



ONT-600 CFP2 Transport Test Module

Supporting 25G, 40G, 50G, and 100G Rates



The Viavi™ ONT-600 CFP2 Transport Test Modules address all second-generation 4 x 25G/28G based 100G challenges. A wide range of transponders, such as CFP2, CFP4, QSFP28 and SFP28, is supported. Its unique applications probe deep into the physical layer. The available electrical adapters enable troubleshooting and service verification tests on board level in labs. The CFP2 Transport Test Module is a key enabler bringing transport components and systems to market faster and more reliably.

The CFP2 Module, based on 25/28G input/output (I/O) technology, is critical for driving mass deployment of 100G cost-effectively. While the first-generation 100G CFP was based on 10G I/O, CFP2 density and price drivers require deploying novel 25/28G technology, challenging everyone from integrated circuits (IC) and optical module vendors through equipment manufacturers. Signal integrity and physical layer considerations add more complexity.

Key Features

- Supports wide range of transport bitrates, from 25 Gbps to 112 Gbps
- Native support for CFP2 and QSFP+
- SFP28, CFP4, QSFP28 form factors and electrical access supported by adapters
- Physical test features, dynamic skew variation, jitter insertion, advanced error analysis, MDIO/I²C access
- Comprehensive troubleshooting tools at PCS/Ethernet and multiplexed OTN signals and their clients
- Fully independent dual-port test with OTN / Ethernet drop-and-insert functionality

Key Benefits

- Securing investments by future-proof platform
- All-in one solution provides flexibility to utilize platform for a variety of transponders and technologies
- Pre-qualification and in-depth validation of transponders and receivers for type approval and production
- Simplification and acceleration of System Verification Testing (SVT) while maintaining test depth
- Mapping/de-mapping bulk, Ethernet or SDH/SONET clients into complex OTN MUX structures

Applications

- System development: Viavi's CFP2 Transport Test Module covers the physical layer through to PCS, Ethernet/IP, SDH/SONET and OTN, making it the ideal tool for hardware and software developers to proof their designs. In system verification labs, it leaves no area uncovered, and with its leading-edge automation support it is helping Network Equipment Manufacturers to bring new 100G systems to market quickly and with greater confidence.
- Transponder test: Support for CFP2/CFP4/QSFP28/SFP28 modules with MDIO/I²C debugging and single-button CFP2 Stress test applications help develop and validate modules to challenging standard requirements, like dynamic skew tolerance.
- IC development and validation test: A powerful, flexible electrical interface (via active CFP2 electrical adapter) with wide ranging physical-layer applications and comprehensive troubleshooting tools for signal integrity, PCS, Ethernet, and OTN traffic using real-world traffic rather than limited, unframed PRBS signals to validate performance.
- Manufacturing test: A less expensive version is available that is optimized specifically for manufacturing and SVT applications (ONT-602). The comprehensive and fast automation provides higher production output without compromising test depth.

Additional Features

- Industry's most complete Transport Test Module
- Native support for 4x25/28G I/O used in CFP2, CFP4, QSFP28 and 100G ASICs and FPGAs
- High-performance active electrical adapter and powerful applications to support other technologies based on 25/28G I/O
- Includes all the key features component manufacturers require with many unique applications for validating ICs and transponders at 25/28G
- Unique physical-layer applications that quickly identify the root cause of errors with complete coverage from signal integrity through to CDR issues, timing, and pattern sensitivity
- 25GE, 40GE and 100GE Ethernet generation and analysis capabilities including:
 - various frame formats and sizes
 - RFC 2544 test suite
 - IPv4 and IPv6 support with up to 256 streams
 - MPLS, VLAN, and QinQ support
 - native Ethernet as well as full Ethernet client functionality in OTN
- Comprehensively tests and validates QSFP28 modules, components, and SR4, PSM4, CWDM4, SWDM4, LR4 interfaces as well as validates line card RS FEC implementation and performance
- Simultaneously conduct 40GE / OTU3 or 100GE / OTU4 dual-port tests for SVT or manufacturing applications
- Industry's most complete OTN multiplexing test depth
- Unique solution for testing PTP 1588v2 at 40GE and 100GE
- SR4 FEC validation option verifies and stresses RS FEC core implementations

Additional Benefits

- All-in one solution cuts costs for new system development and production with configurable tests for the physical layer through to PCS, Ethernet, OTN and PTP 1588v2 applications
- Verification of master-slave delay and PDV accuracy for Carrier Ethernet and Mobile Backhaul applications
- All-in one solution provides flexibility to utilize platform for different transponders and technologies
- One-box solution combines flexible generation and real-time analytics in one simple to use and economic solution
- In-depth testing of Ethernet and real-life payloads within ODU channels
- Provides best-in-class tools for rapid and comprehensive debugging of protocol and 25/28G physical layer issues

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Mainframe Hardware Configurations

The Viavi CFP2 Transport Test Module benefits from experience with our industry- reference ONT CFP module, a powerful 40/100G core engine that blends high-performance I/O with our far-reaching, leading applications from the physical layer through complex OTN applications. This ensures that high-fidelity 25/28G signals and their clock sources will underpin all second-generation 100G technology. Low jitter and low phase noise I/O on the front panel provide confidence in signal integrity. The test solution can scale as customer needs increase, first focusing on validation of the physical layer and then comprehensive applications for Ethernet/IP and OTN.

Various ONT CFP2 solution configurations are available that address the needs of IC vendors, optical module vendors, network equipment manufacturers, or service provider labs. The various configurations offer applications used in design verification; hardware, software, and SVT; and manufacturing. It can be purchased as a modular solution for ONT-603, -606, or -612 mainframes or as a rack-mounted point solution called the ONT-602.



Dual-port CFP2 plugged into ONT-603 Mainframe



19" ONT-612 Rack Mount mainframe - houses up to 6 CFP2 modules or combination of other ONT modules



Dual Port CFP2 Stand-alone solution: ONT-602D

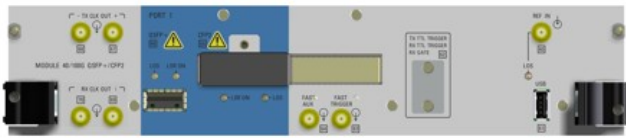
CFP2 Transport Test Modules

CFP2 Phy/Data Single Port Module (BN 3076/92.80)

The CFP2 Phy/Data Single Port Module offers the complete in-depth test capabilities needed for physical layer R&D applications, including dynamic skew insertion, jitter injection, advanced error analysis and many more. In addition, it covers the complete range of CFP2 based OTN, Ethernet and SDH/SONET testing in R&D, SVT and Manufacturing.

CFP2 Data Single Port Module (BN 3076/92.82)

The CFP2 Data Single Port Module covers the complete range of CFP2 based OTN, Ethernet and SDH/SONET testing in R&D, SVT and Manufacturing. More economical since it does not support in-depth physical layer testing. Covers the complete range of CFP2 based OTN, Ethernet and SDH/SONET testing in SVT and Manufacturing. Does not support in-depth physical layer testing.



Front Panel of CFP2 Single Port Phy/Data Module

ID	Function	In/Out	Type	Comment
[60]	REF IN	IN	50Ω SMA	f/40 or f/160 selectable
[61]	USB 2.0	IN/OUT	A-coded USB socket	Internal use
[62]	TTL Trigger I/O			
[63]	FAST TRIGGER	OUT	50 W SMA	
[64]	FAST AUX	OUT	optical	f/4
[65]	CFP2 cage, port 1	IN/OUT	optical	CFP2 MSA compatible pluggables
[66]	QSFP+ cage, port 1	IN/OUT	optical	QSFP+ MSA compatible pluggables
[67, 68]	TX CLK OUT	OUT	50 Ω SMA	f/40 or f/160 selectable
[69, 70]	RX CLK OUT	OUT	50 Ω SMA	

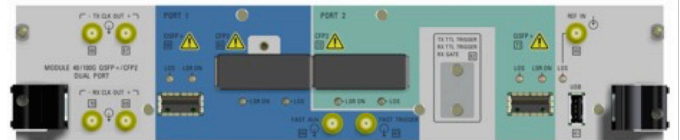
f = CAUI/XLAUI Electrical lane speed

CFP2 Phy/Data Dual Port Module (BN 3076/92.83)

The CFP2 Phy/Data Dual Port Module offers the complete, in-depth test capabilities needed for physical layer R&D applications, including dynamic skew insertion, jitter injection, advanced error analysis and many more. In addition, its second port allows for bidirectional OTN monitoring with Through Mode and can add/drop Ethernet client signals to/from OTN high-speed signals for further evaluation. Covers the complete range of CFP2 based OTN, Ethernet and SDH/SONET testing in R&D, SVT and Manufacturing.

CFP2 Data Dual Port Module (BN 3076/92.81)

The CFP2 Data Dual Port Module offers higher port density more cost-effectively per port that can test on two Ethernet/OTN ports simultaneously. It can perform bidirectional OTN monitoring with Through Mode and can add/drop Ethernet client signals to/from OTN high-speed signals for further evaluation. Covers the complete range of CFP2 based OTN, Ethernet and SDH/SONET testing in SVT and Manufacturing. Does not support in-depth physical layer testing.



Front Panel of CFP2 Dual Port Phy/Data Module

ID	Function	In/Out	Type	Comment
[60]	REF IN	IN	50 Ω SMA	f/40 or f/160 selectable
[61]	USB 2.0	IN/OUT	A-coded USB socket	Internal use
[62]	TTL Trigger I/O			
[63]	FAST TRIGGER	OUT	50 Ω SMA	
[64]	FAST AUX	OUT	optical	f/4
[65]	CFP2 cage, port 1	IN/OUT	optical	CFP2 MSA compatible pluggables
[66]	QSFP+ cage, port 1	IN/OUT	optical	QSFP+ MSA compatible pluggables
[67/68]	TX CLK OUT	OUT	50 Ω SMA	f/40 or f/160 selectable
[69/70]	RX CLK OUT	OUT	50 Ω SMA	
[71]	QSFP+ cage, port 2	IN/OUT	optical	QSFP+ MSA compatible pluggables
[72]	CFP2 cage, port 2	IN/OUT	optical	CFP2 MSA compatible pluggables

f = CAUI/XLAUI Electrical lane speed

Special attractively priced versions for 40GE and/or 25GE only are also available:

3076/92.84	CFP2 25G Data Dual Port Module
3076/92.85	CFP2 25G Data Single Port Module
3076/92.86	CFP2 40G Data Dual Port Module
3076/92.87	CFP2 40G Data Single Port Module

CFP2 Stand-alone Point Solutions

ONT-602D CFP2 Data Dual Port Point Solution (BN 3076/22)

The **ONT-602D** Dual-port CFP2 Point Solution offers high port density cost-effectively per port that can test on two Ethernet/OTN ports simultaneously. It can perform bidirectional OTN monitoring with Through Mode and can add/drop Ethernet client signals to/from OTN high-speed signals for further evaluation. Covers the complete range of CFP2 based testing in SVT and Manufacturing. Does not support in-depth physical layer testing.

ONT-602S CFP2 Data Single Port Module (BN 3076/21)

The **ONT-602S** Single-port CFP2 Point Solution is an economical one-port solution for the complete range of CFP2 based testing in SVT and Manufacturing. Does not support in-depth physical layer testing.

Special attractively priced versions for 40GE and/or 25GE only are also available, see order information section

3076/23	ONT-602 25G CFP2-S Single Port Point Solution
3076/24	ONT-602 25G CFP2-D Dual Port Point Solution
3076/25	ONT-602 40G CFP2-S Single Port Point Solution
3076/26	ONT-602 40G CFP2-D Dual Port Point Solution

Hardware Adapters and Transponders

The CFP2 Module has one or two native CFP2 cages (4 * 28G based) and QSFP+ cages (4 * 10G based). A variety of transponders and adapters is available for the 4 * 28G based cage(s).

Using the available phy-level electrical adapter, in-depth physical layer testing of transponders and evaluation boards is possible via port 1 of the CFP2 Phy modules.

The "Basic electrical adapter" can be used in port 1, but also in port 1 and 2 in parallel, mainly for manufacturing applications.

Other adapters are available to accommodate different form factor transponders such as QSFP28, SFP28 or CFP4.

CFP2 to CFP4 Passive Adapter (BN 3076/92.92)



This adapter lets you operate a CFP4 transponder inside the CFP2 cage. Full management access via the ONT GUI. Can operate in ports 1 and 2.

CFP2 to QSFP28 Active Adapter 3076/92.93



This adapter lets you operate a QSFP (4x28G) transponder inside the CFP2 cage. It also gives full management access from the ONT GUI via the I²C interface (instead of the MDIO which is used with CFP2 transponders). Can operate in ports 1 and 2.

CFP2 to SFP28 Active Adapter (BN 3076/92.98)



Allows to operate an SFP28 Transponder inside the CFP2 cage.
Supports one 25GE per port. Can operate in ports 1 and 2

Jitter modulation range: 30 kHz - 1 GHz, with 2 Ulpp maximum amplitude

Electrical connectors: three Huber+Suhner MXP series 8 x 1 cable assemblies.

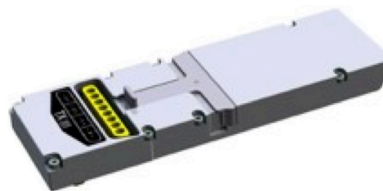
- Connector 1 RX CAUI4 (4 lanes, differential)
- Connector 2 TX CAUI4 (4 lanes, differential)
- Connector 3 Auxiliary connector with jitter injection input, reference CDR Out, and TX CAUI4 (lane 3) with added jitter

CFP2 4x25G Electrical Adapter (BN 3076/92.90)



- With Wideband Jitter insertion and recovered clock output
- Electrical access to 4x25 interface, includes 4 times K1002 (8 coax cable assembly), will work in Port 1 only of ONT CFP2 Phy modules
- High-performance active CFP2 electrical adapter ,works with the ONT CFP2 module to test external devices such as ICs and modules based on 25/28G I/O. GUI access to MDIO interface of external eval-board is possible via optional cable K1001.
With Wideband Jitter insertion and recovered clock output
- Dynamic skew insertion and low-band jitter injection work as before.
- Supports wideband jitter inject on one TX lane with an external modulation signal connected to the modulation input of the CFP2 electrical adapter

CFP2 Basic 4x25G Electrical Adapter (BN 3076/92.94)



Basic electrical access to 4x25G interface, will work in Port 1 and 2 of ONT CFP2 Phy and Data modules. Cable set **not** included in Basic Electrical Adapter.

Active CFP2 electrical adapter to test external devices such as ICs and modules based on 25/28G I/O.

Electrical interface consists of two Huber+Suhner MXP series 8 x 1 connectors. 8 coax cable assembly to be provided by customer.

- Connector 1 RX CAUI4 (4 lanes differential)
- Connector 2 TX CAUI4 (4 lanes differential)

Physical Layer Testing

Physical Layer

CFP2 Interface (4 x 25/28G based)	
103.125 Gbps (100G Ethernet) and 111.81 Gbps (OTU4)	
In accordance with CFP2 MSA 2.0	
Reference clock	CAUI4 (CFP2) 1/40, 1/160, MAC rate (156.25 MHz)
Power class	1,2,3,4
MDIO modes	Internal normal, internal relaxed, and external
MDIO functionality	A-page, 2.0, and some 2.2 enhancements
MDIO speed	Slow (500 kHz), normal (2 MHz), and fast (4 MHz)
I ² C Speed (with QSFP28 adapter and SFP28 adapter):	Slow (100 kHz), normal (200 kHz), and fast (400 kHz)
QSFP+ Interface (4 x 10G based)	
Supported bitrates: 39.81 Gbps (SDH/SONET, unframed), 41.25 Gbps (40G Ethernet), 43.018 Gbps (OTU3), 44.57 Gbps (OTU3e1 bulk and unframed), and 44.58 Gbps (OTU3e2 bulk and unframed)	
Adjustable in 0.01 ppm increments up to a range of ±500 ppm (depends on transponder used)	
In accordance with QSFP+ MSA3.5	
Support for power classes 1, 2, 3, 4 (3.5 W maximum power)	
Electrical data interface XLIPPI according to IEEE 802.3ba	
Clock Source	
Internal reference, recovered from Rx, external clock source via mainframe clock input or via high-speed sync clock input (differential or single-ended), adjustable clock bandwidth supported on sync clock input (<100 Hz, ~1 MHz, >15 MHz). The clock bandwidth can be controlled through the relevant application GUI.	
Tx Clock Output	
SMA output, nominal level is 1200 mV into 100 ohm, differential. Single-ended can be used when terminating unused output with 50 ohm. Note: Clock recovery lane is always lane 0.	
Tx Reference Clock	
XLAUI (QSFP+)	Electrical lane speed /16 or /64
CAUI4 (CFP2)	Electrical lane speed /40 or /160
Rx Recovered Clock	
XLAUI (QSFP+)	Electrical lane speed /16 or /64
CAUI4 (CFP2)	Electrical lane speed /40 or /160
CFP2 Tx MCLK	
According to MSA	

Rx Clock Output		
SMA output, nominal level is 1200 mV into 100 ohm, differential. Single-ended can be used when terminating unused output with 50 ohm.		
Modes		
CFP2 Rx MCLK	According to MSA	
Rx Eye Clock	From lanes 0, 1, 2, 3	
“Golden PLL”	Electrical lane speed divided by 8, 16, 32, 64, or 128	
Bandwidth selection	Low < 5 MHz Normal ~10 MHz High > 15 MHz	
Fast trigger output		
Pattern trigger	SMA, 600 mV into 50 ohm	
Physical Layer Functionality		
Unframed 4-channel BERT		
Data Rates Supported		
Applications	Bit Rate (Gbps)	Lane Speed (Gbps)
40 G (QSFP+)		
OC-768	39.8131	9.95328
Ethernet	41.25	10.3125
OTU3	43.01841	10.7546
OTU3e1	44.57097	11.1427
OTU3e2	44.5833	11.14583
100 G (CFP2)		
Ethernet	103.125	25.78125
OTU4	111.089	27.77
BERT Testing		
Tx patterns	PRBS7, -9, -15, -23, -31 and inverted, 32 Bit DW, SSPR, square wave	
Pattern lane offset	None, auto staggered, user-defined	
Bit error insertion	On selected lane, all lanes	
Rx patterns	PRBS7, -9, -15, -23, -31 and inverted, SSPR, 32 Bit DW	
Bit error analysis	Total, errored 1 or 0, ratio	
Gating modes	Manual start/stop, predefined duration, intermediate time	
Lane Operation Modes		
QSFP+	Per lane, each 4 x 10G lane is a separate channel	
CFP2	Per lane, each 25/28G lane is a separate channel with same type of pattern Independent lane, each 25/28G lane can independently choose PRBS or digital word	
4 x (5 x 5 G) mode	Each lane contains five independent bit-multiplexed signals with pattern transparency for CFP and CFP2 gearbox-based implementations. This mode can interoperate with the ONT CFP 10x(2x5G) mode for true end-to-end gearbox testing.	

User-entered bit rate 25 – 28 Gbps (BN 3076/94.34)

Lets users set arbitrary 25.3 to 28.05 Gbps per lane with 1 kbps (~0.01 ppm) resolution.

Hardware Validation (BN 3076/94.30)

The Hardware Validation option adds these capabilities:

- CFP2 debug, including MDIO and CFP2 validation
- Clock-frequency-variation application
- CAUI4 control over TX pre-emphasis and RX gain and slicer level
- Lambda-mapping application

Hardware validation is required for applications such as dynamic-skew variation and advanced-error analysis.

External MDIO and Auxiliary Triggers

Access to the external transponder evaluation board's MDIO interface

Auxiliary bit error trigger and gating control, 3.3 V positive logic

Optional adapter cable (K1001) required

CAUI4 Control

General

CFP2 interface supports 4 lanes, differential RX and TX with control of TX and RX functionality.

TX can be muted and both TX and RX lanes can be inverted. CAUI4 interface is AC coupled with LF cutoff of ~ 30 kHz.

TX Pre-Emphasis Settings

Modes	Normal, high, and user-defined
Normal precursor	400 mV and main = 400 mV
High precursor	570 mV and main = 400 mV
User-defined (with coupled or separate lanes)	Setting range is 200 mV to 1200 mV with 10 mV resolution

RX Equalization

Modes	Normal and user-defined
User-defined lets users set equalization from 0 to 7 dB with 1 dB resolution, lanes can be separate or coupled.	

Data Slicer Level

Modes	Normal and user-defined
User-defined setting can be adjusted from -200 to + 200 mV, with 0 mV as the default.	

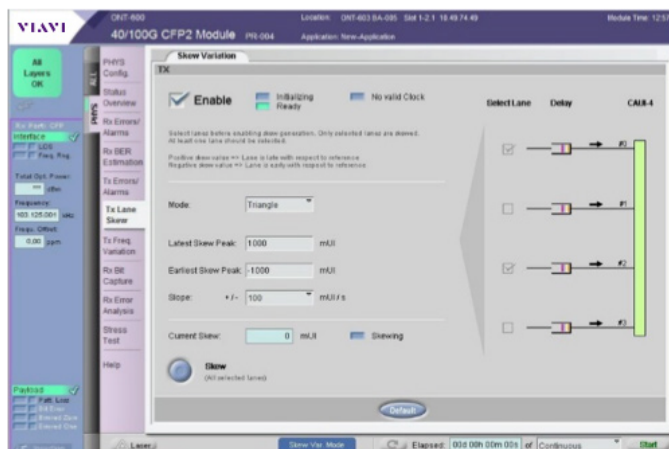
Dynamic Skew Variation (BN 3076/94.32)

Requires option BN 3076/94.30 (hardware validation).

The CFP2 Dynamic Skew Variation option lets users vary the relative skew in individual data lanes over a ±512 bit range in increments as small as 10 mUI.

Modes	Manual or triangle
Clock source	Internal or external
Skew slope	Selectable from 10, 20, 50, 100, 200, 500, 1000, 10000 mUI/s
Range	±512 U

Calibration and de-skew is carried out when the dynamic skew mode is first enabled or if the bit rate is changed. During this process, the TX output signal may be disrupted.



Dynamic skew overview screen

Advanced Error Analysis (BN 3076/94.31)

Requires option BN 3076/94.30 (hardware validation). The advanced error analysis option is a unique set of applications designed to accelerate troubleshooting, fault-finding, and stress testing of 25G+ hardware. It gives unique insight into the very nature of errors and, with clear indications of the patterns and statistics of the errors, it enables root causes to be quickly identified.

Applications include investigating CDR and FIFO slips, hardware pattern sensitivity, and error burst profiling

Bit Capture

The bit capture application allows each lane to be captured to a depth of 512 kbits per lane. The capture occurs after the trigger event.



Bit capture screen

Trigger: manual (via force trigger on GUI), error (any lane or user selected lane), external trigger event (front panel SMA connector [62]). Trigger can be single shot or continuous. Bit errors can also be set to cause a trigger event at the fast trigger output on the front panel. This can be used to trigger external devices (real-time fast oscilloscopes) to allow the physical and logical domains to be compared together to help error cause investigation. Bit errors are indicated by red shading on the errored bit on the GUI. User controls allow scrolling and zoom in/out of view portion of captured pattern.

A captured bit pattern can be saved as a CSV file.

RX Error Analysis

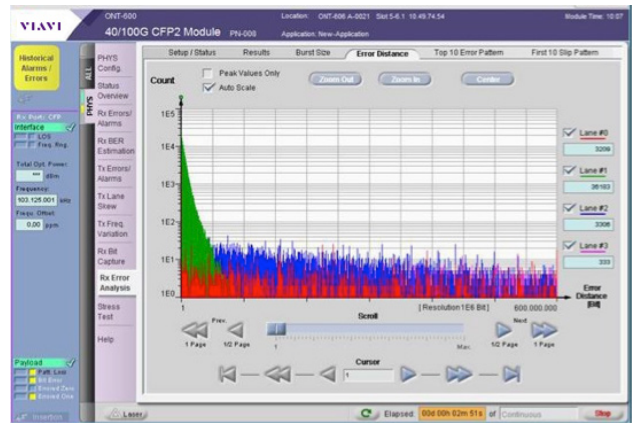
The advanced error analysis application reports the error distance distribution, and burst length distribution as graphs which can be viewed, zoomed, and scaled by the user. Error patterns that caused the highest number of bit errors are captured and displayed to facilitate pattern-sensitivity investigations. The top 10 patterns leading up to bit-slip conditions are also captured and displayed to enable troubleshooting of issues around CDR and FIFO slips.



Advanced error analysis setup screen

Advanced error analysis screenshot showing each lane data analyzed for bit errors, burst errors, and bit slips

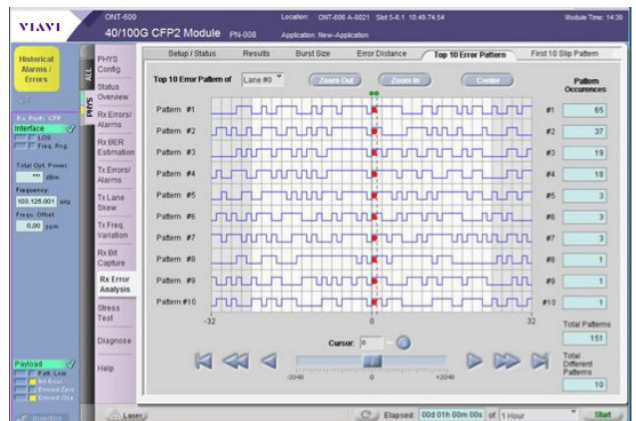
Each of the four lanes is color coded and can be turned on and off in the graphic as required. The user can scroll and zoom into the error distance profile to investigate the error type. Typical (random) errors should exhibit a Poisson-like profile while pattern-dependent or external crosstalk noise may cause discrete spectra.



Comparison of the error distance profile on each lane



Advanced error analysis setup screen



Display of top 10 error patterns showing strong correlation with pattern type

Jitter Insertion (BN 3076/94.33)

Allows user inject jitter on lane 3 of the optional electrical adapter (BN 3076/92.90)

Jitter Modulation Input

Connector	2.92 mm, 50 ohm, AC coupled
Modulation range	≤ ±40 ps
Sensitivity	≥160 ps/V
Frequency range	30 kHz to 1 GHz

MLG 1.0 Support (BN 3076/94.36)

The Multi-Link Gearbox Analysis option for the ONT 100G CFP2 modules generates, monitors, and analyzes the performance of 10 individual 10GBase-R signals encoded over 25G I/O conforming to OIF MLG 1.0. This option also enables ONT 100G CFP2 modules to test MLG-enabled line cards on the 25G side (optical or electrical) while the ONT MTM module can be used to generate/analyze the individual 10GE

Applications	Developing MLG ASIC, testing, and validating MLG pluggable optical modules as well as turning up and validating MLG-enabled line systems
Interfaces	The CFP2 interface natively supports MLG-enabled CFP2 modules, and it can support the MLG module and host ASICs through the CFP2 electrical interface. (BN 3076/92.90)

10GBase-R Encoding/Decoding**10 user-selectable 10GBase-R links**

Disabled link transmit signal	Local fault, scrambled idle
MLG alarm generation/detection	Loss of block lock, loss of alignment marker lock
MLG lane error insertion/detection	Invalid sync header, invalid alignment marker, user-defined alignment marker, BIP-8 error, user lane ID
Static/dynamic skew range	The same as non-MLG mode (100GE)

PCS-Layer (per individual 10GE link)

Minimum interpacket gap	8 to 127 bytes
Minimum interpacket gap threshold	5 to 255
Reconciliation alarm insertion	Local fault, remote fault
64/66B alarm insertion	LOBL, HiBER
64/66 error insertion	Invalid sync header, user control block, error propagation/E/

Statistics

Reconciliation alarms (seconds)	Link down, local fault, remote fault, IPG violation
Reconciliation errors (count and rate)	Error propagation /E/, local fault events, remote fault events, IPG violation events
64B/66B alarms (seconds)	LOBL, HiBER
64/66 errors (count and rate)	Invalid sync header, errored block, invalid block, LOBL events, HiBER events

MAC/IP Layer in the MLG Application

Supports one MAC flow per 10GE link.

Ethernet Generator

Frame type	Ethernet II, SNAP, VPLS with inner and outer MAC, MAC-in-MAC 802.1ah
Ethertype	Editable value
VLAN tagging	Single IEEE 802.1q, double (Q-in-Q) IEEE 802.1ad
Editable parameters	TPI, priority, CFI/DEI, VID

MAC addresses - Source and Destination

MAC frame size	
Predefined frames	64, 128, 256, 512, 1,024, 1,280, 1,518, 2,000, 9,000, 9,600, 10,000 bytes
User-defined frames	64 bytes to 10 kbytes

Dynamic frame size

VPLS framing

MAC-in-MAC 802.1ah framing

Payload type	Viavi test frame, PRBS31, PRBS31 inverted
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Traffic Generator

Traffic control

Mode	Bandwidth-controlled, gap-controlled
Trigger	Continuous, once (bandwidth-controlled)
Traffic type	Constant, burst, back-to-back, ramp, IMIX
Frame size	Editable, fixed values, dynamic increment/decrement, random

MAC Error Insertion (per 10GE link)

Error type	MAC, runt, oversized, FCS errored, invalid SFD)
Error type (test frame)	Loss, mis-insertion, duplication, swapping
Error type (test pattern)	Bit error

Generator Statistics	
Bandwidth	current and average, Mbps, %, plus graphics
Total byte count	
Total frame count and rate	
Pause frame count, rate, and ratio	
MAC bandwidth per flow current and average in bps	
Utilization per flow current and average in %	
Bytes per flow count	
Frames per flow count, rate, and ratio	
Ethernet Analyzer	
MAC Flow Filtering (per 10GE Link)	
Frame type	Ethernet II, SNAP, VPLS with inner and outer MAC, MAC-in-MAC 802.1ah
Ethertype	Editable value
VLAN tagging	
Type	Available for all frame types, single IEEE 802.1q, double (Q-in-Q) IEEE 802.1ad
Editable parameters	TPI, priority, CFI/DEI, VID
MAC addresses	
Destination address	Editable
Source address	Editable
VPLS framing	Supported, see Ethernet Generator
MAC-in-MAC framing	Supported, see Ethernet Generator
Total Link Analysis (non-flow selective)	
Error counts	
MAC frame/byte counts	
Pause quanta and time	
Bandwidth/utilization	
Frame size results	
Frame size distribution	
QoS Measurements (per 10GE link)	
QoS alarms and errors, throughput MAC/IP, transfer delay	
BERT measurements (per 10GE link)	
BERT alarms and errors	
Service Disruption Measurements (per 10GE link)	
Disruption results are given for any disruption that occurs above the disruption time threshold (10GE link selective).	
Packet Jitter Analysis (per 10GE link)	
Instantaneous jitter, jitter hits	

PCS and Ethernet Layers

PCS Layer	
40GE and 100GE only, supported by CFP2 or QSFP+ as appropriate.	
Each lane is clocked from common clock.	
TX/RX scrambler	On/off independent (only available for L2/L3 layer testing)
TX ignore link faults	On/off (only available for L2/L3 layer testing)
Payload	As follows or client signal from higher-layer application.
Pattern Modes	Virtual lane, aggregate
Virtual Lane Mode	
Pattern	PRBS7, -9, -15, -23,-31 and inverted
TX lane offset	Auto staggered, user-defined offset
User-defined offset	10 to 64,000 bits (depends on PRBS pattern)
Aggregate Mode	
Pattern	Scrambled idles
Error Insertion	
Supports simultaneous error and alarm insertion	
Type	Invalid sync header, invalid alignment marker, user-defined alignment marker, BIP-8 error, bit error (all lanes/single lane), block error
Range (depends on type)	All lanes, single lane
Trigger	Once, rate, burst once/cont.
Rate	9.9×10^{-3} to 1×10^{-10}
Burst	N events off, M events on
N, M	1 up to 16,777,215 events
Sync header value	Editable 0 to 3
Alignment marker M0, M1, M2	Editable 0 to 255
BIP-8 error mask	Editable 0 to 255
Alarm Insertion	
Supports simultaneous error and alarm insertion	
Type	LOBL (loss of block lock), LOAML (loss of alignment marker), HI BER (high bit error rate), local and remote fault, bit error (total, per lane)
Range (depends on type)	All lanes, single lane
Trigger (depends on type)	Continuous, burst once/cont.
Burst	N events off, M events
N, M	8 up to 134,217,720 events (local and remote fault)

Error Evaluation	
Type	Invalid sync header, invalid alignment marker loss of alignment marker event, BIP-8 error, BIP-8 bit error, LOBL event, HI BER event, local and remote fault event, bit error (total, per lane), errored zero (total, per lane), errored one (total, per lane), block error
Evaluation (depends on type)	Count, ratio, rate, seconds summary and per lane

Alarm Evaluation	
Type	LOBL, summary, per lane, LOAML, LOA (loss of alignment), HI BER, local and remote fault, link down (only available for higher-layer testing) pattern loss
Evaluation	Seconds

Lane Alignment Marker Insertion PCS Lane Mapping	
For all virtual lanes	User-defined
TX lane mapping	User-programmable (shift)

MAC/IP Layer

Basic Ethernet Features	
Supports one MAC flow for TX and RX. Multistream is optional.	
Ethernet Generator	
Frame type	Ethernet II, SNAP, VPLS with inner and outer MAC, MAC-in-MAC 802.1ah
Ethertype	Editable value
VLAN Tagging	
Type	Available for all frame types single IEEE 802.1q, double (Q-in-Q) IEEE 802.1ad
Editable parameters	TPI, priority, CFI/DEI, VID
MAC Addresses	
Destination address	User-defined, multicast, broadcast
Source address	User-defined, factory default
MAC frame size	User-defined, jumbo
Predefined values	64, 128, 256, 512, 1,024, 1,280, 1,518, 2,000, 9,000, 9,600, 10,000 bytes
User defined	64 bytes to 10 kbytes
Dynamic frame size	Increment/decrement, random, maximum/minimum, user-defined
Selectable increment step size	1 to 10 kbytes

VPLS Framing	
Inner Frame Structure	
As per standard Ethernet frame, including MAC addresses, VLAN tags (2), frame type, Ethertype, and payload	
Outer Frame Structure	
Parameters	MAC addresses, frame type, Ethertype
Tunnel and VC label	Label, CoS, TTL
Control word	Reserved bits, sequence number

MAC-in-MAC 802.1ah Framing	
Inner Frame Structure	
As per standard Ethernet frame including MAC addresses, VLAN tags (2), frame type, Ethertype, and payload	
Outer Frame Structure (PBB/PBT)	
Parameters	MAC addresses
B-Tag	TPI, VID, priority, DEI
I-Tag	TPI, SID, priority, DEI, NCA, Res1, Res2

Payload of MAC Frames	
Type	VIABI test frame, PRBS pattern
VIABI test frame	Time stamp and sequence number
Filling pattern	Editable digital word, PRBS31
PRBS pattern	PRBS31 and inverted
	Up to 124 bytes of user payload are freely editable.

Flow Control	
Modes	Generation, emulation, analysis
Generation of PAUSE frames	Off, once, continuous
Once	Number of frames per shot 1 to 2 ¹⁶
Pause frame interval	Editable 60 ns to 10 s
Pause quanta	Editable 0 to 64,000 (0 to 0.335 ms)
Emulation of flow control	Throttling on/off
Analysis of PAUSE frames	See analyzer

Traffic Generator	
Traffic Control	
Mode	Bandwidth-controlled, gap-controlled
Trigger	Continuous, once (bandwidth- controlled)
Continuous	Ongoing traffic as defined
Once	Triggers generation of programmed number of frames/bursts per flow (see traffic profiles—burst)

All flows are started synchronously

Gap-Controlled Traffic

Gives users precise and direct control over the IPG sequence generated. Resolution of 1 byte.

Traffic Profile for Bandwidth-Controlled Traffic

Each flow must be associated with one of 8 independent traffic profiles. Supports online updates of traffic profiles.

Traffic type	Constant, burst, back-to-back, ramp, IMIX
Frame size	Editable, fixed values, dynamic increment/decrement, random
Back-to-back (enables maximum bandwidth by forcing the traffic to minimum inter-packet gap)	On/off

Constant Mode

Burst Mode

Peak, sustained bandwidth	Adjustable utilization in Mbps and %
Burst size	1 to 64,000 frames
Utilization accuracy	0.1%

Traffic Profile for Gap-Controlled Traffic

Traffic type	Constant IPG, increment/decrement IPG, random IPG
Frame size	Editable, fixed values, dynamic increment/decrement and random
IPG constant	8 to 232 bytes
IPG increment/decrement start/stop	Min to 2,047 bytes
IPG step size	1 to 64 bytes
IPG random minimum/maximum values	Min to 2,047 bytes

MAC Error Insertion (any flow or per flow)

Error type	MAC, runt, oversized, FCS errored, invalid SFD
Triggering	Once, continuous, burst once/burst cont.
Rate	9.9×10^{-3} to 1×10^{-9}
Burst	M errored, N non-errored frames
M, N	1 to 2^{24} frames

MAC Error Insertion (per flow only)

Error type (test frame)	Loss, misinsertion, duplication, swapping
Error type (test pattern)	Bit error
Triggering	Once

Generator Statistics

Bandwidth	Current and average, Mbps, %, plus graphics
Bytes total	Count
Frames total	Count and rate
Pause frames	Count, rate, ratio
MAC bandwidth per flow	Current and average in bps
Utilization per flow	Current and average in %
Bytes per flow	Count
Frames per flow	Count, rate, ratio

Ethernet Analyzer

MAC Flow Filtering

The flow filter defines the parameters that particular flows must fulfill to pass the filter and for detailed analyzed. Others are not looped through to the per-flow analysis. Offers undefined as well as defined values.

Frame type	Ethernet II, SNAP, VPLS with inner and outer MAC, MAC-in-MAC 802.1ah
Ethertype	Editable value

VLAN Tagging

Type	Available for all frame types, single IEEE 802.1q, double (Q-in-Q) IEEE 802.1ad
Editable parameters	TPI, priority, CFI/DEI, VID

MACAddresses

Bandwidth	Adjustable utilization in Mbps and %
Utilization accuracy	0.1%
Destination address	Editable
Source address	Editable
VPLS framing	Supported, see Ethernet Generator
MAC-in-MAC framing	Supported, see Ethernet Generator

Total Link Analysis (non-flow selective)

Error Counts

MAC types	Errored, FCS errored, runt, oversized, invalid preamble, invalid SFD
Evaluation	Count, rate, ratio, seconds

MAC Frame/Byte Counts

Bytes	Total
Frames	Total, good, errored, broadcast, multicast, pause
Evaluation (type dependent)	Count, rate, %, and graphics
Pause quanta and time	Last, min, max, count, rate, ratio

Bandwidth/Utilization	
Total used bandwidth and utilization	
Bandwidth	Current, average in Mbps
Utilization (used bandwidth/ link bandwidth)	Current, average in %
Frame Size	
Results	Min., max., average
Frame size distribution	Count, rate, ratio graphical display of results
Distribution classes	64, 65 to 127, 128 to 255, 256 to 511, 512 to 1,023, 1,024 to 2,000, >2,000 bytes

Analysis per flow

Filtered-in Bandwidth

Evaluation of the Traffic Flows

Bandwidth of all filtered flows	
Bandwidth	Current, average in Mbps
Utilization (used bandwidth/ link bandwidth)	Current, average in %

Bandwidth/Utilization Measurements per Flow

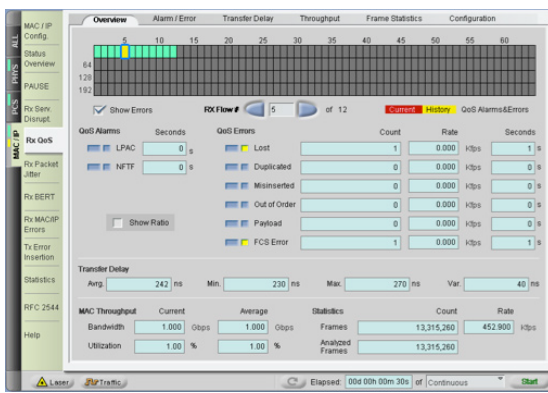
Bandwidth of single filtered flows	
Types	Current MAC, current payload, average MAC, average payload
Bandwidth (used bandwidth/ link bandwidth)	Mbps
Utilization (link)	in %

Frame Counts per Flow

Types	Bytes, frames
Evaluation	Count, rate, ratio

QoS Measurements per Flow

Graphical error/alarm matrix for all active flows with current and historical results. Results of particular flows are selectable.



QoS measurements per flow

QoS alarms	LPAC (loss of performance assessment capability, that is, test frame sync is not possible) NTFF (no flow test frame)
QoS errors	Lost, duplicated, misinserted, out-of-order frames
Evaluation (type dependent)	Count, rate, ratio, seconds
Throughput MAC/IP	Bandwidth, utilization in bps and %
Transfer delay	Min., max., average, variation (packet jitter)
Latency measurement resolution is 1 ns average and 10 ns per packet.	

BERT Measurements (single flow)

BERT alarms	LPAC
BERT errors	Bit error
Evaluation (type dependent)	Count, rate, ratio, seconds Start/stop and user-defined intermediate

Service Disruption Measurements per Flow

Graphical service disruption matrix for all active flows with "Threshold exceeded" and "Disruption" results. Results of particular flows are selectable.

Disruption results are given for any disruption that occurs above the disruption time threshold.

Port Disruption (non-flow selective) Flow Selective

Disruption result	Longest
Disruption result	Shortest, longest, last
Impairment separation	5 to 2 ²⁸ -1 frames
Type	Lost, duplication, out of order, misinsertion, time-out, link alarm

Disruption Counters

Results	Total disruptions, disruptions exceeding threshold
Evaluation	Count, rate, seconds

Packet Jitter Analysis per Flow

Packet jitter is usually caused by queuing and routing across or buffering in switched-transport networks. The final effect of high-packet jitter is the number of rejected packets.

Instantaneous jitter is defined as the difference between packet spacing of the transmitter compared to packet spacing of the receiver. Instantaneous jitter is a measure of jitter dynamics.

Instantaneous jitter	Current, peak, average, minimum in ns, hits in count values
Hit threshold editable	10 ns to 10 s

RFC 2544 Conformance Testing

RFC 2544 addresses the need for service providers to perform QoS measurements in Ethernet and IP networks. Vendors are mandated to qualify the correct behavior of their IP/Ethernet equipment.

The 40/100G ONT lets users perform fully automated RFC 2544 testing at 40 and/or 100GE rates, as applicable. In detail, it performs throughput, frame loss, round-trip delay and back-to-back (burstability) tests. The RFC 2544 is suitable for local and wide area networks (LAN and WAN) as well as OTN-mapped applications. All set up parameters for the four tests are editable on one page, and all the test results are also shown on one page.

Results throughput	Table graph, bar graph
Results frame loss	Table graph
Results latency, back to back	Table
Online parameters shown during the measurement	Test, status, current frame length, remaining test time

Ethernet Options

40G Ethernet BN 3061/94.51

adds support of native 40GE Ethernet via QSFP+ port. Will also enable 2nd port if available

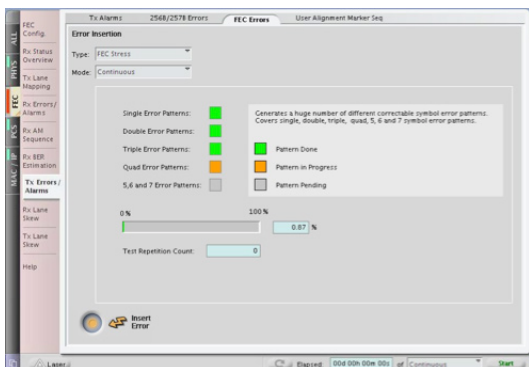
Multistream/IP BN 3061/94.54

adds IP and Multistream (up to 128 flows) support to available 100G or 40G Ethernet

SR4 FEC Validation

The advent of QSFP28 optical modules is driven by the deployment of SR4, CWDM4, and PSM4 datacom and telecom interfaces. In this environment, test equipment must evolve to accommodate this form factor into existing products to test and validate next-generation 100G interfaces.

Deploying 25G I/O-based SR4 interfaces using multimode fiber requires overcoming the inter-symbol interference challenges that dispersion causes in the fiber from using lower-cost optics. One method for achieving this is using RS FEC (per IEEE 802.3bj Clause 91) to improve link performance and thus achieving the desired BER performance without adding to the optics and line cards cost.



SR4 FEC Validation Option BN 3076/94.35

Requires optional CFP2 to QSFP28 or CFP2 to CFP4 adapter

Error insertion

Supports simultaneous error and alarm insertion

Type	Invalid transcoded block (ITB) and user-defined alignment marker sequence
Trigger	Once, continuous, burst once/ continuous
Burst	N events off, M events on
N, M	1 up to 2,147,483,647 events

Alarm insertion

Simultaneous error and alarm insertion is supported

Error evaluation

Type	Uncorrectable code word, correctable code word, correctable symbol, correctable bit, correctable one bit, correctable zero bit, LOAMPS event, LOA event
Evaluation (depends on type)	Count, ratio, rate, seconds; summary; and per lane

Alarm evaluation

Type	LOAMPS (summary, per lane), LOA (loss of alignment), and HI SER
Evaluation	Seconds

Lane alignment marker insertion

For all virtual lanes	User-defined
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SR4FEC lane mapping

TX lane mapping	User-programmable (shift)
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Lane skew generation

Static skew per physical lane 0 to 64,000 bits	
Resolution	1 bit per physical lane

25G Ethernet Testing

25G Ethernet BN 3076/94.37

PCS Configuration

It is settable, if the PCS layer is operating according to IEEE Clause 107 or to 25G Ethernet Consortium (Schedule 3)

64B/66B Error insertion

Simultaneous error and alarm insertion is supported

Type	Invalid sync header, User defined control block, Error propagation/E/
Trigger	Once, rate, burst once/cont.
Rate	9.9×10^{-3} to 1×10^{-10}
Burst	N events off, M events on
N, M	1 up to 1,073,741,823 events
Sync header value	Editable 0 to 3
User defined control block	8 bytes editable 0 to 255

64B/66B Alarm insertion

Simultaneous error and alarm insertion is supported

Type	LOBL (loss of block lock), HI BER ¹⁾ (High Bit Error Ratio)
Trigger	Continuous

1) According to IEEE Clause 107 or 25G Ethernet Consortium (Schedule 3)

Reconciliation Alarm insertion

Simultaneous error and alarm insertion is supported

Type	Local Fault, Remote Fault
Trigger	Continuous, burst once/cont.
Burst	N events off, M events on
N, M	4 up to 67,108,860 events (in steps of 4)

64B/66B Error evaluation

Type	Invalid sync header, Errored block, Invalid block, LOBL events HI BER ¹⁾ events
Evaluation (depends on type)	count, ratio, rate

1) According to IEEE Clause 107 or 25G Ethernet Consortium (Schedule 3)

64B/66B Alarm evaluation

Type	LOBL HI BER ¹⁾
Evaluation	Seconds
Type	LOAMPS (loss of alignment marker payload sequence), HI SER (high symbol error rate)
Trigger (depends on type)	Continuous

Reconciliation Error evaluation

Type	Error Propagation/E/, Local Fault events, Remote Fault events, IPG Violation events
Evaluation (depends on type)	count, ratio, rate

Reconciliation Alarm evaluation

Type	Link Down, Local Fault, Remote Fault, IPG Violation
Evaluation	Seconds

25GE MAC Layer Specifications

Please also refer to chapter "PCS and Ethernet Layers"

Error Insertion

Simultaneous error and alarm insertion is supported

Type	Invalid Transcoded Block (ITB), User Defined Codeword Marker Sequence
Trigger	Once, continuous, burst once/cont.
Burst	N events off, M events on
N, M	1 up to 16,777,215 events
Type	Correctable Codeword Error, Uncorrectable Codeword Error, User Defined Symbol Error
Trigger	Once, continuous, sustained, burst once, burst cont.
Burst	N events off, M events on
N, M	1 up to 2,147,483,647 events

Alarm insertion

Simultaneous error and alarm insertion is supported

Type	LOCWMS (loss of codeword marker sequence), LOFECBL (loss of FEC block lock)
HI SER (high symbol error rate)	

Trigger (depends on type)	Continuous, Single Burst, Continuous Burst
---------------------------	--------------------------------------------

25GE RS-FEC and BASE-R FEC (BN 3076/94.38)

Adds optional RS-FEC and Base-R FEC support to available 25GE

Function RX Description and details

FEC Type TX/RX	<ul style="list-style-type: none">· Bypass (FEC generation/evaluation is disabled)· Reed-Solomon FEC· BASE-R FEC
FEC/PCS	Mode
TX/RX	<ul style="list-style-type: none">· IEEE 802.3- Bypass: Clause 107- RS FEC: Clause 108, Clause 107- BASE-R FEC: Clause 74, Clause 107· 25G Ethernet Consortium (Schedule 3)

FEC Bypass Correction

RX Enable/disable FEC Bypass Correction.

25GE FEC Validation (BN 3076/94.39)

Adds in-depth 25GE FEC evaluation features, runs on one port only

FEC Error Insertion:

Type	Invalid Transcoded Block (ITB), User Defined Codeword Marker Sequence
Trigger	Once, continuous, burst once/cont.
Burst	N events off, M events on
N, M	1 up to 16,777,215 events

Type	Correctable Codeword Error, Uncorrectable Codeword Error, User Defined Symbol Error
Trigger	Once, continuous, sustained, burst once, burst cont.
Burst	N events off, M events on

N, M 1 up to 2,147,483,647 events

FEC Alarm Insertion

Type	LOCWMS (loss of codeword marker sequence), LOFECBL (loss of FEC block lock), HI SER (high symbol error rate)
Trigger (depends on type)	Continuous, Single Burst, Continuous Burst

Error and alarm evaluation:

Type	Uncorrectable codeword, Correctable codeword, Correctable symbol, Corr. Bit, Corr. One Bit, Corr Zero Bit, Corr. burst codeword, Corr. random error, Corr. burst bit, LOCWMS event, LOFECBL event
Evaluation (depends on type)	count, ratio, rate, seconds
Codeword Marker Insertion	user-defined codeword marker
Codeword shift / FEC block shift insertion	0 ... 256 bits

50G Ethernet Testing

50GE (BN 3076/94.43)

Adds basic 50GE testing capabilities. Will run on port 1 only.
For details, see 25GE section

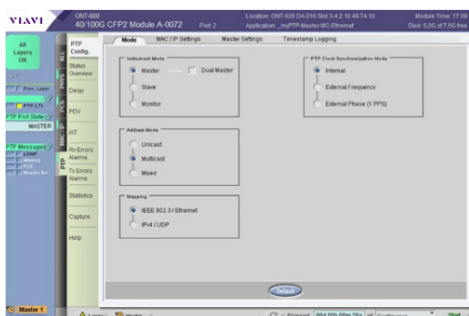
50GE FEC Validation (BN 3076/94.43)

Adds in-depth 50GE FEC testing capabilities. Will run on port 1 only.
For details see 25GE FEC Validation section.

IEEE 1588V2 PTP Master Slave Evaluation (BN 3061/94.84)

As mobile operators continue to deploy IEEE 1588v2 in their mobile backhaul networks using primarily 1GE links at this time with a short-term plan to upgrade to 10GE to address the continuously increasing demand for higher bandwidth, network equipment manufacturers and timing sources vendors must prepare for tomorrow's bandwidth challenges.

As 40GE/100GE technologies have matured and are ready for mainstream use, it has become evident that precision timing protocol (PTP) must be scaled to these bit rates on the aggregation side of the network. Now that grand master clocks are being designed with 40GE/100GE ports, these elements' performance must be thoroughly verified. The PTP evaluation option for ONT-600 100G CFP2 modules provides in-depth test capabilities for analyzing 100GE and 40GE system 1588V2 PTP implementation.



As mobile operators continue deploying IEEE 1588v2 in their Mobile Backhaul Networks using 1GigE links mostly at this time, but with a short term plan to upgrade to 10GE to address the continuously increasing demand for higher bandwidth, Network Equipment Manufacturers and Timing Sources vendors need to prepare for tomorrow's bandwidth challenges.

As 40GE/100GE technologies have matured and are ready for mainstream, it has become evident that Precision Timing Protocol needs to be scaled to these bit rates on the aggregation side of the network. Grand Master clocks are being designed now with 40GE/100GE ports and the performance of these elements need to be thoroughly verified at this stage.

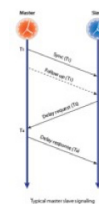
The Precision Timing Protocol Evaluation option for the 100G CFP2 modules of the ONT-600 provides in-depth test capabilities for analyzing the 1588V2 PTP implementation of 100GE and 40GE systems.

Modes of Operation	
Emulation	Single master, dual master, slave clock
PTP Modes	1 and 2 step mode
Monitoring mode (listen only)	Monitor traffic from Master to Slave, Slave to Master
PTP Packet Generation	
Packet rate	1/256 256 packages per second
PTP Analysis	
Modes	packet delay, packet delay variation, delay asymmetry, packet inter arrival time
Time stamp logging	T1, T2, T3, T4 and correction fields, 5 ns resolution
Number of log entries	up to 100E6, can be exported for offline analysis
Ethernet background traffic	
Traffic profile	up to 16 background flows with different traffic parameters
Errors and alarms	
RX Alarms	Loss of Message Flow (LOMF), Loss of Master Clock (LOMC), Loss of Timing Information (LTI) – resolution 1 s
RX Errors	FCS error, IP V.4 Header Error, Missing Message
Analysis modes	seconds (for alarms), count, ratio (for errors)
Error insertion types	dropped messages, runt messages, invalid start of frame delimiter, IP V4 header error
Message statistics	
Port states	disabled, listen, master, slave, monitor
TX and RX PTP message types	Signaling Announce, Sync, Follow-Up, Delay Response Delay Request (count, rate)
RX PTP messages	all, filtered in
Graphical result history	80 min for 2 message types, resolution 10 s
PTP packet capture	256 MByte (Wireshark format)

Modes of Operation	
Emulation	Single master, dual master, slave clock
PTP modes	1 and 2 step mode
Monitoring mode (listen only)	Monitor traffic from master to slave and slave to master
PTP Packet Generation	
Packet rate	1/256 ... 256 packages per second
PTP Packet Generation	
Modes	Packet delay, packet delay variation, delay asymmetry, packet inter-arrival time
Time stamp logging	T1, T2, T3, T4 and correction fields, 5 ns resolution
Number of log entries	Up to 100E6, can be exported for offline analysis
Ethernet Background Traffic	
Traffic profile	Up to 16 background flows with different traffic parameters
Errors and Alarms	
Rx alarms	Loss of message flow (LOMF), loss of master clock (LOMC), loss of timing information (LTI) – resolution 1 s
Rx errors	FCS error, IP V4 header error, missing message
Analysis modes	Seconds (for alarms), count, and ratio (for errors)
Error insertion types	Dropped messages, runt messages, invalid start-of-frame delimiter, IP V4 header error
Message Statistics	
Port states	Disabled, listen, master, slave, monitor
Tx and Rx PTP message types	Signaling announce, sync, follow-up, delay response delay Request (count, rate)
Rx PTP messages	All, filtered in
Graphical result history	80 min for 2 message types, resolution 10 s
PTP packet capture	256 MByte (Wireshark format)
Error evaluation	
Type	Uncorrectable codeword, Correctable codeword, Correctable symbol, Corr. Bit, Corr. One Bit, Corr. Zero bit, Corr. burst codeword, Corr. random error, Corr. burst bit, LOCWMS event, LOFECBL event
Evaluation (depends on type)	count, ratio, rate, seconds
Alarm evaluation	
Type	LOCWMS, LOFECBL, HI SER
Evaluation	Seconds
Codeword marker insertion	
Codeword marker	User-defined
Codeword shift/FEC Block shift insertion	
Shift	0 to 256 bits

As 40/100GE technologies have matured and are ready for mainstream deployment, it is increasingly apparent that PTP must be scaled to these bit rates on the aggregation side of the network. Grandmaster clocks are being designed with 40GE/100GE ports, and performance must be thoroughly verified. Mobile operators continue to deploy IEEE 1588 v2 in their mobile backhaul networks, primarily using 1GE links. They typically have short-term plans to upgrade to 10GE to address the continuously increasing demand for higher bandwidth, but network equipment manufacturers and timing source vendors must prepare for tomorrow's even greater bandwidth challenges.

Up to 16 background flows with individual traffic parameters
0 – 100% load variation



Modes of Operation	
Emulation: Single master, dual master, slave clock	
PTP modes: 1 and 2 step mode	
Monitoring mode (listen only): Monitor traffic from master to slave and slave to master	
Synchronization	
Internal, from ONT clock module (1 pps external clock)	
Selectable Addressing Modes	
Multicast Unicast	
Transport Layer	
Ethernet MAC, VLAN (up to 2 tags), SNAP, IPv4	
Ethernet Background Traffic	
PTP Packet Generation	
Packet rate	1/256 – 256 packets per second
Packet types	Announce, sync, delay request, delay response
PTP Time Stamp Evaluation	
Types	Packet delay, packet delay variation, delay asymmetry, packet inter-arrival time
Time stamp logging (master)	T1, T3, T4 including correction field
Time stamp logging (slave)	T1, T2, T2a, T3, T4, T5 including correction field
Number of log entries	Up to 100 million time stamps
Time stamp post processing	Via wander analysis software (BN 3061/95.98 and 3061/95.99)
Time stamp resolution	1 ns

Error and Alarms	
RX alarms	Loss of message flow (LOMF), loss of master clock (LOMC), loss of timing information (LTI) - resolution: 1 s
RX errors	FCS error, IPv4 header error, missing message
Result modes	Seconds (for alarms), count, ratio (for errors)
Error insertion types	Dropped messages, runt messages, invalid start of frame delimiter, IPv4 header error
Message Statistics	
Port states	Disabled, listen, master, slave, monitor
TX and RX PTP message types	Signaling, announce, sync, follow-up, delay response, delay request (count, rate)
RX PTP messages	All, filtered in
Graphical result history	> 1 hour for 2 message types, resolution: 10 s
PTP packet capture	256MB (Wireshark format)

External Wander Analysis Software

External Wander Analysis (Option BN 3061/95.98)

Packet Data Add-On for Wander Analysis (Option BN 3061/95.99)

In-depth Windows-based analysis tools for logged time-stamp data; comparison of data against all relevant masks per ITU-T G.826x, 827x and others

Synchronous Ethernet

SyncE G.8264 ESMC Testing (BN 3076/94.89)

Synchronous Ethernet (SyncE) equipment requires clock-quality reporting capabilities, and as specified in recommendation ITU-T G.8264 the Ethernet synchronization messaging channel (ESMC) provides these reporting capabilities by means of the synchronization status message (SSM) protocol.

SSM Generator

All static settings of the transmitted SSM frames are displayed. The source address used for the SSM frame is equal to the MAC port address.

SSM Insertion	On/off
Send mode	Single frame, continuous
Message rate	0.1 to 20.0 fps
QL mode	Static, alternating
QL duration	1.0 to 3,600.0 s
SSM asynchronous event	On/off

SSM Analyzer

SSM timeout threshold	1 to 60 s
Sliding window size	1 to 10 s
SSM status display	SSM timeout, SSM rate, last Q-code
SSM statistics	Average/peak rate, min/max inter-frame gap

SSM Delay Measurement:

Switching delays of synchronous Ethernet equipment can be measured by triggering a change of the reported clock quality of an incoming link and simultaneously monitoring the change of reported clock quality of an outgoing link. Through a flexible trigger mechanism, a delay measurement is started when a user-defined trigger match is detected and stopped when the corresponding RX trigger match is detected.

Delay measurement	On/off
TX/RX trigger conditions	Any QL change, Rising QL, Falling QL, Change to QL
Delay measurement	resolution ms
Display of all results with time stamps	
Criteria	Start, end, duration, count
Viewing filters	Events, durations, count

Graphical View

Display of all events as bar graphs versus time. Cursors allow easy identification and zooming (in and out) on results.

Viewing filters	Events
Time axis scale	Second, minute, hour

OTN

OTL Layer

40G OTL3.4 and 100G OTL4.4

Highlights

OTL3.4 and OTL4.4 BERT

- Sophisticated OTL-layer testing with skew measurements
- Dynamic skew generation (optional)
- Support of lambda groups
- Real-time analysis per logical lane

Basic Features

Payload of OTL Frames

PRBS pattern PRBS9, -23, -31 and inverted

OTL Alarm Generation

Alarm types	LOFOTL, OOFOTL
Mode	Continuous (into all lanes, into selected lane)

OTL Error Insertion

OTL4 error types	FAS, LLM, MFAS, user-defined LLM, user-defined MFAS
OTL3 error types	FAS, MFAS, user-defined MFAS
Mode	Once, rate, burst once, burst cont. (into all lanes, into selected lane)
Rate	9.9×10^{-3} to 1.0×10^{-10}
Burst	M errored, N non-errored frames
M, N	1 to 16,777,215

User-Defined Error Insertion	
Mode	Invert, overwrite
LLM value	0 to 255
LLM mask	0 to 255
MFAS value	0 to 255
MFAS mask	0 to 255

Payload Error Insertion	
Error type	Bit error
Triggering	Once, rate
Rate	1.0×10^{-2} to 1.0×10^{-10}

Lane Mapping	
TX lane mapper allows lane rotation at assigned OTL lane.	

Static Skew Generation	
Range	0 to 64,000 bits

Dynamic Skew Generation	
Mode	Manual, triangle
Skew (manual)	-32,000 to 32,000 in mUI
Latest peak (triangle)	-32,000 to 32,000 in mUI
Earliest peak (triangle)	-32,000 to 32,000 in mUI
Slope	10, 20, 50, 100, 200, 500, 1,000 mUI/s
Applied lane	Any physical lane

OTL4.4 Lambda Group Configuration	
Number of groups	4
Mode	Manual, apply per alarm lane

Total Analysis (aggregate)	
Graphical error/alarm matrix for all logical lanes with current and historical results.	

OTL3.4 Measurements	
OTL alarms	LOFOTL, OOFOTL, LOR, OOR, OOMFAS, LOL, OOL, LL swap
OTL errors	FAS, MFAS
Evaluation (type dependent)	Count, ratio, seconds

OTL4.4 Measurements	
OTL alarms	LOFOTL, OOFOTL, LOR, OOR, OOLLM, OOMFAS, LOL, OOL, LL Swap
OTL errors	FAS, LLM, MFAS
Evaluation (type dependent)	Count, ratio, seconds

Maximum Skew	
Evaluation	Current max. skew in bits and picoseconds between earliest and latest lane

Analysis per Logical Lane	
Lane ID	
Evaluation	Current lane ID

OTL3.4 Measurements per Logical Lane	
Graphical error/alarm matrix for all logical lanes with current and historical results. Results of particular lanes are selectable. Alarms/ errors are shown in a common table.	

OTL alarms	LOFOTL, OOFOTL, LOR, OOR, OOMFAS
OTL errors	FAS, MFAS
Evaluation (type dependent)	Count, ratio, seconds

OTL4.4 Measurements per Logical Lane	
Graphical error/alarm matrix for all logical lanes with current and historical results. Results of particular lanes are selectable. Alarms/ errors are shown in a common table.	

OTL alarms	LOFOTL, OOFOTL, LOR, OOR, OOLLM, OOMFAS
OTL errors	FAS, LLM, MFAS
Evaluation (type dependent)	Count, ratio, seconds

Logical Lane Skew (delay)	
Evaluation	Current skew (in bits and picoseconds)

Analysis per Lambda Group

OTL3.4 Measurements per Lambda Group	
Alarms	LOFOTL, OOFOTL, LOR, OOR, OOLLM, OOMFAS
Errors	FAS, MFAS
Evaluation (type dependent)	Count, ratio, seconds

OTL4.4 Measurements per Lambda Group	
Alarms	LOFOTL, OOFOTL, LOR, OOR, OOMFAS
Errors	FAS, LLM, MFAS
Evaluation (type dependent)	Count, ratio, seconds

Payload Measurements (aggregate)	
Payload alarms	Pattern loss
Payload errors	Bit error, errored one, errored zero
Evaluation (type dependent)	Count, ratio, seconds

OTU3 and OTU4 Testing Modes

Terminate Mode

Generators and analyzers run at the same OTN rate

Through Mode

Supports both intrusive and non-intrusive through mode. The generator and analyzer run at the same OTN rate and received traffic is terminated at the OTN layer and retransmitted with the transmitter. All OTN layer information remains unchanged in non-intrusive through mode, whereas intrusive through mode allows for it to be selectively overwritten with the OTN generator. The client signal remains unchanged and is retransmitted and analyzed by the higher layer, if supported.

- Standard and overclocked (optional) OTU3 and OTU4 rates
- Support of all TCM layers
- Transfer delay and service disruption
- Unique FEC stress testing with walking pattern
- Overhead byte capture
- 4-byte APS/PCC access

The functionality includes OTN framing as per G.709 with standard and/or overclocked rates. The OTN applications support generation and analysis of OH bytes, errors, alarms, and FEC. Parameters and measurement results at the OTN and client layer are processed simultaneously.

OTN Generator

Pattern	OTN test, higher layer test, and live traffic
OTN test pattern	PRBS7, -11,-15, -23,- 31 and inverted; 32 Bit DW.

Supports both stuffing and non-stuffing of payload bytes.

Client Offset—Stuffing

Adjust the asynchronous client offset within the ± 65 ppm range to allow manipulation of the stuffing rate of the client.

Client stuffing generation (GMP): displays nominal and effective Cm value

Overhead (frame alignment/OTU/ODU/OPU)

All bytes are statically programmable except for MFAS, SM BIP, PM BIP, and TCM1 ... 6 BIP

- Additional possibilities for SM TTI, PM TTI, and TCM1 ... 6 TTI (trail trace identifier):
- Sequence consisting of the SAPI (16 bytes), DAPI (16 bytes), and the operator-specified (32 bytes)
- User-designed payload structure identifier (PSI), payload type identifier clear text, and MSI support
- One OH byte can be selected for a freely defined sequence of 16/32/64/128/256 bytes
- FTFL free definable forward/backward (FW/BW) fault indication and operator identifier
- 4-byte APS/PCC access

Error Insertion

Type	FAS, MFAS, SM BIP-8, SM BEI, PM BIP-8, PM BEI, TCMi BIP-8, TCMi BEI (i = 1 to 6), OMF, LOMFI, OOMFI applicable only with OTU4, bit errors (only available with OTN test pattern)
Trigger	Single, rate, burst, burst continuous
Burst error	M frames errors, N frames error free, M and N = 0 to 2^{31}

BIP Masks

The position and number of bit errors in the bytes can be selected. Valid for SM BIP, PM BIP, TCMi BIP (i = 1 to 6)

BEI Value

To stress the BEI evaluation of the DUT receiver the BEIs can be set to values from 0 to 15.

Valid for SM BEI, PM BEI, TCMi BEI (i = 1 to 6)

Alarm Generation

Type ODU-AIS, ODU-OCI, ODU-LCK, SM BDI, SM IAE, SM BIAE, PM-BDI, FW-SD, FW-SF, BW-SD, BW-SF, TCMi-LTC, TCMi-IAE, TCMi-BDI, TCMi-BIAE (i = 1 to 6), SM-TIM, PM-TIM, TCMi-TIM

Trigger

Continuous	All alarms
Burst once/burst continuous	All alarms except LOS, LOF, TIMS, OOF, OOM, SD, SF
Burst alarms	M frames with alarm, N frames no alarm, M and N = 0 to 2^{31}

OTU FEC

The FEC generation can be switched on and off. Using the OTU FEC field, FEC based on the Reed-Solomon (255,239) algorithm is performed on the generated frame. Data blocks consisting of 239 data bytes and 16 FEC field bytes enable detection of up to 16 byte errors or correction of 8 byte errors.

FEC Error Insertion Modes

- FEC correctable, FEC uncorrectable
- FEC stress: This function allows for maximum stress tests within a short time frame. Inserts the maximum number of errors possible that the DUT can correct into the OTU frame by a walking pattern that affects all bit positions in less than 2 seconds.

FEC advanced

FEC advanced lets users define the position for error insertion in the OTU frame letting them perform correction capability testing below and above the correction limit.

Selectable parameters	Row, subrow, errored bytes per subrow, start position in subrow, byte error mask
-----------------------	----------------------------------------------------------------------------------

OTN Analyzer

Client Stuffing

Displays payload offset in ppm.

Display of nominal and effective payload rate and Cm value.

Stuffing Counts

Positive, negative, sum count, duration of affected seconds.



Overhead Evaluation (frame alignment/OTU/ODU/OPU)

- Displays the complete overhead

SM TTI, PM TTI, TCM1 ... 6 TTI display of the 64 byte ASCII sequence of SAPI, DAPI, and Operator field

- Capture and display one sequence of up to 256 bytes for a selectable OH byte
- 4-byte APS/PCC access
- Displays payload structure identifier (PSI) bytes, payload type identifier (PT) clear text, and MSI support
- Editable PT expectation value as mismatch criterion
- FTFL forward/backward (FW/BW) fault indication and operator identifier fields

Trace References

Set of SAPI and DAPI expectation values in traces SM TTI, PM TTI, TCM1 ... 6 TTI

Select evaluation type of the received signal: SAPI or DAPI or SAPI/DAPI

General Communication Channel Capture (GCC)

The management information between the network element and the termination equipment is transported in the GCCs in the OTN overhead. This feature enables the capture of transmitted information in real time.

Captured fields	GCC0, GCC1, GCC2, GCC1+2
Captured format	Raw
Capture size	up to 500 MB
Trigger	Manual

Error Measurement

Validation of data for error measurement occurs after frame alignment, descrambling, and FEC computation and correction.

Error Detection

Types	FAS, MFAS, SM BIP, SM BEI, PM BIP, PM BEI, TCMi BIP, TCMi
-------	-----------------------------------------------------------

BEI (i = 1 to 6), GMP CRC5/8, OMFI, bit error (only available for OTN test pattern), FECcorr. bit, FECcorr. code word, FECuncorr. code word

Alarm Detection

Type	LOF, OOF, LOM, OOM, OTU-AIS, ODU-AIS, ODU-OCI, ODU-LCK, SM BDI, SM IAE, SM, BIAE, SM-TIM, PM-BDI, PM-TIM, FW-SD, FW-SF, BW-SD, BW-SF, TCMi-LTC, TCMi-DI, TCMi-IAE, TCMi-BIAE, TCMi-TIM (i = 1 to 6), CSF, LOMF, OOMFI, CL-LOSS (client signal loss of synchronization), PT-MISM, pattern loss (only available for OTN test pattern)
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Resolution	100 ms
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Error and Alarm Results Display

Numerical Display

Displays count, ratio, and duration for each error

Displays duration for each alarm

Tabular Display

Displays all results with time stamps

Criteria	Start, stop, duration, count
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Graphical Display

Displays all events as bar graphs versus time. Cursors allow for easy identification and zooming (in and out) on results. Filters enable event selection.

Time axis	Second, minute, hour
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Live Traffic mode ignores pattern loss and bit errors allowing for analysis of live traffic without trouble indication.

Service Disruption Test

SD criteria

Errors	MFAS, SM-BEI, PM-BIP, PM-BEI, bit errors
Alarms	LOS, LOM, OOM, SM-IAE, SM-BDI, SM-BIAE, ODU-AIS, ODU-OCI, ODU-LCK, PM-BDI
Event sample resolution	100 μ s
Separation time	0.1 to 100,000 ms

Separation time starts at the end of the last event and is used to determine if the following event is a continuation of the same disruption (event occurs within separation time) or the start of the next one (event occurs after separation time has elapsed).

Disruptions Results Display

Numerical Display

Total number of disruptions, begins with time stamp of first disruption and ends with a time stamp of last disruption.

Shortest disruption time (with time stamp)

Longest disruption time (with time stamp)

Average Disruption Time

Users can set service-disruption thresholds that range from 0 to 100,000 ms to identify when violations occur.

Tabular Display

Service disruption events with start/stop times and duration.

Three logging modes are available (no logging; disruption events only; disruption and causing sensor events).

Intermediate Bit Error

In addition to the long-term bit error measurement, intermediate results are available.

Interval	1 to 3,600 s
Results	Current/previous interval, count, and ratio

To analyze service disruption times, the ONT generates a high-speed event list as a result of all detected events.

Sensor to trigger service disruption test, selectable: sequence of SAPI, DAPI, and Operator field

- Capture and display one sequence of up to 256 bytes for selectable OH byte
- 4-byte APS/PCC access
- Displays payload structure identifier (PSI) bytes, payload type identifier (PT) clear text, and MSI support
- Editable PT expectation value as mismatch criterion
- FTFL forward/backward (FW/BW) fault indication and operator identifier fields

OTN SW Options

OTU3 bulk (BN 3061/94.57)

OTU3 bulk option enables a bulk PRBS payload to be carried in an OPU3, ODU3, and into an OTU3 signal. Full monitoring and alarm and error injection at each layer, as appropriate. Applications for delay, TCM, and others.

OTU3e1 bulk (BN 3061/94.58)

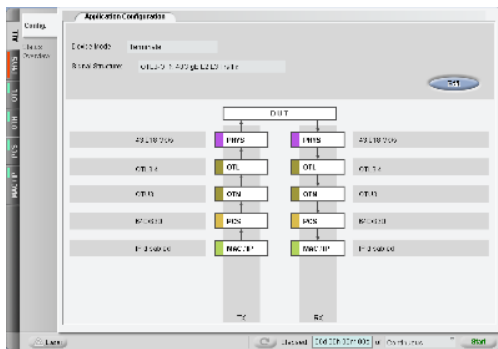
OTU3e1 bulk option enables a bulk PRBS payload to be carried in an OPU3e1, ODU3e1, and into an OTU3e1 (44.57 Gbps) signal. Full monitoring and alarm and error injection at each layer, as appropriate. Applications for delay, TCM, and others.

OTU3e2 bulk (BN 3061/94.59)

OTU3e2 bulk option enables a bulk PRBS payload to be carried in an OPU3e2, ODU3e2, and into an OTU3e2 (44.58 Gbps) signal. Full monitoring and alarm and error injection at each layer, as appropriate. Applications for delay, TCM, and others.

OTU3 with client (BN 3061/94.60)

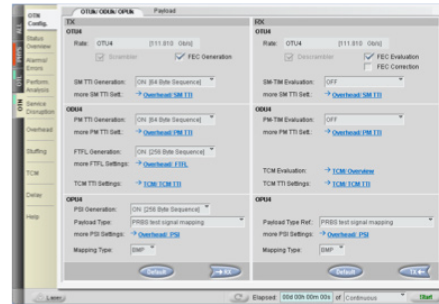
OTU3 with client enables a 40G Ethernet client transcoded into an OPU3, ODU3, and into OTU3. Full control of 40G Ethernet payload as well as monitoring and injection of alarms and errors as appropriate in each layer. Applications for TCM, delay, and service disruption, among others. Full monitoring and alarm and error injection at each layer, as appropriate.



Example of a 40GE client being transcoded into OTU3, full control of 40GE payload and all other layers to the physical layer are possible.

OTU4 bulk (BN 3061/94.55)

OTU4 bulk option enables a bulk PRBS payload to be carried in an OPU4, ODU4, and into an OTU4 signal. Full monitoring and alarm and error injection at each layer, as appropriate. Applications for delay, service disruption, and TCM, among others.



Example of OTU4 bulk control screen

OTU4 with client (BN 3061/94.53)

OTU4 with client enables a 100G Ethernet client carried into an OPU4, ODU4, and into OTU4. Full control of 100G Ethernet payload as well as monitoring and injection of alarms and errors as appropriate in each layer. Applications for TCM, delay, and service disruption, among others. Full monitoring and alarm and error injection at each layer, as appropriate.

OTN enhanced multiplexing (BN 3061/94.61)

OTN enhanced multiplexing enables one level of lower-order multiplexing into the OTU3 and OTU4 signal. An additional option is required for direct multiplexing of ODU3 into OTU4. Applications for TCM, delay, and service disruption, and others. Full monitoring and alarm and error injection at each layer, as appropriate.

OTN multistage multiplexing (BN 3061/94.62)

OTN multistage multiplexing allows for multiple levels of multiplexing into the OTU3 and OTU4 (for example, ODU1 into ODU2 into OTU3) and applications for TCM, delay, and service disruption, and others. Full monitoring and alarm and error injection at each layer, as appropriate.

ODU0 bulk (BN 3061/94.63)

Enables the use of an ODU0 client with PRBS payload in the above multiplexing schemes.

ODUflex bulk (BN 3061/94.64)

Enables the use of an ODUflex client with PRBS payload in the above multiplexing schemes.

ODU0 with SDH/Sonet client (BN 3061/94.65)

This feature maps an STM-1/STS3 or STM-4/STS12 signal into an available ODU0

ODU1/2 with SDH/SONET client (BN 3061/94.66)

This feature maps a 2.5 G SDH/SONET client into OPU1/ODU1 and a 10G SDH/SONET client into OPU2/ODU2 for further multiplexing into the outgoing OTU3 or OTU4 signal. It also provides simultaneous ODU and SDH/SONET testing. To simulate real-world traffic, it supports GMP stuffing of an SDH/SONET client in the transmit direction and receive direction measurements.

OTN 10G Ethernet client mapping (BN 3061/94.68)

This option generates a 10G Ethernet signal used to map 10GBase-R traffic into ODU2e for multiplexing into OTU3, OTU3e1, OTU3e2, and OTU4 signals, depending on the instrument setup, and preserves 64B/66B line codes. It is also required for GFP-F mapping of MAC/IP into ODU1 or ODU2.

GFP-F up to 10G (BN 3061/94.77)

This option provides GFP-F test capability up to 10G. It can work with a 1 GE client (3061/94.70) to test GE with GFP-F into ODU0, and a 10GE client (3061/94.68) to test MAC/IP with GFP-F into ODU1, and MAC/IP with GFP-F into ODU2.

GFP-F up to 43G (BN 3061/94.67)

This option provides GFP-F test capability up to 43 G. It can work with a 1 GE client (3061/94.70) to test GE with GFP-F into ODU0, a 10GE client (3061/94.68) to test MAC/IP with GFP-F into ODU2, and a 43GE client (3061/94.51) GFP-F mapped into ODU3.

OTN GFP-F up to 100G (BN 3061/94.78)

This option provides GFP-F test capability (up to 100G), It can work with a 100GE client, GFP-F mapped into ODU4 or lower rate ODUs. Works in single port mode only, does not include GMP mapped 100GE into OTU4 (3061/94.53).

Transparent 10GE GFP-F mapping (BN 3061/94.69)

This option allows to map a PCS transparent 10G Ethernet signal into an available ODU2, using the Generic Framing Procedure / Framed (GFP-F). This method is also known as "AMCC mapping". Requires at least 10G GFP-F support (BN 3061/94.77).

1GE client (BN 3061/94.70)

This option enables GigabitEthernet as a client to ODU0 via the Generic Framing Procedure – Transparent (GFP-T). The ODU0 bulk option and appropriate muxing structures are required.

The GE client also can be mapped into ODU0 via GFP-F when one of these GFP-F options is available: 3061/94.77 (GFP-F up to 10G), 3061/94.67 (GFP-F up to 40G), or 3061/94.78 (GFP-F up to 100G).

40G SDH/SONET

Adds full 40G SDH/SONET functionality and STL-256 BERT line rate will work in single and dual port mode.

For details on the capabilities of SDH/SONET, please see the generic SDH/SONET layer description. Can be combined with 3061/94.76:

SDH/SONET client in ODU3/OTU3 (BN 3061/94.76)

40G SDH/SONET mapping into into ODU3/OTU3.

Full testing access to SDH/SONET and OTN features

OTN control plane enhancement (BN 3061/94.81)

This option enables capturing and transmitting HDLC traffic in the OTU3 or OTU4 GCC channels (GCC0, GCC1, GCC2, or GCC1+2).

In addition, enables full MFAS synchronous access to the OTU overhead bytes, and allows drop&insert of external GCC traffic

OTN Enhanced Overhead Manipulation (BN 3076/94.87)

This option adds powerful additional capabilities to manipulate and overwrite the internally generated or passed-through TX OTU/OPU/ODU overhead of the OTN Layer. It is fully additional to the existing static Overhead, TTI, alarm & error insertions. Already available error/ alarm insertion features may be used in parallel.

This adds a broad range of capabilities, such as (but not limited to): SAPI/DAPI trace errors and replacements; additional insertion of errors / alarms in parallel to the main error / alarm insertion.

It allows to test specific alarm/error transitions, e.g. in the GCC channels, the OSMC channel or the MFAS. Allows JC-byte manipulation (to test specific GMP mapping-errors). Up to 4 different Overhead bytes can be manipulated concurrently in single, M in N or repetitive modes, using flexible bit masks.

ODU Multichannel (BN 3061/94.73)

The OTN multichannel option enables in-depth, parallel analysis of up to 32 individual channels (ODU0) in an OTU3 or OTU4, depending on enabled options. This powerful analysis application helps end users develop, troubleshoot, and validate complex OTN applications, such as cross-connects.

Users can build signal structures and select a wide range of channel types, such as ODU0s through ODUflex to ODU2e, with a fully monitored and generated bandwidth up to 40G. Each channel has comprehensive high-resolution monitoring to fully control alarm and error generation.

10x10G ODU Multichannel (BN 3076/94.92)

The OTN multichannel option enables in-depth, full bandwidth parallel analysis of up to 10 individual channels (ODU2) in an OTU3 or OTU4, depending on enabled options. This powerful analysis application helps end users develop, troubleshoot, and validate complex OTN applications, such as cross-connects.

Each channel has comprehensive high-resolution monitoring to fully control alarm and error generation. Options 94.73 and 94.92 can be combined to achieve full bandwidth multi-channel test capabilities in a mixed mapping environment.

SDH/SONET client in ODU3/OTU3 (BN 3061/94.76)

Available 40G SDH/SONET can be mapped into ODU3/OTU3 structure. Full testing access to SDH/SONET and OTN features

40GE transcoded in ODU3/OTU4 (BN 3061/94.80)

Mapping of a transcoded 40G Ethernet signal into ODU3/OTU4

OTN Multistage Muxing via ODU3-OTU4 (BN 3061/94.82)

Mapping of lower rate ODU containers into ODU3-OTU4

100G MPLS/IP Client into OTN (BN 3061/94.83)

MPLS/P 100G client can be mapped into OTU4 via GFP-F (requires 94.78)

100G Ethernet D&I from ODU4/OTU4 (BN 3061/94.90)

Dual port option: allows to drop a 100G Ethernet signal from an OTU4, and to insert an external 100GE signal into an OTU4 control alarm and error generation. Options 94.73 and 94.92 can be combined to achieve full bandwidth multi-channel test capabilities in a mixed mapping environment.

List of available OTN Stacks

The OTN features on the 40/100G platform have considerable breadth and depth, the range of options lets users scale applications to meet their needs.

Some of the optional applications depend upon other options being installed, most of the stacks will run on both ports of the CFP2 Module. The following table shows available stacks for dual port and single port modes. If in doubt please consult your Viavi representative.

List of available OTN mappings. See order information section for details on options needed

OTL3-BERT, OTL3-OTN-BERT

OTL3-OTN-LAN-40GigE

OTL3-OTN-GFPF Ethernet *)

OTL3-OTN-ODU-BERT

OTL3-OTN-ODU-ODUflex BERT

OTL3-OTN-ODU-Multichannel BERT *)

OTL3-OTN-ODU2e-10GigE

OTL3-OTN-ODU0-GFPF 1GigE

OTL3-OTN-ODU-GFPF Ethernet

OTL3-OTN-ODU2-GFPF PCS Ethernet

OTL3-OTN-ODU-ODUflex GFPF Ethernet

OTL3-OTN-ODU-SONET/SDH BERT

OTL3-OTN-ODU-ODU BERT

OTL3-OTN-ODU-ODU0-GFPF 1GigE

OTL3-OTN-ODU-ODU-GFPF Ethernet

OTL3-OTN-ODU-ODU-SONET/SDH BERT

OTL3-OTN-ODU2-ODU1-ODU0 BERT

OTL3-OTN-ODU2-ODU1-ODU0-GFPF 1GigE

OTL3-OTN-ODU2-ODU1-ODU0-GFPF Ethernet

OTL3-OTN-ODU2-ODU1-ODU0-SONET/SDH BERT

OTL3-OTN-SONET/SDH BERT

OTL4-BERT, OTL4-OTN BERT

OTL4-OTN-100GigE

OTL4-OTN-GFPF Ethernet *)

OTL4-OTN-ODU-BERT

OTL4-OTN-ODU-ODUflex BERT

OTL4-OTN-ODU-Multichannel BERT [40G or 100G Bandwidth] *)

OTL4-OTN-ODU2e-10GigE

OTL4-OTN-ODU0-GFPF 1GigE

OTL4-OTN-ODU-GFPF Ethernet

OTL4-OTN-ODU2-GFPF PCS Ethernet

OTL4-OTN-ODU-ODUflex GFPF Ethernet *)

OTL4-OTN-ODU-SONET/SDH BERT

OTL4-OTN-ODU-ODU BERT

OTL4-OTN-ODU-ODU0-GFPF 1GigE

OTL4-OTN-ODU-ODU-GFPF Ethernet

OTL4-OTN-ODU-ODU-SONET/SDH BERT

OTL4-OTN-ODU2-ODU1-ODU0 BERT

OTL4-OTN-ODU2-ODU1-ODU0-GFPF 1GigE

OTL4-OTN-ODU2-ODU1-ODU0-GFPF Ethernet

OTL4-OTN-ODU2-ODU1-ODU0-SONET/SDH BERT

OTL4-OTN-ODU3 BERT

OTL4-OTN-ODU3-40GigE

OTL4-OTN-ODU3-GFPF Ethernet *)

OTL4-OTN-ODU3-SONET/SDH

OTL4-OTN-ODU3-ODU BERT

OTL4-OTN-ODU3-ODUflex BERT

OTL4-OTN-ODU3-ODU-SONET/SDH BERT

OTL4-OTN-ODU3-ODU-ODU BERT

OTL4-OTN-ODU3-ODU-ODU-SONET/SDH BERT

OTL4-OTN-ODU3-ODU2-ODU1-ODU0 BERT

OTL4-OTN-ODU3-ODU2-ODU1-ODU0-SONET/SDH BERT

40G SDH/SONET BERT

*) single port only

SDH/SONET Testing

Specification SDH Client

The specification describes the capabilities of the SDH/SONET layer for the native 40G STL-256 signal as well as for mapped SDH/SONET into the appropriate OTN structures, in particular:

40G STL-256 native
 40G SDH/SONET (STM-256 or STS768) mapped into ODU3
 STM-1/STS3, STM-4/STS-12 mapped into ODU0
 STM-16/STS48 mapped into ODU1
 STM-64/STS192 mapped into ODU2

Mappings

AU-3/VC-3, VC-4, VC-4-4c, VC-4-16c, VC-4-64c

Generation of Pointer actions

- Pointer sequences with programmable spacing
- Pointer increment/decrement (continuously repeated)
- Single pointer
- Pointer value setting with or without NDF
- Offset simulation

Contents of SOH and POH bytes

The content of all bytes is programmable with any byte or a user defined byte-sequence p in m

in n (p frames in m frames and the entire sequence repeated n times) can be inserted, with the exception of B- and H-Bytes.

SOH Capture

Single Byte and Double Byte

Capture depth: 512 value changes

Trace identifier

J0, J1, J2	programmable 16/64 byte ASCII sequence with CRC
------------	-------------------------------------------------

Error insertion and measurements

Error types	B1, B2, B3 parity errors, FAS errors, MS-REI, HP-REI, bit errors in test pattern
-------------	----------------------------------------------------------------------------------

Error Insertion Modes

Single, Rate, Single Burst and Continuous Burst

Alarm generation and measurements

Alarm types	LOF, RS-TIM, MS-AIS, MS-RDI, AU-AIS, AU-LOP, HP-UNEQ, HP-PLM, HP-RDI, HP-RDI-C, HP-RDI-S, HP-RDI-P
-------------	----------------------------------------------------------------------------------------------------

Alarm Insertion Modes	Continuous, Single Burst and Continuous Burst
-----------------------	-----------------------------------------------

Test patterns and measurements

PRBS11, -15, -23, -31 and inverted, 32 Bit DW

Service disruption

Number of disruption, first and last disruption, shortest and longest disruption

Disruption Resolution 0.1 ms

Specification SONET Client

Mappings

STS-1 SPE, STS-3c SPE, STS-12c SPE, STS-48c SPE, STS-192c SPE

Generation of Pointer actions

- Pointer sequences with programmable spacing
- Pointer increment/decrement (continuously repeated)
- Single pointer
- Pointer value setting with or without NDF
- Offset simulation

Contents of TOH and POH bytes

The content of all bytes is programmable with any byte or a user defined byte-sequence p in m

in n (p frames in m frames and the entire sequence repeated n times) can be inserted, with the exception of B- and H-Bytes.

TOH Capture

Single Byte and Double Byte

Capture depth: 512 value changes

Trace identifier

J0, J1, J2	programmable 16/64 byte ASCII sequence with CRC
------------	-------------------------------------------------

Error insertion and measurements

Error types	B1, B2, B3 parity errors, FAS errors, MS-REI, HP-REI, bit errors in test pattern
-------------	----------------------------------------------------------------------------------

Error Insertion Modes

Single, Rate, Single Burst and Continuous Burst

Alarm generation and measurements

Alarm types	LOF, TIM-S, AIS-L, RDI-L, AIS-P, LOP-P, UNEQ-P, PLM-P, RDI-P, RDI-P-C, RDI-P-S, RDI-P-P, PDI-P
-------------	------------------------------------------------------------------------------------------------

Alarm Insertion Modes	Continuous, Single Burst and Continuous Burst
-----------------------	-----------------------------------------------

Test patterns and measurements

PRBS11, -15, -23, -31 and inverted, 32 Bit DW

Pointer generation

Increment, Decrement, Sequence; Single, Periodic, Alternating

Service disruption

Number of disruption, first and last disruption, shortest and longest disruption

Disruption Resolution 0.1 ms

100G/40G CFP2 Based Modules and Options

Ordering Information

BN (Part#)	Description	Comments
<i>Modules</i>		
3076/92.80	CFP2 100G/111G Phy / Data Single Port	CFP2 PHY single port module, includes native 100GE, can be upgraded to 40GE and OTU4 and physical layer options
3076/92.83	CFP2 100G/111G Phy / Data Dual Port	CFP2 PHY module with additional data port, includes native 100GE, can be upgraded to 40GE and OTU4 and physical layer options
3076/92.82	CFP2 100G/111G Data Single Port	CFP2 Single Port Data module, includes native 100GE, can be upgraded to 40GE and OTU4
3076/92.81	CFP2 100G/111G Data Dual Port	CFP2 Dual Port Data module, includes native 100GE, can be upgraded to 40GE and OTU4
3076/21	ONT-602 CFP2-S Mainframe	CFP2 Single Port Data point solution, includes native 100GE, all CFP2 Data Module options except D&I can be added
3076/22	ONT-602 CFP2-D Mainframe	CFP2 Dual Port Data point solution, includes native 100GE, all CFP2 Data Module options, including D&I, can be added
3076/92.84	CFP2 25G Data Dual Port	CFP2 Dual Port Data module, includes native 25GE (94.37), can be upgraded to 40GE , 100GE and OTU4
3076/92.85	CFP2 25G Data Single Port	CFP2 Single Port Data module, includes native 25GE (94.37), can be upgraded to 40GE, 100GE and OTU4
3076/92.86	CFP2 40G Data Dual Port	CFP2 Dual Port Data module, includes native 40GE (94.51), can be upgraded to 25GE, 100GE and OTU4
3076/92.87	CFP2 40G Data Single Port	CFP2 Single Port Data module, includes native 40GE (94.51), can be upgraded to 25GE, 100GE and OTU4
3076/23	ONT-602 25G CFP2-S Mainframe	CFP2 Single Port Data point solution, includes native 25GE (94.37), all CFP2 Data Module options except D&I can be added
3076/24	ONT-602 25G CFP2-D Mainframe	CFP2 Dual Port Data point solution, includes native 25GE (94.37), all CFP2 Data Module options, including D&I, can be added
3076/25	ONT-602 40G CFP2-S Mainframe	CFP2 Single Port Data point solution, includes native 40GE (94.51), all CFP2 Data Module options except D&I can be added
3076/26	ONT-602 40G CFP2-D Mainframe	CFP2 Dual Port Data point solution, includes native 40GE (94.51), all CFP2 Data Module options, including D&I, can be added

BN (Part#)	Description	Comments
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"Physical Layer Options (for 3076/92.80 and 92.83 only):"

Software Options

3076/94.31	CFP2 Advanced Error Analysis	advanced bit error analysis, requires 94.30, runs on port 1 only
3076/94.32	CFP2 Dynamic Skew Variation	inserts dynamic lane skew, requires 94.30, runs on port 1 only
3076/94.33	CFP2 Jitter Injection	allows to insert jitter via electrical adapter, requires 94.30, runs on port 1 only
3076/94.34	CFP2 User Entered Bitrate 25 Gb/s to 28 Gb/s	unframed testing at any rate from 25.3 to 28.05 Gb/s, requires 94.30, runs on one or 2 ports

Hardware Options / Accessories

3076/92.90	CFP2 4x25G Electrical Adapter	electrical access to 4x25 interface. Includes 4 times K1002. Will only work in Port 1 of ONT CFP2 Phy modules
K1001	Cable for External CFP2 MDIO Control	needed to transfer MDIO signals to external eval board
K1002	Spare Cable assembly for CFP2 Electrical Adapter	8 coax cable assembly as spare for 3076/92.90

Dual Port Options (only available for 3076/92.81, 3076/92.83, 3076/22):

Software Options

3061/94.90	100G Ethernet D&I from ODU4/OTU4	requires 3076/92.81 or 83 or 3076/22 and 3061/94.53
3061/94.91	40G Ethernet D&I from ODU3/OTU3	requires 3076/92.81 or 83 or 3076/22 and 3061/94.60
3076/94.40	100G/40G OTN Enhanced Muxing for 2nd Port	requires 3061/94.61
3076/94.41	100G/40G Ethernet Client for 2nd port	allows to have Ethernet client inside muxed structure on 2nd port (if available on 1st port); requires 3076/94.40 and at least one of 94.68, 69 or 70
3076/94.42	100G/40G SDH/Sonet Client for 2nd port	allows to have SDH/SONET client inside muxed structure on 2nd port (if available on 1st port); requires 3076/94.40 and at least one of 94.65 or 66

BN (Part#)	Description	Comments
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Options for all 100G CFP2 Modules (not for ONT-602)

Software Options

3061/94.84	IEEE 1588 V2 PTP Master/Slave Evaluation	will work on one or two ports; not available for ONT-602 (3076/22)
3061/95.98	External Wander Analysis	Windows SW for in-depth MTIE/TDEV/FFO/FFD analysis of imported TIE data from any ONT J/W card
3061/95.99	Packet Data Add-On for Wander Analysis	adds IEEE 1588 based analysis of packet data to 3061/95.98

Options available for all CFP2 Modules and all ONT-602 CFP2 Versions:

only one SW option required to enable functions on both ports of a dual port unit unless stated otherwise (restrictions may apply)

Software Options

3076/94.30	CFP2 Hardware Validation	allows static skew analysis and MDIO/I ² C access (runs on port 1 only)
3076/94.35	SR4 FEC Validation	in-depth test and validation of SR4 FEC (runs on port 1 only. Basic SR4-FEC support available on 2 ports, no special option required)
3076/94.36	MLG 1.0 Support	no prerequisites (runs on port 1 only)
3061/94.50	100G Ethernet	adds 100GE to 3076/23, 24, 25, 26 or 3076/92.84, 85, 86 and 87 (single and dual)
3061/94.51	40G Ethernet	adds 40GE to 92.8x, activates QSFP+ connector (single and dual)
3076/94.37	25G Ethernet	adds basic 25GE functions (single and dual)
3076/94.38	25GE RS-FEC and Base-R FEC	adds FEC support, requires 3076/94.37 (single and dual)
3076/94.39	25GE FEC Validation	adds in-depth FEC evaluation features, requires 3076/94.38 (single and dual)
3076/94.43	50G Ethernet	adds basic 50GE functions (runs on port 1 only)
3076/94.44	50GE FEC Validation	adds in-depth FEC evaluation features, requires 3076/94.43 (runs on port 1 only)
3061/94.54	Multistream / IP	adds IP and multistream (up to 256) capability (single port: full feature, limited # of flows in mapped dual port mode)
3076/94.89	ESMC G.8264	generates and emulates ESMC SyncE messages

BN (Part#)	Description	Comments
3061/94.55	111G OTN Bulk	adds 111.8G OTU4 with bulk client (single and dual)
3061/94.57	100G/40G OTU3 bulk	adds 43G OTU3 bulk to 94.51 (single and dual)
3061/94.58	100G/40G OTU3e1 bulk	adds 44.57G OTU3e1 bulk (single and dual) to 94.57
3061/94.59	100G/40G OTU3e2 bulk	adds 44.58G OTU3e2 bulk (single and dual) to 94.57
3061/94.61	100G/40G OTN Enhanced Multiplexing	adds single stage multiplexing to 94.57 or 94.55, dual port needs 94.40
3061/94.62	100G/40G OTN Multistage Multiplexing	adds multi stage multiplexing to 94.61 (not into ODU3 -> OTU4), dual port needs 94.40
3061/94.63	100G/40G OTN ODU0 bulk	adds ODU0 with bulk to 94.61, dual port needs 94.40
3061/94.64	100G/40G OTN ODUFlex bulk	adds ODUFlex with bulk to 94.61, dual port needs 94.40
3061/94.73	100G/40G OTN ODU Multichannel	adds ODU Multichannel to 3061/94.55 or 94.57 (runs on port 1 only)
3076/94.92	100G/40G OTN 10x10G ODU Multichannel	adds ODU Multichannel with full 10 * 10G bandwidth to 3061/94.55 (runs on port 1 only)
3061/94.81	100G/40G OTN Control Plane enhancements	allows PPP D&I and analysis of payload HDLC frames in GCC bytes, requires 94.55 or 57 (runs on port 1 only)
3061/94.82	100G/40G OTN Multistage Muxing via ODU3-OTU4	enables multistage muxing into ODU3-OTU4, requires 94.61 and 62, dual port needs 94.40
3076/94.87	100G/40G OTN Enhanced Overhead Manipulation	fully flexible multiframe access to OTU Overhead bytes, requires 94.55 or 57, dual port needs 94.40
3076/94.88	100G/40G OTN OSMC Analysis	adds capability to analyse OTN Synchronization Messaging Channel; requires 94.55 or 57, dual port needs 94.40
3061/94.77	100G/40G OTN GFP-F up to 10G	adds GFP-F mapped Ethernet functionality (up to 10G bandwidth), requires 94.55 or 57. Can be combined with 94.64 (ODUFlex) and 94.61 (Muxing)
3061/94.67	100G/40G OTN GFP-F up to 43G	adds GFP-F mapped Ethernet functionality (up to 43G bandwidth), requires 94.55 or 57, includes 94.77, can be combined with 94.64 (ODUFlex). Port 1 only
3061/94.78	100G/40G OTN GFP-F up to 100G	adds GFP-F mapped Ethernet functionality (up to 100G), requires 94.55, includes 94.67 and 94.77. Does not include 94.53. Port 1 only

BN (Part#)	Description	Comments
3061/94.53	100G/40G OTU4 with Client	adds capability to map 100G Ethernet via GMP into OTU4, requires 3061/94.55; will also run on 2nd port of 2 port modules
3061/94.60	100G/40G OTU3 with Client via transcoding	adds capability to map 40G Ethernet / transcoded / requires 94.57, dual port needs 94.41
3061/94.80	100G/40G OTN 40GE transcoded in ODU3/OTU4	40GE transcoded Ethernet into ODU3/OTU4, requires 94.55, 61, dual port needs 94.40 and 41
3061/94.68	100G/40G OTN 10G Ethernet	adds 10GE PCS mapped into ODU2e into available OTU3/OTU3e1/OTU3e2 or OTU4 , requires 94.55 or 57, and 61; dual port needs 94.40 and 41
3061/94.69	100G/40G OTN Transparent 10GE GFP-F mapped	adds PCS transparent, GFP-F mapped 10G Ethernet (AMCC Mapping) into available ODU2, also requires 94.77; dual port needs 94.40 and 41
3061/94.70	100G/40G 1 GigE client	GigE via GFP-T into ODU0, requires 94.55 or 57, 61, and 63; dual port needs 94.40 and 41
3061/94.83	100G/40G OTN 100G MPLS/IP Client	requires 94.78 (GFP-F) and 94.55 (OTU4 Bulk), runs on port 1 only
3061/94.72	40G SDH/SONET	adds 40G SDH/SONET and STL-256 BERT line rate to 3061/94.51, both single and dual mode
3061/94.76	100G/40G OTN SDH/SONET client in ODU3/OTU3	40G SDH/SONET into ODU3/OTU3 , requires 94.57, dual port needs 94.40 and 42
3061/94.79	100G/40G OTN SDH/SONET client in ODU3/OTU4	40G SDH/SONET into ODU3/OTU4, requires 94.55, 61, 82; dual port needs 94.40 and 42
3061/94.65	100G/40G ODU0 with SDH/SONET Client	adds SDH/SONET client in ODU0 to 94.63, dual port needs 94.40 and 42
3061/94.66	100G/40G ODU1/2 with SDH/SONET Client	adds SDH/SONET client (concatenated or structured) in ODU1/2 to 94.61 or 94.62, dual port needs 94.40 and 42

BN (Part#)	Description	Comments
<i>Hardware Options / Accessories</i>		
3076/92.91	CFP2 100G LR4	CFP2 100G LR4 Multi Rate Transponder
3076/92.92	CFP2 to CFP4; 4x25/28G; Passive Adapter	allows to operate a 4 by 25/28G CFP4 transponder inside an ONT-600 CFP2 Module slot
3076/92.93	CFP2 to QSFP28; 4x25/28G; Active Adapter	allows to operate a 4 by 25/28G QSFP28 transponder inside an ONT-600 CFP2 Module slot (will also work in available 2nd port)
3061/92.93	QSFP 40G LR4 Multi Rate Transponder	40G QSFP+ Transponder
3076/92.94	CFP2 4x25G Basic Electrical Adapter	basic electrical access to 4x25 interface (no jitter insertion, no clock I/O). 2 adapters can work in parallel on ports 1 and 2. Cables not included.
3076/92.96	QSFP28 SR4 Multi Rate Transponder	SR4 Multi Rate Transponder, 850 nm Multimode, MPO
3076/92.98	CFP2 to SFP28 Active Adapter	allows to operate an SFP28 transponder inside an ONT-600 CFP2 Module slot



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