The Loki-100G-5S-1P is a versatile test solution offering five different Ethernet network speeds: 10GE, 25GE, 40GE, 50GE and 100GE. This unique test module lets users dynamically choose between two different physical transceiver cages and form factors. The first is a single QSFP28/QSFP+ transceiver cage, and the second is two SFP28/SFP+ transceiver cages.

When using the QSFP28/QSFP+ cage, the user can dynamically select between the following modes of operation: 4x10GE / 1x40GE / 4x25GE / 2x50GE / 1x100GE test ports, and when using the dual SFP28 cages: 2 x 10GE / 2x25GE.

The unique combination of five different Ethernet network speeds and multiple physical optical transceiver form factors, makes the Loki-100G-5S-1P a versatile solution for performance and functional testing of network infrastructure and Ethernet equipment such as taps, switches, routers, NICs, packet-brokers, and backhaul platforms.

### PORT LEVEL FEATURES

<table>
<thead>
<tr>
<th>Interface category</th>
<th>QSFP28</th>
<th>QSFP+</th>
<th>SFP28</th>
<th>SFP+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of test ports (software configurable)</td>
<td>1 x 100G, 2 x 50G, 1 x 40G, 4 x 25G, and 4 x 10G Ethernet</td>
<td>1 x 40G and 4 x 10G Ethernet</td>
<td>2 x 25GE and 2 x 10G Ethernet</td>
<td>2 x 10G Ethernet</td>
</tr>
<tr>
<td>Interface options</td>
<td>1 x 100GBASE-SR4, 1 x 100GBASE-LR4, 1 x 100GBASE-CWDM4, 1 x 100GBASE-CR4, or 4 x 10GBASE-iSR</td>
<td>1 x 40GBASE-SR4, 1 x 40GBASE-LR4, 1 x 40GBASE-CR4, or 4 x 10GBASE-iSR</td>
<td>2 x 25GBASE-SR / 25GBASE-LR / 25GBASE-CR, or 2 x 10GBASE-SR / 10GBASE-LR / 10GBASE-CR</td>
<td>2 x 10GBASE-SR / 10GBASE-LR / 10GBASE-CR</td>
</tr>
</tbody>
</table>
**Forward Error Correction (FEC)**

- RS-FEC (Reed Solomon) FEC, IEEE 802.3 Clause 91 (100GE)
- RS-FEC (Reed Solomon) FEC, IEEE 802.3 Clause 108 (25GE)
- RS-FEC (Reed Solomon) FEC, 25/50G Ethernet Consortium (25/50GE)

**Number of transceiver module cages**

- 1 x QSFP28/QSF++ and 2 x SFP28/SFP++ (use QSFP28/QSF++ or SFP28/SFP+ cages)

**Port statistics**

- Link state, FCS errors, pause frames, ARP/PING, error injections, training packet
- All traffic: RX and TX Mbit/s, packets/s, packets, bytes
- 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 208 (128 IFG + 88 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 -400 to 400 ppm in steps of 0.001 ppm (shared across all ports) (featured planned to be added)

**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
- L2RX2TX – RX-to-TX, swap source and destination MAC addresses (*only at 10G*)
- L3RX2TX – RX-to-TX, swap source and destination MAC addresses and IP addresses (*only at 10G*)
- TXON2RX – TX-to-RX, packet is also transmitted from the port
- TXOFF2RX – TX-to-RX, port's transmitter is idle
- Port-to-port – Inline loop mode where all traffic is looped 100% transparent at L1

**Oscillator characteristics**

- Initial Accuracy is 3 ppm
- Frequency drift over 1st year: +/- 3 ppm (over 15 years: +/- 15 ppm)
- Temperature Stability: +/- 20 ppm (Total Stability is +/- 35 ppm)

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### 100/50/40/25GE FRAMED PRBS AND PCS LAYERS

**Payload Test pattern**

- PRBS 2^31

**Error Injection**

- Manual single shot bit-errors or bursts, automatic continuous error injection

**Frame size and header**

- Fixed size from 56 to 9200 bytes, any layer 2/3/4 frame header

**Alarms**

- Pattern loss, bit-error rate threshold

**Error analysis**

- bit-errors: seconds, count, rate
- mismatch '0' / '1': seconds, count, rate logging and analysis of bit-error event timing

**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 measurement (up to 2048 bits), sync header and PCS lane marker error counters, indicators for loss of sync header and lane marker, BIP8 errors

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### TRANSMIT ENGINES

**Number of transmit streams per port**

- 256 (wire-speed)

**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, Pause

**Bandwidth profiles**

- Burst size and density can be specified. Uniform and bursty bandwidth profile streams can be interleaved

**Field modifiers**

- 16-bit header field modifiers with inc, dec, or random mode. Each modifier has configurable bit-mask, repetition, min, max, and step parameters. 6 modifiers per stream

**Packet length controls**

- Fixed, random, butterfly, and incrementing packet length distributions from 56 to 9200 bytes

**Packet payloads**

- Repeated user specified 1 to 188 pattern, a 8-bit incrementing pattern

**Error generation**

- Undersize length (568 min) and oversize length (9200 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

**Packet scheduling modes**

- Normal (stream interleaved mode) – standard scheduling mode, precise rates, minor variation in packet inter-frame gap.
- Strict Uniform – new scheduling mode, with 100% uniform packet inter-frame gap, minor deviation from configured rates.
- Sequential packet scheduling (sequential stream scheduling). Streams are scheduled continuously in sequential order, with configurable number of packets per stream.
- 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.

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1) Counter size: 64 bits
### RECEIVE ENGINE

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of traceable Rx streams per port</td>
<td>2016 (wire-speed)</td>
</tr>
<tr>
<td>Automatic detection of test payload for received packets</td>
<td>Real-time reporting of statistics and latency, loss, payload integrity, sequence error, and misorder error checking</td>
</tr>
<tr>
<td>Jitter measurement</td>
<td>Jitter (Packet Delay Variation) measurements compliant to MEF10 standard with 8 ns accuracy can be measured on up to 32 streams</td>
</tr>
</tbody>
</table>
| Stream statistics | - RX Mbit/s, packets/s, packets, bytes.  
- Loss, payload integrity errors, sequence errors, misorder errors  
- Min latency, max latency, average latency  
- 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 | 4 x 64-bit user-definable match-term patterns with mask, and offset  
4 x frame length comparator terms (longer, shorter)  
4 x user-defined filters expressed from AND/OR’ing of the match and length terms. |

### CAPTURE

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture criteria</td>
<td>All traffic, stream, FCS errors, filter match, or traffic without test payloads</td>
</tr>
<tr>
<td>Capture start/stop triggers</td>
<td>Capture start and stop trigger: none, FCS error, filter match</td>
</tr>
<tr>
<td>Capture limit per packet</td>
<td>16 – 12288 bytes</td>
</tr>
</tbody>
</table>
| Wire-speed capture buffer per port | 256 kB for 100G  
128 kB for 40G |
| Low speed capture buffer per port (10Mbit/s speed) | 4096 packets (any size) |

### ADVANCED PHY FEATURES

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmit Equalization Controls</td>
<td></td>
</tr>
</tbody>
</table>
- Tx Transmit Equalization Controls Pre-emphasis  
- Tx Attenuation  
- Tx Post-emphasis Signal Integrity Analysis Graphical "eye" diagram  
- Rx Optional Auto-Tune of PHY 25Gbps Rx SerDes |
| Signal Integrity Analysis |  
- Graphical "eye" diagram  
- Horizontal bathtub curve estimation  
- Vertical bathtub curve estimation  
- Bit Error Rate (BER) estimation |

### One module - multiple options

The Loki-100G-5S-1P lets you dynamically choose between 2 transceiver cages. This determines which speeds and number of ports you can use.

Once the physical transceiver cage is in use, you can use ValkyrieManager (Xena’s free traffic generation and analysis software) to specify which Ethernet speeds to use.
UNIQUE EYE DIAGRAM

The Loki-100G-5S-1P includes a unique feature for analyzing signal quality called the “eye diagram”. When using the QSFP28 ports, an additional panel called “Advanced PHY Features” will appear in the main Resource Properties tab of ValkyrieManager. This panel controls and monitors the four receive SerDes associated with the 4x10G or 4x25G link at the physical level. It also creates bit-error-rate (BER) eye diagrams, estimates the link BER from the vertical and horizontal BER bathtub curves and controls the PHY tuning in the transmit and the receive directions.

How it works
The BER eye-diagram provides a direct visual representation of the signal quality after RX equalization. The eye-diagram is formed by changing the time dimension (sampling delay) and the amplitude dimension (0/1 threshold) of the sampling point of the PHY step-by-step. For each sampling point (x,y), 1 million bits are measured, the number of bit-errors are counted and a simple division gives the BER. The result is the BER eye-diagram (see below).

The color map shows the measured bit-error rate for each point going from 1 million (maximum red) to zero (black). The color scale is logarithmic. Higher resolutions give a clearer diagram and higher values of X and Y will also give a higher precision in the vertical and horizontal bathtub curve estimations, respectively.

What it shows
The eye-data table provides an estimate of several parameters of the eye, including width, height and jitter. Future releases will also include link BER estimates based on the horizontal and vertical bathtub curves.
### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>ValkyrieCompact</th>
<th>ValkyrieBay (2 slots)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1U ValkyrieCompact</strong></td>
<td>W: 19&quot; (48.26 cm)</td>
<td>W: 19&quot; (48.26 cm)</td>
</tr>
<tr>
<td></td>
<td>H: 1.75&quot; (4.45 cm)</td>
<td>H: 7&quot; (17.78 cm)</td>
</tr>
<tr>
<td></td>
<td>D: 9.8&quot; (25 cm)</td>
<td>D: 19.7&quot; (50 cm)</td>
</tr>
<tr>
<td></td>
<td>Weight: 10 lbs (4.5 kg)</td>
<td>Weight: 36.4 lbs (16.5 kg)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>ValkyrieBay (2 slots)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4U ValkyrieBay (2 slots)</strong></td>
<td>W: 19&quot; (48.26 cm)</td>
</tr>
<tr>
<td></td>
<td>H: 7&quot; (17.78 cm)</td>
</tr>
<tr>
<td></td>
<td>D: 19.7&quot; (50 cm)</td>
</tr>
<tr>
<td></td>
<td>Weight: 36.4 lbs (16.5 kg)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power</th>
<th>ValkyrieCompact</th>
<th>ValkyrieBay</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AC Voltage</strong></td>
<td>100-240V</td>
<td>120W</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>50-60Hz</td>
<td></td>
</tr>
<tr>
<td><strong>Max. Power</strong></td>
<td>90W (ValkyrieCompact)</td>
<td>120W (ValkyrieBay)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating Temperature</strong></td>
<td>10 to 35º C</td>
</tr>
<tr>
<td><strong>Storage Temperature</strong></td>
<td>-40 to 70º C</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>8% to 90% non-condensing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Regulatory</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FCC (US), CE (Europe)</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Max. Noise</th>
<th>ValkyrieCompact: 49 dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ValkyrieBay: 58.5 dBA</td>
</tr>
</tbody>
</table>