MAP Series from VIAVI Solutions

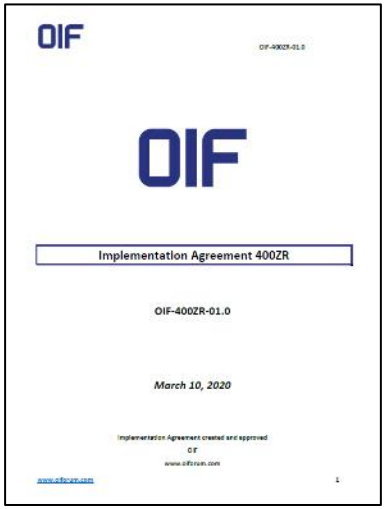
Test Solutions for Fiber Optic Technology

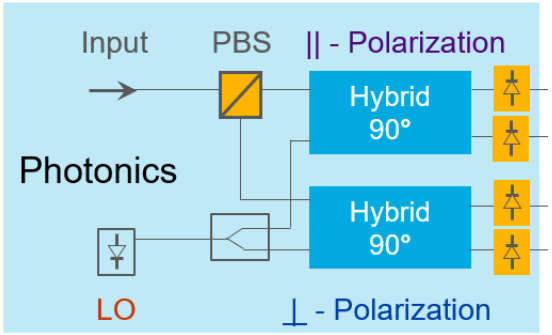
January 2021

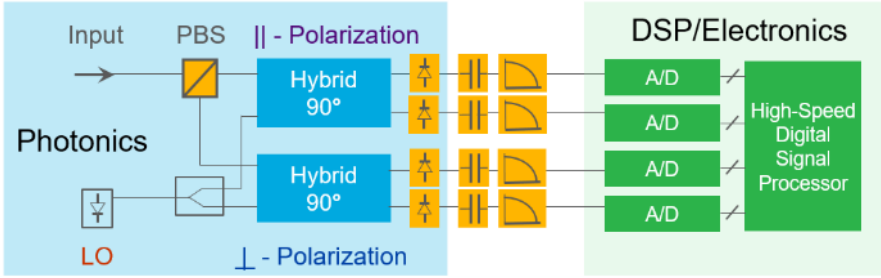
ACO & DCO

- Analog coherent optics – ACO
- Photonic + analog electronics in module
- Some module control
- Analog input/output
- Digital process on host board

- Digital coherent optics – DCO
- Photonics, analog & digital electronics. DSP & framing all in module
- Standard digital interface
- Complex module management
- Standard client interface on host board







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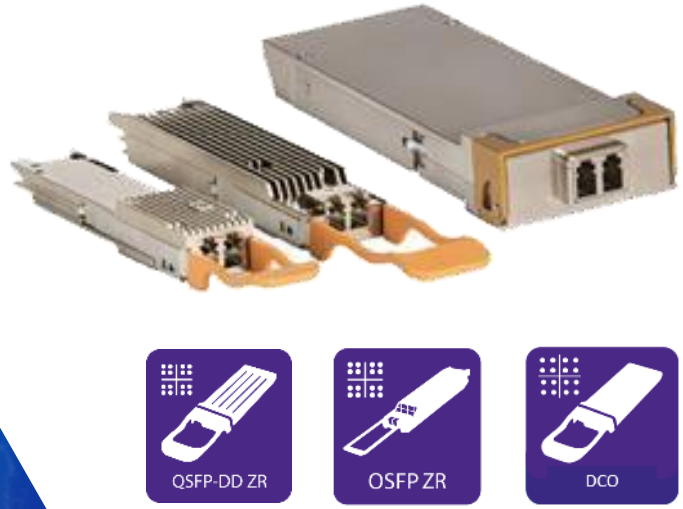
Form Factors

- Complete DCO coherent system including optics (could be tuneable across C-band), modulator drivers, DSP, framer, FEC and client interface
- Designed to plug into a ‘standard’ client host slot albeit with an extended power/cooling and advanced MIS management requirement



Form Factor	Application space	comments
QSFP-DD	Enterprise – ZR, ZR+	Highest density, integration and thermal challenges
OSFP	Enterprise – ZR, ZR+	Focused on Google ecosystem
CFP2	Telecom, DWDM, OpenROADM	High power profile, 32W.

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MAP-300 | New for 2020

- 3rd generation platform release
- Backward compatible SCPI commands with MAP-200
- Field serviceable
- Web enabled multiuser UI

Standard Benchtop

Integrated touchscreen

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Integrated System

Rackmount

Lab Based System

Flexible Web UI
Multiuser
Field Serviceable
Over 3000 modules

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VIAVI Solutions MAP-300 Chassis Summary

Chassis	Module Family	Size	Modular	Format Options	Slots	External Triggering	Field Service Controller	Super Apps	Display(s)	Remote Control	Remote UI
 MAP-220C	LightDirect Only	2U, ½ 19" rack	Yes	Benchtop Rackmount Reverse-Rackmount	2	No	Yes	No	Local UI	Common SCPI commands over Ethernet or **Optional GPIB**	Yes via VNC
 MAP-202C	mISW-C1 Optical Switch Module Only	2U, 19" rack	No		NA [< 75 ports switch]						
 MAP-204C		4U, 19" rack			NA [<160 ports switch]						
 MAP-330	LightDirect & LightTest	3U, ½ 19" rack	Yes	Benchtop Rackmount	3	Yes		Yes	Local Status & Alarm UI Remote HDMI port **Optional USB Touchscreen**		Yes via HTML5 Web UI
 MAP-380		3U, 19" rack		Benchtop Rackmount Reverse-Rackmount	8						

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MAP LightDirect

- Foundational test modules enabling photonic test automation
  - Sources and Amplification
  - Power and Spectrum
  - Switching and Routing
  - Signal Conditioning
- Characterized by simple UI and SCPI
- Speed becoming key

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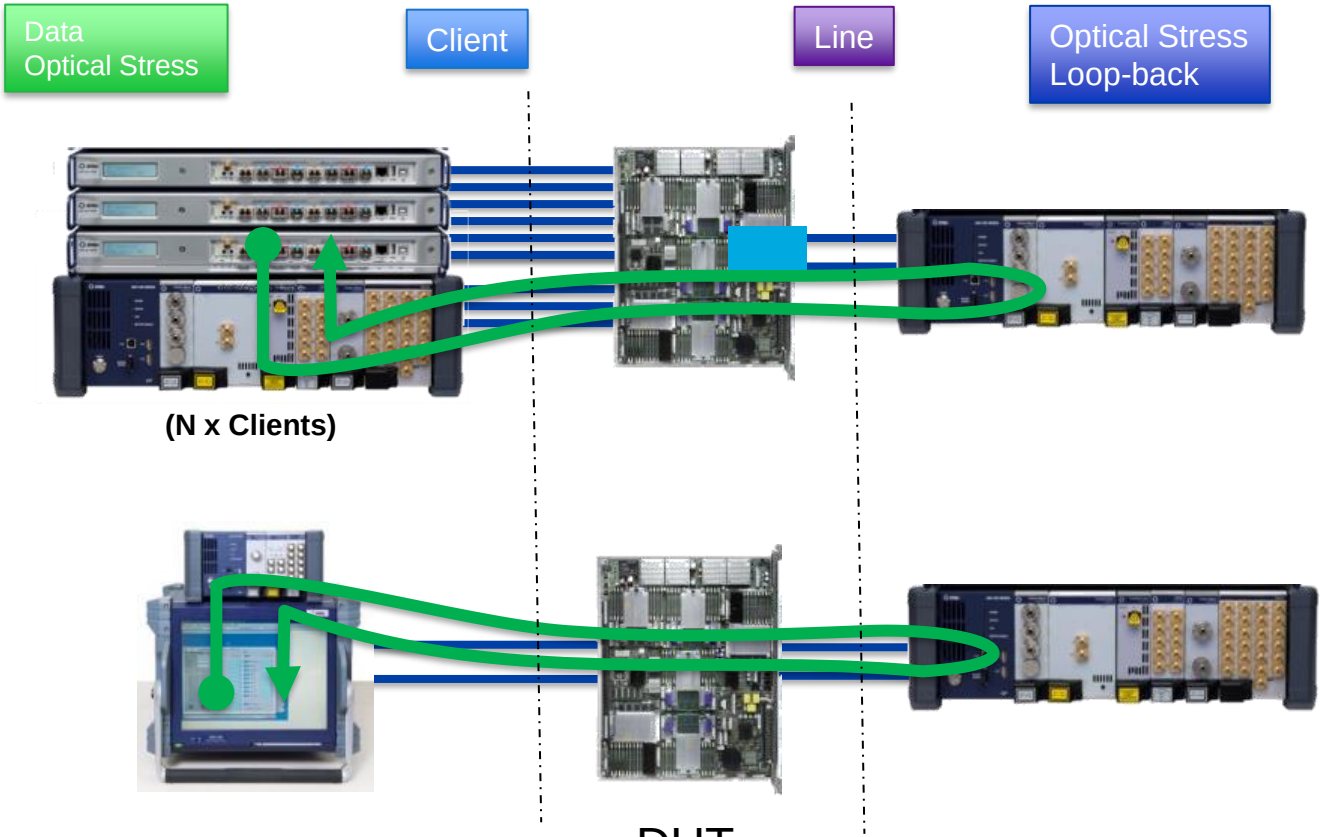
Typical Test Configurations



NRZ/PAM4

Rx:
Attenuation
Over-load

Tx:
Power
Spectrum
Reflection

Coherent

Rx:
Attenuation
Over-load
OSNR
SOP
ROADM's passed

Tx:
Power
Spectrum
Reflection

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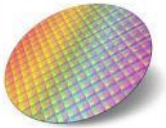
The Coherent Receiver

Ciena Wavelogic
NEL ExaSpeed
Inphi LightSpeed
Acacia

Silicon Photonics

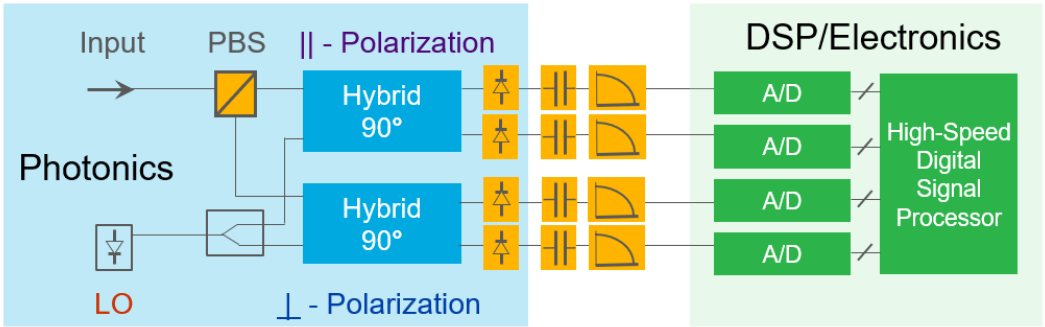


How does the optical front end impact what the signal looks like to the DSP?

Adapting in real time to the specific physical plant

How does the system respond to optical impairments?

What impact does the initial TX quality have?



The DSP can measure impairments – how accurate are the values?

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What’s in our Tool Box?

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Industry Leading Modules | MAP Series LightDIRECT

Sources & Amplifiers

FP, SLED Sources

ITU Tunable Laser

C, L, O Band Amplifiers

C, L Band ASE Broadband Sources

Switching & Routing

Passive Utility

Switching 8x8, 16x16

Switching [1x2], [2x2], and [1x4] to [1x64]

Power, Loss and Spectral Measurement

C-band Coherent OSA

Basic & High Performance OPM

Signal Conditioning

Attenuation & Power control

Pol. Scrambler & Controller

C&L Spectrum Manager & Tunable Filter

The LightDirect family includes a wide range of foundational optical test modules that are used in simple bench test applications, or combined in larger, multi-modules customer driven automated test systems. They are easy-to-control, single-functionality modules.

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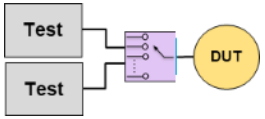
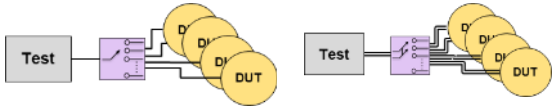
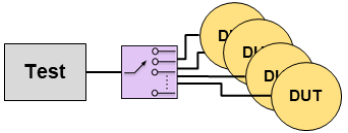
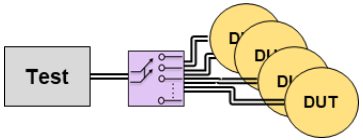
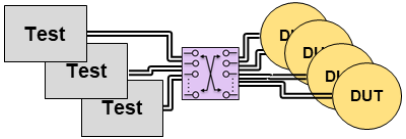
Switch Selection Guide

Series	Model	Where Used / Features	Block Diagram
mOSW-C1		▪ Multiple Test to one DUT ▪ High density, 64 1x2 in 3U 19” ▪ Basic Cost Scaling: 1.5X per port	
mOSW-C1		▪ One Test to multiple DUT (medium) ▪ High density, 8 1x50 in 3U 19” ▪ Basic Cost Scaling: X per port	
mISW-C1		▪ One Test to multiple DUT (large) ▪ Best repeatability in the industry ▪ Basic Cost Scaling: X per port	
mISW-C1		▪ Multiple Test to multiple DUT with fixed ganged relationship ▪ Cost effective parallel testing ▪ Basic Cost Scaling: 1.5 to 2X per port	
mOSX-C1		▪ Multiple Test to multiple DUT with non-blocking independent switching ▪ 8 or 16 ports ▪ Basic Cost Scaling: 5X per port	

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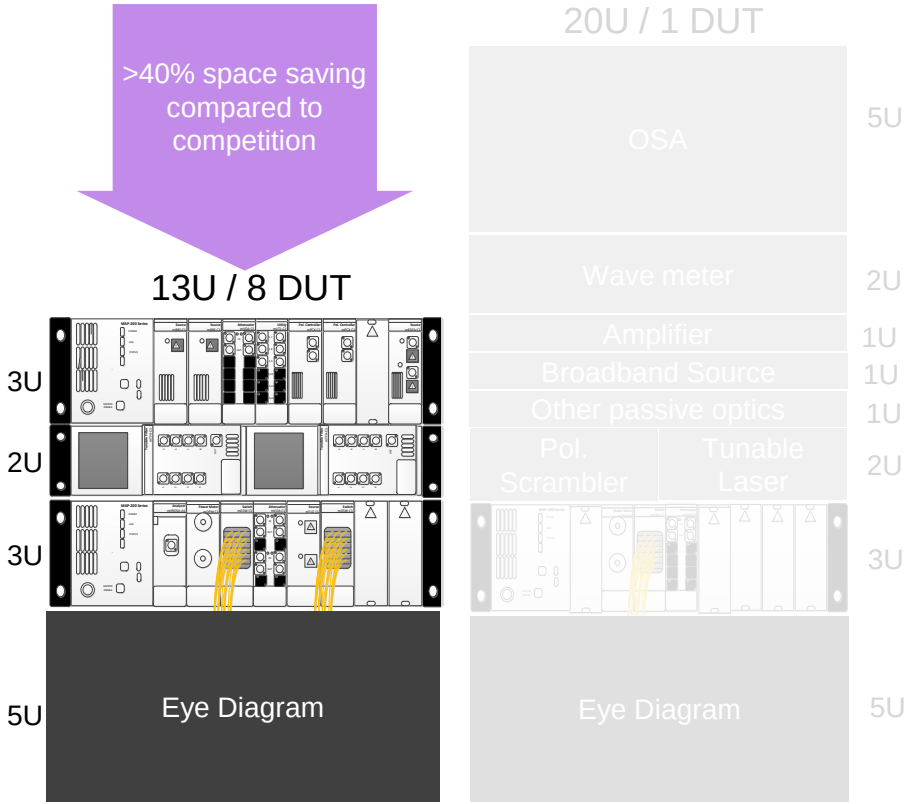
Save Floorspace | Lower Costs | Increase Throughput



Simplified Mechanical Integration
Depth of module portfolio
Hot swap modules
Common SW drivers
Remote trouble shooting over VNC
Field replaceable controller and PS
Shipping in volume

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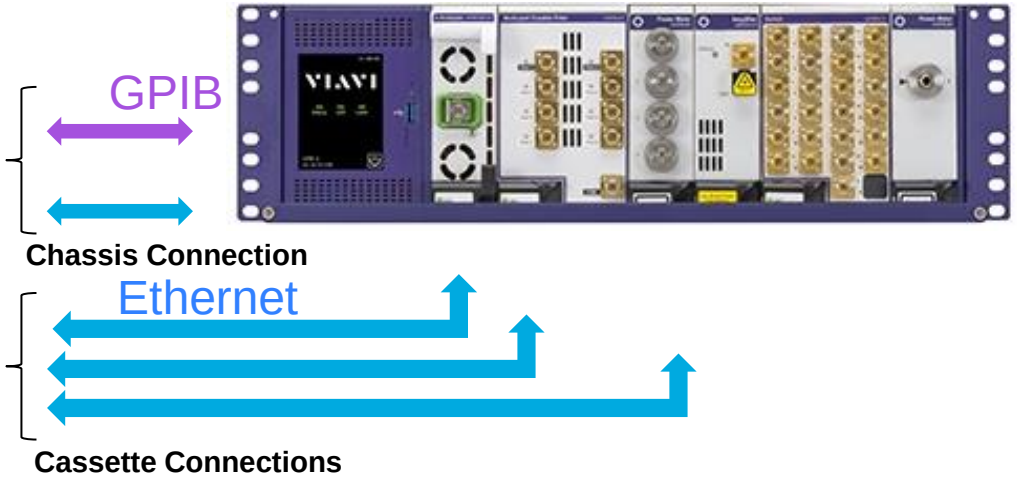
MAP- Series Application Basics

MAP Automation Architecture

- Common Architecture across platforms
  - MAP-200/220/300
  - SCPI protocol
  - Command set compatibility



- Instrument Interfaces:
  - Chassis Controller (CMR)
  - **Cassettes: Independent Instruments**
- Super Applications leverage higher-levels of integration
  - Data processing, database, multiple cassettes, etc.
- GUI operates on same Cassette Interface

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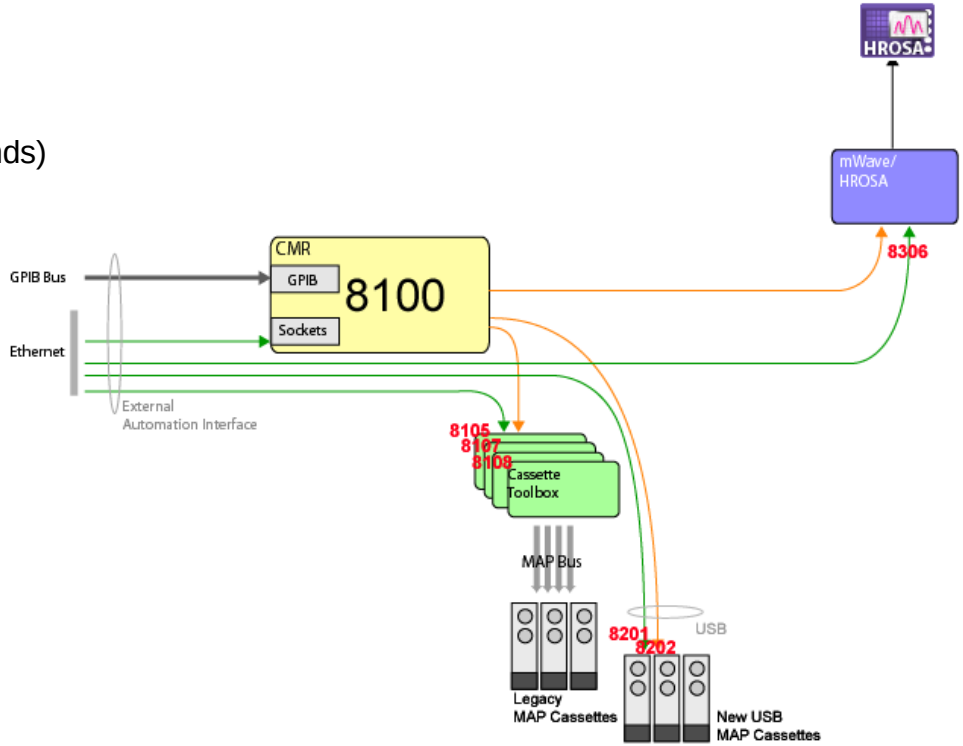
MAP Ethernet Port Connections

- **Connecting to Chassis Controller (CMR) (port 8100)**
  - Equivalent (from SCPI) to GPIB connection
  - Unit identification and enumeration (Layout commands)
  - Obtain system configuration and layout
  - “Chassis as an instrument”
- **Direct Socket connections to cassette**
  - Bypasses CMR
  - Need to know port numbers (from CMR)
    - **Do not assume ports are fixed**
      - Will not change on reset/power cycle
      - May change if cassette layout is changed
  - Possible performance improvement (lower latency)
  - “Cassettes as instruments”



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Coherent Interface Example

Coherent Module Test

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The OIF Clause 13

OIF

OIF-400ZR-01.0

OIF

Implementation Agreement 400ZR

OIF-400ZR-01.0

March 10, 2020

Implementation Agreement created and approved
OIF
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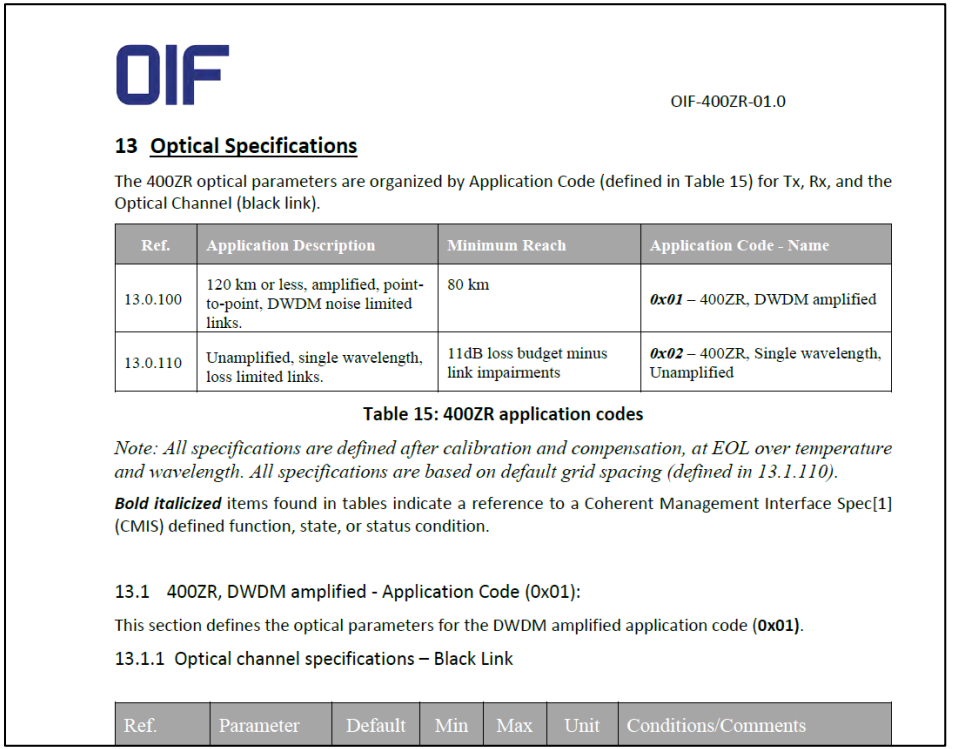

OIF

OIF-400ZR-01.0

13 Optical Specifications

The 400ZR optical parameters are organized by Application Code (defined in Table 15) for Tx, Rx, and the Optical Channel (black link).

Ref.	Application Description	Minimum Reach	Application Code - Name
13.0.100	120 km or less, amplified, point-to-point, DWDM noise limited links.	80 km	***0x01*** – 400ZR, DWDM amplified
13.0.110	Unamplified, single wavelength, loss limited links.	11dB loss budget minus link impairments	***0x02*** – 400ZR, Single wavelength, Unamplified

Table 15: 400ZR application codes

Note: All specifications are defined after calibration and compensation, at EOL over temperature and wavelength. All specifications are based on default grid spacing (defined in 13.1.110).

Bold italicized items found in tables indicate a reference to a Coherent Management Interface Spec[1] (CMIS) defined function, state, or status condition.

13.1 400ZR, DWDM amplified - Application Code (0x01):

This section defines the optical parameters for the DWDM amplified application code (**0x01**).

13.1.1 Optical channel specifications – Black Link

Ref.	Parameter	Default	Min	Max	Unit	Conditions/Comments

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Comprehensive Application Matrix for Clause 13

Viavi Test Number	Test Type	OIF Clause	Parameters
T1 Transmitter Spectrum	Tx Test	13.1.100	Channel frequency
		13.2.100	
		13.1.110	Channel Spacing
		13.1.111	
		13.1.112	
		13.1.200	Laser Frequency accuracy
		13.2.200	Laser Frequency accuracy
		13.1.201	Tx Spectral Excursion
		13.1.230	Inband (IB) OSNR
		13.2.230	
		13.1.231	Out-of-band (OOB) OSNR
		13.1.300	Frequency offset between received carrier and LO
		13.2.300	
T2 Optical Power Test		13.1.220	Allowable output signal power window
		13.2.220	
		13.1.221	Total output power with Tx disabled
		13.2.221	
		13.1.222	Total output power during wavelength switching
		13.1.430	Output power monitor - Accuracy
		13.2.430	
T3 Reflectance Test		13.1.240	Transmitter refelectance
		13.2.240	
		13.1.340	Optical return loss
		13.2.340	
T4 Transmitter Back Reflectance		13.1.161	Optical Return Loss
		13.2.161	
		13.1.162	Discrete Reflectance
		13.2.162	
		13.1.241	Transmitter back reflection tolerance
		13.2.241	
T5 Transmitter Polarization		13.1.250	Transmitter Polarization dependent power
		13.2.250	

T6 Reciever Power	Amplified Rx	13.1.150	Ripple
		13.1.310	Input power range
		13.1.320	Input sensitivity
		13.1.330	OSNR Tolerance
		13.1.353	Optical input power transient tolerance
		13.1.410	Transmitter turn-up time from warm start
		13.1.411	Transmitter turn-up time from cold start
		13.1.420	Transmitter wavelength switching time
		13.1.510	Receiver turn-up time from warm start
		13.1.511	Receiver turn-up time from cold start
		13.1.530	Input total power monitor - Accuracy
		13.1.531	Input Channel power monitor - Accuracy
		13.1.532	Optical Rx_LOS Assert Threshold
		13.1.533	Optical Rx_LOS Hysteresis
T7 Chromatic Dispersion		13.1.160	Chromatic Dispersion
		13.1.341	CD Tolerance
Interferometric Crosstalk		13.1.181	Interferometric Crosstalk
		13.1.342	Optical path OSNR penalty tolerance (CD and interferometric crosstalk)
T9 DGD/PMD		13.1.170	Maximum Instantaneous Differential Group Delay (DGD)
		13.1.350	Average PMD (DGD, SOPMD) tolerance
T10 PDL/PMD		13.1.171	Polarization Dependent Loss (PDL)
		13.1.351	Peak PDL tolerance
T11 SOP Tolerance		13.1.352	Tolerance to change in SOP

T12 Reciever Power	Unamplified Rx	13.2.310	Input power range
		13.2.320	Input sensitivity
		13.2.400	Transmitter laser disable time
		13.2.410	Transmitter turn-up time from warm start
		13.2.411	Transmitter turn-up time from cold start
		13.1.510	Receiver turn-up time from warm start
		13.1.511	Receiver turn-up time from cold start
		13.1.531	Input Channel power monitor - Accuracy
		13.1.532	Optical Rx_LOS Assert Threshold
		13.1.533	Optical Rx_LOS Hysteresis
T13 Chromatic Dispersion		13.2.160	Chromatic Dispersion
		13.2.341	CD Tolerance
T14 Reciever Power Penalty		13.2.342	Optical path OSNR penalty tolerance
T15 DGD/PMD		13.2.170	Maximum Instantaneous Differential Group Delay (DGD)
		13.2.350	Average PMD (DGD, SOPMD) tolerance
T16 PDL/PMD		13.2.171	Polarization Dependent Loss (PDL)
		13.2.351	Peak PDL tolerance
T17 SOP Tolerance		13.2.352	Tolerance to change in SOP
T18 Interferometric	Black Link Compliance	13.1.172	Polarization Rotation Speed
		13.2.172	
T19 CrossTalk and Chromatic Dispersion		13.1.180	Inter-channel Crosstalk

19 test configurations to test 61 optical sub clauses

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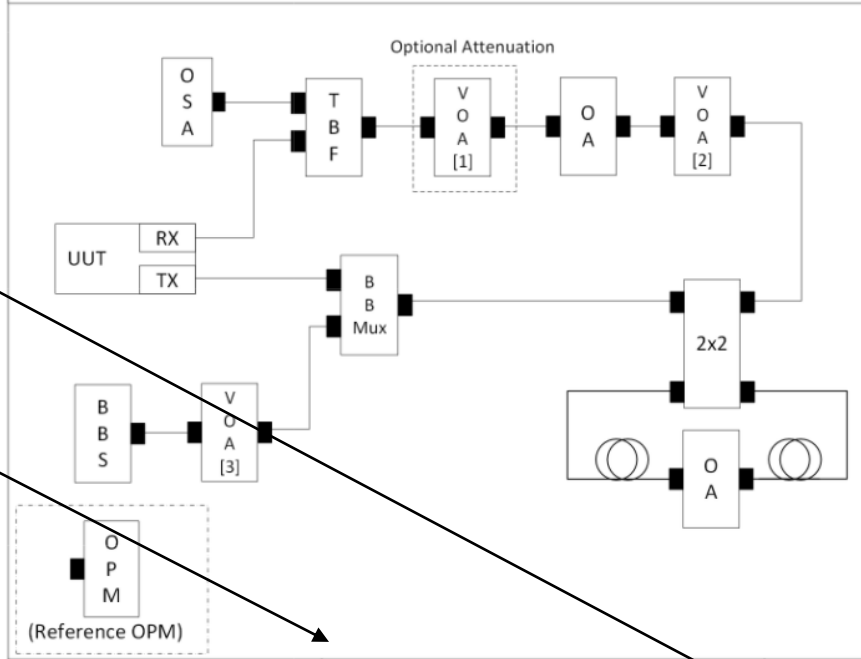
OIF Clause Execution

Spec compliance
Monitor Calibration
Amplified vs Unamplified

Standard: OIF-400ZR-01.0
Type: Amplified Rx (CD)
Clause: 13.1.160 and 13.1.341
Test Number: Test 7



Legend:
- BBS: ASE Source
- VOA: Variable Optical Attenuator
- TBF: Tunable Filter
- OSA: Optical Spectrum Analyzer
- OA: Optical Amplifier
- OPM: Optical Power Meter
- BBMux: Broadband Multiplexer
- CD: Chromatic Dispersion

Procedure Notes:
- Inspect and clean connectors
- Follow procedure of *Test 6*
- Set VOA [1] to generate a pre-FEC error level and record OSNR value
- 2X2 switch is activated to include fiber spools in signal path
- Fiber spool values are set per clause
- VOA [1] is adjusted to ensure power to Rx is the same relative to when impairments bypassed
- Tune OSNR using VOA [2] to achieve equivalent pre-FEC error level and compare to original
- Test across all Rx input power levels
- OSNR shall not vary by more than amount specified in clause

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☑ Amplified Link
☐ Unamplified Link

☑ Coherent Monitor Calibration
☑ Performance Monitor Calibration

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System Planning

Standard: OIF-400ZR-01.0
Type: Amplified Rx (CD)
Clause: 13.1.160 and 13.1.341
Test Number: Test 7

Part Number	Description	Qty
MAP-380A-B	8-Slot 3U 19in Benchtop Mainframe	2
MBBS-C11CA-M100-MFA	Broadband source C-band Flattened	1
MEDFA-C12CA-M100-MFA	Dual Std pwr C-band amplifier Low NF Single channel FC/APC	1
MHROSA-A1CB10-M100-MFA	Wavemeter and high resolution optical spectrum analyzer C-band FC/APC	1
MOPM-C1PMH2-MPMGP	MAP-Series Dual OPM with general purpose panel mount sensors	1
MOSW-C122X002B0-M100-MFA	Dual 2X2 Crossover SMF Bulkhead FC/APC Without Option	1
MTFX-C111C008CM-M100-MFA	Multi-port tunable filter with power monitors C-band SMF FC/APC	1
MUTL-C11110-M100-MFA	Utility cassette with splitter 1X10/90 1X30/70 1X50/50 SMF FC/APC	1
MVOA-C1QSM-M100-MFA	Quad VOA standard power monitor single mode fiber FC/APC	1

Connector Options:

MFA: FC/APC	MFP: FC/PC
MLU: LC/APC	MLC: LC/PC
MSU: SC/APC	MSC: SC/PC

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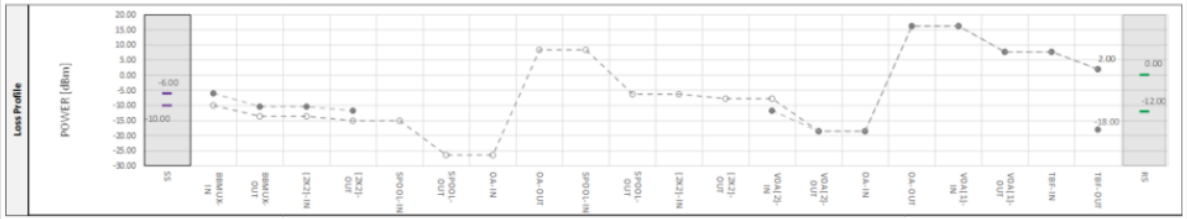
Loss Planning

Standard: OIF-400ZR-01.0
Type: Amplified Rx (CD)
Clause: 13.1.160 and 13.1.341
Test Number: Test 7



SPECS	TX	BBMux		2x2		Spool [1]		OA	Spool [2]		2x2	VOA[2]		OA		VOA[1]		TBF		RX
High power launch, low loss	Cin [dB]			-0.12		-0.12							-0.12		-0.12		-0.12		-0.12	
	Cout [dB]			-0.12		-0.12							-0.12		-0.12		-0.12		-0.12	
	Loss [dB]			-4.10		-1.20							-1.50				-1.50		-5.50	
	Atten. [dB]												-5.00				-6.76		-20.00	
	Gain [dB]														35.00					
	SOPwr [dBm]														20.00					
	Launch [dBm]	-6.00																		
	Element	Ss	BBMux-IN	BBMux-OUT	[2x2]-IN	[2x2]-OUT							VOA[2]-IN	VOA[2]-OUT	OA-IN	OA-OUT	VOA[1]-IN	VOA[1]-OUT	TBF-IN	TBF-OUT	Rs
	Path 1	-6.00	-6.00	-10.34	-10.34	-11.78							-11.78	-18.52	-18.52	16.24	16.24	7.74	7.74	2.00	0.00
	Final Attenuation																			-18.00	-12.00
Low power launch, high loss	Cin [dB]			-0.12		-0.12		-0.12		-0.12		-0.12		-0.12		-0.12		-0.12		-0.12	
	Cout [dB]			-0.12		-0.12		-0.12		-0.12		-0.12		-0.12		-0.12		-0.12		-0.12	
	Loss [dB]			-3.40		-1.20		-11.00		-14.50		-1.20		-1.50				-1.50		-5.50	
	Atten. [dB]													-9.04				-6.76		-20.00	
	Gain [dB]								35.00							35.00					
	SOPwr [dBm]								20.00							20.00					
	Launch [dBm]	-10.00																			
	Element	Ss	BBMux-IN	BBMux-OUT	[2x2]-IN	[2x2]-OUT	Spool-IN	Spool-OUT	OA-IN	OA-OUT	Spool-IN	Spool-OUT	[2x2]-IN	[2x2]-OUT	VOA[2]-IN	VOA[2]-OUT	OA-IN	OA-OUT	VOA[1]-IN	VOA[1]-OUT	TBF-IN	TBF-OUT	Rs
	Path 4	-10.00	-10.00	-13.64	-13.64	-15.08	-15.08	-26.32	-26.32	8.44	8.44	-6.30	-6.30	-7.74	-7.74	-18.52	-18.52	16.24	16.24	7.74	7.74	2.00	0.00
	Final Attenuation																					-18.00	-12.00
	PDL [dB]			0.05		0.07		0.00		0.20		0.00		0.20		0.15		0.20		0.15		0.30	

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All Part Numbers Referenced

Required modules for all Clauses

Part Number	Description
MAP-220C-A	MAP-220C Lightdirect - 2U - 1/2 19In - Benchtop Chassis
MAP-330AD-B	3-Slot 3U Half-19in Benchtop Mainframe with Touchscreen
MAP-380A-B	8-Slot 3U 19in Benchtop Mainframe
MAP-RM-C13500FP-M100-MFA	MAP-220 OCWR IL/RL Meter 1310/1550nm Standard FP laser SMF FC/APC
MBBS-C11CA-M100-MFA	Broadband source C-band Flattened FC/APC
MEDFA-C11CB-M100-MFA	Std pwr C-band amplifier Single channel Auto power option FC/APC
MEDFA-C12CA-M100-MFA	Dual Std pwr C-band amplifier Low NF Single channel FC/APC
MHROSA-A1CB10-M100-MFA	Wavemeter and high resolution optical spectrum analyzer C-band FC/APC
MOPM-C1PMH2-MPMGP	MAP-Series Dual OPM with general purpose panel mount sensors
MOSW-C122X002B0-M100-MFA	Dual 2X2 Crossover SMF Bulkhead FC/APC Without Option
MPCX-C11SFS-M100-MFA	MAP-Series PCX C/L-band high speed pol scrambler SMF FC/APC SOP feedback
MTFX-C111C008CM-M100-MFA	Multi-port tunable filter with power monitors C-band SMF FC/APC
MTLG-C2C10-M100-MFA	Single C-band 50GHz step Tunable laser FC/APC
MTLG-C2C40-M100-MFA	Quad C-band 50GHz step Tunable laser FC/APC
MUTL-C11110-M100-MFA	UTILITY CASSETTE WITH SPLITTER 1X10/90 1X30/70 1X50/50 SMF FC/APC
MVBR-C1SS0-M100-MFA	MAP-Series VBR Single SMF FC/APC no tap option
MVOA-C1QSM-M100-MFA	QUAD VOA STANDARD POWER MONITOR SINGLE MODE FIBERFC/APC

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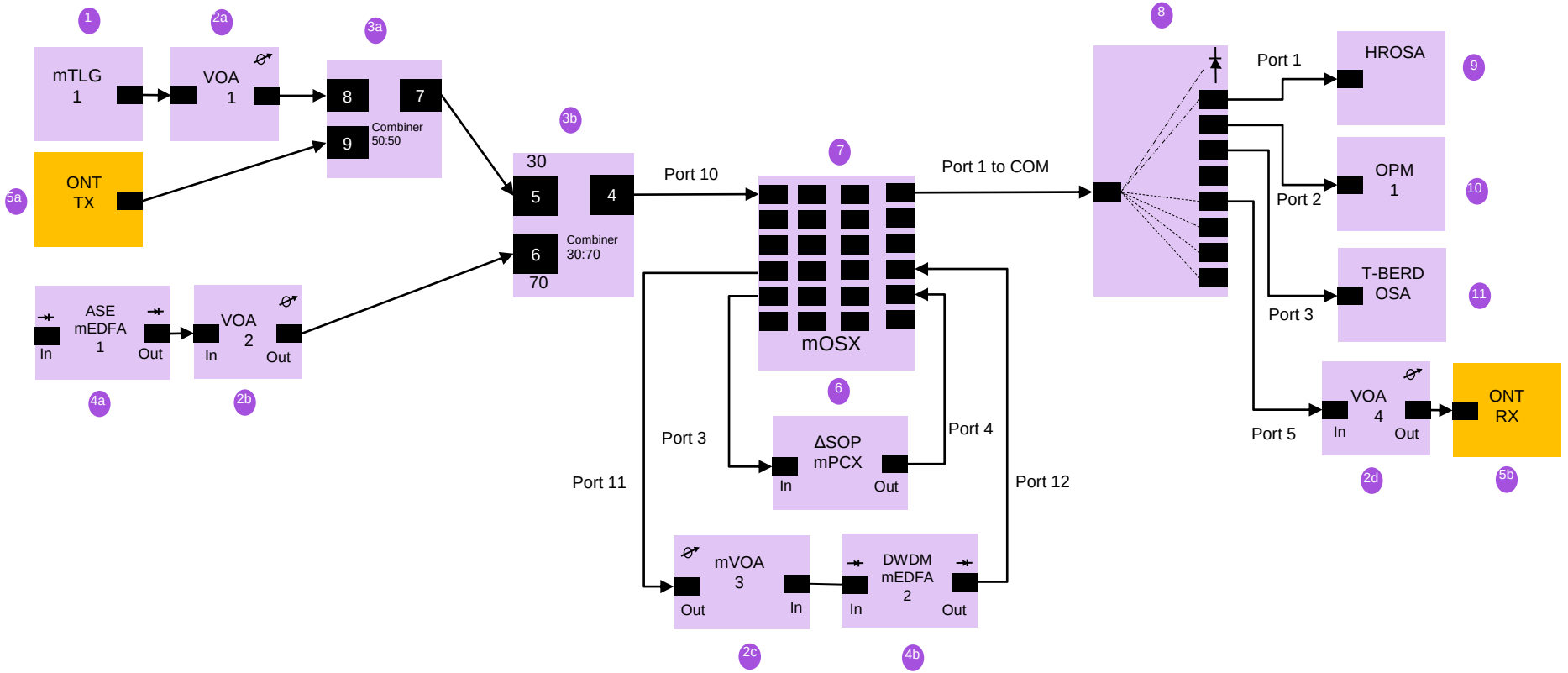
Multi Impairment Systems



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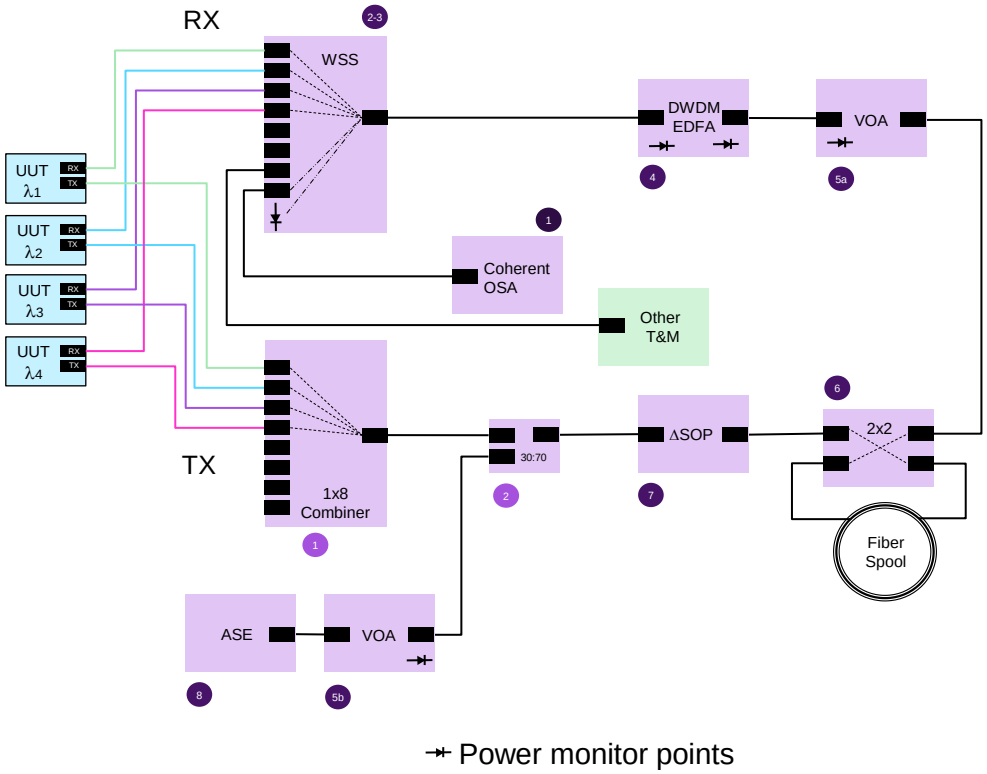
Interoperability test



1. C-band coherent high-resolution OSA [mHROSA;1-slot]
   - 300MHz RBW to resolve modulation products
2. Programmable DEMUX (WSS) signal manager [mTFX;2-slot]
   - Set port, Cλ & BW (0.5 GHz res), Loss (up to 20dB) and shape
   - Hitless switching to embedded OPM and OSA access port
   - Loopback so same UUT or change port/λ to other UUT
4. C-band optical amplifier [mEDFA; 1-slot]
   - 20dBm saturated power, 35dB gain, 5.2 to 5.5 dB NF
5. Dual VOA independent level controller [mVOA; 1-slot]
   a) EDFA level input control and shutter
   b) ASE level input control and shutter
      - 70dB Linear control of OSNR with 0.01 dB resolution
      - Shutter control to toggle to TX limited state
6. 2x2 switch add/remove fiber spool [mOSW; 1-slot]
7. Rate programable Pol. Scrambler [mPCX; 1-slot]
   - Random or Rayleigh scrambling modes up to 3Mrad/s
8. C-band ASE noise source for OSNR set [mBBS; 1-slot]
   - 1dB wavelength flatness

1. 1x8 combiner for colourless mux [mUTL; 1-slot]
   - Allow individual TX λ to be independently set
2. Broadband noise multiplexer [mUTL; 1-slot]
   - Injection point for ASE to generate controllable OSNR

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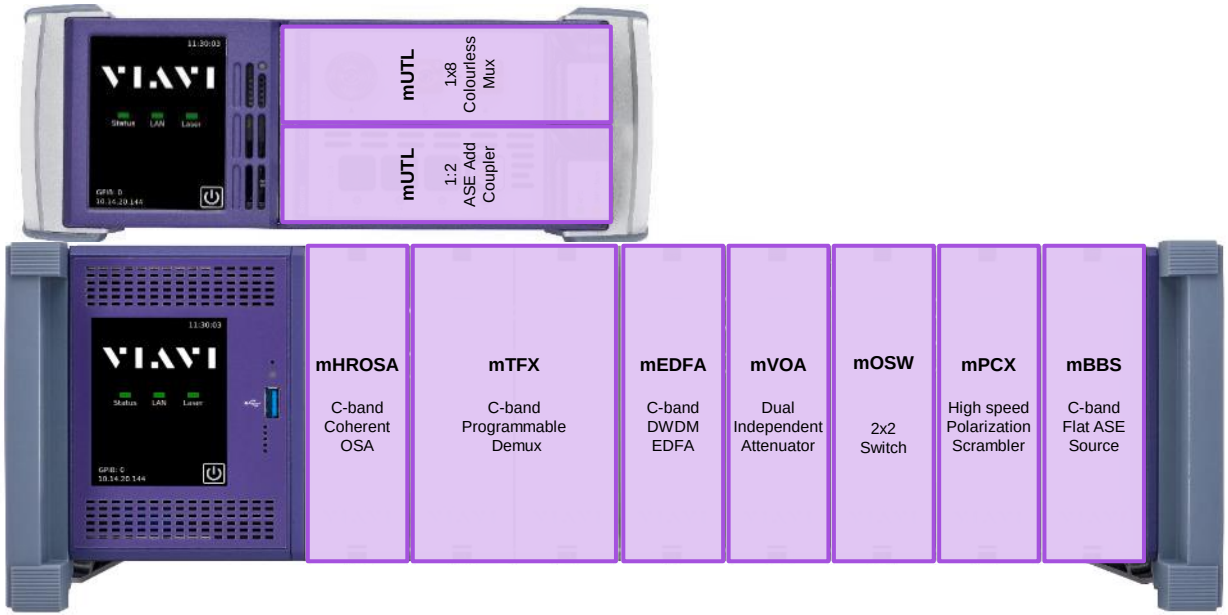
Module Layout



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The X-Series

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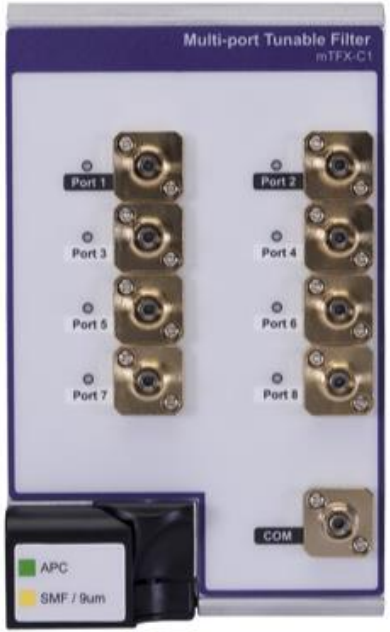
The X-Series Modules

Advanced functions….Simplified

mOSX



mTFX

mPCX

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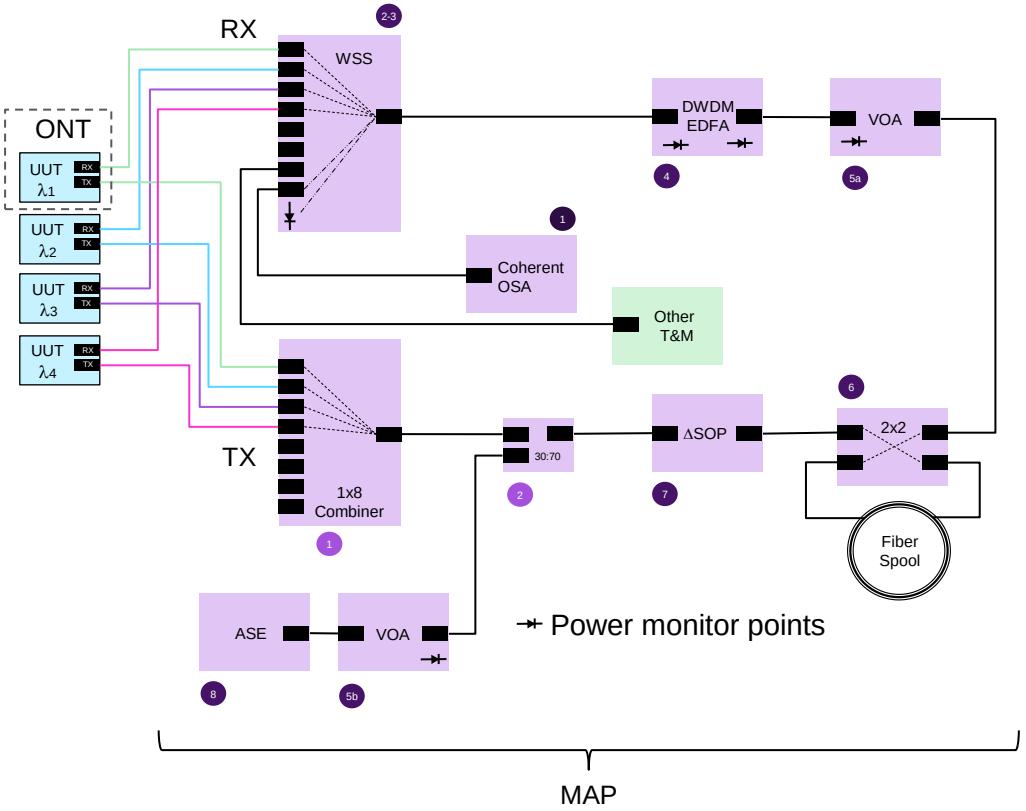
Complete Solution for Coherent Interface Test



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mOSX-C1: Manage your test

- Save the rack space, simplify automation!
  - mOSW / mOSX SCPI commands ARE THE SAME
  - Test and measurement UI – we are not a network device
- Any-Port to Any-Port
- Don’t trap ports where they can’t be used
- Low loss
- Save the U!

Advanced function - Simplified

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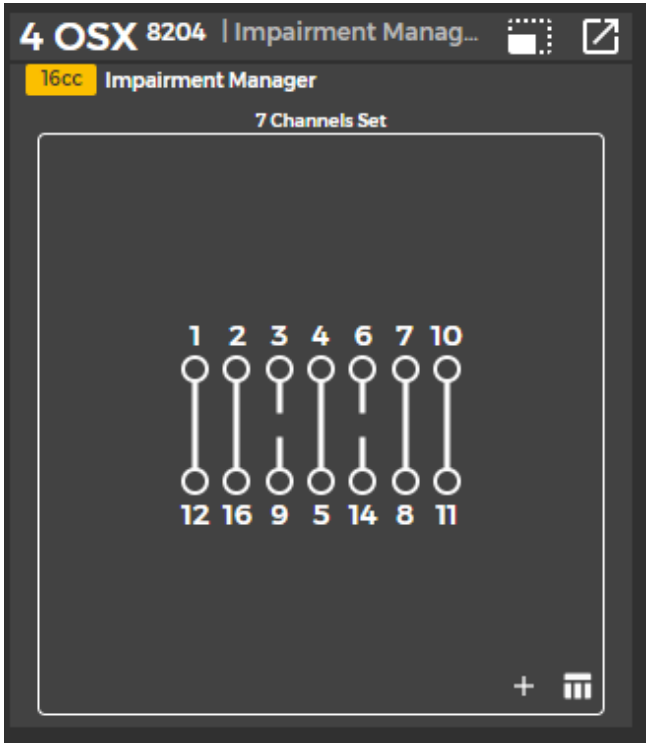
Simple and Integrated



:ROUTe:CLOSe

DESCRIPTION Close connection

INPUT FORMAT :ROUTe:CLOSe <D>,<Input>,<Output>

D	Integer	1 (switch device number)
Input	Integer	1 to max input channel
Output	Integer	0 to max output channel

0 will “open” the channel

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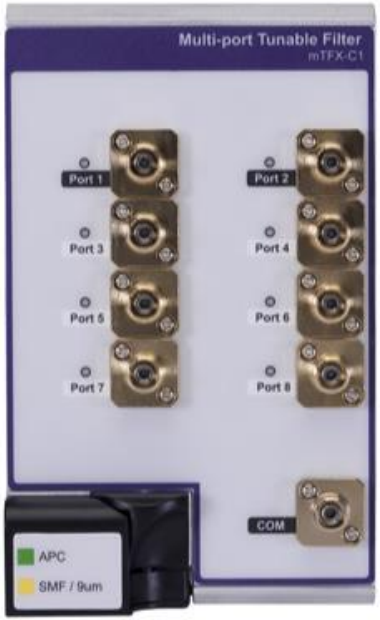
mTFX-C1: Manage your spectrum



- What is a mutli-port tunable filter → a WSS!
- Attenuate, Switch, Mux/demux, Gain Flatten, Measure Power
- Don’t manage LCOS slice rules….we will
  - Manage as a Mux-Demux
  - Manage as an arbitrary filter
  - Combination of both
- Modify or change any part of the spectrum without impacting any other slice
  - Spectrum based multiport test systems
- Pay as you go ports

Advanced function - Simplified

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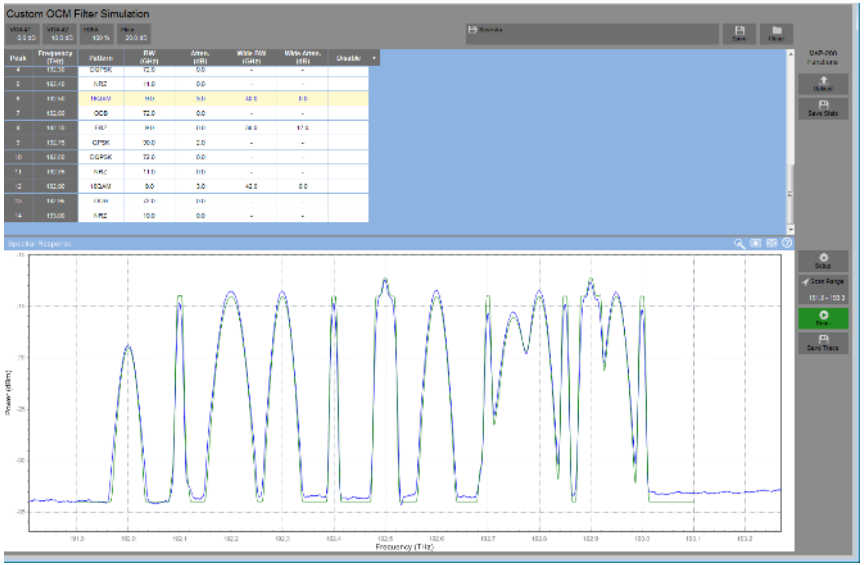
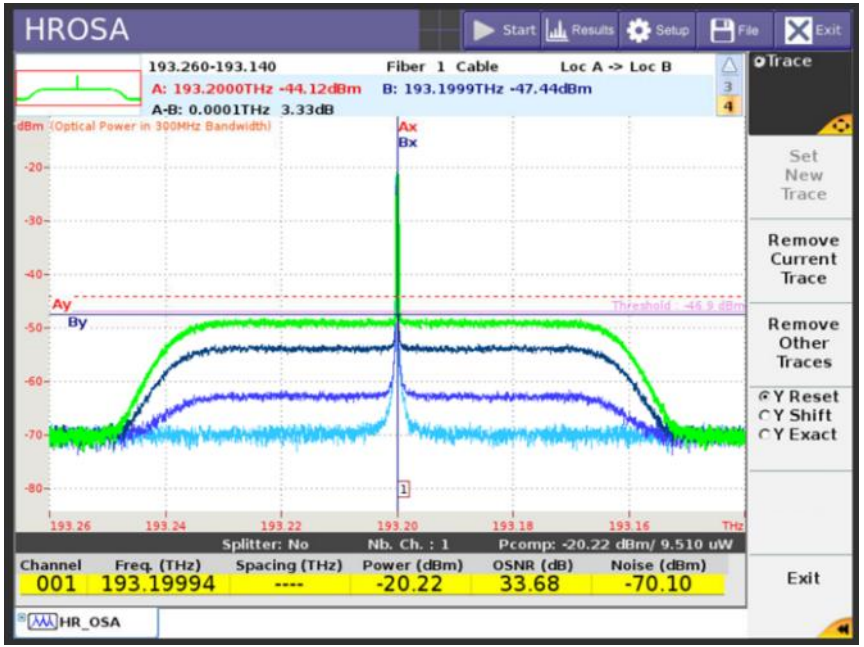
Managing Signals



Source emulation



OSNR Generation

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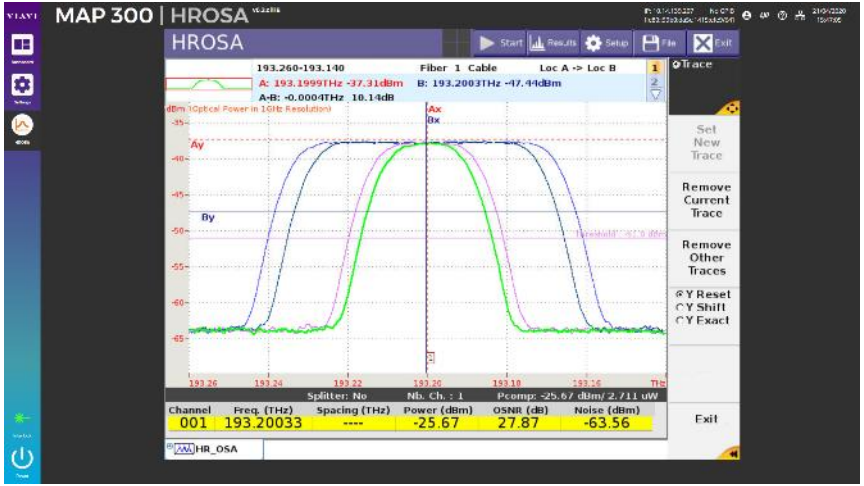
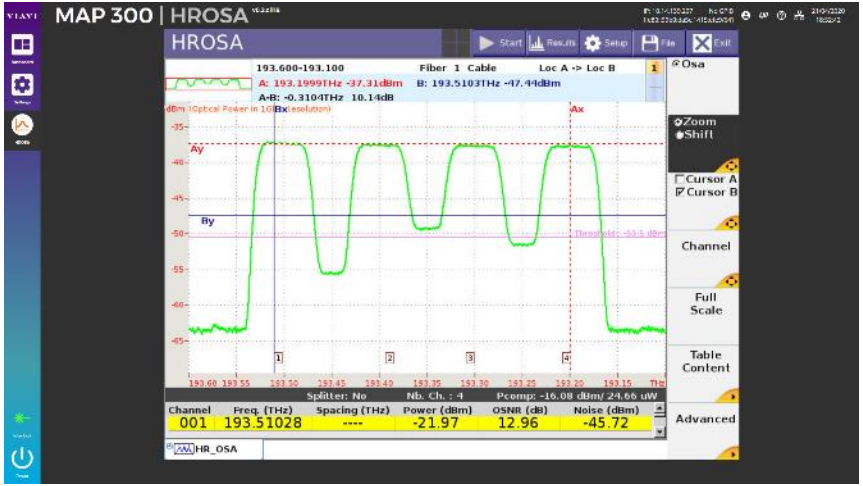
Managing Filters



ROADM Node Emulation



Arbitrary Filters

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mPCX-C1: Manage your ΔSOP

- Scramble, control, stabilize
  - 3 instruments in one
- Calibrated, statistical – details mater
- μS response time
- Lightning strike ready
- >50% size reduction compared to competitors
- Advanced alignment and stabilization closed loop and “user-loop” control
- Deployed in volume across Tier I NEM R&D and manufacturing

Advanced function - Simplified

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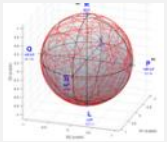
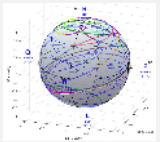
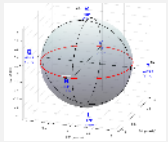
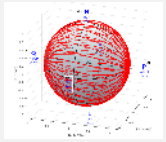
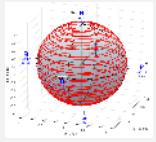
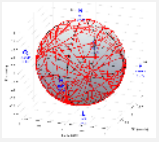
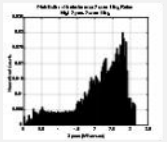
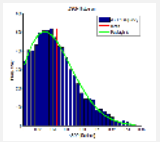
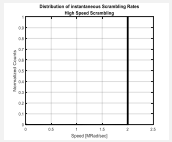
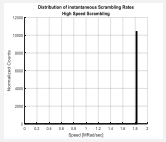
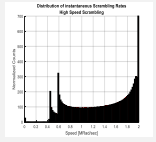
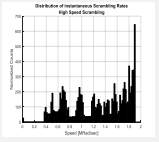
Scrambling Modes Summary

Scrambling Mode	Random Scrambling	Rayleigh	Ring Mode	Polar Ring	Oscillating Ring	Random Ring
Poincare View						
ΔSOP/s Historgram						
Optimized for Ring-Auto-Aligner (RAA)	Not required	Not required	**Yes**	**Yes**	Not required	Not required
Sphere Coverage	Complete	Complete	**Single Plane of SOP**	Complete (if RAA used)	Manually Adjustable	Complete
Rate	Distribution Max 3.0 Mrad/s to 1.0 rad/s	Distribution Mode 350 krad/s to 1.0 rad/s	Rotational Frequency: 1 Mrad/s to 2.5 rad/s (0.1 Hz to 40KHz waveplate rotation)			
ΔSOP Characteristic	Bias towards high frequency	Rayleigh Distribution (Bias toward low frequency)	**Single Tone**	**Single Tone**	Continuous Bathtub	Mix of Polar and Oscillating

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