# THOR-400G-7S-1P

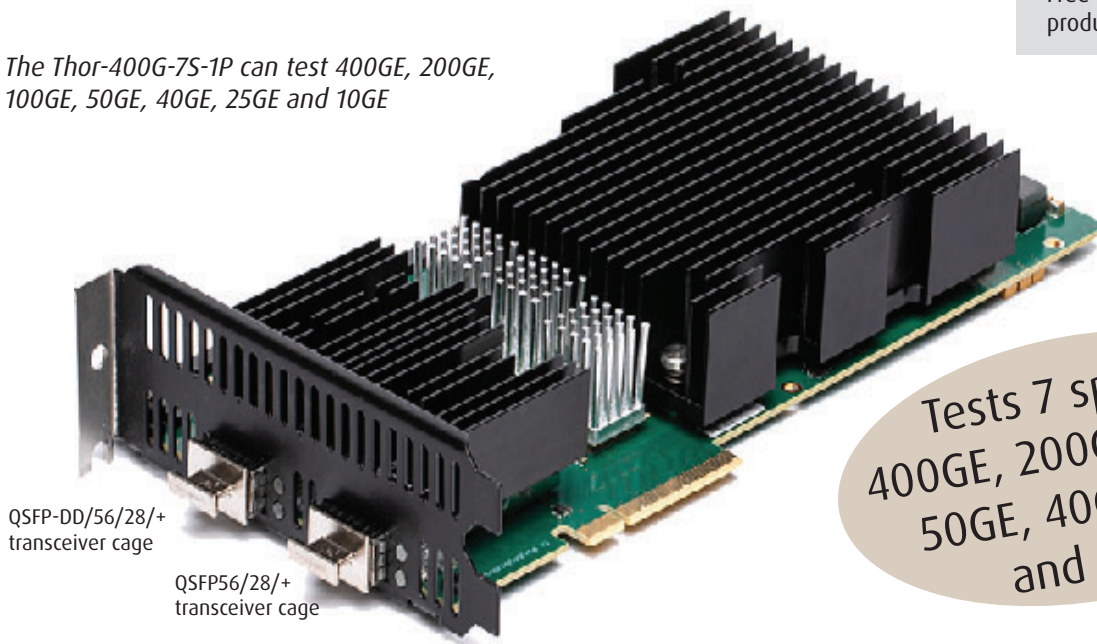## 7-speed PAM4/NRZ 400G dual-media test module

Xena's Thor-400G-7S-1P test module can test seven different Ethernet network speeds - 400GE, 200GE, 100GE, 50GE, 40GE, 25GE and 10GE. This unique flexibility is provided via two physical transceiver cages – one supporting QSFP-DD/56/28/+ transceivers, and the other supporting QSFP56/28/+ transceivers.

The QSFP-DD cage can support the following speeds and ports: 1x400G, 1x200G, 1x100G, 2x100G, 4x100G, 2x50G, 4x50G, 1x40G, 4x25G, and 4x10G Ethernet test ports. The QSFP56 cage can support the exact same speeds except for 400G Ethernet and 4x100G Ethernet. Both cages can be active simultaneously except when the QSFP-DD cage runs 400GE or 4 x 100GBASE-DR.

Thor-400G-7S-1P is unique on the market with its ability to test both NRZ & PAM4 speeds, plus perform Auto-Negotiation and Link Training (AN/LT) with a comprehensive level of interoperability testing.

The result is a highly versatile solution for performance and functional testing of network infrastructure and Ethernet equipment that support 400GE including switches, routers, NICs, TAPs, packet-brokers, and backhaul platforms.

### TOP FEATURES

- 7-speed flexibility: 400GE, 200GE, 100GE, 50GE, 40GE, 25GE and 10GE
- Dual media value
- Supports both NRZ & PAM4 speeds
- Support for Auto-neg & Link Training (AN/LT) - interoperability tested
- Price/performance
- Ease of use

### XENA VALUE PACK*

Included with every Thor-400G-7S-1P

- User-friendly software (ValkyrieManager, Valkyrie3918, Valkyrie2544, Valkyrie1564 Valkyrie2889 and ValkyrieCLI, ValkyrieREST-API)
- Three years' free software updates
- Three years' free hardware warranty
- Free tech support & training for the product lifetime



*The Thor-400G-7S-1P can test 400GE, 200GE, 100GE, 50GE, 40GE, 25GE and 10GE*

QSFP-DD/56/28/+ transceiver cage

QSFP56/28/+ transceiver cage

*Tests 7 speeds: 400GE, 200GE, 100GE, 50GE, 40GE, 25GE and 10GE*

## PORT LEVEL FEATURES

| Interface category | | |
|---|---|---|
| | QSFP-DD | • 400G, 200G, 100G, 50G Ethernet |
| | QSFP56 | • 200G, 100G, 50G Ethernet |
| | QSFP28 | • 100G, 50G, 40G*, 25GE and 10G* Ethernet |
| | QSFP+ | • 40G, 10G Ethernet |
| | | * Depending on transceiver capabilities |
| Total number of test ports (software configurable) | 1x400G, 2x200G, 4x100G, 8x50G, 2x40G, 8x25G, and 8x10G Ethernet | |

| Interface options | | | | Line code | Standard |
|---|---|---|---|---|---|
| | QSFP-DD cage | • 1 x 400GBASE-DR4, 1 x 400GBASE-SR8/FR8/LR8, or | | PAM4 | 802.3bs |
| | | • 2 x 200GBASE-CWDM4 (dual CS connector), or | | PAM4 | 802.3bs/802.3cd |
| | | • 1 x 200GBASE-DR4/SR4/FR4/LR4/CR4, or | | PAM4 | 802.3bs/802.3cd |
| | | • 4 x 100GBASE-CR2, or 4 x 100GBASE-DR, or | | PAM4 | 802.3cd |
| | | • 2 x 100GBASE-SR2/CR2, 2 x 100GBASE-DR (dual CS connector) or | | PAM4 | 802.3cd |
| | | • 1 x 100GBASE-SR4/LR4/CR4, or | | NRZ | 802.3bj |
| | | • 8 x 50GBASE-SR/CR, or | | PAM4 | 802.3cd |
| | | • 4 x 50GBASE-SR/CR, or | | PAM4 | 802.3cd |
| | | • 2 x 50GBASE-SR2/LR2/CR2, or | | NRZ | Consortium** |
| | | • 1 x 40GBASE-SR4/LR4/CR4, or | | NRZ | 802.3ba |
| | | • 4 x 25GBASE-SR/LR/CR, or | | NRZ | 802.3by/Consortium** |
| | | • 4 x 10GBASE-SR/LR/CR | | NRZ | 802.3ae |
| | | Same as QSFP-DD minus support for 400G speeds, 2 x 200GBASE-CWDM4, 4 x 100GBASE-DR, 4 x 100GBASE-CR2 and 8 x 50GBASE-SR/CR.*In addition, the QSFP56 does currently not support 2 x 100GBASE-DR/SR2/CR2* | | | |
| | QSFP56 cage | Actual interface options depend on the capabilities of the inserted transceiver. Both cages can be active simultaneously except when the QSFP-DD cage runs 400GE, 2 x 200GBASE-CWDM4, 1 x 200GBASE-SR8, 4 x 100GBASE-DR or 8 x 50GBASE-SR/CR. Both cages must run with the same base interface configuration (e.g. 2 x 50G). Power capacity per QSFP-DD/QSFP56 cage: 15 watts. | | | |
| | | ** As defined by 25/50 GigabitEthernet Consortium | | | |
| Auto Negotiation and Link Training | IEEE 802.3 Clause 73, Auto-negotiation<br>IEEE 802.3 Clause 72, Link training | | | | |
| Forward Error Correction (FEC) | RS-FEC (Reed Solomon) (544,514,t=15), IEEE 802.3 Clause 119 (200/400GE)<br>RS-FEC (Reed Solomon) (528,514,t=7), IEEE 802.3 Clause 91 (100GE)<br>RS-FEC (Reed Solomon) (544,514,t=15), IEEE 802.3 Clause 134 (100GE/50GE 802.3cd)<br>RS-FEC (Reed Solomon) (528,514,t=7), IEEE 802.3 Clause 108 (25GE)<br>RS-FEC (Reed Solomon) (528,514,t=7), 25/50G Ethernet Consortium (25/50GE)<br>BASE-R FEC (Firecode) 2112,2080 IEEE 802.3 Clause 74 (25GE, 10GE) | | | | |
| Number of transceiver module cages | 1xQSFP-DD/QSFP56/QSFP28/QSFP+ and 1xQSFP56/QSFP28/QSFP+ | | | | |
| Port statistics | Link state, FCS errors, pause frames, ARP/PING, error injections, training packet<br>All traffic: RX and TX Mbit/s, packets/s, packets, bytes<br>Traffic w/o test payload: RX and TX Mbit/s, packets/s, packets, bytes | | | | |
| Adjustable Inter Frame Gap (IFG) | Configurable from 16 to 56 bytes, default is 20B (12B IFG + 8B preamble) | | | | |
| Transmit line rate adjustment | Ability to adjust the effective line rate by forcing idle gaps equivalent to -1000 ppm (increments of 10 ppm) | | | | |
| Transmit line clock adjustment | From -100 to 100 ppm in steps of 0.001 ppm (shared across all ports) | | | | |
| ARP/PING | Supported (configurable IP and MAC address per port) | | | | |
| Field upgradeable | System is fully field upgradeable to product releases (FPGA images and software) | | | | |
| Tx disable | Enable/disable of optical laser or copper link | | | | |
| IGMPv2 multicast join/leave | IGMPv2 continuous multicast join, with configurable repeat interval | | | | |
| Histogram statistics | Two real-time histograms per port. Each histogram can measure one of RX/TX packet length, IFG, or Latency distribution for all traffic, a specific stream, or a filter | | | | |
| Loopback modes | • L1RX2TX – RX-to-TX, transmit byte-by-byte copy of the incoming packet<br>• L2RX2TX – RX-to-TX, swap source and destination MAC addresses (*only at 10G)<br>• L3RX2TX – RX-to-TX, swap source and destination MAC addresses and IP addresses (*only at 10GE)<br>• TXON2RX – TX-to-RX, packet is also transmitted from the port<br>• TXOFF2RX – TX-to-RX, port's transmitter is idle<br>• Port-to-port – Inline loop mode where all traffic is looped 100% transparent at L1 *(All rates except 400GE)* | | | | |
| Oscillator characteristics | • Initial Accuracy is 3 ppm<br>• Frequency drift over 1st year: +/- 3 ppm (over 15 years: +/- 15 ppm)<br>• Temperature Stability: +/- 20 ppm (Total Stability is +/- 35 ppm) | | | | |

## 400/200/100/50/40/25/10GE FRAMED PRBS AND PCS/PMA LAYERS

| | |
|---|---|
| Payload Test pattern | PRBS-7, PRBS-9, PRBS-10, PRBS-11, PRBS-13, PRBS-15, PRBS-20, PRBS-23, PRBS-31, PRBS-49, PRBS-58 |
| Error Injection | Manual single shot bit-errors |
| Alarms | Pattern loss |
| Error analysis | Bit-errors: count, rate |
| PCS virtual lane configuration | User-defined skew insertion per Tx virtual lane, and user defined virtual lane to SerDes mapping for testing of the Rx PCS virtual lane re-order function |
| PCS virtual lane statistics | Relative virtual lane skew measurements (up to 2048 bits)<br>PAM4: Corrected Bit error, PreFEC BER<br>NRZ, No FEC: sync header and PCS lane marker error counters, indicators for loss of sync header and lane marker, BIP8 errors |
| FEC Total statistics | Total corrected FEC symbols, Total uncorrected FEC symbols, Estimated Pre-FEC BER, Estimated Post-FEC BER, Pre-FEC Error Distribution Graph |
| Link Flap | Single short or repeatable link down events with ms precision |
| Error Injection (PMA Layer) | Repeatable error inject periods at PMA layer with ms precision |

*NOTE: Text in blue are features that will be added soon.*

## TRANSMIT ENGINES

| | |
|---|---|
| Number of transmit streams per port | 256 (wire-speed).<br>Each stream can generate millions of traffic flows using field modifiers |
| Test payload insertion per stream | Wire-speed packet generation with timestamps, sequence numbers, and data integrity signature optionally inserted into each packet. |
| Stream statistics | TX Mbit/s, packets/s, packets, bytes, FCS error |
| Bandwidth profiles | Burst size and density can be specified. Uniform and bursty bandwidth profile streams can be interleaved |
| Field modifiers | 16-bit or 32-bit header field modifiers with inc, dec, or random mode. Each modifier has configurable bit-mask, repetition, min, max, and step parameters. 8 (100G/50G PAM4: 2) 16-bit modifiers per stream or 4 (100G/50G PAM4: 1) 32-bit modifiers per stream |
| Packet length controls | Fixed, random, butterfly, and incrementing packet length distributions from 56 to 12288 bytes |
| Packet payloads (basic) | Repeated user specified 1 to 18B pattern, an 8-bit incrementing pattern |
| Extended payload | Fixed full custom payloads can be generated for each stream with payload sizes up to 12288 bytes |
| Error generation | Undersize length (56 bytes min) and oversize length (12288 bytes max.) packet lengths, injection of sequence, misorder, payload integrity, and FCS errors |
| TX packet header support and RX autodecodes | Ethernet, Ethernet II, VLAN, ARP, IPv4, IPv6, UDP, TCP, LLC, SNAP, GTP, ICMP, RTP, RTCP, STP, MPLS, PBB, or fully specified by user |
| Pause Frames | NRZ rates: Responds to incoming pause and PFC (Priority-based Flow Control) frames |
| Packet scheduling modes | • Normal (stream interleaved mode) – standard scheduling mode, precise rates, minor variation in packet inter-frame gap.<br>• Strict Uniform – new scheduling mode, with 100% uniform packet inter-frame gap, minor deviation from configured rates.<br>• Sequential packet scheduling (sequential stream scheduling). Streams are scheduled continuously in sequential order, with configurable number of packets per stream.<br>• Burst. Packets in a stream are organized in bursts. Bursts from active streams form a burst group. The user specifies time from start of one burst group till start of next burst group. |

## RECEIVE ENGINE

| | |
|---|---|
| Number of traceable Rx streams per port | 2016 (wire-speed) |
| Automatic detection of test payload for received packets | Real-time reporting of statistics and latency, loss, payload integrity, sequence error, and misorder error checking |
| Jitter measurement | Jitter (Packet Delay Variation) measurements compliant to MEF10 standard with 8 ns accuracy<br>Jitter can be measured on up to 32 streams |
| Stream statistics | • RX Mbit/s, packets/s, packets, bytes.<br>• Loss, payload integrity errors, sequence errors, misorder errors<br>• Min latency, max latency, average latency<br>• Min jitter, max jitter, average jitter |
| Latency measurements accuracy | ±32 ns |
| Latency measurement resolution | 8 ns *(Latency measurements can calibrate and remove latency from transceiver modules)* |
| Number of filters: | • 6 (100G/50G PAM4: 4) x 64-bit user-definable match-term patterns with mask, and offset<br>• 6 (100G/50G PAM4: 4) x frame length comparator terms (longer, shorter)<br>• 6 (100G/50G PAM4: 4) x user-defined filters expressed from AND/OR'ing of the match and length terms. |
| Filter statistics | Per filter: RX Mbit/s, packets/s, packets, bytes. |

## CAPTURE

| | |
|---|---|
| Capture criteria | All traffic, stream, FCS errors, filter match, or traffic without test payloads |
| Capture start/stop triggers | Capture start and stop trigger: none, FCS error, filter match |
| Capture limit per packet | 16 – 12288 bytes |
| Wire-speed capture buffer per port | 384 kB for 400GE<br>192 kB for 200GE<br>96 kB for 100GE<br>48 kB for 50GE<br>48 kB for 40GE<br>32 kB for 25GE<br>16 kB for 10GE |
| Low speed capture buffer per port (10Mbit/s speed) | 4096 packets (any size) |

## ADVANCED PHY FEATURES
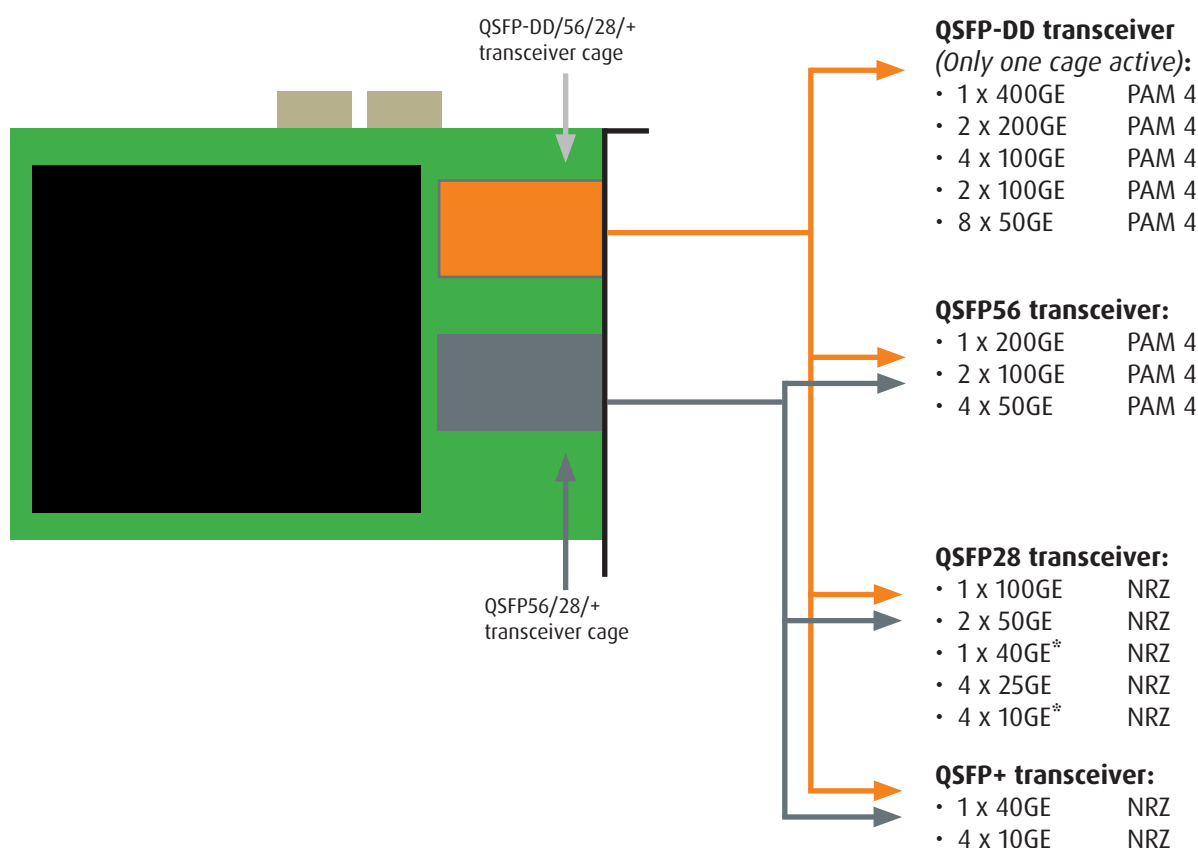
| | |
|---|---|
| Equalization Controls | Tx Transmit Equalization Controls<br>• Pre-emphasis<br>• Tx Attenuation<br>• Tx Post-emphasis Signal Integrity Analysis<br>Optional Auto-Tune of Rx equalizer/CTLE |
| Signal Integrity Analysis | • FEC error correction chart |

*NOTE: Text in blue are features that will be added soon.*

## One module - multiple options

The Thor-400G-7S-1P has 2 transceiver cages. The type of transceiver that is used, determines the speeds and number of ports you can use. The port number / speed configuration must be the same for both cages.

This is defined using ValkyrieManager, the traffic generation and analysis software provided by Xena with all Valkyrie test systems.

QSFP-DD/56/28/+
transceiver cage

QSFP56/28/+
transceiver cage

**QSFP-DD transceiver**
*(Only one cage active)*:
- 1 x 400GE     PAM 4
- 2 x 200GE     PAM 4
- 4 x 100GE     PAM 4
- 2 x 100GE     PAM 4
- 8 x 50GE     PAM 4

**QSFP56 transceiver:**
- 1 x 200GE     PAM 4
- 2 x 100GE     PAM 4
- 4 x 50GE     PAM 4

**QSFP28 transceiver:**
- 1 x 100GE     NRZ
- 2 x 50GE     NRZ
- 1 x 40GE*     NRZ
- 4 x 25GE     NRZ
- 4 x 10GE*     NRZ

**QSFP+ transceiver:**
- 1 x 40GE     NRZ
- 4 x 10GE     NRZ

\* Depending on transceiver capabilities

## HW SPECIFICATIONS

| | |
|---|---|
| Max. Power | • 174 W |
| Weight | • 2.31 lbs (1.05 kg) |
| Environmental | • Operating Temperature: 10 to 35º C<br>• Storage Temperature: -40 to 70º C<br>• Humidity: 8% to 90% non-condensing |
| Regulatory | • FCC (US), CE (Europe) |
| Notes | • This module is only supported by the Val-C12-2400 chassis<br>• This module requires two slots in the Val-C12-2400 chassis |

### PRODUCT NUMBERS (P/N)
- Thor-400G-7S-1P - test module for ValkyrieBay chassis
- C-Thor-400G-7S-1P - mounted in ValkyrieCompact chassis

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