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IXIA NOVUS 25GE SPEED OPTION— INDUSTRY SPECIFICATIONS AND INTEROPERABILITY OVERVIEW

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There are two industry draft specifications that Ixia's customers are using to implement the 25-Gigabit Ethernet (25GE) speed on their network equipment that has QSFP28 or SFP28 physical interfaces.

1. IEEE P802.3by/Draft Standard version 3.2, as of 29th March 2016
2. 25G50G Consortium/Draft Specification version 1.6 as of August 18th, 2015

Currently, both draft specifications are not available to everyone in the industry. The IEEE draft standard is only open to companies and individuals that are IEEE members. The 25G50G Consortium draft specification is only available to the member companies of the 25G50G Consortium (http://www.25gethernet.org_). As a result, Ixia cannot expect every customer to have a complete set of knowledge on these emerging industry specifications. However, Ixia is a member of both organizations.

Given that the above specifications have not been ratified and the standards are continuing to evolve, Ixia anticipates that when using certain combinations of link establishment settings coupled with the physical media types chosen, there may be instances where basic interoperability between Ixia's Novus 25GE product and your device may fail to establish a link. In such scenarios, it is our experience that a joint investigation is required to identify the cause of the link failure, so our recommendation is to contact the Ixia Support organization.

This document provides two important sets of information for Ixia Novus 25GE users:

1. An overview of the fundamental interoperability requirements for 25GE operation using the current state of the 25GE industry specifications
2. How Ixia's Novus QSFP28 100GE/25GE Load Module's 25GE feature-set interworks with the industry standards

TABLE 1: 25GE AND IEEE CLAUSE RELATIONSHIPS FOR BASIC INTEROPERABILITY

LINK ESTABLISHMENT FEATURES	IEEE P802.3BY FOR 25GE	APPLICABLE TECHNOLOGY TYPES	COMMENTS
Auto-negotiation	Clause 73	25GBASE-CR 25GBASE-CR-S	FEC is requested through the auto-negotiation in the base page For copper cable, Novus 25GE sets bits A10 (25GBASE-CR) of the Technology Ability Field during auto-negotiation For cases when the DUT supports only 25GBASE-CR-S, user can override from GUI the default FEC settings to match those for 25GBASE-CR-S
Link Training	Clause 73	25GBASE-CR 25GBASE-CR-S	

LINK ESTABLISHMENT FEATURES	IEEE P802.3BY FOR 25GE	APPLICABLE TECHNOLOGY TYPES	COMMENTS
Forward Error Correction BASE-R FEC	Clause 74	25GBASE-CR 25GBASE-CR-S	The Bit Error Rate for an interconnect must operate at a pre-FEC BER of 10^{-8} or better Base-R FEC cannot correct a link with bit error rates higher than 10^{-8} FEC is advertised and requested through the auto-negotiation (base page) When BASE-R FEC is used (forced or autonegotiated) only CA-25G-S and CA-25G-N cables are supported BASE_R FEC does not operate correctly with CA-25G-L DAC cables
RS-FEC	Clause 108 (IEEE 802.3 by Draft Standard version 3.2)	25GBASE-SR4 25GBASE-CR 25GBASE-CR-S	RS-FEC for 25GE is related to Clause 108 of IEEE 802.3by Draft Standard version 3.2 The Bit Error Rate for an interconnect must operate at a pre-FEC BER of 10^{-5} or better RS-FEC operates correctly with all cable types

¹Cable assembly short (CA-25G-S): Cable assembly that supports links that operate in BASE-R FEC mode, with achievable cable length of at least 3 meters.

²Cable assembly long (CA-25G-L): Cable assembly that supports links that operate in RS-FEC mode with error correction enabled on both link partner, with achievable cable length of at least 5 meters.

Note: Cable assembly no-FEC (CA-25G-N): Cable assembly that supports links that operate in no-FEC mode, with achievable cable length of at least 3 meters.

Table 1 identified the requirements for using auto-negotiation, link training, and the different types of Forward Error Correction methods. Table 2 outlines what type of FEC is required by the current draft standard with the appropriate cable media type.

TABLE 2: FORWARD ERROR CORRECTION METHODS REQUIRED

BASEBAND MEDIUM	BASE-R-FEC SUPPORT (CL74)	RS-FEC SUPPORT (CL108)	COMMENTS
25GBASE-CR	Required	Required	Either one may be used depending on the Bit Error Rating of the copper cable assembly and the length of cable. Typically required for cables > 3 meters in length.
25GBASE-CR-S	Required		Typically required for cables <= 3 meters in length
25GBASE-SR		Required (always on)	

The Ixia Novus 25GE speed option has the following feature support for media and link establishment.

TABLE 3: FEATURE SUPPORT

NOVUS 25GE FEATURE	SUPPORT	COMMENT
Multimode Fiber, Pluggable Transceiver QSFP28-SR4	Yes	Ixia has qualified these SR4 optical transceivers: - Avago AFBR-89CDDZ - Mellanox MMA1B00-C100
Multimode Fiber Active Optical Cable (AOC) QSFP28-SR4	Yes	Ixia has qualified this SR4 AOC: Mellanox MFA1A00-C003 (3m)
Passive, Copper, Direct Attach Cable (DAC) Support	Yes	Ixia has qualified these CR4 point-to-point DACs: - Molex 100297-1301 (3m) - TE 2231368-8 (3m)
Ethernet Forward Error Correction (BASE-R FEC)	Yes, BASE-R FEC (Clause 74)	Novus supports Clause 74 BASE_R-FEC

NOVUS 25GE FEATURE	SUPPORT	COMMENT
Ethernet Forward Error Correction (RS-FEC)	Yes, RS_FEC (Clause 108)	Novus supports Clause 108 RS-FEC
Auto-Negotiation	Yes, Clause 73	Novus will auto-negotiate with a link partner that supports the IEEE P802.3by Clause or 25G/50G Consortium specification that uses the OUI Extended Next Pages with the proper OUI. Novus 25GE will automatically follow the IEEE and the 25G50G Consortium specifications when clicking the checkbox in the Port Properties of the IxExplorer GUI that is labeled "Use IEEE/Consortium Defaults" is checked ON.³
Link Training (only with copper DAC media)	Yes, Clause 93, Clause 110	Novus 25GE sends a link training pattern from Clause 93 IEEE 802.3bj. This pattern is supported by both 25G Consortium and the IEEE P802.3by. Novus 25G is capable of training to any pattern, compliant or non-compliant. During Link Training, the FIR taps (pre, main and post) are greyed out and cannot be edited by the user. Once the Link Training is complete, the values of the FIR taps from the GUI will not reflect the values computed during the training.
NOVUS 25GE FEATURE	SUPPORT/COMMENT	
Forward Error Correction Statistics	Yes	
FC-FEC Corrected Block Count	A BASE-R FEC block is 2112 bits of information, independent of frame boundaries; a FEC block may encapsulate full BASE-R FEC and can correct bursts error up to 11 bits within a FEC block. This statistic is incremented by one each time a BASE-R FEC block is received and that BASE-R FEC is enabled through either being forced on or through successful auto-negotiation. Please be aware that BASE-R FEC statistics have no correlation to CRC errors or frame rate, and that these statistics may increment even when no traffic is being sent or received.	

NOVUS 25GE FEATURE	SUPPORT/COMMENT
FC-FEC Uncorrected Block Count	This statistic is incremented by one each time a BASE-R FEC block is received that contains a burst error of 12 or more bits. It indicates that the block had too many errors to correct. The stat will count only if BASE-R FEC is enabled through either being forced on or through successful auto-negotiation. One may also see PCS, CRC, Fragment, Oversize, or Undersize stats increment when BASE-R FEC blocks errors are encountered. There is no indication available as to how many bits in an uncorrected block were in error.
FC-FEC Corrected Error Bits	This statistic is a running count of total number of bits that have been corrected by BASE-R FEC. Some users may wish to use this statistic to approximate BER on the line. Note that any uncorrected FEC blocks will not affect this counter because zero bits are corrected when a block has a burst error of more than 11bits. If using this stat to approximate BER, note that any uncorrectable BASE-R FEC blocks invalidate a BER calculation, as it is not known how many errored bits were in the uncorrected block. The stat will count only if BASE-R FEC is enabled through either being forced on or through successful auto-negotiation.
Fire code FEC Sync (FC-FEC) aka BASE-R FEC)	This statistic is a real-time indicator that Novus 25GE receive-side FC-FEC detection block has detected valid BASE-R FEC from the link partner. The stat will update only if BASE-R FEC is enabled through either being forced on or through successful auto-negotiation with FEC. If BASE-R FEC is disabled (or not enabled by auto-negotiation), stat will indicate "No Sync".
Force FC-FEC buttons	In the IxExplorer GUI the ability to Force BASE-R FEC on or off is provided mainly for debug. It is not compatible with a DUT unless the DUT has the ability to force BASE-R FEC on or off.
Force FC-FEC On	When enabled, BASE-R FEC functionality is always on, and the Novus 25GE will ignore the Link Partner's advertise and request bits. BASE-R FEC will be on throughout the auto-negotiation and link training process. Novus 25GE will send advertise and request bits during auto-negotiation process if selected.
Force FC-FEC Off	When enabled, BASE-R FEC functionality is always off, and Novus 25GE will ignore the Link Partner's advertise and request bits. Novus 25GE will send advertise and request bits during the auto-negotiation process if selected.
FC-FEC Request & FC-FEC Advertise Buttons	In the IxExplorer GUI these buttons are used to advertise and/or request FC-FEC from Novus 25G during auto-negotiation.

NOVUS 25GE FEATURE	SUPPORT/COMMENT
FC-FEC Advertise	When checked, Novus 25GE will: - Set F2 bit of the OUI Extended Next Page (per 25G Consortium) - Set F0 bit of Base Page (per IEEE P802.3by Clause 73)
FC-FEC Request	When checked, Novus 25GE will: - Set F4 bit of OUI Extended Next Page Code (per 25G Consortium) - Set F1 bit of Base Page (per IEEE P802.3by Clause 73) - Set F3 bit of Base Page (per IEEE P802.3by Clause 73)
RS-FEC Corrected Codeword Count	A RS-FEC codeword is 5280 bits of information consisting of 520 10-bit symbols, independent of frame boundaries; a RS-FEC codeword can correct up to 7 10-bit symbols within a RS-FEC codeword. This statistic is incremented by one each time a RS-FEC codeword is received providing RS-FEC is enabled through either being forced on or through successful auto-negotiation. Please be aware that RS-FEC statistics have no correlation to CRC errors or frame rate, and that these statistics may increment even when no traffic is being sent or received.
RS-FEC Uncorrected Codeword Count	This statistic is incremented by one each time a RS-FEC codeword is received that contains 8 or more errored 10-bit symbols. It indicates that the codeword had too many errors to correct. The stat will count only if RS-FEC is enabled through either being forced on or through successful auto-negotiation. One may also see PCS, CRC, Fragment, Oversize, or Undersize stats increment when RS-FEC codeword errors are encountered. There is no indication available as to how many bits in an uncorrected block were in error.
Force RS-FEC On	When enabled, RS FEC functionality is always on, and the Novus 25GE will ignore the Link Partner's advertise and request bits. RS FEC will be on throughout the auto-negotiation and link training process. Novus 25GE will send advertise and request bits during auto-negotiation process if selected.
Force RS-FEC Off	When enabled, RS FEC functionality is always off, and Novus 25GE will ignore the Link Partner's advertise and request bits. Novus 25GE will send advertise and request bits during the auto-negotiation process if selected.
RS-FEC Request & RS-FEC Advertise Buttons	In the IxExplorer GUI these buttons are used to advertise and/or request RS-FEC from Novus 25G during auto-negotiation.

NOVUS 25GE FEATURE	SUPPORT/COMMENT
RS-FEC Advertise	When checked, Novus 25GE will: Set F1 bit of the OUI Extended Next Page Code (per the 25G Consortium)
RS-FEC Request	When checked, Novus 25GE will: - Set F3 bit of OUI Extended Next Page Code (per 25G Consortium) - Set F2 bit of Base Page (per IEEE P802.3by Clause 73)

Table 4 outlines link partner attributes required to work with the Novus 25GE feature, and what will not work in real world interoperability configurations between the Ixia in 25GE Speed mode and a Device Under Test (DUT).

TABLE 4. LINK PARTNER ATTRIBUTES REQUIRED

	CLAUSE	COMMENT
Auto-negotiation	CL 73	Works for IEEE P802.3by and 2550G Consortium
Link Training	CL 93, CL 110	Works for IEEE P802.3by and 2550G Consortium Only required for passive copper DAC media
BASE-R FEC	CL 74	
RS-FEC	CL 108	RS-FEC is turned on by default for optical cables (SR4)

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