

Data Sheet

VIAVI FlexE Testing

SW Options for ONT-800 CFP8, QFLEX and 800G FLEX Modules

Launch FlexE products faster. ONT FlexE Software Options help to ensure ecosystem interoperability, deliver reliable performance, and accelerate product validation.

FlexE is a homogenous way for Network Managers to deliver flexible high-speed Ethernet services and enable software defined networks (SDN).

The ONT FlexE test application allows thorough design and verification testing of the FlexE Shim logic including FlexE Calendar, FlexE Management Channels, Overhead protocol functions and FlexE Clients configuration and performance.



800G FLEX Module. Order Number 402-002.01



CFP8 QFLEX Data Module. Order Number 3076/92.65

Benefits and Features

- QSFP28 test interfaces
- 4 clients over 4 x 100GBASE-R PHY and 4 x 50GBASE-R PHY
- OIF IA FlexE 2.1
- Clients include N x 5G, 10G, 25G, 40G, 50G, 75G, 100G
- Application for 100G to 400G client testing with N x 5G client size
- Calendar configuration for FlexE Bonding, Sub-Rate and Channelization client setup
- FlexE Shim Alarm Error testing to check FlexE Overhead Frame and Overhead Multi-frame lock
- FlexE Management Channel Test with Transparency Check and Packet Capture
- FlexE Overhead Manipulation
- Port-to-port skew
- MAC client rate utilization and QoS



FlexE Test Introduction

FlexE is an Implementation Agreement defined by the Optical Internetworking Forum (OIF) to address the need for more flexible and scalable bandwidth serving high speed Ethernet rates. FlexE evolved out of earlier technologies such as Link Aggregation (LAG) and Multi-Link Gearbox (MLG). It provides functionality for Channelization, Bonding and Subrating applications to connect one or more Ethernet MACs using standard Ethernet PMDs between routers. Routers can be connected directly or through transport gear as illustrated in the three examples in Figure 1.



Figure 1. Examples for FlexE use cases with 100GBASE-R PHYs include Bonding, Channelization and Sub-Rating with Transport Network Equipment in FlexE Terminate, FlexE Aware and FlexE Unaware operation modes. In essence, FlexE dissociates the Ethernet on the MAC client side from the actual physical interface as illustrated in Figure 2. The following illustration shows clients can be mapped across multiple PHYs through the 20 slots in sub-calendar per PHY.



Figure 2. Enhanced Ethernet Layer model with FlexE Shim with example for 100GBASE-R PHY

The OIF FlexE 2.1 Implementation Agreement allows FlexE Groups composed of 50GBASE-R, 100GBASE-R, 200GBASE-R and 400GBASE-R PHYs. This is accomplished through the concept of a "100G FlexE Instance for 100GBASE-R, 200GBASE-R and 400GBASE-R PHYs." The 200GBASE-R PHY is populated as two and the 400GBASE-R PHY as 4 x 100G FlexE Instances as illustrated in Figure 3, each with its own FlexE Overhead structure including Sub-Calendar. A 50G FlexE Instance carries 1x50GBASE-R PHY.



Figure 3. 100G FlexE Instance, in addition OIF IA FlexE 2.1 introduces the concept of a 50G FlexE Instance for 50GBASE-R PHYs

FlexE Use Cases

FlexE is an important building block for SDN networks as it allows network managers to adjust the network configuration by adding or removing clients from the service for typical use cases as shown in Table 1.

Segment	Use Case	Benefit
Operators	Flexible Ethernet Services	Enables SDN with lower cost per bit and new attractive Services and efficient restoration capabilities
Data Center Interconnect (DCI)	Carrier Ethernet Router to high-speed optical Transport networks	Full rate utilization of existing transport network
Intra-Data Center	Using high capacity circuits	Cost efficiency. Using available 100GE PMDs. Standardization independent
Mobile 5G	Network slicing in 5G Midhaul / Backhaul	Discrete channelization in Ethernet

Table 1. Typical FlexE use cases

FlexE Test Application

IC vendors, network equipment manufacturers and network operators need a test environment to validate and verify FlexE protocol mechanisms that span across multiple MAC clients and PHYs. Table 2 summarizes key ONT FlexE test functions.

FlexE Test Case	What needs to be tested?
Calendar Client Setup	Setup of multiple clients with different client sizes to support applications for bonding, channelization and sub-rating.
RX PHY and Calendar Map	PHY Map for entire FlexE Overhead Multi-frame and Sub-calendar map per time slot and associated client number.
FlexE Alarms and Errors	VIAVI ONT test set provides unique FlexE Shim Alarm and Error tests that help analyze FlexE Overhead logic and interoperability between network elements.
FlexE Overhead Manipulation	User manipulation of any bit in the FlexE Overhead and Overhead Multi-frame to provoke unusual configuration, device and network conditions.
FlexE Management Channel	FlexE Management Channel transparency and user defined bit loading in the Section-to-Section and Shim-to-Shim and optional Synchronization Messaging Channel.
Port Skew	Skew between PHYs because a PHY skew that is too high might prevent the payload from being reconstructable.
64B/66B Reconciliation	64B/66B Block analysis per FlexE client. Including Local and Remote Fault.
MAC / IP	FlexE MAC client rate, utilization, QoS, errors.

Table 2. ONT FlexE key test functions

FlexE Shim Alarms and Errors

The ONT FlexE test application introduces specific FlexE alarms and errors as listed in Table 3. Local Fault (LF) as defined in the OIF FlexE implementation agreement is presented on the ONT 64B/66B layer together with Remote Fault.

Test Metric	Туре	Use Case
LOGA (Loss of Group Alignment)	Alarm	Indication that payload cannot be reconstructed.
Summary GNM (GIDM)	Alarm	Summary GNM alarm. Asserted if any instance has GNM. GIDM is in accordance with ITU-T G. 798 definition.
EPS (Excessive Port Skew)	Alarm	Skew between PHYs exceeding defined threshold
Group Numbers Inconsistent	Alarm	Accepted FlexE group numbers are not identical across the group.
Instance Numbers Inconsistent	Alarm	Accepted 100G FlexE Instance numbers do not match the accepted FlexE Map map on one or more 100G FlexE Instances.
FlexE Maps Inconsistent	Alarm	Accepted FlexE Maps are not identical across the group.
Calendar in Use Inconsistent	Alarm	Accepted "Calendar in use" does not match across the group.
LOF (Loss of FlexE Overhead frame)	Alarm	Loss of FlexE Overhead frame. Definition acc. ITU-T G. 798 (3 ms).
LOM (Loss of Multiframe)	Alarm	Loss of FlexE Overhead Multi-frame. Definition acc. ITU-T G. 798 (10 ms timer).
RPF (Remote PHY Fault) – OIF	Alarm	Inform far-end shim of locally detected failure of the PHY.
Unequipped Instance (PHY# for 100G)	Alarm	Enable/disable Unequipped Instance detection. Note, not supported for 100GBASE-R PHYs.
OOF (Out-of-frame)	Alarm	FlexE Overhead Frame mismatches on the sync header, control block typ or O code field for 5 occurrences.
OOM (Out-of-multiframe)	Alarm	Two consecutive FlexE Overhead Frames with failure to the expected OMF bit transition although good CRC.
GNM (Group Number Mismatch)	Configuration Alarm	Accepted group number does not match the Rx configured value.
Instance Number mismatch (INM)	Configuration Alarm	Accepted FlexE 100G Instance number does not match the RX configured value.
FlexE Map Mismatch (FMAPM)	Configuration Alarm	Accepted FlexE Map does not match the enabled PHYs.
CM (Calendar Mismatch)	Configuration Alarm	TX/RX calendar in use don't match.
CCM (Calendar configuration Mismatch)	Configuration Alarm	"Accepted calendar" of the "Accepted calendar in use" is different from the configured "RX calendar" of the "RX calendar in use".
Synchronization Configuration Mismatch	Configuration Alarm	Synchronization Configuration bit mismatch.
OH Block #1 Error	Error	Overhead anchor block error.
CRC-16 Error	Error	CRC-16 to protect FlexE overhead. FlexE Map values are only accepted from overhead frames with good CRC.
C-Bit Error	Error	3 x C-Bit in majority vote define the Calendar in Use.

FlexE Management Channel Test

The IA OIF-FLEXE-02.1 supports two optional Management Channels and an optional Synchronization Messaging Channel. Use cases for Management Channels include (not exclusive):

- Management Channel Enabling FlexE Aware use cases with sub-rating towards a FlexE Aware node
- Shim-to-Shim Management Channel possible application is LLDP
- Synchronization Messaging Channel can be used to carry PTP and/or SSM messages

The use of the different Management Channels is vendor specific. The only constraint is compliance of every 66B block as legal format according to IEEE 802.3 clause 82.

The ONT FlexE Management Channel Test Application includes a Transparency Check with Idle, User Data and Transparency Test pattern payload as per Table 4 and Alarm and Errors as defined by Table 5.

For additional troubleshooting of the Management Channels, the received 66B blocks according to the IEEE 802.3 clause 82.2.3 can be captured to a file.

Channel	Transparency Check Payload Pattern
Section Management Channel	PRBS31
Shim-to-shim Management Channel	PRBS31 inverted
Synchronization Message Channel	PRBS23

Table 4. ONT FlexE Management Channel Transparency Check payload pattern

VIAVI	ONT-600 400G CF	P8 PHY Module 3076	92620B0070 Port	Location: ONT-606 DC-0 1 Application: New-Applica	017 Slot 4-6.1 10.49.16.25 Module Time: 10 tion Disk: 3.3GE	0:57 AM CEST I of 7.2GB free
All Layers OK	FlexE Config. Rx Status Overview	Errors / Alarms Sta	tistics 66B Data	Capture Transparency Ch	eck Packet Capture	0
Prev. Layer FlexE Shim LOGA LOF	Rx Accept. FlexE Map Rx Accept. Calendar	PHY# 1	S			
COP DAMA PFF UNEQ GNM GNM FAAPH FMA FM FAAPH FAA	Alarms PX Errors/ PX Errors/ Alarms TX Errors/ Alarms TX User Cverhead TX User Cverhead TX User Channels RX Mngmt. Channels RX Port Skew Help	Channel Alarms	Seconds s s s s s s s	Channel Errors Section ISH S2S ISH (SMC ISH)*	Count	
F Insertion	Lase	r		C Elapsed:	00d 00h 00m 00s of Continuous	Start

Figure 4. FlexE Management Channel Transparency Check with Bit Error per Management Channel

Test Metric	Туре	Use Case
Section LOBL (Section Management Cannel loss of block lock)	Alarm	Loss of Block Lock
S2S LOBL (Shim-to-Shim Management Channel loss of lock)	Alarm	Loss of Block Lock
SMC LOBL (Synchronization Message Channel loss of block lock)	Alarm	Loss of Block Lock
SCM (Synchronization Configuration mismatch)	Alarm	The SC bit RX value received does not match the expected RX configuration.
Section Management Channel invalid sync header	Error	Valid sync header values are 10 or 01
Shim-to-Shim Management Channel invalid sync header	Error	Valid sync header values are 10 or 01
Synchronization Message Channel invalid sync header	Error	Valid sync header values are 10 or 01
Section management channel pattern Loss	Error	Section Management Transparency Test
Synchronization message channel pattern Loss	Error	Synchronization Message Channel Transparency Test
Shim-to-shim management channel pattern Loss	Error	Shim-to-Shim Management Channel Transparency Test
Section management channel bit error	Error	Section Management Transparency Test – Bit Error Rate
Synchronization message channel bit error	Error	Synchronization Message Channel Transparency Test – Bit Error Rate
Shim-to-shim management channel bit error	Error	Shim-to-Shim Management Channel Transparency Test – Bit Error Rate

Table 5. ONT FlexE Management Channel Test Alarms & Errors

VIAVI	C	0NT-600 400G CF	PHY Module 307692620A0065 Port 1	Location: ONT-606 DA-0199 Slot 4-6.1 10.49.74.53 Application: New-Application	3 Module Time: 09:44 AM CEST Disk: 3.4GB of 7.2GB free
All		FlexE	Main Tx Clients Tx Calendar Rx C	lients Rx Calendar Management Channels	
Layers OK	PHYS ALL	Rx Status Overview Rx Accept.			A /B to Clients Rate [Gb/s] Client #
FlexE Shim	Ec	Rx Accept. Calendar	Sort Calendar by FlexE PHY Number		
	le	Rx Errors/ Alarms	Slot# 0 1 2 3 4 5 6 7 8 9 10 PHY# 1 1 1 2 2 2 2 2 2 2 2 2 2 2	11 12 13 14 15 16 17 18 19 2 3 3 3 3 3 3 3 X X X X	
RPF UNEQ GNM	M	Rx Overhead	PHY# 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	3 3 XX XX XX XX XX	Total Used: 185 Gb/s Total Unused: 115 Gb/s Total Unavail: 100 Gb/s
E EMAPM CM CCM	SH	Tx Errors/ Alarms	PHY# 4 3 3 4 4		
GNI INI FMAPI	64B/66E	Tx User Overhead	PHY# 5 NA	NA NA NA NA NA NA NA NA	
UCI LOF EV. OOF EV.	l e	Rx Mngmt Channels	Slot# 0 1 2 3 4 5 6 7 8 9 10 PHY#1 1 1 2 2 2 2 2 2 2 2 2 2 2 2	11 12 13 14 15 15 17 18 19 2 3 3 3 x x x x x x x x x x x x	
00M EV. 00H EV. 0H BI. #1 CRC-16 Err.	MAC	Channels Rx Port	PHY#2 3 3 3 3 3 3 3 3 3 3 3 3	3 3 XX XX XX XX XX	Total Used: 185 Gb/s Total Unused: 115 Gb/s
C Bit En.		Skew Tx Port	PHY#3334444	XX XX XX XX XX	Total Unavail.: 100 Gb/s
MC Alarms MC Errors		Skew Help	PHY#5 NA	NA NA NA NA NA NA NA NA	Edit →RX
				Default	→ RX
🖨 Insertion	G	A Lase		C Elapsed: 00d 00h 00m 00s of Cor	ntinuous Start

Figure 5. ONT FlexE applications with user configurable client setup into FlexE Calendar



Figure 6. ONT FlexE RX Status Overview with key Alarms and Errors

VIAVI	ONT-600 400G CF	P8 PHY Module 307692	Lo 2620A0065 Port 1 Ap	cation: ONT-606 DA- plication: New-Applic	0199 Slot 4-6.1 10.49.7 ation	4.53 Module Time: 09:49 AM CEST Disk: 3.4GB of 7.2GB free
All Layers OK Prev. Layer FlexE Shim & LOGA LOGA LOGA LOGA COF LOM RPF UNFO	400G CF FlexE Config. Rx Status Overview Rx Accept FlexE Map Rx Accept Calendar Rx Accept Alarms Rx	P8 PHY Module 307692 Overhead I I	Grp.No. 05 0000000 SH C 1000 05 0000000 SH C 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0 1000 05 0000000 01 0	PHY Map PHY No. 000000000 10 00000000 10 00000000 10 00000000	Res. SH C 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0 00000000000 01 0	Disk: 3.4GB of 7.2GB free Cal. A Cal. B CP. CA Pes CPC 10 10 0 0.0000 C476 10 20 0 0.0000 C57 20 20 0 0.0000 F633 20 20 0 0.0000 8302 20 20 0 0.0000 8302 20 20 0 0.0000 8302 20 20 0 0.0000 8302 20 20 0 0.0000 8322 20 20 0 0.0000 8322 20 20 0 0.0000 8322 20 20 0 0.0000 8322 20 20 0 0.0000 8322
GINA GINM FMAPM CM CM CM GN GN INI FMAPI UCF UCF UCF LOF EV. DON EV.	Overhead Alarms Tx User Overhead Rx Mngmt. Channels Tx Mngmt. Tx Mngmt.	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01 1000 05 0000000 01	000000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10	00000000000000000000000000000000000000	20 20 20 0 0 0000 8322 20 20 0 0 0000 8322 30 30 0 0 0000 9955 30 30 0 0 0000 9955 35 30 0 0 0000 9955 5535 65535 0 0000 0805 5535 65535 0 0000 7300 65535 65535 0 0000 7300 65535 65535 0 0000 7300 65535 6533 0 0000 7300 65535 6533 0 0000 7300 65535 6533 0 0000 7300 65536 6533 0 0000 7300 6533 6533 0 0000 7300 7 0 0 0 0000 3685
O O B = 1 O H B = 1 C CC-16 En C B En C B En SCM MC Alarms MC Alarms	Rx Port Skew Tx Port Skew Help	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	1000 05 0000000 01 1000 05 0000000 01 01 1000 05 0000000 01 01 1000 05 0000000 01 01 1000 05 0000000 01 01 1000 05 0000000 01 01 1000 05 0000000 01 01 1000 05 0000000 01 01 1000 05 0000000 01 01 1000 05 0000000 01 01 1000 05 0000000 01 01 1000 05 0000000 01 01 1000 05 0000000 01 01	00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10 00000000 10	00000000000000000000000000000000000000	0 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685 0 0 0 0000 3685
🖨 Insertion	Laser	U		C Elapsed:	00d 00h 00m 00s of	Continuous Start

Figure 7. The ONT FlexE applications allows user defined overhead bit configuration

VIAVI	C	400G CF	P8 PHY Module 307692620A0065 Port 1	Location: ONT-606 DA-0199 Slot 4-6.1 10. Application: New-Application	49.74.53 Module Time: 10:34 AM CEST Disk: 3.4GB of 7.2GB free
All Layers OK Prev. Layer FlexE Shim LOGA LOGA LOGA LOGA LOGA LOGA COM RHAPH CM CM CM CM CM CM CM CM CM CM	MAC /IP 648/668 SHIM MLD FEC PHYS ALL	FlexE Config. Rx Status Overview Rx Accept Calendar Rx Errors/ Alarms Rx Overhead Tx Errors/ Alarms Tx User Overhead Rx Mngmt Channels Rx Mngmt Channels Rx Port Skew Help	Port Skew Increment / Decrement Step Size: 1000 Bits Skew: 1000 Bits Skew: 1000 Bits	Application: New-Application Delay in Bits 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Delay Delay $\rightarrow PHY \#1$ $\rightarrow PHY \#2$ $\rightarrow PHY \#3$ $\rightarrow PHY \#4$ $\rightarrow PHY \#4$
🗲 Insertion	G	🛆 Laser	j.	C Elapsed: 00d 00h 00m 00s	of Continuous Start

Figure 8. FlexE Port-to-Port Skew Test



Figure 9. 800G FLEX Module includes 2 x QSFP-DD 400GE/PHY testing and optional FlexE using up to 4 x QSFP28 ports per portgroup.

Order number 402-002.01



Figure 10. 400G CFP8 PHY Module includes 400GE/PHY testing and optional FlexE and/or FlexO testing using the QSFP28 ports. Order number 3076/92.62



Figure 11. 400G CFP8 QFLEX DATA Module includes CFP8 slot and optional 400GE Test Application SW. QSFP28 Ports support optional FlexE or FlexO testing. Order number 3076/92.65



Figure 12. QFLEX Module with QSFP28 ports for optional FlexE and FlexO testing. Order number 3076/92.63

Software Options for FlexE testing on CFP8/QFLEX Modules

All FlexE testing over up to 4 x QSFP28 test interface.

Part Number	Description
3076/97.50	FlexE 100GBASE-R PHY with clients up to 100GE
3076/97.51	FlexE FEC Validation
3076/97.52	FlexE Management Channel Test
3076/97.53	FlexE 100GBASE-R with client 100GE to 400GE
3076/97.54	Block code Based OAM

Software Options for FlexE testing on 800G FLEX Module

All FlexE testing over up to 4 x QSFP28 test interface.

Part Number	Description
402-620.61	FlexE 4x100GBASE-R PHY with client size up to 100G - Port Group 1
402-620.62	FlexE 4x100GBASE-R PHY with client size up to 100G - Port Group 2
402-864.60	FlexE 100G Ethernet FEC Validation - Module Option
402-868.60	FlexE Management Channel Test - Module Option

Ordering Guide

The following Test Modules support FlexE testing. They all occupy 3 slots within an ONT mainframe.

Part Number	Description	Comment	Test Interface
402-002.01	800G FLEX V2 Module	400G Module with 2xQSFP-DD slot, supports optional Physical Layer testing, full support of optional electrical interface, optional FlexE/O via QSFP28 interfaces.	2xQSFP-DD, 6xQSFP56, 8xQSFP28
3076/92.62	400G CFP8 PHY MODULE	400G Module with CFP8 slot, supports optional Physical Layer testing, full support of optional electrical interface, optional FlexE/O via QSFP28 interfaces. Already includes 400GE application SW.	CFP8, 4xQSFP28
3076/92.65	CFP8 QFLEX DATA MODULE	Module with CFP8 slot and QSFP28 slots. No application SW included	CFP8, 4xQSFP28
3076/92.63	QFLEX MODULE	FlexEthernet/Flex OTN Module with QSFP28 slots. No application SW included	4xQSFP28



Contact Us +1 844 GO VIAVI (+1 844 468 4284)

To reach the VIAVI office nearest you, visit viavisolutions.com/contact.

© 2020 VIAVI Solutions Inc. Product specifications and descriptions in this document are subject to change without notice. ontflexe-ds-opt-nse-ae 30186306 904 0120