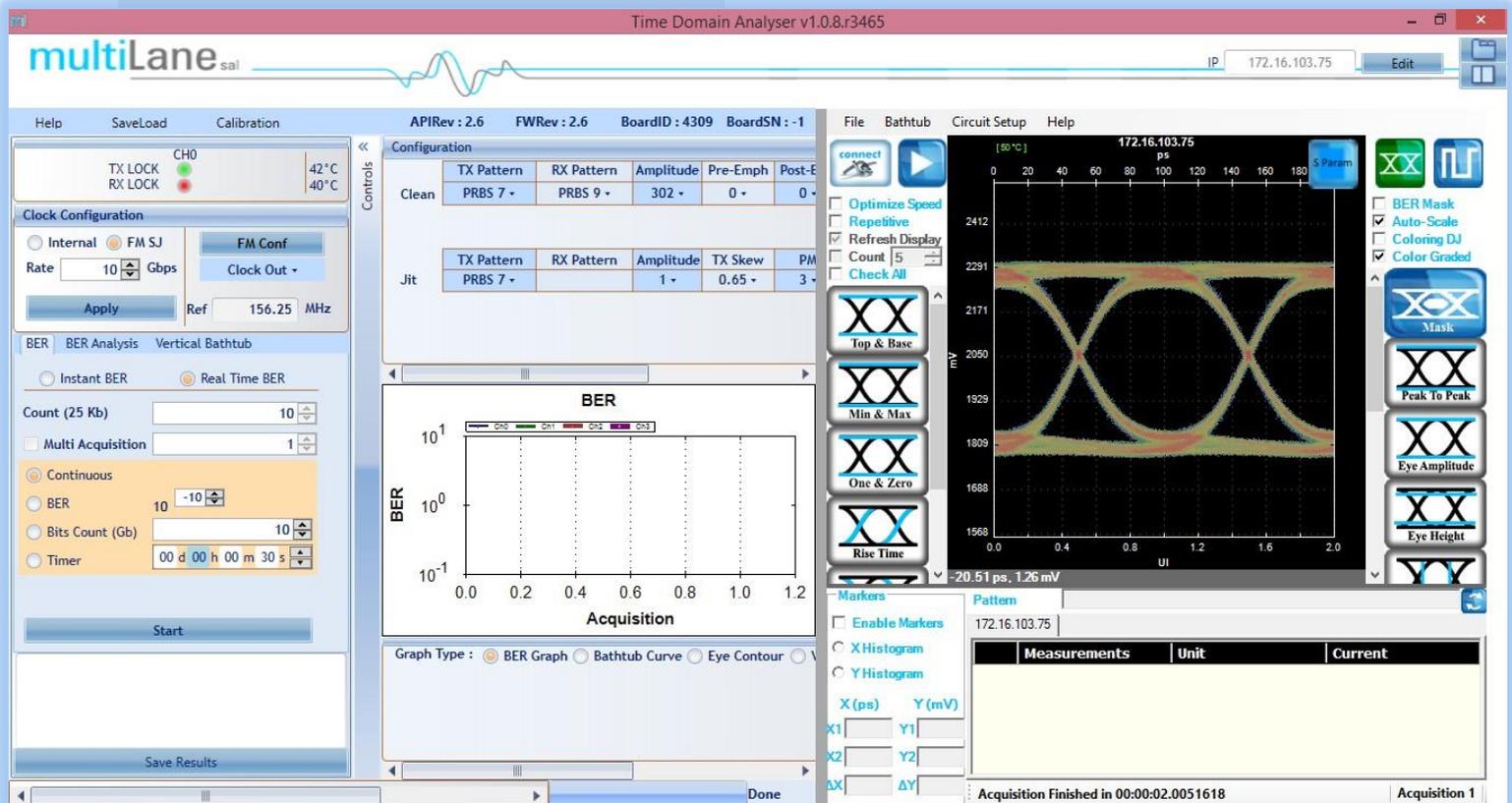# ML4004-JIT Rev B Time Domain Analyzer User Manual

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ML4004-JIT Rev B

Single Lane 3.1-5 and 6.2-15 and 18.6-30.2Gb/s ML-TDA

User Manual Revision 1.0
Windows GUI Version 1.0.8
API Version 2.6*
Firmware Version 2.6*

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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.

These terms may appear in this manual:

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

⚠ **CAUTION. Provide adequate cooling.** Provide adequate cooling to the board to avoid damaging any part of it specifically for the ATE version of the board. Refer to the power section to know the power dissipation values.

Preface

This is the user manual for the **ML4004-JIT Rev B**. It covers the following information:

- Describes the capabilities of the instrument: how to install it and its software
- Explains how to operate the instrument for: Pattern generation, Error Detection; how to control the clocking system, inputs/outputs and all the available measurements
- Lists the specifications

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Contact MultiLane SAL

Multi**Lane SAL** *is an engineering services company and an OEM supplier of specialty test and communication equipment for the semiconductor and optical transport industries. Multilane delivers ultra-compact test instruments of the highest value and performance for high speed communication and signal integrity applications. The Company has a large engineering team and a fully equipped lab with state of the art equipment, having recently moved to a 6,000sq foot facility in* **Houmal Technology Park (HTP).**

MultiLane SAL *customers can leverage great flexibility and capability in product customization thanks to our team's in-depth expertise in high speed I/O, Signal Integrity, and access to advanced development and test tools. MultiLane has the resources and know-how to meet customer's product development and design requirements. Our R&D has a proven track record in delivering leading edge products and development tool kits to the Automated Test market while applying the production processes to deliver high quality products on schedule and within budget.*

MultiLane SAL*'s team is composed of experienced and disciplined engineers offering products and turnkey solutions of modules and systems for high speed IO, Signal Integrity, SOC development and optical communication from verbal requirements (Architecture, PRD, HW/FW/SW design implementation and characterization).*

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Product Description

This chapter describes your instrument, operating under Windows.

- *Installation* shows you how to configure and install the instrument, as well as how to install the system software included with the product.
- *Incoming Inspection* provides a procedure for verifying basic operation and functionality
- *Accessories and Options* lists the instrument options available and the standard and optional accessories for this product.

Model and Package Content

- This manual supports the instrument ML4004-JIT

Hardware Package
ML4004-JIT Rev B: Single Channel 3.1-5 and 6.2-15 and 18.6-30.2 Gbps BERT with jitter generation, reference clock output, external reference clock input, DSO, High-Voltage output swing (Optional)

User Guide Manual
- Manual containing user operation guide, software installation and start up procedure.

Software package and documentations:
- Main ML4004-JIT Rev B GUI.
- USB driver. The Ethernet interface is controlled though the API version 2.0 that includes the Ethernet package.

Overview

The ML4004-JIT Rev B Time Domain Analyzer is a Single Channel BERT and DSO with jitter generation. It is low cost, simple to use, fully integrated, ultra compact, and USB/Fast Ethernet controlled. It is an instrument that combines the functions and features of a signal generator, bit error-rate tester, digital sampling oscilloscope, and data analysis system with Post Emphasis and Pre Emphasis capabilities with lower intrinsic jitter than ever before. The TDA features an optional CDR mode in scope orientation, allowing the user to sample an incoming signal with no input reference clock necessary.

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Key Features

- Available as a standalone boxed instrument
- Scope portion can be set to CDR mode, sampling a signal without input clock.
- Supports 3.1-5 and 6.2-15 and 18.6-30.2Gb/s data rates
- SW filters applicable include PTB, CTLE, FFE, De-Embedding, Moving Averages
- Vertical and Horizontal eye closure
- Composite sinusoidal and jitter generation
- Vertical amplitude random noise injection
- Optional External reference clock input
- Automated J2/J9 measurement
- Integrated synthesizer
- Eye contour measurement
- Intuitive comprehensive GUI
- Window and Linux API available
- Repeatable traceable measurement
- Low cost instrument grade sampling scope optimized for high speed data analysis.
- 32 GHz input BW
- External reference clock input (SMA)
- Single ended and differential electrical input (SMA).
- Eye, jitter, rise/fall, histogram, mask measurement and pattern capture in a single instrument.
- Multiple modules can be controlled via Fast Ethernet 100Base-T
- The DSO tool can operate in a data acquisition only mode where the data is saved on multiple acquisitions for post processing.
- Supports high density parallel application with unlimited concurrent testing.
- Ultra compact form-factor replaces conventional rack test solutions and solves impractical physical requirements of testing large lane counts. Can fit in the Verigy 93K.
- User friendly GUI that enables: zooming, markers, X and Y histograms, overlays, pre-emphasis and multiple measurements, statistics.
- Load and analyze data that was previously captured in simulation mode
- Capability to save statistical measurement, data files and configurations
- Color graded persistence display in eye and pattern capture mode
- Standard stress masks selection for LRM pre-cursor, LRM post-cursor, LRM symmetric, and LRM Clean Eye.
- Mask user defined, Auto Detect Mask
- Percentage of failing points
- Save data and Mask
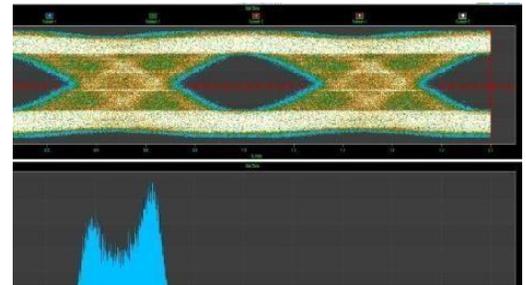- Load Mask

Figure 1: ML4004-JIT Eye Diagram

BER and Scope Measurement Suite
- Low cost simple to use single channel BERT in case of ML4004 TDA and double channel in case of ML4004-jit Rev B and ML4004-HV
- Supports all basic BERT functions

- Complete BERT measurement capability (eye contour and bathtub curve)
- 6 dB pre-emphasis
- 10 dB CTLE calibration
- Mask Margin, Alternate Mask Margin rules available.
- The mask margin (positive or negative) can be extracted for a defined number of points that fail, thus allowing for DUT quality assessment.
- The number of failed points for a region can be returned as well as the actual points that failed.
- Eye opening, Eye height and width, Eye Amplitude, Top, Base, Hi, Lo, Peak to Peak, Max, Min.
- Rise/ Fall Time, Single Edge measurement in pattern capture.
- Total Edge Jitter.
- Statistics histograms and Histogram measurements.
- Crossing point, crossing percentage.
- Advanced Pattern Measurements:
  o Eye measurements on specific bits of the pattern.
  o Single Edge measurement in pattern capture.
  o Pre-emphasis (Positive and Negative, Height and Width).
- Jitter Analysis
  o Deterministic jitter.
  o Random jitter.
  o Low Frequency SONET Jitter.

Target Applications

- Interconnect testing (SFP, SFP28, CFP, CFP2, CFP4, QSFP, QSFP28, ...)
- Backplane testing
- Wafer level testing where an output clock cannot be extracted from an IC
- Interference and crosstalk testing
- Receiver sensitivity testing
- Receiver jitter tolerance testing equalizer characterization
- Electro-optical module testing
- Electrical stressed eye testing for 100 Gbps Ethernet, MLD/CAUI application, OIF CEI-28G-VSR, CPPI-4, CAUI-4, 32G Fiber Channel chip to module
- High Speed SerDes Testing & Characterization.
- Handheld 10G test equipment for field Installation and maintenance.
- Multi-port system testing or Line Cards.
- In-Situ testing of high port count systems.
- Can be mounted in Automatic Test Equipment or in socketed load board
- Telecoms equipment test for installation and maintenance.
- Fiber channel, Ethernet, PON, parallel optics, etc.*
- High port count burn-in test
- Research and development applications.

Product Software

The user interface for the ML4004-JIT Rev B is an all-new combination of the MLBert and ML DSO programs. Both the DSO and Bert functions are accessible by the same IP address, and can either be arranged to be tabs, or side by side in the same window, as seen below:
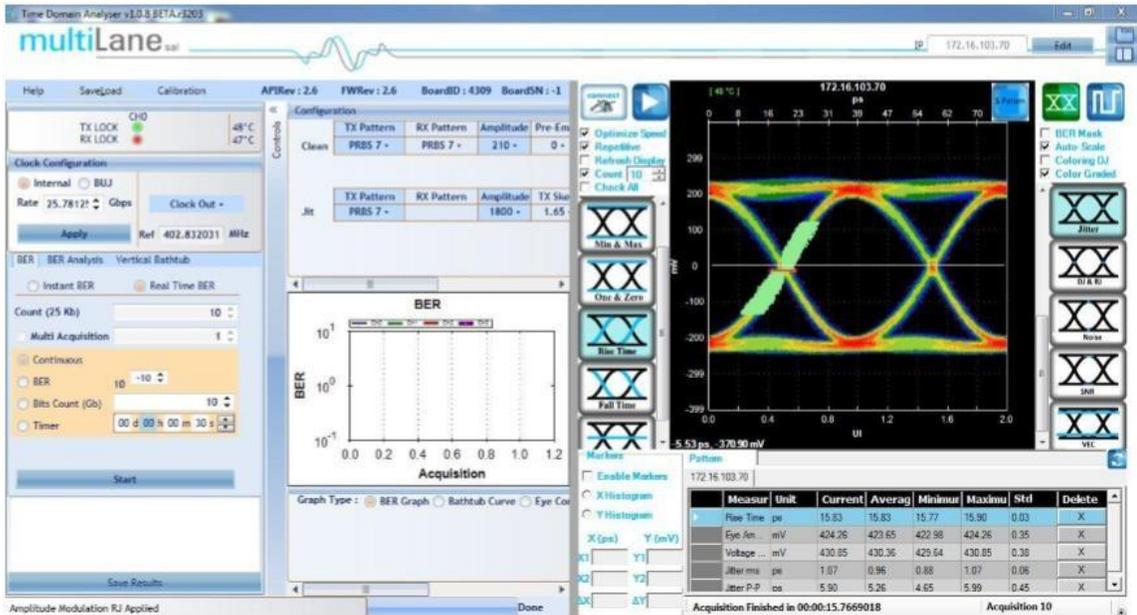
Figure 2: ML4004-JIT Rev B ML-TDA GUI

The instrument comes with the following software:

- **ML-TDA GUI** (GUI to Control the Instrument)
- **MultiLane ML4004-JIT Rev B USB driver**
- **ML4004-JIT Rev B ETH Configuration Software** (Utility to configure the static IP Address over USB)
- **ML-IP changer**(Utility to configure the static IP Address over Ethernet)
-
The Multilane Software runs on Windows XP (32/64 bit), Windows 7 and 8.

NOTE. *These applications requires the Microsoft .NET Framework 4. If the Microsoft .NET Framework 4 is needed, it can be downloaded through this link:*
https://www.microsoft.com/en-us/download/details.aspx?id=17851

For more products updates, check the following webpage:
www.multilaneinc.com/products.html

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Minimum PC Requirements

The Windows PC properties for the Multilane Software must meet the following specifications:

- Windows XP SP3 or greater
- Minimum 2 GB RAM
- 1 Ethernet card to establish connection with the device
- USB Connector
- Pentium 4 processor 2.0 GHz or greater
- NET Framework 4

NOTE: *It is recommended to connect the ML-TDA via Ethernet to one PC only to prevent conflict from multiple user commands.*
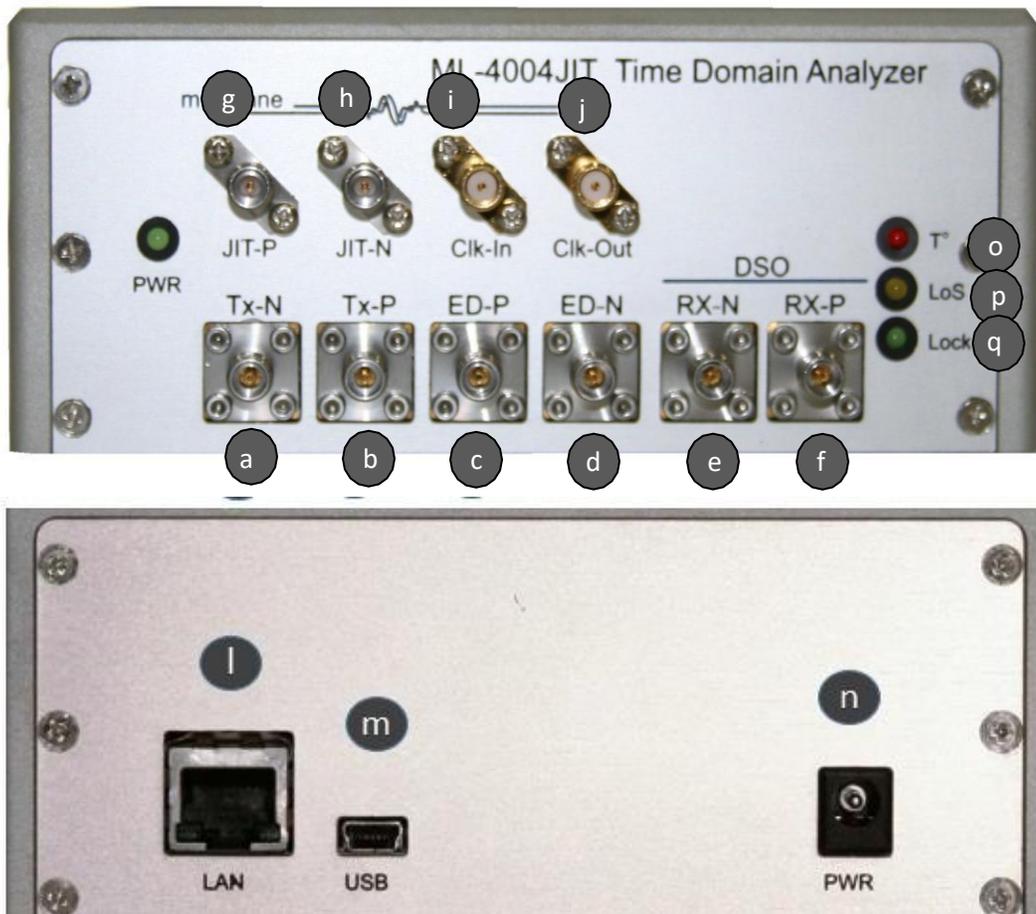

Instrument Ports

Figure 3: ML4004-JIT Rev B Panels

ML4004-JIT Rev B Ports

	Port Name	Description
a	Tx-N	Negative TX Channel Amplitude range: 125-800mV Differential. Bit rate 3.1-5 and 6.2-15 and 18.6-30.2 Gb/s– Electric interface
b	Tx-P	Positive TX Channel
c	ED-P	Positive Error detector
d	ED-N	Negative Error detector
e	RX-N	RX-N for DSO
f	RX-P	RX-P for DSO
g	JIT-P	Input JIT-P
h	JIT-N	Input JIT-N
i	Clk-in	DSO Ref Clock in
j	Clk-Out	TX Reference Clock Output: This clock will be equal to the line rate divided by 64.
o	T	LED, indicates the board is overheating when glowing red
p	Los	LED, indicates loss of signal on Rx when glowing red for the following reasons: ▪ Cable not inserted ▪ Signal inverted ▪ PRBS pattern on Rx do not match the TX pattern
q	Lock	LED, indicates **Ref CLK-Out** is functional when lit green, ML4004-JIT Rev B is generating a clock signal.
l	LAN	RJ-45 port
m	USB	Mini-B USB port
n	PWR	Power port

Table 1. Instrument Ports

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Installation

This chapter covers installation of the instrument, addressing the following topics:
- System Start-up
- How to connect to the instrument

Note: always run the GUI as administrator

System Start-up

To use the **ML-TDA GUI** under Windows XP, Windows 7 and 8, it is important that the correct start-up sequence is followed:
- Make sure you have Microsoft *.NET Framework 4* installed.

If not installed, refer to the Note in the Software section.
- Install the **ML-TDA GUI**.
- After installation, open it with double click on the software icon on desktop or from your start menu.
- A new window will appear titled **ML-TDA GUI**; this is the main software interface.
- Note: The **ML-TDA GUI** itself only operates over Ethernet. USB is only used to configure the static IP address of the card with the ETH Configuration Utility that requires a USB cable to be connected from the ML4004-JIT Rev B to your PC. Using USB cable to configure IP is not mandatory as you can stick to the default IP that came with the device
- Follow the steps below to connect the **ML-TDA** GUI to the ML4004-JIT Rev B:
    - Connect your PC to the ML4004-JIT Rev B via the RJ45 connector located on the front panel through an Ethernet cable. In order to connect via Ethernet the IP address of the board is required and the IP address of your PC needs to be on the same subnet as the address of the ML4004-JIT Rev B Box. To learn more options on how to connect the Ethernet cable go to the section Connect through an Ethernet Cable.
    - Ping your device to make sure that you are connected.
    - Note that no drivers are required; you only have to know the current board IP address, which you need to enter it in the text box next to the **IP** label shown in the below picture, then click on the **config** button.

Figure 4: Configure IP of device

    - Depending on which module you want to use, you need to connect separately on the BERT or DSO side. Once connected, on the BERT side, you'll get a green light and a temperature indicator which confirms a successful connection. On the DSO side, when clicking connect on the configuration settings window, you would get a clear error in case of failure to connect; otherwise, the settings window would close taking you back to the main screen, confirming a successful connection.

o If you need to change the IP address of the board, you need to install the USB drivers (refer to section USB Driver Installation). Install the ETH Ethernet configuration Utility that allows you to read, write the **IP** address, Subnet **Mask** and **Gateway** of the instrument.
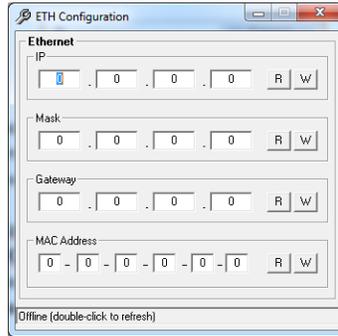

Figure 5: Ethernet Configuration

o If you have failed to connect via Ethernet, and you are not able to ping the instrument, then it could be an Ethernet Configuration error. Connect your PC via USB to the ML4004-JIT Rev B Box and use the ETH Utility to change the static board IP address to fit in the network range. Refer to the section **"How to connect to this Instrument**".

The instrument is now controlled by the **ML-TDA GUI**. Next, if you'll be using the BERT features of the ML4004-JIT Rev B, click on 'Connect'. Once the temperature is getting read, you need to configure the line rate of the Pattern Generator, i.e. set the output line rate of the TX outputs.


Figure 6: Bit Rate Configuration

Setting the TX Line Rate

▪ First select the internal clock generator, then write the bit rate value next to the **Line Rate** label. The value entered must be in between 3.1-5 and 6.2-15 and 18.6-30.2 Gb/s. The line rate will apply to the TX output channel
▪ Press **Apply** to save the value. You'll see 'Bitrate Applied' on the status bar confirming the changed values.
▪ A reference clock output (synchronous to the transmit clock) is provided on SMA. This clock will be equal to the line rate divided by the divider chosen.

The frequency of the reference clock output signal is shown in the field next to the **Ref** label in the GUI as can be seen in figure 6.

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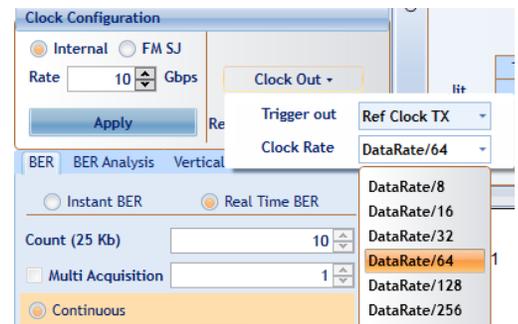
- If you want to provide a clock with FM SJ, then choose the FM SJ and enter the FM configuration.
- Note: External Reference CLK input is not supported on the Single Channel BERTs.
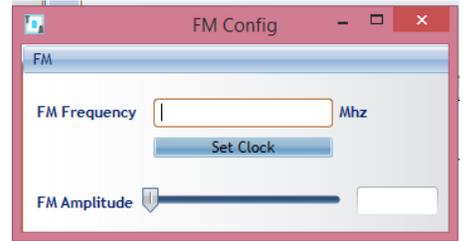
Pattern Configuration

- In the **PRBS Configuration** group box, select the pattern required; the available patterns are 7, 9, 15, 23, 31 and user defined in addition to the 40 bits user pattern. The TX Pattern tab is used for Configuring the Transmit Patterns, the RX Pattern tab is used for pattern verification.
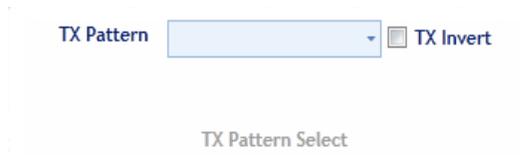
Figure 7: PRBS Channel Configuration

Note: while a 40-bit user pattern is selectable, the error detector can NOT lock onto user patterns. This can only take place with PRBS patterns.

- To use the **User defined** capability, first select it from the **Pattern** combo box list, then in the text box specified for the **User Defined** write the sequence of bits you want, and then select the **Set** button.
- In case the test engineer wires the positive TX channel to the negative RX Channel by mistake, the software can compensate for this error by clicking on the invert button.
- The specified generator now starts generating a clean signal. If you would like to inject jitter to the signal generated to start shaping the eye diagram, you have to adjust the slide bars existing in the Eye Shaping group box (refer to **Eye Shaping** below).

Jitter Calibration

Often times, users of the JIT-BERT need to control jitter injection (SJ and RJ) directly in picoseconds. This is especially useful in compliance testing e.g. OIF-CEI 3.1, IEEE 802.3bm, etc. The GUI gives you the possibility to calibrate jitter. For this to happen, you need to go to the calibration menu and start the process there. You will be required to connect a cable to loopback TX into RX. If you want to calibrate all 4 channels you will have to repeat this procedure four times. Once a channel is calibrated, the values will be saved in EEPROM so you don't have to go through this process another time. The method applied to calibrate jitter relies on bathtub analysis on the received data at different levels.

For the jitter calibration to take effect, the TX Skew optimization must be active! (make sure the Optimization checkbox is activated)

PRBS Pattern Verification

There are 2 ways to set the Error Detector for the RX Channel of the **ML4004-JIT Rev B:**

- ▪ **MANUAL**: pick the same pattern as you selected for the TX channel, the RX Channel LED in the top of the GUI indicates that the channel is locked by turning green. Channel will be locked if the data received at RX matches the selected pattern. If not locked try inverting the TX or RX side using the checkbox.

- ▪ **AUTOMATIC:** If the user selects **Automatic Verification**, the software will try to detect the received signal pattern, even if it is inverted; upon success it will show the result and the LED will indicate that the channel is locked.

Figure 8: RX Configuration

Eye Shaping

The **ML-TDA GUI** provides 3 sliders to shape the data eye of the TX output: amplitude, Pre-emphasis and Post-emphasis. All slider values and other configurations are saved in the EPROM:

- - **Amplitude**: TX output amplitude is between 0mV and 750 mV.
- - **Pre Emphasis**: TX output Pre-emphasis amplitude value can be changed from 0 to 20%.
- - **Post Emphasis**: TX output Signal Post-emphasis amplitude value can be changed from 0 to 35%.
  Pre and Post Emphasis values can be adjusted in order to attain the clearest eye condition (e.g. 2/4 and 5/10).

Figure 9: Eye Shaping Sliders

Error Insertion

The **Error-Insr** tab allows the user to insert errors into the transmit output Pattern for the TX channel. The **Rate** menu field allows the user to choose between 0 and 40 bits. The errors can be either inserted once or continuously by selecting the **Continuous** checkbox.
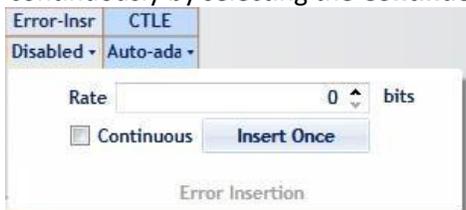

Figure 10: Error Insertion

Note: Due to a HW limitation the continuous error rate cannot be quantified accurately.

CTLE Configuration

Each RX input has its own programmable CTLE that can correct up to 10 dB of cable signal loss from the DUT to the BERT and to de-embed the system losses. The **CTLE Tab** allows the user to select the CTLE level from 0 to 10dB. CTLE ranges can be selected in order to attain the lowest J2/J9 jitter values at the optimum point of CTLE.
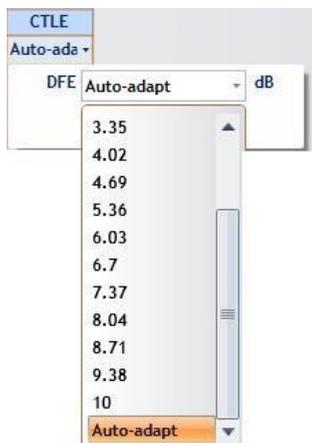

Figure 11: CTLE Configuration

Running BER Tests

In order to run a BER test, the TX port needs to be connected to the RX port, simply looped back on itself.
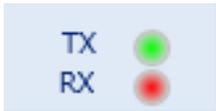

Figure 12: LED Channels

The TX LED indicator lights in the top right hand corner of the GUI (see Figure below) indicate if the TX channel is transmitting data. The RX indicator LEDs are defined as follows:
-   If the LED is green that means the RX channel is locked to the incoming data pattern.
-   If the LED is red that means that the RX channel is not locked to the incoming data. Please make sure the RX Channel is expecting the correct PRBS pattern that is being transmitted on the TX channel (of Auto Verification is turned off), also make sure the cables are not inverted by selecting the Invert checkbox in the Pattern Generation Tab for the TX Channel.

When the TX and RX LEDs are both Green, you can use the **ML-TDA GUI** to run several different BER tests on this channel. Select the BER Tab in the GUI. This will show a menu as displayed in Figure 10. In this menu one can select one of 2 different BER Test modes: Instant BER or Real-time BER. These two modes are described in detail below.
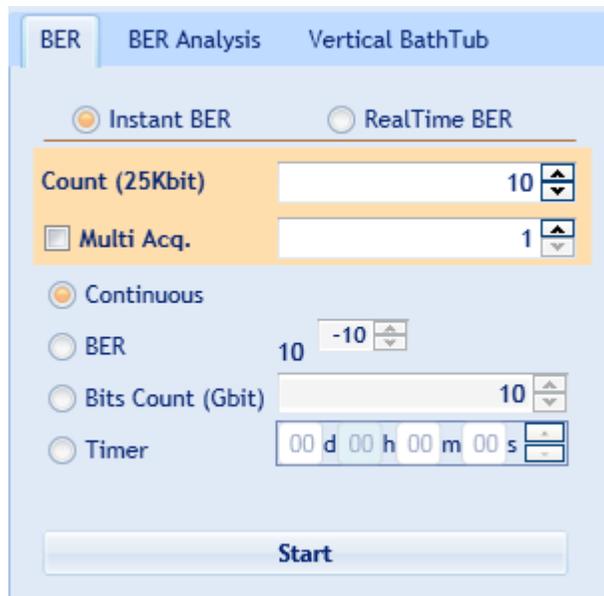

Figure 13: BER Configuration

Instant BER

The Instant BER Mode is useful for test cases where a very high error rate is expected (i.e. an error rate above 4x10^-5) and an accurate reading is needed. In Instant BER mode the BERT takes a snapshot of 25K bit samples, counts the exact number of errors, and returns the error rate. If the user selects multiple 25Kbit acquisitions, the BERT will continue to take 25KBit samples, return the BER and take the next sample etc. This way, the user is able to read an exact BER with rates as high as 10^-1. However, not all errors can be captured as there is a delay in between taking 25KBit snapshots and therefore not all received bits are examined for errors.

The Instant BER test has the following configurations:

Count (25Kbit): Number of 25K Bit snapshots to be collected (Controller Hardware Count).

Multi Acq: This allows you to choose the number of acquisitions (Software Count).

Note: A very high sample count of 25Kbit samples will take a short time but could use up 100% of the Micro Controller's Bandwidth possibly preventing the **ML-TDA GUI** from responding to any other configuration changes while the test continues to run. It is best to select a balanced number of 25Kbit Counts and Multiple Acquisitions.

Once you have selected the desired number of 25Kbit counts and Multi Acquisitions, press the start button as shown in figure 10.

Real Time BER

In this mode, the Error Detector is constantly looking for errors, therefore this mode is good for long BER test cases with relatively small amounts of errors (low BER rates). However, in this mode the user is limited to Bit Error Rates below 4x10^-5 due to error counter limitations of the Error Detector itself. So for Bit Error Rates above 4x10^-5, BER test in Real-time BER mode are not 100% accurate like the Instant BER mode because the error counter will overflow before the next scheduled counter read, and therefore some bit errors will pass the Error Detector without being detected.

The Real Time BER test can be run in 4 different modes as described below. It can be run by pressing the start button.

Real Time BER Configurations:

Bit Count: This configuration will run a BER test until the user-set number of bits have been transmitted and received.
Continuous BER: This process begins collecting BER data when the user presses start, and ends when the user presses stop.
BER (Target): The BER test will run till it reaches the BER level selected.
Timer: The BER test will run for the specified amount of time.

BER Graph

The BER Graph Window plots the channel BER Rate in the above mentioned BER Test Modes. An example graph is shown below.
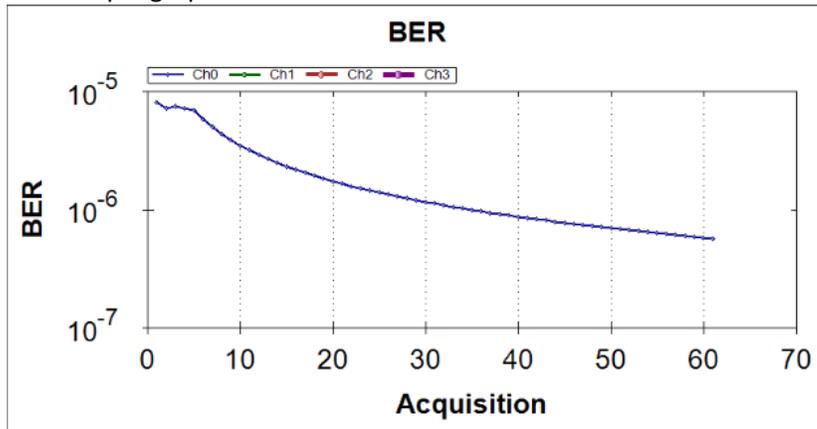

Figure 14: BER Graph

BER Analysis

The **ML-TDA GUI** offers 2 different Bit Error Rate Analysis modes: The Horizontal Bathtub Plot and the Eye Contour Map. Selecting the BER Analysis Tab in the GUI provides the menu as shown below:
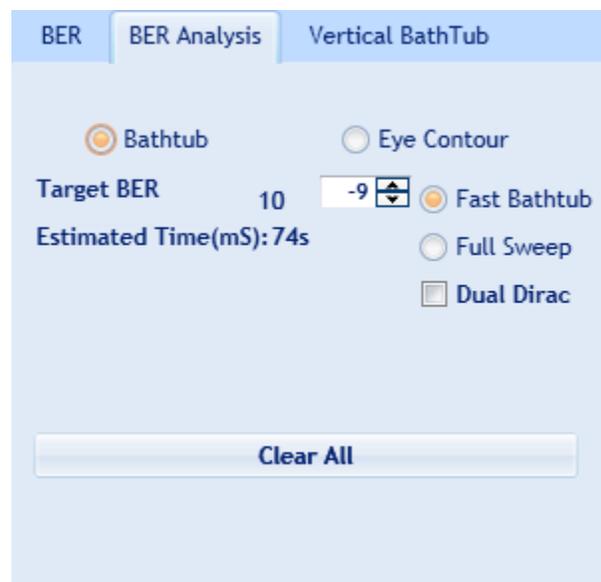

Figure 15: BER Analysis Menu

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The Bathtub Plot

An indication of jitter in a data eye is provided by a *bathtub plot*, so named because its characteristic curve looks like the cross section of a bathtub. It is a graph of BER versus sampling point throughout the unit interval of the sampled data eye. It is typically shown with a log scale, which illustrates the functional relationship of sampling time to bit error ratio.

When the sampling point is at or near the transition points, the BER is 0.5 (equal probability for success or failure of a bit transmission). The curve is fairly at in these regions, which are dominated by deterministic jitter mechanisms.

As the sampling point moves inward from both ends of the unit interval, the BER drops off dramatically.

These regions are dominated by random jitter mechanisms and the BER is determined by the sigma of the Gaussian processes producing the random jitter. As expected, the center of the unit interval provides the optimum sampling point. Note that there is BER measured for the middle sampling times.
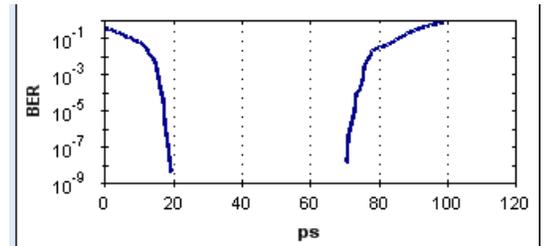

Figure 16: Bathtub Graph

Plotting the points on a graph of BER versus sampling location in time results in curves as shown in Figure 13. A bathtub curve can be created either by software extrapolation from voltage over time measurements done by an oscilloscope, or by actually sampling the bits as done by a BERT.

For development engineers, the final proof of performance of a component or subsystem is the direct measurement of BER at optimized timing and threshold levels employing error detection on every transmitted bit. However, the speed of the BER measurement is a function of the BER to be measured and the desired statistical confidence factor for the result.

NOTE: The **ML-TDA GUI** *version only supports the Horizontal Bathtub plot.*

Bathtub Measurement Configuration

When running a Bathtub Measurement, the **ML-TDA GUI** allows you to select the **Target BER** as shown in Figure 12. Once the target BER is selected, the GUI will give an indication of how long the measurement will take.

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Jitter measurements

Below the Bathtub Plot is a Jitter Measurement Menu as shown in Figure 14. This allows you to select which type of Jitter Parameter(s) to measure from the Bathtub Plot. The values for the selected Jitter (usually J2 and J9) will be displayed in the results window below the BER Analysis Menu. Below is a definition of J2 and J9:

J2 and J9 provide a measure of the eye width at 2.5×10^{-2} and 2.5×10^{-9}.
J2 gives a measure of the DJ.
J9 gives a measure of the RJ.

Figure 17: Jitter

Jit Option

The TDA-JIT includes sliders for amplitude modulation and jitter injection. All sliders values and other configurations are saved in EPROM:
- **Amplitude**: TX output amplitude is between 20mV to 1200mV, within 5 mV steps.
- **Skew**: Lane-Lane Skew Control from 0 to 140ps within 4096 steps.
- **PM**: The frequency of the sinusoidal jitter used to modulate the output. This Value can be changed from 0 to 4095 steps. The user can set the frequency and change the amplitude of the signal, and the user can insert to it a Random Jitter that has a Gaussian distribution, this Radom jitter can be amplified by the RJ slider from 0 to 4095 steps. The sum of this signal will be added to the output of the BERT in order to generate a sinusoidal jitter and Radom jitter to the TX signal.
 - **AM RJ**: This is a combination between a DC that changes from 0 to 4095 steps, and RJ signal that has a Gaussian distribution, to create a noisy reference amplitude for the main signal.
In addition there is a capability to save your current settings and load them at any time; the saved settings file is compatible with the API calls, so can be used for the API input files.

Amplitude	TX Skew	PM	AM RJ	Error-Insr	CTLE
250 ▾	2065 ▾	0 ▾	0 ▾	Disabled ▾	2.01 ▾
250 ▾	2081 ▾	0 ▾	0 ▾	Disabled ▾	2.01 ▾
250 ▾	2048 ▾	0 ▾	0 ▾	Disabled ▾	2.01 ▾
250 ▾	2113 ▾	0 ▾	0 ▾	Disabled ▾	2.01 ▾

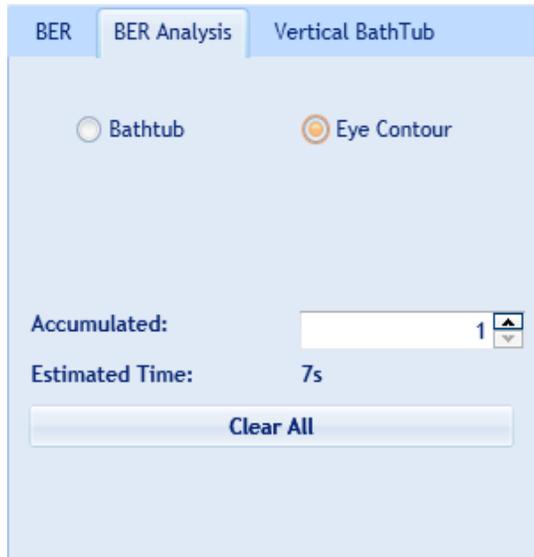OMMUNICATION TEST & MEASUREMENT SOLUTIONS

Eye Contour Measurements

Figure 18: Eye Configuration

As mentioned earlier, the other BER Analysis tool is the Eye Contour Map. This mode is selected by checking the Eye Contour button in the BER Analysis menu as shown in figure 15.

The eye contour is a key characteristic of the receiver of a device under test. The BER is displayed as a function of sampling delay and sampling threshold. This analysis calculates the bit error rate around the perimeter of the eye opening and fits these results to the expected bit error rate response curves predicted by additive noise. The depth of the contours can then be extrapolated to lower levels than the actual measurement would allow.

Eye Contours are used to identify how much headroom may be present in a system after considering the amount of decision-point variation that might occur.

Eye Contour Configuration

The Eye Contour Test allows you to select an eye acquisition with the **Accumulated** Setting. Upon selection, an estimation of the time will be given. Figure 16 shows a single channel Eye Contour example.
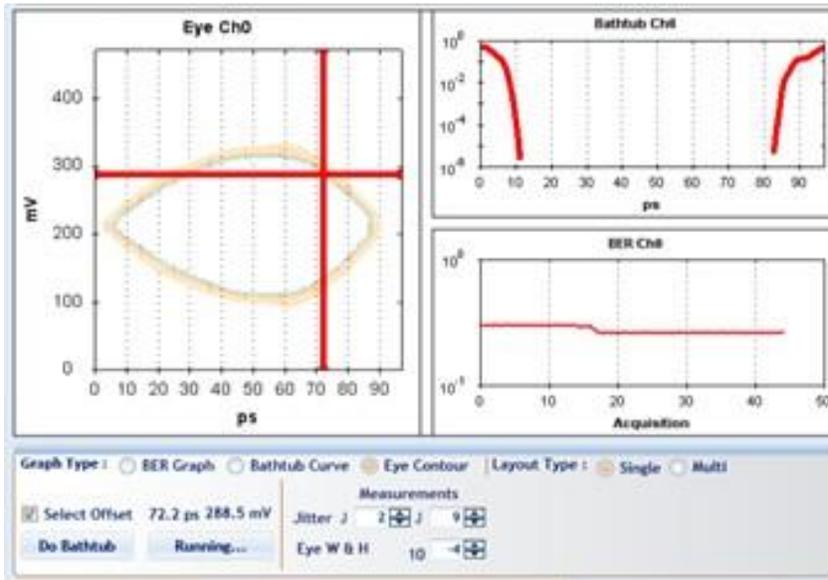
Figure 19. Eye Contour

The **ML-TDA GUI** allows you to specify a point on the eye in picoseconds[X-axis] and millivolts[Y-axis] by selecting the Offset checkbox (see Figure 16) and then calculate the Bathtub curve for that point or calculate the BER rate by pressing the Do Bathtub or Do BER Buttons. These 2 buttons are defined as:

Do Bathtub button displays the Bathtub curve and shows the Jitter measurements in the result window below the BER Analysis Menu tab.

Do BER button displays BER graph and shows BER results.

Full sweep: Read the BER between the chosen start and stop points of the bathtub (Max 128, start/stop ranging 0 -> 127). It allows the user to choose the time for scanning each point (in mSec). After accumulating data for the specified time for each of the points, it returns the bathtub curve measured. This is very accurate but does not cover BER < 1E-10 unless you enable Dual Dirac with it

Dual Dirac: Uses full/fast sweep data to calculate/estimate and continue the bathtub curve up till BER 1E-15
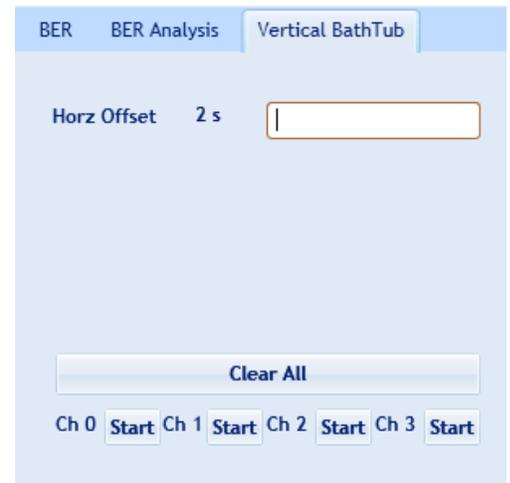
Figure 20. Vertical Bathtub

Vertical Bathtub

The V Bathtub allows the user to get the vertical Bathtub of a specific channel.

The value entered in the textbox must be between 0 and 255 steps, and according to the estimated time 2 s, the curve will be drawn
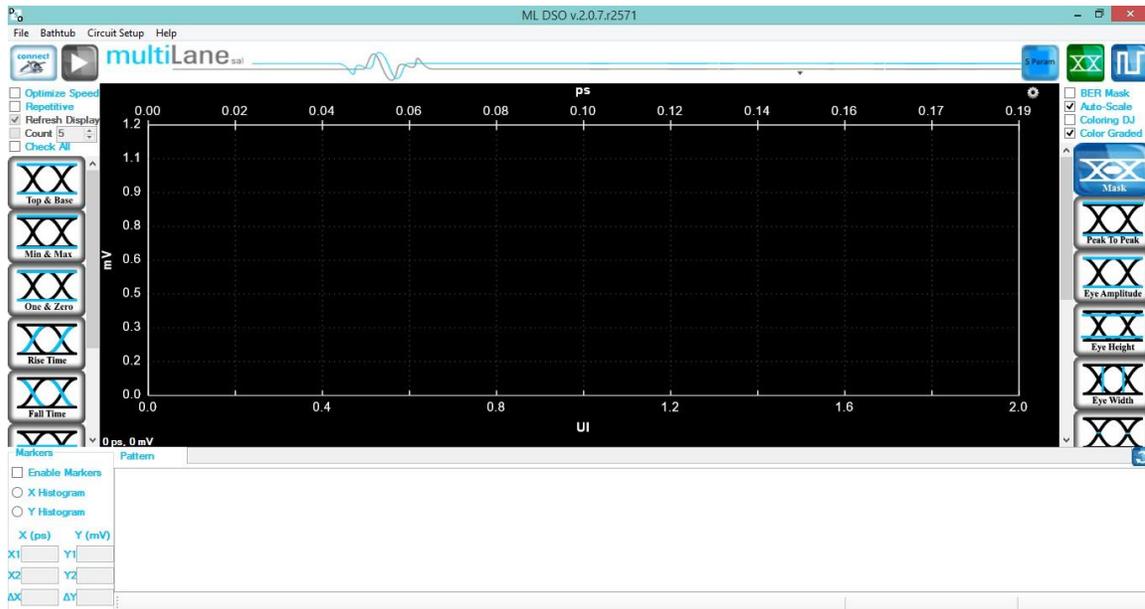
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Digital Sampling Oscilloscope

Figure 21: GUI

- Click the connect button [connect icon] at the top right of your screen.
- The "Connect to ML-DSO" window will pop up.
- Click on the add button [+] to add the virtual ML-DSO.
- The "ML-DSO configuration" window opens

- If both software the ML-DSO and simulator are being worked with on the same computer, choose the "Simulation" mode.

- If one of the software is being run on a different PC, choose "Hardware" instead of "Simulation" and enter the "IP" of the PC where the simulator is running.

- Click on the refresh button [refresh icon] , in order to retrieve the simulator configuration, or configure the ML-DSO by filling the "ML-DSO configuration" window respecting the information provided by the simulator. For more information on how to fill the "ML-DSO configuration" window refer to the following section.

Note that any data file that has already been saved using the **ML-DSO** software can be loaded.
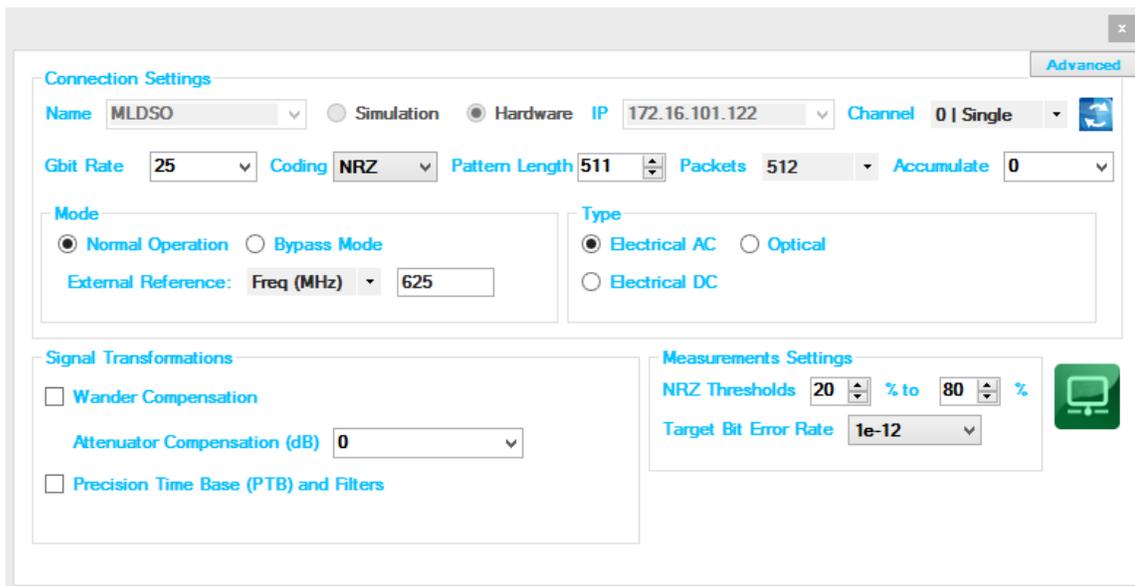
DSO Configuration

Connection Configuration

- Change the configuration as needed:

  - The default display name of DSO can be edited as preferred.

  - The IP of the DSO connected by writing it next to "IP" label

  - Name the DSO by writing next to the "Name" label.

  - Click on the hardware radio button to use the instrument.

Data Configuration

The DSO has 3 SMA inputs (two for the differential data (RF Input +, RF Input –) and one for the Clock input)
- The ML-DSO can be mounted in different modes:
  - Normal Operation
  - Bypass Mode

Normal Operation

Clock Input in normal mode ranges between 50 and 710 MHz.

- Choose the Normal Operation radio button to use the onboard timing generator.

- Enter a line rate less than 15Gbps into Line Rate (Gbps) or choose a Gbps value, example: 10.709, 10.625, 10.3125, 9.95328, 8.5, 6.25, 4.25 and 3.125.

- Specify the number of packets; it can be 4, 8, 16, 32, 64, 128, 256 or 512.

  The number of packets specifies the number of sample blocks that will be used to create the 'Eye diagram'. Each sample block consists of 512 sample points per UI, which are duplicated when drawing the Eye. Eg: 256 packets means 131072 points per pattern, and 262144 points per Eye (131072 for each of the 2 UIs displayed in Eye mode)
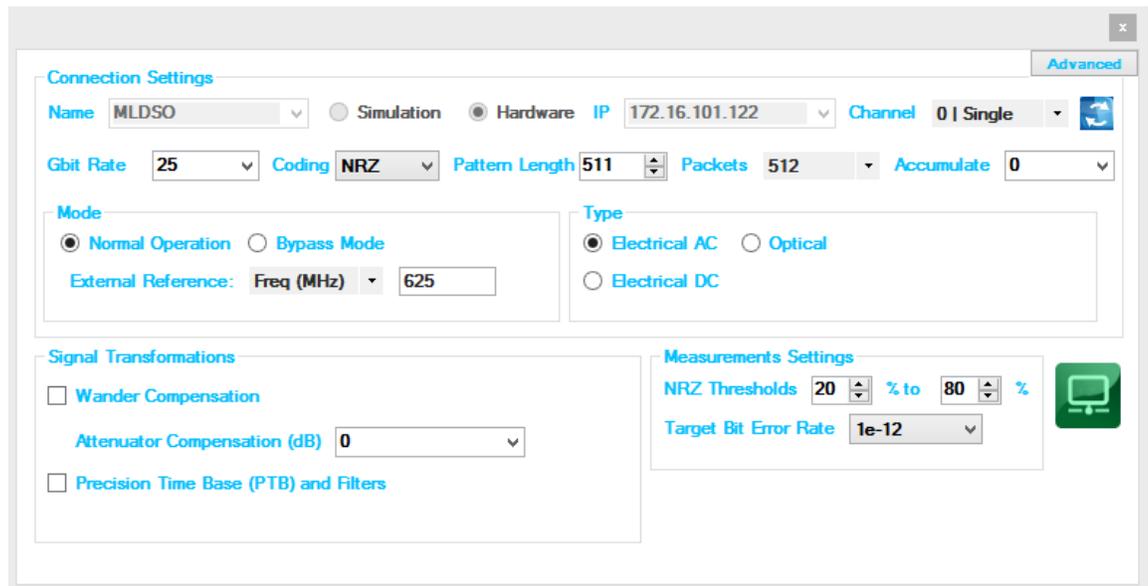
Figure 22. DSO Configuration

- Enter the percentage level of rising and falling time next to the "**NRZ Thresholds**".

- Enter the External Reference Clock frequency in MHz or as a factor of the bit rate

- Its value can vary from 50MHz to 710MHz, with an amplitude range from 0.25 to 1.5 Vpp:

- Typically this will be rate / 16, 64, or 80, but can be any other rate.

- Enter the "Pattern Length" of the data feeding the ML-DSO to capture the full pattern. Incorrect pattern length would still be able to display the eye mode, however full

pattern capture is required for certain features of the software such as Jitter decomposition, PTB and filters.

e.g: Pattern Length = 127 for PRBS-7, The Pattern length of PN(n) is (2^n) - 1.

- To get wander correction, check its box; then choose between the 3 frequencies, 1024 or 2048 or 4096 Hz

- In order to retrieve the last configuration, enter the specified IP and then press the refresh button.

- In order to scale the measured results, to remove the effect of an attenuator connected at the receiving end of the scope, enter the Attenuation value in dB. In optical mode, the value is doubled when the attenuator is at 3dB. In electrical mode, at 6dB.

- To capture more points for finer measurements, accumulate the number of points from all the acquisitions by entering the total number of points to persist in the accumulate field. This will set the number of points filling the entire eye diagram, for both UI's; half this number of points will be displayed in the pattern diagram. Accumulation works in infinite persistence mode, and unless the points are cleared or the connection is reset, all acquisitions will take part in the accumulated result with equal amounts of points randomly selected from each acquisition.

- In order to improve graph clarity and minimize/cancel random jitter, enable "Precision Time Base (PTB)", and enter a value greater than zero. With PTB enabled, you can apply filters such as:
  - Moving average filter for smoothing and can specify window size.
  - 4th Order Bessel Thomson filter at Frequency equal to 0.75 of the bit rate
  - CTLE filter, and can automatically or manually select the filter parameters
  - S2P De-Embedding filter simulating the inverse of a channel or DUT, where the channel's S2P file is loaded
  - DFE : decision feedback equalizer (nonlinear adaptive equalizer), it is based on the principle that once you have determined the value of the current transmitted symbol, you can exactly remove the ISI contribution of that symbol to future received symbols
    FFE: feed forward equalizer (linear equalizer) each value of the output sequence is a weighted sum of the most recent input values
    The user can use the latest GUI to generate taps automatically for either DFE or FFE, but it can only come up with taps for NRZ PRBS 7 or PRBS 9 signals. The taps can be applied on any type of signal, PAM 4 or NRZ. Therefore if in need of using the software to come up with taps that open the eye, generate the taps for a specific channel using an NRZ PRBS7 or 9 signal, then switch to the desired signal over the same channel using the same taps.

    The configuration parameters are:
    For FFE:
    1- The Tap Delay, expressed as an integer fraction of the Bit Period.

2- The number of taps

3- Tap coefficients: here you enter the different tap coefficients separated by commas, from tap 0 to tap N

4- Normalize: This would normalize the filter taps ensuring unity gain. Note that if taps were generated automatically, they would be already normalize (their sum = 1)

For DFE:

1- The number of taps.

In DFE tap delay is always fixed to 1 tap per bit

2- Tap coefficients: here you enter the different tap coefficients separated by commas, from tap 0 to tap N

3- A delay value in Pico Seconds, which should be ranging from negative bit period / 2, -Tb / 2 to +Tb / 2. This delay defines a shift from the center of the bit UI, at which the DFE slicer decision should be made

Wander Compensation

The Time Base "**Wander Compensation"** check box enables or disables the Time Base Wander Correction for a measurement. Small variations in the **DSO** internal reference time base appear as low-frequency jitter (wander) in the acquired signal.

For mask tests and edge jitter measurements, the **DSO** analyzes the acquired samples and removes the effect of the temporal drift (wander). Wander correction improves the accuracy of **DSO** measurements but may increase the time to acquire data. For applications where measurement speed is important, disabling wander correction is suggested. Reducing the number of blocks to less than 128 significantly reduces the effect of wander and increases the throughputs.
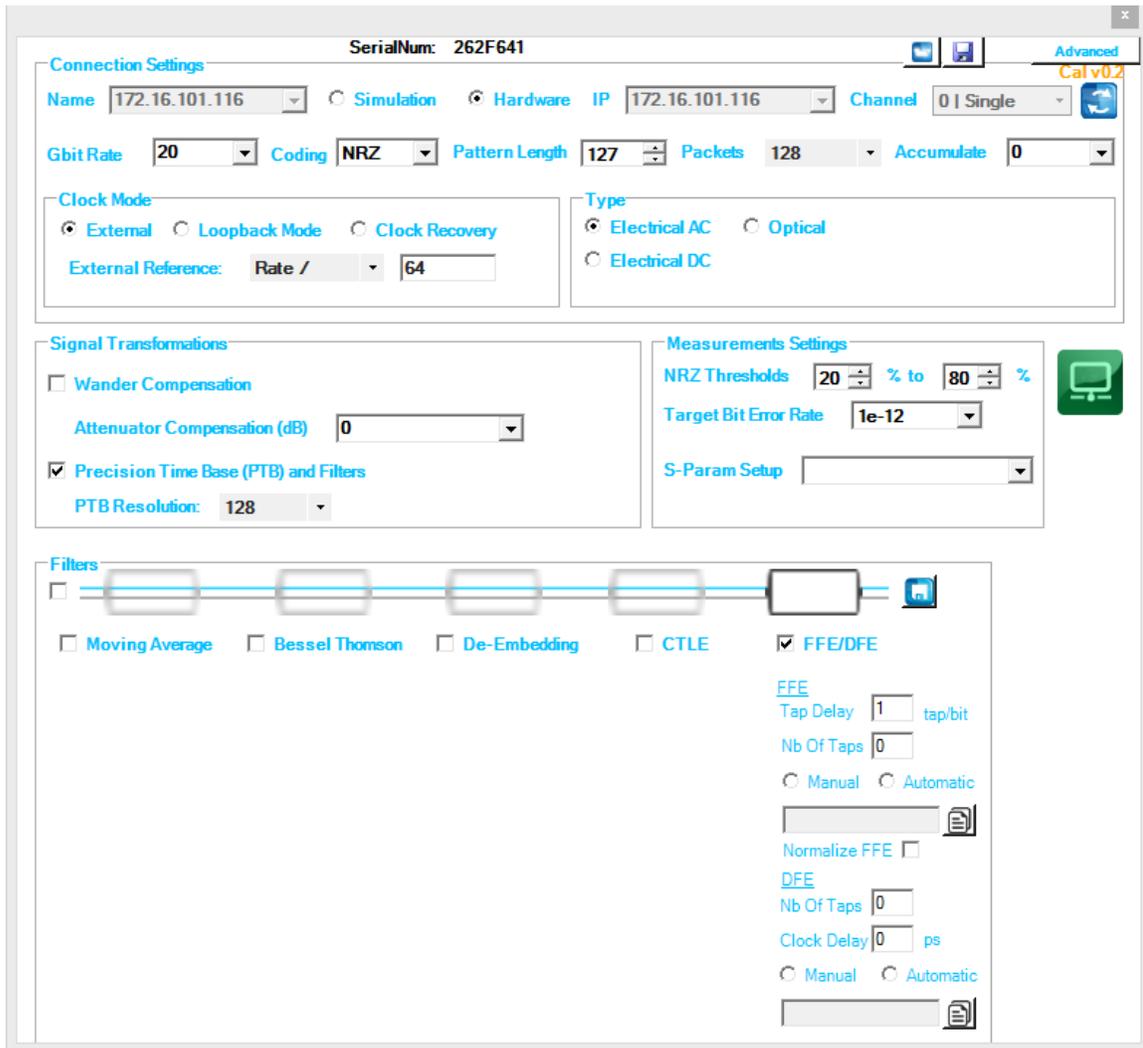
Figure 23: Filters

Figure 24: Wander Compensation

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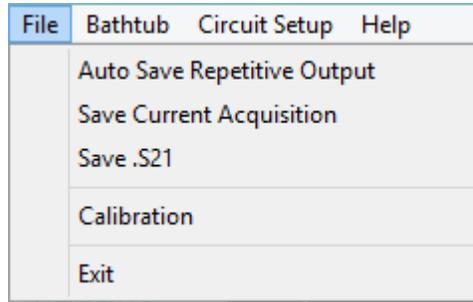
DSO menu bar

Figure 25: DSO menu bar

The menu bar includes "**File**" and "**Help**" menus. It is visible when you right click on the DSO part of the GUI

File menu

- **Save: after clicking on this icon, a "Save" window appears enabling to save Configurations, data and measurements files for each acquisition.**

In the case of being connected to multiple **DSO**s, there are check boxes next to each **DSO**, check the one related to the needed **DSO** and save preferences. Each checked **DSO** has a separate folder. If the 3 options Conf, Data and Measurements are checked; in this folder 3 kinds of files will be found.
Conf: check it to save the configuration file.
Data: check it to save the Data file.
Measurements: check it to save the statistical measurements files.
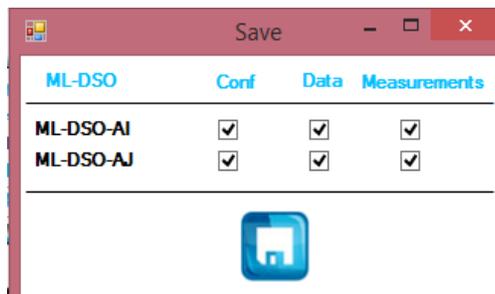
Figure 26: Save window

The version for this software can be found after selecting the "**About Us**" under "**help**" menu option. Then, the following information will be displayed:
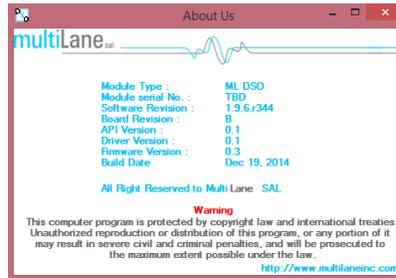
Figure 27: About us

Zoom functions

Zooming can be done by clicking on the graph and dragging, which would draw a dotted window. When the mouse is release, the graph will zoom to display only the content within the drawn box. This method of zooming may alter aspect ratio of the graph is the drawn box is of disproportional dimensions.

Zooming also can be done using the mouse wheel when the Ctrl button is held. This method will maintain the original aspect ratio of the graph.

In order to go back to the initial view, right click on the graph, and choose "**Undo All Zoom/ Plan**"

Panning

The position of the graph in the display window can be panned by dragging the graph with the mouse while the Ctrl key is held.

Copy, Save, Undo Zoom and print a graph

Right clicking the graph exposes these features:

Copy: to copy the present graph as an image into clipboard.
Save Image As: to save the present graph in the desired location.
Page Setup: View page information for printing.
Print: to print the graph.
Show point values: to display the coordinates of points when hovering over them in the graph.
Un-Zoom: to undo the last zooming performed
Undo All Zoom/ Plan: to undo all zooming
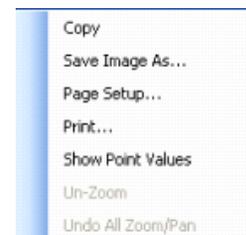
Mode of operation

This section covers the different operation mode of the instrument, addressing the following topics:

- Eye Measurements Mode
  - Oscilloscope Measurements
  - Multiple measurements

- o NRZ Measurements
- o PAM4 Measurements
- o Mask Test

- Color Graded Persistence Mode
- Pattern Capture Mode including Jitter components decomposition

Eye Measurements Mode

Irrespective of hardware or the simulation mode, it will be possible to draw the eye and attain its measurements after filling the configuration window and connecting to the instrument.
In the Eye Mode, in order to draw the eye diagram, click on the "**Start data acquisition**" button 📲.
Check the "**Check All**" button to view all the eye measurements down the screen for one time, or select only the needed measurement by pressing on the specified button. Use the second option to reduce the measurements operation time.
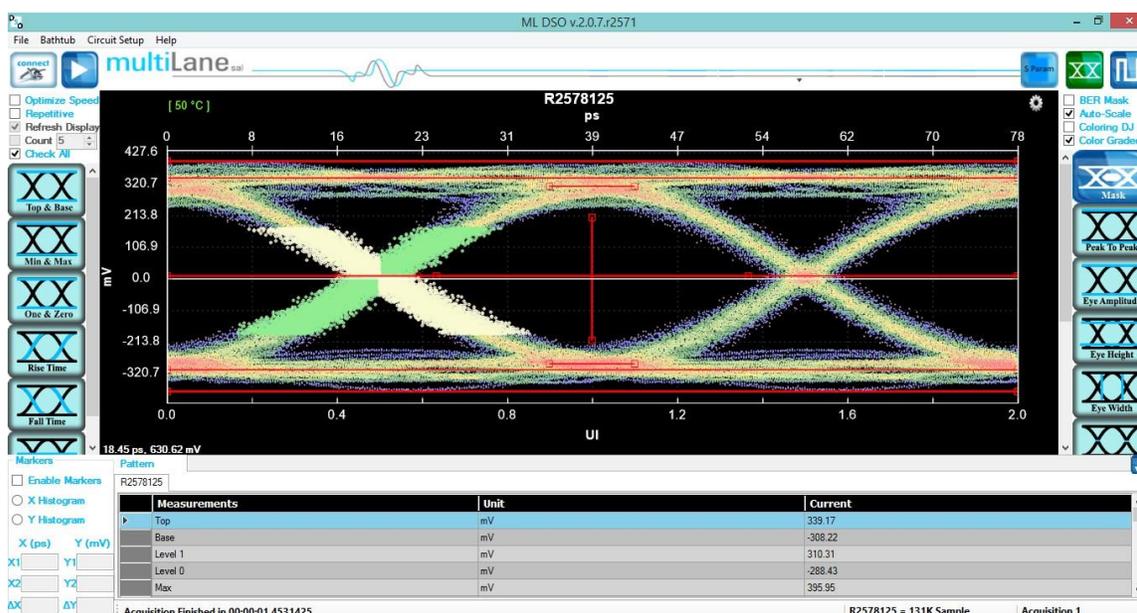
Figure 28: Measurements Mode

If a large number of acquisitions need to be done, click on the "**Repetitive**" check box, then press the "**Start data acquisition**" button 📲 . Check the "**Count**" Text box and specify the number of acquisition if you want acquisition to stop automatically after a certain number of measurements.
By default, the measurements are displayed continuously. However, the eye diagram is frozen since the first acquisition; in order to display the eye for each acquisition check the "**Refresh Display**" text box.
By default the Eye Mode is chosen; if you are located in the Pattern Capture Mode, to move to the Eye Mode click on the button "**Switch to Eye Mode**" XX

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During the acquisition phase the "**Start data acquisition**" button turns to be red and becomes a stop acquisition functionality. Clicking on the red stop button will stop after completing the acquisition currently in progress, and will display the eye and its statistical measurements.

In order to restart the acquisitions, click again on the "**Start data acquisition**" button; a new set of acquisition starts. Accumulated data continues across several runs if not cleared.

In order to save data, statistical measurements and to save configuration files check the SavedData folder under the deployment directory. A folder is created for each **ML-DSO** and inside of this folder you can find 3 different files one for the statistical measurements, one for the configuration, and a data file.

Status Bar

Number of Samples

The status bar displays the number of kilo samples drawn in the Eye mode.

1k Samples is equivalent to 1000 samples point in the Eye Graph, including accumulated point when applicable.

Operation Status

Operation Status	Status description
Gathering Data	Acquiring data (reading from hardware)
Saving Data	Saving data in the data file
Error connecting to DSO	When the connection between SW and HW cannot be established
Error applying Wander Compensation on DSO	Wander cannot be applied because an eye cannot be detected at the first place
Saving Results	Saving acquired data points and statistical measurements into their file.
Displaying results	Showing the statistical measurements and refreshing the graph
Acquisition Finished	Acquiring data and sampling is finished

Table 2: Operation Status

How to add multiple ML-DSOs/Disconnect/Reconfigure

To add a new **ML-DSO**, press the "**Add New ML-DSO**" button in the "**Connect to ML-DSO**" configuration window. Fill it and press connect.

To disconnect from a specified **ML-DSO**, simply click on the "**Close**" button next to its name in the "**Connect to ML-DSO**" form.

To reconfigure the data, click the "**Edit ML-DSO configuration**" icon, and then fill the configuration window as preferred.

To add multiple **ML-DSO**s, repeat the first step.

Oscilloscope Measurements

Drawing the eye, the user can perform eye measurements by simply clicking the corresponding buttons: Top, Base, Min, Max, Fall time, Rise time, Peak to Peak, Eye Amplitude, Eye Height, Eye Width, Jitter, and the crossing percentage. The "**Check All**" text box can be selected to see all the measurements in one shot.
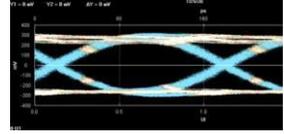
When multiple **DSO**s are connected, and after drawing all the eyes or patterns, the measurements are displayed for all **DSO**s down the screen in the tables.

Markers

This feature by default is Off; in order to use it, switch it to On by choosing the "**On**" radio button, under the "**Markers**" group box.

Pair of movable markers in both X-axis and Y-axis is displayed. The horizontal and vertical markers help bound the measurement region by giving the difference between the 2 horizontal and vertical markers.

The results are displayed in the top of the graph. Pico second or UI is the unit of the X axis; mV is the unit of the Y axis.
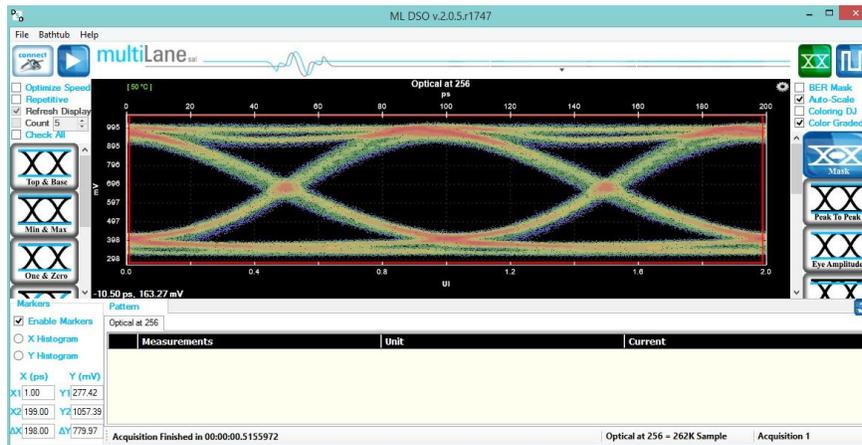
Figure 29: DSO Markers

▪ First select the marker to be moved; it should be highlighted in yellow.

▪ Drag the markers to the required location.

▪ The marker values displayed in the textboxes bottom left can be used to manually specify the marker positions.

▪ Markers help verify horizontal and vertical measurements, such as jitter, eye width, eye height, and mask margins. They can be dragged manually to view the delta or difference between 2 markers.

Histograms

The X and Y histograms shows the Density Distribution of the samples along the x and y axis.
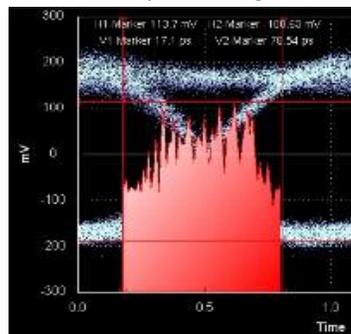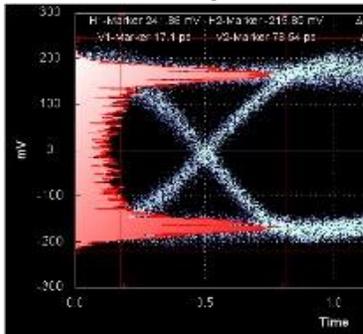
Top
The average y-value of the high-to-high transitions.
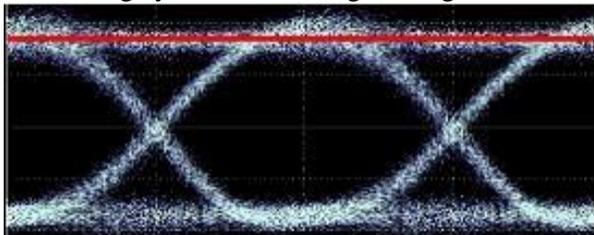
Base
The average y-value of the low-to-low transitions.
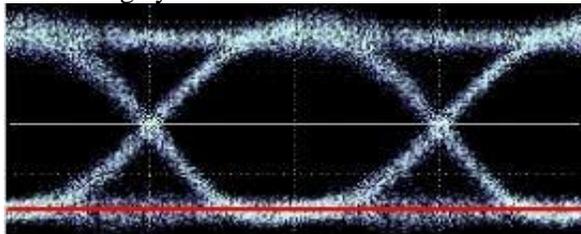
One and Zero level
The average y-value at 20% around center of the eye
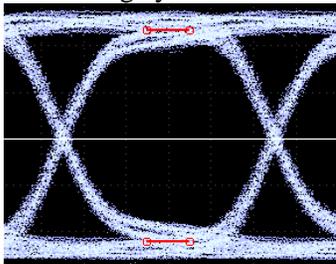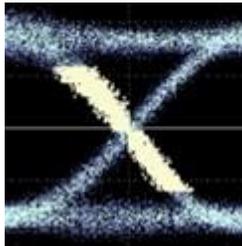
Min

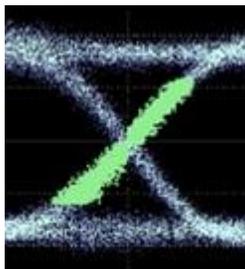The minimum sample value.
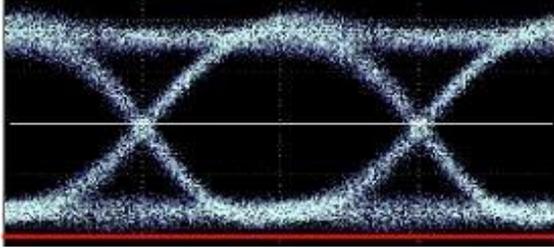
Max

The maximum sample value.
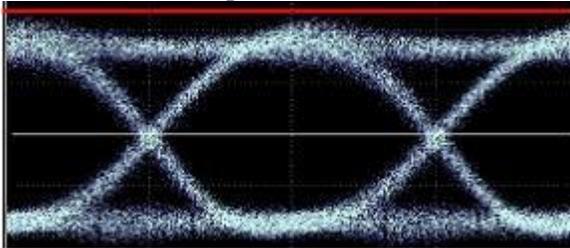
Fall Time

The mean transition time of the data on the downward slope of an eye diagram between 2 defined thresholds e.g. 80% and 20%. Note that the percentage level of the rise and falling time can be changed by modifying the NRZ thresholds in the data configuration window.

Rise Time

The mean transition time of the data on the upward slope of an eye diagram between 2 defined thresholds e.g. 20% and 80%.

Peak to Peak

The difference between the max and the min eye sample values, here Max is the value of the sample point with the highest amplitude and Min is the value of the sample point with the lowest amplitude.
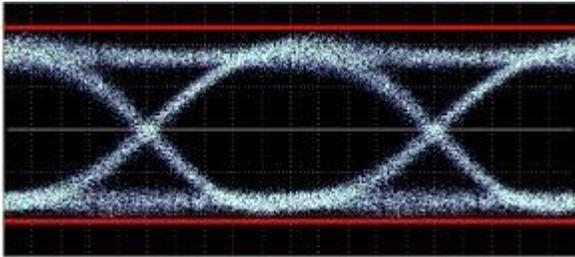
Eye Amplitude

The difference between One level and Zero level of an eye.
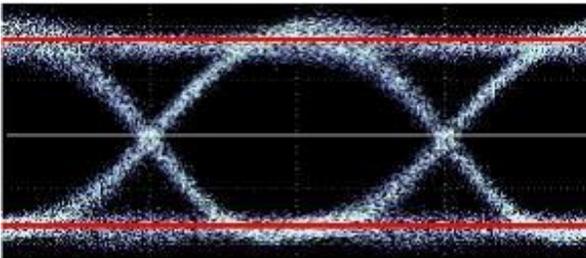
Voltage Amplitude

The difference between top and base of an eye.
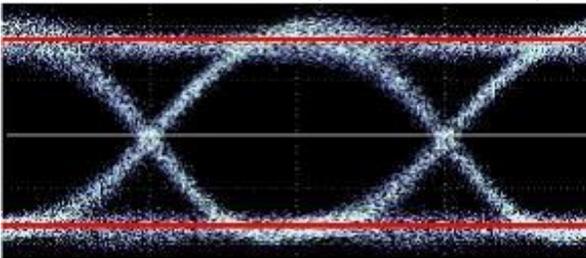
Eye Height

The vertical opening of the eye. Eye Height is the vertical opening of the eye measured as the difference between the -3 sigma value of the high samples within the NRZ window and the +3 sigma values of the low samples within the NRZ window.
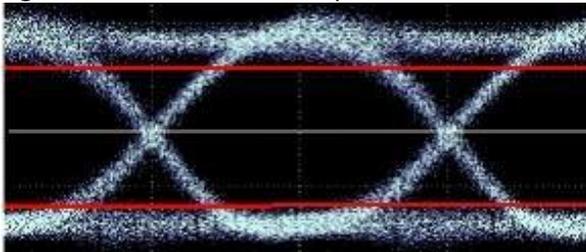
Eye Width

The time between the latest possible occurrences of one eye Crossing to the earliest possible occurrence of the next crossing
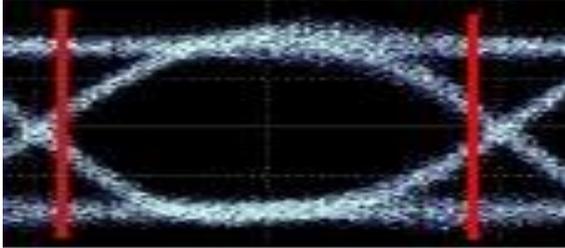
Total Peak-to-peak Jitter

Jitter is defined as a measure of the short-term variations of the significant instances of a digital signal from its ideal position on the time axis. In other words, ideally, an edge should always land at the same position on the time axis. In the real world, the edge is sometimes a little early, sometimes a little late. This is jitter. In this revision the Jitter value is Peak to Peak.
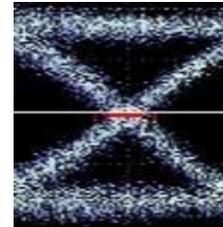
Crossing percentage

The amplitude of the crossing level relative to the low and high levels.
(The value of the crossing percentage is displayed in the bottom of the screen.)
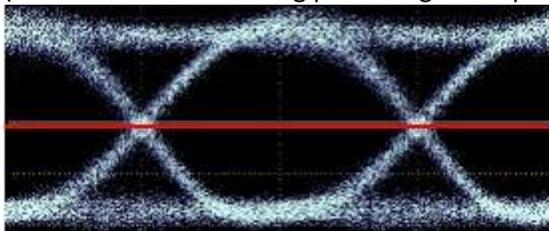
SNR

The signal to noise is a ratio of the signal difference between one level and zero level relative to the noise present at both levels.

Jitter

The jitter measurement allow to calculate the total jitter, the jitter peak to peak and the jitter rms in ps.
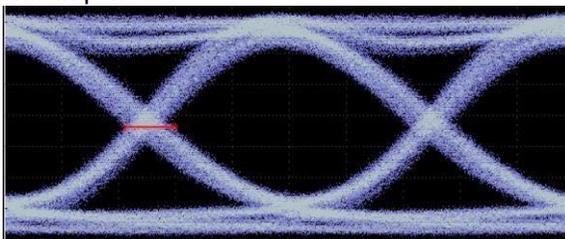
VEC

VEC = Vertical Eye Closure in dB.

Calculated in NRZ as: 20 x Log [Eye Amplitude / Eye Height]
Calculated in PAM 4 as: 20 x Log [Max(AVupp/Vupp , AVmid/Vmid , AVlow/Vlow)]

Note: AV is the eye amplitude and V is the eye height in PAM4 mode

Multiple measurements

The multiple measurements gives the user the ability to view the different measurements: Top, Base, Min, Max, Fall/ Rise time, Peak to Peak, Eye Amplitude, Eye Height, Eye Width, Jitter, and the crossing percentage for a number of measurements specified in the repetitive box or for an undetermined number. Use the **Check All** text box to display all the measurements

Statistics

To enable repetitive data acquisition, and statistics measurements, the repetitive mode needs to be checked or the numbers of acquisition in the counter box needs to be increased, then the statistical measurements are shown and the following is displayed: Current value, Average, Minimum, Maximum and the standard deviation of each measurement.

DJ & RJ

The DJ value is displayed in ps, and the RJ value in fs
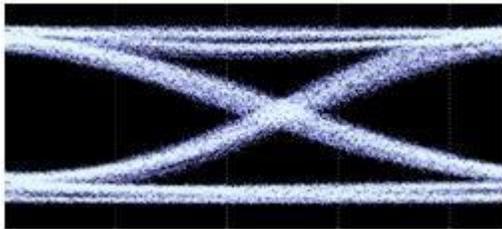
Mask Margin

The "**Switch to Mask Mode**" button, located between the Eye and Pattern buttons, is used to find the maximum mask margin that results in no more than a specified number of failing points. The figure below shows an example where the user wants to determine the maximum mask margin available for the highest number of failing points, but no more than 25.

The answer in this example is +13% for 8 points. Setting the margin below this level would result in less failing points in total. Setting the margin above this level would result in fewer failing points.
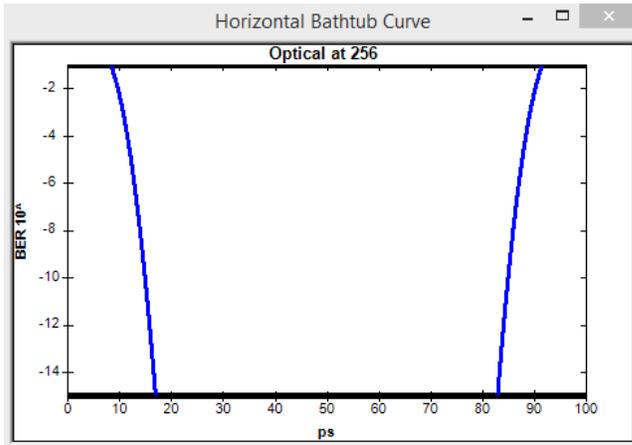
The number of failing points is displayed down the screen in the status bar.
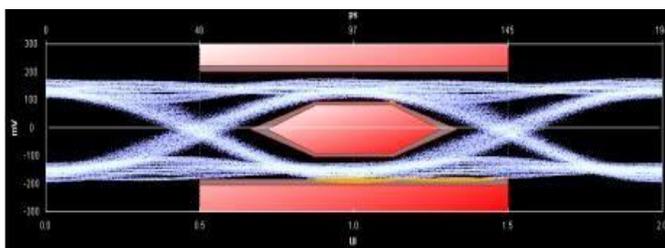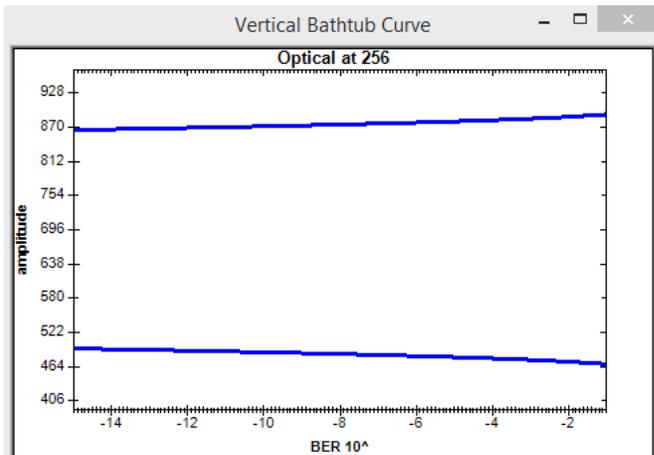
The **DSO** has these standard masks: 100Gbase-SR, LR, STM-1, STM-4, STM-16, Gb Ethernet, Fiber Channel (1x), Fiber Channel (2x, 4x), Fiber Channel (8x), Fiber Channel (10x), 10 Gb Ethernet, and user defined masks. New masks are continuously added. Recent additions are QDR & FDR.
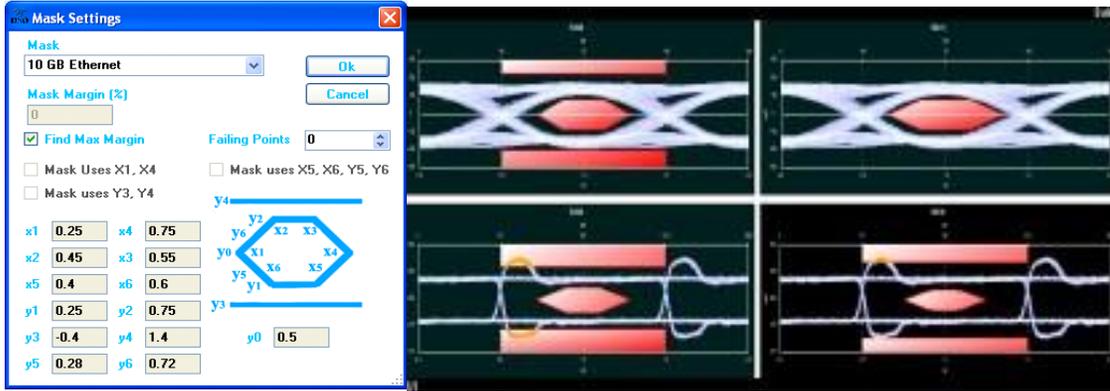
Horizontal Bathtub

Vertical Bathtub

Pattern Capture Mode

The Pattern Capture mode enables the bit sequence captured by the DSO to be seen. In order to see the behavior of a specified sequence of bits, zoom in and out by scrolling the mouse wheel, or using the cursor to specify the region to be zoomed in upon. Pattern rise/fall times pre-emphasis, post-emphasis, PRBS validity and VMA (voltage modulation amplitude) can be measured in this mode. Note Pattern Capture mode needs to be able to show the full pattern for certain features of the software to work, such as:
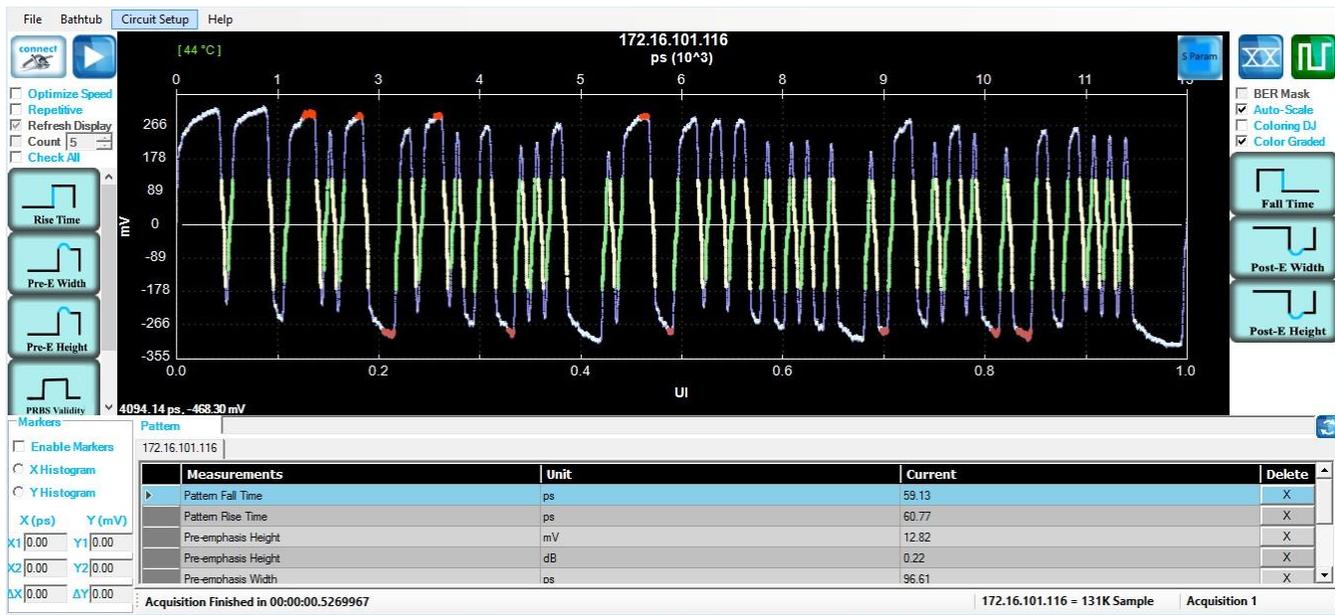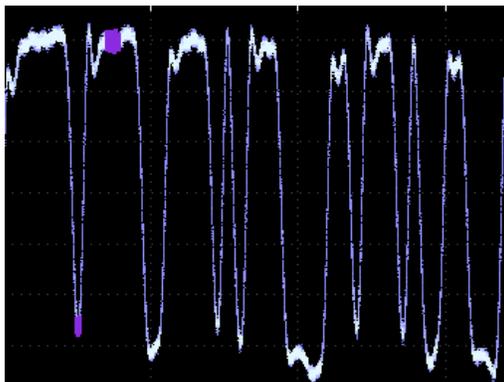

Figure 30: Pattern Mode

VMA

The voltage modulation amplitude of a pattern displayed in mV

PAM4

Pulse-amplitude modulation (PAM4), is a form of signal modulation where the message information is encoded as one of 4 amplitude levels. Unlike NRZ which varies between 2 amplitude levels indicating zero and one, PAM 4 varies between 4 amplitude levels indicating with one symbol a value in the range zero to three. This leads to double the bit rate for the same baude rate as NRZ.

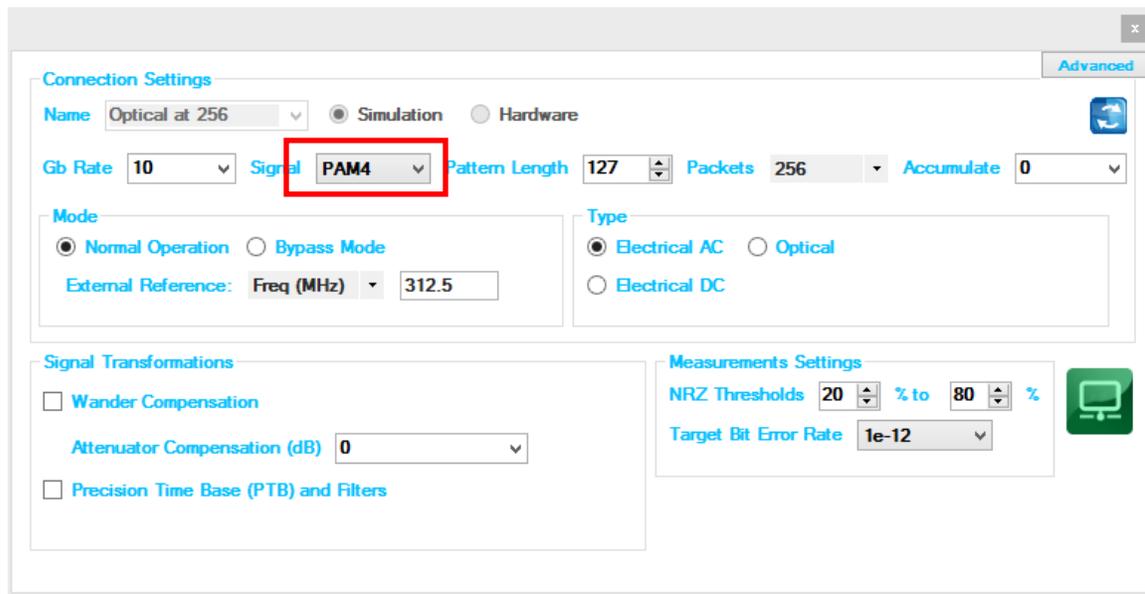To use the PAM4 you have to choose the PAM 4 mode.

Figure 31: Enabling PAM4

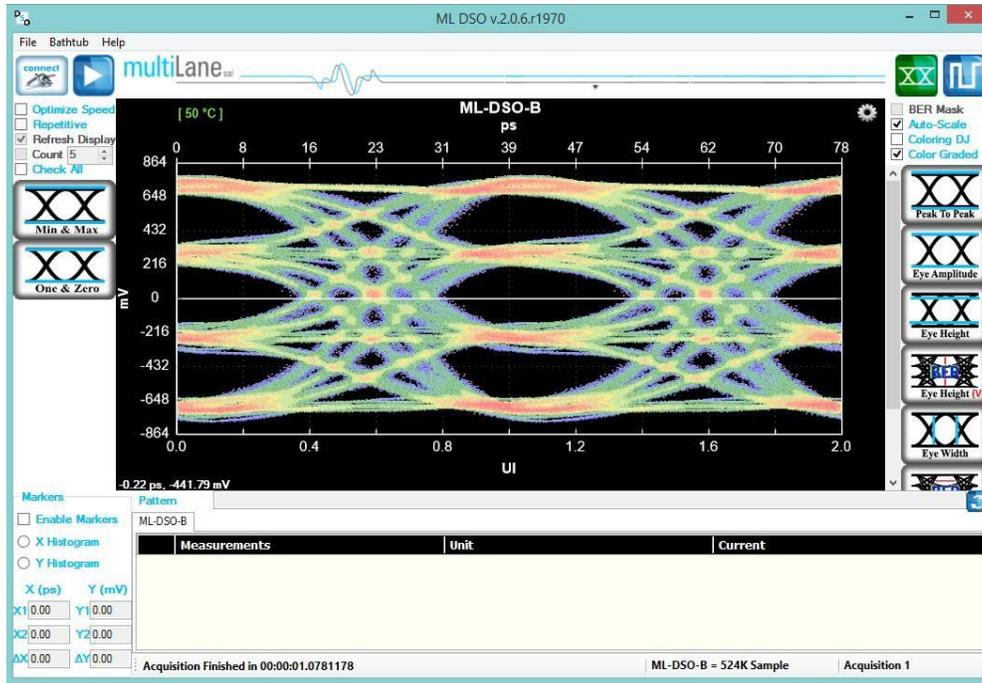Three eyes will be displayed on 4 levels as shown below

Figure 32: PAM4 Display

Some of the measurements (Min, Max, One, Zero, Peak to Peak, Eye Amplitude, Eye Height, Eye width, Eye Height BER, Eye Width BER and VEC)are applied on the PAM 4 mode
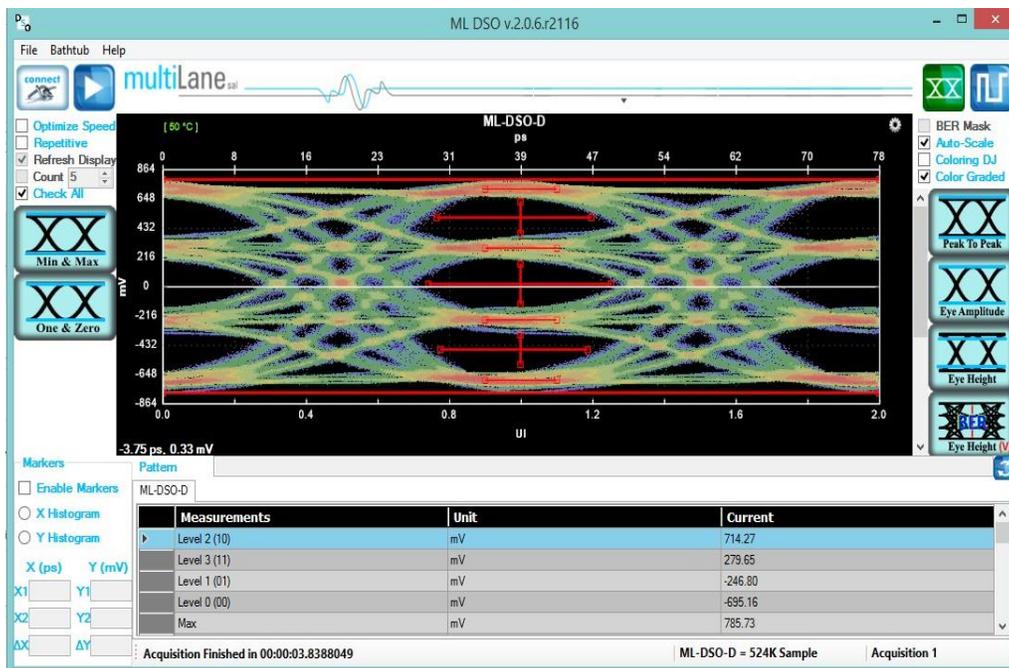

Figure 33: PAM4 Measurements

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Figure 34: PAM4 pattern mode

S Parameter Mode

The Multilane DSO is now capable of measuring the insertion loss S-Parameter.
Depending on how you connect the DSO, you should be able to measure either of S21 dd, S12 dd, S21, S12, S43, S34…

The only difference between all the above is:
1- Whether you're connected single ended or differential
2- The direction in which you've connected the DUT for which you are measuring S-Parameters
3- The ports which you've used when connecting the DUT in case of a Single Ended connection

The approach used consists of these steps:
1- Define your Circuits:
     a. Main Circuit: Contains the DUT whose S-Parameters is to be measured
     b. Reference Circuit:
          i. Excludes the DUT whose S-Parameters need to me measured
          ii. Is as identical as possible to the Main Circuit, except for the DUT
          iii. May require an additional component, such as a through, to be placed in the location of the DUT in order to close the circuit

2- Setup your PPG:
     a. PRBS 7 or 9, 9 is recommended
     b. Maximum Bit-Rate supported (For Maximum Frequency Range in your result)
     c. Cleanest Eye Possible. This sometimes translates to Maximum Amplitude in order to maximize Signal-To-Noise Ratio. However be careful not to exceed the maximum amplitude supported by your MultiLane DSO without using attenuators

     Kindly note PPG settings and amplitudes should not be altered after this point
3- Capture your Reference Signal: When having the cleanest PPG settings as above, and your Reference Circuit connected, run the DSO S-Parameter Setup Wizard to capture reference data for you

4- Without altering any of the PPG settings, connect your Main Circuit, basically just connect the DUT where needed to switch from 'Reference Circuit' to 'Main Circuit', and run in S-Parameter mode, you should now be able to see the S21 Insertion Loss Magnitude drawn on the screen.

     For a constant PPG Source Signal, S21 Is calculated using the equation:
     Frequency Response of DUT = FFT (Main Circuit Signal) / FFT (Reference Circuit Signal)
5- The insertion loss can be saved in external .S21 and .DsoCirc files. These files contain both magnitude and phase information; however phase information is not accurate in the sense that there will always be a linear shift in phase. These files with their

magnitude and phase information can later be used in the DSO Software for de-embedding or emulating the DUT

Components in Use

1- Two Pairs of Cable
2- Two Module Compliance Boards that support the DAC connector. We will need the S-Parameters of these MCBs. Often S-Parameter information is supplied by their vendor
3- One DAC Cable
4- Two through connectors that can connect the cable pairs together. These connectors will be considered to have negligible insertion loss
5- A MultiLane DSO
6- Any PPG, in this example the MultiLane BERT was used

First, Connect Your Reference Circuit Hardware

Begin with connecting the circuit you will use as reference circuit as follows:
Connect PPG differentially to Cable Pair 1, to Throughs, to Cable Pair 2, then to the DSO
PPG → Cables 1 → Through → Cables 2 → DSO

Step 2, Configure your PPG for Cleanest Signal

1- Setup your PPG:
  a. PRBS 7 or 9, PRBS 9 is recommended
  b. Maximum Bit-Rate supported (For Maximum Frequency Range in your result)
  c. Cleanest Eye Possible. This sometimes translates to Maximum Amplitude in order to maximize Signal-To-Noise Ratio. However be careful not to exceed the maximum amplitude supported by your MultiLane DSO without using attenuators

2- Observe the signal on the DSO after Going through the 'Reference Circuit'. Tune the PPG settings, sometimes you need to alter emphasis settings, sometimes amplitudes, sometimes bit rates. Do your best to achieve the cleanest eye possible, for the highest rate possible. Note that you will get S-Parameter Data up to 80% of this rate used

3- Once you have clean settings, note them down. Kindly note PPG settings should not be altered after this point

Step 3, Go Through the S-Parameter Wizard on the DSO

Connect to the DSO

This DSO should currently be reading the signal going through the reference circuit
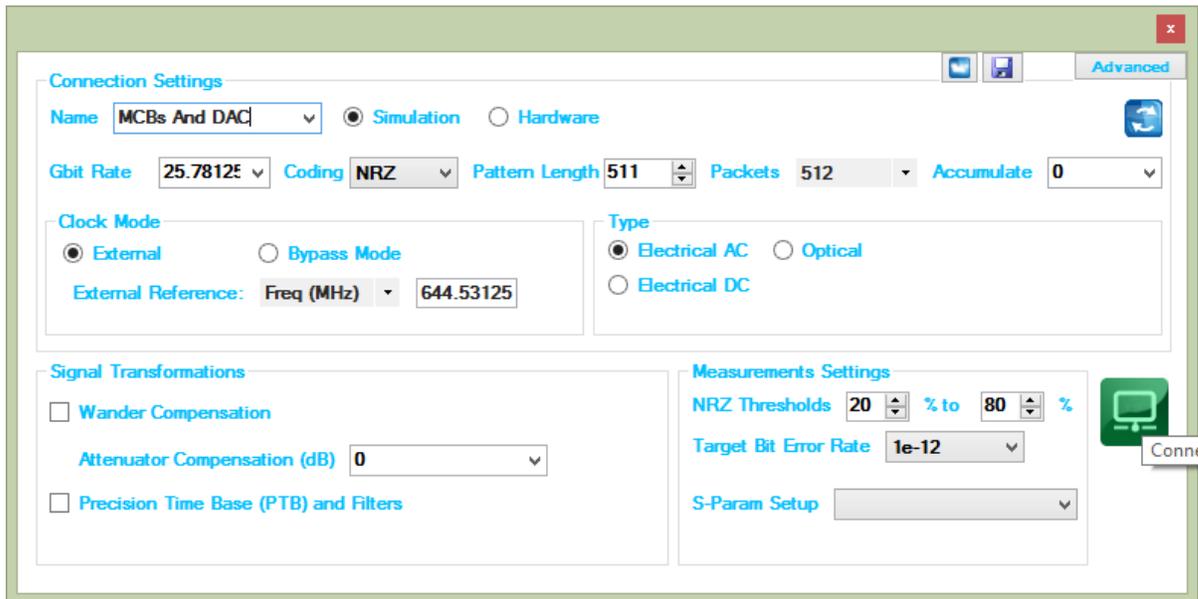Recommended settings include 512 for Packets and PTB

Figure 35: S-Param Configuration
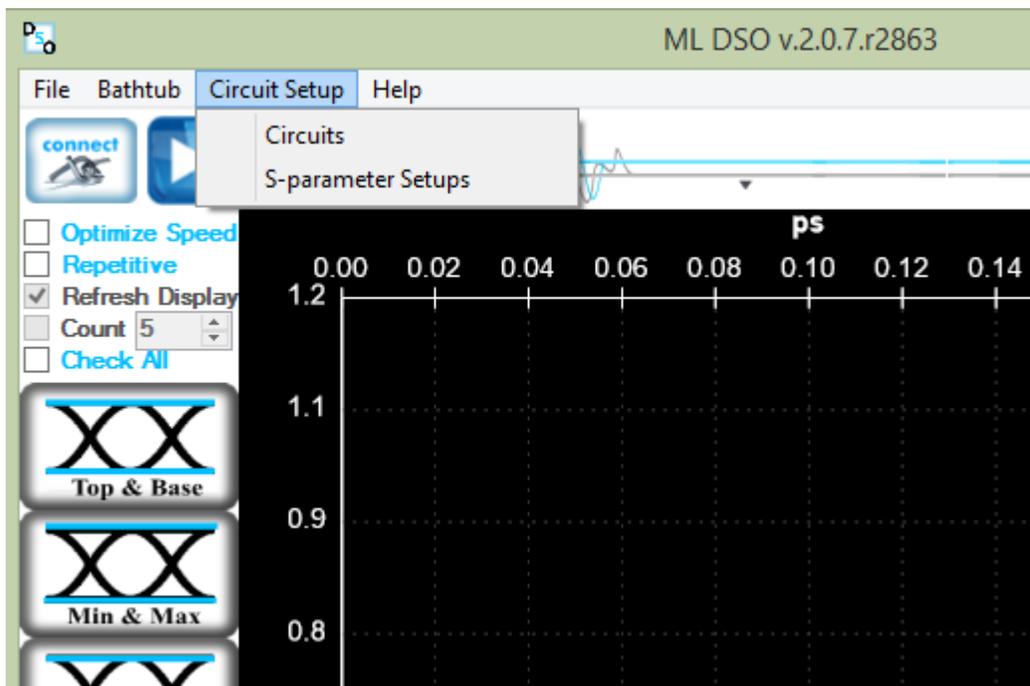
Go to S-Parameter Setup

Figure 36: S-Param setup

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Select the DSO Connected

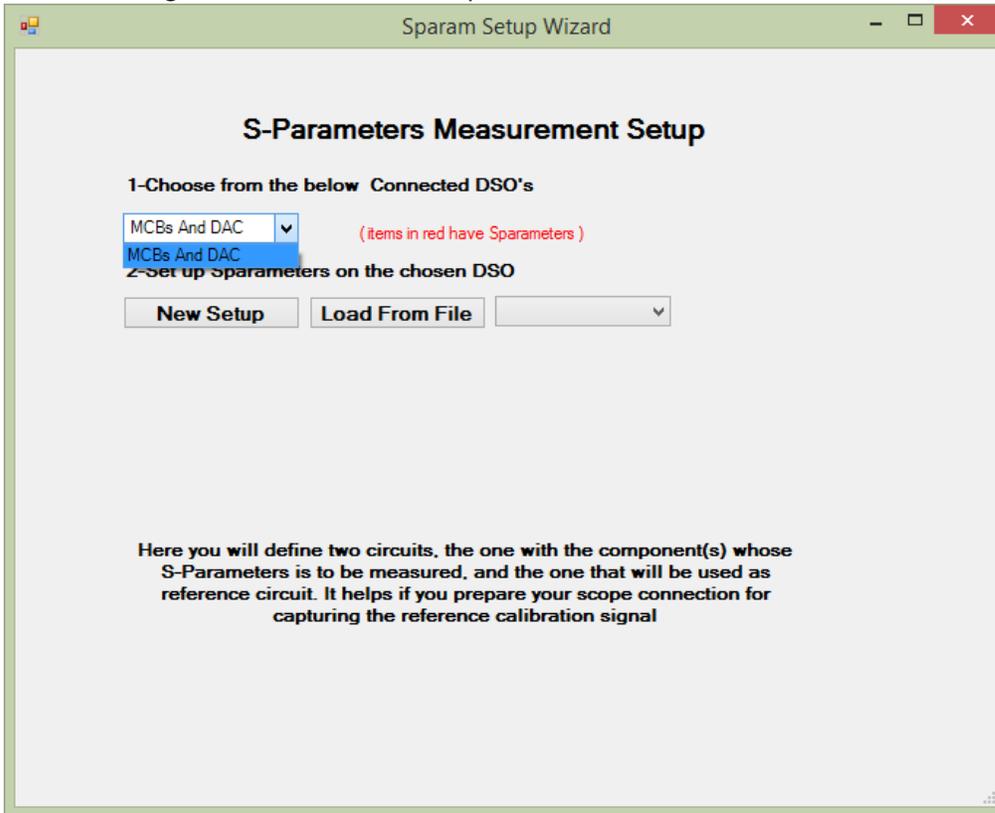After Selecting the DSO click 'New Setup'

Figure 37: Setup
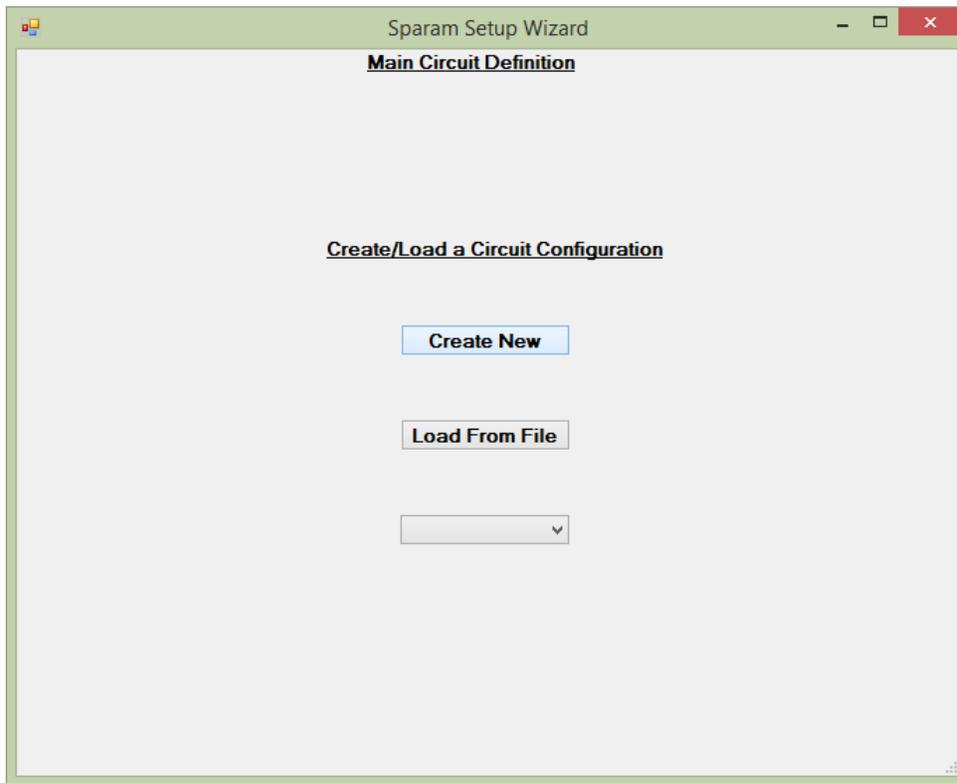
Create Your Main Circuit

Figure 38: Main Circuit

Add the Main Circuit Components

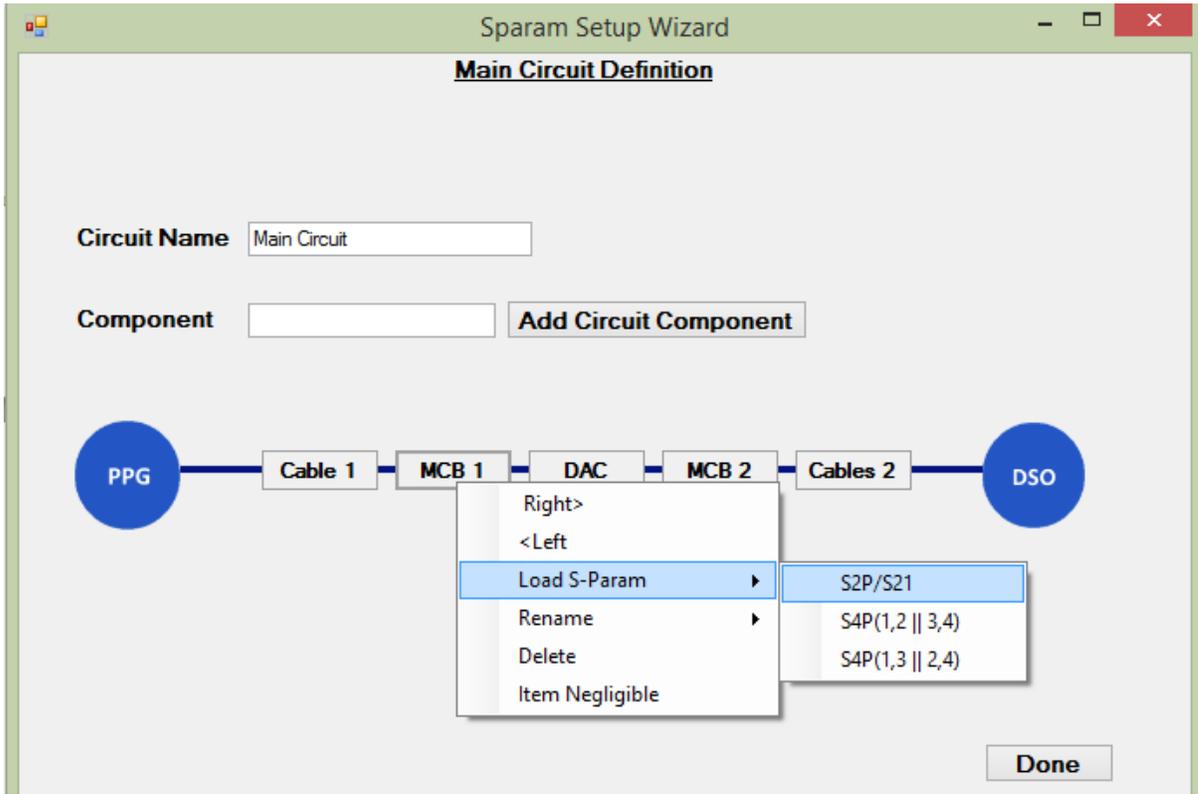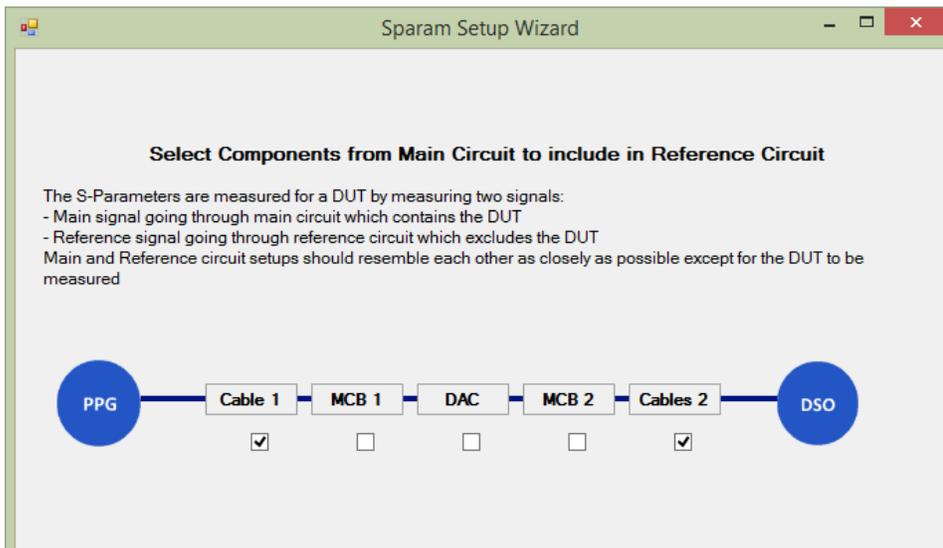Load the S-Parameters of the MCBs. These will be used to calculate the S-Parameters of the DAC
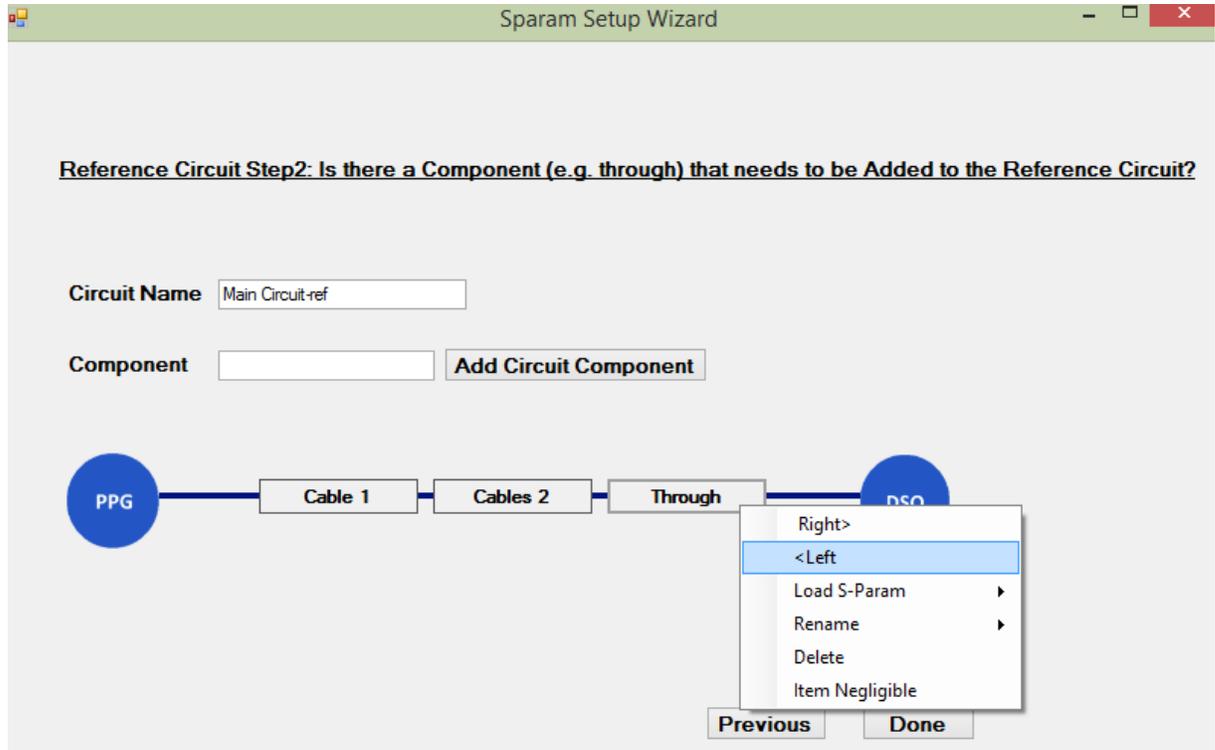
Figure 39: Main circuit component

Proceed by clicking 'Done'

Select Components from Main Circuit Present in Reference Circuit
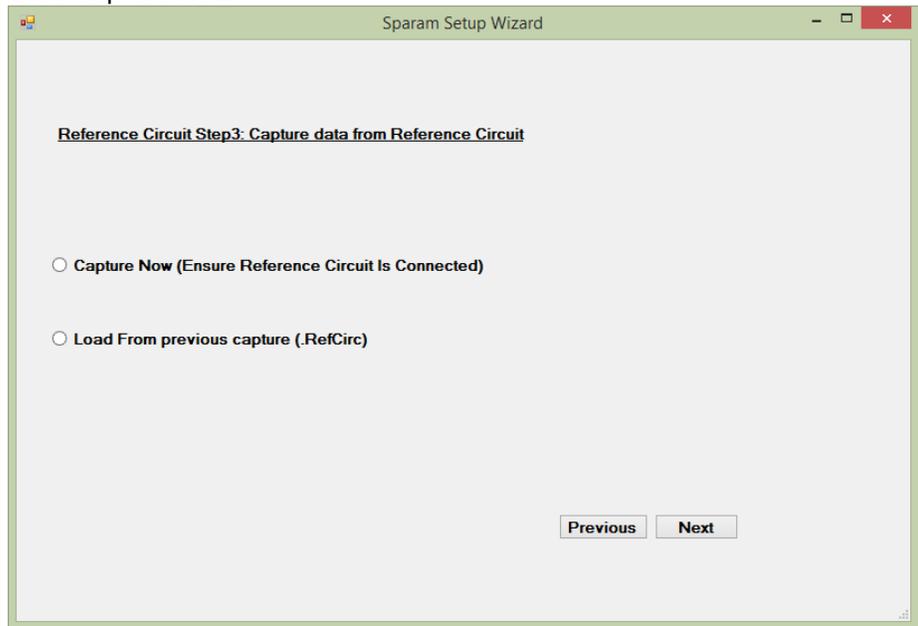
Select Cables 1 and 2 and click Next

**Add Through Connector in Reference Circuit Definition**

When done, click next,

Capture Your Reference Data

Click 'Capture Now'

You are presented with the captured eye,
You may accept it or capture again
Alternatively, you may 'Accept and Save' the reference eye data. This will save the captured reference data for future use, allowing you to use 'Load from .RefCirc' in the future when visiting this page, hence you avoid reconnecting the Reference Circuit
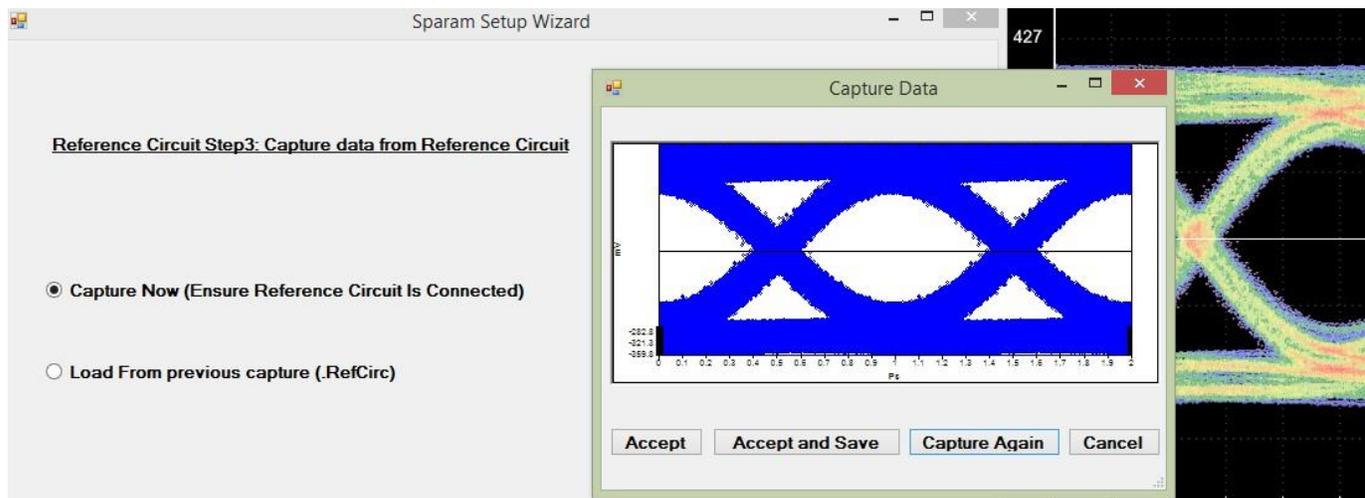
Click 'Next'

How to connect to this instrument

This section covers the connection options of the instrument, addressing the following topic:

- **ML4004-JIT Rev B** BERT Fast Ethernet and USB Connections.

NOTE: The ML BERT GUI can only communicate with the ML4004-JIT over Fast Ethernet. USB is only used to reconfigure the static IP address of the instrument. (note that the IP[1] should be in the same range of the network).

Connecting through an Ethernet cable

To establish an Ethernet connection between the **ML4004-JIT Rev B** Box and a PC, connect an Ethernet **straight** cable between the ML4004-JIT Rev B and the Router or Switch, and make sure you can connect your PC to the router via cable or wireless. Or instead use a **crossover** cable directly between the ML4004-JIT Rev B and the PC. The device can be pinged to verify that a connection has been established.

Make sure to have the correct IP address

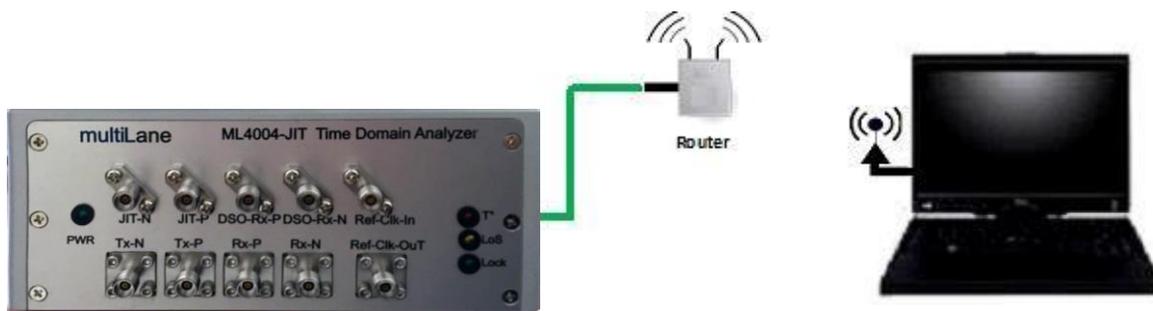**Figure 40: ML4004-JIT Rev B connected with Ethernet crossover cable**

Figure 41: ML4004-JIT Rev B connected to PC via Wireless

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[1]http://*en.wikipedia.org/wiki/***IP**_*address*

USB Driver Installation

USB software drivers' names:

- **ML4004-JIT Rev B USB driver**.

The following instructions are applicable for a manual USB driver installation using Windows XP, Windows 7 and 8. If you're on windows 8, you first should disable driver signing.

- Power up the instrument.
- Plug the USB cable into the PC and connect it to the ML4004-JIT Rev B
- Ignore the messages *new hardware found* or *driver software not successfully installed* by pressing **cancel** or **close**.
- Go to the device manager via a right click on **My Computer:**
    o Click on **Manage**.
    o Click on **Device Manager**.
- Right click on the top level tab
  (Here multilane-PC) and select "**Scan for hardware changes**".

Figure 42: Scan for Hardware

- A message appears stating: "**Scanning Plug and Play compliant hardware**".


Figure 43: Scanning for plug and play compliant hardware

- In the **Other Devices** tab, the **ML4004-JIT Rev B USB Device** description appears.
- In the **Other Devices** tab, right-click on the **ML4004-JIT Rev B USB Device** and select "**Update Driver Software**"…
- A dialog box appears asking for the method to search for the driver software. Select "**Browse my computer for driver software**".
- A dialog box appears asking for the Driver software path. Enter the path and click "**Next**".
- A security dialog box appears, select "**Install this driver software anyway**".
- The PC commences Driver software installation.
  - A Windows message appears (after some time) saying that you have successfully updated your driver software.
- Press close.
- In the Device Manager, a new tab appears named **MultiLane SAL Devices**. Expanding it reveals "**MultiLane SAL ML4004-JIT Rev B USB Device**".
- You are now connected via USB and you can control the instrument.

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Firmware Upgrade

Instructions to upgrade the Firmware

1. In order to invoke the device into boot loader mode, run the ML-IP changer tool
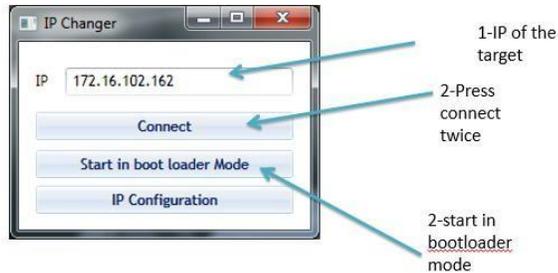
Press connect twice, start in boot loader mode, you will be redirected to the PIC 32 tool.

2. In order to successfully connect the Boot loader to the ML4004-JIT Rev B Boot IP address of 192.168.1.11, the user's laptop must have its Ethernet port configured with the same 192.168.1.XX Subnet. This may necessitate disabling the wireless connection via Network sharing settings in the control panel.

3. When connecting to an instrument with outdated/incorrect firmware, the board LEDs 1 and 2 start blinking and Boot loader Software pops up automatically.
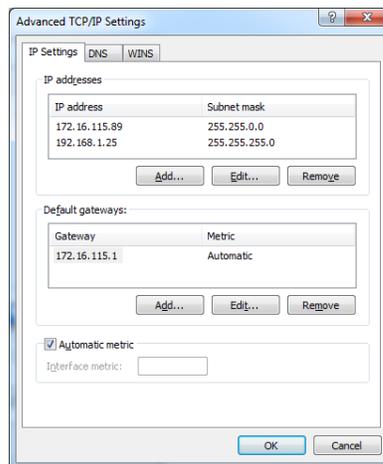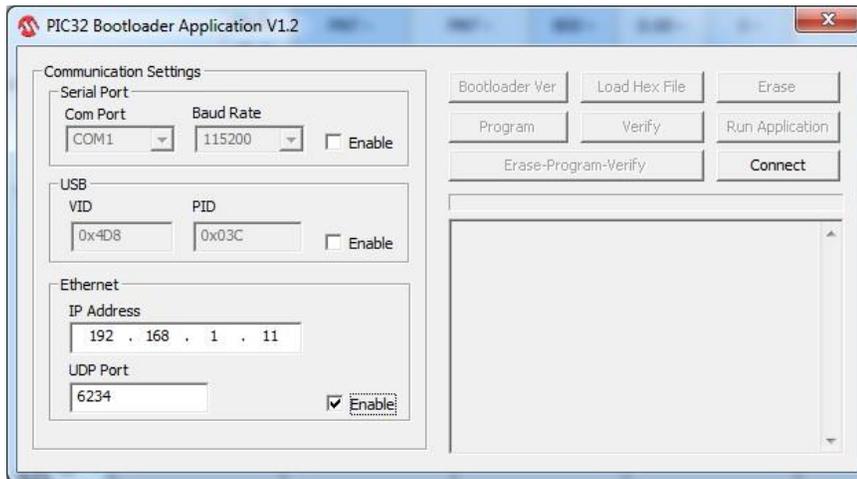

Figure 44: Boot loader Software

4. The IP Address should already be set to 192.168.1.11 and the UDP port should already be set to 6234. Next, click on the "Enable" check box in the Ethernet Tab and then press the "Connect" button.

5. If the connection is successful, the software will display "Device connected"
6. Press "Load Hex File" then load the new ML4004-JIT Rev B firmware and press on "Open". The firmware hex file is located in C:/Program files/Multilane SAL/ML BERT/FWLoad.
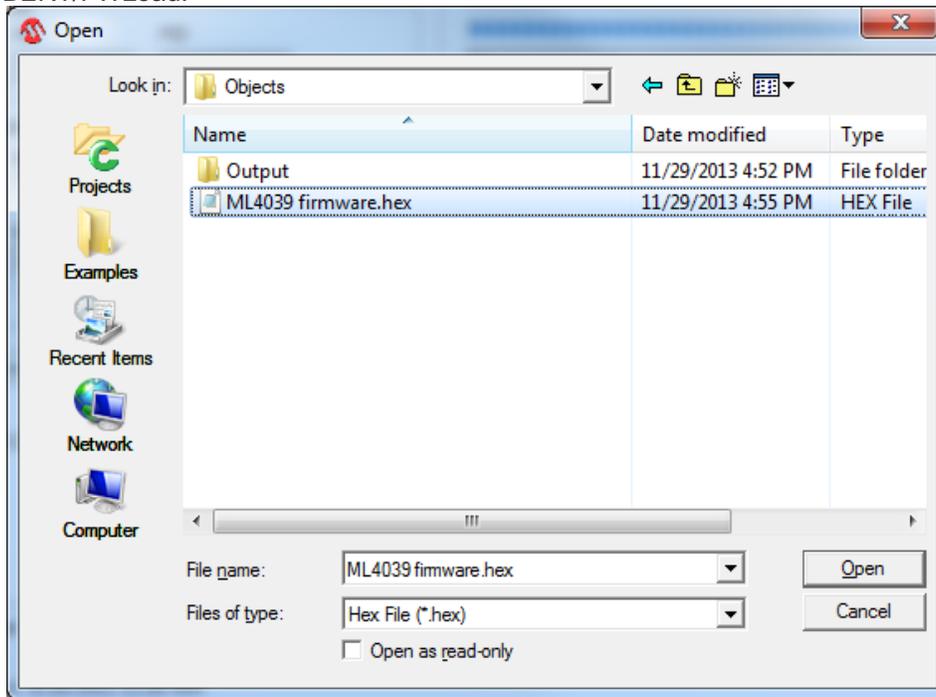

Figure 45: Select Hex File

7. Then press the "Erase-Program-Verify" button. A successful firmware load will show the same results in the Boot loader message window as shown below.
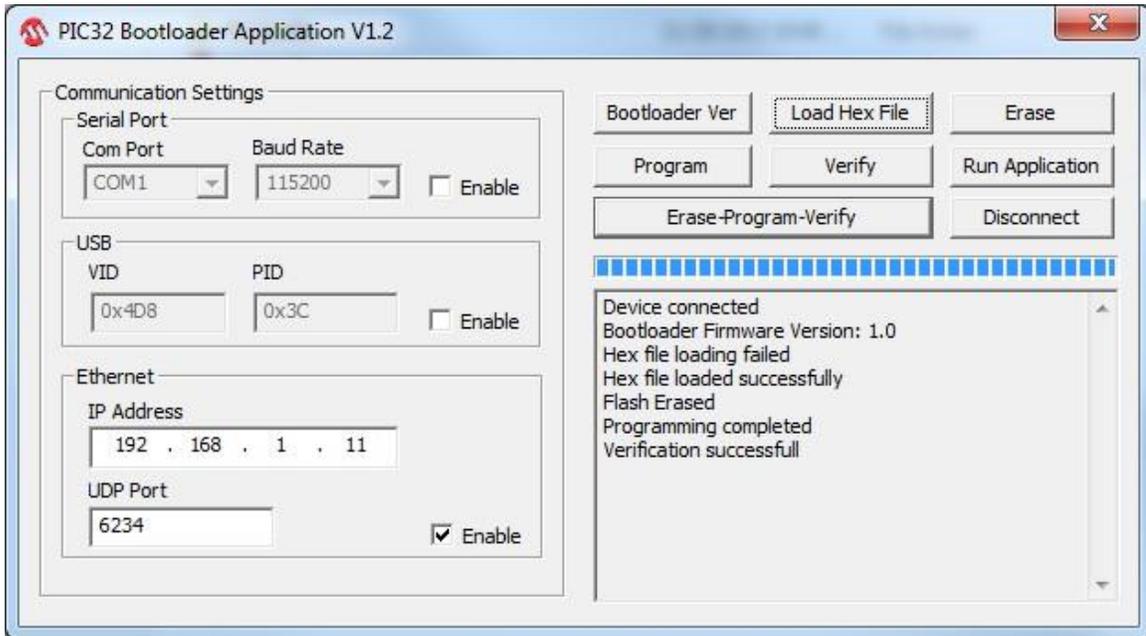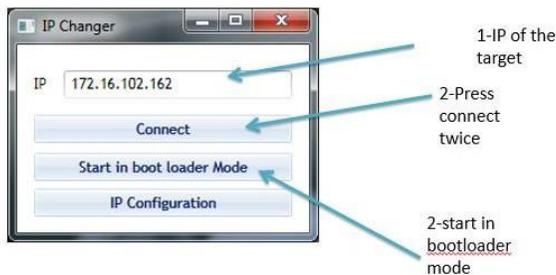
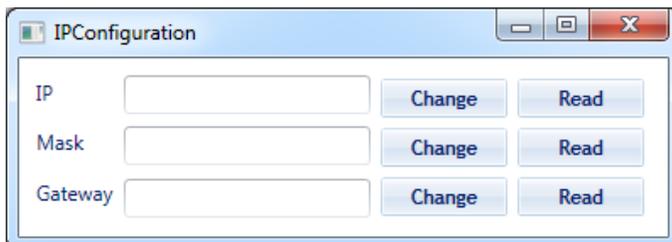**Figure 46: Erase-Program-Verify**

8. Next, power cycle the **ML4004-JIT Rev B.**
9. The **ML4004-JIT Rev B** is now ready for normal operation.

IP changing

1. In the same ML-IP changer tool, click "IP Configuration"

2. Press Read to read the current IP, Mask and Gateway configuration. To put custom configuration press change.

RELATED PRODUCTS

For a complete transmitter/receiver test solution, MultiLane offers the following products:

- **ML4039**: Four Channel 28G BERT for low cost production testing.
- **ML4039-JIT**: Four Channel BERT with full jitter control for receiver sensitivity and jitter tolerance testing.
- **ML4009-JIT**: Single channel with full jitter control for receiver sensitivity and jitter tolerance testing in a standalone metal box.

Ordering Information

Order Information	
Order No.	**Description**
ML4004	Base Model, 800 mV diff. output swing
ML4004-HV	High Voltage option, 3.2V diff. output swing
ML4004-JIT	Jitter Generation output option
ML4004-JIT Rev B	Jitter Generation output option Rev B
• Standard Warranty - 1 Year	
For more information on this or other products, contact Multilane sales team by email at sales@multilaneinc.com	

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Manual Revision History

This section describes the changes that were implemented in this document. The changes are listed by revision, starting with the most current publication.
Revision 1.0: October 11th, 2016; First publication of this document by CB, preliminary revision constructed from original BERT and DSO manuals.

Glossary of Terms/ Acronyms

BW: Bandwidth
TDA: Time Domain Analyzer
NRZ: Non Return to Zero
DUT: Device under test
SONET: Synchronous Optical Networking
SOC: System On a Chip
PCIe: Peripheral Component Interconnect Express
SATA: Serial Advanced Technology Attachment
Optical Reference Receiver: 12G Wideband Optical Reference Receiver, MultiLane's product
Sim: Simulation
Conf: Configuration
PRD: Product Requirements Documentation
HW: Hardware
FW: Firmware
SW: Software
RF: Radio Frequency
Gbps: Gigabits per second
P.C. Mode: Pattern Capture Mode
GUI: Graphic User Interface

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