Application Note

METHOD OF IMPLEMENTATION (MOI) FOR USB3.2 LEGACY CABLE TEST

Products:

► R&S®ZNB

Patrick McKenzie | 1SL408 | Version 0e | 11.2023

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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 legacy cable.

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
Legacy test fixture	Standard-A test fixture: Luxshare-ICT TFU-12R4R Standard-B test fixture: Luxshare-ICT TFU-19R4R Micro-B test fixture: Luxshare-ICT TFU-14R4R Mini-B test fixture: Luxshare-ICT TFU-26R4R	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 legacy passive cables with USB3.1 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.

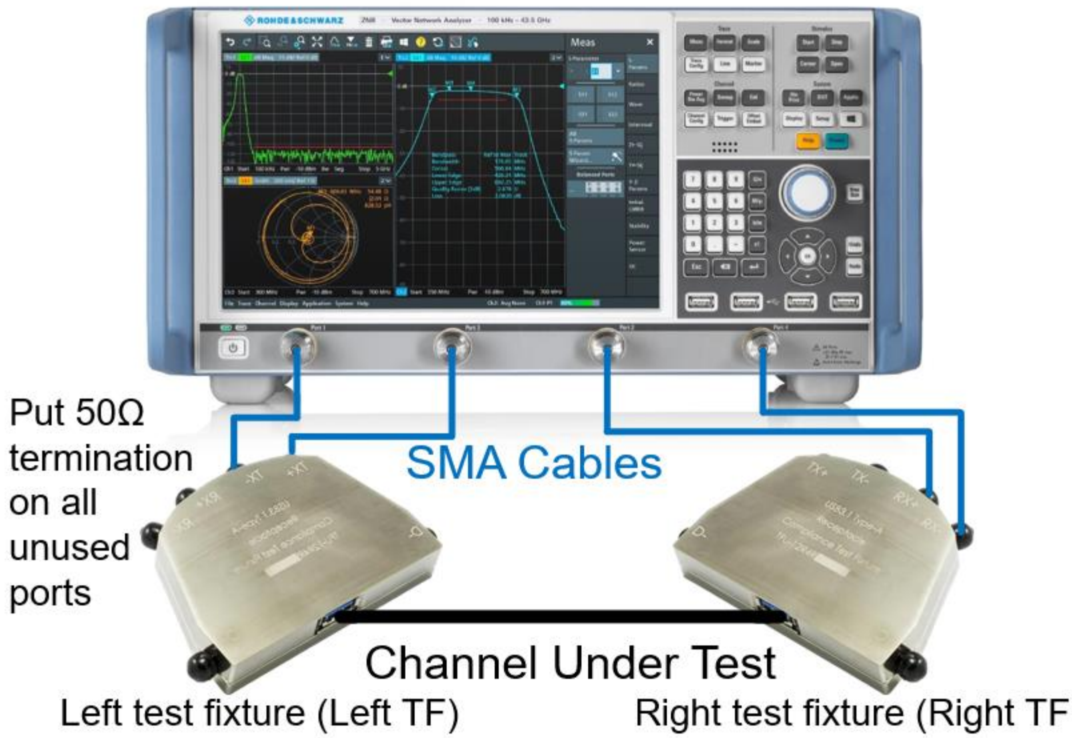
There are two legacy connectors supported by the USB-IF specification. These include USB 3.1 Standard Type-A, USB3.1 Standard Type-B, USB3.1 Micro-B, USB3.1 Micro AB and USB3.1 Micro-A. For simplicity, the diagrams within this document will demonstrate test setups with a Type-A connector, but all test instructions are applicable to all legacy connector types listed above.

Normative compliance requirements are listed below:

– Differential Crosstalk Between D+/D− and SuperSpeed Pairs
– D+/D- Pair Intra-Pair Skew
– D+/D- Pair Propagation Delay
– D+/D- Pair Propagation Delay Skew
– Differential Impedance of SuperSpeed Mated Connectors
– Differential Near-End Crosstalk Between SuperSpeed Pairs
– D+/D- pair attenuation
– Differential Insertion Loss
– Differential-to-Common-Mode Conversion

3.2 Test setup

3.2.1 R&S®ZNB20 test setup



Equipment needed for testing is listed in Fehler! Verweisquelle konnte nicht gefunden werden.. 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).

3.3 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.

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 (*.znxml) for the desired tests.

   In total there are 4 recall files for the different test groups and another one dedicated for the calibration procedure:

   — Common setup file

— D+ D- pair attenuation

— Differential insertion loss

— Differential-to-Common-Mode conversion

— Calibration

Overview about the setting in the different recall files:

Recall file	Start	Stop	Step size	IFBW	Power
Common_setup_file.znxml	10 MHz	20 GHz	10 MHz	1 kHz	-10 dBm
Differential_insertion_loss.znxml	100 MHz	7.5 GHz	10 MHz	1 kHz	-10 dBm
D+_D-_pair_attenuation.znxml	12 MHz	400 MHz	10 MHz	1 kHz	-10 dBm
Differential_to_Common-Mode_conversion.znxml	100 MHz	10 GHz	10 MHz	1 kHz	-10 dBm
Calibration.znxml	300 kHz	20 GHz	10 MHz	1 kHz	-10 dBm

3.4 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 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 as In-Situ De-embedding (ISD), are also supported by R&S®ZNB20.

The three different test groups use different frequency ranges. The calibration recall file includes all the required frequency ranges in one setup. This allows the user to do the calibration at once.

3.4.1 Coaxial calibration

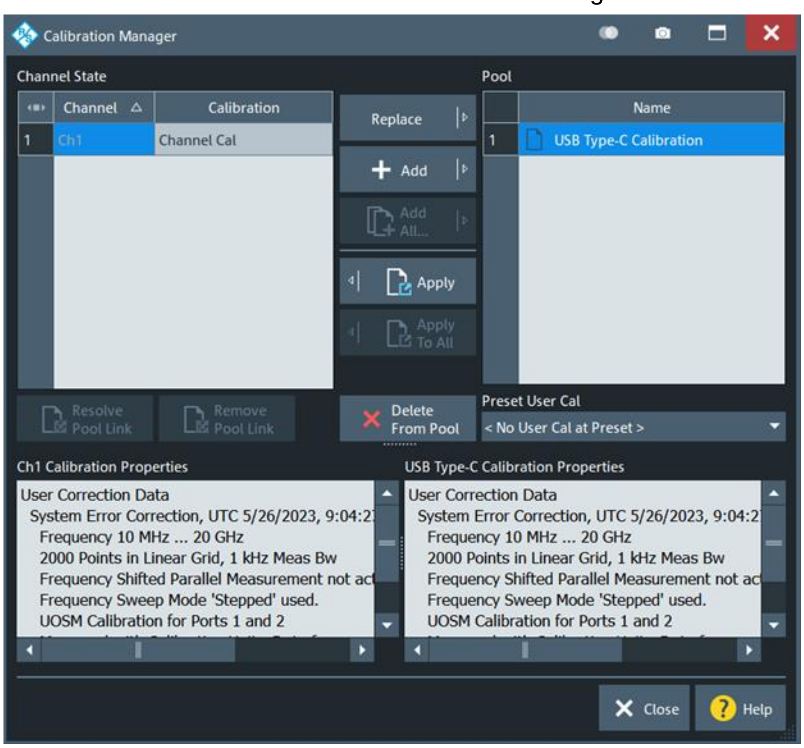
3.4.1.1 Calibration with automated calibration unit

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.



3.4.1.2 Manual calibration with calibration kit

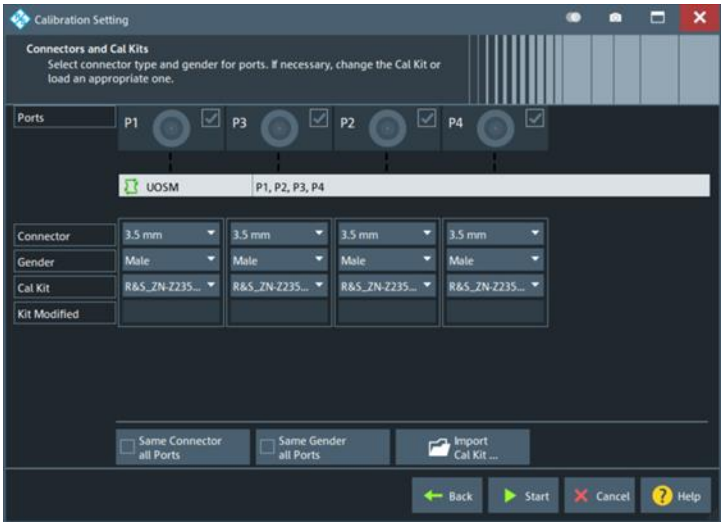
Alternatively, if an automated calibration unit is not available, then a manual calibration kit can be used instead.

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

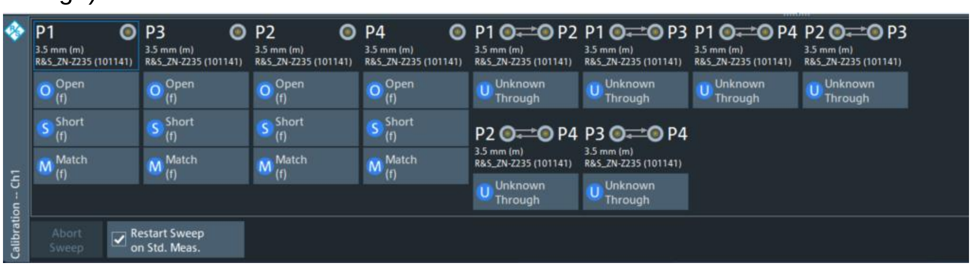
3. Select Calibration Type "UOSM" for best accuracy.

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 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.

Recalling coaxial calibration

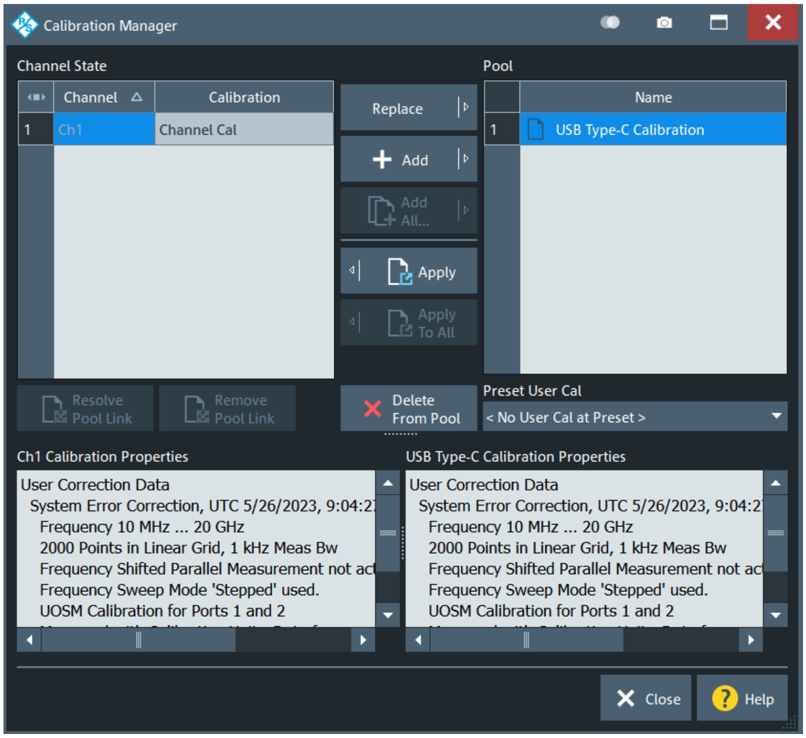
After calibrating to the end of the RF cables and storing the calibration data, select the measurement group preset where measurements should be performed. Then recall the calibration in the selected measurement group:

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.



3.4.2 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.

3.4.2.1 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)

3.4.2.2 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.

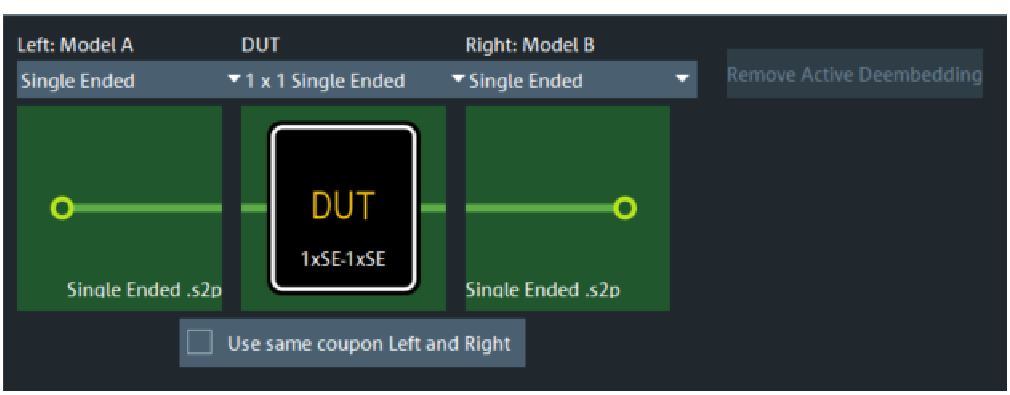
Performing EZD De-embedding

This section describes how to de-embed the test fixtures from the setup. Since this is for Type-C to legacy adapter testing, Test fixture L and test fixture R will not be identical. The following procedure describes how to perform de-embedding of an asymmetrical test setup. For simplicity, test fixture L is assumed to be populated with the Type-C receptacle connector, and test fixture R is assumed to be populated with the legacy plug connector (USB 3.1 Type-A or USB 2.0 Micro-B).

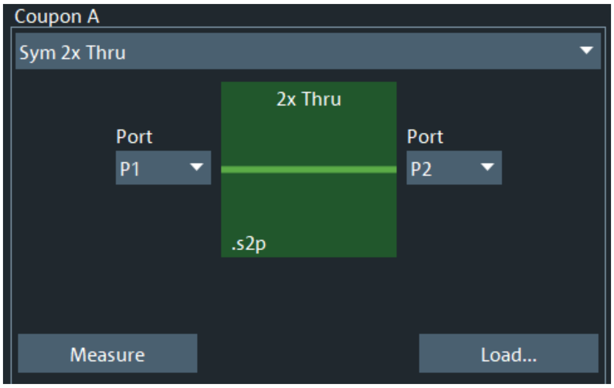
EZD de-embedding requires the test fixtures to include a "2x Thru" trace, referred to as a “Coupon”. When distinguishing between the coupons on the left and right test fixtures, the R&S®ZNB deembed assistant refers to the coupons as "Coupon A" and "Coupon B"; where coupon A is measured from test fixture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

If the test fixtures are reversed (ie test fixture R is populated with the Type-C connector), this procedure is also appropriate.

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 Sigle 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.

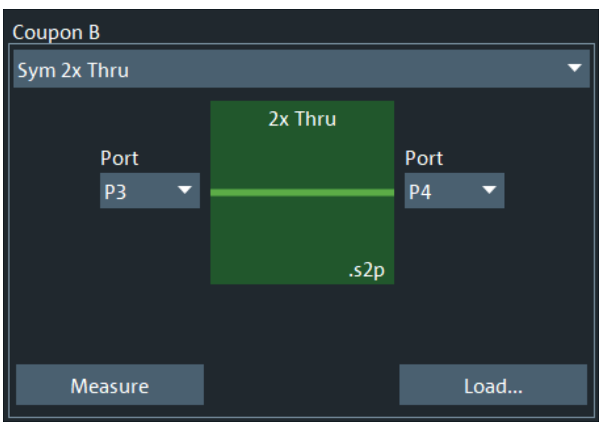


b) Connect Port 1 and Port 2 of the VNA to each side of the 2x_Thru_Top calibration trace on the left fixture board.

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 “De-embedding 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.

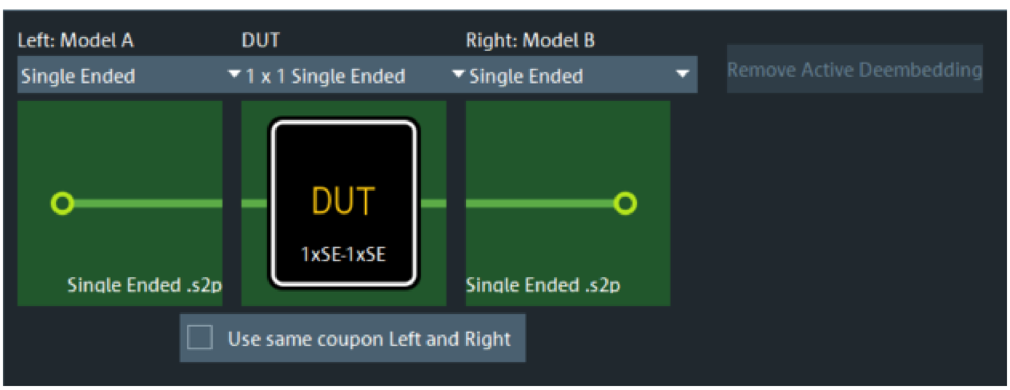
12. Use the following configuration:

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

    e) “Left: Model A = Single Ended”

    f) “Right: Model B = Single Ended”

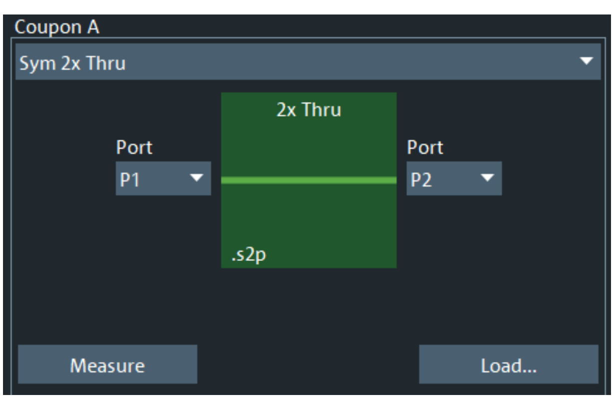
    g) “DUT = 1x1 Sigle Ended”



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.

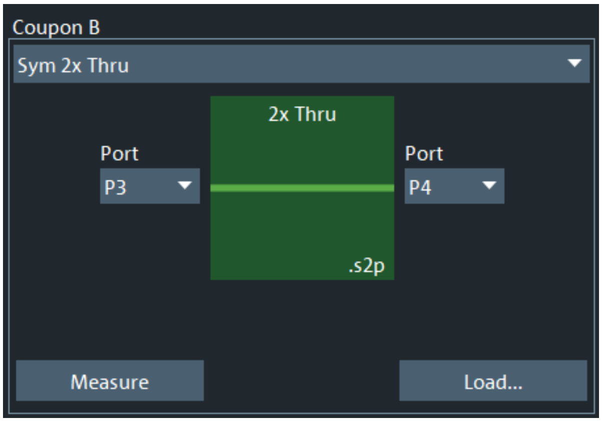


    b) Connect Port 1 and Port 2 of the VNA to each side of the 2x_Thru_Bottom calibration trace on the left fixture board.

    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.

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

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

   f) 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.

   g) 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.

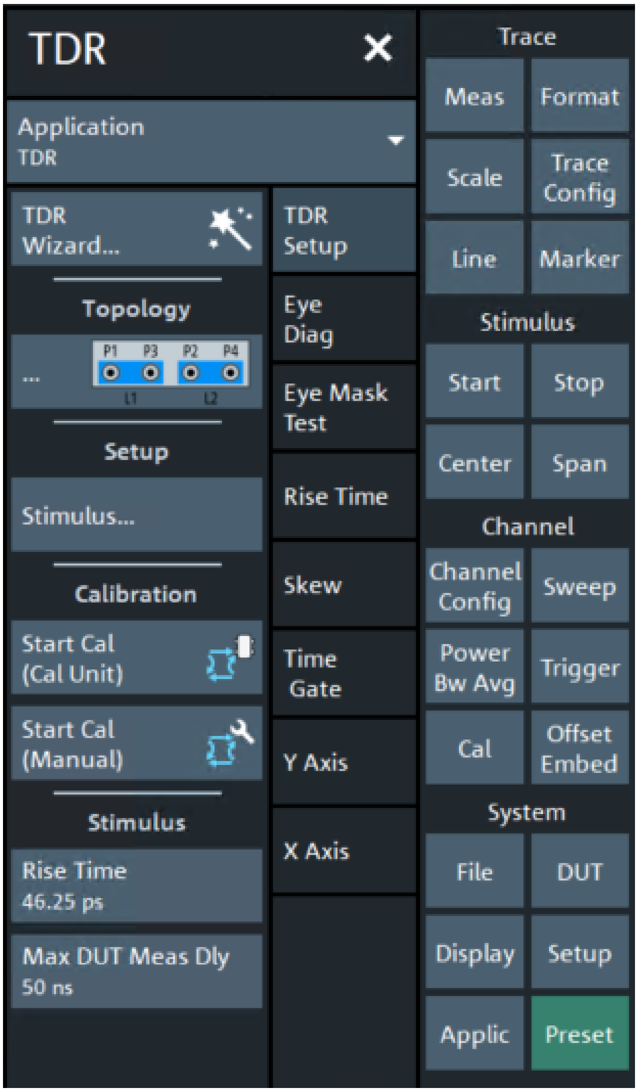
3.5 Stimulus risetime adjustment

This section demonstrates how the stimulus risetime 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 risetimes 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 risetime.

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

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. Tests are broken into Time Domain and Frequency Domain measurements.

Tests covered in this section:

Differential Crosstalk Between D+/D− and SuperSpeed Pairs

D+/D- Pair Intra-Pair Skew

D+/D- Pair Propagation Delay

D+/D- Pair Propagation Delay Skew

Differential Impedance of SuperSpeed Mated Connectors

Test Case	Rise Time %	Target Rise Time	Pass Criteria
Differential Crosstalk Between D+/D− and SuperSpeed Pairs	10 – 90 %	500 ps	Standard-A connector: 0.9% Standard-B connector: 1.8% Micro connector family: 1.2%
D+/D- Pair Intra-Pair Skew	10 – 90 %	200 ps	Crossing at 50% of input voltage
D+/D- Pair Propagation Delay	10 – 90 %	200 ps	Standard connector: 16 ns maximum Micro connector family: 10 ns maximum
D+/D- Pair Propagation Delay Skew	10 – 90 %	200 ps	100 ps maximum
Differential Impedance of SuperSpeed Mated Connectors	20 – 80 %	50 ps	Minimum: 75Ω Maximum: 105Ω
Differential Near-End Crosstalk Between SuperSpeed Pairs	20 – 80 %	50 ps	Standard-A connector: 0.9% Standard-B connector: 1.8% Micro connector family: 1.2%

4.1.1 Differential Crosstalk Between D+/D− and SuperSpeed Pairs

1. Recall Common_setup_file.znxml setup file
2. Make sure the calibration data is recalled and used. This is indicated by “Cal” in the trace information.
3. Connect ports 1 to 4 to the test fixture according to the table below:

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	D+ (Left TF)	D- (Left TF)	Tx+ (Right TF)	Tx- (Right TF)

4. Make measurement on $S_{dd}21$
5. Analyze results, pass criteria is in table below:

Connector Type	Allowable near-end crosstalk
Standard A	0.9% of Peak-to-Peak
Standard B	1.8% of Peak-to-Peak

Connector Type	Allowable near-end crosstalk
Micro connector family	1.2% of Peak-to-Peak

6. Repeat steps 4 and 5 for the following connections:

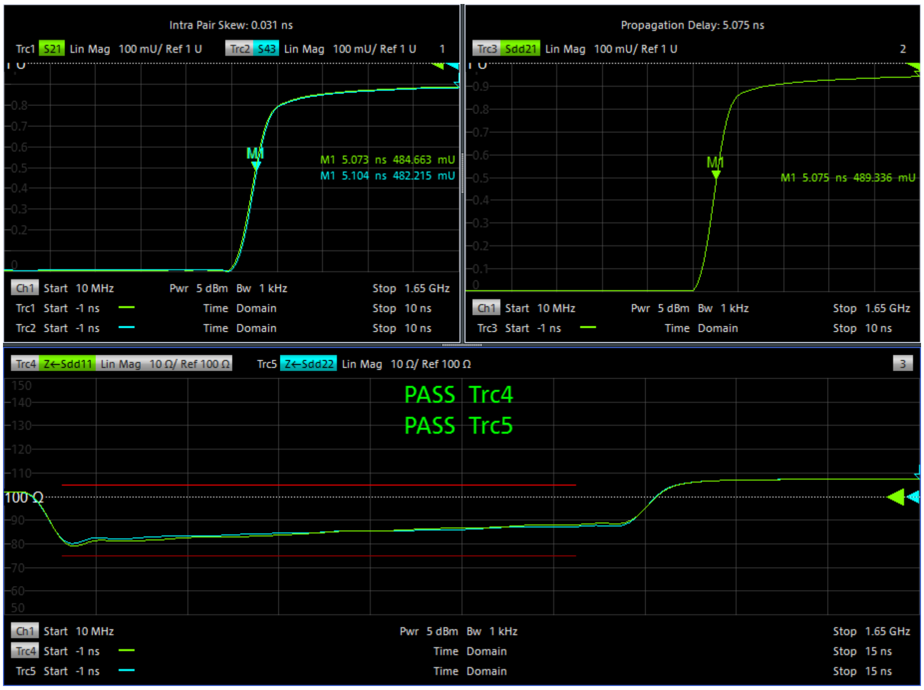
VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	D+ (Left TF)	D- (Left TF)	Tx+ (Right TF)	Tx- (Right TF)
	D+ (Left TF)	D- (Left TF)	Rx+ (Left TF)	Tx- (Left TF)
	D+ (Left TF)	D- (Left TF)	Rx+ (Right TF)	Rx- (Right TF)
	D+ (Right TF)	D- (Right TF)	Tx+ (Right TF)	Tx- (Right TF)
	D+ (Right TF)	D- (Right TF)	Rx+ (Right TF)	Rx- (Right TF)
	D+ (Right TF)	D- (Right TF)	Tx+ (Left TF)	Tx- (Left TF)
	D+ (Right TF)	D- (Right TF)	Rx+ (Left TF)	Rx- (Left TF)

4.1.2 D+/D- Pair Intra-Pair Skew

1. Recall Common_setup_file.znxml setup file
2. Make sure the calibration data is recalled and used. This is indicated by “Cal” in the trace information.
3. Connect ports 1 to 4 to the test fixture according to the table below:

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	D+ (Left TF)	D- (Left TF)	D+ (Right TF)	D- (Right TF)

4. Make measurement on trace S21 and S43
5. Analyze results, the difference in time between the two marker values is the measured intra-pair skew. The value shall be not more than 100 ps.



4.1.3 D+/D- Pair Propagation Delay

1. Recall Common_setup_file.znxml setup file
2. Make sure the calibration data is recalled and used. This is indicated by “Cal” in the trace information.
3. Connect ports 1 to 4 to the test fixture according to the table below:

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	D+ (Left TF)	D- (Left TF)	D+ (Right TF)	D- (Right TF)

4. Make measurement on trace $S_{dd}21$
5. Analyze results, pass if measurement is below 16 ns for Standard connector and 10 ns for Micro connector family

4.1.4 D+/D- Pair Propagation Delay Skew

1. Recall Common_setup_file.znxml setup file
2. Make sure the calibration data is recalled and used. This is indicated by “Cal” in the trace information.
3. Connect ports 1 to 4 to the test fixture according to the table below:

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	D+ (Left TF)	D- (Left TF)	D+ (Right TF)	D- (Right TF)

4. Make measurement on trace S21 and S43

5. Analyze results, the difference in time between the two marker values is the measured intra-pair skew. The value shall be not more than 100 ps.

4.1.5 Differential Impedance of SuperSpeed Mated Connectors

1. Recall Common_setup_file.znxml setup file
2. Make sure the calibration data is recalled and used. This is indicated by “Cal” in the trace information.
3. Connect ports 1 to 4 to the test fixture according to the table below:

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	Tx+ (Left TF)	Tx- (Left TF)	Tx+ (Right TF)	Tx- (Right TF)

4. Make measurements on trace $S_{dd}11$ and $S_{dd}22$
5. Analyze results, pass if the resulting impedance is between 75Ω and 105Ω for the duration of measurement using 50 ps (20% to 80%) rise time
6. Repeat steps 4 and 5

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	Rx+ (Left TF)	Rx- (Left TF)	Rx+ (Right TF)	Rx- (Right TF)

Tests covered in this section:

Differential Near-End Crosstalk Between SuperSpeed Pairs

D+/D- pair attenuation

Differential Insertion Loss

Differential-to-Common-Mode Conversion

4.2.1 Differential Near-End Crosstalk Between SuperSpeed Pairs

1. Recall Common_setup_file.znxml setup file
2. Make sure the calibration data is recalled and used. This is indicated by “Cal” in the trace information.
3. Connect ports 1 to 4 to the test fixture according to the table below:

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	D+ (Left TF)	Tx+ (Left TF)	D- (Left TF)	Tx- (Left TF)

4. Make measurement on trace $S_{dd}21$
5. Analyze results, pass if the results for your given connector below are within the limit shown

Connector Type	Allowable near-end crosstalk
Standard A	0.9% of Peak-to-Peak
Standard B	1.8% of Peak-to-Peak
Micro connector family	1.2% of Peak-to-Peak

6. Repeat steps 4 and 5 with new test fixture connections shown in table below:

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	D+ (Left TF)	Rx+ (Left TF)	D- (Left TF)	Rx- (Left TF)
	D+ (Left TF)	Tx+ (Right TF)	D- (Left TF)	Tx- (Right TF)
	D+ (Left TF)	Rx+ (Right TF)	D- (Left TF)	Rx- (Right TF)

4.2.2 D+/D- pair attenuation

1. Recall D+_D-_pair_attenuation.znxml setup file
2. Make sure the calibration data is recalled and used. This is indicated by “Cal” in the trace information.
3. Connect ports 1 to 4 to the test fixture according to the table below:

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	D+ (Left TF)	D- (Right TF)	D+ (Right TF)	D- (Left TF)

4. Make measurement on $S_{dd}21$
5. Analyze results, pass if the resulting trace is within limit line

All connector test points	
Frequency	Max
12 MHz	-0.67 dB
24 MHz	-0.95 dB
48 MHz	-1.35 dB
96 MHz	-1.90 dB
200 MHz	-3.20 dB
400 MHz	-5.80 dB

4.2.3 Differential Insertion Loss

1. Recall Differential_insertion_loss.znxm setup file

2. Make sure the calibration data is recalled and used. This is indicated by “Cal” in the trace information.
3. Connect ports 1 to 4 to the test fixture according to the table below:

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	Tx1+ (Left TF)	Tx+ (Right TF)	Tx- (Left TF)	Tx- (Right TF)

4. Make measurement on $S_{dd}21$
5. Analyze results, pass if the resulting trace is within limit line

Standard B	
Frequency	Limit
100 MHz	-1.50 dB
1.25 GHz	-5.0 dB
2.5 GHz	-7.5 dB
7.5 GHz	-25 dB

Micro connector Family	
Frequency	Limit
100 MHz	-0.6 dB
1.25 GHz	-2.33 dB
2.5 GHz	-3.5 dB
7.5 GHz	-11.67 dB

4.2.4 Differential-to-Common-Mode Conversion

1. Recall Differential_to_Common-Mode_conversion.znxml setup file
2. Make sure the calibration data is recalled and used. This is indicated by “Cal” in the trace information.
3. Connect ports 1 through 4 to the test fixture according to the table below:

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	Tx+ (Left TF)	Rx+ (Right TF)	Tx- (Left TF)	Rx- (Right TF)

4. Make measurement on $S_{cd}21$

Start Frequency	Stop Frequency	Start Limit	End Limit
100 MHz	10 GHz	-20 dB	-20 dB

5. Analyze results, pass if the resulting trace is within the limit line of -20 dB from 100 MHz to 10 GHz
6. Repeat steps 4 and 5 for the following connection

VNA Port	Port 1	Port 3	Port 2	Port 4
Test Fixture	Rx+ (Left TF)	Tx+ (Right TF)	RX- (Left TF)	Tx- (Right TF)

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Application Note | Method of Implementation (MOI) for USB3.2 legacy cable test
Data without tolerance limits is not binding | Subject to change