multiLane

Data Center Test Solutions

Nexus

User Guide

Benefits and Applications:

- System and host port characterization: I2C and low-speed signals.
- 800G capable SI traces
- Ecosystem interoperability testing: I2C sniffer between host and module
- Validates CMIS implementation on module in seconds.
- Voltage noise measurements
- Platform for active modules with module state machine, data path state machine tests and MBM validation tools

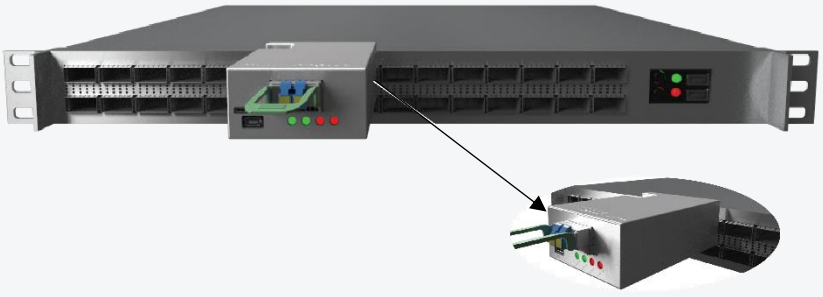


Table of Contents

Key Features

Adapter

800G Adapter Key Features:

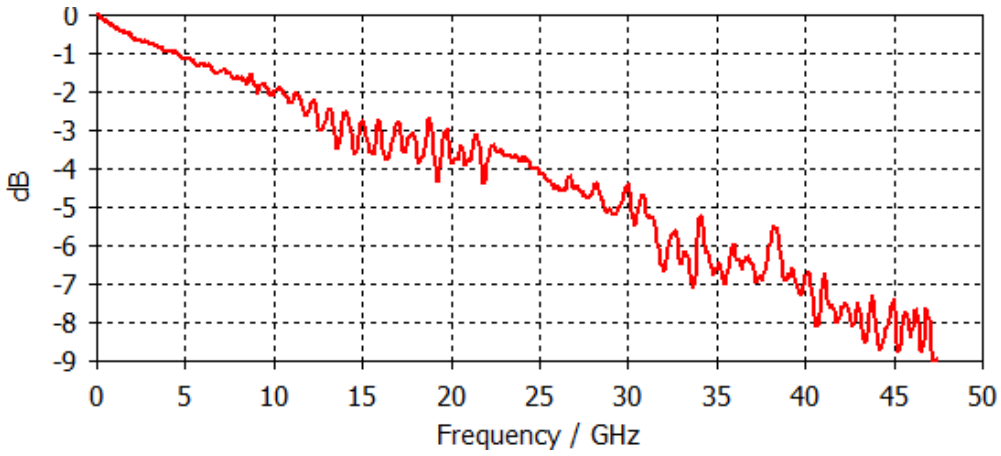
- SI traces and connector support 112G rates
- Support up to 30W modules
- Current and temperature sensor
- Module power ripples and inrush current measurement
- Detection of power spikes during module state transitions
- Probing interface for Vcc and GND pins
- External I2C
- Dip switch to choose low-speed signal source: internal/external
- Available in all SFF/CMIS form factors

Analyzer

800G Analyzer Key Features:

- Voltage sensor
- ePPS signal validation
- 1 MHz I2C
- Probing interface for low-speed signals
- External control for any low-speed signal:
  - INT/RST
  - LPW/PRS
  - SDA
  - SCL
- LEDs for control/alarm signal status
- USB port for PC connection to use GUI or API features
- Available in all SFF/CMIS form factors

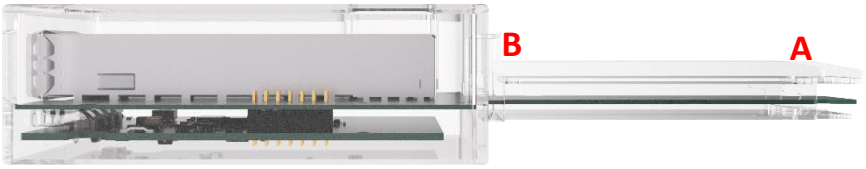
Measured Insertion Loss data of 800G Adapter:



Nexus Hardware

Nexus includes an adapter with 800G traces, which supports 30W modules. Through a set of low-speed pin headers, the adapter mates with the analyzer which gives the user access to the Nexus Software.

The hardware also includes a dip switch, and a front probing interface for low-speed signals access and control:



A: Signals from host side at OSFP800 plug

B: Signals to OSFP800 connector inside Nexus, going to module

Low-speed signals	Dip switch		Front Pin Headers	
	ON	OFF	DIP SWITCH ON	DIP SWITCH OFF
SCL	Plug connected to connector	Front pin headers to connector, plug side disconnected	Probing interface	External driver
SDA	Plug connected to connector	Front pin headers to connector, plug side disconnected	Probing interface	External driver
INT/RSTn	Plug connected to connector	Front pin headers to connector, plug side disconnected	Probing interface	External driver
LPWn/PRSn	Plug connected to connector	Front pin headers to connector, plug side disconnected	Probing interface	External driver

Nexus GUI Installation*

Step 1: USB Driver

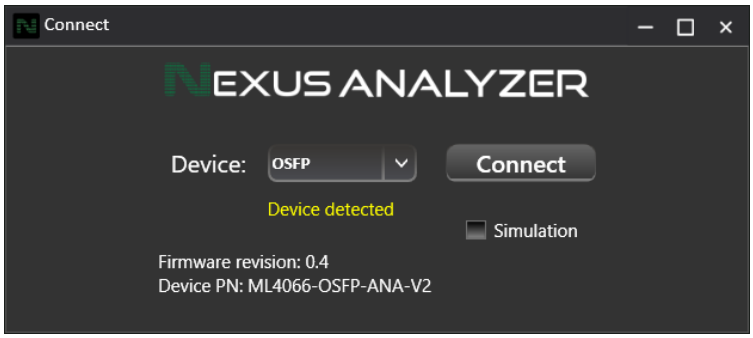
- Download USB Driver https://multilaneinc.com/wp-content/uploads/2023/06/ML4066_ANA_V2_USB_Driver_Signed_V0.1.zip
- Power up Nexus by plugging it into host
- Connect Nexus to the PC through USB cable
- Download the USB driver file
- Go to "Device Manager"
- Find the target device that need to install the driver
- Right-click on the device and select Update Driver Software
- Select Browse my computer for driver software
- Browse you PC and select the driver file
- Click Next and wait until the driver is installed

Step 2: Download Software

https://www.multilaneinc.com/wp-content/uploads/2023/10/Setup_Nexus-Analyzer_v0.5.9.5_2023-10-30.zip

Step 3: Connection & Initialization

Once the software was downloaded, you can access it and the below screen should appear:



Choose the device form factor accordingly and press “Connect”.

Press “Simulation” for a GUI test run without hardware: Simulation mode is also accessed through a simulation license provided by MultiLane.

**GUI installation is only accessible to users with ML4066-NX-Pro.*

This does not apply and is inaccessible to users with ML4066-NX-HW

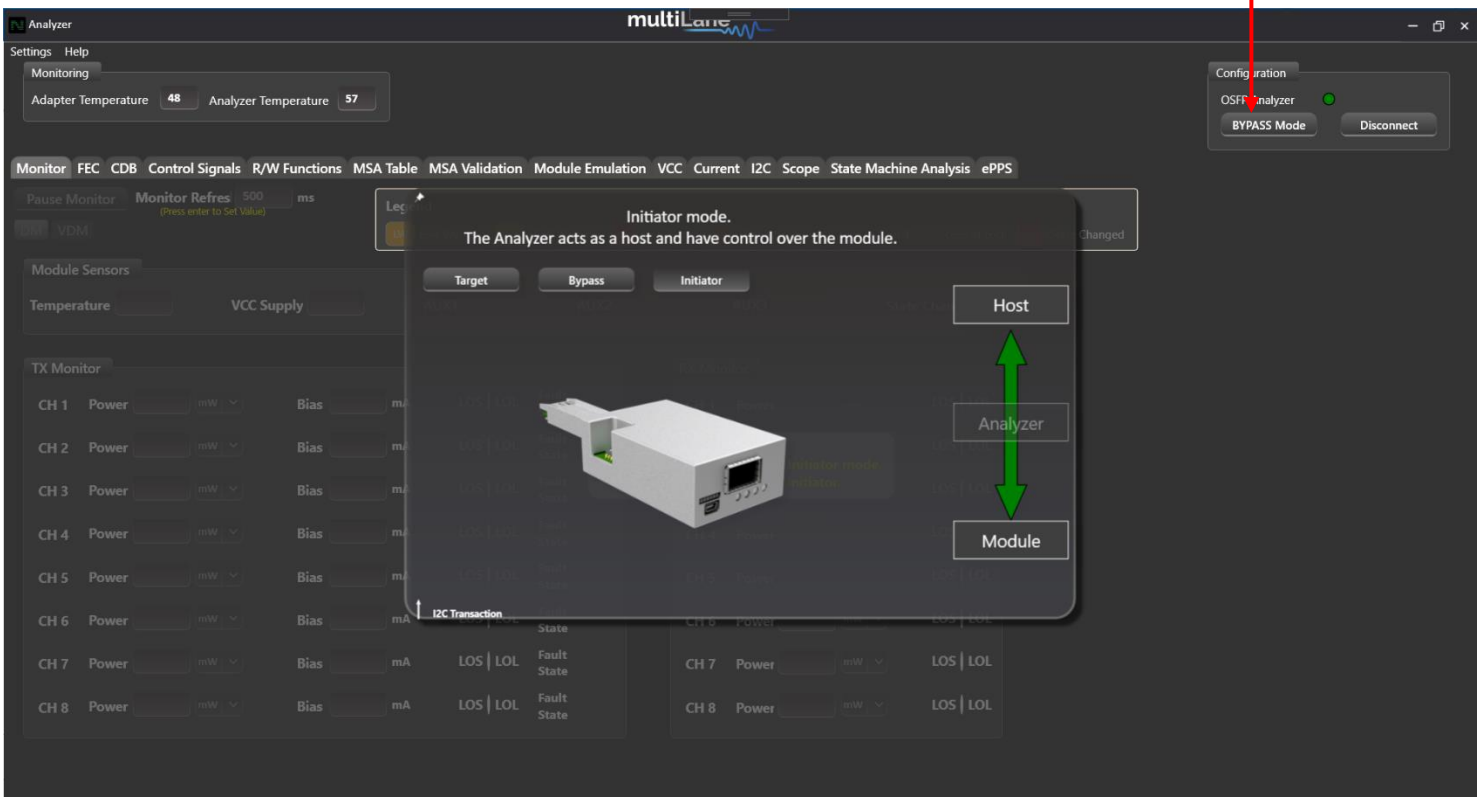
Nexus GUI

Nexus GUI Features	Description
Monitor Tab	Diagnostic and Versatile Diagnostic Monitoring
FEC Tab	Monitor FEC status on their module.
Common Data Block (CDB) Tab	Update their module firmware.
Control Signals	Access to low-speed signals in three different modes
R/W Functions Tab	I2C read/write operations
MSA Table Tab	Gives the user acccess to their module memory.
MSA Validation Tab	Full CMIS/SFF register sweep.
VCC Tab	Continuous VCC Supply measurements.
Current Tab	Continuous and in-rush current measurements.
I2C Tab	I2C packets capturing and packet details analysis.
Scope Mode Tab (any 2 signals at realtime ideal to detect root cause of issues)	SCL, SDA, VCC and Current measurements.
State Machine Analysis Tab	State Machine, Data Path State Machine, and Module State Behavior tests available.

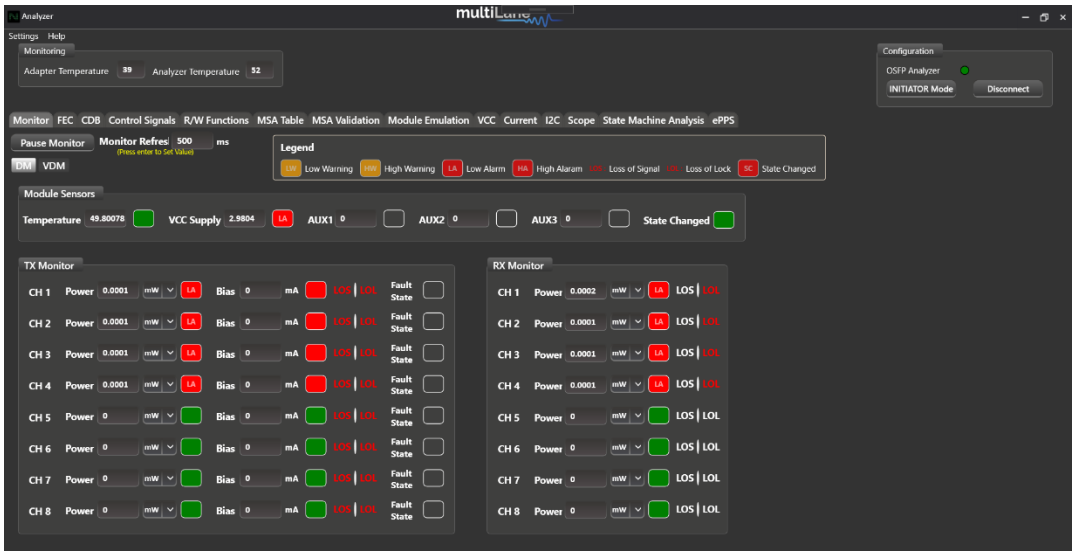
Nexus operates in three modes:

- Target mode: the analyzer acts as a module for a host DUT
- Initiator mode: the analyzer acts as a host for a module DUT
- Bypass mode: the analyzer monitors exchange between host and module.

Access three modes through this button

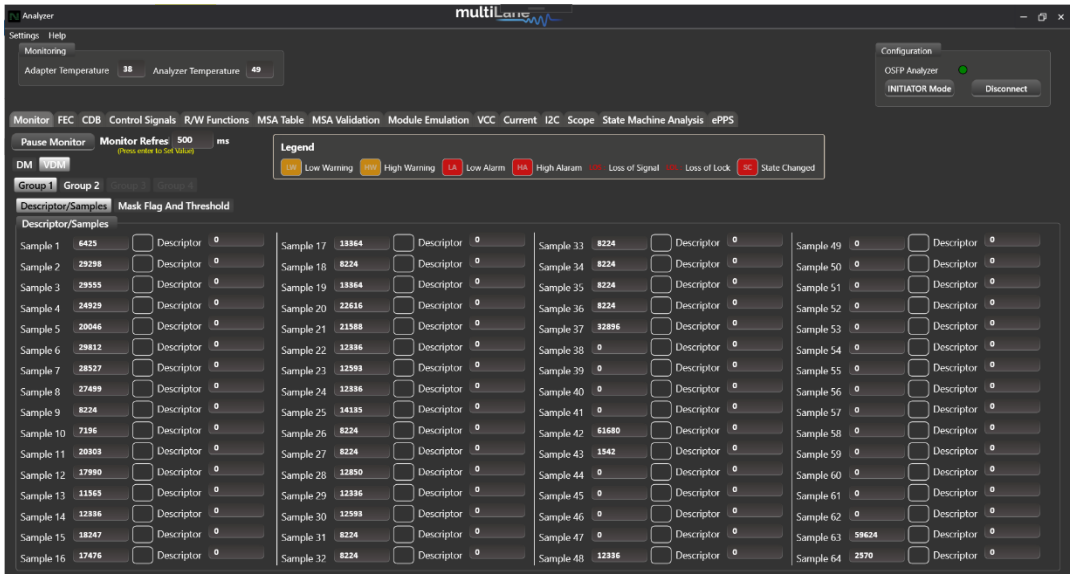


Monitor Tab:



Digital Monitoring

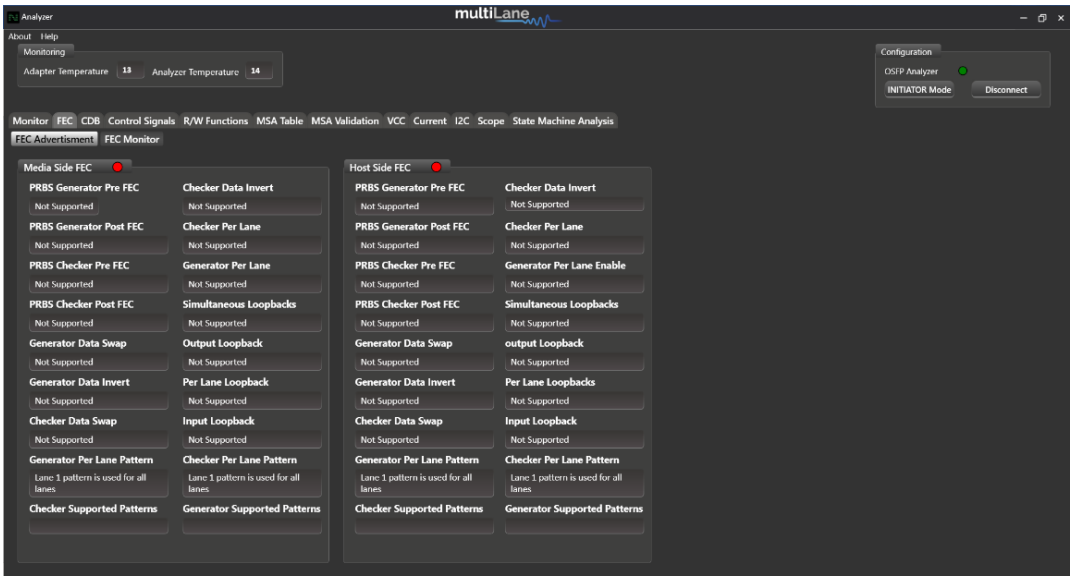
- Operates in initiator mode
- Module monitoring interface
- Color coded high alarms/ high warnings.
- Color coded low alarms/ low warnings.



Versatile Diagnostic Monitoring

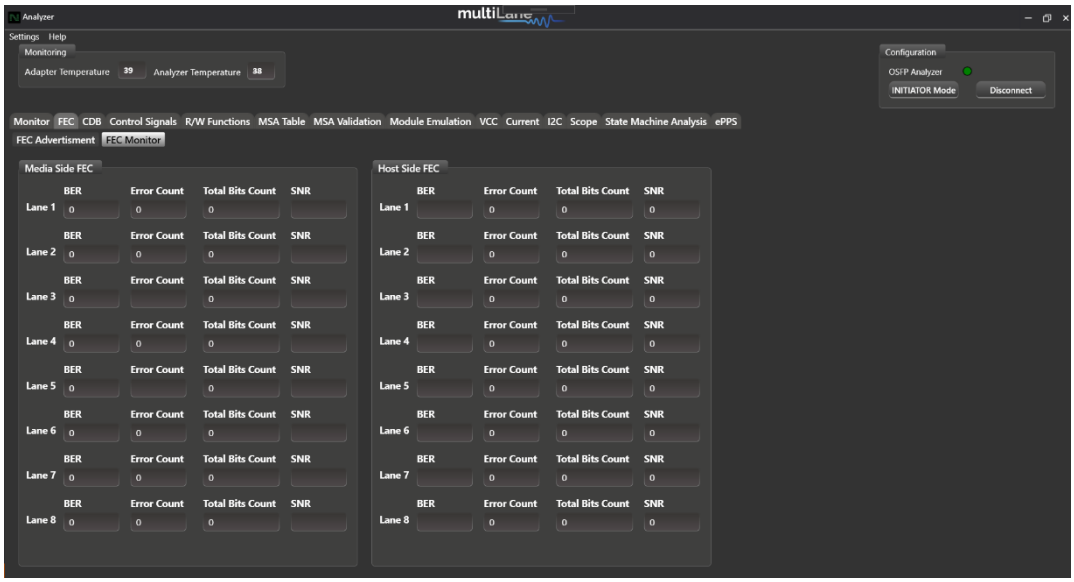
- Operates in initiator mode
- Access to enabled/disabled groups in the module
- Indexing available for module interrupts

FEC Tab



FEC Advertisement

- Operates in initiator mode
- FEC advertisement for transceiver characteristics
- Access to post FEC
- FEC Monitoring interface for BER, error count, and SNR
- Reads FEC diagnostics from module, implements MSA formatting and presents final BER data

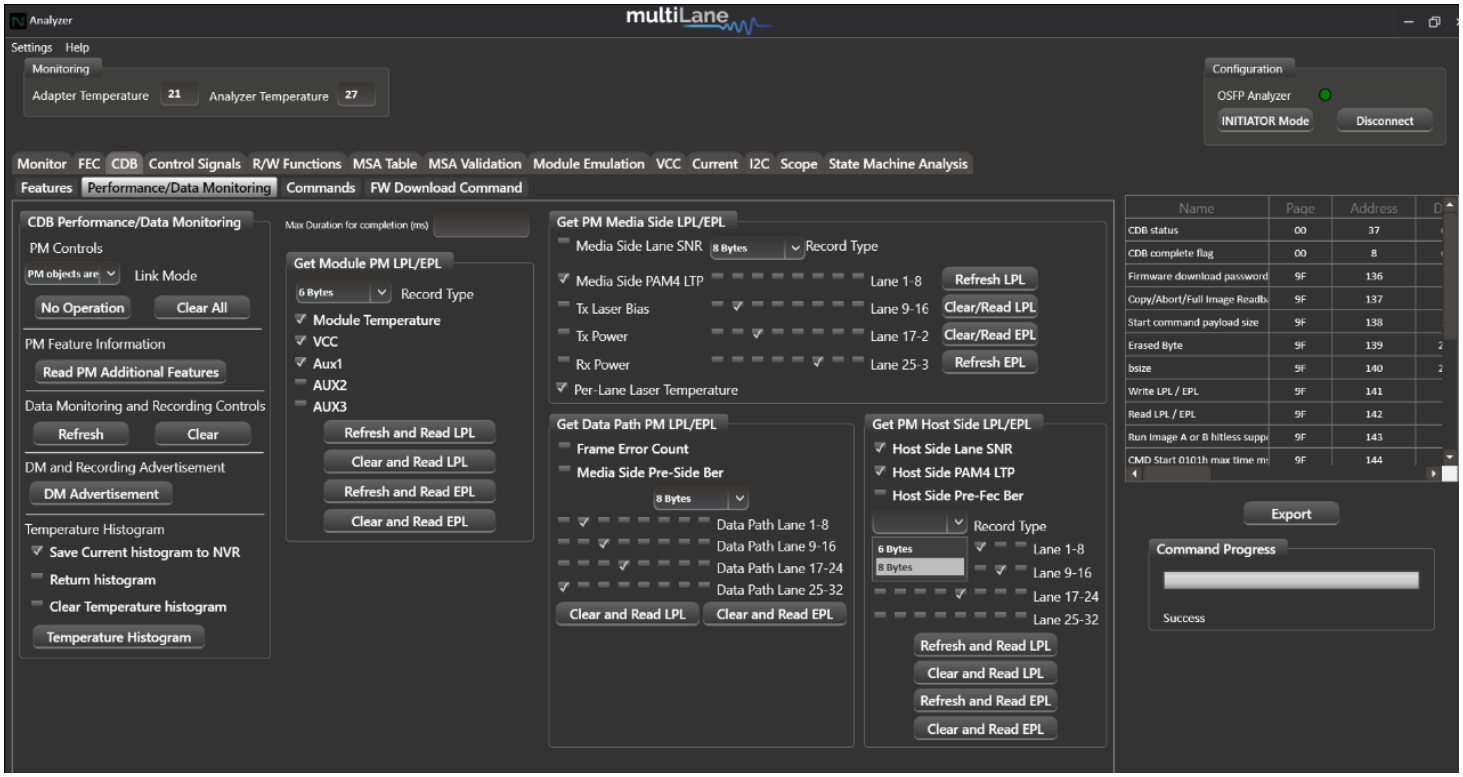


FEC Monitor

- Operates in initiator mode
- FEC Monitoring interface for BER, error count, and SNR
- Reads FEC diagnostics from module, implements MSA formatting and presents final BER data

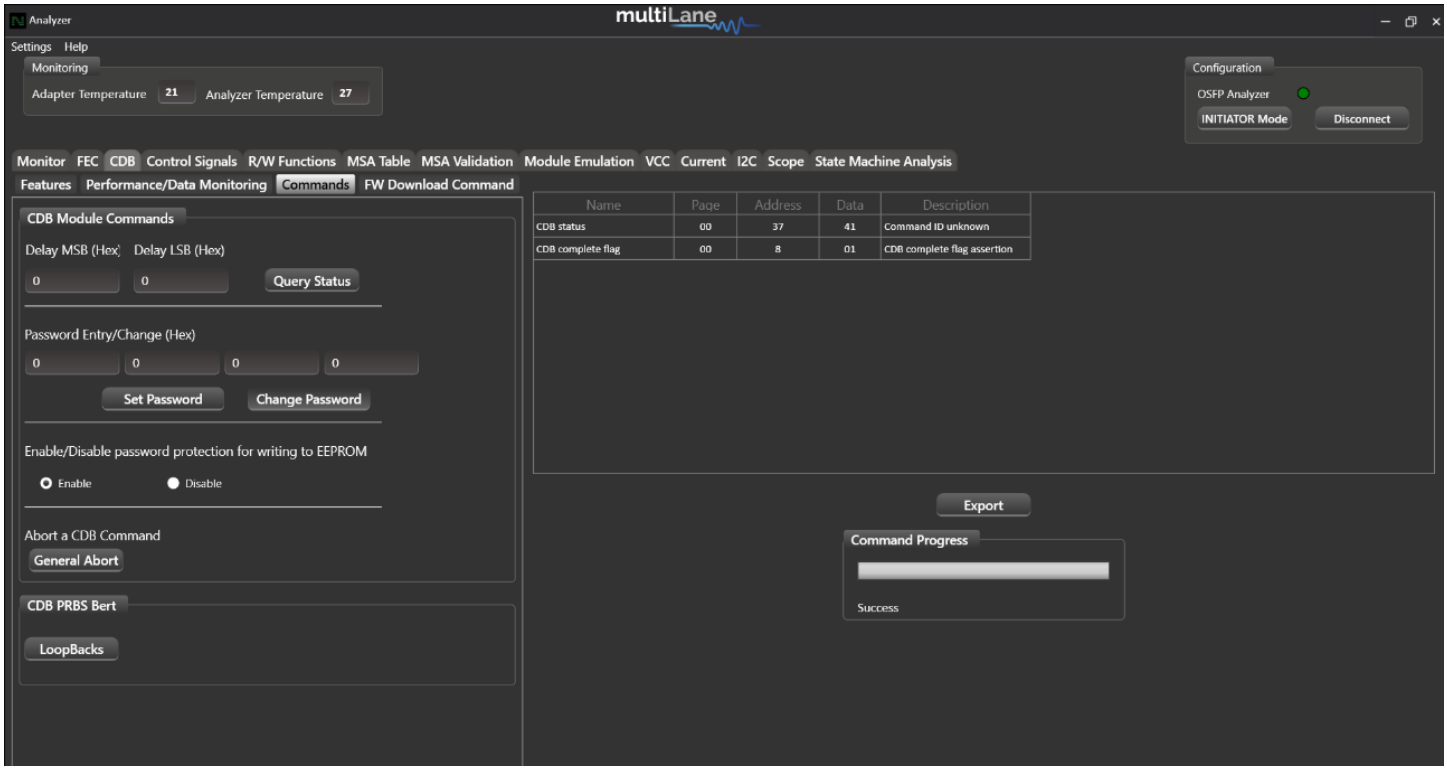
Commong Data Management (CDB) Tab

CDB operates in initiator mode



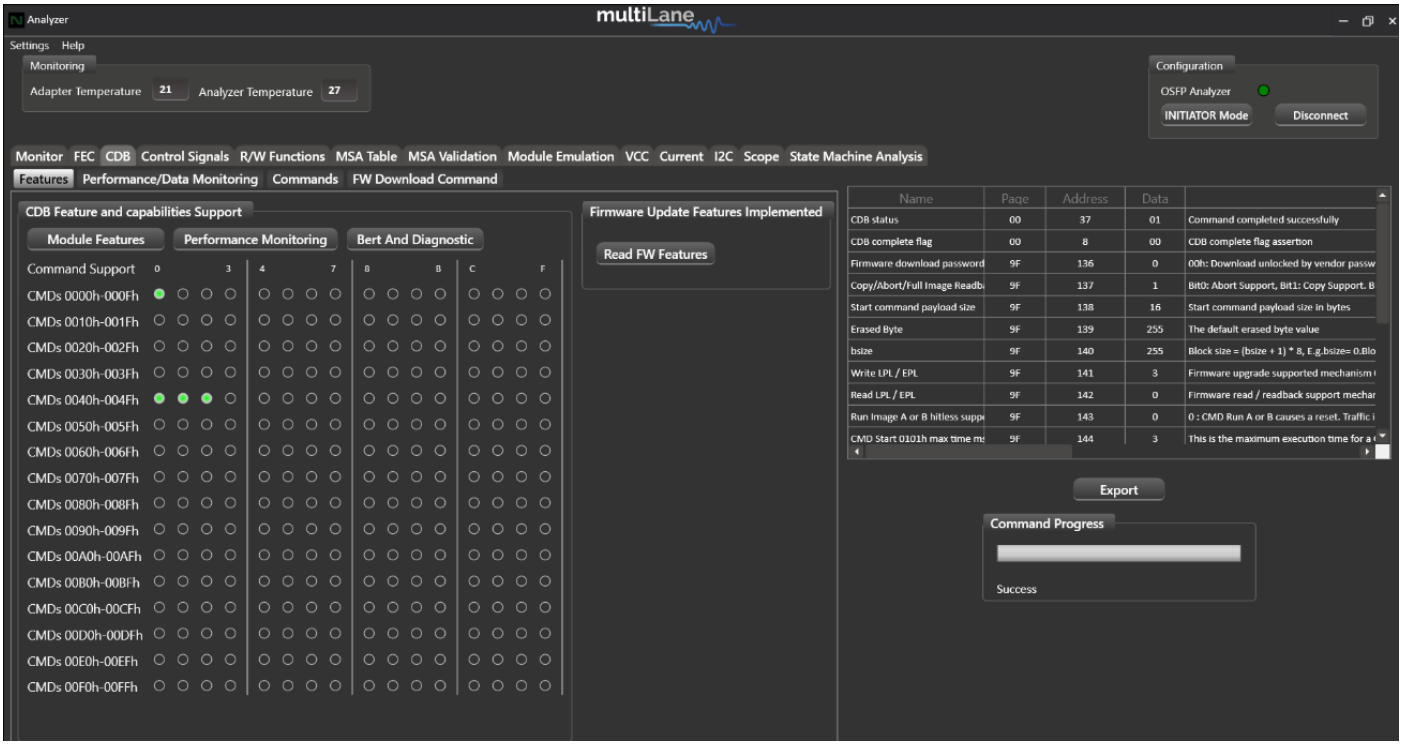
Performance and Data Monitoring

- **CMD 0200h PM Controls**: Extract Performance Monitoring data records such as minimum/average/maximum values. “No Operation” reads the most recent values, while “Clear All” clears the extracted values for all lanes in the interconnect.
- **CMD 0201h PM Feature Information**: Reads the PM’s additional features.
- **CMD 0280h Data Monitoring and Recording Controls**: “Refresh” loads the most recent attributes. “Clear All” clears all values for all parameters for all lanes at the same time.
- **CMD 0281h Data monitoring and recording** advertisement
- **CMD 0290h Temperature Histogram**: Displays the temperature intervals of the interconnect and how long it stayed at each temperature interval.
- **CMD 0210h, 0211h Get Module PM LPL/EPL**: Choose parameters of the module’s performance monitoring records, and replace the current values of the minimum, average, and maximum values. “Refresh” replaces the old values, while “Clear and Read” reads and resets the old values.
- **CMD 0212h, 0213h Get PM Host Side LPL/EPL**: Choose parameters of the host’s performance monitoring records, and replace the current values of the minimum, average, and maximum values. “Refresh” replaces the old values, while “Clear and Read” reads and resets the old values.
- **CMD 0214h, 0214h Get PM Media Side LPL/EPL**: Choose parameters the performance monitoring records of specific lanes, and replace the current values of the minimum, average, and maximum values. “Refresh” replaces the old values, while “Clear and Read” reads and resets the old values.
- **CMD 0216h, 0217h Get Data Path PM LPL/EPL**: Choose the data path for specific lanes and replace the current values of the minimum, average, and maximum values. “Refresh” replaces the old values, while “Clear and Read” reads and resets the old values.



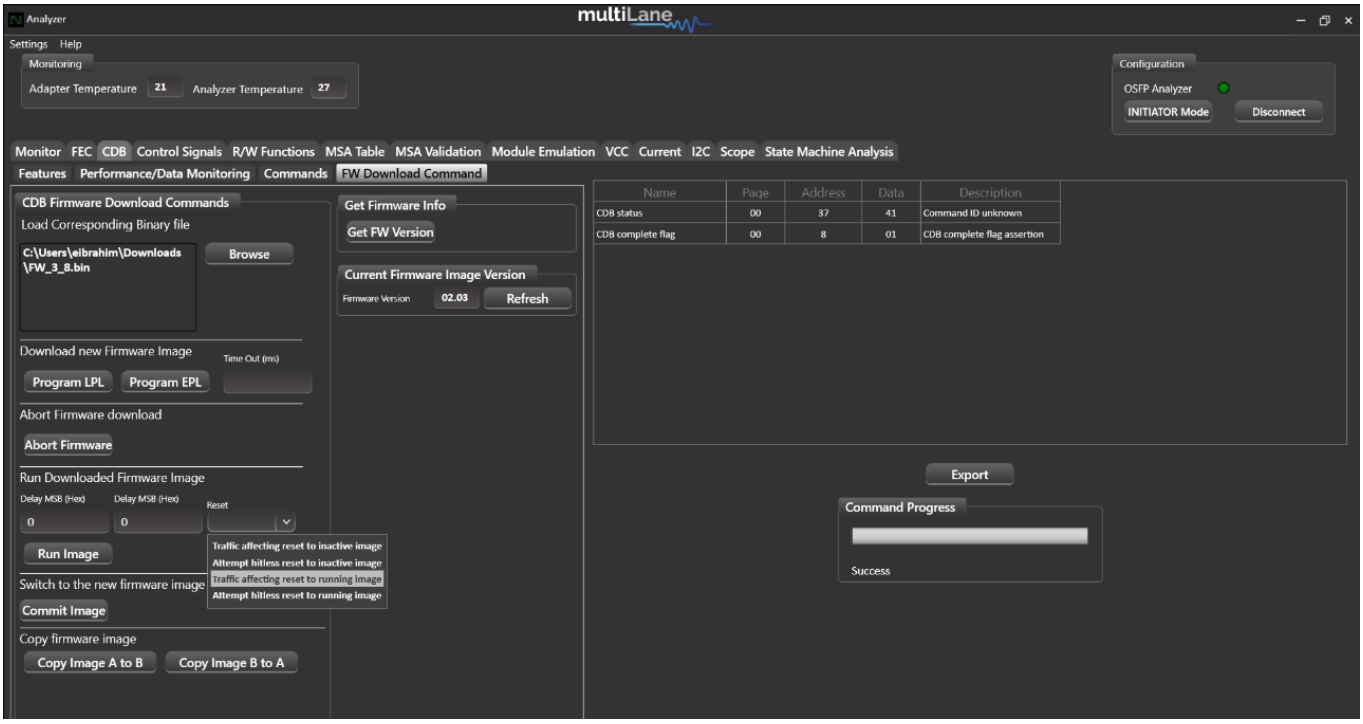
CDB Commands

- **CMD 0000h** Query Status
- **CMD 0001h** Enter Password
- **CMD 0002h** Change Password
- **CMD 0003h** Enable/Disable Password Protection
- **CMD 0004h** General Abort
- **CMD 0380h** Loopbacks



CDB Features

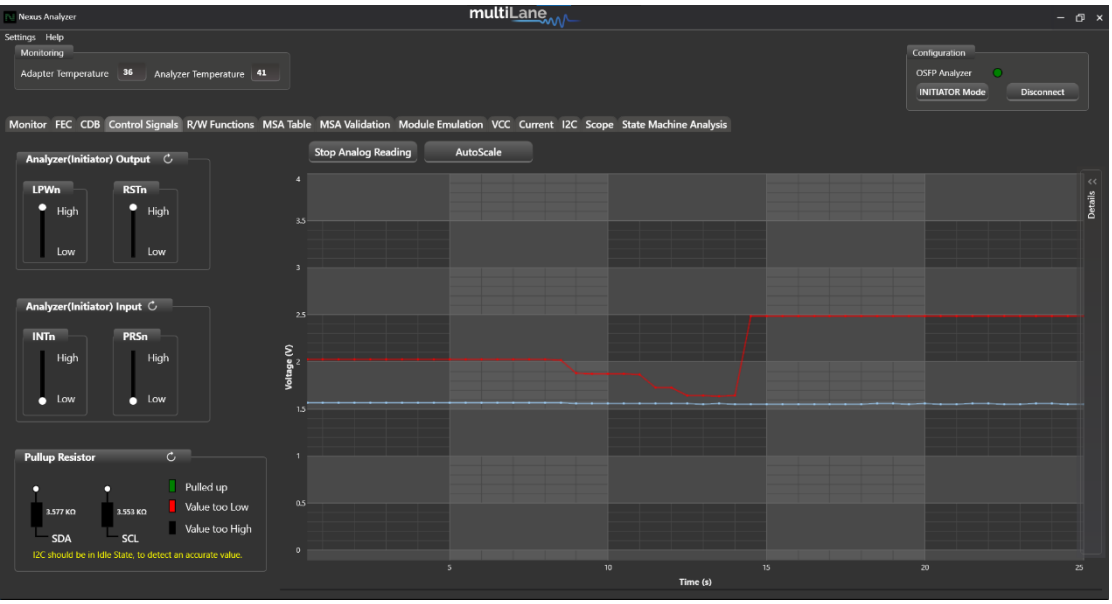
- **CMD 0040h Module Features**: Identifies which commands are supported, from CMD 0 to CMD 00FF along with the maximum CDB command execution time.
- **CMD 0042h Performance Monitoring**: Identifies which commands are supported from 0200h to 02FFh.
- **CMD 0043h Bert and diagnostics**: Identifies CMD 0300h to 03FFh.
- **CMD 0041h Read FW Features**: Identifies many parameters supported the firmware features including firmware download transfer type, if copy/abort/full image readback commands are supported, start command payload size, erased byte, the firmware update features, if read/write firmware is supported, the firmware can be upgraded, etc. Use this feature to determine whether a device supports LPL or EPL firmware.
- The green buttons indicate which commands are supported.



CDB FW Download Commands

- **CMD 0101h, 0103h, 0107h Program LPL:** Loads the firmware binary file for Local Payload (LPL). Allows for updating interconnect firmware.
- **CMD 0101h, 0104h, 0107h Program EPL:** Loads the firmware binary file for Extended Payload (EPL). EPL support varies depending on the interconnect. Allows for updating interconnect firmware.
- **CMD 0101h, 0105h, 0107h Read Image LPL:** Read the latest upgraded firmware image using LPL
- **CMD 0101h, 0106h, 0107h Read Image EPL:** Read the latest upgraded firmware image using EPL.
- **Export Image:** Exports an image of the firmware after the read is completed as a .bin file, which in turn can be loaded into and read by other interconnects.
- **CMD 0102h Abort FW download:** Stops the firmware from being installed onto the interconnect.
- **CMD 0109h Run image:** After the new LPL or EPL Firmware is loaded, this command switches to the latest firmware image. Does not replace the existing firmware image on the interconnect.
- **CMD 010Ah Commit image:** Replaces the firmware image on the interconnect with the new loaded firmware image. Prior to this command being executed, the old firmware will still be executed on startup. Always ensure the new image is running perfectly (by running it on the interconnect using the previous commands) before using this command.
- **CMD 0108h Copy image A to B/B to A:** In the event of two images being present on the same interconnect and both images are written to flash, this command makes ensures that both images are identical, with the copied image being specified in the commands as either image A to image B, or image B to image A.
- **CMD 0100h Get FW Info:** Loads the information about the latest firmware on the interconnect, for both image A and image B.

Control Signals



- INTn/PRSn and LPWn/RSTn
  - Read/ drive control signals
  - Analog sampling of signals in real time
- Graph features vertical and horizontal markers.
- Pull up resistors: display SDA and SCL resistors values, where I2C should be in idle state to detect accurate values.
- Ability to export/import data

Access to **OSFP** low-speed signals in three modes:

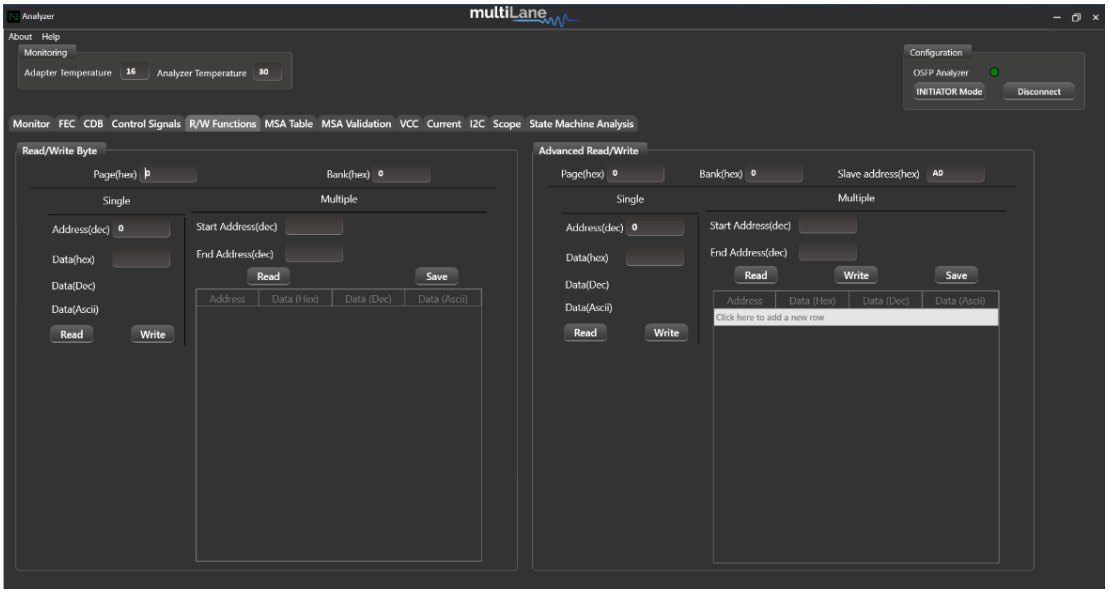
Signals / Modes	LWPn	RSTn	INTn	PRSn
Initiator	Output signal	Output signal	Input signal	Input signal
Bypass*	No control	No control	No control	No control
Target	Input signal	Input signal	Output signal	Output signal

Access to **QSFP-DD** low-speed signals in three modes:

Signals / Modes	LPMode	ResetL	IntL	ModPrsL
Initiator	Output signal	Output signal	Input signal	Input signal
Bypass*	No control	No control	No control	No control
Target	Input signal	Input signal	Output signal	Output Signal

*In bypass mode, Nexus only samples the signal between host and module.

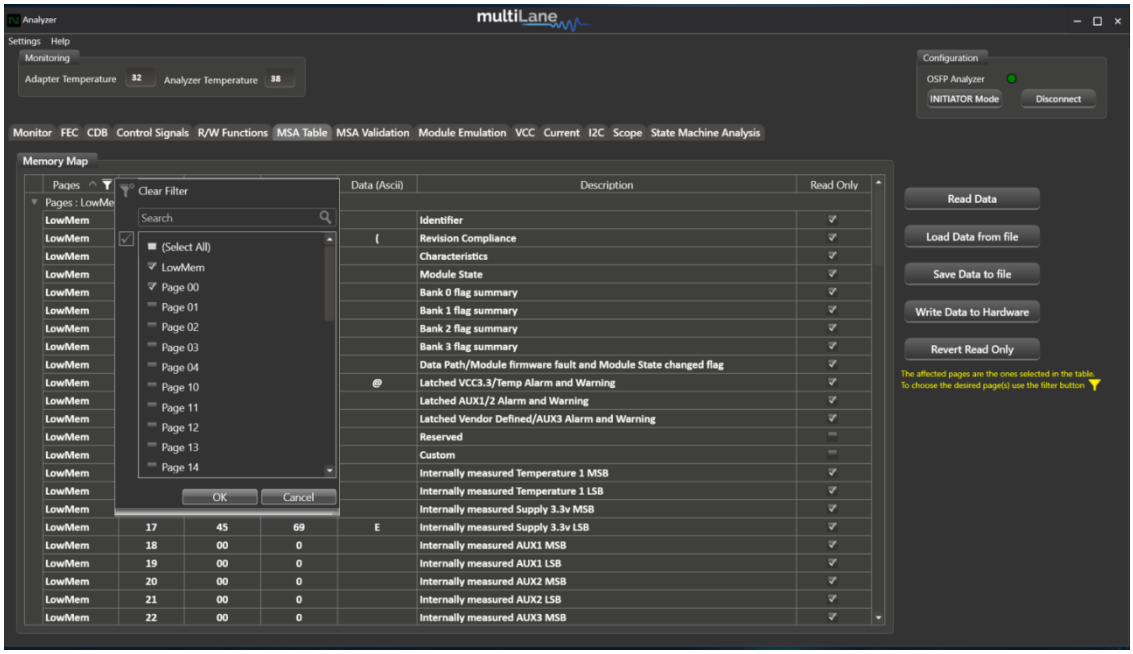
I2C Read/Write Operations



Operates in initiator mode

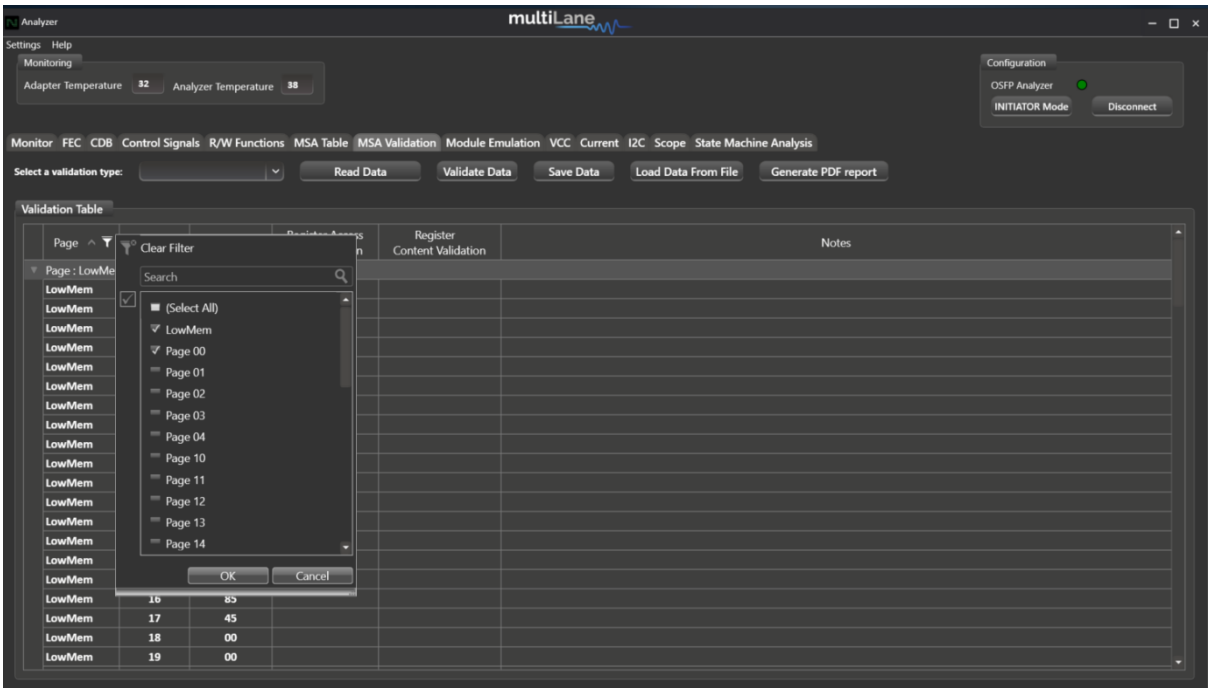
- Single byte read/write operations
- Multiple byte read operations
- Advanced R/W used to read from or write to multiple registers simultaneously

MSA Table Tab

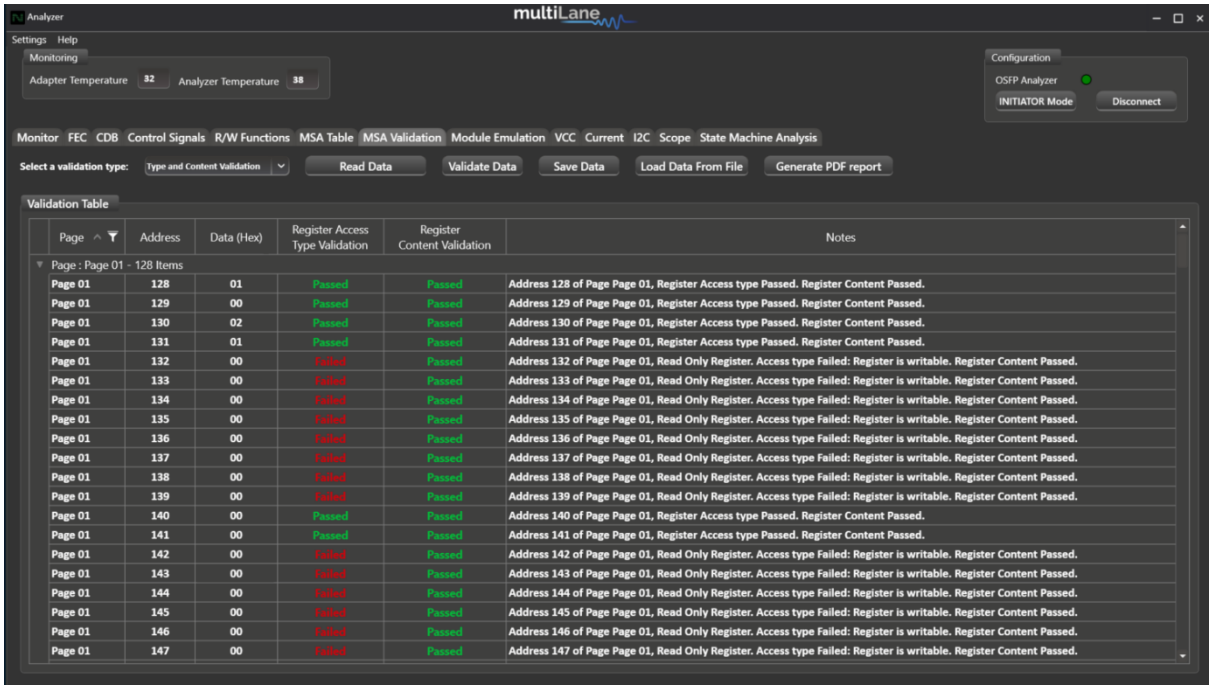


- Operates in initiator mode
- Select page(s) to read
- Read data from device for selected page(s)
- Save data to file
- Load data from file
- Write data to hardware to have the data required in respective addresses
- Read only column: checked boxes refer to read only registers, while unchecked boxes refer to read/write registers, **as per MSA**. Use these to make R/W registers RO, and RO registers R/W, affecting MSA compliance
- Revert read only: revert back to the original type access of all registers as per MSA

MSA Validation Tab



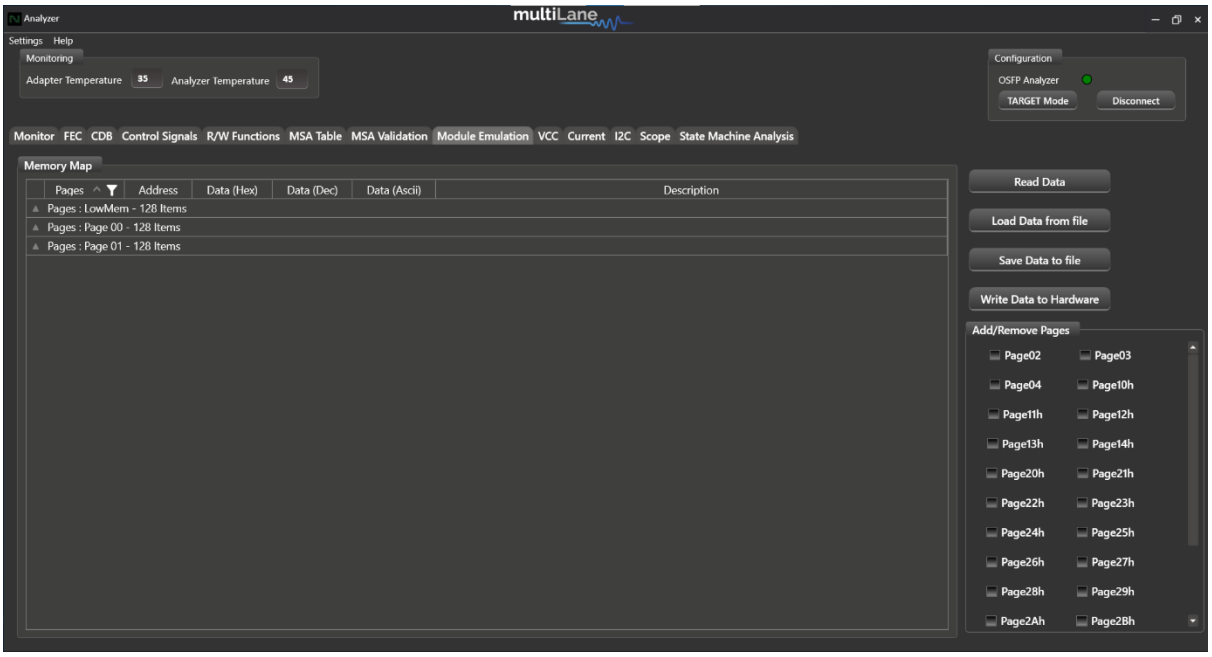
- Operates in initiator mode
- Select page(s) to read
- Read data from device for selected page(s)
- Select validation type: Register Access Type Validation or Register Content Validation, or both
- Validate data against CMIS standards
- Save data to file
- Load data from file
- Generate PDF report for the selected page(s)



After validating the chosen page(s), a set of pass/fail registers appear as shown with the respective description of success or failure.

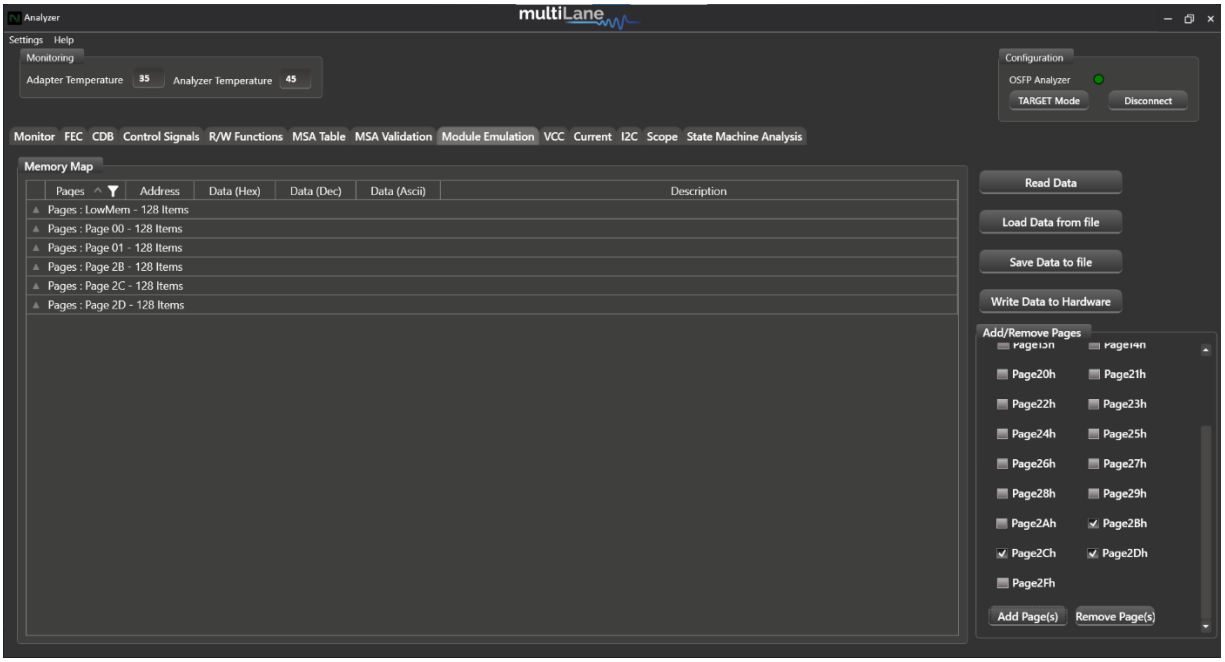
Module Emulation

Module emulation works in target mode, where Nexus emulates a module memory as per CMIS. It allows you to validate the host register access, by confirming that the host is adopting the proper access types (RO/RW) for CMIS specific addresses.



Upon opening the tab, there are three pages added by default, LowMem, Pages 00 and 01.

You can add a maximum of three pages onto those, from the “Add/Remove Pages” window, by checking the pages you want to add and pressing “Add pages”



You can work with the added pages as custom pages, and can overwrite them as you see fit.

Deletion of pages is only possible with added pages. You cannot delete LowMem, Pages 00 and 01.

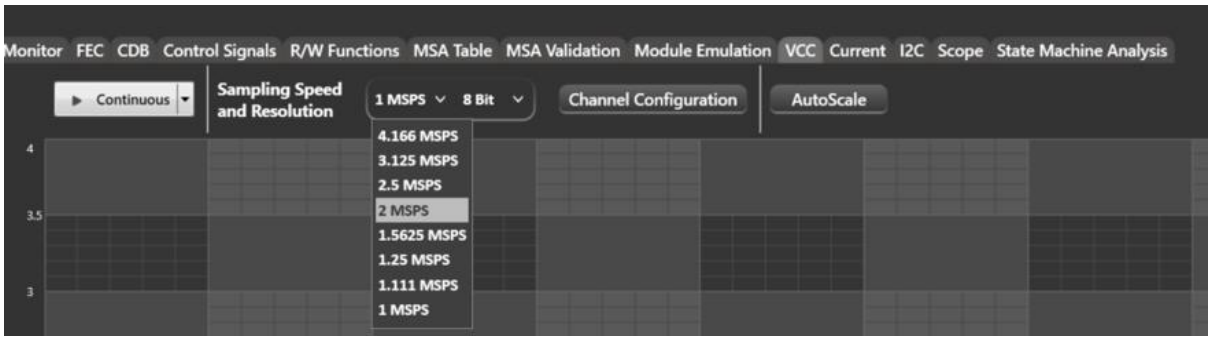
Graphs and Measurements

Nexus allows for the measruement of realtime VCC supply, In-rush and continuous current, I2C communication, and real time probing of voltage, current, SDA and SCL signals. All graphs and measurements are configured in the same steps, listed below:

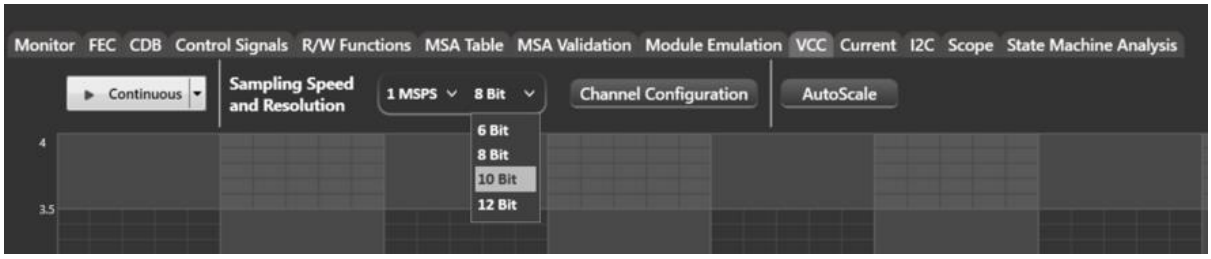
The below example was done on the VCC tab, and applies to the Current tab, I2C Tab, and Scope Mode tab.

Data configuration:

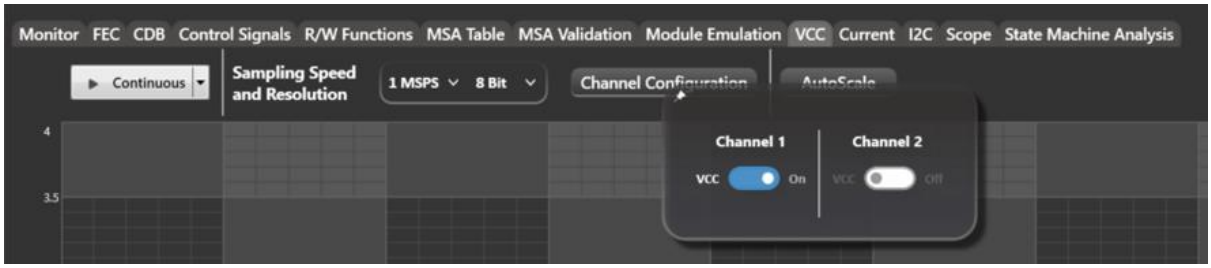
- Set your required sampling speed



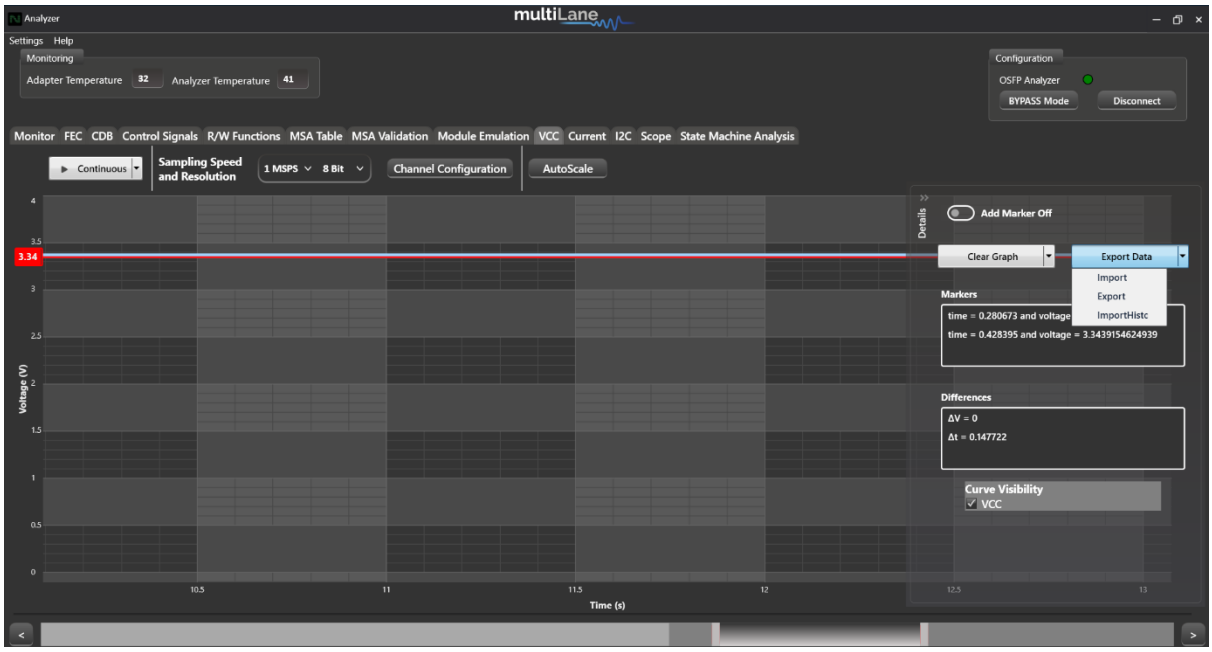
- Set your required sampling resolution



- Set your channel configuration



Once the measurement is done, expand the Details window as below:



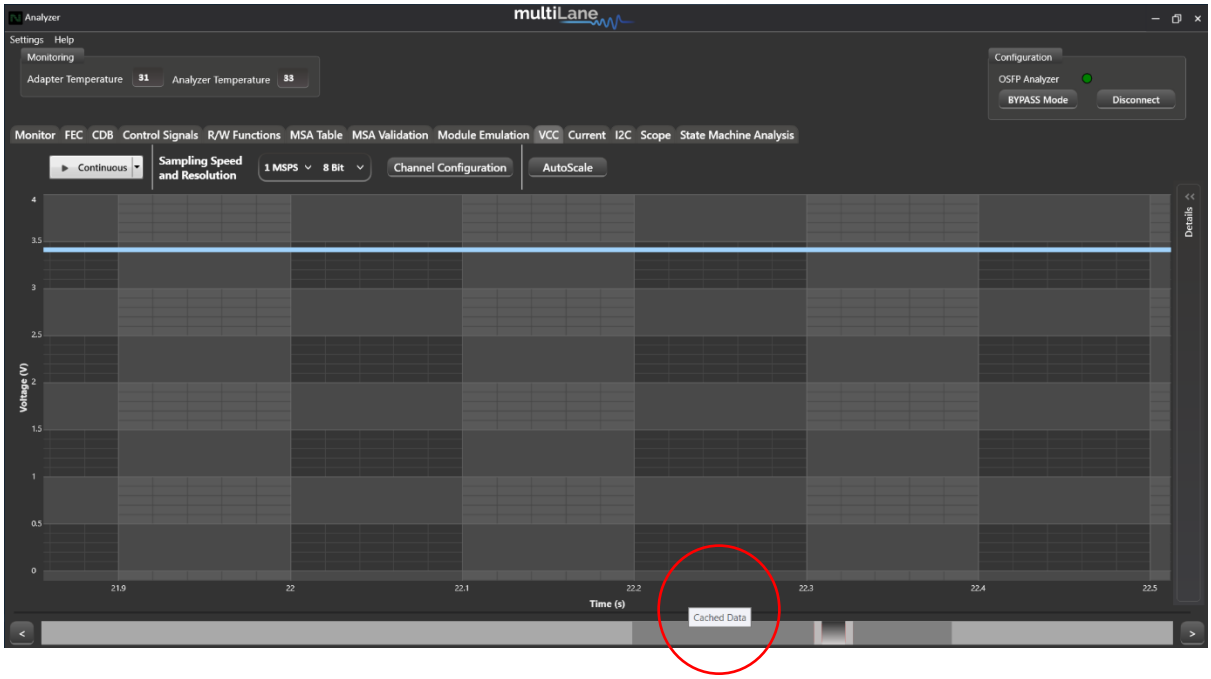
- Add Marker: go back to the graph and press on any point directly onto it to add your marker.
- “Markers” box indicates the time and voltage marker values
- “Differences” box indicates the difference by voltage and time between markers
- Clear graph:
  - Data: clear all markers
  - Graph: clear all captured data
- Export data:
  - Import: import a single file to visualize data on graph
  - Export: export data and save file
  - Import History: import more than one file

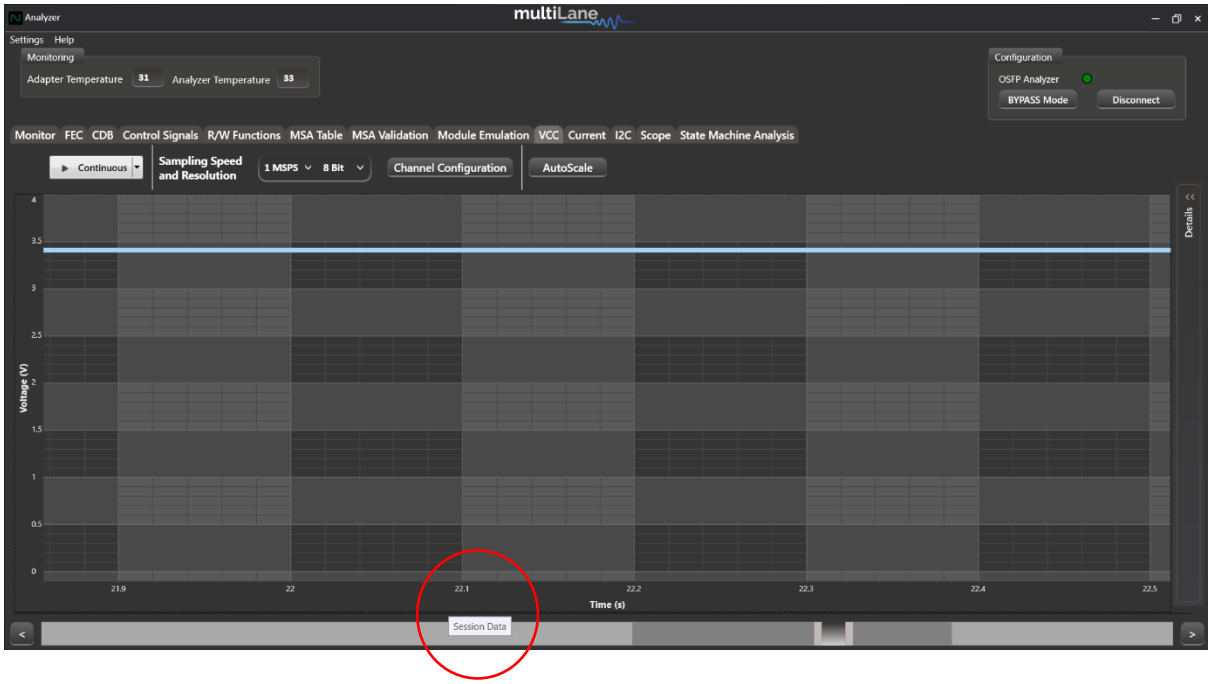
Graph timeline:

After capturing data in continuous mode for a large interval of time, you can use the graph timeline as shown below, to focus the data on a specific interval of time.

Hovering over the timeline you will see the data is categorized into cached data, and session data.

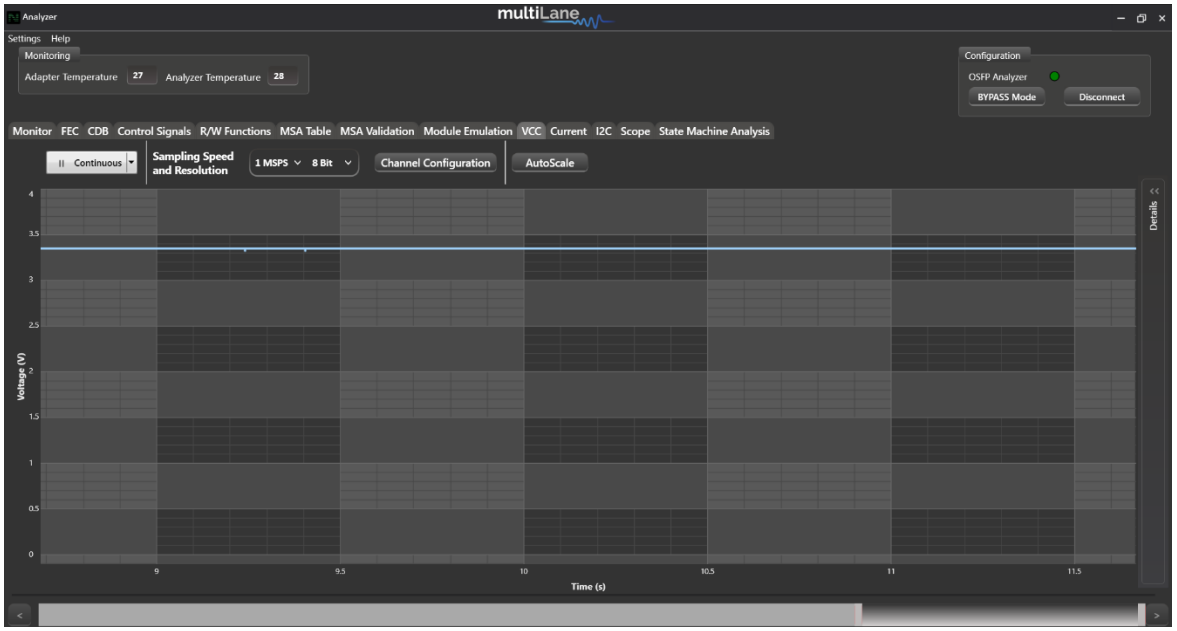
Cached data offers real time reading of data, while session data is saved into files which we have to access to read.



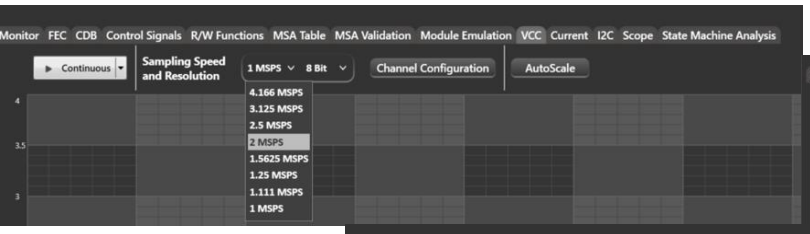


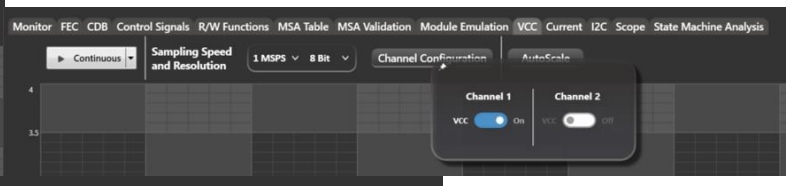
VCC Measurements Tab:

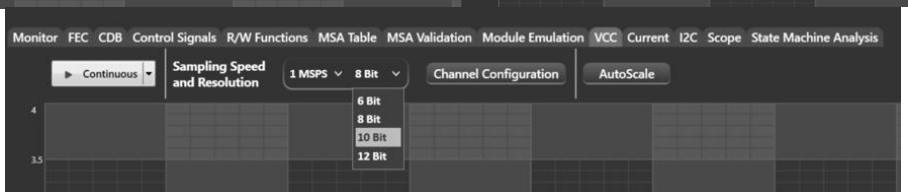
VCC Measurements can be done in initiator, bypass or target modes.



Measure VCC in continuous mode by configuring the sampling speed and resolution, as well as the channels:



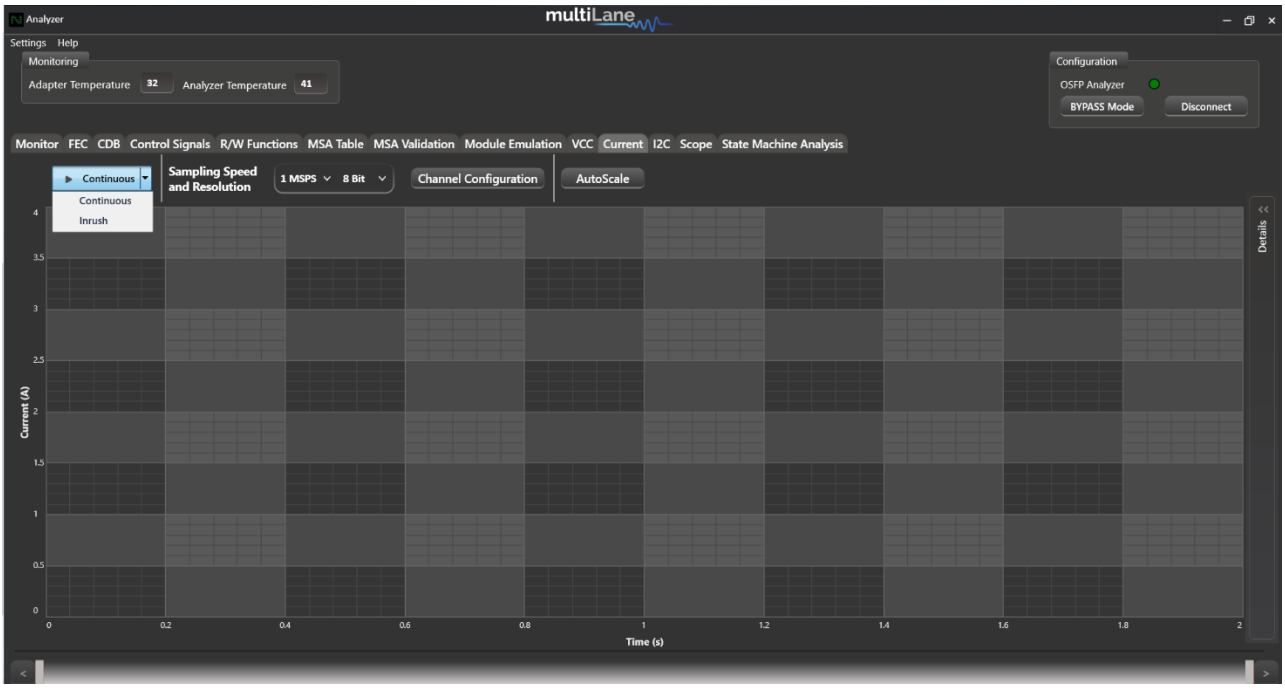




Once your configuration is done, press “Continuous” to get the data.

Current Measurements

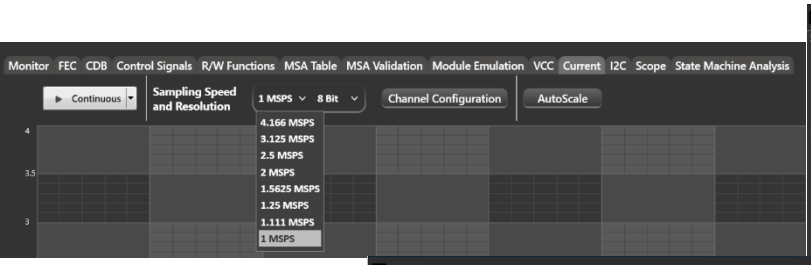
Current Measurements can be done in initiator, bypass or target modes.

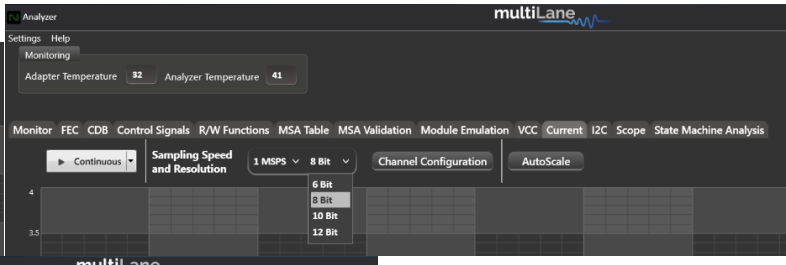


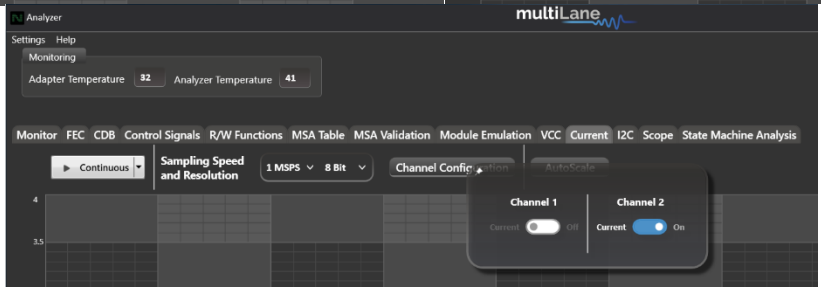
Choose your required current measurement:

- Continuous current measurements
- In-rush current measurements

Set your sampling speed and resolution, and configure the channels:

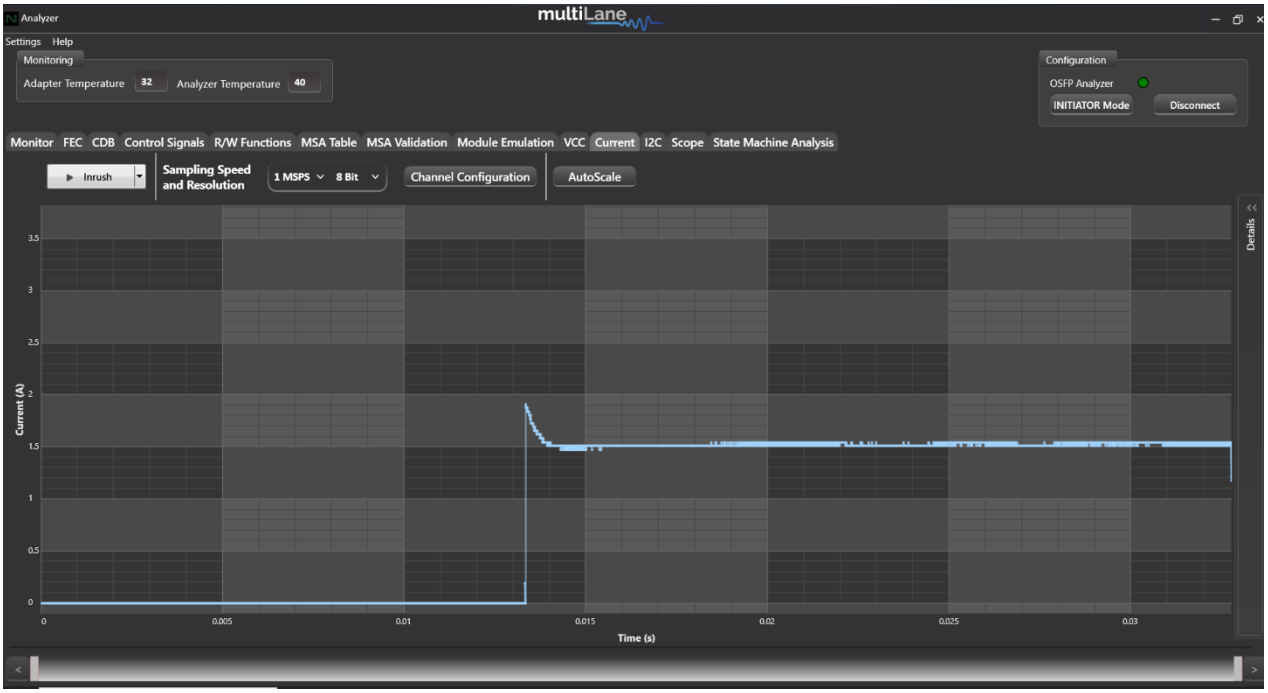




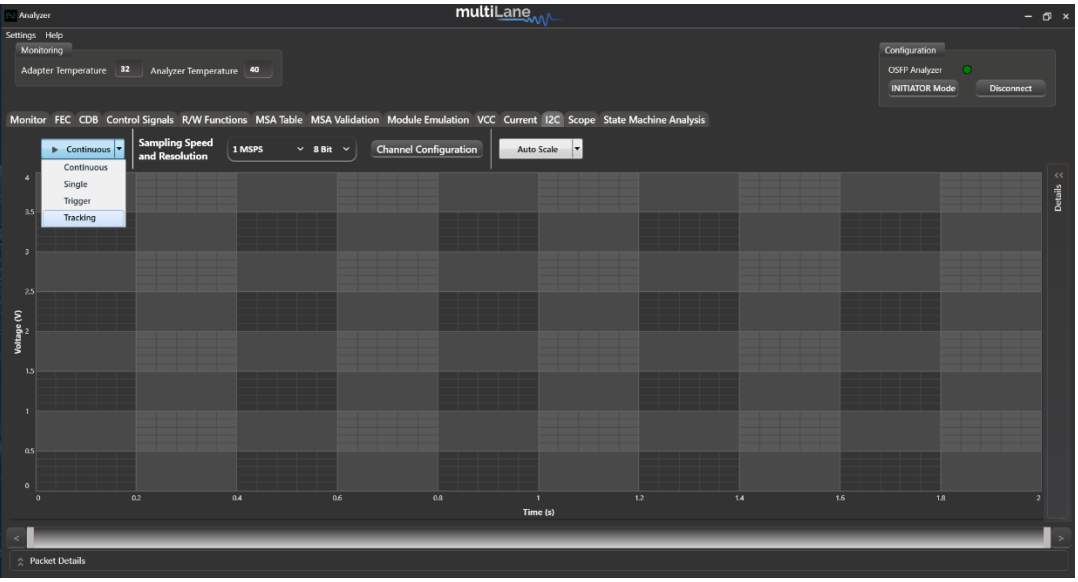


In-rush current measurements:

- Nexus should be in Initiator mode
- DUT should be unplugged from Nexus
- To capture in-rush current upon module power-up, start capturing while DUT is unplugged, and plug in DUT once you start capturing data. (shown below)

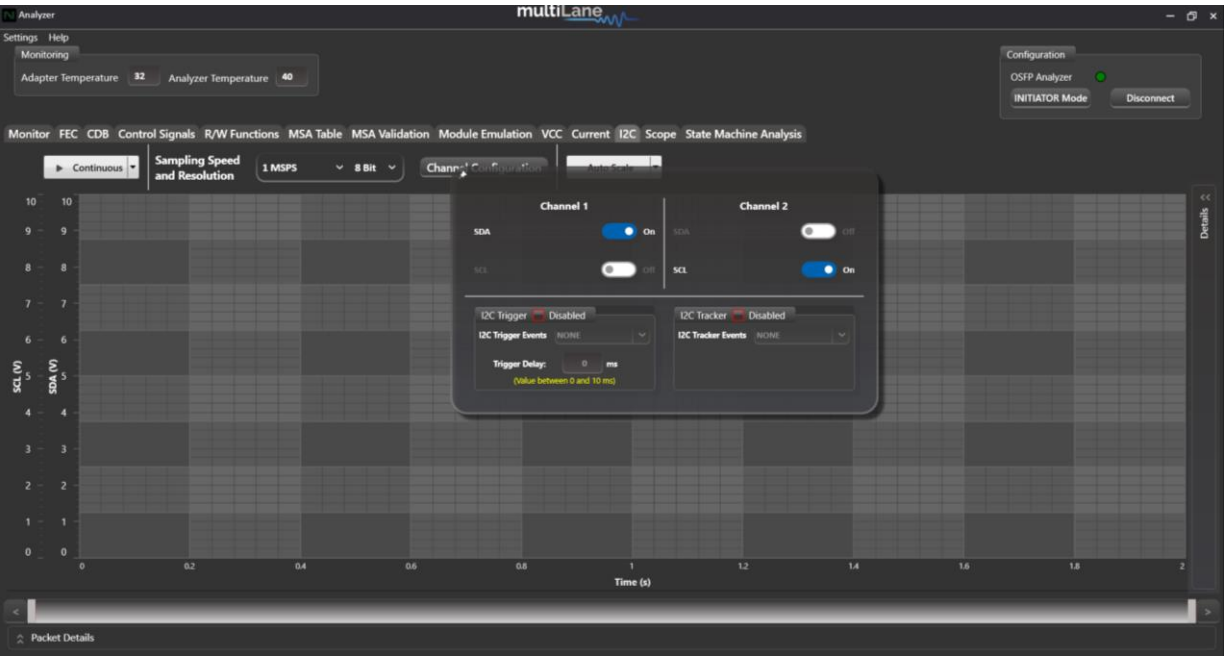


I2C Packet Analysis



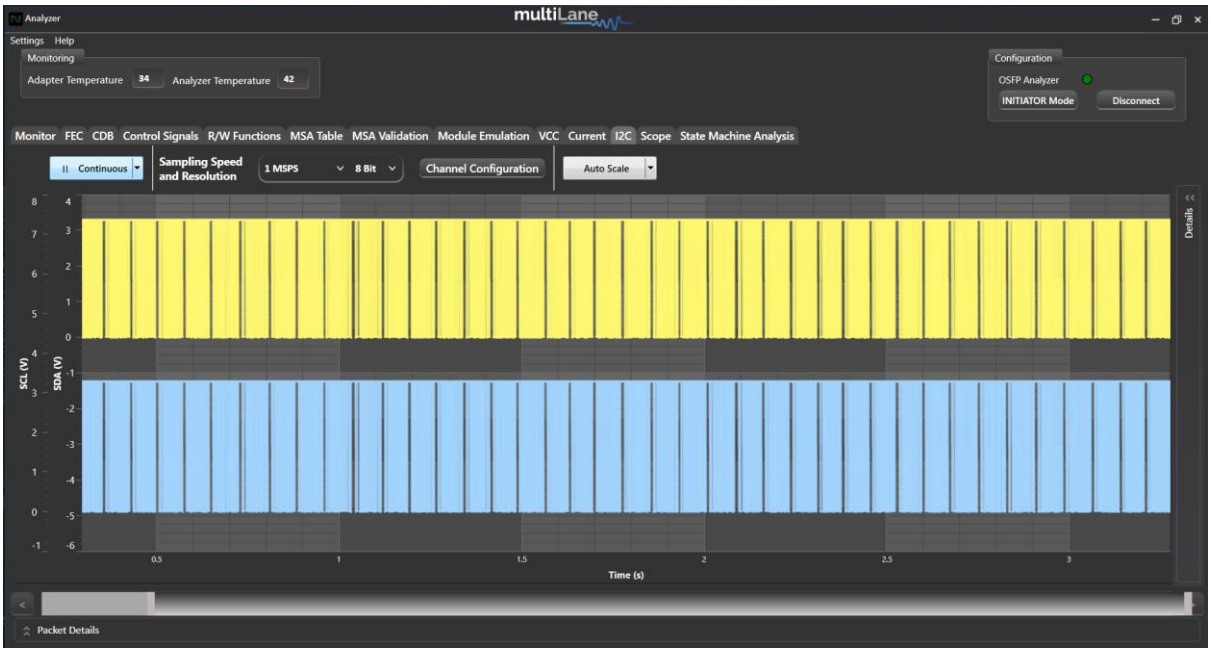
- I2C Captures can be done in initiator, bypass or target modes
- Single and continuous captures
- I2C trigger and tracking events
- Different sampling speeds available
- Represent SCL, SDA, ACK/NACK, and I2C edges graphically

Configure the sampling speed, resolution and choose channels:



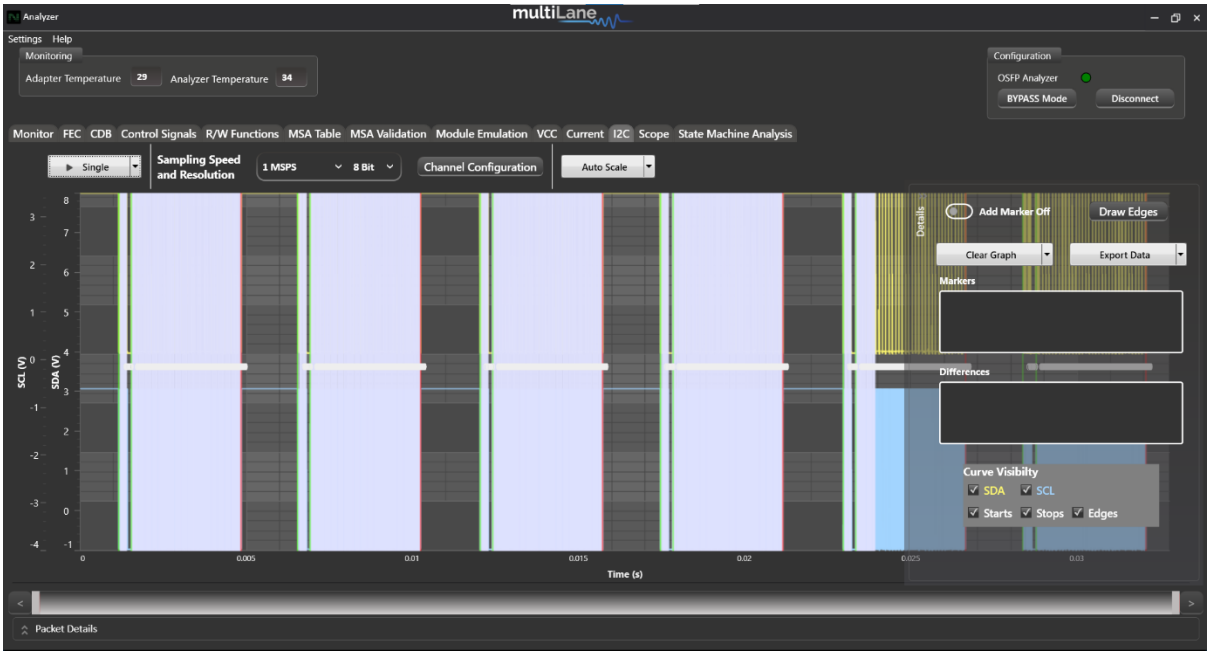
After which, you can start your measurements.

Continuous Capture:



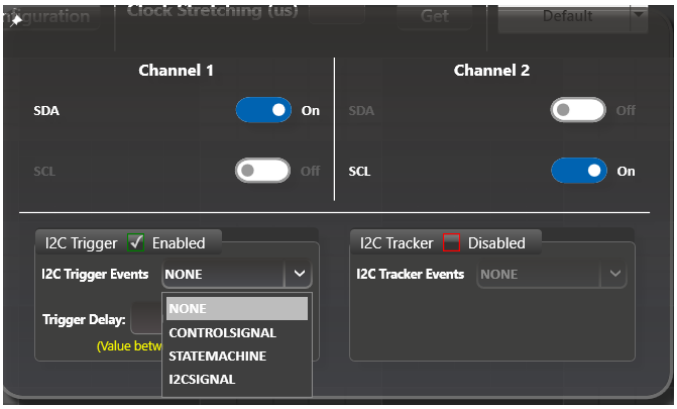
I2C continuous capture shows SDA and SCL data.

Single Capture:



I2C Single, trigger and tracking captures show SDA, SCL, Start, Stop and Edges on the graphs.

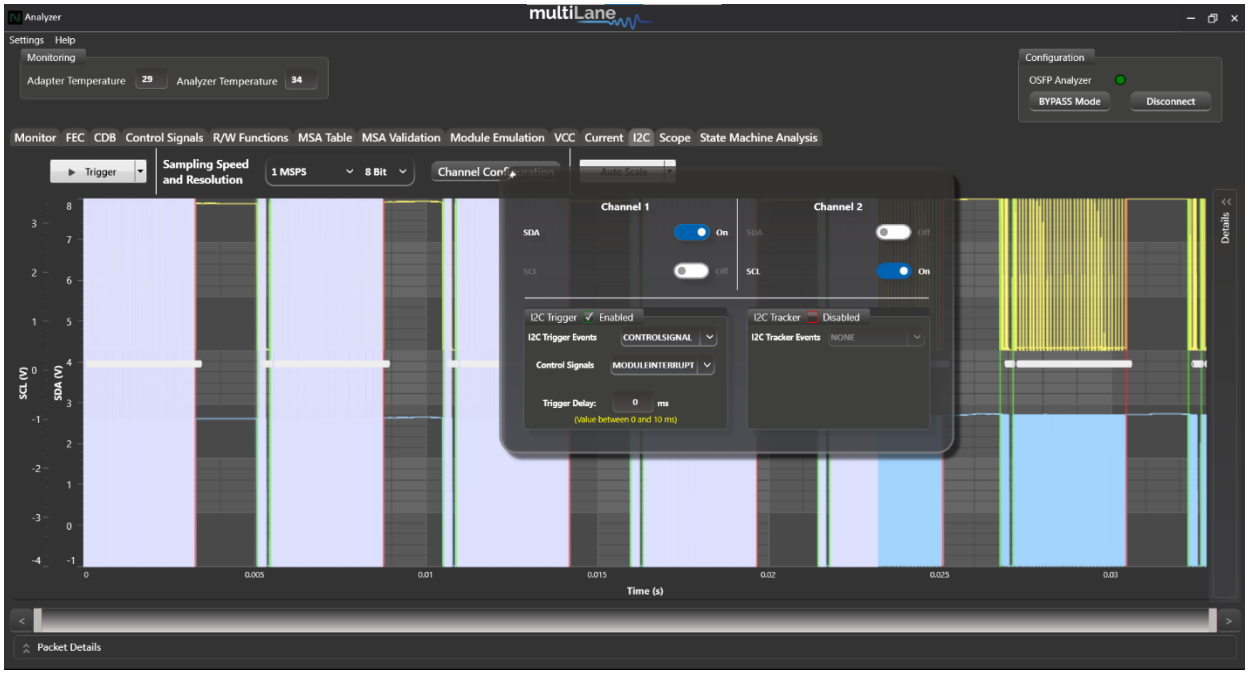
I2C Trigger capture:



Trigger I2C with:

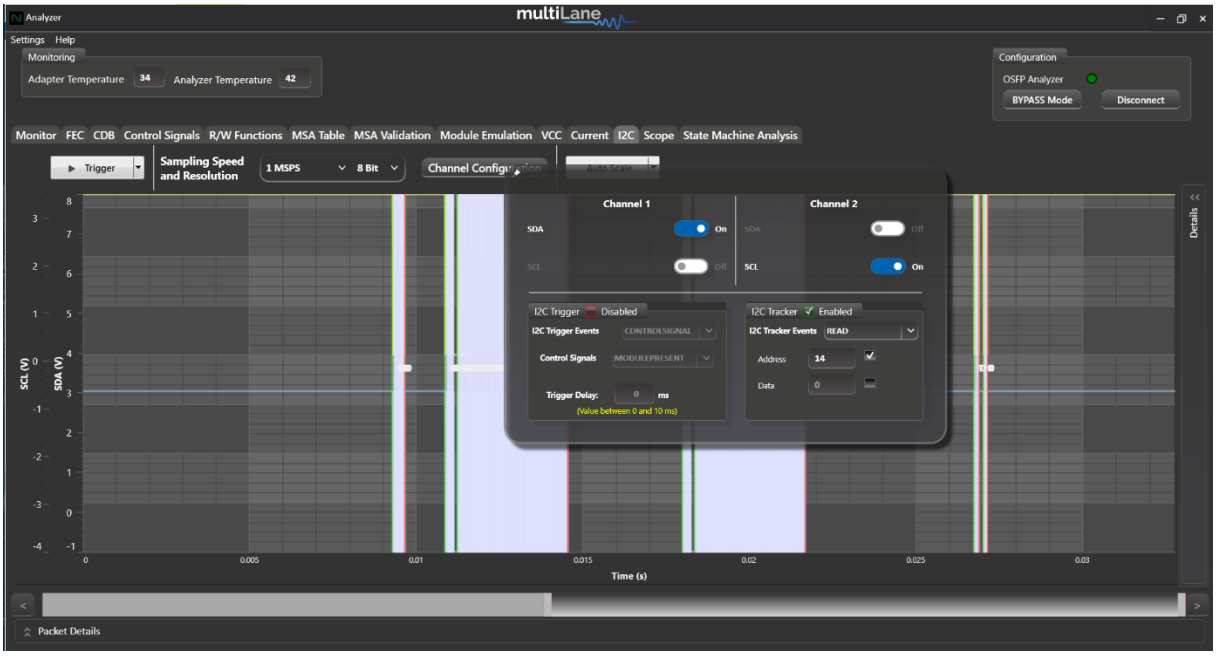
- Control Signals:
  - Module Interrupt
  - Module Present
  - Reset
  - Low Power
- State Machine
- I2C Signal:
  - Start
  - Stop

Choose the trigger required and measure the data:

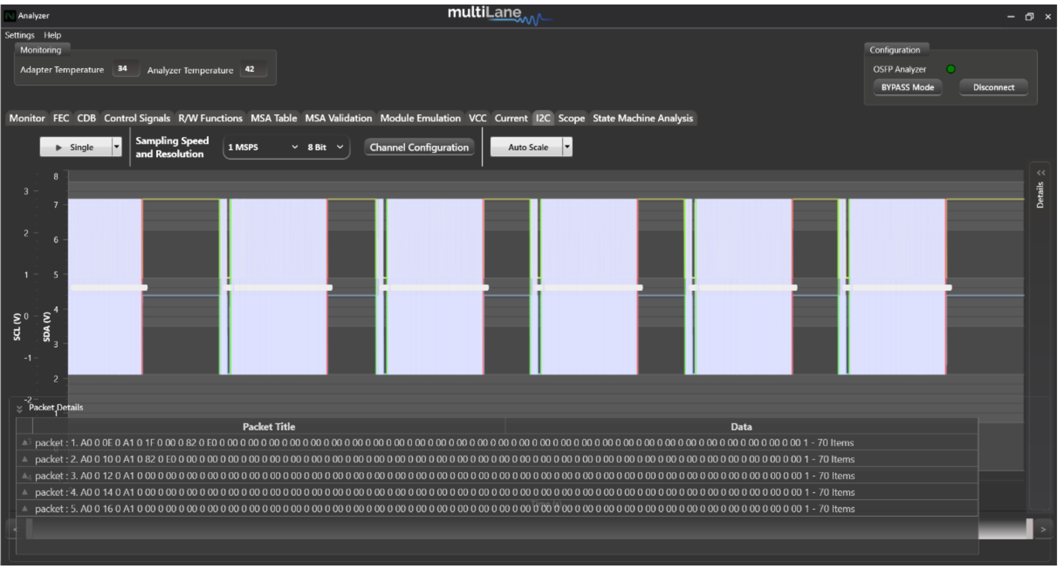


I2C Tracking capture:

Indicate which address you want to capture, and if you'd like this data tracked.



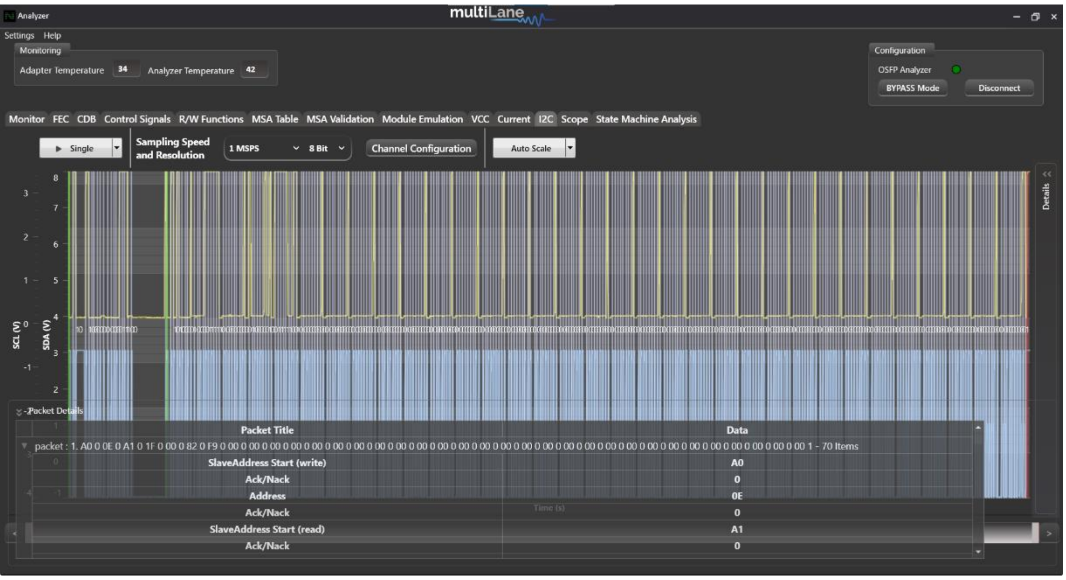
Packet details expansion:



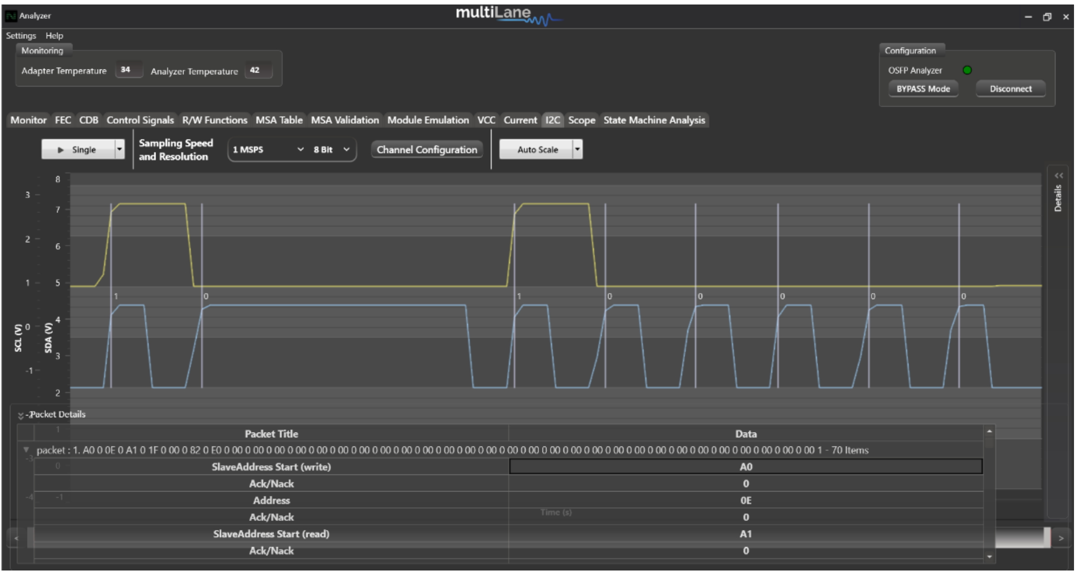
Single/Trigger/Tracker Capture: press on Packet Details to expand and look into the data captured.

Continuous Capture: draw a precise portion of data on the graph, click Draw Edges, and expand Packet Details.

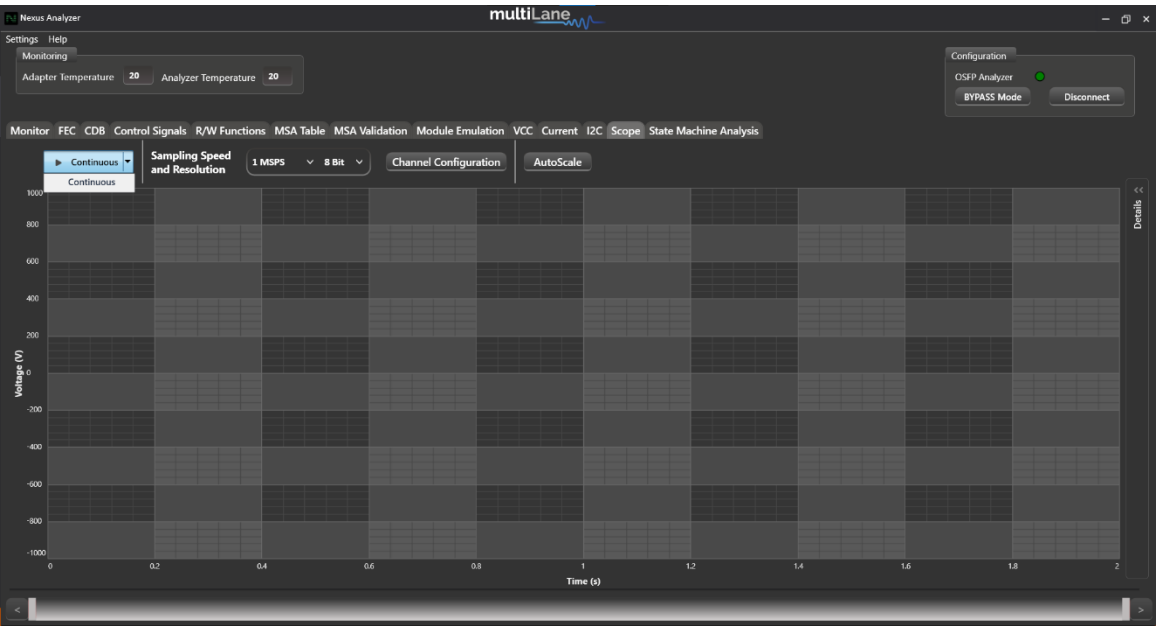
Press on one packet for more details on the data. This will also position you to the chosen packet on the graph:



Press on one byte from chosen packet to also position yourself accordingly on the graph:



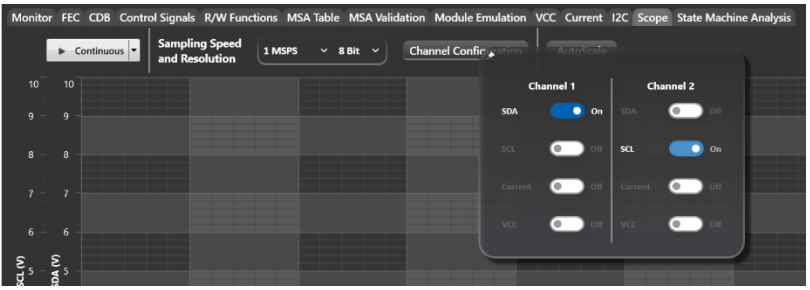
Scope Mode Tab:



- Scope Mode data can be measured in initiator, bypass and target modes.
- Measure data in continuous mode.

Configure your sampling speed and resolution, and move on to the channel configuration:

State Machine Tests: Configure your sampling speed and resolution, and move on to the channel configuration:



Choose to measure two signals from two different channels at once, choosing between:

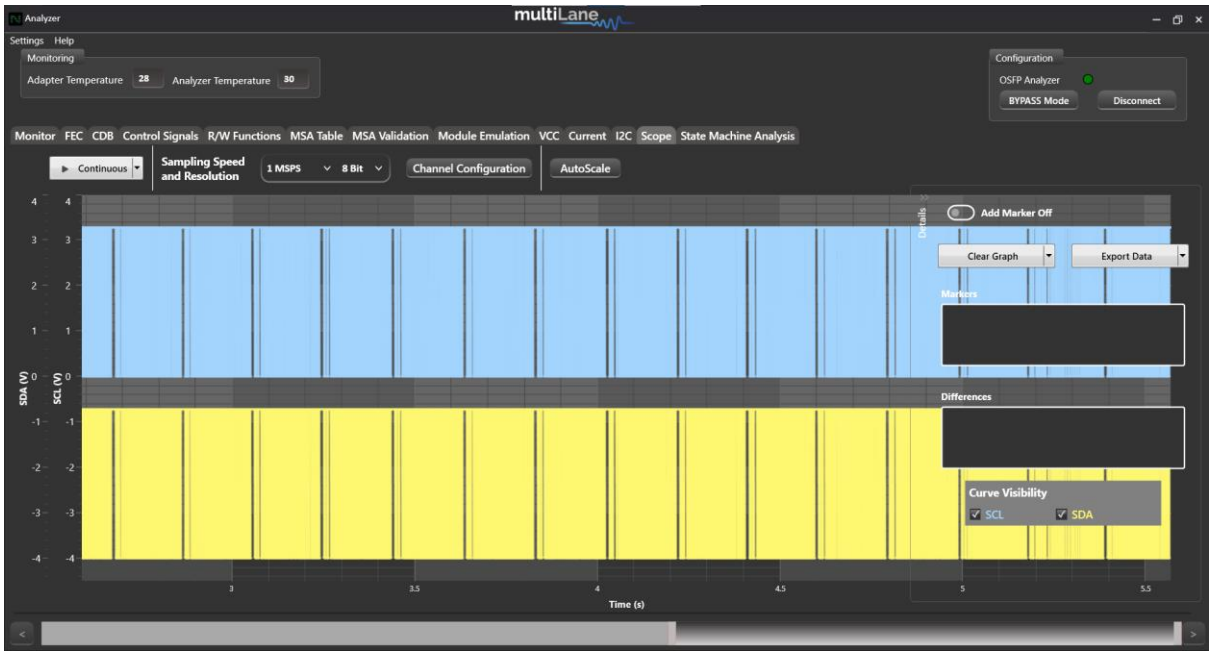
SDA

SCL

Current

VCC

Measure the continuous data:

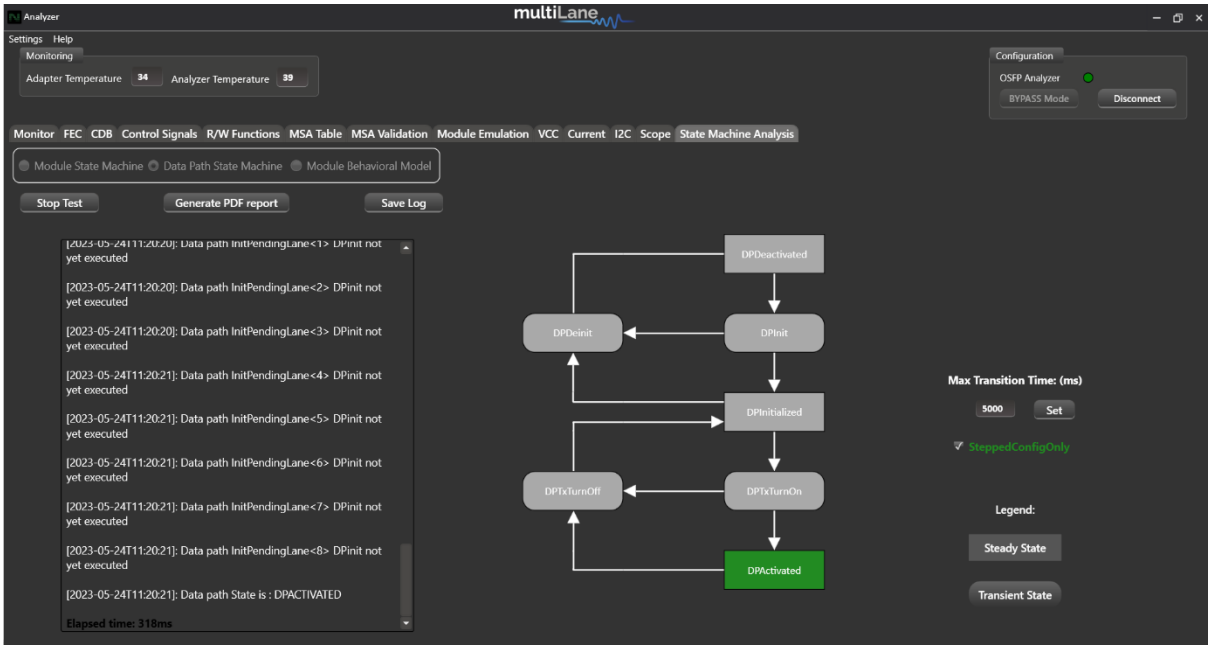


State Machine Test:

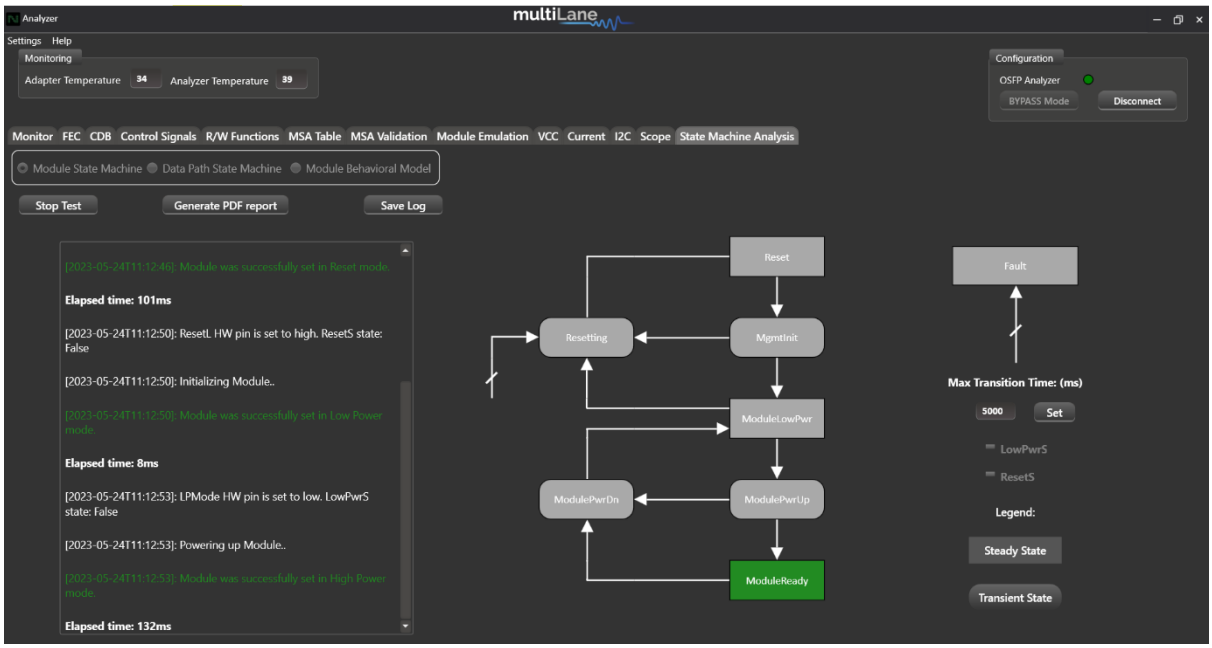
The below tests are all automatically done in initiator mode

Interactive tests to drive module state transitions, using MSM and DPSM to debug and validate module implementation, and confirm compliance between host and module.

Module state machine test:

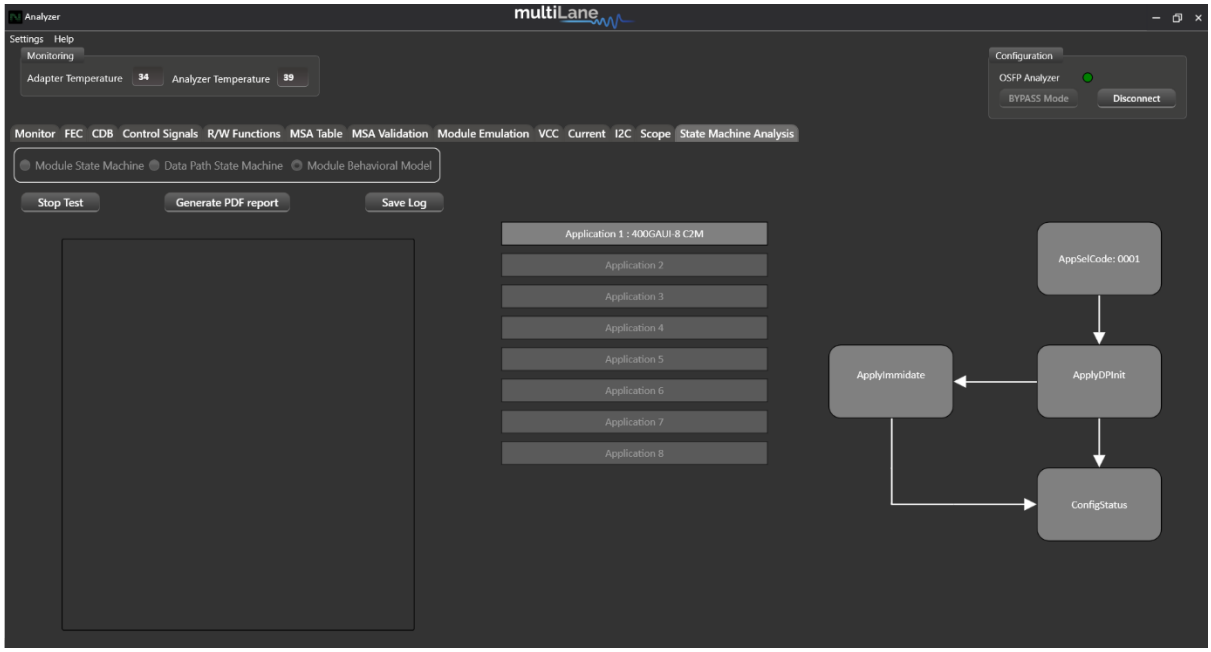


Data path state machine test:



Module behavioral model:

Access the Appsel codes supported on your DUT through the Module behavioral model.



All three tests above are equipped with detailed logging on time and state transitions, which can be generated into a PDF report.

To stop a test, exiting the tab does not suffice. Press “stop test” to exit the tab and move forward with other tests.

Revision History

Revision Number	Date	Description
1.0	6/12/2023	Preliminary
1.1	8/2/2023	Added Module Emulation
1.2	11/1/2023	Added QSFP-DD Support in control signals

Annex

Accuracy of signals for ML4066-NX-Pro-OSFP REV1.0:

Signal	Notes
VCC	+/- 5 mv accuracy (12 bit sampling resolution)
Current	+/-40 mA accuracy (12 bit sampling resolution)
Operating Temperature	Max 85C
Sampling Resolution	6 bit, 8 bit, 10 bit, 12 bit
Sampling Speed	Min 1 MSPS Max 4.1666 MSPS

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