Ixia’s XMVAE Gigabit Ethernet Load Modules offer complete Layer 2-3 network and application testing functionality in a single test system for Automotive Ethernet switch and ECU testing. Each test port on the module has auto-negotiable 10/100/1000 Mbps Ethernet over various physical mediums over SPF transceivers slots, or integrated over copper RJ45.

The ability to test Automotive Ethernet network components in next-generation vehicles and smart cars, requires the Ixia test system to support Automotive Ethernet specific interface for 10/100/1000 Mbps Ethernet speeds. The XMVAE load modules include support for BroadR-Reach transceivers for testing BroadR-Reach enabled Automotive Ethernet switch and ECU functionality.

Each port on a 10/100/1000 Mbps XMVAE module contains a powerful RISC processor running Linux and a full, test-optimized TCP/IP stack. This architecture provides unprecedented performance and flexibility for testing BroadR-Reach enabled Automotive switches, ADAS/Infotainment ECUs, gateways and AUTOSAR IP/Ethernet applications for Automotive use.

The load module supports wire-speed Layer 2-3 traffic generation and analysis, high performance IPv4/IPv6 protocol emulations, Ethernet ECU behavior emulation and Layer 4-7 application traffic generation on each test port. Extensive statistics for control and data plane traffic helps debug the issues quickly and extensively in a scaled setup consisting of many ECUs, switches and gateways.

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**HIGHLIGHTS**

- Supports 10/100/1000 Mbps Ethernet Speeds for Automotive switch and ECU testing.
- Supports BroadR-Reach transceiver (100BASE-T1 or 1000BASE-T1)
- Supports various Automotive Ethernet, switching, IPv4, IPv6, and AVB protocols, including gPTP time sync
- Application Layer Performance Testing
- Flexible packet generation and real-time capture
- Real-Time latency, data integrity, and sequence error measurements
- Transmit Scheduler with nanosecond-level precision
- Automation of all GUI functions through TCL/Perl/Python APIs

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*Figure 1 – 10/100/1000 Mbps Ethernet and Gigabit Fiber XMVAE Load Modules*
Ixia’s XMVAE Gigabit Ethernet Modules are offered in 8 and 16 port full-performance configurations, providing scalability and affordability for a diverse range of test requirements. With 12 slots per XGS12-SD high performance chassis, up to 192 Ethernet ports can be simulated in a single test system to create high density automotive network test environments. In an XGS2-SD or XGS2-HD chassis system, up to 32 ports can be simulated, each port capable of emulating a complex network behind it.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load module</td>
<td>LSM1000XMVAE8, LSM1000XMVAE16</td>
</tr>
<tr>
<td>Connector type</td>
<td>Split RJ45 or SFP (which can connect to BroadR-Reach or Fiber transceivers)</td>
</tr>
<tr>
<td>Maximum ports per chassis</td>
<td>32 ports – XGS2-SD or XGS2-HD Desktop</td>
</tr>
<tr>
<td></td>
<td>192 ports in XGS12-SD Rack mount</td>
</tr>
<tr>
<td>Connection speed</td>
<td>Capable of 100/1000 Mbps Automotive Ethernet with transceiver, auto-negotiable 10/100/1000 Mbps Ethernet over copper and Gigabit Fiber and 100Base-FX Ethernet over Fiber</td>
</tr>
<tr>
<td>Port CPU/memory per port</td>
<td>800MHz /1GB</td>
</tr>
<tr>
<td>Number of ports per model</td>
<td>8 or 16</td>
</tr>
<tr>
<td>Layer 2-3 switching/routing protocol testing</td>
<td>Yes</td>
</tr>
<tr>
<td>RFC 2544 and 2889 tests</td>
<td>Yes</td>
</tr>
<tr>
<td>AUTOSAR Ethernet compatibility tests</td>
<td>Yes</td>
</tr>
<tr>
<td>AUTOSAR TCP/IP Stack Acceptance Tests 1.1 support</td>
<td>Yes</td>
</tr>
<tr>
<td>AUTOSAR Testability Protocol 1.0 support</td>
<td>Yes</td>
</tr>
<tr>
<td>OPEN Alliance ECU Test Specification 1.0 support</td>
<td>Yes</td>
</tr>
<tr>
<td>FEATURE</td>
<td>DETAILS</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>IEEE Audio Video Bridging tests for bridge and endpoints</td>
<td>Yes</td>
</tr>
<tr>
<td>IEEE 802.1AS/gPTP timing and sync tests for Boundary, Grandmaster, and Slave clocks</td>
<td>Yes</td>
</tr>
<tr>
<td>AVnu Automotive Profile 1.4 Support</td>
<td>Yes</td>
</tr>
<tr>
<td>Capture buffer per port</td>
<td>64MB</td>
</tr>
<tr>
<td>Number of transmit flows per port (sequential values)</td>
<td>Billions</td>
</tr>
<tr>
<td>Number of transmit flows per port (arbitrary values)</td>
<td>98K</td>
</tr>
<tr>
<td>Number of track-able receive flows per port</td>
<td>512K</td>
</tr>
<tr>
<td>Number of stream definitions per port</td>
<td>4096</td>
</tr>
<tr>
<td>Transmit engine</td>
<td>Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures.</td>
</tr>
<tr>
<td>Receive engine</td>
<td>Wire-speed packet filtering, capturing, real-time latency for each packet group, data integrity, and sequence checking.</td>
</tr>
<tr>
<td>User defined field (UDF) features</td>
<td>Fixed, increment, or decrement by user-defined step, value lists, range lists, cascade, random, and chained.</td>
</tr>
<tr>
<td>Table UDF feature</td>
<td>Comprehensive packet editing function for emulating large numbers of sophisticated flows. Up to 98K table UDF entries are supported.</td>
</tr>
<tr>
<td>Filters</td>
<td>48-bit source/destination address, 2x128-bit user-definable pattern and offset, frame length range, CRC error, data integrity error, sequence checking error (small, big, reverse).</td>
</tr>
<tr>
<td>Data field (per stream)</td>
<td>Fixed, increment (byte/word), decrement (byte/word), random, repeating, user-specified up to 13K bytes.</td>
</tr>
</tbody>
</table>
### FEATURE DETAILS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statistics and rates (counter size: 64-Bit)</strong></td>
<td>Link State, Line Speed, Frames Sent, Valid Frames Received, Bytes Sent/Received, Fragments, Undersize, Oversize, CRC Errors, VLAN Tagged Frames, User-Defined Stat 1, User- Defined Stat 2, Capture Trigger (UDS 3), Capture filter (UDS 4), User-Defined Stat 5, User-Defined Stat 6, 8 QoS counters, Data Integrity Frames, Data Integrity Errors, PRBS BER, PRBS Errored Bits, and PRBS Bits Received, Sequence Checking Frames, Sequence Checking Errors, ARP, and Ping requests and replies.</td>
</tr>
<tr>
<td><strong>Error generation</strong></td>
<td>CRC (Good/Bad/None), Undersize, Oversize.</td>
</tr>
<tr>
<td><strong>Packet flow statistics</strong></td>
<td>Real-time statistics to track up to 128K packet flows with throughput and latency measurements.</td>
</tr>
<tr>
<td><strong>Latency measurements</strong></td>
<td>20ns resolution</td>
</tr>
<tr>
<td><strong>IPv4, IPv6, UDP, TCP</strong></td>
<td>Hardware checksum generation</td>
</tr>
<tr>
<td><strong>Frame length controls</strong></td>
<td>Fixed, random, weighted random, or increment by user-defined step, random, weighted random.</td>
</tr>
</tbody>
</table>

### APPLICATIONS SUPPORT

<table>
<thead>
<tr>
<th>Application</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application - IxExplorer™</strong></td>
<td>A full-featured layer 2-3 wire-speed Ethernet traffic generation and analysis test application with full support for stateless protocol functional and scalability testing. IxExplorer is included with the purchase of all Ixia chassis.</td>
</tr>
<tr>
<td><strong>Application - IxNetwork™</strong></td>
<td>IxNetwork provides wire-rate traffic generation with service modeling that builds realistic, dynamically-controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for switching, routing, ARP, ICMP, DHCP, IPv4, IPv6, multicast, AVB and timing (gPTP and 1588) protocols.</td>
</tr>
<tr>
<td><strong>Application IxANVL</strong></td>
<td>Provides industry standard AUTOSAR IP/Ethernet compatibility, standards compliance, interoperability, ECU configuration and functionality tests for Automotive Ethernet switches and ECUs.</td>
</tr>
</tbody>
</table>
KEY FEATURES

FLEXIBLE PACKET GENERATION
Each Ixia GE XMVAE test port is capable of generating precisely-controlled network traffic at up to wire speed using Ixia's IxExplorer test application. Millions of packet flows can be configured on each port with fully customizable packet header fields. Flexible header control is available for Ethernet, AVB, IPv4/v6, ARP, TCP, UDP, VLANs, Q-in-Q, DHCP, and many others protocols. Payload contents can also be customized with incrementing/decrementing, fixed, random, or user-defined information. Frame sizes can be fixed, varied according to a pattern, or randomly assigned across a weighted range. Rate control can be flexibly defined in frames per second, bits per second, percentage of line rate, or inter-packet gap time.

REAL-TIME LATENCY
Packets representing different traffic profiles can be associated with packet group identifiers (PGIDs). The receiving port measures the minimum, maximum, and average latency in real time for each packet belonging to different groups. Measurable latencies include:

- Instantaneous latency and inter-arrival time where each packet is associated with one group ID
- Latency bins, where PGIDs can be associated with a latency range
- Latency over time, where multiple PGIDs can be placed in "time buckets" with fixed durations
- First and last time stamps, where each PGID can store the timestamps of first and last received packets

TRANSMIT SCHEDULER
There are two modes of transmission available - Packet Stream and Advanced Stream Scheduler:

PACKET STREAM SCHEDULER
In Packet Stream Scheduler mode, the transmit engine allows configuration of up to 256 unique sequential stream groupings on each port. Multiple streams can be defined in sequence, each containing multiple packet flows defined by unique characteristics. After transmission of all packets in the first stream, control is passed to the next defined stream in the sequence. After reaching the last stream in the sequence, transmission may either cease, or control may be passed on to any other stream in the sequence. Therefore, multiple streams are cycled through, representing different traffic profiles to simulate real network traffic.

ADVANCED STREAM SCHEDULER
In Advanced Stream Scheduler mode, the transmission of stream groupings is interleaved per port. For example, assume a port is configured with three streams. If Stream 1 is defined with UDP packets at 20% of line rate, Stream 2 is defined with TCP packets at 50% of line rate, and Stream 3 is defined with AVB packets at 30% of line rate, data on the port will be transmitted at an aggregate utilization of 100% with interleaved UDP, TCP, and AVB packets.
EXTENSIVE STATISTICS

- Real-time 64-bit frame counts and rates
- Spreadsheet presentation format for convenient manipulation of statistics counters
- Eight quality of service counters (supporting 802.1p, DSCP, and IPv4 TOS measurements)
- Six user-defined statistics that use a trigger condition
- Extended statistics for ARP, IP, ICMP, DHCP, gPTP and MSRP
- Transmit stream statistics for frame counts and rates
- External logging to file for statistics and alerts
- Audible and visual alerts with user-definable thresholds

DATA CAPTURE

Each port is equipped with 64 MB of capture memory, capable of storing tens of thousands of packets in real time. The capture buffer can be configured to store packets based on user-defined trigger and filter conditions. Decodes for VLAN, IPv4, IPv6, ARP, ICMP, DHCP, IGMP, UDP, TCP, gPTP, 1722, MSRP and various other protocols are provided.

DATA INTEGRITY

As packets traverse through networks, IP header contents may change resulting in the recalculation of packet CRC values. To validate device performance, the data integrity function of XMVAE Gigabit Ethernet modules allows packet payload contents to be verified with a unique CRC that is independent of the packet CRC. This ensures that the payload is not disturbed as the device changes header fields.

SEQUENCE AND DUPLICATE PACKET CHECKING

Sequence numbers can be inserted at a user-defined offset in the payload of each transmitted packet. Upon receipt of the packets by the device under test (DUT), out-of-sequence errors or duplicated packets are reported in real time at wire-speed rates. The user can define a sequence error threshold to distinguish between small versus big errors, and the receive port can measure the amount of small, big, reversed, and total errors. Alternatively, the user can use the duplicate packet detection mode to observe that multiple packets with the same sequence number are received and analyzed.

L2-3 PROTOCOL EMULATION

Ixia's XMVAE Gigabit Ethernet modules support performance and functionality testing using routing/bridging protocol emulation via the IxNetwork and IxAutomate applications. Protocols supported include: MSRP, gPTP, VLAN, STP/RSTP, MSTP, PVST+/RPVST+, MSRP, link aggregation (LACP), ESMC, PTP, PPPoX, DHCPv4 client/server, DHCPv6 client/server, 802.1x, WebAuth.

IxNetwork offers the customization and flexibility to test hundreds of switches and ECUs. IxNetwork can customize millions of traffic flows to stress data plane performance. Powerful GUI wizards and grid controls allow users to create sophisticated traffic flows with ease. Its enhanced real-time analysis and statistics are capable of reporting comprehensive protocol status and detailed per-flow traffic performance metrics.
AVB TESTING
Ixia's XMVAE Gigabit Ethernet modules support functional and performance testing of MSRP and gPTP protocols. Users can send both 1722 and 1733 encapsulated and VLAN encapsulated traffic at line rate for the AVB reserved streams. Clock hierarchy can be established using gPTP BMCA algorithm or using static clock roles (typical for automotive environments) and synchronization of various clocks can be measured using the in-built Stratum-3 clock that has 20 ns of timestamp resolution. This load module’s capability to measure the latency, latency variation, loss and sequence errors allows extensive performance evaluation of various algorithms such as Strict Priority Queuing, Weighted Round-Robin, Weighted Fair Queuing and Credit Based Shaper implementations.

ECU TESTING
Ixia's XMVAE Gigabit Ethernet load modules can connect to the BroadR-Reach interface in ECUs using PHY media converters. The load module can be used to load the Automotive Ethernet network with traffic and test ECU functionality. IxNetwork's powerful Traffic Template can be used to generate custom ECU protocols and load the desired traffic that can be sent at any rate up to the wire-speed. Various benchmarking tests like RFC 2544 can be run to fully qualify the embedded switches in the ECUs.

TCL, PERL AND PYTHON API
Ixia's XMVAE Gigabit Ethernet modules are supported by a comprehensive Tcl, Perl and Python application programming interface (API). This API allows users to develop custom scripts and integrate the modules into automated test environments.

ORDERING INFORMATION

944-1130
LSM1000XMVAE8 GIGABIT ETHERNET LOAD MODULE, 8-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps; full featured L2-L7 with BroadR-Reach enabled (requires separate BroadR-Reach transceivers); Fiber Ports REQUIRE SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU. The load module is compatible with the XGS12-SD 12-slot, standard performance rack mount chassis bundle (940-0011), XGS12-HS 12-slot, high-speed performance rackmount chassis bundle (940-0006), XG12 12-slot, rackmount chassis (940-0005), XGS2-SD 2-slot, 3RU standard performance chassis bundle (940-0010), XGS2-HS 2-slot, 3RU high-speed performance chassis bundle (940-0012) and the XM2 desktop chassis (941-0003).

944-1131
LSM1000XMVAE16 Gigabit Ethernet Load Module, 16-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps; full featured L2-L7 with BroadR-Reach enabled (requires separate BroadR-Reach transceivers); Fiber Ports REQUIRE SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU. The load module is compatible with the XGS12-SD 12-slot, standard performance rack mount chassis bundle (940-0011), XGS12-HS 12-slot, high-speed performance rackmount chassis bundle (940-0006), XG12 12-slot, rackmount chassis (940-0005), XGS2-SD 2-slot, 3RU standard performance chassis bundle (940-0010), XGS2-HS 2-slot, 3RU high-speed performance chassis bundle (940-0012) and the XM2 desktop chassis (941-0003).
RELATED PRODUCTS

948-0033
100Base-T1 automotive BroadR-Reach transceiver, requires compatible Automotive Ethernet XMVAE card (944-1130 or 944-1131)

930-2056

930-2113
IxNetwork AVB/TSN. Includes: gPTP, Qbv Scheduled Traffic, CBS, MSRP, 1722 and 1733 protocol emulation with support the AVnu Automotive Profile 1.4 Specification testing. Requires 930-2056 or 930-2076.