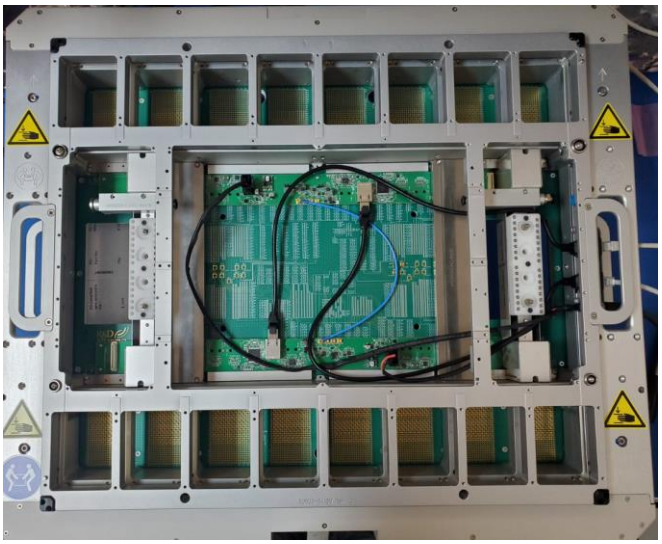
multiLane

AT93000 BERT Calibration User Manual

BERT Calibration Guide

AT93000 BERT Calibration Guide-rev1.0
June 2021



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Notices

General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of the system. Read the General Safety Summary in other system manuals for warnings and cautions related to operating the system.

To Avoid Fire or Personal Injury

Use Proper Power Cord. Only use the power cord specified for this product and certified for the country of use.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do not apply a potential to any terminal, including the common terminal that exceeds the maximum rating of that terminal.

Do Not Operate Without Covers.

Do not operate this product with covers or panels removed.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Do Not Operate with Suspected Failures.

If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Operate in Wet/Damp Conditions. Do Not Operate in an Explosive Atmosphere. Keep Product Surfaces Clean and Dry

Caution statements identify conditions or practices that could result in damage to this product or other property.

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Scope of this Manual

This manual describes how to calibrate the following signal paths from:

- Multilane BERT transmit (Tx) to DUT Receive (Rx) using the BERT Calibration GUI.
- DUT Tx to Multilane DSO Rx using the DSO GUI.

Both GUIs are available on the MultiLane public website. The remainder of this Manual discusses BERT calibration. Note that while DSO factory calibration is recommended annually, there is no DSO field calibration. See “Appendix III: BERT and DSO Calibration Use Cases” on page 16 for more about DSO calibration Use cases.

Multilane ATE instruments reside in a twinning frame that is hard docked to an Advantest 93000. A picture of the twinning frame with two Multilane instrument cassettes is shown in Figure 1. A depiction of signals paths requiring calibration to/from the Multilane instruments is shown in Figure 2.

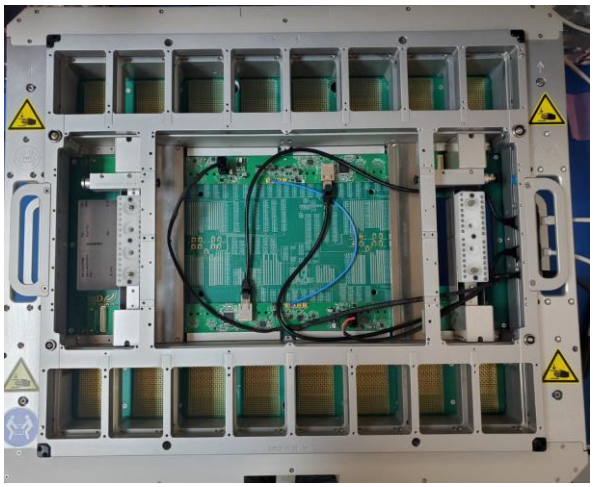

Figure 1: AT93000 internal view

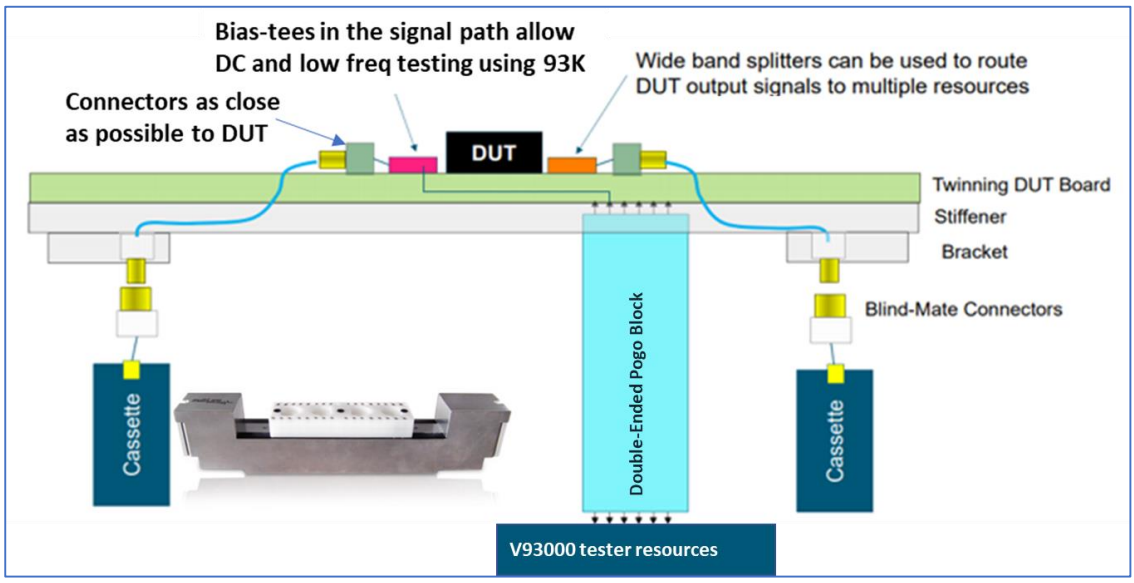

Figure 2: Signal path to/from Multilane Instrument Cassettes

The Multilane BERTs in the following table can be calibrated using this GUI. The same table shows the Multilane DSO scopes that can be used as the measurement vehicle for the calibration. We recommend you contact MultiLane technical support before cabling from the twinning frame to a benchtop scope.

Supported Instrument	Instrument Type	Firmware Revision[++]	FPGA Revision[++]
AT4039E	ATE BERT	1.9 or higher	-
AT4039D	ATE BERT	1.1 or higher	-
AT4079B	ATE BERT	1.0 or higher	-
AT4025 rev A	ATE DSO	1.7 or higher	0.7 or higher
AT4025 rev B	ATE DSO	1.0 or higher	0.7 or higher
ML4025-ATE	BENCH TOP DSO	0.2 or higher	0.1 or higher
ML4035	BENCH TOP BERT&DSO	2.2 or higher	0.5 or higher

[++] To read the instrument's firmware revision and FPGA revision, refer to the Diagnostic GUI for assistance

Purpose of this User Manual

This Calibration Guide explains how to compensate for high-frequency signal losses in the path from a Multilane ATE BERT to the device under test (DUT). These corrections are then "embedded" into the BERT Tx signal to compensate for the signal loss. This Calibration Guide also explains how to correct for high-frequency signal losses in the path from the DUT to the Multilane ATE DSO scope. In this case, the signal losses will be de-embedded by the Multilane DSO scope using the DSO GUI filters, as shown in Figure 3.

Note: Refer to your DSO's GUI User Manual on MultiLane website to know more about the Scope Filters.

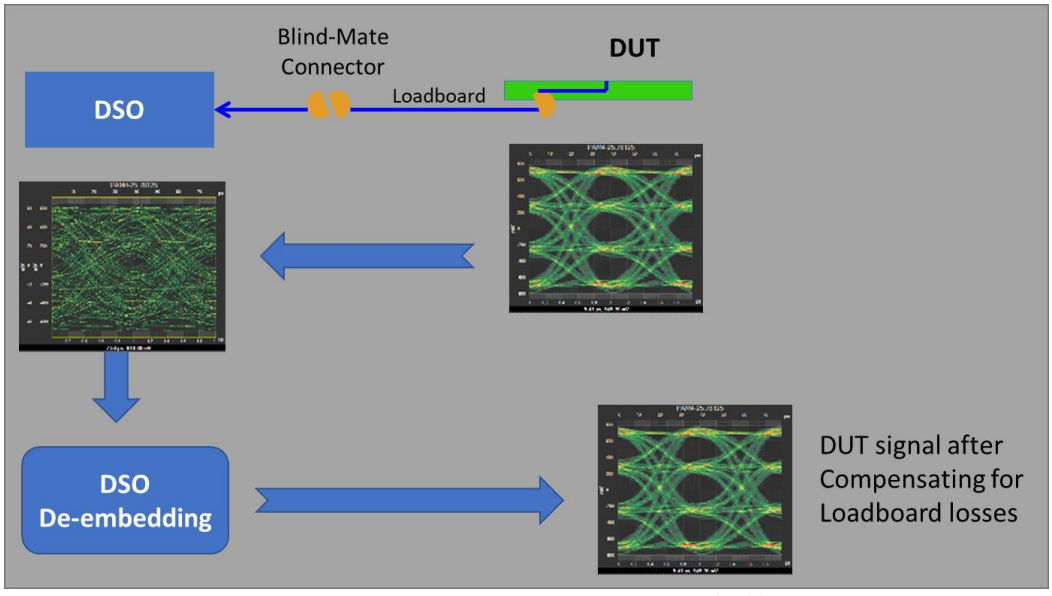

Figure 3: AT93000 DSO De-embedding

Factory Calibration vs User Calibration

Factory calibration calibrates the BERT and DSO instruments to the cassette blindmate connector. The factory calibration values are stored in the instrument's nonvolatile memory, so the factory calibration parameters follow the instrument.

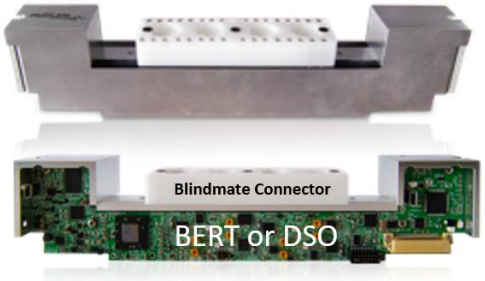

Figure 4: AT93000 Cassette with exposed instrument

The User Calibration described in this manual stores its calibration results in a file that can be loaded when the Smartest program is run. This allows the test engineer to calibrate the different possible combinations of Multilane instrument twinning frames along with the multiple loadboards that might be found in a production environment.

For example, for DUT XYZ, the following might be the case at a production testing facility. Testing parts with the same test program operating on two different V93K's with two identical twinning frame setups and two identical loadboards. The V93K's, twinning frames and loadboards are interchangeable. On a given day, you can have any combined assembly to test DUT XYZ. A separate calibration file can be created for each combination of twinning frame and loadboard. The test program can load the appropriate calibration file at runtime.

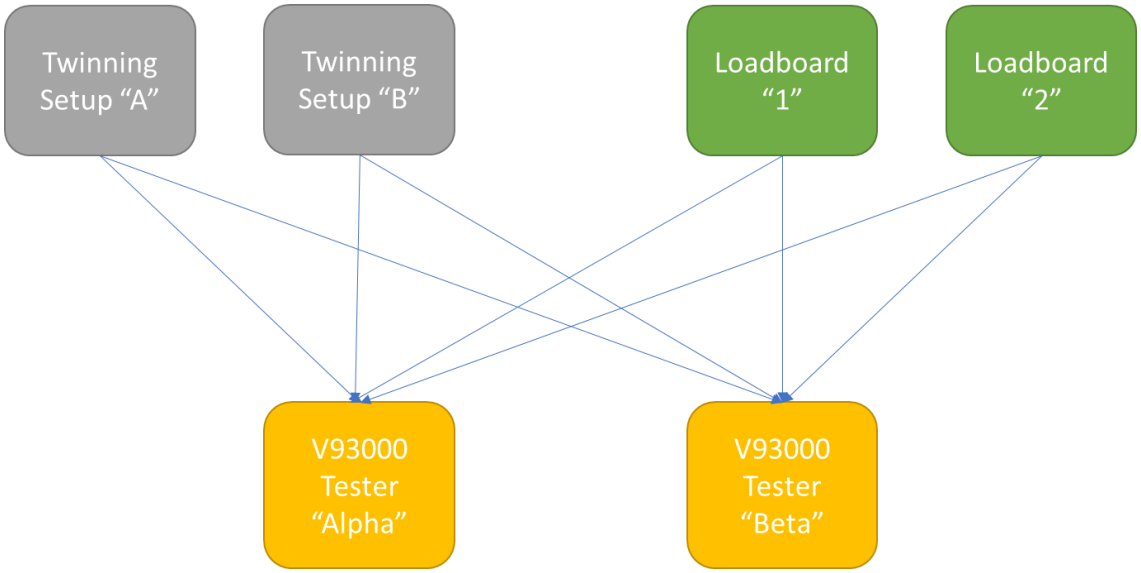

Figure 5: Production Test Floor Example

Assembly combinations			
V93K #	Twinning Setup #	Loadboard #	Calibration File #
Alpha	A	1	XYZ_A1
		2	XYZ_A2
	B	1	XYZ_B1
		2	XYZ_B2
Beta	A	1	XYZ_A1
		2	XYZ_A2
	B	1	XYZ_B1
		2	XYZ_B2

NOTE:

- Your loadboard should have a method by which you can readback whether it is loadboard #1 or loadboard #2
- The twinning setup # can be deduced by reading the IP addresses of the installed Multilane instruments

Quick checks before running calibration

Instrument Ping Check

Start by trying to ping an instrument using its IP address to make sure that the instrument is turned ON and a proper Ethernet connection is available.

Twinning Frame Docking Check

- See Advantest manuals for proper docking procedures.
- Is AT93000 Twinning Frame properly docked to the Advantest V93000?
- Is DUT Loadboard properly docked to the AT93000 twinning frame? This can be done manually or using the Advantest docking remote control.

Backplane Jumper and Sync Cable Checks

For BERTs and DSOs to be properly synchronized, make sure that the backplane jumpers and clock sync cables between backplanes 1 and 2 are properly installed for your application. Each application may require different jumper settings and a different cable installation. Consult the application's documentation and the AT93000 System User Guide for correct settings.

When the GUI is opened, the following window will appear, containing a “Setup” tab and a “Calibration” tab.

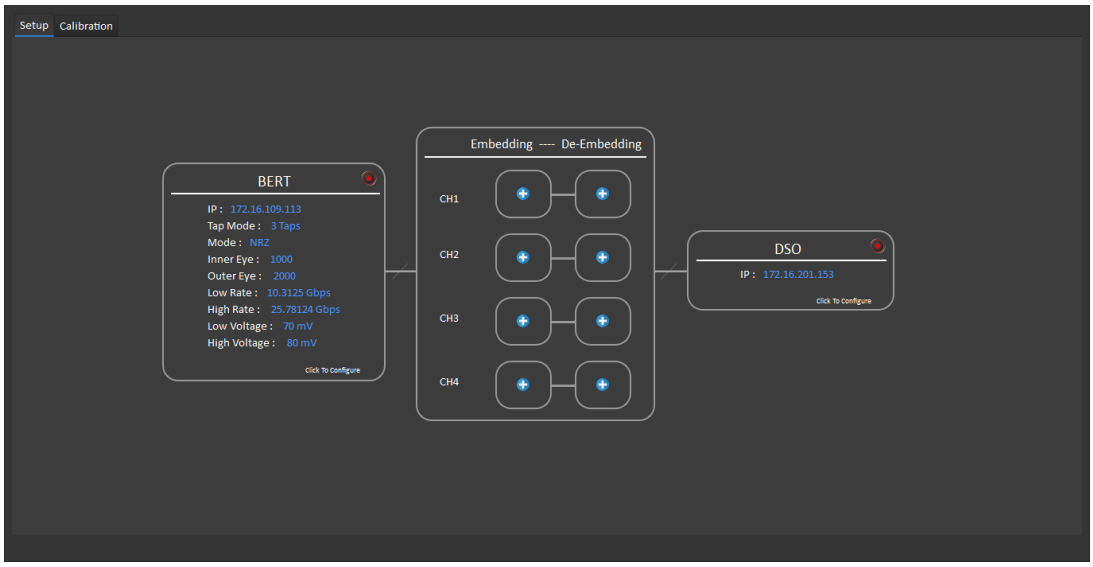

Figure 6: ATE BERT Calibration GUI

Calibration Setup

In the setup tab, start by connecting to the desired BERT and DSO by writing the IP addresses while setting the rates, voltages, and desired number of taps of the BERT to be calibrated. In case of embedding or de-embedding requirement, user should import the S-parameter file, for each channel, while mentioning the ports polarities, if needed, by clicking on “Embedding ---- De-embedding”.

Note:

1) If desired rate is not available refer to “Appendix II: Adding a Line Rate”.
2) BERT calibration is always performed on 4 channels. One cannot calibrate 8 channels at the same time. Therefore, when calibrating an 8 channel BERT like the AT4079B, the user will calibrate 4 channels at a time: channels 1-4 followed by channels 5-8. Also acceptable is channels 5-8 followed by channels 1-4.

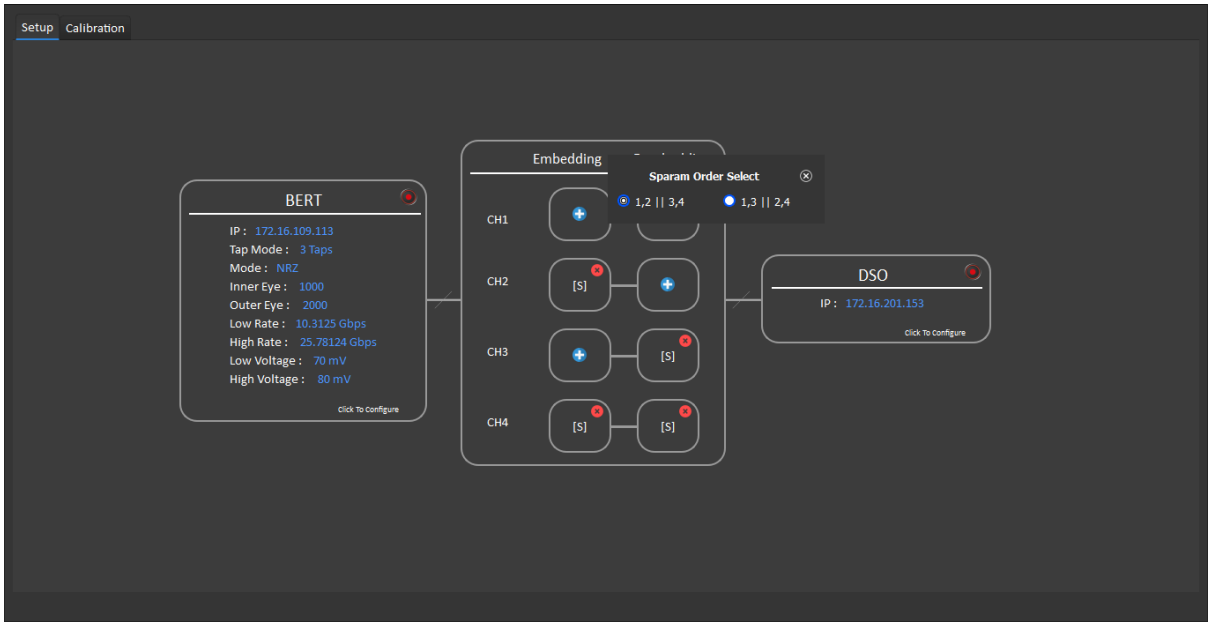

Figure 7: Calibration Setup

After connecting the BERT and DSO, the calibration process is initialized from the calibration tab which is split by itself into 3 modes: Optimization, Run, and Save. Note that the following steps need to be repeated for each mode, but not for each channel.

Optimization

Referencing Figure 8, while in the optimization mode, the following steps should be done by respective order:

1. Check appropriate *Select Mode* box
    a. LR = low rate | HR = high rate
    b. LV = low voltage | HV = high voltage
2. Check appropriate *Embed / De-embed* check box
    a. See “Appendix III: BERT and DSO Calibration Use Cases” on page 16.
3. Click on *Initialize* and *Optimize* to allow the DSO to take captures.
    a. One can click on *clear* and *initialize* again to take new captures.
4. Check the *Lock Bar* to note which DSO channels are receiving signals
5. The GUI in Figure 8 also shows the FFE taps generated, initial eye, and optimized eye.
6. The circle next to the chosen mode should turn orange if the process is successful.
    a. If mode does not turn ORANGE, then your setup between calibration point and measurement device should be checked

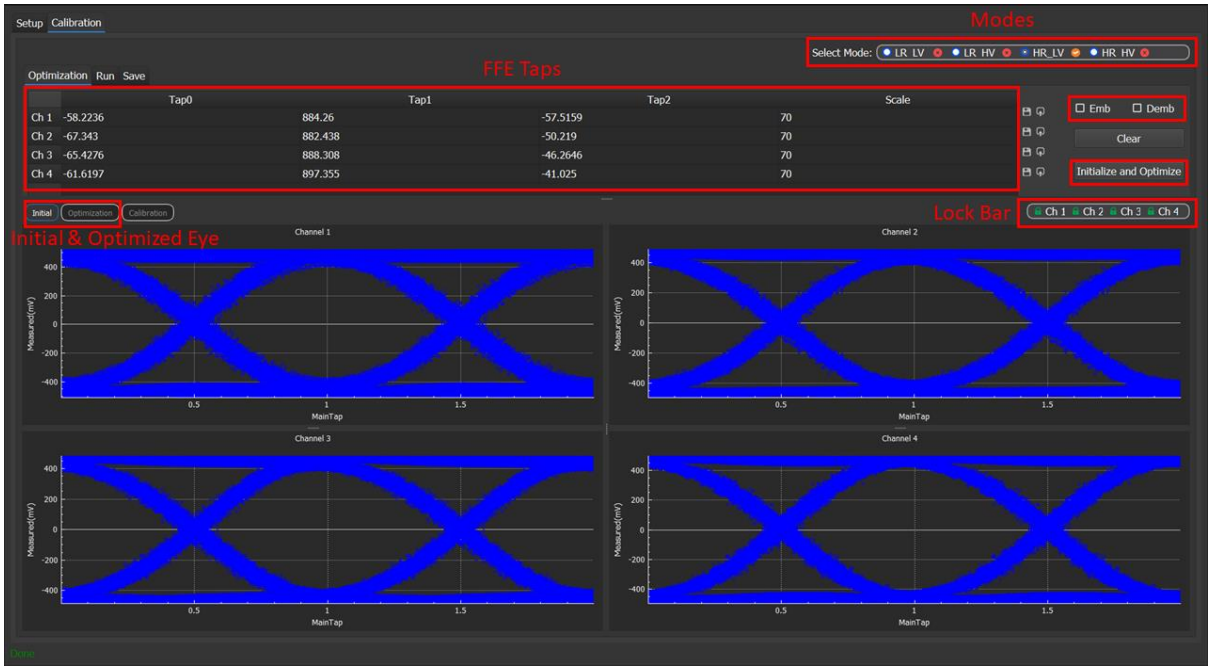

Figure 8: Calibration - Optimization

Run

Referring to Figure 9, after the DSO captures are taken and the FFE taps are generated, the next step is to run the calibration by clicking on "*Run*". The user can observe the different calibration points measured by the DSO by looking at the taps or observing the graph in the small calibration window. Also, one can always delete one of the points by selecting it and then clicking on "delete". When the process is successfully finished, the circle next to the chosen mode will turn green. In Figure 9, the HR_LV mode has turned green.

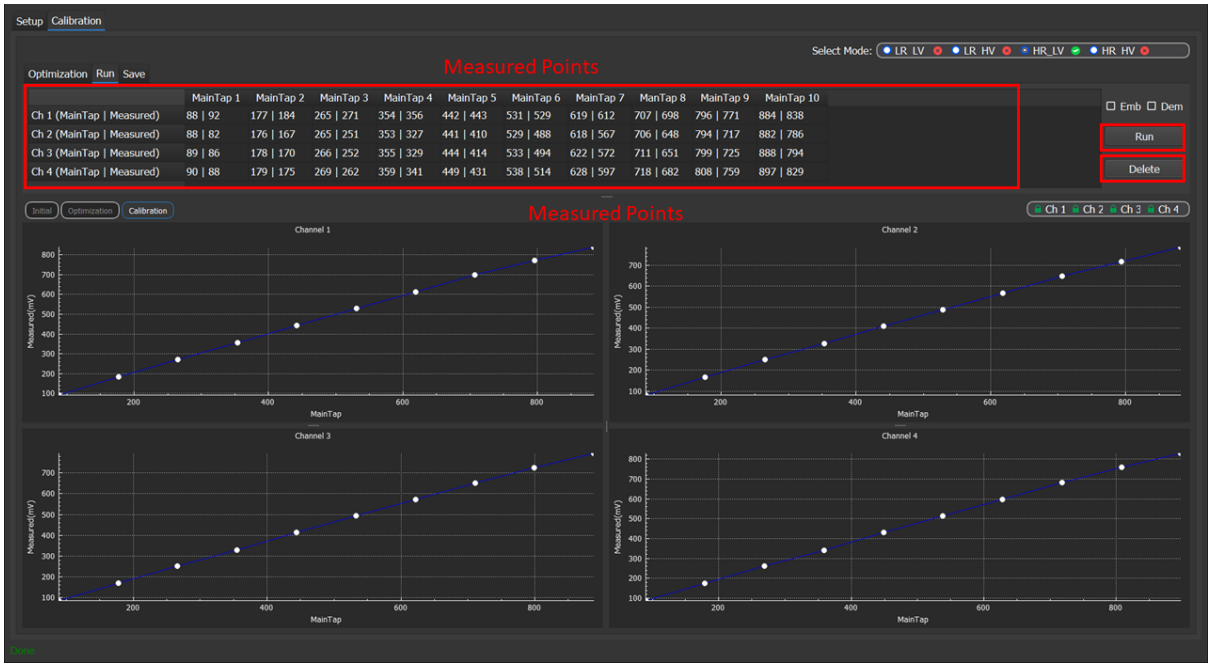

Figure 9: Calibration - Run

Save

The last step is to save the calibrated BERT path's "SmarTest-compatible" file freshly generated by clicking on "*Save to file*".

Note: In case of an AT4079B, the user can choose an existing calibration file of the first 4 calibrated channels to append the calibration data of the last 4 calibrated channels.

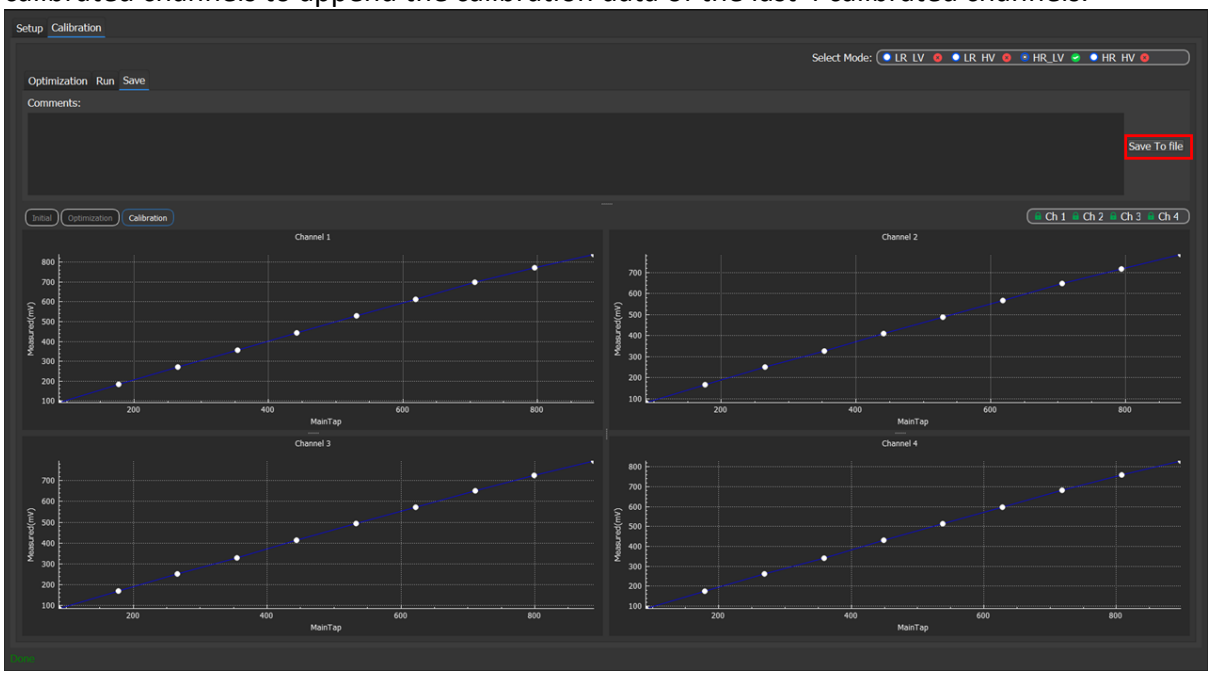

Figure 10: Calibration – Save File

Loading the Calibration File into SmarTest

To load the calibration parameters from a specific file, create a new entry **<BERT IP address> = <calibration file path>** in the "Calibrated Amplitude" section of the **model.conf** file (section name is case-sensitive).

e.g.

```
[Calibrated Amplitude]
172.16.108.193 = ../Mutlilane/Calibration/AT4039E.cal   # BERT 1 in the system
172.16.108.195 = ../Mutlilane/Calibration/AT4039EML.cal   # BERT 2 in the system
```

As a result, *calibrated amplitude* will be enabled and advanced amplitude settings used to manually adjust the BERT transmit signal (MainTap, Pre-Emphasis, Post-Emphasis, etc) will be disabled for this instrument. You should now be able to use "setAmplitude" function from BERTPin class to set a calibrated amplitude.

Note: Since there can be a different calibration file required for each test floor configuration of loadboards, twinning frames and V93K testers, as depicted in Figure 5 on page 6, there can be multiple model.conf files – one for each test floor configuration. Therefore, we suggest a method should be written by which the test program can read back the specific configuration details to load the correct **model.conf** file.

Appendix I: BERT Instrument Calibration Examples

In this example, to run a BERT calibration on four differential channels, the transmitted signal of the BERT should be connected directly to the DSO channels using coax cables. Suggested materials to connect BERT Tx to DSO Rx 4-channels without requiring a loadboard:

Multilane P/N	Description	Quantity	Color Used in this document
AT93000-POGO	Blindmate connector shown in Figure 11	1 or 2	
TM40-0200-01	Cable: 1x1 38cm, SMPM-BM(f) <-> 1.85mm(m)	8 (shipped as matched pairs)	Green Lines
TM40-0430-01	Cable: 1x1 38cm, SMPM-BM(f) <-> 1.85mm(f)	8 (shipped as matched pairs)	Red Lines

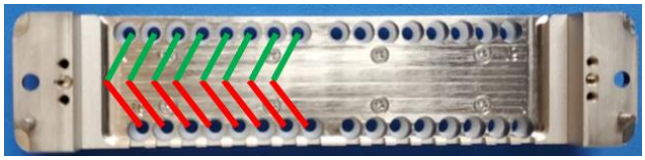

Figure 11: AT93000-POGO with 4 coax cables

Note:

- All instrument datasheets and user manuals are available on the MultiLane Website.
- Refer to the System User Manual for clock routing over the Multilane backplane.
- If you do not calibrate all channels on a BERT, there will be warning messages back to you from the Smartest program, but you can continue calibrating a subset of BERT channels.

Figure 12 shows an AT4039 BERT and AT4025 DSO installed in the same cassette. This example shows cabling such that the AT4039D (or AT4039E) signal (Tx) is transmitted into the AT4025 channels (Rx). In this 4-channel example, AT4039 channel 1 is connected to AT4025 channel 1; AT4039 channel 2 is connected to AT4025 channel 2; etc.

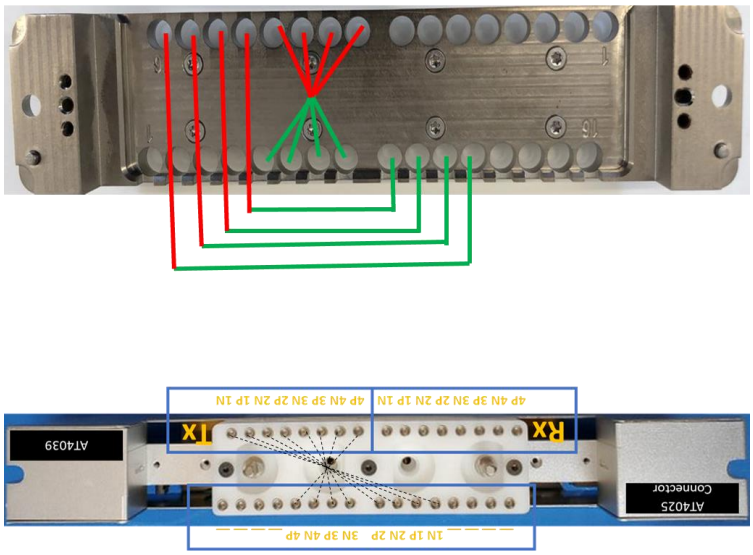

Figure 12: BERT Calibration Example – AT4039 + AT4025

Figure 13 shows the configuration of an AT4079B signal (Tx) (channels 5-8) transmitted into the AT4025 channels (Rx) (channels 1-4) on two different cassettes.

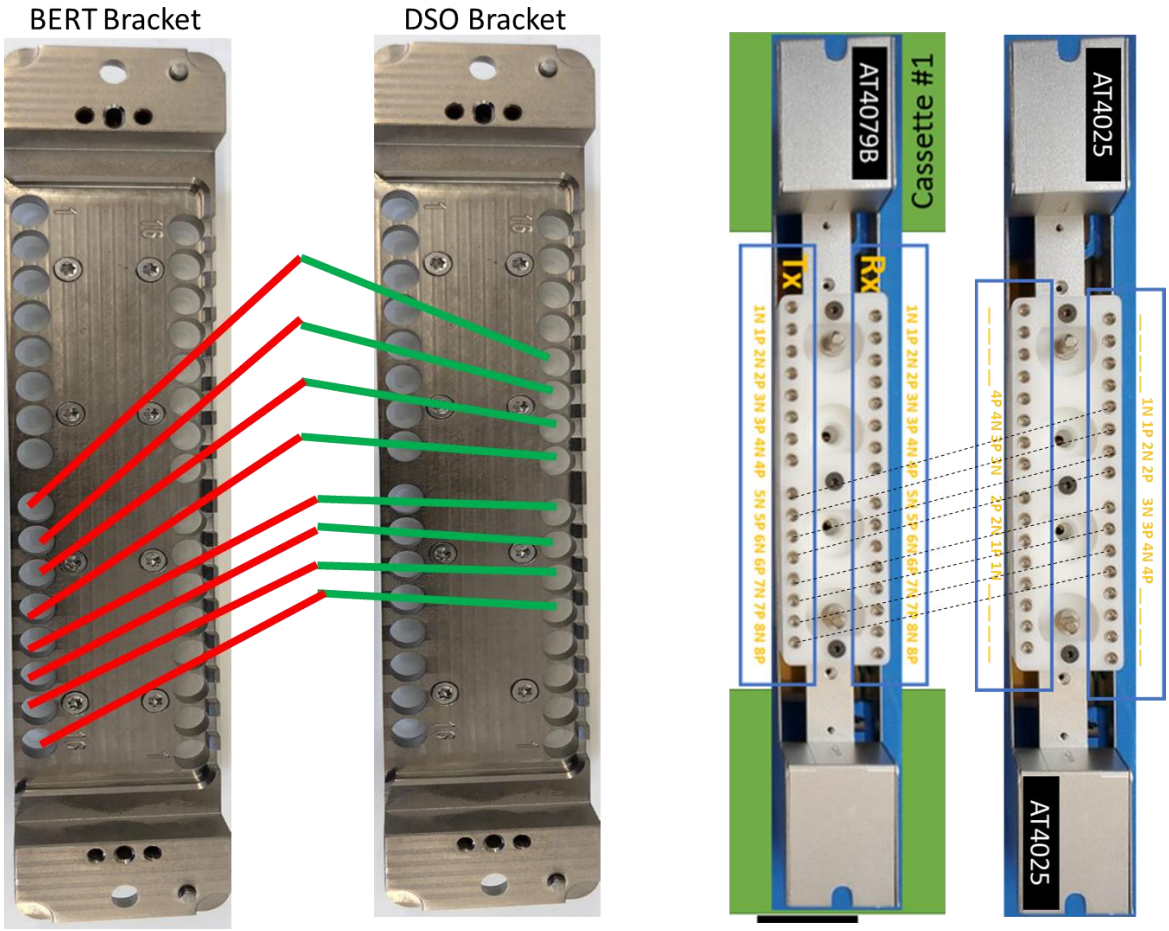

Figure 13: BERT Calibration Example – AT4079B + AT4025

Appendix II: Adding a Line Rate

While connecting to the BERT, if desired line rate is not available in the suggested list, the following process needs to be done by the user:

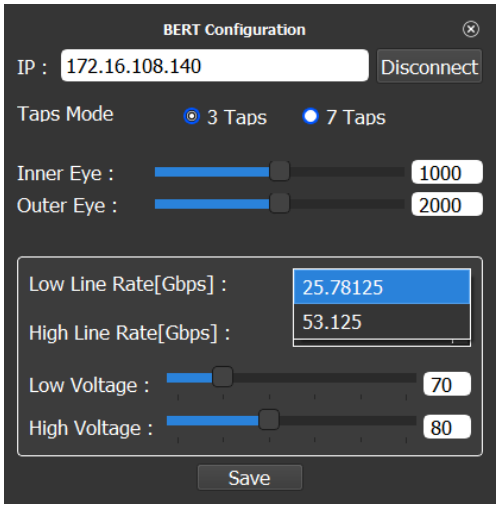

Figure 14: Desired Rate Missing

1. Open the windows BERT GUI and connect to your BERT while applying the desired rate that is missing from the Calibration GUI. Also memorize your "board ID" that appears in the upper right of the MLBERT-GUI, shown in Figure 15. When the apply button is clicked on a specific rate, a clock file for the custom line rate will be automatically generated and stored in the BERT GUI installation destination file under the clock line rate's name. For example, "26.5625.clk" as shown in Figure 15 and Figure 16.

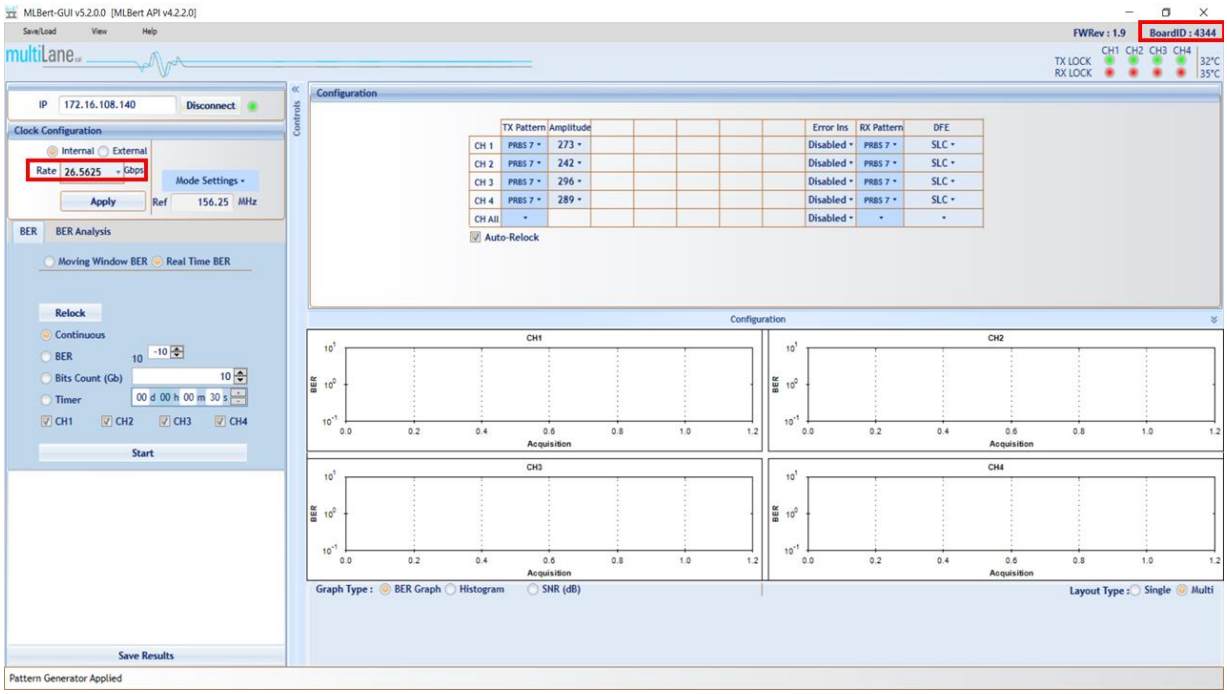

Figure 15: MLBERT-GUI

2. Prepare for a **COPY/PASTE** operation: **COPY** the appropriate clk file from the BERT GUI "clk" subdirectory. The appropriate file is under the name of the desired rate previously applied.

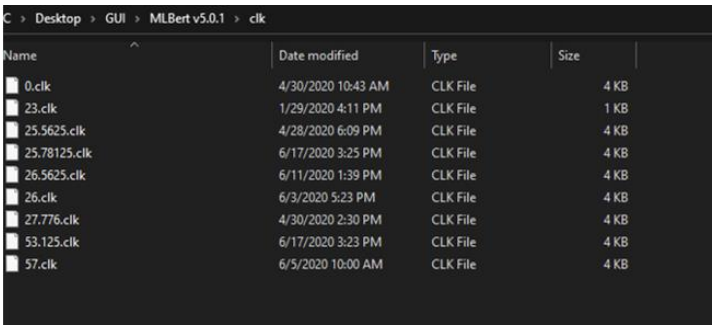

Figure 16: Copying the Clock File

3. Navigate to the ATE Calibration installation destination directory. Then go into the "clk" subdirectory. Then go into the "clk-<YOUR BOARD ID>" subdirectory. **PASTE** the clock file.

4. Restart the Calibration GUI. The new line rate will appear within the list.

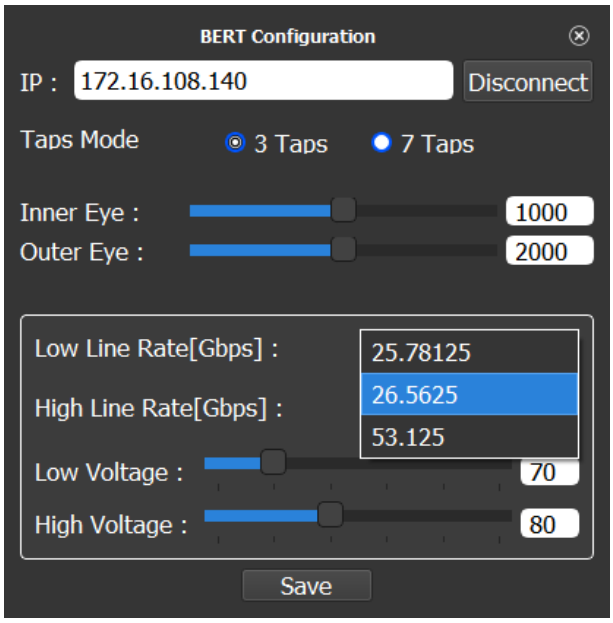

Figure 17: Added Rate

Appendix III: BERT and DSO Calibration Use Cases

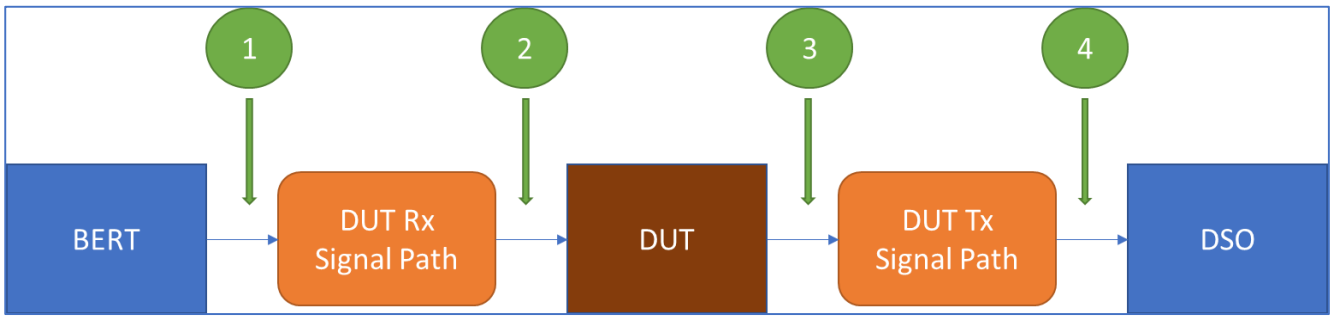

Figure 18: BERT and DSO calibration User cases

Using this BERT calibration guide and referring to Figure , the BERT can be calibrated in the following ways:

BERT Calibration	Scope Location*	Calibrated Point	Embed/De-embed Check Boxes	Embed DUT Rx Signal Path	Location of Calibration Values
BERT-only at ML factory	1	1	☐ Emb ☐ Dem	No	BERT EEPROM
BERT-only at customer	1	1	☐ Emb ☐ Dem	No	Extracted File for DUT test program
BERT-DUT Path	1	2	⊛ Emb ☐ Dem	Import signal path S-param file during calibration for embedding	Extracted File for DUT test program
	2	2	☐ Emb ☐ Dem	No	Extracted File for DUT test program

*In all cases, the scope instrument can either be one of the ATE DSO instruments or an external Multilane DSO instrument

There is no customer calibration required for the DSO instruments. Instead, the signal path S-param file is used to de-embed or embed a signal path by using the DSO GUI filter. Referring to Figure , the DSO can be calibrated in the following ways:

DSO Calibration	Signal Injection Location	Calibrated Point	Embed/De-embed Filter	De-embed DUT Tx Signal Path	Location of Calibration Values
DSO-only at ML factory	4	4	None	No	DSO EEPROM
DUT-DSO Path	No cal required	3	DeEmbedding	Import signal path S-param file into DUT test program	N/A

Note: Refer to your DSO's GUI User Manual on MultiLane website to know more about the Scope Filters.

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