TELEDYNE LECROY
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High-speed Port Configuration

APPLICATION NOTE

High-speed Port Configuration for Teledyne LeCroy Xena 400GE, 100GE and 40GE Test Modules

Contents

Teledyne LeCroy Xena 400GE, 100GE and 40GE test modules can support 400 Gbps, 200 Gbps, 100 Gbps, 50 Gbps, 40 Gbps, 25 Gbps and 10 Gbps port speeds depending on test module, transceiver and in some cases splitter cables.

This Application Note describes what can be achieved with the test modules and explains various related topics like:

- The use of parallel paths for transmission of high speed signals
- Naming conventions for 400 G to 10 G Interface options
- The difference between 100GBASE-LR4 and 100GBASE-CWDM4
- Optical connectors used for high speed transmission

You will find information on transceivers, cables and other items available from Teledyne LeCroy Xena. You can also see how these that can be used with the Teledyne LeCroy Xena 400GE, 100GE and 40GE test modules in the “What Goes Where” section. Finally, the Application Note includes an example on how to configure the 400 GE Thor-400G-7S-1P test module to the speeds supported by the module.

Transmission of high-speed Ethernet signals

Transmission of high speed Ethernet signals with data rates at or above 10 Gbps has evolved over time. The first generation supports data rates 100 Gbps, 40 Gbps and 10 Gbps. The signals are sent using 10.3125 Gbps streams/SERDES:

- 100 Gbps signals are sent as 10 parallel 10.3125 Gbps streams/SERDES
- 40 Gbps signals are sent as 4 parallel 10.3125 Gbps streams/SERDES
- 10 Gbps signals are sent as a single 10.3125 Gbps stream/SERDES

The second generation of systems, supporting data rates up to 100 Gbps, use 25.78125 Gbps streams/SERDES. With this stream/SERDES speed 100Gbps, 50 Gbps and 25 Gbps data rates are supported:

- 100 Gbps signals are sent as 4 parallel 25.78125 Gbps streams/SERDES
- 50 Gbps signals are sent as 2 parallel 25.78125 Gbps streams/SERDES
- 25 Gbps signals are sent as a single 25.78125 Gbps stream/SERDES

The most recent systems support data rates up to 400 Gbps. This could be achieved using sixteen 25.78125 Gbps streams/SERDES. However, a desire to reduce the spectral bandwidth and reduce number of streams/SERDES has introduced a new line coding technique: The PAM4 Line Code. Older Ethernet communication systems are based on the Non-Return-to-Zero (NRZ) line code, which will transfer is 1 bit per sent symbol. PAM4 (Pulse Amplitude Modulation) encodes two bits in a single symbol by using 4 signal levels. This provides 53.125 Gbps stream/SERDES with a symbol rate (or baud rate) of 26.5625 Gbaud. Figure 1 illustrates the difference between the NRZ and PAM line codes.

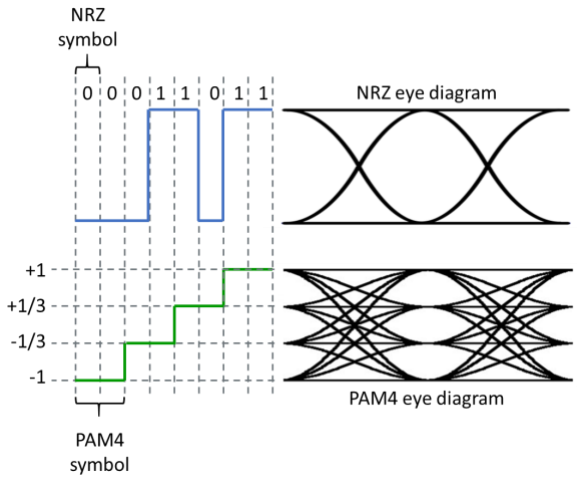

Figure 1: PAM4 and NRZ line codes and eye diagrams

Systems supporting 400 Gbps, 200 Gbps, 100 Gbps and 50 Gbps data rates, using PAM4 line code and 53.125 Gbps stream/SERDES or 26.5625 Gbaud stream/SERDES:

- 400 Gbps signals are sent as 8 parallel 26.5625 Gbaud streams/SERDES
- 200 Gbps signals are sent as 4 parallel 26.5625 Gbaud streams/SERDES
- 100 Gbps signals are sent as 2 parallel 26.5625 Gbaud streams/SERDES
- 50 Gbps signals are sent as a single 26.5625 Gbaud stream/SERDES

Physical Media

For the physical media between communications devices there are two options:

- Very short ranges (up to 7 meters): Electrical cables are normally used as they are cost effective.
- Longer distances: Optical cables are used. For distances up to 100 meters multimode cables can be used; for longer distances the more expensive single mode cables are needed.

Optical signals

Optical signals using more than a single stream/SERDES can be sent in two ways:

1. As a number of physical signals – 10, 8, 4, 2 or 1 depending on speed and technology. This means that this number of optical fibers are needed between the communication devices (multi-fiber connections).

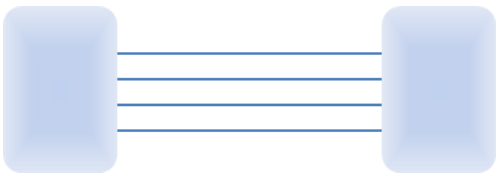

Figure 2: Several fibers between devices

2. With a number of optical wave lengths (10, 8, 4, 2 or 1 depending on speed and technology) using Wavelength Division Multiplexing (WDM) techniques. This means that the signals are sent as several different wavelengths (or colors) in parallel over a single optical fiber. This is used for longer distances as only one optical cable is required.

Figure 3: A single fiber between devices – several wavelengths are used

Multimode fiber optic systems are normally implemented as multi-fiber connections, while Single Mode fiber optic systems normally use WDM techniques. However Single Mode fiber optic can also use multi-fiber connections, which is also known as Parallel Single Mode (PSM) or PSM4 when 4 fibers are used in parallel.

Electrical signals

Electrical signals are always sent as physical electrical signals, which means that signals – 10, 8, 4 or 2 depending on speed. This means that this number of electrical cables are needed between the devices.

Naming of 400 G to 10 G Interface Options

100 G to 10 G NRZ Interface options are normally named xxxGBASEyy#, where

- xxx indicates the speed (xxx=100 means 100 Gbps, XXX= 40 means 40 Gbps and so on)
- yy typically indicates reach and cable type:
  - yy=CR means very short reach on an electrical Copper cable
  - yy=SR means short reach on a multimode optical fiber
  - yy=LR means long reach on a single mode optical fiber
  - yy=ER means extended reach on a single mode optical fiber
- # shows number of lanes i.e. #=4 for 4 lanes and #=10 for 10 lanes

400 G to 50 G PAM4 Interface options are named xxxGBASEyy#, where

- xxx indicates the speed (xxx=400 means 400 Gbps, XXX= 200 means 200 Gbps and so on)
- yy typically indicates reach and cable type:
  - yy=CR means very short reach on an electrical Copper cable
  - yy=SR means short reach (70-150 m, depending on cable type) on a multimode optical fiber
  - yy=DR means short reach (up to 0.5 km) on a single mode optical fiber
  - yy=FR means medium reach (up to 2 km) on a single mode optical fiber
  - yy=LR means long reach (up to 10 km) on a single mode optical fiber
  - yy=ER means extended reach (up to 40 km) on a single mode optical fiber
  - yy=ZR means very long reach (up to 80 km) on a single mode optical fiber
- # shows number of lanes e.g. #=4 for 4 lanes and #=10 for 10 lanes

What is the difference between 100GBASE-LR4 and 100GBASE-CWDM4?

There are two versions of 4 lane 100 Gbps optical WDM systems running on a single mode fiber: 100GBASE-LR4/ER4 and 100GBASE-CWDM4 (CWDM = Coarse Wavelength Division Multiplex). 100GBASE-LR4 and 100GBASE-ER4 are both defined by IEEE in IEEE 802.3ba; 100GBASE-CWDM4 is defined by CWDM4 MSA group as a lower cost alternative for distances up to 2 km in data center applications. Both systems use 4 different wavelengths for the 4 lanes:

- 100GBASE-LR4/ER4 uses 1295.56 nm, 1300.05 nm, 1304.59 nm and 1309.14 nm
- 100GBASE-CWDM4 uses 1271 nm, 1291 nm, 1311 nm and 1331 nm

Direct Attached Cables (DACs) and Active Optical Cables (AOC)

High speed communication devices are typically equipped with cages where transceivers can be installed. In some cases, the cables between devices are directly connected to the transceivers, which are known as Direct Attached Cables (DACs). Connections with electrical cables are normally made with DACs. DACs with optical cables and transceivers are also known as Active Optical Cables (AOC).

	Description	Type	Length	See Fig.
FCBN425QB1C05 (AOC)	Finisar 100G QSFP28 100GBASE-SR4	AOC	5 m	4
2010LF (DAC)	FCI Direct Attached Cable, 4 x 25Gbps qualified, AWG30	DAC	1 m	3
2030LF (DAC)	FCI Direct Attached Cable, 4 x 25Gbps qualified, AWG30	DAC	3 m	3
4050LF (DAC)	FCI Direct Attached Cable, 4 x 25Gbps qualified, AWG26	DAC	1 m	3

Table 1: 100 Gbps QSFP28 AOC and DACs available from Teledyne LeCroy Xena

Figure 4: 100 Gbps DAC with two electrical QSFP28 transceivers

Figure 5: 100 Gbps AOC with two optical QSFP28 transceivers

Optical Connectors

Optical transceivers are equipped with connectors – unless they are a part of an Active Optical Cable. Two types are normally used:

1. **Multi-fiber connections:** Multi-fiber Push-On (MPO) connectors are used. They can connect up to 12 (MPO12), 16 (MPO16) or 24 (MPO24) optical fibers. For 4 lane systems 8 fibers are required (4 for the optical transmitters and 4 fibers for the optical receivers). These systems will use 8 of the 12 fiber connections in MPO12 connectors. 8 lane systems will use all 16 connections in the MPO16 connector, while 10 lane systems will use 20 of the 24 connections in MPO24 connectors.
   Multi-fiber Termination Push-on (MTP) is a brand name for an improved connector developed by US Connect; MTP connects to MPO.

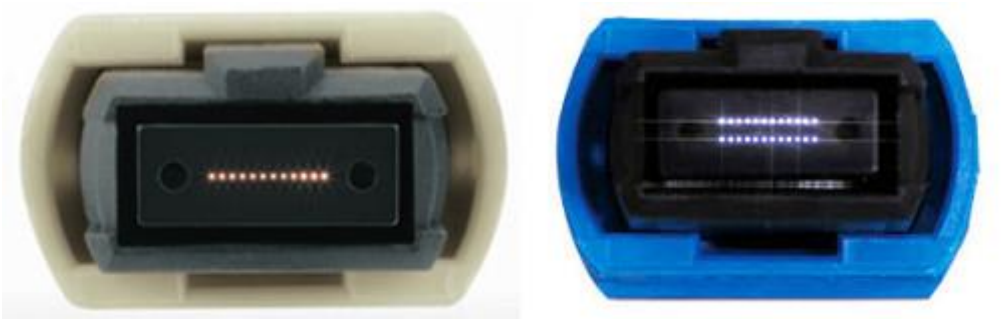

Figure 6: 12 fiber ends in an MPO12 connector; 24 fiber ends in an MPO24 connector

2. **Single fiber connections:** Transceivers and fiber cables are normally equipped with LC connectors; two fiber cables are required, one for transmit, one for receive.

Figure 7: LC connector

Break Out Cables and Splitter Cables

For some applications like connecting servers to Top-of-Rack (ToR) switches in data centers, it is relevant to use the 4 25 Gbps lanes in a multi-cable connection as 4 individual 25 Gbps data streams. Hereby you can connect a 100 Gbps port in the ToR switch with 4 data center servers equipped with 25 Gbps ports. This is done with a DAC or AOC break out cable connecting a QSFP28 100GbE port with four independent 25GE SFP28 ports. The DAC/AOC break out cable will have a QSFP28 transceiver connected in one end breaking out to four cables, each terminated with a SFP28 transceiver.

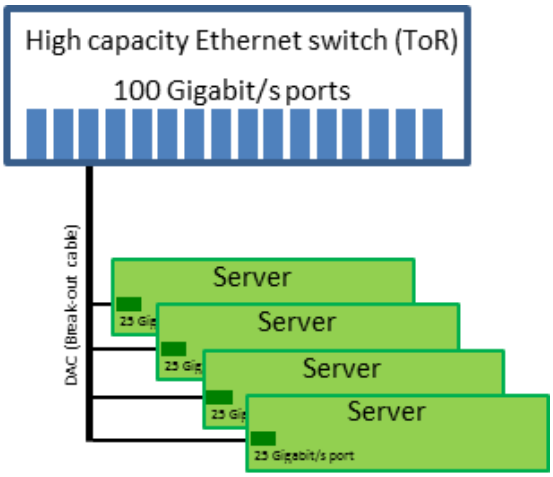

Figure 8: 100 GE to 4*25 GE break-out cable

DAC and AOC break out cables are available for electrical and optical interfaces, where 40 Gbps and 100 Gbps signals are sent as 4 (or 10) physical signals. For single fiber connections break out cables are not available; splitting a WDM signal into 4 lower rate signals would require a WDM multiplexer/demultiplexer.

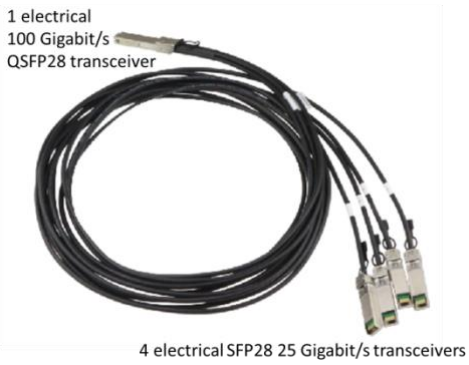

Figure 9: 100 Gigabit/s QSFP28 to 4 x 25 Gigabit/s SFP28 DAC electrical break-out cable

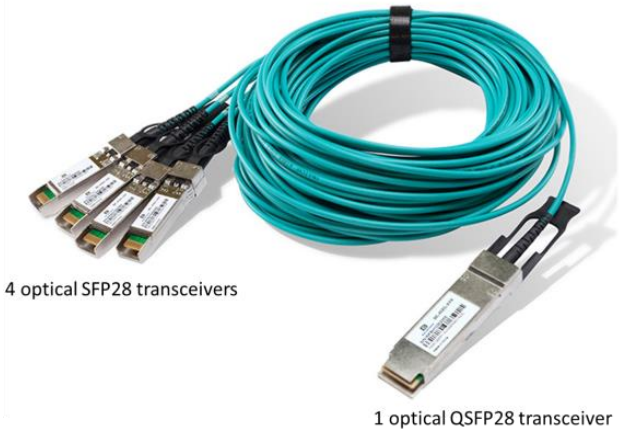

Figure 10: 100 Gigabit/s QSFP28 to 4 x 25 Gigabit/s SFP28 break-out Active Optical Cable (AOC)

In addition to DAC and AOC break out cables, passive optical breakout cables (or splitter cables) are available splitting a 4 (or 10) lane signal into 4 (or 10) separate signals. This means for example that 4 25 Gbps optical signals from a QSFP28 optical transceiver with MPO/MTP connector can be split into 4 individual cable pairs to be connected to SFP28 optical transceivers with LC connectors as shown in figure 11.

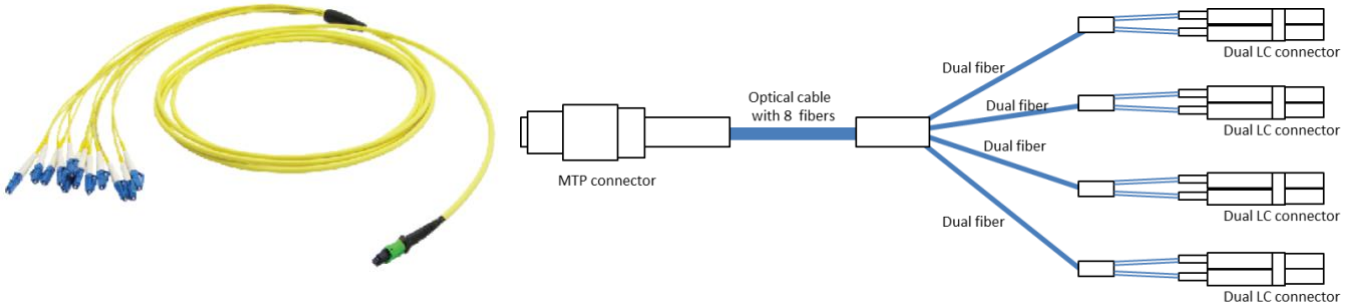

Figure 11: MTP to 4 dual LC passive optical splitter cable

For 10 lane multi-fiber optical transceivers with MPO24 connectors optical splitter cables can split the signal into 12 cable pairs, providing access to all 24 fibers in the MPO24 connector.

	Description	Cable type	Length	See Fig.
SR4-4xLC	Optical splitter cable, SR4 MTP(F) <-> 4 x LC	MMF	5 m	10
iSM4-4xLC	Optical splitter cable, iSM4 MTP(F) <-> 4 x LC	SMF	5 m	10
SR4-LOOP	Loopback fiber cable, SR4, MTP(F)	MMF		11
SR10-2xSR4	Cassette, SR10 MTP(F) <-> 2 x QSFP receptacle, including 3 mm SR10 cable	MMF		13
SR10-12xLC	Optical splitter cable, SR10 MTP(F) <-> 12 x LC (Molex 106284-5003)	MMF	5 m	10
SR10-LOOP	Loopback fiber cable, SR10, MTP(F),	MMF		11
SR4-Trunk	MTP(female) to MTP(female) 50/125/OM3, 12 Fiber Dia. 3,0mm	MMF	3 m	12
SR10-Trunk	MTP(female) to MTP(female) 50/125/OM3, 24 Fiber Dia. 3,8mm	MMF	3 m	12
SR8-LOOP	Loopback fiber cable, 16 fibers, MPO/MTP(F), MMF	MMF		11
SR8-Trunk	MPO/MTP(female) to MPO/MTP(female) 50/125/OM3 MMF	MMF	3 m	12

Table 2: Cables and splitters available from Teledyne LeCroy Xena

As you can see in table 2, splitter cables are equipped with MTP (MPO) connectors. They can split signals from optical (multi-fiber) transceivers that also are equipped with MTP (MPO) connectors; they can't split signals from optical (WDM) transceivers with LC connectors.

Figure 12: Two SR4-LOOP Loopback fiber cables

Figure 13: SR4-Trunk cable

Splitter Cassette P/N SR10-2xSR4

Figure 14: Splitter Cassette for 100GBASE-SR10 (MPO) <-> 2 x 40GBASE-SR4 MPO connectors (P/N SR10-2xSR4)

SR10-2xSR4 splits the signals from the CXP cage in Loki-100G-3S-1P to 2 x 40G or (by adding splitter cables) 8 x 10G signals depending on settings. It is equipped with one MPO24 connector and two MPO12 connectors. The MPO24 connector must be connected to a 100GBASE-SR10 transceiver with MPO24 connector through an MTP/MPO24-to-MTP/MPO24 cable (e.g. the cable

SR10-Trunk available from Teledyne LeCroy Xena). Inside the device the MPO24 connector is connected to two MPO12 connectors using 2 x 8 fibers. The MPO12 connectors will act as two 40GBASE-SR4 (QSFP+) transceivers.

Multiple Port Speeds in Teledyne LeCroy Xena 400G, 100G and 40G test modules

Teledyne LeCroy Xena 400G, 100G and 40G test modules can support 400 Gbps, 200 Gbps 100 Gbps, 50 Gbps, 40 Gbps, 25 Gbps and 10 Gbps port speeds depending on test module, transceiver module and in some cases splitter cables. Tables 3 and 4 give an overview of the speeds supported by each of these test modules.

Product Number	Port Speed	Interface Form Factor	No. of Ports	Type of Interface
Z400q Thor	400G (or) 200G (or) 100G (or) 100G (or) 50G (or) 50G (or) 40G (or) 25G (or) 10G	QSFP-DD QSFP-DD/QSFP56 QSFP-DD/QSFP56 QSFP28 QSFP-DD/QSFP56 QSFP28 QSFP28/QSFP+ QSFP28 QSFP28/QSFP+	1 2 4 2 8 4 2 8 8	400GBASE-SR8/FR8/LR8/DR4 (PAM4) 200GBASE- DR4/SR4/FR4/LR4/CR4 (PAM4) 100GBASE- SR2/LR2/CR2 (PAM4) 100GBASE-SR4/LR4/CWDM4/CR4 (NRZ) 50GBASE-SR/CR (PAM4) 50GBASE-SR2/LR2/CR2 (NRZ) 40GBASE-SR4/LR4/CR4 (NRZ) 25GBASE-SR/LR/CR (NRZ) 10GBASE-iSR(NRZ)
Thor-100G-5S-4P 5 speed	100G (or) 100G (or) 50G (or) 50G (or) 40G (or) 25G (or) 10G	QSFP-DD/QSFP56 QSFP28 QSFP-DD/QSFP56 QSFP28 QSFP28/QSFP+ QSFP28 QSFP28/QSFP+	4 2 8 4 2 8 8	100GBASE- SR2/LR2/CR2 (PAM4) 100GBASE-SR4/LR4/CWDM4/CR4 (NRZ) 50GBASE-SR/CR (PAM4) 50GBASE-SR2/LR2/CR2 (NRZ) 40GBASE-SR4/LR4/CR4 (NRZ) 25GBASE-SR/LR/CR (NRZ) 10GBASE-iSR(NRZ)
Loki-100G-5S-2P 5 speed	100G (or) 50G (or) 40G (or) 25G (or) 10G	QSFP28 QSFP28 QSFP28/QSFP+ QSFP28 QSFP28/QSFP+	2 4 2 8 8	100GBASE-SR4/LR4/CWDM4/CR4 50GBASE-SR2/LR2/CR2 40GBASE-SR4/LR4/CR4 25GBASE-SR/LR/CR 10GBASE-iSR
Loki-100G-5S-1P 5 speed Dual-media	100G (or) 50G (or) 40G (or)	QSFP28 QSFP28 QSFP28/QSFP+ QSFP28	1 2 1 4	100GBASE-SR4/LR4/CWDM4/CR4 50GBASE-SR2/LR2/CR2 40GBASE-SR4/LR4/CR4 25GBASE-SR/LR/CR

	25G (or) 10G (or) 25G (or) 10G	QSFP28/QSFP+ SFP28 SFP28/SFP+	4 2 2	10GBASE-iSR 25GBASE-SR/LR/CR 10GBASE- SR/LR/CR
Loki-100G-3S-1P **3 speed** **Dual-media**	100G (or) 40G (or) 100G (or) 40G (or) 10G	QSFP28 QSFP28/QSFP+ CXP CXP CXP	1 1 1 2 8	100GBASE-SR4/LR4/CWDM4 40GBASE-SR4/LR4 100GBASE-SR10 40GBASE-iSR4 10GBASE-iSR
Loki-100G-3S-1P-B **3 speed** **Triple-media**	100G (or) 100G (or) 40G (or) 100G (or) 40G (or) 10G	CFP4 QSFP28 QSFP28/QSFP+ CXP CXP CXP	1 1 1 1 2 8	100GBASE-SR4/LR4 100GBASE-SR4/LR4/CWDM4 40GBASE-SR4/LR4 100GBASE-SR10 40GBASE-SR4 10GBASE-iSR

Table 3: Teledyne LeCroy Xena 400G and 100G test modules

Product Number	Port Speed	Interface Form Factor	No. of Ports	Type of Interface
Odin-40G-2S-2P	40G (or) 10G	QSFP+	2 8	40GBASE-SR4/LR4/DAC 10GBASE-iSR/iSM/DAC

Table 4: Teledyne LeCroy Xena 40G test module

For iSR the “i” represents interoperability between the transceiver and any 10GBASE-SR compliant modules. For iSM, the “i” represents interoperability between the transceiver and any single mode (SM) 10GBASE-LR compliant modules up to 2 km link length.

Port Speeds per Teledyne LeCroy Xena 400G, 100G and 40G test modules

To change the port speed, the user must configure the port speed and, in some cases, change transceiver and cables. A summary of the port speeds supported by Teledyne LeCroy Xena 100G and 40G test modules together with the transceiver type required to support a given speed is shown in tables 5 to 11.

Cages	Port Speeds/ Interface Options	Cable Type	Transceiver Type
2 x QSFP28/QSFP+	2 x 100GBASE-SR4	MMF	100GBASE-SR4
	2 x 100GBASE-LR4	SMF	100GBASE-LR4
	2 x 100GBASE-CWDM4	SMF	100GBASE-CWDM4
	2 x 100GBASE-CR4	Copper	100GBASE-CR4 (DAC)
	4 x 50GBASE-SR2	MMF	100GBASE-SR4 and splitter
	4 x 50GBASE-LR2	SMF	100GBASE-LR4 PSM4 and splitter
	4 x 50GBASE-CR2	Copper	100GBASE-CR4 (DAC with break-out)
	8 x 25GBASE-SR	MMF	100GBASE-SR4 and splitter
	8 x 25GBASE-LR	SMF	100GBASE-LR4 PSM4 and splitter
	8 x 25GBASE-CR	Copper	100GBASE-CR4 (DAC with break-out)
	2 x 40GBASE-SR4	MMF	40GBASE-SR4
	2 x 40GBASE-LR4	SMF	40GBASE-LR4
	2 x 40GBASE-CR4	Copper	40GBASE-CR4
	8 x 10GBASE-iSR	MMF	40GBASE-SR4 and splitter

Table 5: Port speeds supported by Teledyne LeCroy Xena Z100 Loki.

Cages	Port Speeds/ Interface Options	Cable Type	Transceiver Type
1 x QQSFP-DD (PAM4)	1 x 400GBASE-SR8	MMF	400GBASE-SR8
	1 x 400GBASE-FR8/LR8/DR4	SMF	400GBASE-FR8/LR8/DR4
	1 x 400GBASE-CR8	Copper	400GBASE-CR8
	2 x 200GBASE-SR4	MMF	400GBASE-SR8 and splitter
	2 x 200GBASE-SR4/FR4/LR4	SMF	400GBASE-SR8/FR8/LR8 and splitter
	2 x 200GBASE- CR4	Copper	400GBASE-CR8 and splitter
	4 x 100GBASE- SR2	MMF	400GBASE-SR8 and splitter
	4 x 100GBASE- LR2	SMF	400GBASE-LR8 and splitter
	4 x 100GBASE- CR2	Copper	400GBASE-CR8 and splitter
	8 x 50GBASE- LR2	SMF	400GBASE-LR8 and splitter
	8 x 50GBASE- CR2	Copper	400GBASE-CR8 and splitter
2 x QSFP56 (PAM4)	2 x 200GBASE-SR4	MMF	200GBASE-SR4
	2 x 200GBASE-SR4/FR4/LR4	SMF	200GBASE-SR4/FR4/LR4
	2 x 200GBASE- CR4	Copper	200GBASE-CR4
	4 x 100GBASE- SR2	MMF	200GBASE-SR4 and splitter
	4 x 100GBASE- LR2	SMF	200GBASE-LR4 and splitter
	4 x 100GBASE- CR2	Copper	200GBASE-CR4 and splitter
	8 x 50GBASE- LR2	SMF	200GBASE-LR4 and splitter
	8 x 50GBASE- CR2	Copper	200GBASE-CR4 and splitter
2 x QSFP28/QSFP+	2 x 100GBASE-SR4	MMF	100GBASE-SR4
	2 x 100GBASE-LR4	SMF	100GBASE-LR4

(NRZ)	2 x 100GBASE-CWDM4	SMF	100GBASE-CWDM4
	2 x 100GBASE-CR4	Copper	100GBASE-CR4 (DAC)
	4 x 50GBASE-SR2	MMF	100GBASE-SR4 and splitter
	4 x 50GBASE-LR2	SMF	100GBASE-LR4 PSM4 and splitter
	4 x 50GBASE-CR2	Copper	100GBASE-CR4 (DAC with break-out)
	8 x 25GBASE-SR	MMF	100GBASE-SR4 and splitter
	8 x 25GBASE-LR	SMF	100GBASE-LR4 PSM4 and splitter
	8 x 25GBASE-CR	Copper	100GBASE-CR4 (DAC with break-out)
	2 x 40GBASE-SR4	MMF	40GBASE-SR4
	2 x 40GBASE-LR4	SMF	40GBASE-LR4
	2 x 40GBASE-CR4	Copper	40GBASE-CR4
	8 x 10GBASE-iSR	MMF	40GBASE-SR4 and splitter

Table 6: Port speeds supported by Teledyne LeCroy Xena Z400 Thor.

Cages	Port Speeds/ Interface Options	Cable Type	Transceiver Type
1 x QQSFP-DD (PAM4)	4 x 100GBASE- SR2	MMF	400GBASE-SR8 and splitter
	4 x 100GBASE- LR2	SMF	400GBASE-LR8 and splitter
	4 x 100GBASE- CR2	Copper	400GBASE-CR8 and splitter
	8 x 50GBASE- LR2	SMF	400GBASE-LR8 and splitter
	8 x 50GBASE- CR2	Copper	400GBASE-CR8 and splitter
2 x QSFP56 (PAM4)	4 x 100GBASE- SR2	MMF	200GBASE-SR4 and splitter
	4 x 100GBASE- LR2	SMF	200GBASE-LR4 and splitter
	4 x 100GBASE- CR2	Copper	200GBASE-CR4 and splitter
	8 x 50GBASE- LR2	SMF	200GBASE-LR4 and splitter
	8 x 50GBASE- CR2	Copper	200GBASE-CR4 and splitter
2 x QSFP28/QSFP+ (NRZ)	2 x 100GBASE-SR4	MMF	100GBASE-SR4
	2 x 100GBASE-LR4	SMF	100GBASE-LR4
	2 x 100GBASE-CWDM4	SMF	100GBASE-CWDM4
	2 x 100GBASE-CR4	Copper	100GBASE-CR4 (DAC)
	4 x 50GBASE-SR2	MMF	100GBASE-SR4 and splitter
	4 x 50GBASE-LR2	SMF	100GBASE-LR4 PSM4 and splitter
	4 x 50GBASE-CR2	Copper	100GBASE-CR4 (DAC with break-out)
	8 x 25GBASE-SR	MMF	100GBASE-SR4 and splitter
	8 x 25GBASE-LR	SMF	100GBASE-LR4 PSM4 and splitter
	8 x 25GBASE-CR	Copper	100GBASE-CR4 (DAC with break-out)
	2 x 40GBASE-SR4	MMF	40GBASE-SR4
	2 x 40GBASE-LR4	SMF	40GBASE-LR4
	2 x 40GBASE-CR4	Copper	40GBASE-CR4
	8 x 10GBASE-iSR	MMF	40GBASE-SR4 and splitter

Table 7: Port speeds supported by Teledyne LeCroy Xena Z400 Thor.

Cages	Port Speeds/ Interface Options	Cable Type	Transceiver Type
1 x QSFP28/QSFP+	1 x 100GBASE-SR4	MMF	100GBASE-SR4
	1 x 100GBASE-LR4	SMF	100GBASE-LR4
	1 x 100GBASE-CWDM4	SMF	100GBASE-CWDM4
	1 x 100GBASE-CR4	Copper	100GBASE-CR4 (DAC)
	2 x 50GBASE-SR2	MMF	100GBASE-SR4 and splitter
	2 x 50GBASE-LR2	SMF	100GBASE-LR4 PSM4 and splitter
	2 x 50GBASE-CR2	Copper	100GBASE-CR4 (DAC with break-out)
	4 x 25GBASE-SR	MMF	100GBASE-SR4 and splitter
	4 x 25GBASE-LR	SMF	100GBASE-LR4 PSM4 and splitter
	4 x 25GBASE-CR	Copper	100GBASE-CR4 (DAC with break-out)
	1 x 40GBASE-SR4	MMF	40GBASE-SR4
	1 x 40GBASE-LR4	SMF	40GBASE-LR4
	1 x 40GBASE-CR4	Copper	40GBASE-CR4
	4 x 10GBASE-iSR	MMF	40GBASE-SR4 and splitter
2 x SFP28/SFP+	2 x 25GBASE-SR	MMF	25GBASE-SR
	2 x 25GBASE-LR	SMF	25GBASE-LR
	2 x 25GBASE-CR	Copper	25GBASE-CR (DAC)
	2 x 10GBASE-SR	MMF	10GBASE-SR
	2 x 10GBASE-LR	SMF	10GBASE-LR
	2 x 10GBASE-CR	Copper	10GBASE-CR

Table 8: Port speeds supported by Teledyne LeCroy Xena Z100 Loki.

Cages	Port Speeds / Interface Options	Cable Type	Transceiver Type
1 x QSFP28/QSFP+ 1 x CXP	1 x 100GBASE-SR10	MMF	100GBASE-SR10
	2 x 40GBASE-iSR4	MMF	100GBASE-SR10 and splitter
	8 x 10GBASE-iSR	MMF	100GBASE-SR10 and splitter
	1 x 100GBASE-SR4	MMF	100GBASE-SR4
	1 x 100GBASE-LR4	SMF	100GBASE-LR4
	1 x 100GBASE-CWDM4	SMF	100GBASE-CWDM4
	1 x 40GBASE-SR4	MMF	40GBASE-SR4
	1 x 40GBASE-LR4	SMF	40GBASE-LR4

Table 9: Port speeds supported by Teledyne LeCroy Xena Z100 Loki.

Cages	Port Speeds/ Interface Options	Cable Type	Transceiver Type
1 x CFP4 **1 x QSFP28/QSFP+** **1 x CXP**	1 x 100GBASE-SR10	MMF	100GBASE-SR10
	1 x 40GBASE-iSR4	MMF	100GBASE-SR10 and splitter
	8 x 10GBASE-iSR	MMF	100GBASE-SR10 and splitter
	1 x 100GBASE-SR4	MMF	100GBASE-SR4
	1 x 100GBASE-LR4	SMF	100GBASE-LR4
	1 x 100GBASE-SR4	MMF	100GBASE-SR4
	1 x 100GBASE-LR4	SMF	100GBASE-LR4
	1 x 40GBASE-SR4	MMF	40GBASE-SR4
	1 x 40GBASE-LR4	SMF	40GBASE-LR4

Table 10: Port speeds supported by Teledyne LeCroy Xena Z100 Loki. *End of life module*

Cages	Port Speeds/ Interface Options	Cable Type	
2 x QSFP+	2 x 40GBASE-LR4	SMF	40GBASE-LR4
	2 x 40GBASE-SR4	MMF	40GBASE-SR4
	8 x 10GBASE-iSR	MMF	40GBASE-SR4 with splitter
	8 x 10GBASE-iSM	SMF	4x10GBASE-LR4 PSM4 with splitter

Table 11 Port speeds supported by Teledyne LeCroy Xena Z10 Odin.

400G to 10G transceivers available from Teledyne LeCroy

P/Ns	Description	Wave length	Con-nec-tor	Reach	Cable type
400 Gbps QSFP-DD					
T-DQ8FNS-H00	Innolight 400G QSFP-DD SR8 OM3	850 nm	MPO	70 m	MMF
200 Gbps QSFP-DD					
T-FX4FNS-N00	Innolight 200G QSFP56 SR4 OM3	850 nm	MPO	70 m	MMF
100 Gbps CFP4					
SFF1400L4LNGG01B (LR4)	Excelight (Sumitomo) 100G CFP4 100GBASE-LR4	1310 nm	LC	10 km	SMF
FTLC9141RENM (SR4)	Finisar 100G CFP4 100GBASE-SR4	850 nm	MPO	100 m	MMF
FTLC1141RDNL (LR4)	Finisar 100G CFP4 100GBASE-LR4	1310 nm	LC	10 km	SMF
100 Gbps QSFP28					
TR-FC85S	Innolight 100G QSFP28 100GBASE-SR4	850 nm	MPO	100 m	MMF
TR-FC13L	Innolight 100G QSFP28 100GBASE-LR4	1310 nm	LC	10 km	SMF
100 Gbps CXP					
FTLD10CE1C	Finisar 100G CXP 100GBASE-SR10	850 nm	MPO	100 m	MMF
40 Gbps CFP					
CF-X08 (2 x SR4)	Reflex Photonics 2x40G CFP Dual 40GBASE-SR4	850 nm	MPOx2	100 m	MMF
CF-X04 (SR4)	Reflex Photonics 40G CFP 40GBASE-SR4	850 nm	MPO	100 m	MMF
FTLQ8181EBLM (SR4)	Finisar 40G CFP 40GBASE-SR4	850 nm	MPO	100 m	MMF
40 Gbps QSFP+					
AFBR-79EIDZ	Avago 40G QSFP+ 40GBASE-SR4	850 nm	MPO	100 m	MMF
AFCT-88EEPZ	Avago 40G QSFP+ 40GBASE-LR4	1310 nm	LC	10 km	SMF
FTL410QE2C	Finisar 40G QSFP+ 40GBASE-SR4	850 nm	MPO	100 m	MMF
FTL4C1QE1C	Finisar 40G QSFP+ 40GBASE-LR4	1310 nm	LC	10 km	SMF
TR-IQ13L	Innolight 4x10G QSFP+ 4x10GBASE-LR4 Parallel Single Mode (PSM)	1310 nm	MPO	10 km	SMF

Table 12: 400G to 40G transceivers available from Teledyne LeCroy Xena.

P/Ns	Description	Wave length	Con-nec-tor	Reach	Cable type
25 Gbps SFP28					
TR-PY85S	Innolight SFP28 SR	850 nm	LC	70m /100m	MMF
TR-PY13L	Innolight SFP28 LR	1310 nm	LC	10 km	SMF
10 Gbps SFP+					
FTLX8573D3BT	Finisar 10G SFP+ 10GBASE-SR	850 nm	LC	300 m	MMF
SPP5300LR-GL	Excelight (Sumitomo) 10G SFP+ 10GBASE-LR	1310 nm	LC	10 km	SMF
SFP-10G-T-NC	Prolabs 10G SFP+ 10GBASE-T	n/a	RJ45	40 km	Copper

Table 13: 25G and 10G transceivers available from Teledyne LeCroy Xena

		
Excelight (Sumitomo) 100G CFP4 100GBASE-LR4	Innolight 100G QSFP28 100GBASE-LR4	Finisar 100G CXP 100GBASE-SR10

Figure 15: Examples of transceivers available from Teledyne LeCroy Xena

What goes where?

Table 14 and 15 shows how transceivers available from Teledyne LeCroy Xena can be used with Xena´s 400G, 100 G and 40 G test modules and with cables and splitters.

		Teledyne LeCroy Xena Test Modules								Cables and splitters								
	Connector	Thor-400G-7S-1P	Thor-100G-5S-4P	Loki-100G-5S-2P	Loki-100G-5S-1P	Loki-100G-3S-1P	Loki-100G-3S-1P-D*	Odin-40G-2S-2P	Odin-10G-1S-12P*	SR4-4xLC	iSM4-4xLC	SR4-LOOP	SR10-2xSR4	SR10-12xLC	SR10-LOOP	SR4-Trunk	SR8-Trunk	SR10-Trunk
T-DQ8FNS-H00	MPO	√	√														√	
T-FX4FNS-N00	MPO	√	√							√		√				√		
SFF1400L4LNGG01B (LR4)	LC						√											
FTLC9141RENM (SR4)	MPO						√			√		√				√		
FTLC1141RDNL (LR4)	LC						√											
TR-FC85S (SR4)	MPO	√	√	√	√	√	√			√		√				√		
TR-FC13L (LR4)	LC	√	√	√	√	√	√											
FTLD10CE1C (SR10)	MPO					√	√						√	√	√			√
AFBR-79EIDZ (SR4)	MPO	√	√	√	√	√	√	√		√		√				√		
AFCT-88EEPZ (LR4)	LC	√	√	√	√	√	√	√										
FTL410QE2C (SR4)	MPO	√	√	√	√	√	√	√		√		√				√		
FTL4C1QE1C (LR4)	LC	√	√	√	√	√	√	√										
TR-IQ13L (LR4)	MPO	√	√	√	√	√	√	√	√		√							

Table 14: Transceivers, Teledyne LeCroy Xena 400G/100G/40G test modules, cables and splitters

**End of life modules*

		Teledyne LeCroy Xena Test Modules								Cables and splitters								
	Connector	Thor-400G-7S-1P	Thor-100G-5S-4P	Loki-100G-5S-1P	Loki-100G-5S-1P	Loki-100G-3S-1P	Loki-100G-3S-1P-B*	Odin-40G-2S-2P	Odin-10G-1S-12P*	SR4-4xLC	iSM4-4xLC	SR4-LOOP	SR10-2xSR4	SR10-12xLC	SR10-LOOP	SR4-Trunk	SR8-Trunk	SR10-Trunk
TR-PY85S	LC				√													
TR-PY13L	LC				√													
FTLX8573D3BT	LC				√													
SPP5300LR-GL	LC				√													
SFP-10G-T-NC	RJ45				√													
FCBN425QB1C05 (AOC)		√	√	√	√	√	√											
2010LF (DAC)		√	√	√	√													
2030LF (DAC)		√	√	√	√													
4050LF (DAC)		√	√	√	√													

Table 15: Transceivers, Teledyne LeCroy Xena 400G/100G/4G test modules, cables and splitters

**End of life modules*

Configuring Teledyne LeCroy Xena 400G, 100G and 40G test modules

The first step in configuring the Teledyne LeCroy Xena 400G, 100G and 40G test modules is to select and reserve the test module in XenaManager. In the example in this section the module used is the 400G test module Z400 Thor, which supports QSFP-DD, QSFP56, QSFP28 and QSFP+ transceivers. The module will be configured to support 8 x 10G interfaces.

Select the module in the XenaManager Testbed explorer window, right-click on it and Reserve Module.

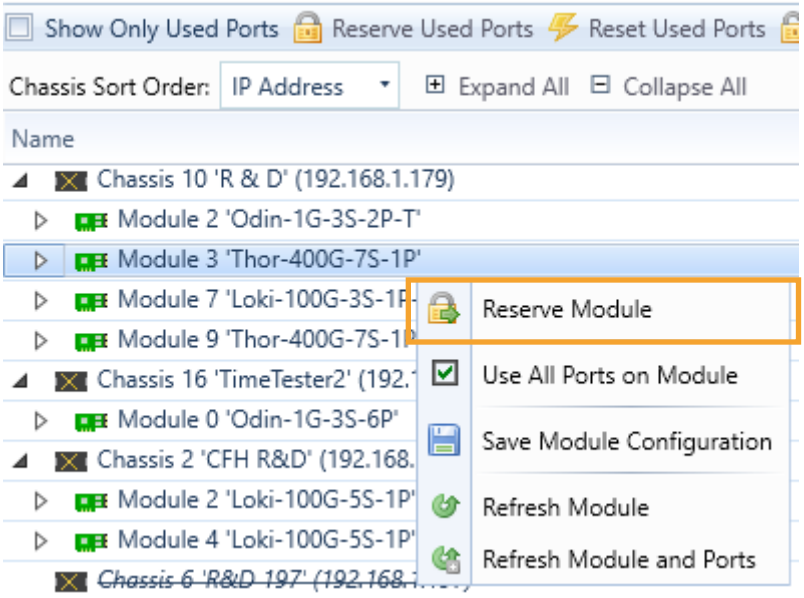

Figure 16: Reserve module

Select the Resource Properties tab; you will now see the module properties. Next step is to select the media to be used for the test; in the example QSFP28 is selected from the drop-down menu.

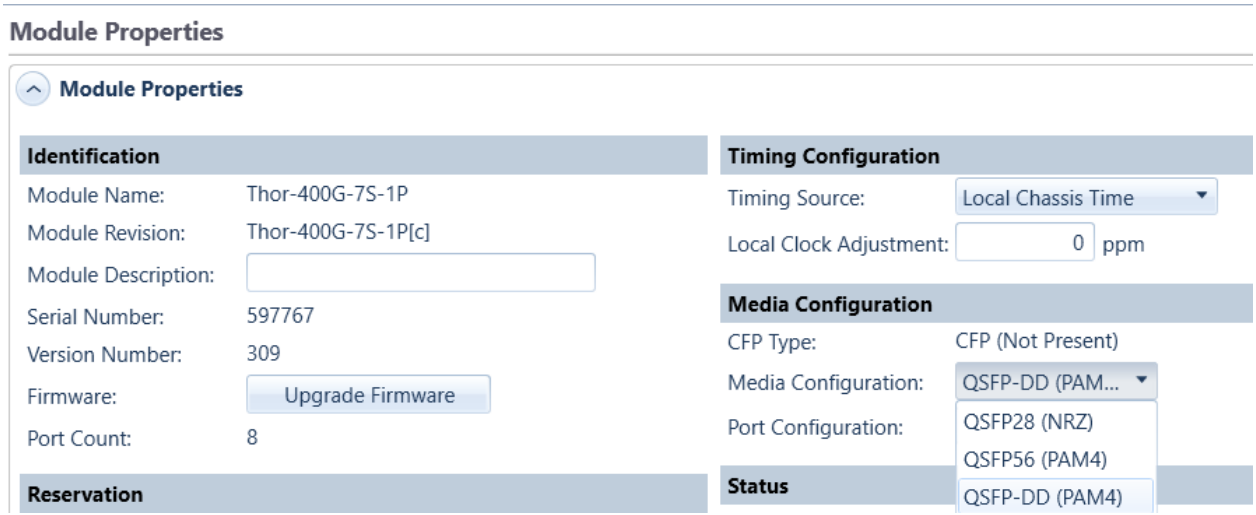

Figure 17: Select Media configuration

The Media Configuration of the Thor-400G-7S-1P provides 3 options. Table 16 shows these options and what interfaces they support.

Media Configuration option	Cage(s) used	Interfaces supported (all used cages)
QSFP-DD (PAM4)	Cage 0 only	• 1 x 400G (PAM4) • 2 x 200G (PAM4) through splitter • 4 x 100G (PAM4) through splitter • 8 x 50G (PAM4) through splitter
QSFP56 (PAM4)	Cage 0 and 1	• 2 x 200G (PAM4) • 4 x 100G (PAM4) through splitter • 8 x 50G (PAM4) through splitter
QSFP28 (NRZ) **For 40G and 10G speeds QSFP+ transceivers can be used**	Cage 0 and 1	• 2 x 100G (NRZ) • 4 x 50G (NRZ) through splitter • 2 x 40G (NRZ) • 8 x 25G (NRZ) through splitter • 8 x 10G (NRZ) through splitter

Table 16: Media Configuration options for Thor-400G-7S-1P

Finally, the speeds to be used for the test needs to be selected; in this case 8 x 10G is selected from the port configuration drop-down menu.

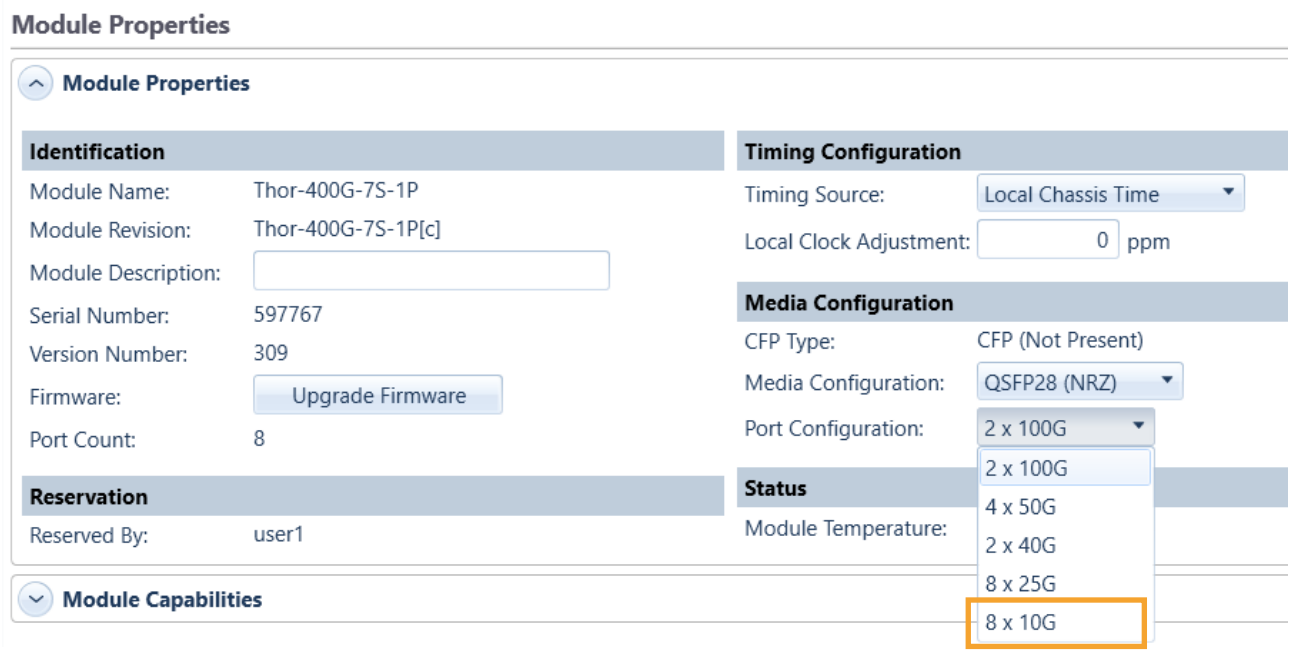

Figure 18: Select port configuration (speed)

In the XenaManager Testbed explorer window, you now see eight 10G test ports as shown in figure 19.

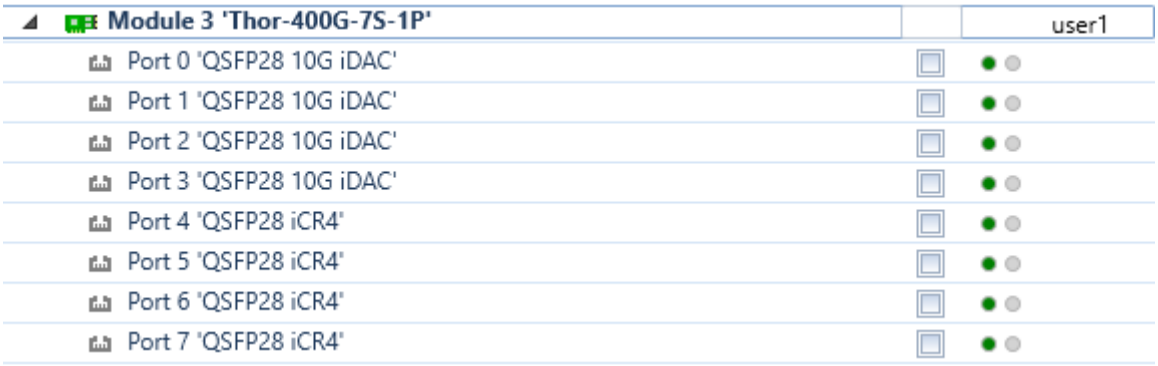

Figure 19: Eight 10G test ports in the XenaManager Testbed explorer window

You can now reserve and configure the 10 Gbps ports as required.

When the tester is configured to operate in 8 x 10 Gbps port speed mode, the Teledyne LeCroy Xena tester operate as eight fully independent 10 Gbps ports, corresponding to the eight logical test ports shown in figure 19. By using two optical splitter cables like the SR4-4xLC splitter cable, two QSFP+ transceivers in the two cages of the Thor-400G-7S-1P module will provide eight fully physical 10 Gbps ports.

SR10-12xLC Splitter Cable

Test Ports 40G	10G	Cable LC Numbering scheme: #1 - #12	Cable LC Numbering scheme: #0 - #9, #A, #B
0	0	Cable LC #2	Cable LC #0
	1	Cable LC #3	Cable LC #1
	2	Cable LC #4	Cable LC #2
	3	Cable LC #5	Cable LC #3
1	4	Cable LC #7	Cable LC #5
	5	Cable LC #8	Cable LC #6
	6	Cable LC #9	Cable LC #7
	7	Cable LC #10	Cable LC #8
Comment:		Cable LC #1, #6, #11, #12 are not connected (unused)	Cable LC #4, #9, #A, #B are not connected (unused)

Table 17: SR10 -> 12 x LC MMF cable port mapping

When using the SR10-12xLC (SR10 <-> 12 x LC MMF) splitter cable, the 8 x 10 Gbps test ports are mapped to the 12 LC connectors as illustrated in table 17. Table 17 also shows how 2 x 40 Gbps test ports will be mapped to the 12 LC connectors.

In both cases, all the eight 10 Gbps ports must be connected to the device under test. If the DUT has less than eight 10 Gbps ports, the redundant 10 Gbps ports must be connected with optical loop cables, or connected port-to-port using a LC-assembly link between the ports.

SR4-4xLC Splitter Cable

When using the SR4-4xLC (SR4 <-> 4 x LC and iSM4 <-> 4 x LC) splitter cables, the labels on the LC end of the cables will show the number of the related test port.