G.hn Access Multiplexer (GAM)
Quick Installation Guide
GAM-4-CRX / GAM-4-CX

Publication Information

Disclaimer Notice
Although Positron Access Solutions has made every effort to ensure the accuracy of the information
contained herein, this document is subject to change.

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Chapter 1

About the GAM

1.1 Introduction

The GAM is a Fiber to the Distribution Point (FTTDp) solution typically installed inside a wiring closet. The GAM-4-CRX and GAM-4-CX come with one (1) 10 Gigabit SFP+ interfaces to support any type of fiber or PON standards (using an SFP-based or external ONT as required that is compatible with the OLT).

The ITU-T G.9960 G.hn Wave-2 standard leverages the existing telephone wiring (UTP, CAT-3 or CAT-5/5e) or RG-6/RG-59 coax cabling to deliver a Gigabit Internet service to each subscriber without the cost, complexity and delays associated with in-building fiber installation. G.hn is an Access technology for Operators looking to simplify their access network and backend infrastructure with an Ethernet-like technology that is highly scalable without some of the inherent complexity of DSL-related technologies. With G.hn, Operators deliver advanced services such as Gigabit High Speed Residential Internet and 4K IPTV without the high capital and operational expenses associated with a fiber retrofit. Each G.hn subscriber port supports up to 1.7 Gbps of dynamically allocated bandwidth for near symmetrical Gigabit services over the existing telephone wire or coaxial cable. The Positron GAM solution is MEF CE 2.0 compliant and is ideally suited to deliver Business Ethernet services in an MDU and/or MTU deployment.

Note: Read Chapter 4 Safety and Warnings before proceeding.

1.2 GAM Connections

This section provides an overview of the connectors inside the GAM-4-CRX and GAM-4-CX.   Please refer to section 2 for a detailed step-by-step installation procedure.

1.2.1 Power Connection

The GAM-4-CRX is Reverse Power Fed (from G1001-CR endpoint devices) while the GAM-4-CX is locally powered.   There must be at least one (1) G1001-CR device per G.hn coax port of a GAM-4-CRX that is serving customers.   Other subscribers can then use a G1001-CR or a G1001-C/G1000-C as needed.

12Vdc power connector
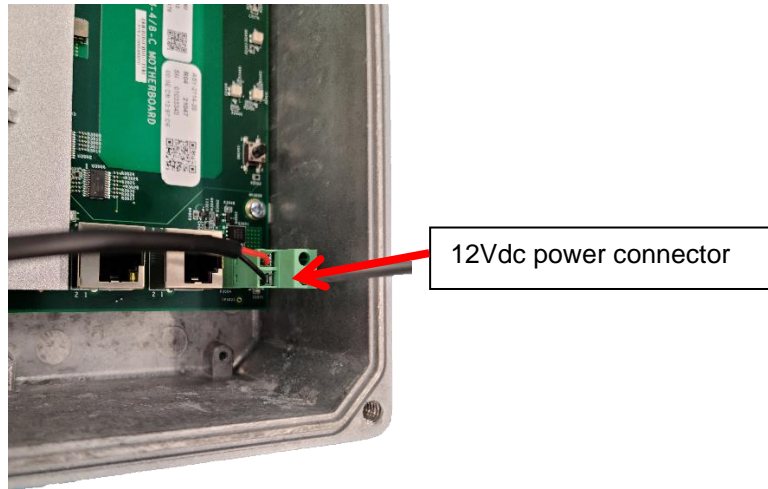
Figure 1*: GAM-4-CR Local Power Input Connector*

1.2.2 **Ethernet (SFP+) Port**
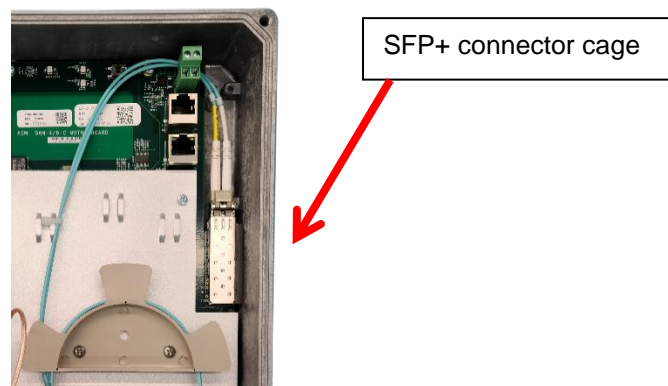
SFP+ connector cage

Figure 2*: GAM SFP+ Connectors*

The GAM has one (1) SFP+ ports that support any MSA-compliant SFP/SFP+ modules. (Fiber: 1G, 10G and Copper RJ-45: 100M, 1G).

Important note: When connecting the SFP+ port to a Passive Optical Network (PON) fiber connection, please make sure to use an Optical Network Unit (ONU) approved by the OLT vendor you are using.

1.2.3 **G.hn Ports**

The GAM-4-CRX and GAM-4-CX have 4 F-type coaxial connectors.

COAX F-type
Connectors

Figure 3: F-type connectors

1.2.4 **Local management ports**

The GAM devices have two (2) local management ports located near the top right corner of the enclosure.

Craft (serial) port

Gigabit Ethernet
Management port
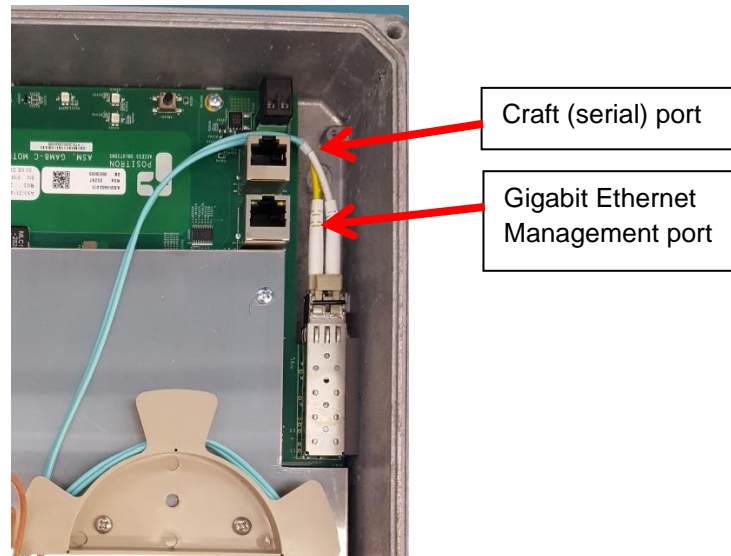
Figure 4: *Local Management Ports are at the top right corner of the GAM circuitry*

The CRAFT port is a standard serial (V.24, 115200, 8, N, 1)) port that provides access to the command line interface of the GAM device.

The pinout of the RJ-45 serial port is compatible with the popular Cisco pinout as per the following diagram:
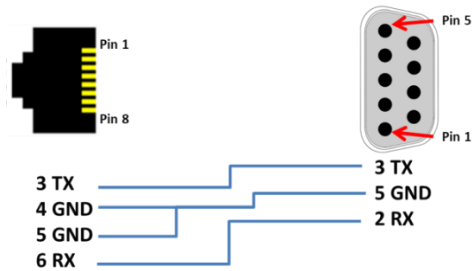
Figure 5: *GAM Serial Management Port pinout*

The MGMT port is a 10/100/1000Base-T Ethernet port provides access to the WEB GUI interface using a standard WEB browser or an SSH interface to the command line interface of the GAM device.

1.2.5 **GAM LED Indicators**

The GAM uses three (3) LED indicators inserted in the cover of the IP67 enclosure to provide information about its global status and operating mode.

Figure 6: *GAM global status LEDs*

LED	Condition	Function
RPF	Off On	Always OFF for the GAM-4-CX since it does not support a Reverse Power Feed
SRV	Solid Green Solid Yellow Solid Red	System OK GAM is starting up No Internet Connection
STA	Solid Green Solid Yellow Blinking Yellow Solid Red	Normal Minor Alarm Active Firmware Update in Progress Critical or Major Alarm Active

Table 1: *GAM Global LED indicators*

Each of the G.hn ports has two (2) status LEDs.
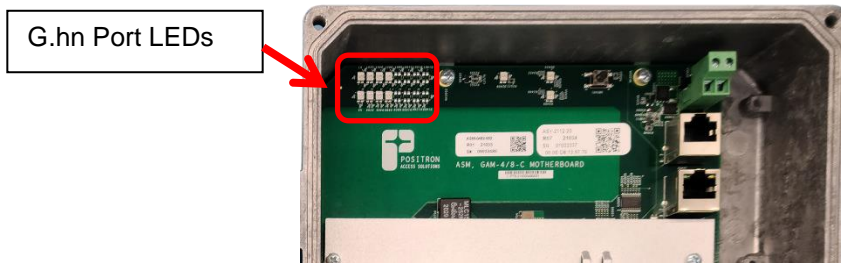
Figure 7: *G.hn Ports LEDs*

The top row of LEDs indicates the state of the G.hn link while the bottom row indicates the presence of the Reverse Power Feed source (from a G1001-CR device at the customer end).

LED	Condition	Function
G.hn ports	Off	Disabled or Link Down
	Blinking	Bad or low speed G.hn link
	On	Link is Up
G.hn port power	Off	Always ON for the GAM-4-CX
	Green	since it is locally powered

Table 2: *G.hn Ports LED indicators*

The SFP+ port of the GAM has a dedicated status LED located near the top of the PCB, to the right of the G.hn LEDs.
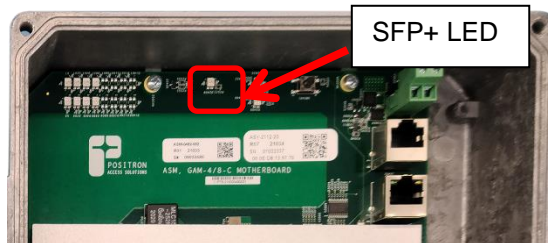
Figure 8: *SFP+ LED*

LED	Condition	Function
Located under SFP+ connector	Off	Disabled or Link is Down
	Green	Link is Up
	Blinking green	Link Activity

Table 3: *SFP+ LED indicator*

1.2.6 **GAM Reset Button**

Press the RST button to reset the GAM. When depressed for two (2) to ten (10) seconds, it will perform a cold reboot of the GAM. When depressed for more than ten (10) seconds, it will return the GAM device to its original factory default settings and will perform a cold reboot of the GAM.
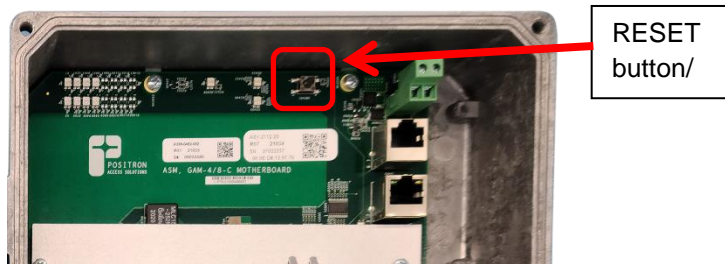
RESET button/

Figure 9: *GAM Reset (RST) button*

Chapter 2

Step by Step Installation

2.1 Step by Step Installation Procedure

Here is a step-by-step procedure to install the GAM-4-CRX and GAM-4-CX outdoor unit.

Begin by connecting the AC-DC Power supply included as part of your GAM-4-CX. You should skip this step if you are using a Reverse Power Fed GAM-4-CRX unless you plan to temporarily power the GAM for a temporary 12Vdc power source during the initial installation / activation of the unit.

Step 1: The 12Vdc connector is located at the top right corner of the GAM enclosure. Pull on the male power connector that ships pre-installed in unit.	

Step 2: using 18 AWG wire, insert the power cable through the rightmost cable gland. You can then connect the 12Vdc power pair to the male power connector and tighten with a small flat screwdriver. +12V GND	
Step 3: insert the male power connector into the female receptacle. You can now connect the other end of the 12Vdc / 4A adapter to the local 110-220VAC power source.	
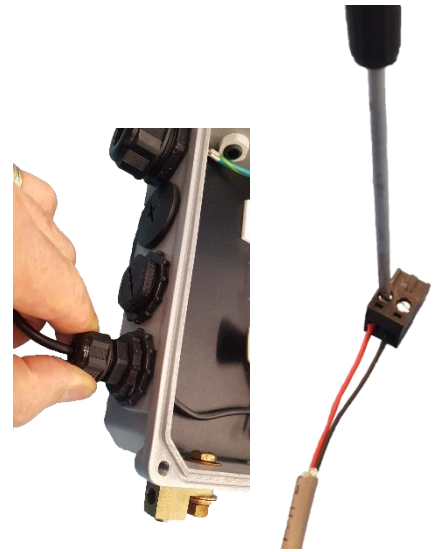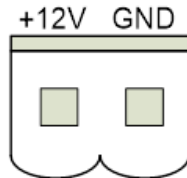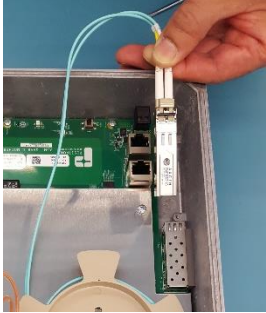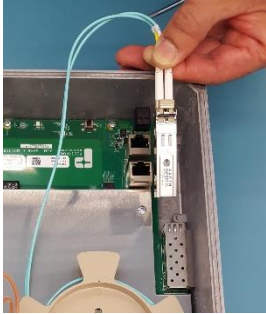
The next step is the insertion of the SFP or SFP+ module that provides the uplink connection.
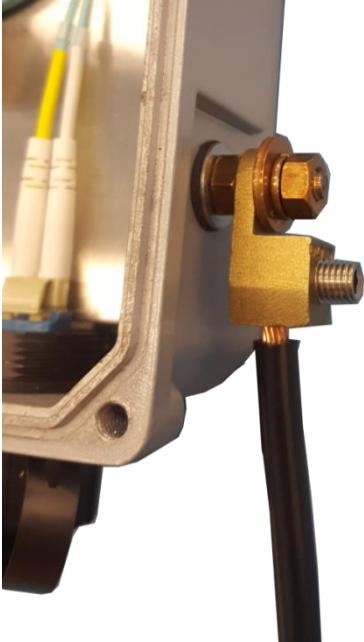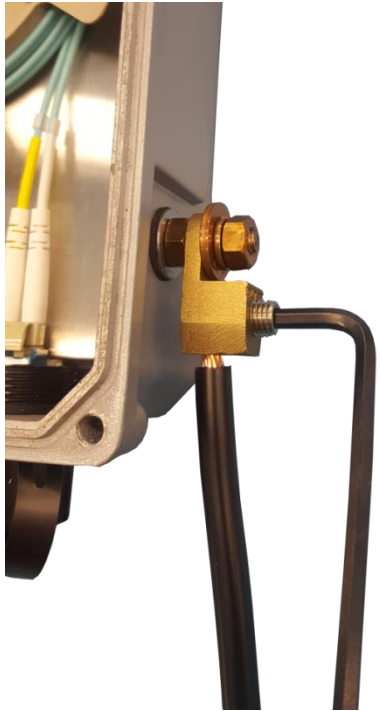
Step 4: Insert the SFP or SFP+ module into the SFP cage at the top right section of the GAM enclosure. Make sure to lock the SFP / SFP+ module in place. **Note:** the SFP cage can accommodate modules that draw up to 3W of power.	

Step 5: install the fiber patch cable around the fiber spool as per the fiber cable provider guidelines. Make sure you have enough length to reach the SFP cage while routing the fiber cable above the 2 x RJ-45 ports at the top right of the GAM enclosure.	
Step 6: insert the fiber connectors into the SFP / SFP+ module. **Note:** while an LC patch cable is shown here, you can also use an SC patch cable or a copper (CAT-5/6e) when using a copper SFP.	
Step 7: make sure you carefully route the fiber patch above and around the internal mini-COAX cables.	

You are now ready to install the ground wire into the ground lug at the bottom right edge of the GAM enclosure.

Step 8: insert the 6 AWG ground wire into the ground lug.	
Step 9: use a 4 mm Allen (hex) key to secure the ground wire.	

You are now ready to securely fasten the cover back onto the enclosure.

Step 10: use a 5 mm Allen (hex) key to secure the 4 screws to ensure the IP67 water protection of the enclosure. Tighten the screws in an X fashion (top-right, bottom-left, top left, bottom right).	

You can now connect the coaxial cable(s) to the F-type COAX connectors of the unit.

Step 11: remove the protective cap on the F-type connector(s) where you will attach a coaxial cable.	
Step 12: securely fasten the F-type connector to the coaxial cable	
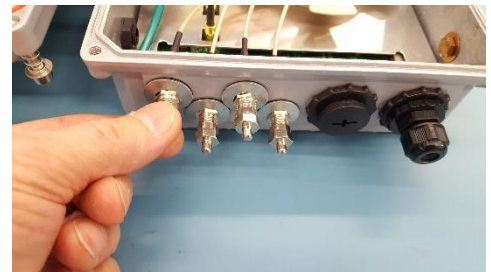
The final step is the installation of the mounting bracket. The mounting bracket included with the GAM enclosure facilitates installation on a pole or a flat surface. You can also strand-mount the device using the optional **GAM-STRAND-KIT** adapter. **NOTE:** the installation and mounting of the GAM shall be done by a qualified technician.

Step 13: the top and bottom brackets are identical. Using the Phillips screws supplied with the unit to fasten the bracket on the back side of the enclosure. Apply a torque of 2.0 Nm (1.47 lb-ft) ± 10% to each M5 screw to secure the bracket.	
Step 14: Once both brackets are attached to the enclosure, you are ready to install the unit at its definitive location. It is recommended to mount the GAM on a ¾ inch plywood using #12 screws (5.5 mm). If you decide to mount on another type of surface, make sure the mounting can withstand the weight of the GAM and of the cables attached to the GAM.	
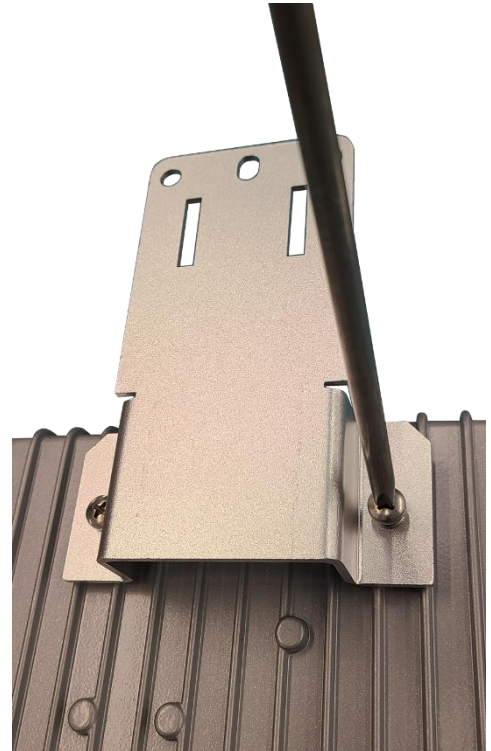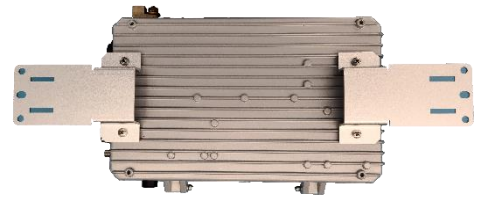
Chapter 3

WEB Management

3.1 Introduction

A WEB GUI interface and a Command Line Interface (CLI) are available to manage GAM devices. Supported WEB browsers include Chrome, Edge, or Firefox.

3.2 System Management

3.2.1 Logging into the WEB GUI

The default configuration values of the GAM devices are:

IP Address	192.168.10.1
Subnet Mask	255.255.255.0
Username	admin
Password	

Table 4: *GAM default credentials*

Enter the system's IP Address into the Web browser and a login screen similar to the following will appear:
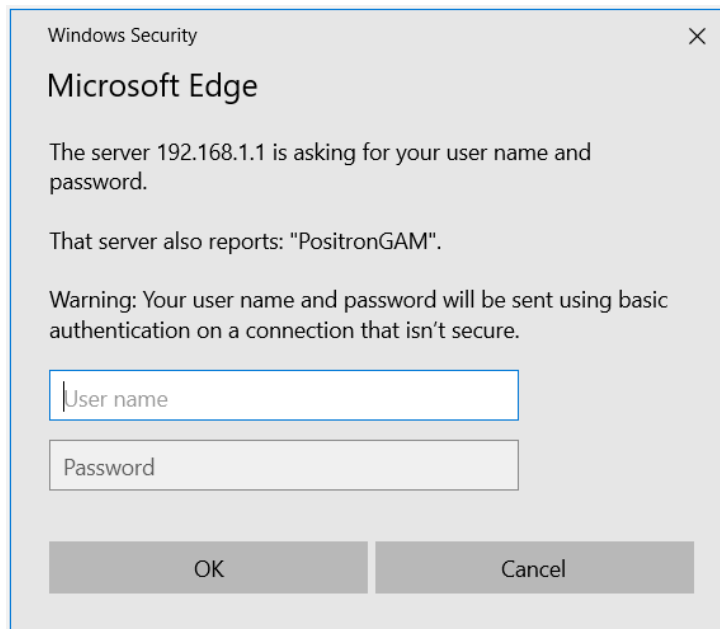
Figure 10: *GAM Login Page (Browser specific)*

Enter a Username and Password for the GAM device. The default Username is **admin** and the default password is null (not defined). Click **OK.**

IMPORTANT SECURITY NOTE: After a successful initial login, please change the password to avoid unauthorized access to the GAM device.

About the X.509 Public Key Infrastructure (PKI) Certificate: you may want to replace the default Positron-signed PKI Certificate used by the WEB GUI Administration Interface pre-installed by Positron with one from your preferred Certificate Authority.

Note: Secure HTTP is disabled by default. HTTPS can be enabled via menu: Configuration>Security>Switch>HTTPS

3.2.2 System

The System monitor page provides a front panel representation of the GAM device. The front panel is specific to the version of the GAM device.   The sample screenshot below is for the GAM-4-CRX.

Figure 11: *GAM Port Status page (default page after login)*

3.2.3 General Information
For complete detail on web management, please refer to the GAM User's Guide.

Chapter 4

Technical Specifications

4.1 GAM Technical Specifications

Part Number	10 GigE SFP+	G.hn Ports / Type	Out-of-band Management Ports
GAM-4-CRX	1	4 x COAX (F-type)	1 x 10/100/1000BaseT 1 x serial
GAM-4-CX	1	4 x COAX (F-type)	1 x 10/100/1000BaseT 1 x serial
Environmental			
Dimensions	8" W x 12" H x 3" D / 200 mm W x 300 mm H x 75 mm D		
Weight	6.4 lbs / 2.9 kg		
Reverse Fed Power Source for GAM-4-CRX	Reverse Power Fed from G1001-CR.		
Local Power Source for GAM-4-CX	110-240VAC to 12Vdc 4A power adapter attached to 12Vdc connector inside the GAM-4-CX		
Safety certification	IEC 62368-1		
Electromagnetic Compatibility	EN 55032, FCC Part 15 Class A		
Other mark	CE		
Operating Temperature	-40ºC to +65ºC		
Storage Temperature	-40ºC to +70ºC		
Operating Humidity	Up to 95% relative, non-condensing		
10 Gbps Network-Network Interface (NNI)			
1 x SFP+ port	SFP+ offer versatile support for Active Ethernet and for GEPON, 10GEPON, NG-PON2 and XGS-PON via external ONU/ONT devices Also compatible with 3rd party PON SFP ONT modules		
G.hn Specification			
G.hn Standards	G.hn Wave-2 Domain Master on all GAM ports (Coax) Based on GigaWire Alliance specification and fully compliant with the following ITU-T standards • G.9960 Amendment 2 - System Architecture and PHY Layer • G.9961 Data Link Layer • G.9962 Management • G.9964 PSD		
Ease of Deployment	Support G.hn operation over coax cabling (F-type connector)		

Point-to-point and Point-to-multipoint Support	Point-to-point (coax) Point-to-multipoint operation (coax) for up to 16 Subscriber CPEs per G.hn port
Ease of Operation	Supports firmware and configuration management of G.hn end-point devices
Encryption	AES-128 encryption with individual keys for each End Point. The Positron GAM Domain Master is also acting as the G.hn Security Controller
Modulation and Frequency Band	Supports OFDM 200 MHz. Radio Band Notching function allows cohabitation with legacy analog cable TV channels on coax cabling
Bandwidth Management	Up to 1.7 Gbps with Dynamic Bandwidth Allocation to optimize throughput based on nature of traffic flows with TDD Multiplexing for programmable upstream / downstream ratio
Reliability and Resiliency	State of the art LDPC Forward Error Correction (FEC)
Layer 2 Switching	
Spanning Tree Protocol (STP)	Standard Spanning Tree 802.1d Rapid Spanning Tree (RSTP) 802.1w Multiple Spanning Tree (MSTP) 802.1s
MAC Table	Up to 32K MAC addresses
Trunking	Link Aggregation Control Protocol (LACP) IEEE 802.3ad for any SFP+ or G.hn ports
VLAN	Supports up to 4K VLANs simultaneously (out of 4096 VLAN IDs) • Port-based VLAN • IEEE 802.1Q tag-based VLAN • IEEE 802.1ad (Q-in-Q) double tag VLAN • MAC-based VLAN • Management VLAN • Private VLAN Edge (PVE)
Generic VLAN Registration (GVRP)	Protocols for automatically propagating and configuring VLANs in a Multicast Domain for IPTV and other multicast services
IGMP v1/v2/v3 snooping	IGMP limits bandwidth-intensive multicast traffic to only the requesters Supports 1024 multicast groups
IGMP Proxy	IGMP snooping with proxy reporting or report suppression actively filters IGMP packets to reduce load on the multicast router
IGMP Query	IGMP query is used to support layer-2 multicast domain in the absence of a multicast router
MLD v1/v2 snooping	Deliver IPv6 multicast packets only to the required receivers
DHCP Server	Supports DHCP server to assign addresses to IPv4 client devices
DHCP Snooping	DHCP snooping provides security by filtering un-trusted DHCP messages and by building and maintaining a DHCP snooping binding table
DHCP Relay	By supporting DHCP option 82, it is possible to forward DHCP requests to another specific DHCP server via DHCP relay. The DHCP server may be on another network
Layer-3 Support	
IPv4 Static Routing	Static routing of IPv4 unicast traffic
IPv6 Static Routing	Static routing of IPv6 unicast traffic

Security	
Secure Shell (SSH) Protocol	SSH secures Telnet traffic in and out of the switch, SSH v1, v2 are supported
Secure Sockets Layer (SSL)	SSL encrypts the HTTP traffic, allowing advanced secure access to the browser-based management GUI in the switch
IEEE 802.1X	IEEE 802.1X: RADIUS authentication, authorization, and accounting, MD5 hash, single / multiple host mode and single / multiple sessions Supports IGMP-RADIUS based 802.1X Dynamic VLAN assignment
RADIUS/ TACACS+	Supports RADIUS and TACACS+ authentication G.hn Aggregation Multiplexer acting as a RADIUS client
Layer 2 Isolation Private VLAN Edge (PVE)	PVE (also known as protected ports) provides L2 isolation between clients in the same VLAN, supports multiple uplinks
Port Security	Locks MAC Addresses to ports and limits the number of learned MAC addresses
Storm Control	Prevents traffic on a LAN from being disrupted by a broadcast, multicast, or unicast storm on a port
ACLs	Supports up to 256 entries Drop or rate limitation based on source and destination MAC, VLAN ID or IP address, protocol, port, differentiated services code point (DSCP) / IP precedence, TCP / UDP source and destination ports, 802.1p priority, Ethernet type, Internet Control Message Protocol (ICMP) packets, IGMP packets, TCP flag
Quality of Service	
Hardware Priority Queue	Support 8 hardware queues
Scheduling	Strict priority and Weighted Round-Robin (WRR) Queue assignment based on DSCP and class of service (802.1p/ CoS)
Classification	Port based; 802.1p VLAN priority based; IPv4/IPv6 precedence/ type of service (ToS) / DSCP based; Differentiated Services (DiffServ); classification and re-marking ACLs, trusted QoS
Rate Limiting	Ingress policer; egress shaping and rate control; per VLAN, per port and flow based
IPv6 Support	Web/ SSL, Telnet/ SSH, ping, Simple Network Time Protocol (SNTP), Trivial File Transfer Protocol (TFTP), SNMP, RADIUS, Syslog, DNS Client, protocol based VLANs
Carrier Ethernet Protocol and features	
IEEE 802.3ah Ethernet OAM	Link Fault Management (LFM) for Ethernet links as defined in IEEE 802.3ah
IEEE 802.1ag Ethernet CFM	IEEE 802.1ag Ethernet CFM function that provides connectivity fault management
ITU-T Y.1731	ITU-T service OAM standard Y.1731 divides a network into maintenance domains in the form of hierarchy levels
ITU-T G.8031 and G.8032v2	Provides the standards-based method of delivering high-performance Carrier Ethernet services over a multi-node ring protection switching to serve large MDUs or MTUs

Management	
Web GUI Interface	Built-in configuration utility for browser-based device configuration (HTTP/ HTTPs). Supports configuration, system dashboard, maintenance, and monitoring
Firmware Upgrade	Web browser upgrade (HTTP/ HTTPs) and FTP Secure upgrade through console port
Dual Firmware Image	Dual image and firmware partition provide independent primary and secondary OS files for backup while upgrading. Each firmware image has its corresponding firmware partition
SNMP	SNMP version1, 2c and 3 with support for traps and SNMP version 3 user-based security model (USM)
Remote Monitoring (RMON)	Embedded RMON software agent supports RMON groups 1,2,3,9 (history, statistics, alarms, and events) for enhanced traffic management, monitoring and analysis
IPv4 and IPv6 Dual Stack	Coexistence of both protocol stacks to support a seamless migration
Port Mirroring	Traffic on a port can be mirrored to another port for Legal Interception (CALEA) or analysis with a network analyzer or RMON probe. Up to N-1 (N is Switch's Ports) ports can be mirrored to single destination port. A single session is supported
Network Time Protocol	Network Time Protocol (NTP) for clock synchronization over packet switched networks
Other Management	HTTP / HTTPs; SSH; RADIUS; DHCP Client / DHCPv6 Client; SNTP; cable diagnostics; ping; syslog; Telnet client (SSH secure support), IPv6 Management
Discovery	Link Layer Discovery Protocol (LLDP) (IEEE 802.1ab) with LLDP-MED extensions

Table 5: *GAM Summary Features*

Chapter 4

Safety and Warnings

Safety and Warnings

To ensure your safety when servicing and installing this equipment, please take the following precautions:

Make sure the primary protective ground (earthing) is connected to the GAM (using the proper wire gauge) before opening the enclosure and making connections.

The GAM-4-CRX / GAM-4-CX products can be powered by a local power source connected into the AUX power port. When power is applied to the AUX power port, make sure the power source can provide 4A or more at 12Vdc. Make sure the power source is protected for power fault conditions and meets UL 60950-1 / CSA C22.2 No 60950-1 safety standards to avoid human injuries or damage to the GAM unit. Use cabling that will limit its voltage drop to less than 1.5V.

Only qualified personnel should service this system.

All wiring external to the product should follow the local wiring codes.

Use of this product in a manner other than defined in this installation guide may cause damage to equipment or injury to personnel.

If a problem has been isolated to this unit, do not attempt to repair. The unit's components are not user serviceable and therefore must not be replaced. Please return the unit to Positron Access Solutions for repair.

Observe local practice electrostatic discharge precautions when handling electronic equipment. Do not hold electronic plugs by their edge. Do not touch components or circuitry. Use a grounding wrist strap attached to a grounding connection point. Use only ESD-protective packaging materials when transporting equipment.

C A U T I O N !
SUBJECT TO ELECTROSTATIC DAMAGE
OR DECREASE IN RELIABILITY.
HANDLING PRECAUTIONS REQUIRED.

WARNING: The management (Craft, Ethernet) and AUX power ports of the equipment are suitable for connection to intra-building or unexposed wiring or cabling only. These ports MUST NOT be metallically connected to interfaces which

connect to the OSP or its wiring. These interfaces require isolation from the exposed OSP cabling. The addition of Primary Protectors is not sufficient protection to connect these interfaces metallically to OSP wiring. Connection to these ports should be for temporary use during installation or maintenance.

THIS PRODUCT IS SUITABLE FOR MOUNTING ABOVE GROUND OR UNDER GROUND AT A MAXIMUM DEPTH OF 3 FEET. THE UNIT MUST ALWAYS BE CONNECTED TO EARTH GROUND FOR SAFETY OF EQUIPMENT AND PERSONEL.

⚠ CAUTION

Hot surface.
Do not touch.

WARNING: Under some installation and/or climate conditions the outdoor GAM equipment can become hot, do not touch. In order to prevent injuries, equipment shall be handled only by qualified personnel wearing safety gears.

Chapter 5

Warranty and Customer Service

Positron Access Solutions will replace or repair this product within the warranty period if it does not meet its published specifications or fails while in service. Warranty information can be found in your Positron Access customer web portal: http://www.positronaccess.com/Portal.php

Positron Access Solutions Sales Pricing/Availability and Technical Support

US and Canada: 1-888-577-5254

International: +1-514-345-2220

customerservice@positronaccess.com

Repair and Return Address

Contact Customer Service prior to returning equipment to Positron.

Telephone US and Canada: 1-888-577-5254 option 6

International: +1-514-345-2220 option 6