

GRID SOLUTIONS JPAX-H



High Capacity Optical Multi-Technology Solution

JPAX-H is a FANLESS device supporting both MPLS-TP (Multi-protocol Label Switching) and Carrier Ethernet (EPL, EVPL, EPLAN, EVC defined in MEF) for packet transportation. In addition to native Ethernet transport, JPAX-H can be used as a gateway for legacy PDH and SDH/SONET networks to enter Packet Switched Networks maintaining deterministic performance, service integrity, ease of integration and at the same time increasing efficiency.

To minimize latencies, TDM data encapsulation into MPLS and asymmetric delays for teleprotection services, the JPAX-H platform implements an innovative Hybrid+ technology that allows for optionally carrying TDM services over the SONET/SDH transport layer established alongside the MPLS-TP transport layer (without impacting its capacity) over the same fiber ensuring sub-ms latency time for critical applications. This innovative transport concept offers the best of both worlds by preserving SONET/SDH performance in a packet-switched network without a need for additional fibers or advanced traffic engineering.

JPAX-H has core switching bandwidth of 400Gbps capable to transport 100GE, 40GE, 10GE and 1GE along with additional TDM interfaces, including STM-n/OC-n, E1/T1, and a rich variety of low-speed DS0 interfaces. The system is a perfect combination of PTN/CE, SDH, and PDH technologies. It supports MPLS-TP LSP 1:1/1+1 protection and ERPS, with protection switching time <50ms. Ethernet and MPLS section and end-to-end OAM are also provided for monitoring service integrity and performance. The JPAX-H is 5U in height, and its powerful functions enable customers to provision a service-grooming hub, ring, or mesh packet network with ultimate ease.

Key Benefits

- FANLESS solution
- Sub-ms latency for critical applications
- Customer data protection (encryption)
- Multi-technology platform supporting legacy, PDH, SDH, SONET, and MPLS-TP

Multiple Interface Variants

- High board density
- Conventional FXO, FXS, E&M, RS232, RS422, RS484, V.35, V.36, X.21, Nx 64k, dry contact
- Dedicated for power utilities: DTT, C37.94, TDMoE, G704 Co and Contra-Directional
- PDH/SDH/SONET: E1/T1, STM1, STM4, STM16, OC-3, OC-12, OC-48
- Ethernet with Layer 2 and Layer 3 support
- Packet: 1G, 10G, 40G, 100G MPLS-TP

Advanced Features

- PoE, PoE+ and PoE++
- Security: MacSec (auto key rotation), LSPSec, IPSec, HTTPS, SSH, SNMPv3 and syslog

Robust & Reliable

- FANLESS design (IEEE1613)
- Extended -20°C to +60°C / -4F to +140F operating temperature
- High level of reliability via full redundancy
- Hot swappable units eliminate the need to power down the multiplexer, minimizing traffic disruptions
- SNCP, MSP (1+1), LSP 1+1/1:1, ERPS protection network topology
- Hitless protection
- Fully compliant with international standards

Network Management

- Graphical local and remote management
- End-to-end service provisioning (TDM/ MPLS-TP)
- Real-time system redundancy
- SNMP-based



GE VERNOVA

GE's JPAX-H is a purpose-built fiber optic solution for high-performance industrial communication networks requiring mission-critical and time-sensitive communications within harsh utility environments. The platform provides private, secure, and reliable communication between collection/access sites, and guarantees performance over aggregation and backhaul networks for protection and/or control. The JPAX-H has been designed for utilities with standards based MPLS-TP for superior performance of packet delivery and network operations, taking into consideration the operational and environmental conditions and addressing the communication challenges that utilities are currently facing as well as meeting future business needs.

The JPAX-H provides the following benefits:

- Designed for teleprotection and superior performance
- Scalable for high-capacity data transmission up to 100Gbps
- Single solution in a multi-technology platform converging and simplifying operations
- Ruggedized and modular design lowering total cost of ownership
- Compatible with existing GE JMUX/PAX networks and 3rd party standard devices
- Cybersecurity

Ideally Suited for Teleprotection

The JPAX-H platform has been improved to deliver teleprotection with utility-grade performance with through MPLS-TP or Hybrid transmission with sub-ms latency time. Designed with layers of redundancy, there is no single point of failure, providing customers with an assurance that critical teleprotection circuits are delivered securely and dependably across the network.

Benefits of JPAX-H Platform Include:

- Perform critical low latency applications where security and dependability must be guaranteed
- Employ hardware-based fault detection with protection switching mechanisms to restore services via route diversified paths
- Utilize Synchronous Ethernet (SyncE) to tightly control variability in transmission that affects critical communication services
- Support co-routed bidirectional paths to eliminate asymmetrical delays that affect critical communication services across a network
- Provide determinism via a connection-oriented approach to packet transmission
- Permit static assignment of working and protect paths to ensure application performance and eliminate complexity associated with dynamic control plane protocols

Flexible Connectivity Future Proofs Investment

The JPAX-H platform has considerable flexibility and scalability, enabling wider deployment options and diverse network connectivity choices. The platform offers customers a solution to address the challenges of capacity constraints while maintaining essential service separation between disparate applications. JPAX-H is a converged platform that future proofs a customer's investment with a lower cost of ownership by offering flexible connectivity options to carry diverse packet and TDM-based client services.

Ruggedized for Longer Life

The JPAX-H is industrially hardened and designed for deployment in harsh substation environments where conditions are not optimal for traditional telecom equipment. The superior thermal design enables reliable operation across an extended temperature range without active cooling, enabling improved reliability, longer life and lower maintenance costs.

The rugged, industrial features of the solution include:

- Designed for compliance to IEEE 1613 and IEC 61850-3, with no cooling fans
- Extended temperature range from -20°C to +60°C (-4°F to +140°F)
- Quality component selection / design for five 9's
- Hot-swappable modules



Simplified Migration from JMUX/TN1U to JPAX-H Networks

The Evolution module allows compatibility and simplified migration of GE Lentronics SONET/SDH multiplexer networks to JPAX-H MPLS-TP/Hybrid networks on a ring-by-ring or node-by-node basis. The VT1.5/TU-12 traffic originated at JMUX/TN1U nodes can be terminated at JPAX-H nodes while its working and protect paths can be either partially or entirely carried over the SONET/SDH layer.

1. TDM traffic is presented into both left and right fiber directions (1+1 protection)
2. JMUX/TN1U node equipped with Evolution Modules pass the TDM traffic over 1G+ optical links to JPAX-H (single or dual-homed) equipped with JEVO module
3. JPAX-H has the flexibility to convert the TDM traffic to packet or preserve the TDM traffic over a Hybrid transport mode
4. JPAX-H terminates the Packet or TDM traffic from both redundant fiber paths

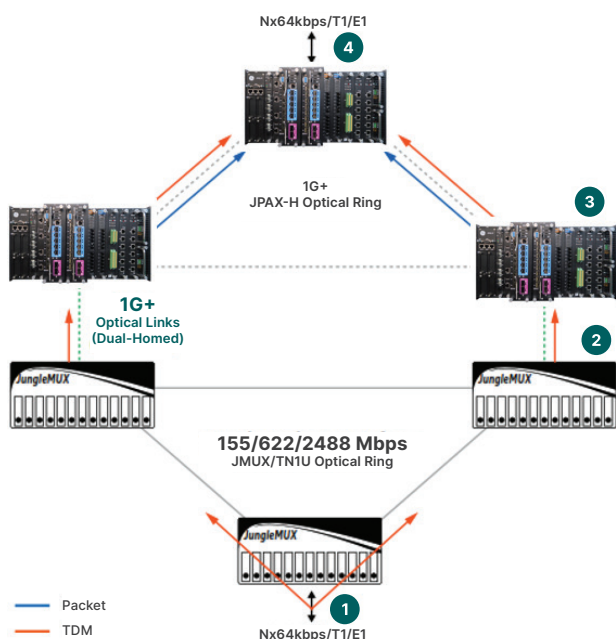


Figure 1 – Flexibility of routing either packetized traffic or preserving TDM end-to-end

Customer Applications



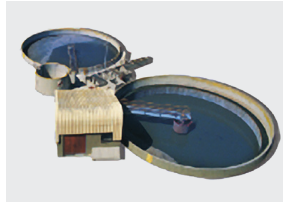
Energy

- Communication between substations, generation plants, control centers, and administration offices
- Supporting teleprotection, video surveillance, SCADA, substation automation, voice and data



Oil & Gas

- Communication between well clusters, production platforms, tank storage, and control centers
- Voice, data, CCTV, IP/Ethernet telecom services for SCADA, safety/fire, and security sub-systems



Water & Wastewater

- Communication between remote wells, dams, metering, treatment facilities, pumping/compressor stations, and control centers
- Voice, data, CCTV, IP/Ethernet, security and safety sub-systems



Transportation

- Communication for train platforms, traction power substations, wayside cabinets, maintenance facilities, and control centers
- Data, voice, transducers and contacts, IP/Ethernet

Features

Mechanical and Electrical

- 5U height, 19" width ETSI unit (front access)
- Power supply: hot swappable DC, dual for redundancy
- Operating Temperature: -20 °C to 60 °C (-4°F to +140°F)
- Supports FANLESS operation

Digital Counters

- 2 × 100GE/40GE ports (external FAN required)
- 34 × 10GE
- 87 × 1GE
- 70 x FE Base-T
- 224 x E1/T1 ports
- 112 x DS3 ports
- 52 x STM-1/ OC-3
- 49 x STM4 ports / OC-12
- 12 x STM16 ports / OC-48

MPLS-TP

- Any Ethernet port can be configured as NNI (MPLS port) or UNI (Ethernet service port)
- Bi-directional LSP
- Static LSP/PW provisioning via NMS
- Ethernet (VPWS, VPLS, H-VPLS) and TDM (CESoPSN, CEP, and SAToP) services
- MPLS-TP OAM and QoS
- TDM PW Support per card:
 - 32TE1 card: up to 256 pseudowires
 - B16 card: up to 1024 pseudowires

Carrier Ethernet

- L2 Switching/Bridging
- STP, RSTP, MSTP
- Port based VLAN and port isolation
- VLAN Stacking (Q-in-Q)
- CE OAM
 - CFM: Ethernet Service OAM (802.1ag/Y1731)
 - EFM: Ethernet Link OAM (802.3ah)
- Flow Control
- Link Aggregation Control Protocol (LACP)
- Jumbo Frame (MTU) : 9600
- Layer 2 Multicast Entries: 2K
- EPL, EVPL, EP-LAN, EPV-LAN, EP-Tree
- E-Access: EPL-Access, EPVL-Access

Network Protection

- MPLS-TP
 - LSP 1+1/1:1
 - LSP E2E protection switching < 50ms
 - PW Redundancy
 - Based on TP OAM for fault detection
- CE
 - ERPS Ring (G.8032) Protection
 - ELPS (G.8031) Linear Protection
- SDH/SONET
 - STM-n/OC-n MSP 1+1 Protection
- HITLESS

TDM Pseudowire Services

- Circuit Emulation
 - DS0 (64K timeslots): CES & multiframe PW
 - Unframed E1/T1: SAToP PW
 - VC-3/4/11/12, VT-1.5/2, STS-1/3: CEP PW
- PDH Timing recovery: ACR/DCR/System
- ACR/DCR support
- SDH Circuit Emulation over Packet (CEP)
- Encapsulation
 - PW/LSP (TDM over MPLS-TP),
 - "Dry martini", MEF 8 (TDM over Ethernet),
 - TDM over IP
- DS0 cross-connection
 - Two-way FE1(N*DS0) to FE1/VC12/STM1 cross-connection
 - Two-way FE1(N*DS0) to FE1(N*DS0) cross-connection

Ethernet Pseudowire Services

- E-Line, E-LAN, E-Tree services as defined by MEF 9 and 14 and using VPWS/VPLS
- Native Ethernet packets supported
- Encapsulation: PW/LSP (MPLS-TP), VLAN tagging (1Q), VLAN double tagging (Q-in-Q)

VPLS

- VPLS bridging
- H-VPLS bridging
- 128K MAC addresses
- 2K VPLS/VFI instances per device
- Split horizon to prevent forwarding loops

CoS/QoS

- 8 Priority Queues
- Scheduling: Strict Priority, WRR with Hierarchy
- Ingress Policing & Egress Shaping per service
- CIR / PIR (EIR) 2-rate-3-color
- MPLS: TC/EXP-Inferred-PSC (Per Hop Behavior Scheduling Class) LSP

Timing

- SSM quality level compatible
- IEEE 1588 v2 (via SyncE only)
 - PTP Clocks: Ordinary/Boundary/Transparent
 - ToD (Time of day)
 - 1-PPS (One Pulse per second) output interface
 - G.8265.1 Profile (Frequency Synchronization)
- SyncE
 - Synchronous Ethernet from all built-in and plug-in GbE, 10/40/100GbE ports
 - ITU-T Ethernet Synchronous Message Channel (ESMC)
- Stratum 3 timing
- TDM line clock: E1/T1 and STM/OC ports
- External clock input and output (2 Mbps / 2 MHz)

Management

- Fully manageable via SNMP (v1, v2, v3)
- Fully manageable via CLI
 - Serial port
 - SSH, Telnet via Ethernet
- GbE Interface in-bands
- Account Security
 - Two types of privileges: Operator (read only) and Administrator (read and write)
 - Radius Client and 802.1x Authentication
- Upload/Download NE configuration
- Syslog, NTP
- SNMP Port 1:1 Protection
- Console 1+1 Protection

Layer 3

- VRF without multicast protocols
- ARP, Ping, Trace route
- VRRP
- Static Route
- RIP v1/v2
- OSPF
- Routing among Physical Ethernet ports, VLAN virtual port (VLAN routing), and PW ports.
- 32 Subinterfaces
- IGMP v2/v3
- PIM-SM
- NTP server/client

Network Security

- MACSec (Media Access Control Security)
 - IEEE 802.1AE MACsec
 - AES-128-CMAC or AES-256-CMAC
 - Authentication using Certificate or Pre-Shared Keys (PSK)
 - Switch-to-Switch (static CAK) mode
 - Switch-to-Host (dynamic CAK) mode
- IPSec (Internet Protocol Security)
 - IPSec/IKE VPN tunnel for Control-plane
 - IKEv1/IKEv2 support
 - Support encryption algorithms: AES128, AES256
 - Support integrity algorithms – md5, sha1, sha256
 - Password- (PSK) based and certificate- (pubkey) based keys

Ordering Information

Note: RoHS compliant units are identified by the letter **G** appearing at the end of the ordering code.

| ORDERING CODE | DESCRIPTION |
|------------------------------------|---|
| Main Unit | |
| GE-JPAX-H-CHB-G | 5U height rack chassis for JPAX-H without CPU, power, connector board, fan and plug-in cards. |
| Connector Board | |
| GE-JPAX-H-CBB-G | 1* DB15 for TOD/PPS 1* RJ45 for CLK I/O (2*IN & 2*OUT for 2M/E1) 1* RJ45 for ALARM I/P (4 alarm Inputs) 1* RJ45 for ALARM O/P (4 alarm outputs) |
| CPU Module | |
| GE-JPAX-H-CC2-LITE-G | Controller/CPU module for JPAX-H chassis with RS232 console port. It supports core switching bandwidth up to 400Gbps and I/O bandwidth up to 396Gbps with full-duplex at wire-speed. This module also supports built-in line interfaces including — 2 × 10GE SFP+ ports, and additional 10GE ports available with activation license — 4 × 1GE SFP ports, and additional 1GE ports available with activation license — Optional two 100GE/40GE ports available with activation license |
| Port Activation License | |
| GE-JPAX-H-CC2-100G-LIC | 100G/40G port activation license on single CC2 controller One license will activate all 100G/40G ports on single controller. For systems with CC2 controller redundancy, each CC2 requires its own license activation respectively |
| GE-JPAX-H-CC2-10G-LIC | License to activate ONE 10GE Port on single CC2 controller One license will activate ONE 10G port on single controller. For systems with CC2 controller redundancy, each CC2 requires its own 10G license activation respectively |
| GE-JPAX-H-CC2-1G-LIC | 100G/40G port activation license on single CC2 controller One license will activate ONE 1GE port on single controller. For systems with CC2 controller redundancy, each CC2 requires its own 1GE license activation respectively |
| External Fan Control Module | |
| GE-JPAX-H-eFBC-G | External Fan Control card on the master unit to control the eFBOX unit (optional) |

Select 1 to 7 cards from High-Speed and Low-Speed Tributary Module Lists

High Speed or High Density Tributary Modules

| ORDERING CODE | DESCRIPTION |
|------------------------|---|
| GE-JPAX-H-TE1-32CEM-G | 32-port E1(120 ohm) or 32-port T1 software programmable plug-in module with SCSI interfaces. Used for T1/E1 CEM over PTN |
| GE-JPAX-H-TE1-16CEM-G | 16-port E1(120 ohm) or 16-port T1 software programmable plug-in module with SCSI interfaces. Used for T1/E1 CEM over PTN |
| GE-JPAX-H-GFEO-G | 10 × 1G or 1 × 10G Ethernet SFP Optical Interface Card (10G BP slots) 10 x FE SFP Optical Interface Card (1G BP slots) |
| GE-JPAX-H-GEO-1XG-G | 1 × 10G Ethernet SFP Optical Interface card |
| GE-JPAX-H-GEO-10S-G | 10 × 1G Ethernet Optical Interface card |
| GE-JPAX-H-XGEO-G | 9 × 10G Ethernet Port SFP Optical Interface |
| GE-JPAX-H-GFET-8T-G | 8 × 1000/100/10Mbps Ethernet Twist-Pair RJ45 (10G BP slots) 8 × 100/10Mbps Twist-Pair RJ45 (1G BP slots) |
| GE-JPAX-H-GFET-8POE1-G | Powered by the backplane 8 × 1000/100/10Mbps Ethernet Twist-Pair w/ PoE RJ45 (10G BP slots) 8 × 100/10Mbps FE Twist-Pair w/ PoE RJ45 (1G BP slots) |
| GE-JPAX-H-GFET-8POE2-G | External power for PoE+ 8 × 1000/100/10Mbps Ethernet Twist-Pair w/ PoE/PoE+ RJ45 (10G BP slots) 8 × 100/10Mbps FE Twist-Pair w/ PoE/PoE+ RJ45 (1G BP slots) |
| GE-JPAX-H-GFET-4POEP-G | External Power for PoE+/PoE++ (PoE++ for 4 ports only) 8 × 1000/100/10Mbps Ethernet Twist-Pair w/ PoE/PoE+/++ RJ45 (10G BP slots) 8 × 100/10Mbps FE Twist-Pair w/ PoE/PoE+/++ RJ45 (1G BP slots) |
| GE-JPAX-H-B2G5-1CEM-G | One STM-16/OC-48 or Four STM-4/STM-1/OC-12/OC-3 interfaces without SFP (mini-GBIC) optical modules (10G BP slots) One STM-4/OC-3 or Four STM-1/OC-3 interfaces without SFP (mini-GBIC) optical modules (1G BP slots) |
| GE-JPAX-H-B2G5-2CEM-G | Two STM-16/OC-48 or Eight STM-4/STM-1/OC-12/OC-3 interfaces without SFP (mini-GBIC) optical modules (10G BP slots) |
| GE-JPAX-H-B2G5-EoS-G | Ethernet over SDH/SoNET with 1 x STM16 / 1 x OC48 worth traffic over CEM card. |

| ORDERING CODE | DESCRIPTION |
|------------------------------------|---|
| GE-JPAX-H-JEVO-G | JEVO card is used to interface with GE JMUX/JPAX devices via proprietary 1G+ (WIS WAN Ethernet) interface (slot 3 & 4) |
| Low Speed Tributary Modules | |
| GE-JPAX-H-12FXOA-G | 12-channel FXOA plug-in card with 600/900 Impedance, Battery Reverse and Loop Start. Without Ground Start and Metering Pulse. Used with 12 RJ11. |
| GE-JPAX-H-12FXSA-GMP-G | 12-channel FXSA plug-in card with 600/900 Impedance, Battery Reverse, Loop Start, PLAR, [PLAR bit programmable], [Ground Start] and [Metering Pulse]. Used with 12 RJ11. |
| GE-JPAX-H-8EMA-G | 8-channel 2W/4W E&MA plug-in card. Used with 8 RJ45 connectors or 1 Telco 64 connector |
| GE-JPAX-H-4E1-G | 4-channel E1 plug-in card |
| GE-JPAX-H-4T1-G | 4-channel T1 plug-in card |
| GE-JPAX-H-6UDTEA-G | 6-port universal data interface card that supports three software configurable modes: Port 1 to 4: two DB44 connectors Port 5 to 6: two RJ48 connectors Mode 1: Port 1 to 4: RS232/RS422/X.21, Async/Sync 64kbps and subrate with V.110 encoding Port 5 to 6: RS232 for ASYNC only Mode 2: Port 1 to 4: X.21/RS422 SYNC N*64k (N=1~32) Port 5 to 6: Disabled Mode 3: Port 1 to 3: X.21/RS422 SYNC N*64k, (N=1~32). Port 4: X.21/RS422 SYNC, N*64k, (N=1~20). Port 5 to 6: RS232 N*64k (N=1~6) oversampling for ASYNC data. Mode 4: Port 1 to 4: RS232/RS422/X.21/V.35/V.36/EIA530 SYNC 38.4K and subrate Port 5 to 6: Disabled Mode 5: Port 1 to 4: X.21/RS449/RS422/RS232/V.35/V.36/EIA530 SYNC N*64k (N=1~32) Port 5 to 6: Disabled |
| GE-JPAX-H-8UDTEA-G | 8-port universal data interface card that supports RS232/RS422/RS485 full-duplex DCE interface which is software configurable Available option mode: Terminal Server, Omnibus, and Clock Pass Through |
| GE-JPAX-H-8RS232-RJ-G | 8-port RS232 plug-in card with X.50 subrate multiplexing scheme and X.54 encoding, with 8 RJ48 connectors for 8 RS232 Async ports |
| GE-JPAX-H-8RS232-DB-G | 8-port RS232 plug-in card with X.50 subrate multiplexing scheme and X.54 encoding, with 2 RJ48 connectors and 2 DB44 connectors for Async and Sync ports |
| GE-JPAX-H-6RS232i-RJ-G | 6-port RS232 card with port isolation, 6 x RJ connectors for 6 Sync/Async RS232 ports |
| GE-JPAX-H-6CDA-G | 6-channel G.703 Interface at 64 Kbps data rate. Per port configurable for Co-directional or Contra-directional interfaces. |
| GE-JPAX-H-8DCC-G | 8-channel dry contact type A plug-in card with maximum voltage 100 Vdc or 250 Vac |
| GE-JPAX-H-8DCB-G | 8-channel dry contact type B plug-in card with maximum voltage 220 Vdc or 250 Vac |
| GE-JPAX-H-4C37-G | 4-channel C37.94 plug-in card |
| GE-JPAX-H-RTB-G | 8-LAN port/64 WAN ports router/bridge plug-in card |
| GE-JPAX-H-DTT-G | Transfer trip plug-in module with two ports for DTT input and output. Complied with 48/125V voltage. |

Select 1 to 7 cards from High-Speed and Low-Speed Tributary Module Lists

High Speed or High Density Tributary Modules

| ORDERING CODE | DESCRIPTION |
|----------------------|---|
| GE-JPAX-H-S1T1-G | 1-channel T1 interface card |
| GE-JPAX-H-S1E75-G | 1-channel of E1plug-in card w/ 75 ohm |
| GE-JPAX-H-S1E120-G | 1-channel of E1 plug-in card w/ 120 ohm |
| GE-JPAX-H-SM4T1-G | Mini Quad T1 plug-in card |
| GE-JPAX-H-SM4E75-G | Mini Quad E1 plug-in card with 75 ohm |
| GE-JPAX-H-SM4E120-G | Mini Quad E1 plug-in card with 120 ohm |
| GE-JPAX-H-SFOM-opt-G | Fiber Optical plug-in card |

| ORDERING CODE | DESCRIPTION |
|-----------------------------|---|
| GE-JPAX-H-S1V35-G | 1-channel V.35 plug-in card |
| GE-JPAX-H-S1X21-G | 1-channel X.21 plug-in card |
| GE-JPAX-H-S1RS232-G | 1-channel RS232 plug-in card |
| GE-JPAX-H-S3RS232a-G | 3-channel RS232 Async/Sync, DCE/DTE plug-in card |
| GE-JPAX-H-SQEMA-wr-m-Tn-x-G | Jumper selectable: 2/4 WIRE; A/B side Quad E&M voice card, complied with IEEE1613 standard. |
| GE-JPAX-H-SQFXOA-x-G | Quad FXO voice plug-in card used with 4 RJ11 |
| GE-JPAX-H-SQFXOA-GS-x-G | Quad FXO with GS plug-in card used with 4 RJ11 |
| GE-JPAX-H-SQFXSA-x-pt-G | Quad FXSA voice plug-in card |
| GE-JPAX-H-SQFXSA-M-x-pt-G | Quad FXSA with MP 16 KHz voice plug-in card |
| GE-JPAX-H-SQFXSA-M12-x-pt-G | Quad FXSA with MP 12 KHz voice plug-in card used |
| GE-JPAX-H-SQFXSA-GS-x-pt-G | Quad FXSA with GS plug-in card |
| GE-JPAX-H-SQFXSA-GM-x-pt-G | Quad FXSA with GS and MP 16 KHz voice plug-in card |
| GE-JPAX-H-SRTA-G | 2-LAN ports/64 WAN port router/bridge plug-in card |
| GE-JPAX-H-SM1C37-LSFOM-G | 1- channel C37.94 plug-in mini card |
| Accessories | |
| GE-JPAX-H-SDA-G | Single -48 Vdc (-36 to 75 Vdc) power module |
| GE-JPAX-H-SDB-G | Single 130 Vdc (67.2 to 154 Vdc) power module (future) |
| External FAN Module | |
| GE-JPAX-H-eFBOX-G | 1U External Fan Box with fan slots for master unit cooling This External Fan Box includes one DB15 cable and one DC power cable for connection between eFBOX and master unit |
| GE-JPAX-H-eFAN-G | Fan plug-in module which fits into eFBOX. |

Specifications

| PHYSICAL/ELECTRICAL | |
|---------------------|--|
| Dimensions | 5U, 442× 220 × 223.5 mm (W x H x D) / 17.4 × 8.7 × 8.8 inches (WxHxD) |
| Power | --- 24 Vdc/-48 Vdc (-18 to -75 Vdc) power module --- 130Vdc (future) |
| Temperature | -20 to +60°C / -4 to +140°F (operation) -30 to +70°C / -22 to 158°F (storage) |
| Humidity | 0-95%RH (non-condensing) |
| Mounting | Desk-top stackable, 19/23 inch rack mountable |

Standard Compliance

RFC (IETF)

| | | | |
|------|---|------|--|
| 1042 | Standard for the transmission of IP Datagrams over IEEE 802 Networks | 4664 | Framework for L2VPNs (VPLS/VPWS) |
| 1112 | IGMP V1 | 4665 | Service Requirements for Layer 2 Provider-Provisioned Virtual Private Networks (QoS) |
| 1305 | Network Time Protocol (NTP) Version 3 | 4842 | Considerations for a Transport Profile |
| 2236 | Internet Group Management Protocol, Version 2 | 5085 | Pseudowire Virtual Circuit Connectivity Verification (VCCV) |
| | SNMPv3Applications | 5086 | CESoPSN |
| 2273 | OSPF Version 2 | 5254 | Requirements for Multi-Segment PWE3 |
| 2328 | RIP Version 2 | 5317 | Multiprotocol Label Switching (MPLS) MPLS Generic Associated Channel |
| 2453 | An Architecture for Describing SNMP | 5462 | MPLS Label Stack Entry |
| 2571 | Management Frameworks Message Processing and Dispatching for the | 5586 | MPLS Generic Associated Channel |
| 2572 | Simple Network Management Protocol (SNMP) SNMP Applications Entity MIB (Management Information Base) | 5601 | Pseudowire (PW) Management Information Base (MIB) |
| 2573 | (Version 2) | 5602 | PW over MPLS PSN MIB |
| 2737 | Remote Authentication Dial-In User Service (RADIUS) | 5603 | Ethernet PW MIB |
| 2865 | Multiprotocol Label Switching Architecture MPLS Label Stack Encoding | 5654 | Requirements OAM for MPLS-TP |
| 3031 | MPLS Support of Differentiated Services | 5659 | An Architecture for Multi-Segment PWE3 |
| 3032 | Internet Group Management Protocol, Version 3 | 5710 | Path Error Message Triggered MPLS and GMPLS LSP Reroutes |
| 3270 | Introduction and Applicability Statements for | 5718 | An In-band Data Communication Network for MPLS-TP |
| 3376 | Internet Standard Management Framework An Architecture for Describing SNMP | 5798 | Virtual Router Redundancy Protocol VRRP Version 3 for IPv4 and IPv6 |
| 3410 | Management Frameworks Message Processing and Dispatching | 5860 | Requirements for OAM in MPLS-TP |
| 3411 | SNMP Applications User-based Security Model | 5880 | Bidirectional Forwarding Detection (BFD) |
| 3412 | View-based Access Control Model | 5882 | Generic Application of Bidirectional Forwarding Detection |
| 3413 | Transport Mappings for the SNMP | 5884 | BFD for MPLS Label Switched Paths |
| 3414 | Management Information Base (MIB) for the | 5885 | BFD for the Pseudowire VCCV |
| 3415 | Simple Network Management Protocol (SNMP) | 5920 | Security Framework for MPLS and GMPLS Networks |
| 3417 | Virtual Router Redundancy Protocol VRRPv2 | 5921 | A Framework of MPLS in Transport Network |
| 3418 | Defense of Textual Conventions (TCs) for MPLS Management MPLS Traffic Engineering (TE) Management Information Base (MIB) | 5950 | MPLS-TP Network Management Framework |
| 3768 | MPLS Label Switching Router (LSR) Management Information Base (MIB) | 5951 | Network Management Requirements for MPLS-TP |
| 3811 | The Advanced Encryption Standard (AES) Cypher Algorithm in the SNMP User-based | 5960 | MPLS-TP Data Plane Architecture |
| 3812 | Security Model Pseudo Wire Emulation Edge-to-Edge | 6215 | MPLS-TP User-to-Network and Network-to-Network Interfaces |
| 3813 | Architecture A Differentiated Service Two-Rate, Three-Color | 6291 | Guidelines for Using "OAM" in the IETF |
| 3826 | Marker with Efficient Handling of In-Profile Traffic Detecting Multi-Protocol Label Switched (MPLS) Data Plane Failures | 6370 | MPLS Transport Profile (MPLS-TP) Identifier |
| 3985 | Pseudowire Emulation Edge-to-Edge (PWE3) Encapsulation Methods for Transport of Ethernet | 6371 | OAM Framework for MPLS-Based Transport Networks |
| 4115 | over MPLS Use over an MPLS PSN SAToP (Structured Agnostic TDM over Packet Switched Networks) Networks | 6372 | MPLS-TP Survivability Framework |
| 4379 | Framework for L2VPNs (VPLS/VPWS) Service Requirements for Layer 2 | 6373 | MPLS-TP Control Plane Framework |
| 4385 | Provider-Provisioned Virtual Private Networks (QoS) | 6374 | Packet Loss and Delay Measurement for MPLS Networks |
| 4448 | Encapsulation Methods for Transport of Ethernet over MPLS Networks | 6375 | A Packet Loss and Delay Measurement Profile for MPLS-Based Transport Networks |
| 4553 | SAToP (Structured Agnostic TDM over Packet Switched Networks) Networks | 6378 | MPLS-TP Linear Protection |
| | | 6426 | On Demand Connectivity Verification |
| | | 6427 | MPLS Fault Management OAM |
| | | 6428 | Proactive Connectivity Verification |
| | | 6478 | Pseudowire Status for Static Pseudowire |
| | | 6639 | MPLS-TP MIB-Based Management Overview |
| | | 6669 | Overview of the OAM Toolset for MPLS-Based Transport Networks |
| | | 6941 | MPLS Transport Profile (MPLS-TP) Security Framework |
| | | 7213 | MPLS Transport Profile (MPLS-TP) Next-Hop Ethernet Addressing |
| | | 7276 | An Overview of OAM |
| | | 7331 | Bidirectional Forwarding Detection (BFD) Management Information Base (MIB) |
| | | 826 | Address Resolution Protocol (ADP) |
| | | 854 | MIL STD 1782 Telnet Protocol Specification |

ITU-T

- G.8031 EPLS
- G.8032 ERPS
- G.8101 Terms and Definitions for MPLS Transport Profile
- G.811 Timing Characteristics of Primary Reference Clocks
- G.8110 MPLS Layer Network Architecture
- G.8110.1 Architecture of MPLS-TP Layer Network
- G.8112 Interfaces for the MPLS-TP Transport Profile Layer Network
- G.8113.2 MPLS-TP OAM
- G.8121 Characteristics of MPLS-TP Network Equipment Functional Blocks
- G.8121.2 Characteristics of MPLS-TP Equipment Functional Blocks Supporting ITU-T G.8113.2/Y.1372.2
- G.8131 MPLS-TP Linear Protection
- G.8151 Management Aspects of the MPLS-TP Network Element
- G.8271 Time and Phase Synchronization Aspects of Packet Networks
- G.8262 Timing Characteristics of a Synchronous Ethernet Equipment Slave Clock
Timing and Synchronization Aspects in Packet Networks
- G.8261 Ethernet OAM
- Y.1731 Operations, Administration and Maintenance (OAM) Functions and Mechanisms for Ethernet-Based Networks

EMC/EMI

- FCC 15 Class A
- EN 55032 Class A/EN 55035
- EN 50121-4
- IEC 61850-3
- ANSI C63.4a-2017
- ETSI EN 300386
- ETSI ES 201468
- ETSI EN 300 019-1-1, 1-2, 1-3, 2-1, 2-2, 2-3
- IEC 61000-4-3
- IEC 61000-4-4
- IEC 61000-4-6
- IEC 60068-2-1
- IEC 60068-2-3
- IEC 60068-2-52
- IEC 60068-2-64

IEEE

- 802.1d STP
- 802.1p Traffic Prioritization
- 802.1w RSTP
- 802.1s MPSP
- 802.1q VLAN
- 802.1ab Local and Metropolitan Area Networks – Station and Media Access Control Connectivity Discovery
- 802.1ad VLAN Tag Stacking (Q-in-Q)
- 802.1ag Ethernet OAM (CFM)
- 802.1X Local and Metropolitan Area Networks: Port-based
- 802.3 Carrier Sense Multiple Access with Collision Detection
- 802.3ab Gigabit Ethernet over Copper
- 802.3ad Link Aggregation Control Protocol
- 802.3ae 10 Gigabit Ethernet
- 802.3ah Ethernet in the First Mile (EFM)
- 802.3u Type 100Base-T MAC Parameters, Physical Layer, MAUs, and Repeater for 100Mb/s Operation
- 802.3x Flow Control
- 802.3z Gigabit Ethernet standard over Fiber (1000Base-SX/LX)
- 1588 v2 Precision Time Protocol (PTP)
- 1613 Environmental and Testing Requirements for Communication Networking Devices Installed in Electric Power Substations

Safety

- EN62368-1

MEF

- 8
- 9
- 14
- MEF Carrier Ethernet (CE) 2.0 Compliant for EPL (Ethernet Private Line), EVPL (Ethernet Virtual Private Line), EVP-LAN (Ethernet Virtual Private LAN), EP-Tree (Ethernet Private Tree), and EVP-Tree (Ethernet Virtual Private Tree)

Environmental Protection Standards

- 2011/65/EU & (EU)2015/863
- 2012/19/EU (WEEE)

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