D9120FECP FEC (KP4) 400GE (100G Optical Lane) Decode/Trigger

for Infiniium Oscilloscopes

Introduction

The D9020FECP software package allows your UXR series oscilloscope to utilize the N4891A 400GBase FEC-aware test solution to trigger and investigate burst errors leading to frame loss.

KEYSIGHT

400GbE KP4 FEC Overview

The steadily increasing demand for more computing power and bandwidth fueled by cloud applications has accelerated the deployment of higher speed interfaces in datacenters. The move from NRZ-based 100G interfaces to PAM4-based 400G interfaces exponentially increased the level of complexity for the development of stable port electronics in all networking devices. 400G links typically operate at rather high intrinsic bit error rates (BER) and forward error correction (FEC) is therefore required. The combination of adaptive equalization and FEC has drastically increased the level of complexity in the characterization and validation of silicon devices, application specific integrated circuits (ASICs), fiber and copper interconnects, optical transceivers, and the port electronics of switches and routers. Identifying potential performance and interoperability issues at an early stage is critical as answers are complex and time-consuming to solve.

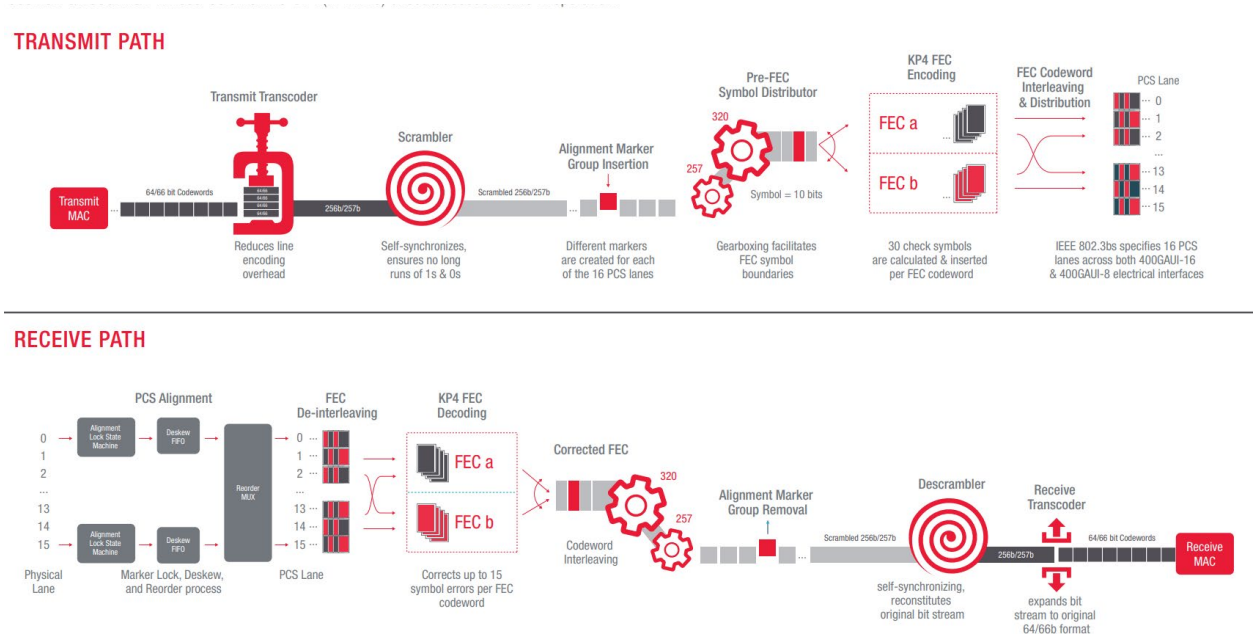

Figure 1. Anatomy of a 400GE FEC. Source: Keysight.com

Testing FEC-enable links

The IEEE 400GBASE standard clauses require the use of the Reed-Solomon code RS (544,514), also known as KP4, to ensure error-free operation. When bit errors are randomly distributed, the system margin and resulting Frame Loss Ratio (FLR) can be easily derived from the pre-FEC BER. However, besides jitter mechanisms and pattern-dependent effects (like inter-symbol interference, ISI), adaptive Decision Feedback Equalizer (DFE) which are necessary to cancel impact of reflection in the links are a major source of error bursts, which can exceed the error correction capability of the FEC, resulting in loss of the entire FEC code word – several thousands of bits of lost data. As such effects have a direct impact on interoperability, 400G Ethernet standards compliance tests for electrical and optical interface require meeting both a conventional BER limit, as well as a Frame Loss Ratio (FLR) measurement.

The Need for A New Tool (Finding & Analyzing)

The new D9120FECP software package allows your UXR series oscilloscope to utilize the N4891A 400GBase FEC-aware test solution to trigger on and investigate burst errors leading to frame loss.

Have you got an unacceptable Frame Loss Ratio (FLR) even with the following results from your real-time scope or BERT?

- Passing electrical and optical transmitter and receiver compliance test.
- With transmitter TDECQ and receiver BER/SER in spec.
- No burst errors is found in real-time scope and stressed receiver test.

The Infiniium UXR with the new D9120FECP can locate and investigate these bursts of errors with help from the N4891A. The UXR gets a trigger from the N4891A to isolate a burst of errors and also the correct values of the symbols near that trigger (and optionally, the symbols the N4891A received that caused the trigger.) With the trigger and information from N4891A, the correct symbols can be used to highlight errors in the UXR received symbols. Thus, the cause of the burst errors (hence the possible frame loss) can be investigated.

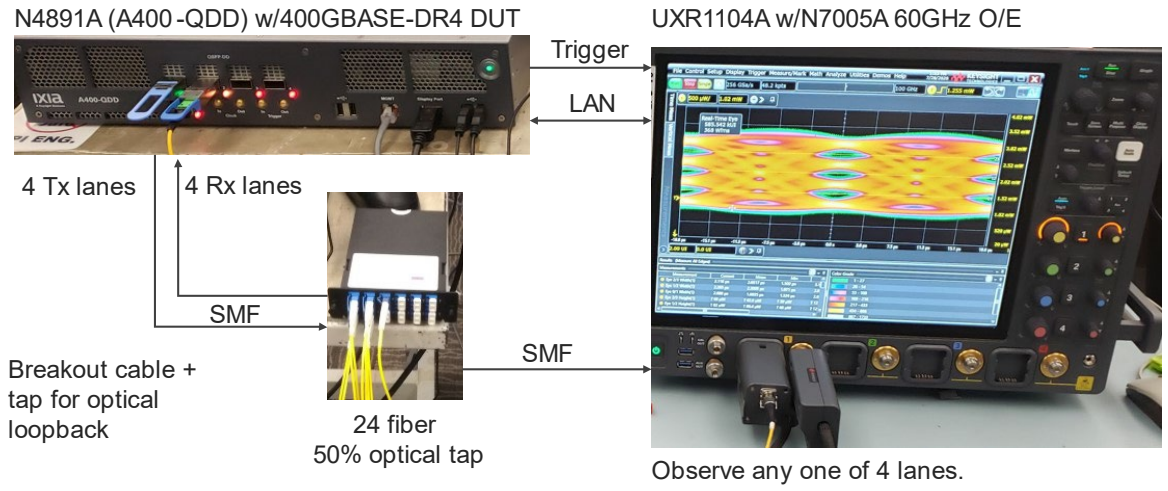

Figure 2. N7005A with UXR 110 GHz tapping SMF from N4891A

D9120FECP Overview

The D9120FECP FEC (KP4) 400GE Decode/Trigger software package with Infiniium UXR Series oscilloscope makes it easy to debug and test designs:

- Identifies FEC errors in 400G optical waveforms on UXR oscilloscopes.
- Works with N7004/5A O/Es to capture 50/100G (26/53GBd PAM4) optical lanes on 1 to 4 channels.
- Takes triggers from N4891A/A400GE to capture infrequent bursts of errors.
- Imports 50G PAM4 symbols near the trigger from N4891A/A400GE over LAN.
- Aligns both FEC-expected and Trigger electrical PAM4 symbols from N4891A/A400GE with 50G or 100G optical PAM4 symbols recovered from acquired optical waveform.
- Color codes and searches for errors, either transmitter errors (where waveform symbols do not match FEC-expected symbols) or receive errors (where trigger symbols from the N4891A/A400GE do not match the FEC-expected signals).
- Allows user to modify PAM4 optical clock recovery, equalization, and thresholds to see if errors can be eliminated on the captured symbols.
- Allows user to quickly identify if errors are at the electrical or optical level.

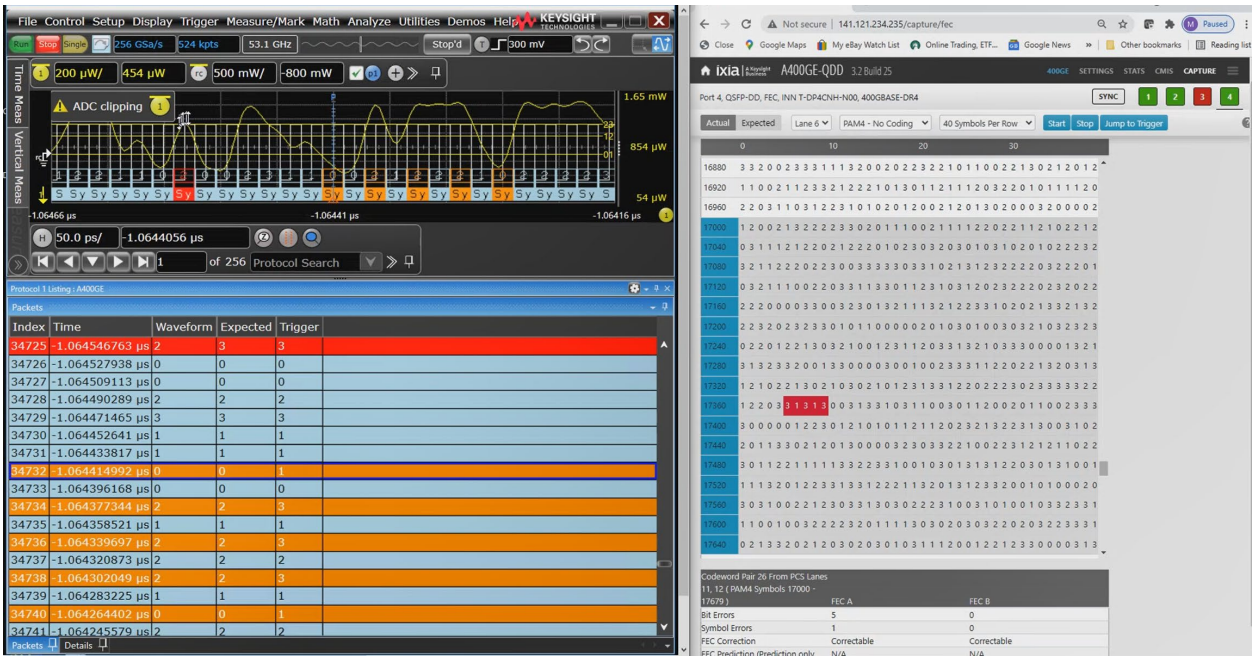

Figure 3. Optical errors captured on UXR (left) and electrical errors captured by N4891A (right)

Specifications

Key specifications

Signal decoded	50G and 100G lanes (26/53GBd PAM4) of KP4 400G links generated by N4891A/A400GE FEC-aware test solution 1 to 4 lanes Electrical or optical (w/N7004A or N7005A O/E)
Triggers	From N4891A/A400GE via Aux Trig. Includes specified number of errors per codeword. Errors are specified in number of bits or FEC-symbols. Errors can be per 50G lane, 100G lane, or link.
PAM4 symbol types	Waveform symbols are decoded from optical waveform (Observed symbols) Expected Symbols- FEC corrected symbols (Transmitted symbols) Trigger Symbols- Cause of trigger from N4891A/A400GE (Received symbols)
Search	Search on any errors, waveform/transmitter errors, or trigger/reciever errors.
Details tab	Trace LSB and MSB of optical 100G PAM4 symbols to LSB and MSB of electrical 50G PAM4 symbols in N4891A/A400GE.

Ordering Information

Recommended oscilloscopes

The protocol triggering and decode software is compatible with Keysight Infiniium UXR Series oscilloscopes with operating software revision 11.20 or higher. The table below determines the bandwidth needed on which application.

50G / 26GBd PAM4 on SMF or MMF capture

UXR0334A Infiniium UXR Real-Time Oscilloscope, 33 GHz, 128 GSa/s, 4Ch
N7004A Optical-to-electrical converter, 33 GHz

100G/53 GBd PAM4 on SMF capture

UXR0704AP Infiniium UXR Real-Time Oscilloscope, 70 GHz, 1mm, 256 GSa/s, 4Ch (recommended)
UXR0592A Infiniium UXR Real-Time Oscilloscope, 59 GHz, 256 GSa/s, 2Ch (minimum requirement)
N7005A Optical-to-electrical converter, 60 GHz

Required software

D9120PAMA	Pulse Amplitude Modulation PAM-N Analysis Software
D9120ASIA	Advanced Signal Integrity Software (EQ, InfiiniSimAdv, Crosstalk)
D9120FECP	FEC (KP4) 400GE (100G Optical Lane) Decode/Trigger Software

To ensure you continue to receive all the latest software updates and enhancements on your UXR-Series scopes, you will need to have a current core software subscription. A node-locked perpetual core software license and a minimum 1-year updates and enhancements subscription is included with new UXR-Series scopes. The subscription can be extended to 3 or 5 years at the time of purchase and can then be renewed later for a fee.

FEC aware test solution recommendation

The D9120FECP software package allows your UXR series oscilloscope to utilize the N4891A 400G. Base FEC-aware test solution to trigger on and investigate burst errors leading to frame loss. A400GE or N4891A is required to trigger UXR and find burst errors.

A400GE required configuration

941-0081 Ixia, A400GE-QDD, 4-port, 400GE/200GE/100GE/50GE Layer 1 BERT QSFP-QDD test system (recommended)
941-0080 Ixia, A400GE-QDD, 2-port, 400GE/200GE/100GE/50GE Layer 1 BERT QSFP-QDD test system (minimum requirement)
905-1051 Ixia, A400GE-QDD, Option, KP4 FEC add-on test option
905-1100 Ixia, A400GE-QDD, Option, Trigger and Capture add-on test option

N4891A required configuration

N4891A-004 400G Multiport Module Tester with four QSFP-DD Ports (recommended)
N4891A-002 400G Multiport Module Tester with two QSFP-DD Ports (minimum requirement)
N4891A-KP4 KP4 FEC Feature
N4891A-TRG Trigger and Capture Feature

Flexible software licenses

Keysight offers a variety of flexible licensing options to fit your needs and budget. Choose your license term, and license type.

License terms

Perpetual – Perpetual licenses can be used indefinitely.

Subscription – Subscription licenses can be used through the term of the license only (6, 12, 24, or 36 months).

License types

Node-locked – License can be used on one specified instrument/computer.

Transportable – License can be used on one instrument/computer at a time but may be transferred to another using Keysight Software Manager (internet connection required).

USB Portable – License can be used on one instrument/computer at a time but may be transferred to another using a certified USB dongle (available for additional purchase with Keysight part number E8900-D10).

Floating (single site) – Networked instruments/computers can access a license from a server one at a time. Multiple licenses can be purchased for concurrent usage.

Selecting your license

Step 1. Choose your software product (e.g. D9120FECP)

Step 2. Choose your license term: perpetual or time-based.

Step 3. Choose your license type: node-locked, transportable, USB portable, or floating.

To ensure you continue to receive all the latest software updates and enhancements on your MXR and UXR-Series scopes, make sure your core software subscription is current.

Example

If you selected:	Your quote will look like this:	
	Part number	**Description**
D9120FECP node-locked perpetual license	D9120FECP R-B5P-001-A	FEC (KP4) 400GE (100G Optical Lane) Decode/Trigger Software Node-locked perpetual license
D9120FEC P transportable subscription 6-month license	D9120FECP R-B7P-004-F	FEC (KP4) 400GE (100G Optical Lane) Decode/Trigger Software 6-months, transportable subscription license

To configure your product and request a quote:

http://www.keysight.com/find/software

Contact your Keysight representative or authorized partner for more information or to place an order:

www.keysight.com/find/contactus

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