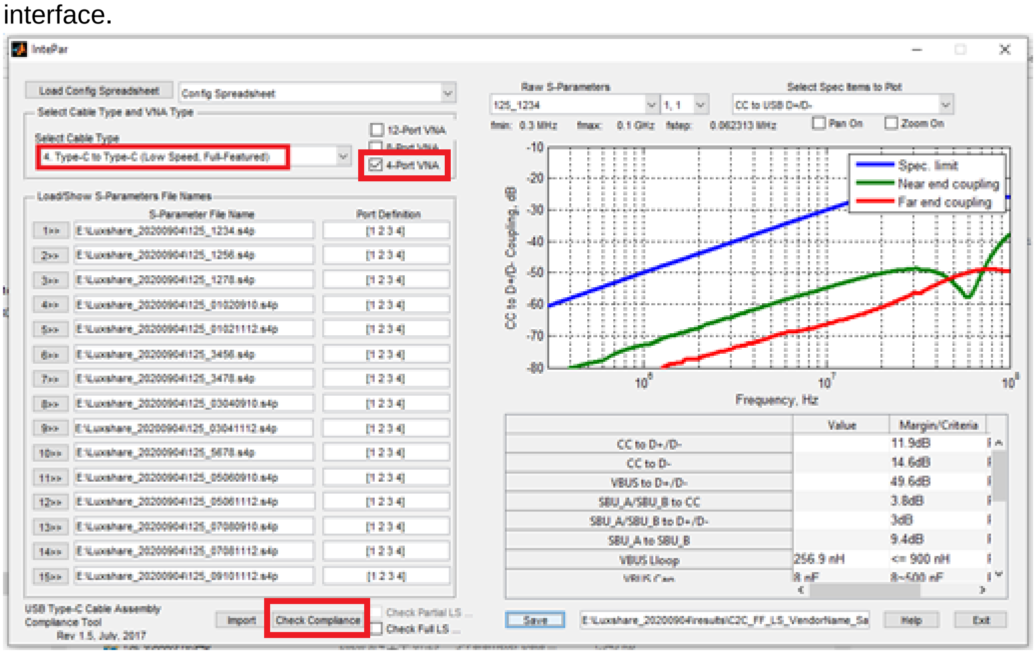
a) After downloading the latest Intepar files, described in 3.3.2 IntePar, extract the content of the .zip file.

b) In the extracted content, run the executable file called ‘Intepar.exe’.

c) In the Select Cable Type dropdown menu, select "4. Type-C to Type-C (Low Speed, Full-Featured)".

d) Select the ‘4-port VNA’ checkbox

e) Run the IntePar tool by clicking the ‘Check Compliance’ button at the bottom of the IntePar user interface.



6. Retrieve the analysis results from the table in the bottom right corner Intepar user interface.

4.2.2 Low speed channel time domain requirements

Time domain measurements are directly performed on the R&S®ZNB20 vector network analyzer. Only for this section the R&S®ZNB-K2 time domain option is required.

In this group following coupling tests will be performed:

► Intra-pair skew

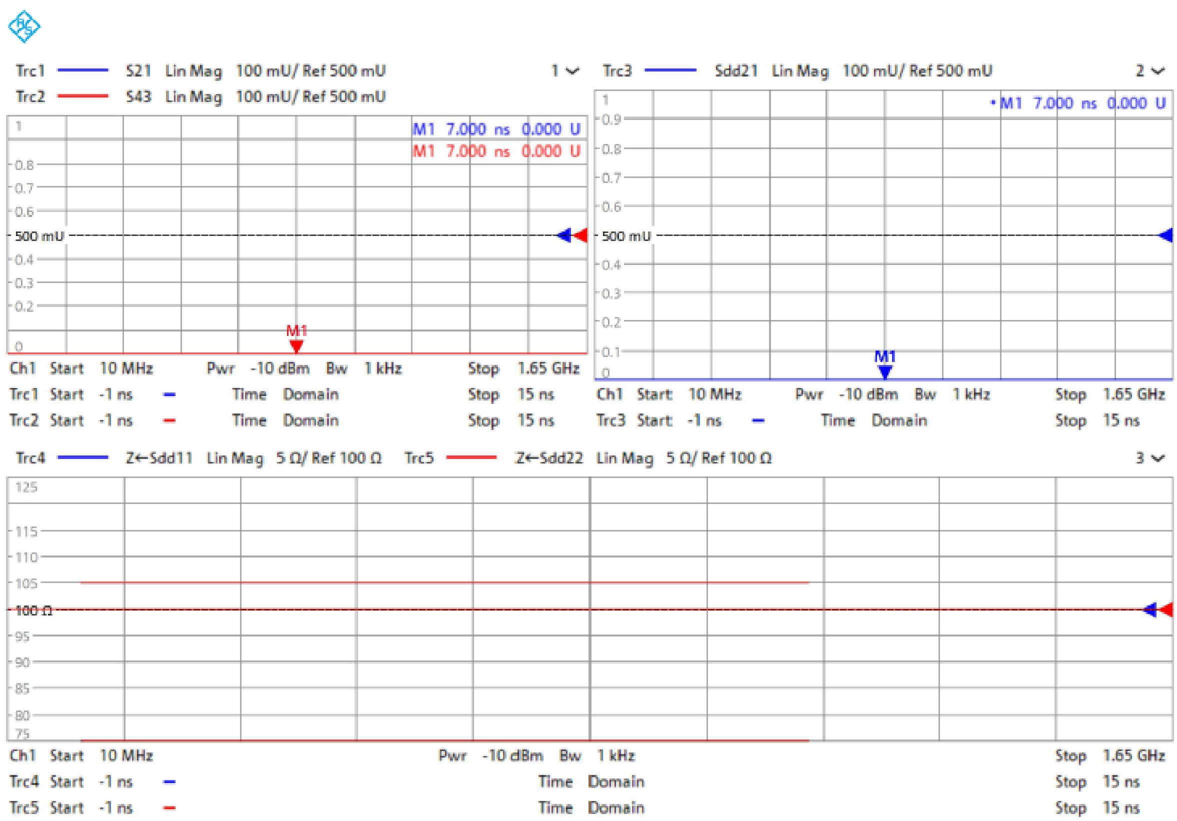
► Propagation delay

► Differential impedance

4.2.2.1 Test Procedure

For this test the Type-C cable is connect to either the low speed or the super speed test fixtures.

1. Recall the Low_Speed_Time_Domain.znx state file, if not already performed.



2. Verify that the calibration and de-embedding data is recalled and enabled.

3. Adjust the ZNB20 rise time as needed, using the procedure described in 3.7 Stimulus rise time adjustment, to target 400 ps.

4. Perform the measurements.

   a) Using the port mapping defined in the below table, connect Port 1, Port 2, Port 3, and Port 4 to the respective test fixture pins.

#	Test Item	Port 1	Port 3	Port 2	Port 4
1	D+/D- Time Domain	D+ (Left TF)	D- (Left TF)	D+ (Right TF)	D- (Right TF)

b) Intra-pair skew can be verified using trace1 (S21) and trace2 (S43) in the top left window.

   The two marker values are used to measure the difference in skew between positive and negative polarities. To pass, the difference must be ≤ 100 ps.

c) Propagation delay can be verified using trace3 (Sdd21) in the top right window.

   The marker value is used to measure the delay. To pass, the difference must be ≤ 20 ps.

d) Differential impedance can be verified using trace4 (Z ← S_{dd}11) and trace5 (Z ← S_{dd}22) in the bottom window.

   The two red lines in the window are representing the limits defined by USB-IF for differential impedance. Both traces shall be within the limit lines of 75 and 105 Ω.

5. Export the Touchstone file.

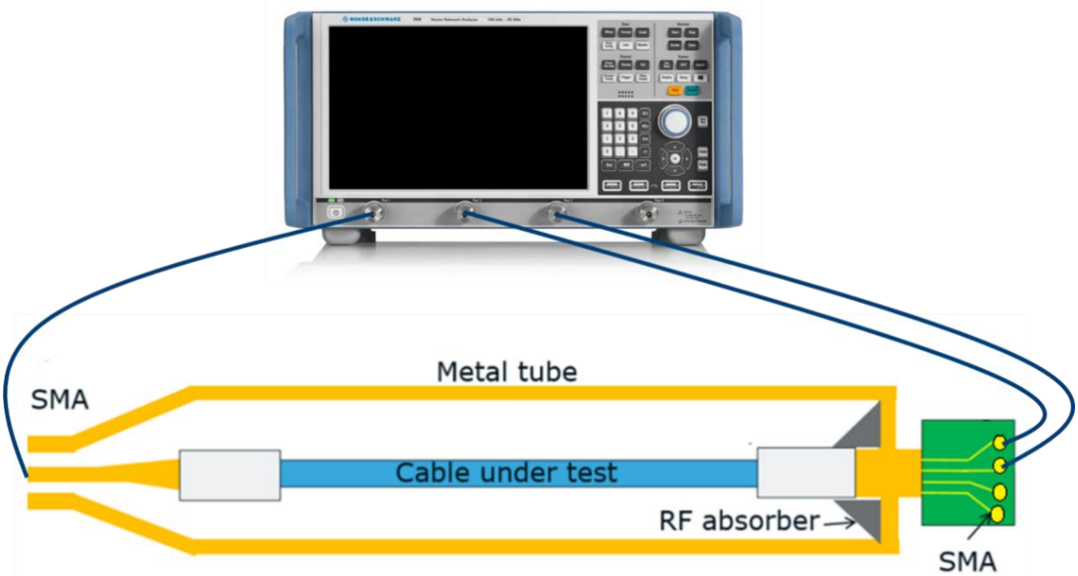
   a) After an acquisition is complete, select “FILE” on the front panel then Select “Trace Data” > “s4p Port 1,2,3,4...”.

4.3 Shielding Effectiveness Test

In the shielding effectiveness test, the RFI and EMI levels from the cable assembly are measured. This test group requires four 4-port Touchstone files (*.s4p) to be measured.

For this measurement a coaxial calibration is mandatory, but de-embedding of the test fixture is not required.

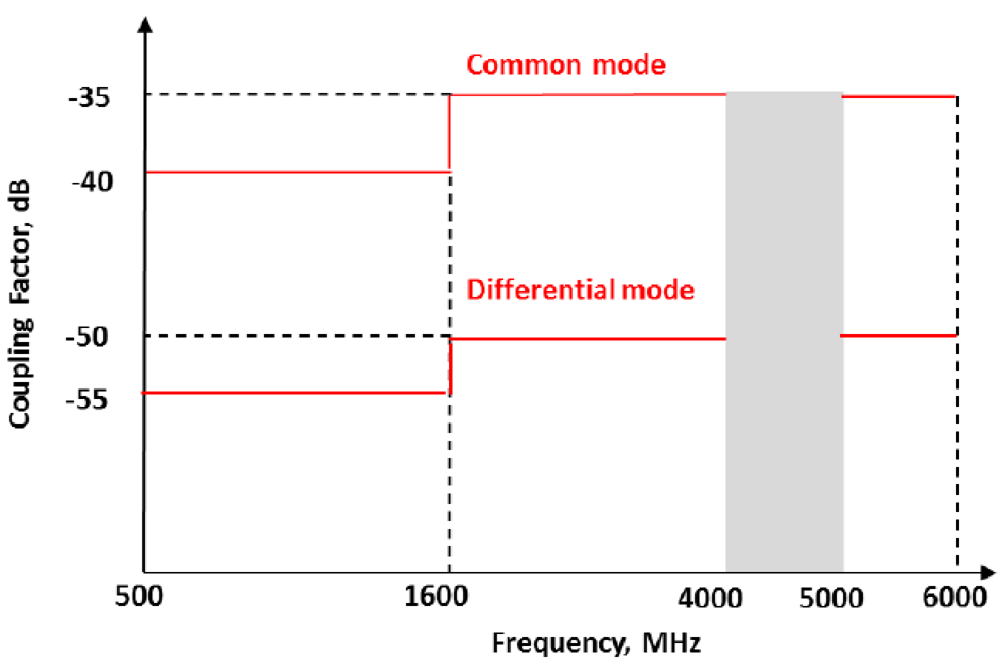
A specialized test fixture is used for the shielding effectiveness test. The test setup is demonstrated on the following figure.



4.3.1 Test Procedure

1. Recall the state file 'RFI_Type-C to Type-C Cable Assembly.znx'.

   This will configure the R&S®ZNB with limit lines respective to the RFI compliance limits for Type-C to Type-C cable assemblies. Below is a description of the RFI limit.



Measurement	Start Frequency (MHz)	Stop Frequency (MHz)	Start Limit (dB)	Stop Limit (dB)
Differential Mode (Sds21)	500	1600	-55.0	-55.0
	1600	4000	-50.0	-50.0
	5000	6000	-50.0	-50.0
Common Mode (Scs21)	500	1600	-40.0	-40.0
	1600	4000	-35.0	-35.0
	5000	6000	-35.0	-35.0

2. Verify that the calibration data is recalled. De-embedding is not required for this test and therefore should be disabled.

3. Perform the measurement and export the Touchstone file.

   a) Using the port mapping defined in the below table, connect Port 1, Port 2, and Port 3 to the respective test fixture pins. Port 4 is unused, and can be left terminated with 50 Ω load.

#	Test Item	Port 1	Port 3	Port 2	Port 4
1a	RFI TX1	Driver Side (Left)	TX1+ (Right TF)	TX1- (Right TF)	Terminated with 50 Ω
1b	RFI RX1	Driver Side (Left)	RX1+ (Right TF)	RX1- (Right TF)	Terminated with 50 Ω
1c	RFI TX2	Driver Side (Left)	TX2+ (Right TF)	TX2- (Right TF)	Terminated with 50 Ω
1d	RFI RX2	Driver Side (Left)	RX2+ (Right TF)	RX2- (Right TF)	Terminated with 50 Ω

   b) After an acquisition is complete, select “FILE” on the front panel then Select “Trace Data” > “s4p Port 1,2,3,4...”.

   c) Use the test # in the above table for the file name of the exported Touchstone file.

4. Repeat step 3.a through 3.c for all 4 measurements.

5 Literature

[1] "Universal Serial Bus Type-C Connectors and Cable Assemblies Compliance Document," Revision 2.1b (June 2021).

[2] Universal Serial Bus Type-C Cable and Connector Specification, Revision 2.1 (May 2021).

[1] "Universal Serial Bus Type-C Connectors and Cable Assemblies Compliance Document," Revision 2.1b (June 2021).

[2] Universal Serial Bus Type-C Cable and Connector Specification, Revision 2.1 (May 2021).

6 Appendix

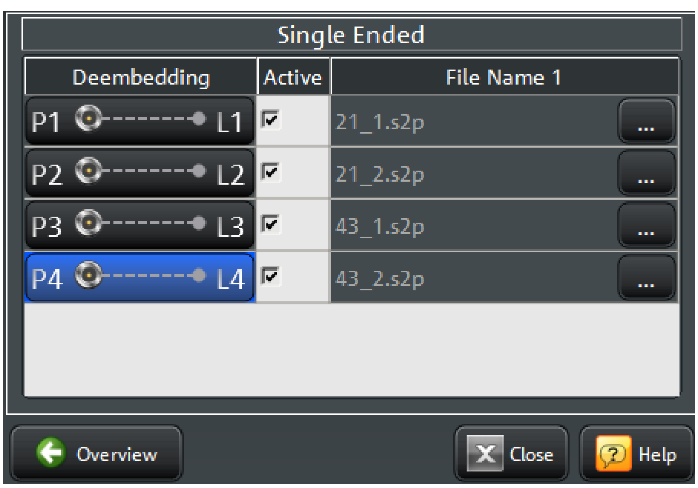
A De-embedding USB test fixtures with older R&S®ZNB firmware versions

The process described in 3.6.2 De-embedding USB test fixtures assumes the R&S®ZNB20 is updated and running firmware version 3.45 or newer. This section describes how to perform de-embedding with firmware versions older than 3.45.

A.1 Using de-embedding files provided by test fixture supplier

The most convenient de-embedding method is to use files provided by the test fixture vendor.

1. On the front panel, select “OFFSET EMBED”.
2. Select “Offset Embed” > “Single Ended”.
3. Import the 2-port Touchstone files (*.s2p) which are delivered together with the test fixtures of Luxshare-ICT (except for RFI test which requires no de-embedding files).



A.2 Measuring and generating de-embedding files

In case the test fixture vendor could not supply the necessary files for de-embedding, or there is a concern regarding accuracy of such files (from fixture aging/use due to cable insertion over time), the user can create new de-embedding files by making measurements in the VNA firmware. This procedure will be using the EAZY De-embedding (EZD) tool which requires the R&S®ZNB-K210 software option. This De-embedding algorithm is based upon the IEEE 370 document.

Performing EZD de-embedding

This section describes how to de-embed *symmetrical test setups*.

1. On the front panel, select “OFFSET EMBED”.
2. Select “Offset Embed” > “Single Ended”.

3. In the single-ended de-embedding dialog, check the “Active” checkboxes for all ports.

   This enables the ability to launch the fixture tools. By default, “Through” is loaded.

   See below for example:

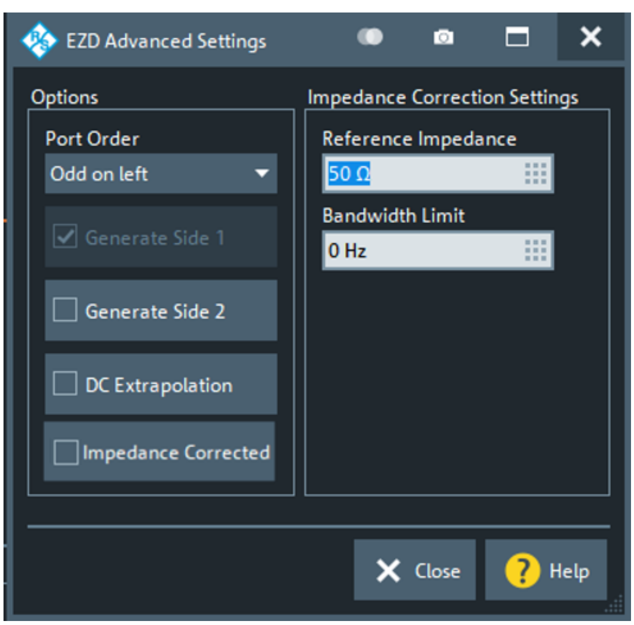
4. Select “Fixture Tool” > “EZD”.
5. Click the “Run Tool…” button.

   The dialog “EZD Single Ended Ports” appears.
6. Select “Advanced Settings…”.

   f) Uncheck the “Impedance Corrected” box.

   g) Uncheck the “Generate Side 2” box.

   h) Select “Close”.



7. Configure the “EZD – Single Ended Ports” settings as follows:

8. Measure the test fixture coupon:

   i) Connect Port 1 and Port 2 of the VNA to each side of the 2x_Thru_Top calibration trace on the left fixture board.

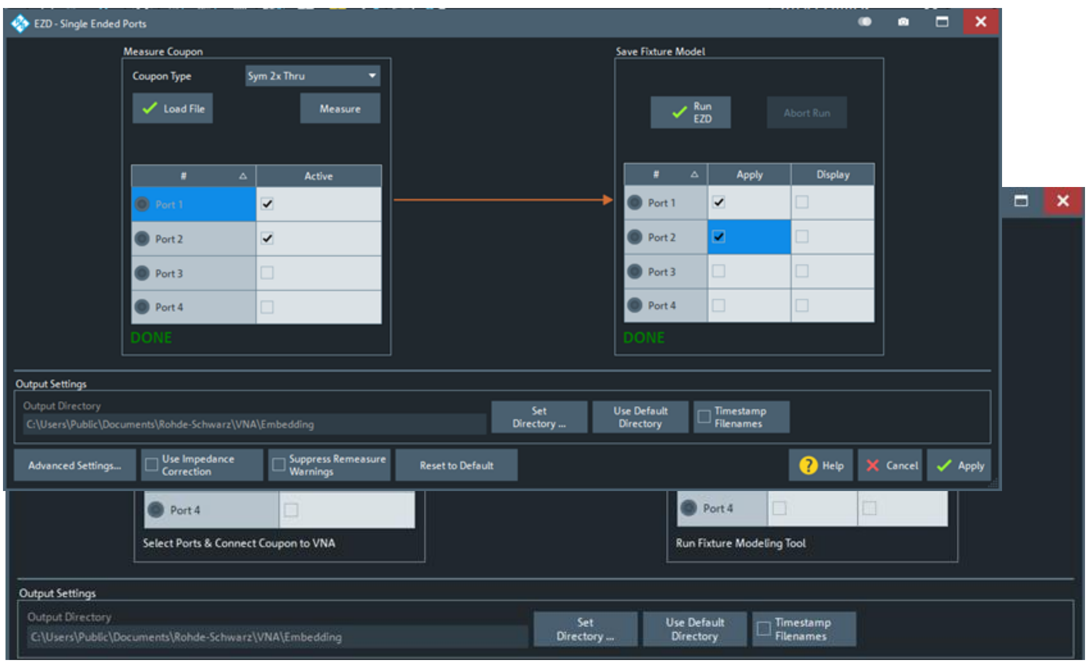
   j) Enable that the checkboxes next to Port 1 and Port 2.

   k) Select “Measure Coupon” > “Measure”.

9. Select “Save Fixture Model” > “Run EZD” to start the EZD process.

   The EZD de-embedding process is completed, and the appropriate de-embedding file can be saved.

10. In the “EZD – Single Ended Ports“ dialog, select “Apply”.



All pop-up dialogs should be closed, and the main firmware interface is present. The test fixture file for the left-side, top-layer fixture has been created.

11. Click the Windows button (⊞) on the tool bar to access the Windows Start menu and open the Windows file browser.

   a) Navigate to the directory “C:\Users\Public\Documents\Rohde-Schwarz\VNA\Embedding\”.

   b) Verify that the file "dut_plus_fixtures.s2p_LEFT_DUT.s2p" exists, and that the timestamp matches the expected time of the de-embedding operation just completed.

   c) Since the EZD de-embedding process will overwrite existing files when performed, rename the file "dut_plus_fixtures.s2p_LEFT_DUT.s2p".

   The preconfigured R&S®ZNB state files are populated with a default file name.

   Rename "dut_plus_fixtures.s2p_LEFT_DUT.s2p" to "USBHS_top_left_fixture.s2p".

   The left-side, top layer fixture has been de-embedded.

12. De-embed *the left-side bottom layer fixture*:

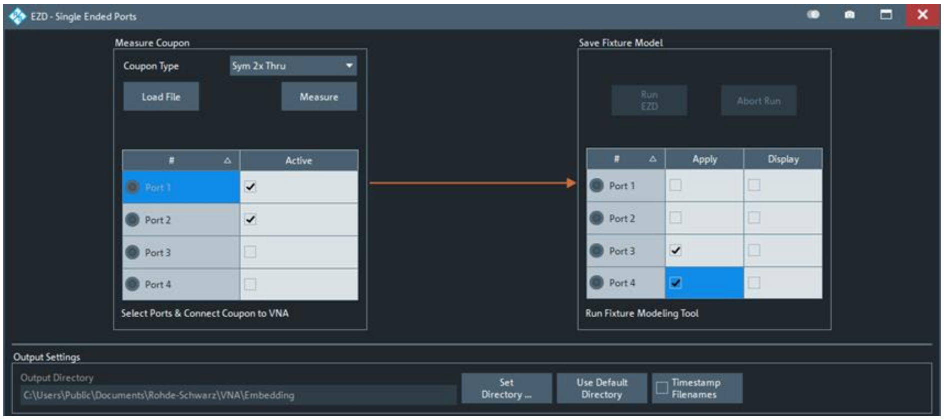
   a) On the front panel, select “OFFSET EMBED”.

   b) Select “Offset Embed” > “Single Ended”.

c) Select “Run Tool…”

The dialog “EZD Single Ended Ports” opens.

d) Configure the “EZD – Single Ended Ports” settings as follows:



13. Measure the test fixture coupon:

a) Connect Port 1 and Port 2 of the VNA to each side of the 2x_Thru_Bottom calibration trace for the left fixture board.

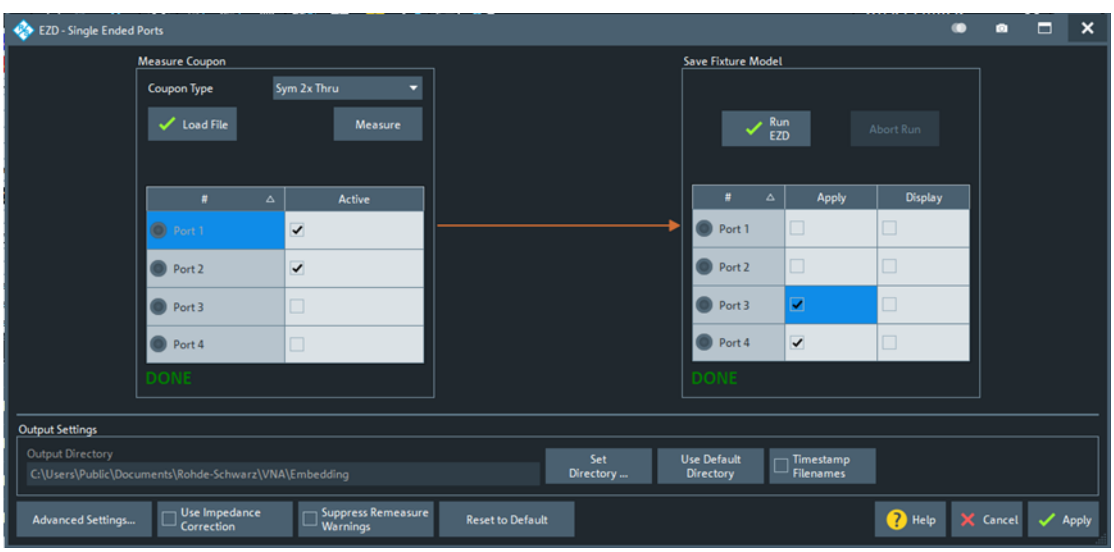
b) Enable the checkboxes next to Port 1 and Port 2.

c) Select “Measure Coupon” > “Measure”.

14. Select “Save Fixture Model" > “Run EZD” to start the EZD process.

The EZD de-embedding process is completed, and the appropriate de-embedding file can be saved.

15. In the “EZD – Single Ended Ports” dialog, select “Apply”.



All pop-up dialogue boxes should be closed, and the main firmware interface is present. The test fixture file for the left-side, bottom-layer fixture has been created.

16. Click the Windows button (⊞) on the tool bar to access the Windows Start menu and open the Windows file browser.

a) Navigate to the directory “C:\Users\Public\Documents\Rohde-Schwarz\VNA\Embedding\”.

b) Verify that the file "dut_plus_fixtures.s2p_LEFT_DUT.s2p" exists, and that the timestamp matches the expected time of the de-embedding operation just completed.

c) Since the EZD de-embedding process will overwrite existing files when performed, rename the file "dut_plus_fixtures.s2p_LEFT_DUT.s2p".

The preconfigured R&S®ZNB state files are populated with a default file name.

Rename "dut_plus_fixtures.s2p_LEFT_DUT.s2p" to "USBHS_bottom_left_fixture.s2p".

The left-side, bottom layer fixture has been de-embedded.

17. De-embed the *right-side top layer fixture*.

d) On the front panel, select “OFFSET EMBED”.

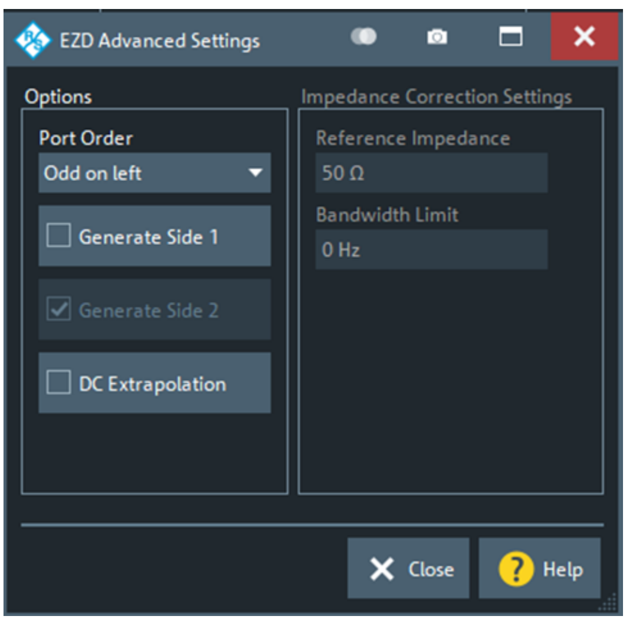
e) Select “Offset Embed” > “Single Ended”.

f) Select “Run Tool…”

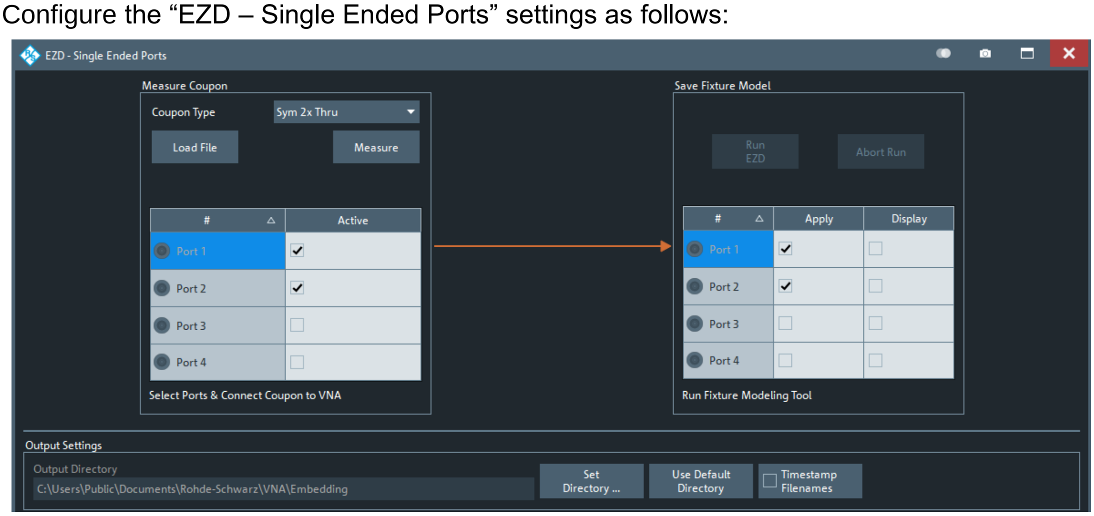
The dialog “EZD Single Ended Ports” opens.

g) Select “Advanced Settings…”.

h) Check the Generate Side 2 box. Uncheck the Generate Side 1 box. Select “Close”.



18. Configure the “EZD – Single Ended Ports” settings as follows:



19. Measure the test fixture coupon:

    a) Connect Port 1 and Port 2 of the VNA to each side of the 2x_Thru_Top calibration trace for the right fixture board.

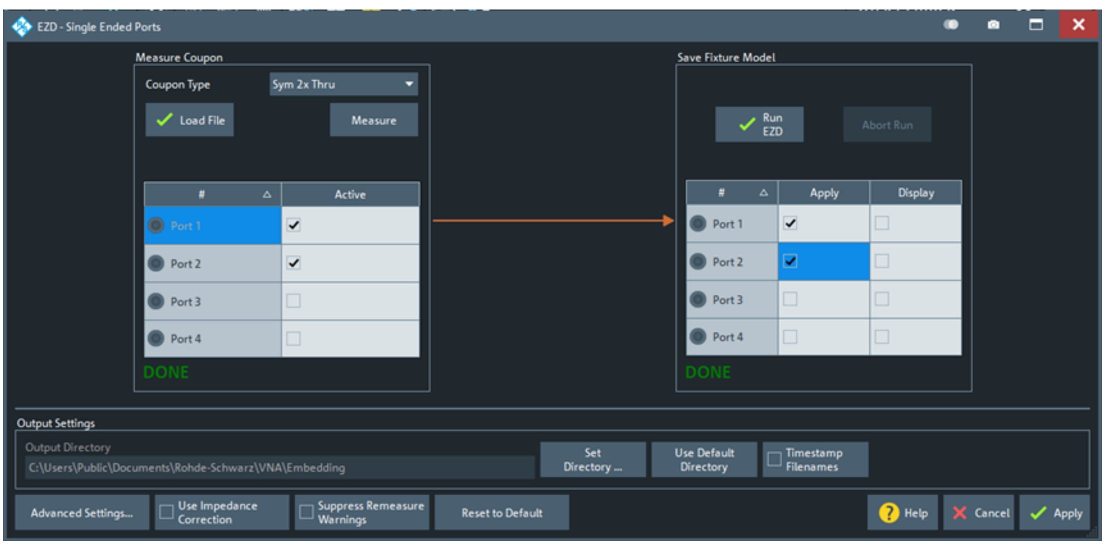
    b) Enable the checkboxes next to Port 1 and Port 2.

    c) Select “Measure Coupon” > “Measure”.

20. In the “Save Fixture Model” dialog, select “Run EZD” to start the EZD process.

    The EZD de-embedding process is completed, and the appropriate de-embedding file can be saved.

21. In the “EZD – Single Ended Ports” dialog, select “Apply”.



All pop-up dialogue boxes should be closed, and the main firmware interface is present. The test fixture file for the left-side, bottom-layer fixture has been created.

22. Click the Windows button () on the tool bar to access the Windows Start menu and open the Windows file browser.

    d) Navigate to the directory “C:\Users\Public\Documents\Rohde-Schwarz\VNA\Embedding\”.

    e) Verify that the file "dut_plus_fixtures.s2p_RIGHT_DUT.s2p" exists, and that the timestamp matches the expected time of the de-embedding operation just completed.

    f) Since the EZD de-embedding process will overwrite existing files when performed, rename the file "dut_plus_fixtures.s2p_RIGHT_DUT.s2p".

       The preconfigured R&S®ZNB state files are populated with a default file name, thus rename "dut_plus_fixtures.s2p_RIGHT_DUT.s2p" to "USBHS_top_right_fixture.s2p".

    The right-side, top layer fixture has been de-embedded.

23. De-embed *the right-side bottom layer fixture*:

    a) On the front panel, select “OFFSET EMBED”.

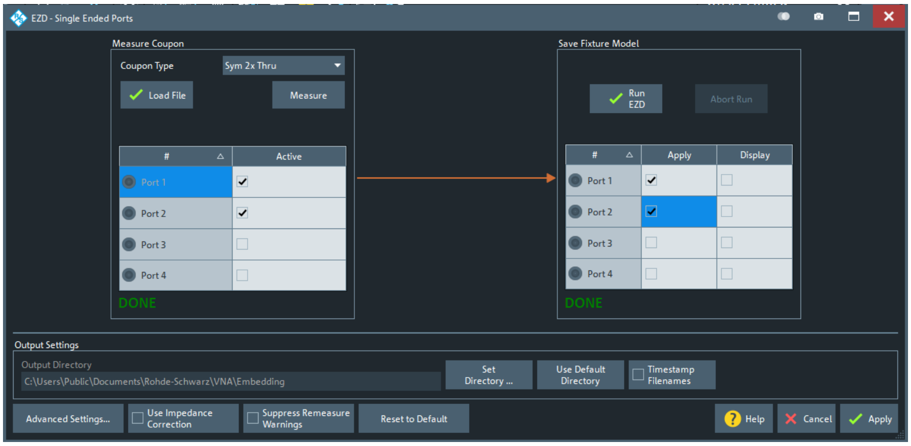
    b) Select “Offset Embed” > “Single Ended”.

    c) Select “Run Tool…”

d) The dialog “EZD Single Ended Ports” opens.

e) Select “Advanced Settings…”.

f) Configure the “EZD – Single Ended Ports” settings as follows:



24. Measure the test fixture coupon:

    a) Connect Port 1 and Port 2 of the VNA to each side of the 2x_Thru_Bottom calibration trace for the right fixture board.

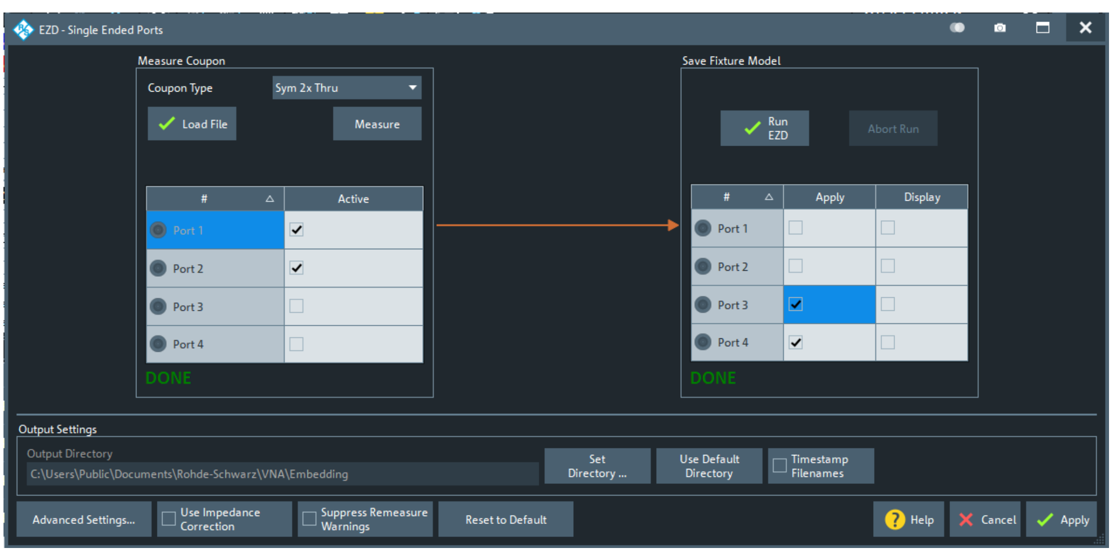
    b) Enable the checkboxes next to Port 1 and Port 2.

    c) Select “Measure Coupon” > “Measure”.

25. In the “Save Fixture Model” dialog, select “Run EZD” to start the EZD process.

    The EZD de-embedding process is completed, and the appropriate de-embedding file can be saved.

26. In the “EZD – Single Ended Ports” dialog, select “Apply”.



All pop-up dialogue boxes should be closed, and the main firmware interface is present. The test fixture file for the left-side, bottom-layer fixture has been created.

27. Click the Windows button ( ) on the tool bar to access the Windows Start menu and open the Windows file browser.

    a) Navigate to the directory “C:\Users\Public\Documents\Rohde-Schwarz\VNA\Embedding\”.

    b) Verify that the file "dut_plus_fixtures.s2p_RIGHT_DUT.s2p" exists, and that the timestamp matches the expected time of the de-embedding operation just completed.

c) Since the EZD de-embedding process will overwrite existing files when performed, rename the file "dut_plus_fixtures.s2p_RIGHT_DUT.s2p".

The preconfigured R&S®ZNB state files are populated with a default file name, thus rename "dut_plus_fixtures.s2p_RIGHT_DUT.s2p" to "USBHS_top_right_fixture.s2p".

The right-side, bottom layer fixture has been de-embedded.

28. Load the 4 fixture files that were created into the single-ended de-embedding dialogs.

29. Configure as follow:

Deembedding	Active	File Name 1	Swap Gates
P1	✓	USBHS_top_left_fixture.s2p •••	
P2	✓	USBHS_bottom_right_fixture.s2p •••	
P3	✓	USBHS_top_left_fixture.s2p •••	
P4	✓	USBHS_bottom_right_fixture.s2p •••	

EZD De-embedding is now completed. You can start the measurements.

Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

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1SL405 | Version 1e | 08.2023
Application Note | Method of Implementation (MOI) for USB Type-C to Type-C Cable Assembly Compliance Tests
Data without tolerance limits is not binding | Subject to change