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Interface Practices Subcommittee

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Generic Access Platform (GAP) Modules Specification

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140 Philips Road
Exton, PA 19341

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Document Type: Specification

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1. Introduction

1.1. Executive Summary

This document details the requirements placed on interoperable modules for use in the Generic Access Platform (GAP) Enclosure including physical, electrical, environmental constraints and module communications mechanisms. GAP Modules complying to the requirements in this document are expected to exhibit a baseline physical and logical interoperability when combined in a GAP compliant node enclosure. Extended interoperability testing and validation is supported through the Systems Integrator role and related SCTE best practices documentation.

1.2. Scope

The scope of the Generic Access Platform is to define a mechanical housing that provides physical support for electrical and mechanical components and protection from the outside world for those internal components. The specification is also intended to cover sufficient internal details such that internal modules can be constructed to fit inside the housing. The specification is intended to facilitate various existing and future technologies. The specification is not intended to define new technologies use-cases or to re-define existing technologies, but rather to enable the physical enclosure and protection of those technologies.

For example, the Generic Access Platform housing could be used as a DOCSIS® remote PHY node containing a remote PHY device (RPD) module and RF amplifiers. Another example would be a DOCSIS-backhauled small-cell radio, where the Generic Access Platform housing is used to enclose both a cable modem module and a radio transceiver module with an associated antenna or antenna-array.

In both cases, each modular component is an individual technology subject to specific and existing standards. The Generic Access Platform housing becomes a means to enclose those components as physical modules covered by this GAP specification.

This GAP Modules specification defines the requirements for interoperable modules that can be installed into the GAP Enclosure, including constraints on:

- Physical dimensioning, connector formats, tolerances, materials, screw locations of modules
- Environmental limits and thermal dissipation expectations for modules
- Electrical powering and connector pin definitions for modules
- Inter-module communications mechanisms for modules

In addition to generalized module slots this specification also provides requirements and constraints on two special types of modules: Power Supplies and (RF) Port Entry Modules.

DOCSIS 4.0 specifications include operation at frequencies up to 1794 MHz and many service providers would like to futureproof their networks for eventual operation up to 3000 MHz.

The GAP Enclosure is capable of 3000 MHz operation but the bandwidth performance is dependent on the performance of the individual components installed in the Enclosure.

1.3. Benefits

The Generic Access Platform has the following aims:

- Reduce the number of custom designed and manufactured housings.
- Address this market need ahead of a large growth in outdoor equipment predicted by distributed access architecture (DAA) and smart-city applications.
- Reduced operational expenditure for cable and fiber system operators and telecommunications companies.
- Increased longevity for deployed housing due to re-purposing rather than housing replacement.
- Increased availability and ability to integrate advanced technologies within a modular approach.
- Facilitating inter-operability between different vendor technologies.
- Introduction of a common industry-wide approach to outdoor deployed devices.
- Increased access to market-share for new technology providers.
- Long-term continuity to new technology deployments through standardized modules and evolutionary interfaces.

The GAP Modules specification (this specification) provides constraints for modules design to ensure interoperability of modules installed within the GAP Enclosure when sourced from multiple vendors or for varied use-cases.

1.4. Intended Audience

Cable, fiber and telecommunications designers, operators, and engineers.

1.5. Areas for Further Investigation or to be Added in Future Versions

- Addition of higher speed interfaces such as:
  - PCIe (Peripheral Component Interconnect Express) generation 5 and future versions.
  - GAP Internal Module Interface – future higher speed versions.
- Increases in backplane power capability and performance.
- Increased heat dissipation housing design and cooling techniques.
- Updates and extensions to the GAP communication and management protocols
- Future updates to the physical footprints to allow for larger or smaller enclosures, or to address additional markets outside of North America.

2. Normative References

The following documents contain provisions which, through reference in this text, constitute provisions of this document. The editions indicated were valid at the time of subcommittee approval. All documents are subject to revision and, while parties to any agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents might not be compatible with the referenced version.

2.1. SCTE References

[SCTE 91]	ANSI/SCTE 91 2015, Specification for 5/8-24 RF & AC Equipment Port, Female
[SCTE 92]	ANSI/SCTE 92 2016, Specification for 5/8-24 Plug (Male), Trunk & Distribution Connectors
[SCTE 153]	ANSI/SCTE 153 2016, Drop Passives: Splitters and Couplers

[SCTE 158]	ANSI/SCTE 158, Recommended Environmental Condition Ranges for Broadband Communications Equipment
[SCTE 203]	ANSI/SCTE 203 2019, Product Environmental Requirements for Cable Telecommunications Facilities - Test Procedures
[SCTE 216]	ANSI/SCTE 216 2015, Adaptive Power System Interface Specification (APSIS™)
[GAP Enclosure]	SCTE 273-1 2021, Generic Access Platform Enclosure Specification

2.2. Standards from Other Organizations

[IEC61000-4-2]	IEC 61000-4-2, Edition 1.2, 2001-04; Electromagnetic Compatibility (EMC) – Part 4-2
[ISO11898-1]	ISO 11898-1, Road Vehicles – Controller Area Network (CAN) - Part 1: Data link layer
[ISO11898-2]	ISO 11898-2, Road Vehicles – Controller Area Network (CAN) - Part 2: High-speed medium access unit
[ISO11898-3]	ISO 11898-3, Road Vehicles – Controller Area Network (CAN) - Part 3: Low-speed, Fault-tolerant, medium-dependent interface
[CiA301]	CiA 301, CANopen Application layer and communication profile
[CiA302]	CiA 302, CANopen additional application layer functions
[CiA303-2]	CiA 303-2, CANopen additional specification – Part 2: Representation of SI Unit and Prefix
[CiA305]	CiA 305, CANopen layer setting services (LSS) and protocols
[CiA453]	CiA 453 – Device Profile for Power Supplies
[CiA458]	CiA 458 – Device Profile for Energy Measurements
[RFC6020]	IETF RFC 6020, YANG 1.0 – A Data modelling language for network configuration protocol (NETCONF)
[RFC7950]	IETF RFC 7950, YANG 1.1 - YANG data modelling language
[RFC 6991]	IETF RFC 6991, Common YANG Data Types
[RFC8343]	IETF RFC 8343, A YANG Data Model for Interface Management
[IANAHardware]	https://www.iana.org/protocols, IANA Hardware YANG
[RFC8348]	IETF RFC 8348, A YANG Data Model for Hardware Management
[RFC8344]	IETF RFC 8344, A YANG Data Model for IP Management
[RFC8632]	IETF RFC 8632, A YANG Data Model for Alarm Management

2.3. Other Published Materials

No normative references are applicable.

3. Informative References

The following documents might provide valuable information to the reader but are not required when complying with this document.

3.1. SCTE References

No informative references are applicable.

3.2. Standards from Other Organizations

No informative references are applicable.

3.3. Other Published Materials

No informative references are applicable.

4. Compliance Notation

shall	This word or the adjective "***required***" means that the item is an absolute requirement of this document.
shall not	This phrase means that the item is an absolute prohibition of this document.
forbidden	This word means the value specified shall never be used.
should	This word or the adjective "*recommended*" means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighted before choosing a different course.
should not	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
may	This word or the adjective "*optional*" means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.
deprecated	Use is permissible for legacy purposes only. Deprecated features *may* be removed from future versions of this document. Implementations *should* avoid use of deprecated features.

5. Abbreviations and Definitions

5.1. Abbreviations

AC	alternating current
CAN	Controller Area Network
CANH	CAN High
CANL	CAN Low
CU	central unit
DU	distributed unit
DC	direct current
DOCSIS®	Data-over-Cable Service Interface Specifications
EGI	external GAP interface
ESD	electrostatic discharge
GAP	Generic Access Platform
GCP	generic control plane
GHz	gigahertz
GND	ground
GME	GAP Management Entity
HFC	hybrid fiber-coax
HTTP	hypertext transfer protocol
Hz	hertz
ID	identity
IMI	Internal Module Interface
IP	Internet protocol
ISO	International Organization for Standardization
LED	light emitting diode
mm	millimeter
MAC	media access control
MHAv2	Modular Headend Architecture version 2
MHz	megahertz
NETCONF	network configuration
OAM	operations, administration, and management
PCIe	Peripheral Component Interconnect Express
PHY	physical
RF	radio frequency
REST	representational state transfer
RESTCONF	RESTful configuration
RFC	request for comments
RMD	Remote MACPHY device
RPD	Remote PHY device
SCTE	Society of Cable Telecommunications Engineers
SSH	secure shell
TCP	transmission control protocol
V	volt
W	watt
YANG	Yet Another Next Generation

5.2. Definitions

Definitions of terms used in this document are provided in this section. Defined terms that have specific meanings are capitalized. When the capitalized term is used in this document, the term has the specific meaning as defined in this section.

Active Module	Modules which contain active powered electronics
Base	The specific portion of the Enclosure which remains attached to the strand in an aerial strand-mount installation
Base Entry Port	Base equipment port that supports RF signals and AC powering.
Base Module	Field replaceable modular components which fit into the Base of the GAP Enclosure and plug into either the Base Short Backplane or the Base Module Backplane
Full-Size Base Module	A large Base Module which connects directly to the Base Short Backplane and occupies a significant part of the available Base Module area
Small Base Module	A Base Module which connects to and occupies a specific number of slots of the Base Module Backplane
Base Module Backplane	An internal circuit board assembly used for mounting Base Modules and to route signals and DC power to/from Base Modules
Base Short Backplane	An internal circuit board used for mounting Power Supplies and routing signals and DC power to/from Power Supplies; routing signals and DC power to/from the Base Module Backplane or a directly attached Base Module; and routing signals and DC power to/from the Lid Backplane
Base Module Area	A flat mounting surface which can accommodate multiple variants of Base Modules with standardized mounting holes.
Enclosure	The Generic Access Platform housing consisting of Base and Lid, along with internal backplanes for connecting Base Modules, Power Supplies, and Lid Modules
Lid	The specific portion of the Enclosure which is normally attached to the Base and hinges open for operator access to components inside the Enclosure
Lid Backplane	An internal circuit board used for mounting Lid Modules and to route signals and DC power to/from Lid Modules; routing signals and DC power to/from the Base Short Backplane.
Lid High-Speed Backplane	A Lid Backplane which provides DC power, CAN signals, and high speed (PCIe and KR) point-point connectivity between a Special Module and other Lid Modules.
Lid Low-Speed Backplane	A Lid Backplane which provides only DC power and CAN signals to Lid Modules and includes 6 standard Lid Module slots.
Lid Module	Field replaceable components which fit into the Lid of the GAP Enclosure and plug into the Lid Backplane
Lid Module Slot	Location for attaching Lid Modules with standardized mounting and connector for DC output and internal communications.
Standard Lid Module	A Lid Module that is not a Special Module.
Passive Module	Modules which do not contain active powered electronics
Port Entry Module Area	Left and right side mounting areas for modules which interface RF and/or AC signals with other GAP Modules for a particular use case.

Power Supply	Voltage converter used to provide DC power for GAP Modules and includes basic monitoring functions and load sharing operation.
Power Supply Slot	Location for attaching GAP AC-DC Power Supply with standardized mounting holes and connector for DC output, internal communications, and load sharing between Power Supplies.
Reference 3D Model	GAP Reference 3D model associated with this document and published as a STEP file
Special Module	A module that acts as the termination point for high-speed point-point connectivity from up to four (4) Standard Lid Modules.

6. Architecture Overview

A detailed informative GAP system overview is provided in [GAP Enclosure].

GAP Modules comply with the mechanical, electrical, environmental, and communication requirements detailed within this specification to enable an interoperable environmentally hardened outside plant node housing usable for today’s technology and flexible enough to support tomorrow’s technology.

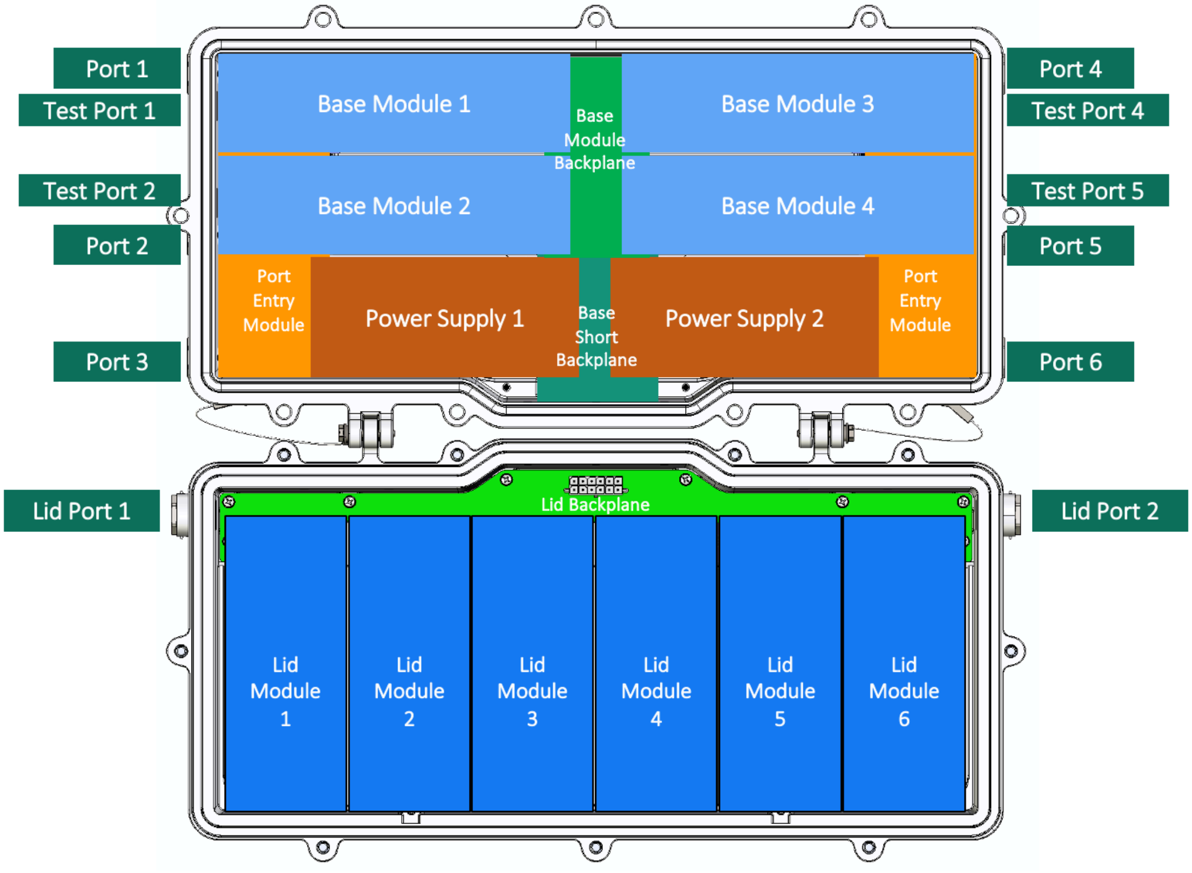

Figure 1 – GAP Reference Architecture

Specifically, the GAP defines 6 unique module classes. Each module class is restricted on where it can be physical placed within a GAP enclosure.

1. Small Base Modules: Using the extended Base Module Backplane, the GAP chassis supports 4 single-sized Base Module slots, or 2 double-sized Base Module slots, or a combination of 2 single-sized and 1 double-sized slots.
2. Full-Size Base Modules: Consuming the entire top-half of the Base, a Full-Size Base Module consumes all the Base Module mounting area and removes the extended Base Module Backplane to grant a large flat thermal surface for flexible mixed-use module applications.
3. Port Entry Modules: GAP leaves this module vendor defined, placing only sizing and keep-out limitations. However, the Port Entry Module Area is a well-specified area in [GAP Enclosure].
4. Power Supplies: GAP supports 2 load-sharing power supplies. Specifics on electrical node interfacing are defined within this specification.
5. Standard Modules (Lid): GAP supports up to 6 flexible Lid Module slots. GAP allows a single module to consume multiple module slots, as needed.
6. Special Module (Lid): GAP supports 1 Special Module. This special module consumes 1 or more Standard Module slots and has unique Lid Backplane connectivity.

Each module class has requirements constraints during module design to ensure multi-vendor interoperability within a GAP enclosure. The requirements for physical dimensions, electrical properties, and environmental/thermal constraints for each module class can vary significantly. The requirements focused on communication are largely uniform between the module classes to ensure a vendor-agnostic inventorying communication mechanism is available to all modules installed into a single GAP enclosure.

7. Power Supplies

7.1. Mechanical

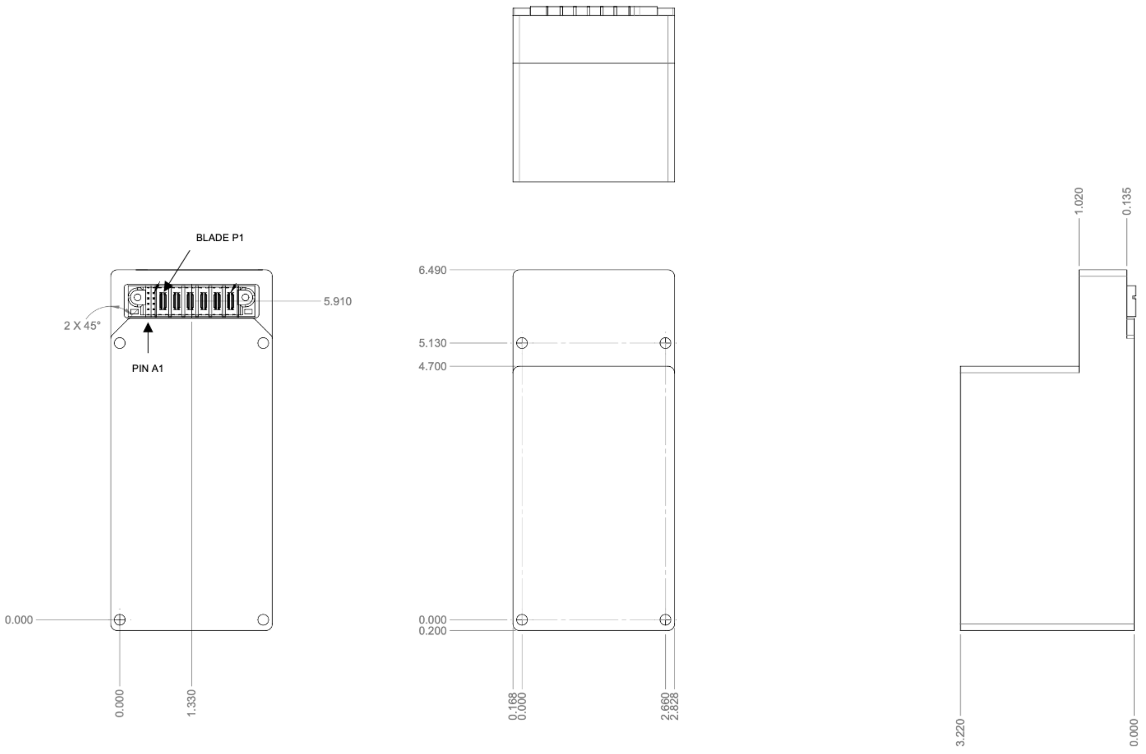

Figure 2 – Power Supply Dimensions

Power Supply ***shall*** not exceed the dimensions provided in Figure 2[1]. A Power Supply maximum sized module is included in the [GAP Enclosure] Reference 3D Model.

Power Supply ***shall*** be mounted to the Base using a #10-32 captive mounting screws in a vendor-specific combination of holes from the set including C3-C8, C11-C18, C21-C26 as specified in [GAP Enclosure] Section 11.

Power Supply *should* include external voltage test points for input and DC output voltages.

7.2. Electrical

The Power Supply ***shall*** have two bi-color LED indicators visible to the operator/installer with behavior listed in Table 1:

Table 1 – Power Supply LED Behavior

Input Voltage Status Indicator	Green: Input voltage is within vendor-specified limits
	Red: Input voltage is outside of vendor-specified limits
DC Output Voltage Status Indicator	Green: All DC output voltages within vendor-specified limits
	Red: One or more DC voltage(s) are outside of vendor-specified limits

Power Supply ***shall*** have two connectors:

- Power Supply Input Cable Connector for AC (or DC) power input coming from a Port Entry Module
- Power Supply Output Module Connector for DC output, GAP-IMI monitoring, and load sharing connected to the Base Short Backplane

In the HFC use case the input power will likely consist of 60/90 VAC. In other applications, there may be other power inputs such as 48 VDC.

Dual redundant power supplies ***shall*** be supported. Redundant power supplies ***shall*** be capable of supporting the entire power load for a specific application with a single power supply.

Power Supply *should* provide uninterrupted output DC power during transitions of external input power to/from battery backup.

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[1] Although units of the International System of Units (SI) are the preferred units of measurement in SCTE and American National Standards, United States customary units are commonly used and are consistent with the technology being standardized

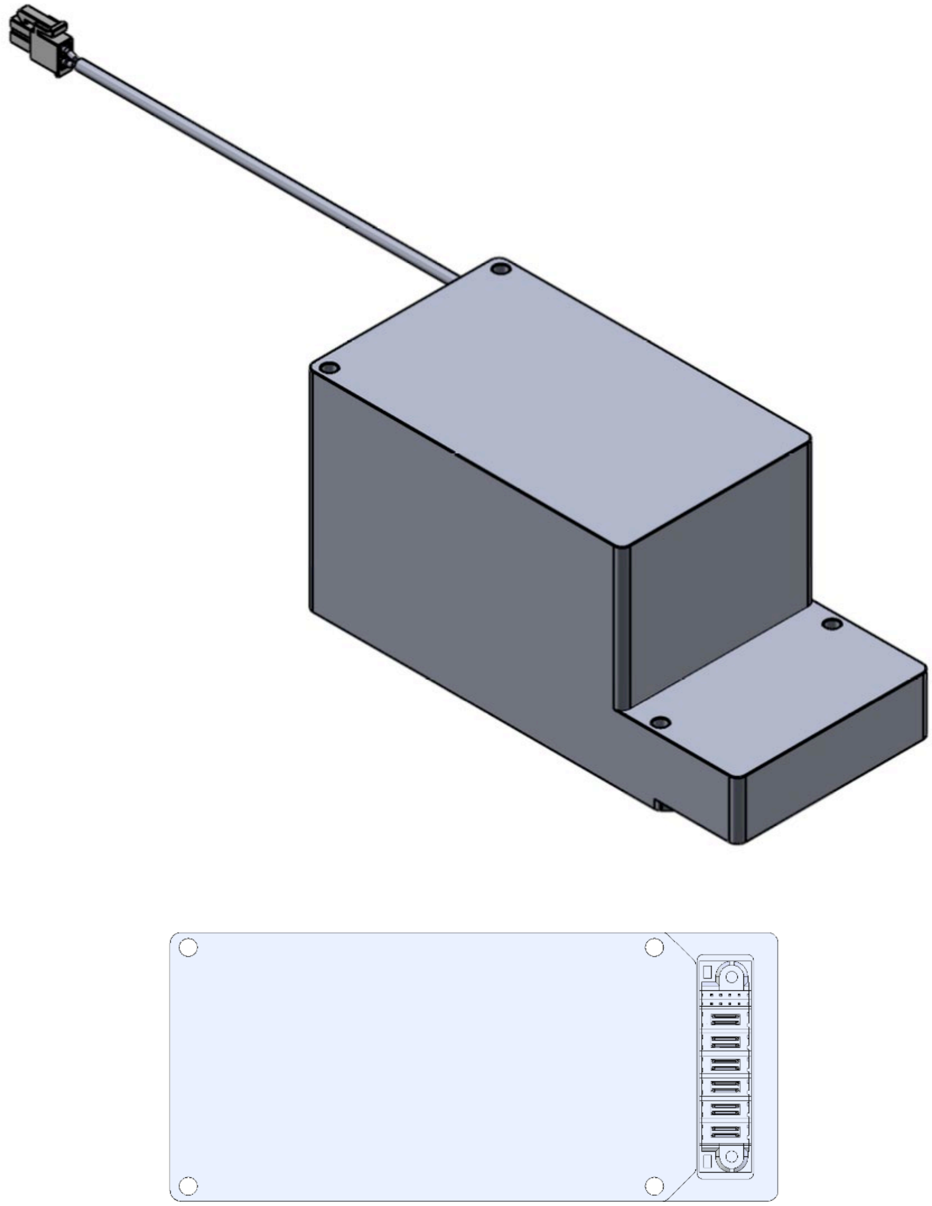

Figure 3 – Example GAP Power Supply

Figure 3 illustrates a typical GAP Power Supply. The Power Supply Input Cable connector on the end of the cable shown on the left plugs into a Port Entry Power Connector on a Port Entry Module.

Power Supply Input Cable Connector cable length ***shall*** be 300 ± 10 mm. A cable is provided to give vendors flexibility in locating the corresponding Port Entry Power Connector(s).

Power Supply Input Cable Connector ***shall*** be a 2 pin latching 4.2 mm pitch connector as shown in Figure 4.[2]

Figure 4 – Power Supply Input Cable Connector

The Power Supply Output Module Connector ***shall*** be 6 pin high current blade + 8 signal connector as illustrated in Figure 5.[3]

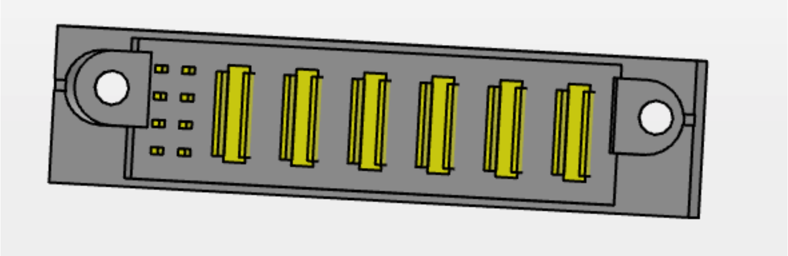

Figure 5 – Power Supply Output Module Connector

Power Supply Output Module Connector pinout ***shall*** be per Table 2.

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[2] Connectors that are compliant with Figure 3 include Molex 39012025 or equivalent. This identification of compliant connectors is not an endorsement of those products or services of those suppliers.

[3] Connectors that are compliant with Figure 4 include Amphenol 51701-10000806AALF, Medlon JYP-M0806B-VT21R, or equivalent. This identification of compliant connectors is not an endorsement of those products or services of those suppliers.

Table 2 – Power Supply Output Module Connector

D1	D2	P1	P2	P3	P4	P5	P6
LSHARE_12V	**LSHARE_5.75V**						
C1	C2						
LSHARE_Vaux	**LSHARE_25V**						
B1	B2	**GND**	**25V**	**12V**	**GND**	**Vaux**	**5.75V**
CANH	**GND**						
A1	A2						
CANL	**ADDR0**						

The Power Supply Output Module Connector signals are broken into 3 classes: Power, Control/Status, and CAN.

The Power Supply Output Module Connector ***shall*** be capable of supporting the currents listed in Table 3.

Table 3 – Power Supply Output Module Connector Signal Class: Power

Power Rail	Current (A)
5.75V	40 A
12V	40 A
25V	40 A
Vaux	40 A
Ground	80 A

Power Supply Output Module Connector signal behavior for the Control/Status signals ***shall*** be as per Table 4.

Table 4 – Power Supply Output Module Connector Signal Class: Control/Status

Signal	Description
LSHARE_5.75V	Load share pins, vendor-specific behavior
LSHARE_12V	
LSHARE_25V	
LSHARE_Vaux	
ADDR0	Module slot identifier provided by Base Short Backplane: Power Supply 1: GND Power Supply 2: 5.75V

CANH and CANL signal requirements are specified in Section 11.3.2.2.

Power Supply Output Module Connector DC output voltage rails ***shall*** comply with requirements noted in Table 5.

Table 5 – Power Supply Output Voltage Requirements

Power Rail	Output Voltage Range	Conditions
5.75V	5.75 V +/- 3% (5.578 – 5.923 V)	Total variation due to setpoint accuracy, temperature, line and load regulation
12V	12.0 V +/- 3% (11.64-12.36 V)	
25V	25.0 V +/- 3% (24.25-25.75 V)	
Vaux	60 V maximum	Vaux voltage is vendor-specific

When using multiple Power Supplies in a load-sharing configuration, the same Power Supply ***shall*** be required in both slots.

Power Supply ***shall*** be clearly marked to indicate manufacturer supported output voltage rails, available current per rail, and total power available.

7.3. Environmental

Power Supply ***shall*** *not* have any moving cooling components such as electromechanical fans (passive cooling only).

8. Port Entry Modules

8.1. Mechanical

8.1.1. Port Entry Module RF Seizure Mechanism

Port Entry Modules ***shall*** provide an RF seizure mechanism to interface to the center pin of a standard 5/8-24 plug connector as defined in [SCTE 91] for 3 GHz equipment ports.

This RF seizure mechanism, whether a separate Port Entry Module or integral to a Base Module, ***shall*** be field replaceable without requiring the removal of the installed hardline coaxial connector.

Any screws used to seize the center pin of a coaxial connector ***shall*** have a minimum of 3/16” hex head and torque specification provided by manufacturer.

Acceptable hardline connector center pin length ***shall*** be compliant with [SCTE 92] requirement for 3 GHz equipment ports.

Any hardline connector seizure mechanism ***shall*** be compliant with the minimum point of contact for Male Pin – 3 GHz as specified in [SCTE 91].

8.2. Electrical

The Port Entry Module ***shall*** have a 2 pin 4.2 mm latching power connector as shown in Figure 6.[4]

Figure 6 – Port Entry Power Connector

The Port Entry Power Connector pinout ***shall*** be per Table 6.

Table 6 – Port Entry Power Connector Pinout

Signal	Pin #
GND	1 (adjacent to ramp)
V_{input}	2

Input voltage requirements are outside the scope of the GAP specifications.

Line powering ***shall*** be capable of arriving on any Base Entry Port.

Port Entry Modules ***shall*** be capable of passing power from the incoming power Base Entry Port to any other Base Entry Port by insertion of an automotive blade style fuse or shunt.

Port Entry Modules *should* be able to provide incoming power by using independent line powering from different Base Entry Ports.

8.3. Environmental

Port Entry Module ***shall not*** have any moving cooling components such as electromechanical fans (passive cooling only).

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[4] Connectors that are compliant with Figure 5 include Molex 39310028 or equivalent. This identification of compliant connectors is not an endorsement of those products or services of those suppliers.

9. Base Modules

The GAP Base provides mounting, power, and communication for up to four (4) application-specific modules. Exact size of Base Modules is left to vendor implementation but reference DC/communication connector locations and pinouts are specified. For RF applications, a pairing of Port Entry Module(s) and Base Module(s) from a single vendor is expected but not required. This specification does not dictate exactly which functions reside in the Base but typical uses could include:

- RF Amplifier modules for HFC node applications
- DOCSIS cable modem for DOCSIS-fed wireless
- Wireless radios/amplifiers
- Optical amplification and multiplexing/demultiplexing functions

9.1. Small Base Module Overview (Informative)

Using the extended Base Module Backplane, the GAP chassis supports 4 single-sized Base Module slots, or 2 double-sized Base Module slots, or a combination of 2 single-sized and 1 double-sized slots. These combinations are shown in Figure 7 and Figure 8.

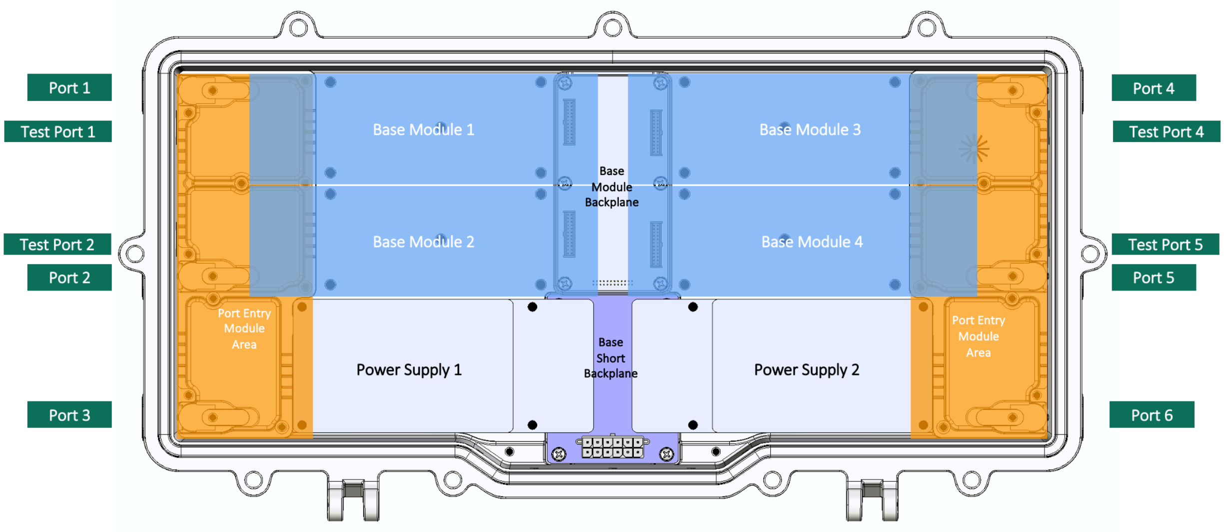

Figure 7 – GAP Base with Single Slot Small Base Modules

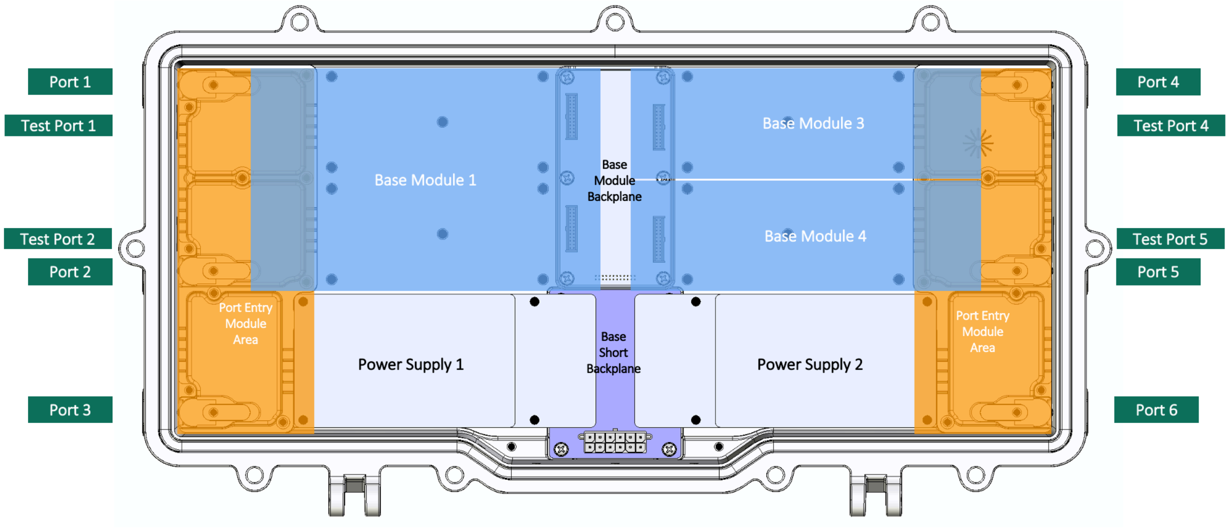

Figure 8 – GAP Base with Single and Double Slot Small Base Modules

9.2. Full-Size Base Module Overview (Informative)

Consuming the entire top-half of the Base, a Full-Size Base Module as shown in Figure 9 consumes all the Base Module mounting area and removes the extended Base Module Backplane to grant a large flat thermal surface for flexible mixed-use module applications.

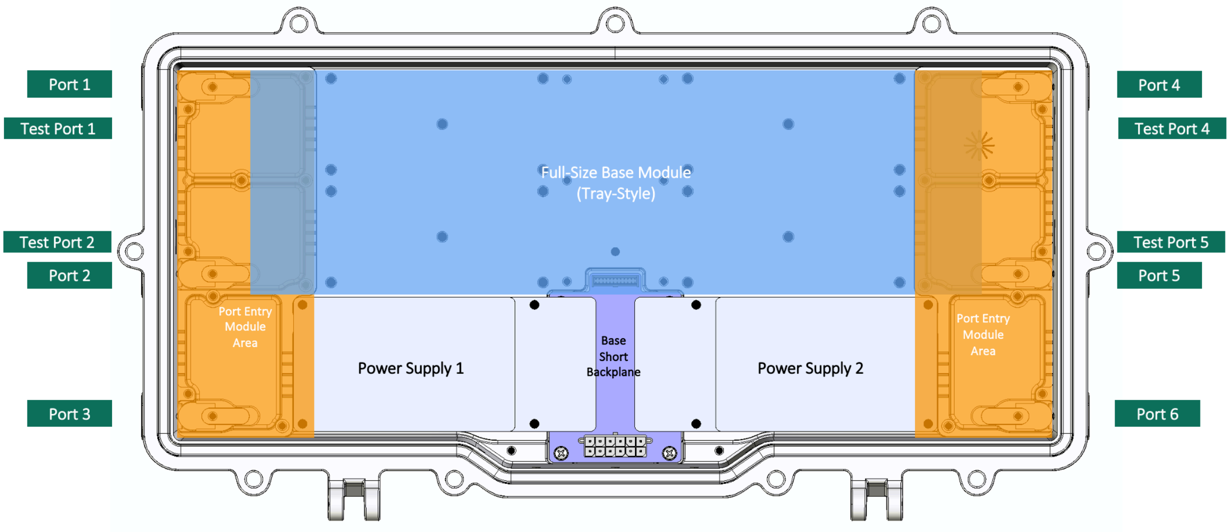

Figure 9 – GAP Base with a Full-Size Base Module

9.3. Mechanical

9.3.1. Common Requirements

Requirements in this section apply to both Small Base Modules and Full-Size Base Modules.

Base Modules ***shall*** be no more than 3.220” in height measured from the Base Module Area mounting surface. Length and width of Base Modules is vendor specific.

Base Modules ***shall*** be located and oriented so that they do not interfere with a maximum size Power Supply mounted in either or both Power Supply Area(s).

9.3.2. Small Base Module

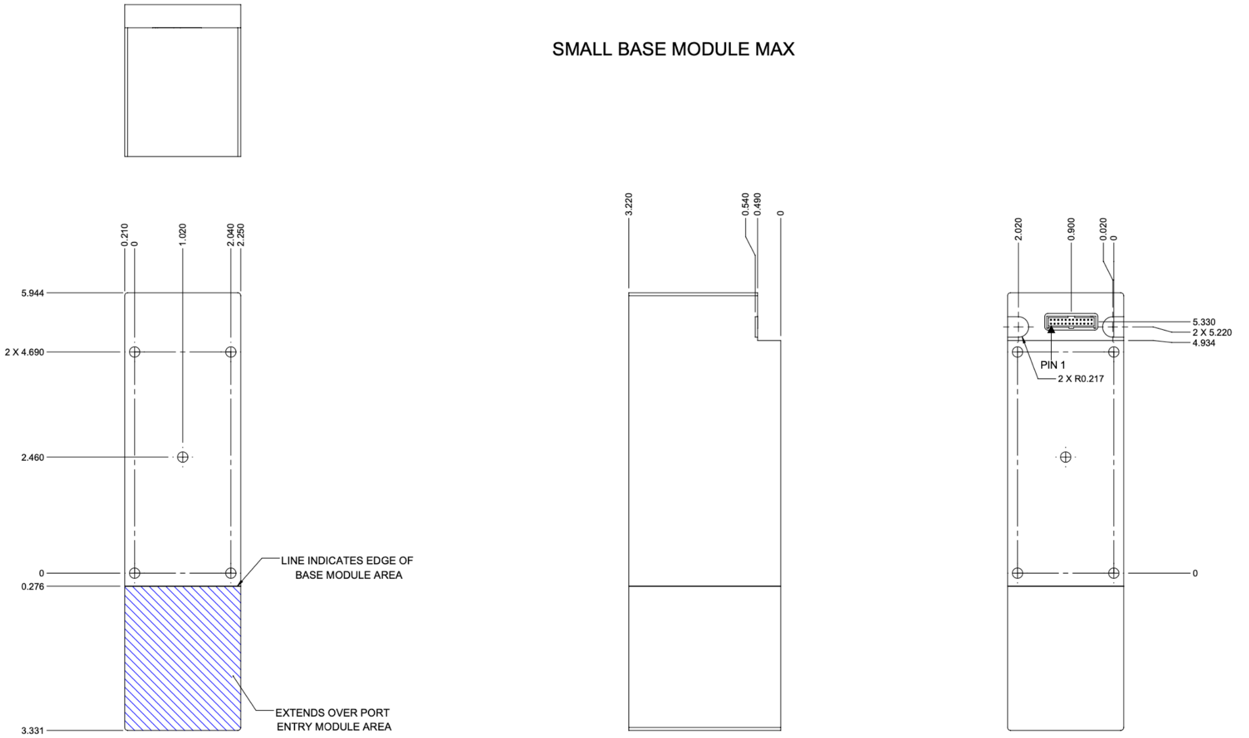

Figure 10 – Small Base Module Dimensions Reference

Figure 10 provides a reference drawing for the dimensions of a maximum Small Base Module. This reference is provided as guidance to vendors on sizing that will allow coexistence of up to four (4) Small Base Modules. This reference is also included in the Reference 3D Model. Any connectors and cabling for the Small Base Module are assumed to be contained within this shape.

Small Base Modules *may* overlap or occupy the Left or Right Port Entry Module Area corresponding to the side of the base they are mounted to. Overlap of Small Base Modules and Port Entry Modules is expected in HFC RF use cases for GAP, so the hatched area in Figure 10 identifies that area which might interfere with specific Port Entry Module designs. The Reference 3D Model includes separate coloring of this overlapping area. Vendors building Small Base Modules not connecting to Port Entry Modules are advised to avoid the use of this overlapping area if universal fit is needed.

Small Base Modules ***shall*** be mounted to the Base using a vendor-specific combination of #10-32 captive screws in holes from the Base Module Area and Port Entry Module Area(s) as specified in [GAP Enclosure] Section 11.

Small Base Modules ***shall*** be located and oriented so that a connector on the Small Base Module mates with one or more of the Base Module Backplane Connectors located on the Base Module Backplane and specified in [GAP Enclosure]. Figure 10 provides additional detail as reference.

9.3.3. *Full-Size Base Module*

Full-Size Base Module *may* overlap or occupy one or both Port Entry Module Area(s).

Full-Size Base Module ***shall*** be mounted to the Base using a vendor-specific combination of holes from the Base Module Area (including Base Module Backplane mounting holes) and Port Entry Module Area(s) as specified in [GAP Enclosure] Section 11.

9.4. Electrical

Requirements in this section apply to both Small Base Modules and Full-Size Base Modules except where noted.

Base Modules ***shall*** include a connector compatible with the Base Module Backplane Connector specified in [GAP Enclosure] section 8.6.1.

Base Module Connector pinout ***shall*** be per Table 7.Table 7 – Base Module Connector Pinout

Table 7 – Base Module Connector Pinout

2	4	6	8	10	12	14	16	18	20	22	24
GND	**25V**	**5.75V**	**5.75V**	**5.75V**	**ADDR1**	**CANL**	**CANH**	**GND**	**Vaux**	**12V**	**GND**
1	3	5	7	9	11	13	15	17	19	21	23
GND	**25V**	**5.75V**	**5.75V**	**5.75V**	**ADDR2**	**GND**	**GND**	**GND**	**Vaux**	**12V**	**12V**

The Base Module Connector signals are broken into 3 classes: Power, Control/Status, and CAN.

The Base Module Connector ***shall*** be capable of supporting the currents listed in Table 8.

Table 8 – Base Module Connector Signal Class: Power

Power Rail	Current (A)
5.75V	18 A
12V	9 A
25V	6 A
Vaux	6 A
Ground	21 A

Base Module Connector signal behavior for the Control/Status signals ***shall*** be as per Table 9.

Table 9 – Base Module Connector Signal Class: Control/Status

Signal	Description
ADDR0	Module slot identifier provided by Base Module Backplane or Base Short Backplane, see Note 1 following this table
ADDR1	

Note 1: Signals ADDR0 and ADDR1 identify the Base Module slot numbers 1 through 4 as shown in Figure 7. Full-Size Base Modules are provided ADDR0 and ADDR1 connections of GND from the Base Short Backplane corresponding to Slot 1. Base Module slot addressing is shown in Table 10:

Table 10 – Base Module Slot Addressing

Slot	ADDR1	ADDR0
Slot 1	GND	GND
Slot 2	GND	5.75V
Slot 3	5.75V	GND
Slot 4	5.75V	5.75V

CANH and CANL signal behavior is specified in Section 11.3.2.2. The Full-Size Base Module ***shall*** include a 120 ohm, 0.25 W termination resistor between CANH and CANL. Note this limits the supply voltage of the CAN transceivers in the Full-Size Base Module to 5 V maximum.

Base Modules ***shall*** be hot swappable without removing power or interrupting other active modules unless the module being replaced is physically below the Base Module.

Base Modules ***shall*** support insertion and removal with DC voltage rails already energized.

Base Modules ***shall*** accept any arbitrary power-up sequence of the DC voltages.

Base Modules peak currents on any voltage rail ***shall not*** exceed the connector current specified in Table 8. Current limiting devices ***shall*** be placed as close to the connector as possible.

Base Modules ***shall*** limit inrush current to less than 1A on any DC voltage rail during insertion or initial power application.

Base Modules ***shall*** provide short-circuit protection to prevent internal faults from affecting other modules in the GAP Enclosure.

Base Modules ***shall*** provide protection from overvoltage on any DC voltage rail.

Base Module maximum current consumption per DC voltage rail ***shall*** be included in published specifications.

9.5. Environmental

Requirements in this section apply to both Small Base Small Modules and Full-Size Base Modules.

Base Modules ***shall*** comply with the recommended environmental conditions from [GAP Enclosure] Table 22 which are suitable to the specific installation environment.

Base Modules electrostatic discharge (ESD) test ***shall*** be executed according to clauses 7 and 8 of [IEC61000-4-2]. Positive and negative polarity voltage tests shall be completed.

ESD tests ***shall*** be performed on all accessible equipment points accessible when the equipment is operating, is being installed, or while under maintenance.

Contact discharge method ESD tests ***shall*** be applied to conductive surfaces and conductive planes. Air discharge method tests ***shall*** be applied to insulating surfaces.

Test points for both normal operating, storage, and maintenance type ESD testing ***shall*** be selected based on recommendations in [IEC61000-4-2] Clause 8.

9.5.1. Thermal Constraints

Base Modules ***shall not*** exceed an average rated power of 22.5 W per occupied slot under the reference conditions described in [GAP Enclosure] section 10.2.1.

10. Lid Modules

10.1. Lid Module Overview (Informative)

GAP Lid Modules provide specific device functionality in a GAP Node. Modules can operate independently or collaboratively to support specific customer use cases. This section defines physical size, power, thermal and communications requirements to allow manufacturers to develop independent service functionality for use in GAP deployments by an operator.

Up to six (6) application-specific modules are mounted in the Lid and connected using a Lid Backplane as shown in Figure 11. Individual modules can use more than one Module Slot as needed for thermal dissipation and/or component space.

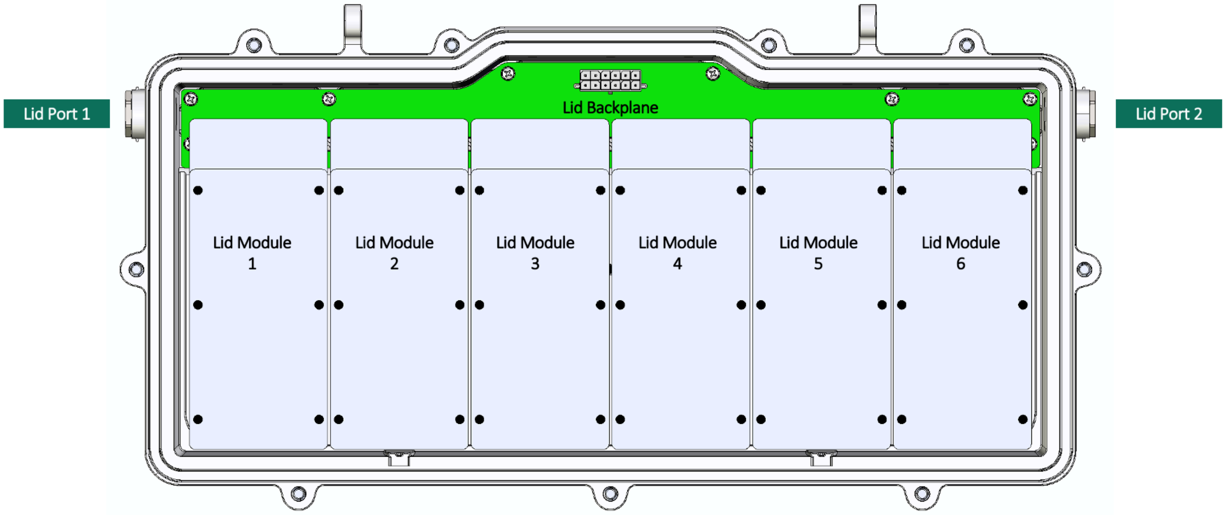

Figure 11 – GAP Lid Architecture

This specification does not dictate exactly which functions reside in the Lid but typically the Lid Module(s) provide uplink connectivity to central operator facilities and uses could include the following:

- RMD or RPD
- Edge compute processing
- Wireless baseband (CU, DU) or radio functions
- Ethernet or PCIe switch
- Optical muxponder

10.1.1. Standard Lid Modules

Standard Lid Modules occupy one or more module slots and have a combination of the following interfaces to serve a specific application use case.

- One or more input voltage rails – 5.75V, 12V, 25 V or Vaux (vendor-specific)
- CAN communication bus supporting GAP-IMI
- Module slot identification
- Point-point connectivity with the Special Module using the High-Speed Lid Backplane
    - Up to four (4) PCIe Gen4 lanes
    - Up to one (1) lane of 25 Gbps (25GBASE-KR) Ethernet

- Pluggable optical interface(s) for interfacing:
    - To other modules inside the GAP Enclosure
    - Outside the GAP Enclosure with GAP-EGI support

10.1.2. Special Modules

Special Modules occupy Slot 1 (and optionally Slots 2-6) and act as the termination for the point-point connectivity with Standard Lid Modules. Special Modules might have a combination of the following interfaces as needed to serve a specific application use case:

- One or more input voltage rails – 5.75 V, 12 V, 25 V or Vaux (vendor-specific)
- CAN communication bus supporting GAP-IMI
- Module slot identification
- Point-point connectivity termination for Standard Lid Modules
    - Up to four (4) PCIe Gen4 lanes each to Lid Module Slots 3, 4, 5 and/or 6
    - Up to one (1) lane of 25 Gbps (25GBASE-KR) Ethernet to each of Lid Module Slots 3, 4, 5, and/or 6
- Pluggable optical interface(s) for interfacing:
    - To other modules inside the GAP Enclosure
    - Outside the GAP Enclosure with GAP-EGI support

10.2. Mechanical

10.2.1. Common Requirements

Requirements in this section apply to both Standard Lid Modules and Special Modules.

Lid Modules ***shall*** not exceed the dimensions provided in Figure 12. A maximum sized single slot Standard Lid Module is included in the [GAP Enclosure] Reference 3D Model.

Lid Modules ***may*** occupy more than one Lid Module slot.

Lid Modules which occupy more than one Lid Module slot *should not* use more than two (2) connectors.

Lid Modules ***shall*** be mounted to the Lid using #10-32 captive screws in a vendor-specific combination of holes from the set including A1-A36 as specified in [GAP Enclosure] Section 12.

10.2.2. Standard Lid Module

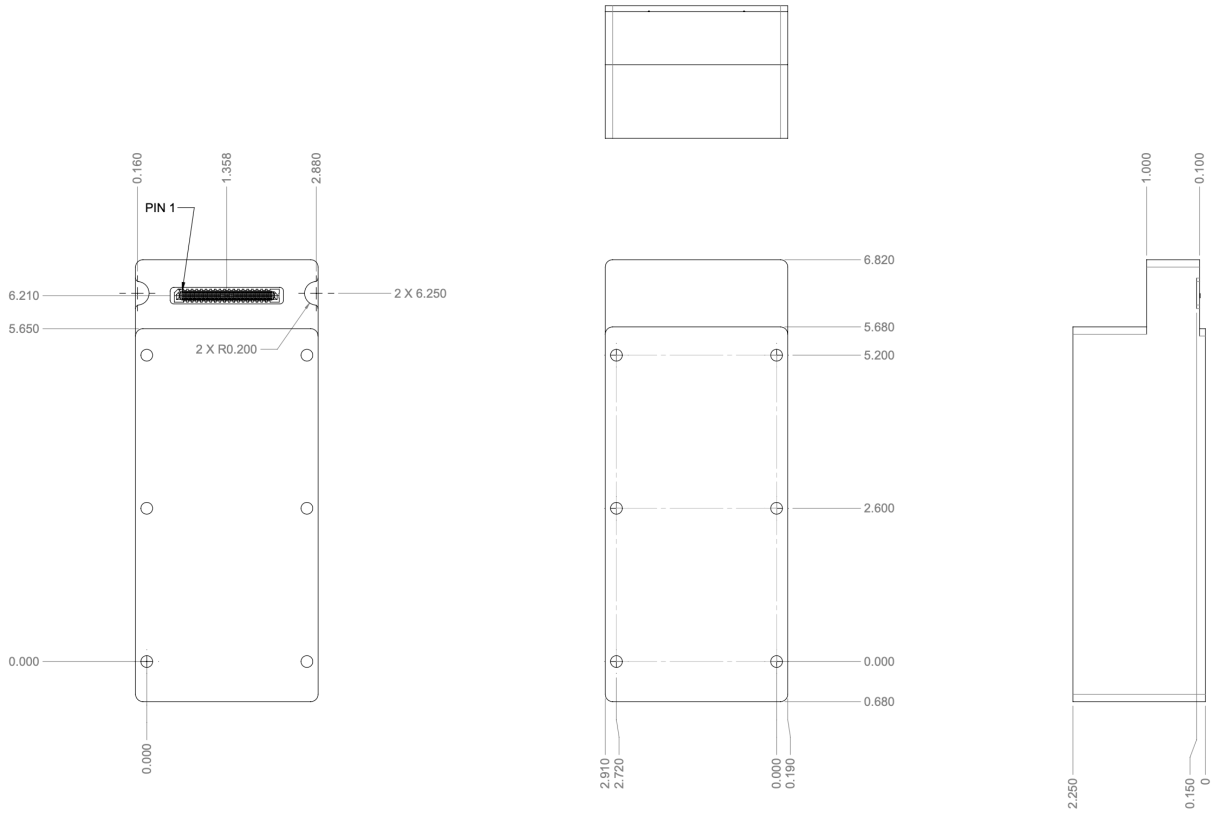

Figure 12 – Standard Lid Module Maximum

Standard Lid Module connectors ***shall*** be located and oriented as shown in Figure 12.

Standard Lid Modules occupying more than one Lid Module slot *should not* use the leftmost Lid Module Connector. This allows multi-slot Standard Lid Modules to occupy Slot 2 (which has no connector) if the Special Module is only occupying Slot 1.

10.2.3. Special Module

Special Module connector ***shall*** be located and oriented to interface to the Special Module Backplane Connector location specified in [GAP Enclosure] Section 12.

10.3. Connector

10.3.1. Standard Lid Module

The Standard Lid Module connector ***shall*** be a 2x49 rugged high speed socket as shown Figure 13.[5]

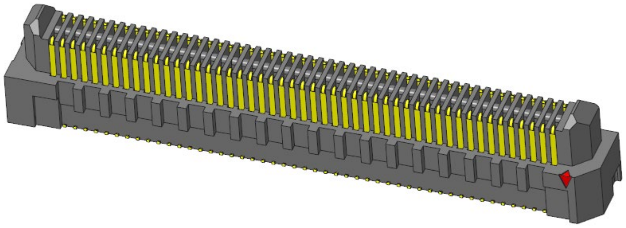

Figure 13 – Standard Lid Module Connector

Standard Lid Module Connector pinout ***shall*** be per Table 11.

The following high speed signal pins ***shall*** be left unconnected if unused:

- All PCIe pin #s: 33, 34, 35, 40, 42, 45, 47, 52, 54, 57, 59, 64, 66, 69, 71, 76, 78, 81, 83
- All KR pin #s: 88, 90, 93, 95

Table 11 – Lid Module Backplane Connector Pinout

#	Signal	Pin Length	#	Signal	Pin Length
2	GND	Long	1	GND	Long
4	25V	Short	3	PRESENT_N1	Short
6	25V	Short	5	25V	Short
8	GND	Long	7	GND	Long
10	12V	Short	9	12V	Short
12	12V	Short	11	12V	Short
14	GND	Long	13	GND	Long

---

[5] Connectors that are compliant with Figure 10 include one of the following (or equivalents) with the connector height chosen as required for the specific module design mating height: Samtec ERM8-049-05.0-L-DV-DS, Samtec ERM8-049-08.0-L-DV, Samtec ERM8-049-09.0-L-DV or equivalent. This identification of compliant connectors is not an endorsement of those products or services of those suppliers.

16	12V	Short	15	12V	Short
18	12V	Short	17	12V	Short
20	GND	Long	19	GND	Long
22	Vaux	Short	21	Vaux	Short
24	ADDR0	Short	23	Vaux	Short
26	GND	Long	25	GND	Long
28	CANH	Short	27	ADDR1	Short
30	CANL	Short	29	ADDR2	Short
32	GND	Long	31	GND	Long
34	PCIE_RST_N	Short	33	PCIe_CLK_N	Short
36	GND	Short	35	PCIe_CLK_P	Short
38	GND	Long	37	GND	Long
40	PCIe TX0_N	Short	39	5.75V	Short
42	PCIe TX0_P	Short	41	5.75V	Short
44	GND	Long	43	GND	Long
46	5.75V	Short	45	PCIe RX0_N	Short
48	5.75V	Short	47	PCIe RX0_P	Short
50	GND	Long	49	GND	Long
52	PCIe TX1_N	Short	51	5.75V	Short
54	PCIe TX1_P	Short	53	5.75V	Short
56	GND	Long	55	GND	Long
58	5.75V	Short	57	PCIe RX1_N	Short
60	5.75V	Short	59	PCIe RX1_P	Short
62	GND	Long	61	GND	Long
64	PCIe TX2_N	Short	63	GND	Short
66	PCIe TX2_P	Short	65	GND	Short
68	GND	Long	67	GND	Long
70	GND	Short	69	PCIe RX2_N	Short

72	GND	Short	71	PCIe RX2_P	Short
74	GND	Long	73	GND	Long
76	PCIe TX3_N	Short	75	GND	Short
78	PCIe TX3_P	Short	77	GND	Short
80	GND	Long	79	GND	Long
82	GND	Short	81	PCIe RX3_N	Short
84	GND	Short	83	PCIe RX3_P	Short
86	GND	Long	85	GND	Long
88	KR_TX_N	Short	87	GND	Short
90	KR_TX_P	Short	89	GND	Short
92	GND	Long	91	GND	Long
94	GND	Short	93	KR_RX_N	Short
96	PRESENT_N2	Short	95	KR_RX_P	Short
98	GND	Long	97	GND	Long

10.3.2. Special Module

The Special Module Connector ***shall*** be an 8x30 high-speed high-density open pin-field array socket as shown in Figure 14.[6]

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[6] Connectors that are compliant with Figure 11 include the following with the connector height chosen as required for the specific module design mating height. This identification of compliant connectors is not an endorsement of those products or services of those suppliers.

Samtec SEAM-30-06.5-L-08-2-A-K-X or equivalent
Samtec SEAM-30-07.0-L-08-2-A-K-X or equivalent
Samtec SEAM-30-09.0-L-08-2-A-K-X or equivalent
Samtec SEAM-30-11.0-L-08-2-A-K-X or equivalent

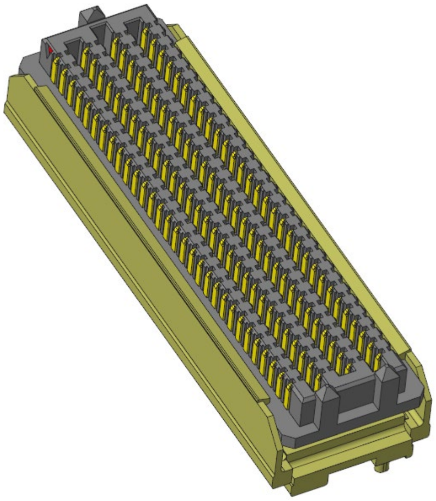

Figure 14 – Special Module Backplane Connector

Special Module Connector pinout ***shall*** be per Table 12.

All RFU (Reserved for Future Use) connections ***shall*** be left unconnected.

The following high speed signal pins ***shall*** be left unconnected if unused:

- All PCIe TXn_P, TXn_N, RXn_P, RXn_N pins
- All KR TX_P, TX_N, RX_P, RX_N pins

Table 12 – Special Module Backplane Connector Pinout

	H	G	F	E	D	C	B	A
1	GND	GND	GND	GND	GND	GND	GND	GND
2	M4_PCIe TX3_P	GND	M4_PCIe TX1_P	GND	M4_PCIe RX3_P	GND	M4_PCIe RX1_P	GND
3	M4_PCIe TX3_N	GND	M4_PCIe TX1_N	GND	M4_PCIe RX3_N	GND	M4_PCIe RX1_N	GND
4	GND	M4_PCIe TX2_P	GND	M4_PCIe TX0_P	GND	M4_PCIe RX2_P	GND	M4_PCIe RX0_P
5	GND	M4_PCIe TX2_N	GND	M4_PCIe TX0_N	GND	M4_PCIe RX2_N	GND	M4_PCIe RX0_N
6	M4_KR_TX_P	GND	M4_KR_RX_P	GND	M4_PRESENT_N	GND	M4_PCIe_CLK_P	GND
7	M4_KR_TX_N	GND	M4_KR_RX_N	GND	RFU	GND	M4_PCIe_CLK_N	GND
8	GND	M3_PCIe TX3_P	GND	M3_PCIe TX1_P	GND	M3_PCIe RX3_P	GND	M3_PCIe RX1_P
9	GND	M3_PCIe TX3_N	GND	M3_PCIe TX1_N	GND	M3_PCIe RX3_N	GND	M3_PCIe RX1_N
10	M3_PCIe TX2_P	GND	M3_PCIe TX0_P	GND	M3_PCIe RX2_P	GND	M3_PCIe RX0_P	GND

11	M3_PCIe TX2_N	GND	M3_PCIe TX0_N	GND	M3_PCIe RX2_N	GND	M3_PCIe RX0_N	GND
12	GND	M3_KR_TX_P	GND	M3_KR_RX_P	GND	M3_PRESENT_N	GND	M3_PCIe_CLK_P
13	GND	M3_KR_TX_N	GND	M3_KR_RX_N	GND	RFU	GND	M3_PCIe_CLK_N
14	M2_PCIe TX3_P	GND	M2_PCIe TX1_P	GND	M2_PCIe RX3_P	GND	M2_PCIe RX1_P	GND
15	M2_PCIe TX3_N	GND	M2_PCIe TX1_N	GND	M2_PCIe RX3_N	GND	M2_PCIe RX1_N	GND
16	GND	M2_PCIe TX2_P	GND	M4_PCIe TX0_P	GND	M2_PCIe RX2_P	GND	M2_PCIe RX0_P
17	GND	M2_PCIe TX2_N	GND	M4_PCIe TX0_N	GND	M2_PCIe RX2_N	GND	M2_PCIe RX0_N
18	M2_KR_TX_P	GND	M2_KR_RX_P	GND	M2_PRESENT_N	GND	M2_PCIe_CLK_P	GND
19	M2_KR_TX_N	GND	M2_KR_RX_N	GND	RFU	GND	M2_PCIe_CLK_N	GND
20	GND	M1_PCIe TX3_P	GND	M1_PCIe TX1_P	GND	M1_PCIe RX3_P	GND	M1_PCIe RX1_P
21	GND	M1_PCIe TX3_N	GND	M1_PCIe TX1_N	GND	M1_PCIe RX3_N	GND	M1_PCIe RX1_N
22	M1_PCIe TX2_P	GND	M1_PCIe TX0_P	GND	M1_PCIe RX2_P	GND	M1_PCIe RX0_P	GND
23	M1_PCIe TX2_N	GND	M1_PCIe TX0_N	GND	M1_PCIe RX2_N	GND	M1_PCIe RX0_N	GND
24	GND	M1_KR_TX_P	GND	M1_KR_RX_P	GND	M1_PRESENT_N	GND	M1_PCIe_CLK_P
25	GND	M1_KR_TX_N	GND	M1_KR_RX_N	RFU	RFU	GND	M1_PCIe_CLK_N
26	CANL	GND	RFU	GND	RFU	RFU	PCIE_RST_N	GND
27	CANH	GND	AUX	GND	5.75V	5.75V	5.75V	5.75V
28	GND	AUX	AUX	AUX	5.75V	5.75V	5.75V	5.75V
29	GND	GND	GND	GND	GND	GND	12V	12V
30	25V	25V	25V	25V	12V	12V	12V	12V

10.4. Electrical

10.4.1. Common Requirements

Requirements in this section apply to both Standard Lid Modules and Special Modules.

Lid Module signals are broken into 5 classes: Power, Control/Status, CAN, PCIe, KR Ethernet. Control/Status, PCIe and KR Ethernet signal behavior is specific to the Lid Module type (Standard or Special)

Table 13 – Lid Module Signal Class: Power

Power Rail	Current (A)
5.75V	21.6 A
12V	14.4 A
25V	7.2 A
Vaux	7.2 A
Ground	21.6 A

Lid Modules ***shall*** support insertion and removal with DC voltage rails already energized.

Lid Modules ***shall*** accept any arbitrary power-up sequence of the DC voltages.

Lid Modules peak currents on any voltage rail ***shall not*** exceed the connector current specified in Table 13. Current limiting devices ***shall*** be placed as close to the connector as possible.

Lid Modules ***shall*** limit inrush current to less than 1 A on any DC voltage rail during insertion or initial power application.

Lid Modules ***shall*** provide short-circuit protection to prevent internal faults from affecting other modules in the GAP Enclosure.

Lid Modules ***shall*** provide protection from overvoltage on any DC voltage rail.

Lid Module maximum current consumption per DC voltage rail ***shall*** be specified in published specifications.

CANH and CANL signal behavior is specified in Section 11.3.2.2.

PCIe and KR signal classes are only used when terminated by the Special Module on a High-Speed Backplane.

Lid Modules *may* use backplane PCIe or KR lane(s) for module-to-module communication.

Lid Modules *may* use external cables or fibers to connect multiple modules as needed.

Connections between the Special Module and each Standard Lid Module for PCIe use ***shall*** be as per Table 14.

Table 14 – Lid High-Speed Backplane Signal Class: PCIe

Signal	Connectors
M4_PCIe_RX1/2/3/4_P/N	Special Module and Standard Lid Module 4
M4_PCIe_TX1/2/3/4_P/N	Special Module and Standard Lid Module 4
M4_PCIe_CLK_P/N	Special Module and Standard Lid Module 4
M3_PCIe_RX1/2/3/4_P/N	Special Module and Standard Lid Module 3
M3_PCIe_TX1/2/3/4_P/N	Special Module and Standard Lid Module 3
M3_PCIe_CLK_P/N	Special Module and Standard Lid Module 3
M2_PCIe_RX1/2/3/4_P/N	Special Module and Standard Lid Module 2
M2_PCIe_TX1/2/3/4_P/N	Special Module and Standard Lid Module 2
M2_PCIe_CLK_P/N	Special Module and Standard Lid Module 2
M1_PCIe_RX1/2/3/4_P/N	Special Module and Standard Lid Module 1
M1_PCIe_TX1/2/3/4_P/N	Special Module and Standard Lid Module 1
M1_PCIe_CLK_P/N	Special Module and Standard Lid Module 1
PCIE_RST_N	Special Module and all Standard Lid Modules

All terminations and AC coupling for PCIe signals ***shall*** be internal to the modules.

Signal behavior for all PCIe signals ***shall*** be compliant with [PCIe Gen4 Base].

Connections between the Special Module and each Standard Lid Module for KR Ethernet use ***shall*** be as per Table 15.

Table 15 – Lid High-Speed Backplane Signal Class: KR Ethernet

Signal	Connectors
M4_KR_RX_P/N	Special Module and Standard Lid Module 4
M4_KR_TX_P/N	Special Module and Standard Lid Module 4
M3_KR_RX_P/N	Special Module and Standard Lid Module 3
M3_KR_TX_P/N	Special Module and Standard Lid Module 3
M2_KR_RX_P/N	Special Module and Standard Lid Module 2
M2_KR_TX_P/N	Special Module and Standard Lid Module 2
M1_KR_RX_P/N	Special Module and Standard Lid Module 1
M1_KR_TX_P/N	Special Module and Standard Lid Module 1

All terminations and AC coupling for KR Ethernet signals ***shall*** be internal to the modules.

Signal behavior of KR Ethernet signals ***shall*** be compliant with [IEEE 802.3] Clause 72

10.4.2. Standard Lid Module

Standard Lid Modules ***shall*** be hot swappable without removing power or interrupting other active modules that are not directly dependent upon the module being swapped.

Standard Lid Module signal behavior for the Control/Status signals ***shall*** be as per Table 16.

Table 16 – Standard Lid Module Signal Class: Control/Status

Signal	Description
PRESENT_N1	Connected to ground on each module. Connection impedance ***shall*** be less than or equal to 100 ohms.
PRESENT_N2	
ADDR0	Module slot identifier provided by Lid Backplane, see Note 1 following this table
ADDR1	
ADDR2	

Note 1: Signals ADDR0, ADDR1 and ADDR2 identify the Lid Module slot numbers 1 through 6 as shown in Figure 11. ADDR2 is MSB, Lid Module slot numbering is shown in Table 17:

Table 17 – Lid Module Slot Addressing

Slot	ADDR2	ADDR1	ADDR0
Slot 1	GND	GND	5.75V
Slot 2	GND	5.75V	GND
Slot 3	GND	5.75V	5.75V
Slot 4	5.75V	GND	GND
Slot 5	5.75V	GND	5.75V
Slot 6	5.75V	5.75V	GND

10.4.3. Special Module

Special Modules *may* be hot swappable without removing power or interrupting other active modules.

Special Module signal behavior for the Control/Status signals ***shall*** be as per Table 18.

Table 18 – Lid Backplane Signal Class: Control/Status

Signal	Description
M4_PRESENT_N	Pulled high on the Special Module. Connection to the high level ***shall*** be 10k or greater.
M3_PRESENT_N	
M2_PRESENT_N	
M1_PRESENT_N	

10.5. Environmental

Requirements in this section apply to both Standard Lid Modules and Special Modules.

Lid Modules ***shall*** comply with the recommended environmental conditions from [GAP Enclosure] Table 22 which are suitable to the specific installation environment.

Lid Modules electrostatic discharge (ESD) test ***shall*** be executed according to clauses 7 and 8 of [IEC61000-4-2]. Positive and negative polarity voltage tests ***shall*** be completed.

ESD tests ***shall*** be performed on all accessible equipment points accessible when the equipment is operating, is being installed, or while under maintenance.

Contact discharge method ESD tests ***shall*** be applied to conductive surfaces and conductive planes. Air discharge method tests shall be applied to insulating surfaces.

Test points for both normal operating, storage, and maintenance type ESD testing ***shall*** be selected based on recommendations in [IEC61000-4-2] Clause 8.

10.5.1. Thermal Constraints

Lid Modules ***shall not*** exceed an average rated power of 20 W per occupied slot under the reference conditions described in [GAP Enclosure] section 10.2.1.

11. Module Communications

11.1. Overview (Informative)

The GAP Communications specification covers two interfaces with differing scopes and requirements. The Internal Module Interface (IMI) is used internally between GAP modules while the External GAP Interface (EGI) is used between a principal module and an external back-office entity.

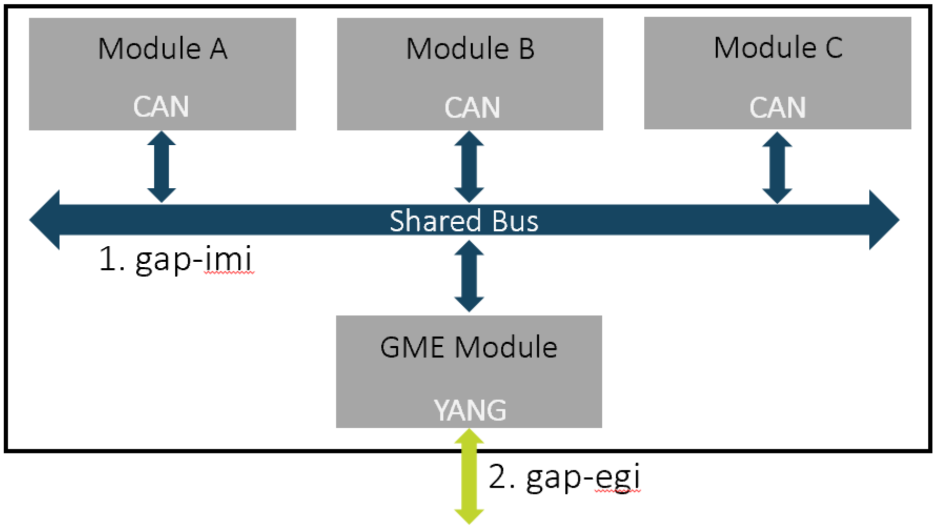

Figure 15 – GAP Management Interfaces

The GAP node architecture is designed around flexible and interoperable modules within a standardized GAP node housing design. The GAP architecture allows for the modules within the node to be sourced from different vendors and integrated into the same node housing. The communications specification provides a foundation for multi-vendor interoperability consistent with this goal.

The **IMI** or GAP-IMI is the internal shared bus available to all GAP modules. This is a low-speed, highly resilient, shared communication bus where any module can communicate with any other module on the bus. All GAP compliant modules participate in this bus for, at minimum, providing inventory and monitoring. The IMI requirements specify the physical layer, network layer, and some common application layer networking behaviors while also providing mechanisms for vendor-specific extensions.

The **EGI** or GAP-EGI is the external point-to-point communication from the principal GAP module to an external management entity outside the GAP housing. A single module within a GAP housing deployment, determined during hardware configuration of the housing, is installed as the principal or GAP Management Entity (GME) module. The GME facilitates communication from the outside world to status and control of modules inside the node. The GME module is likely, but not required, to be the main access technology being deployed within the GAP node. The GME is likely to support upgrading other modules within the housing over the IMI standard software upgrade mechanisms. It is assumed that the GME module has a high-speed, digital connection to an unspecified back-office entity, such as a 10G Ethernet link over fiber-optics. The EGI requirements specify data-model requirements (in the form of YANG models) to be transported over an unspecified point-to-point communication protocol.

The HS-P2P or High-Speed P2P is an internal point-to-point communication channel from the Special Module to each remaining Standard Lid Module slot. This communication channel requires a High-Speed Lid Backplane to have been installed into the GAP enclosure.

11.2. External GAP Interface – EGI

11.2.1. Overview (Informative)

The EGI interface is a point-to-point interface from the GAP Management Entity (GME) to an unspecified external entity. While not required by the EGI, it is generally assumed that the GME is capable of communicating over higher layer protocols such as IP, TCP, SSH, HTTP, and encryption such as TLS.

The flexibility of the GAP housing introduces challenges in requiring a specific protocol fulfilled north of the GME, as requiring a certain protocol can reduce the flexibility of the GAP housing. The GME is expected to "forward" status and configuration from the GAP housing to an external entity, but the protocol used to transmit that information can vary significantly between GME implementations. Some possible GAP GME modules are envisioned to be layer2 only with no IP-based stack, while others are envisioned to support advanced HTTP/2 protocol stacks.

The approach, then, is to specify the protocol independent data models we would expect to be available from the GME and leave the realization of those models mapped to a specific protocol up to a GME implementation decision. This allows the GME vendor to implement the models at the protocol layer that is expected based on the access technology environment of the GME.

In many GME applications, an operator could expect a "YANG native" protocol, such as NETCONF or RESTCONF, as the transport for the EGI models. While other GME modules could elect to transmit the model leaf-fields over a more technology-appropriate protocol such as MHAv2 GCP or OAM. The mechanism of mapping of the model leaf-fields to the transport protocol is left to vendor specification.

11.2.2. YANG Modeling

Table 19 defines the minimum YANG models a GME ***shall*** implement for GAP compliance.

The GME *may* implement any additional models needed for its access technology environment. The GME ***shall*** provide the YANG models over a protocol appropriate to the GME Access technology landscape. If a non-"YANG native" protocol is used for the transport protocol, then the GAP Integrator or GME module vendor ***shall*** provide documentation on the model mapping mechanism.

Table 19 – YANG Module compliance matrix

YANG Module	Requirement	Reference	Comment
IETF YANG Types	***shall***	RFC 6991	A collection of common data types derived from the built-in YANG data types. The derived types are designed to be applicable for modeling all areas of management information.

IETF Interfaces	***shall***	RFC 8343	Data model for managing network interfaces on a device.
IANA Hardware	***shall***	https://www.iana.org/protocols	Base hardware entity types derived from the IANA-ENTITY-MIB.
IETF Hardware	***shall***	RFC 8348	Data model for management of hardware in a device, derived from ENTITY-MIB.
IETF IP	*should*	RFC 8344	Data model for management of IP implementations of a device.
IETF Alarms	*may*	RFC 8632	Data model for alarm life-cycle management.
APSIS	*should*	SCTE 216 2015	Data model for reporting power consumption.

11.3. Internal Module Interface - IMI

The Internal Module Interface (IMI) is a shared bus topology network designed to be resilient, interoperable, and shared for all GAP modules within the same GAP housing. Allowing all modules to communicate with all other modules across a shared bus provides a flexible solution to multi-vendor GAP housing deployments. Special consideration was given on bus physical properties and protocol host resource usage.

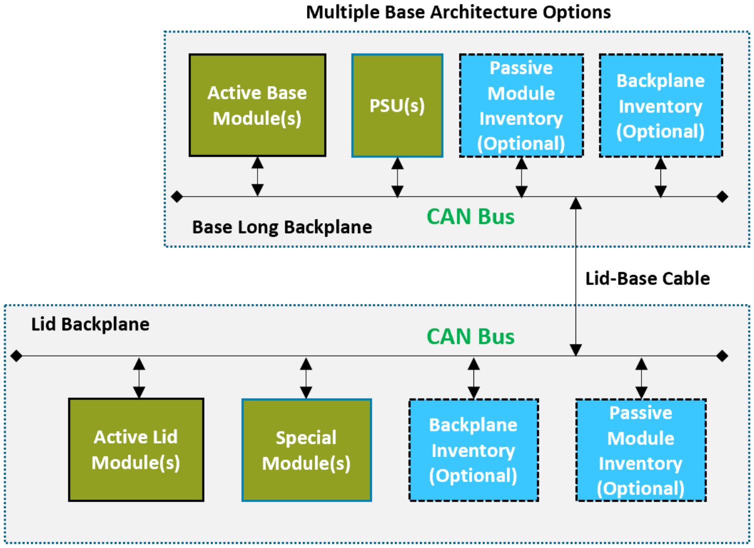

Figure 16 – IMI Shared Bus Architecture

The IMI bus is shared between all the GAP modules installed across both the lid and the base as shown in Figure 16.

All active modules ***shall*** support the IMI. Passive modules *may* support the IMI.

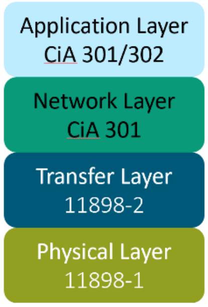

Figure 17 – IMI Protocol layers

The IMI makes use of two different external standards, the ISO 11898 CAN specification for the physical properties and message framing. And the CiA 301/302 CANopen specification for network and application protocol behaviors.

11.3.1. CAN Bus Interface

The IMI bus ***shall*** be based on a 2-wire CAN physical layer with differential signaling and CAN framing. The IMI bus ***shall*** comply with ISO 11898 CAN physical and transfer layer standard for high-speed transceivers.

A GAP module complying to the IMI CAN bus requirements ***shall*** support CAN Standard Frames with an 11-bit Identifier Field as shown in Figure 18. The CAN Extended Frame 29-bit Identifier ***shall not*** be used on the IMI. This limits the maximum number of GAP Modules in a GAP housing to 127.

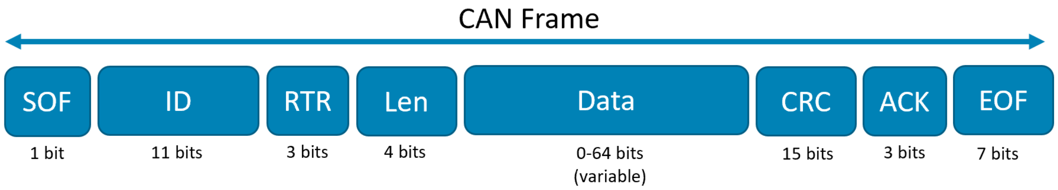

Figure 18 – CAN Frame

The CAN standard defines the physical properties, frame format, bus arbitration, message resiliency, and error detection parameters. The CAN standard does not define the message identifier (ID) construction mechanisms or the data payload meaning.

A CAN bus is a single shared broadcast domain and all CAN nodes on the bus can read any frames written to the CAN bus. All CAN nodes can write to the shared CAN bus and rules on contention, bus errors, and bus priority are detailed in ISO 11898.

11.3.2. CANopen Application Protocol

11.3.2.1. Overview (Informative)

The ISO 11898 CAN standard defines the physical properties and the CAN framing format but does not specify the data payload formatting or the message identifier (ID) meaning or assignment.

To provide Node ID assignment, network entry rules, network maintenance, data payload formatting, access controls, and data read/write mechanisms the IMI makes use of the CANopen specification. The CANopen specification can easily be extended or specialized for specific applications as it consists of a small set of foundational functionalities which are utilized for specific technologies.

11.3.2.2. Physical Layer

GAP modules ***shall*** support CANopen networking compliant with CiA 301 and CiA 302.

GAP modules ***shall*** support the CANopen heartbeat functionality. GAP modules *may* support CANopen guarding functionality.

11.3.2.2.1. Transmission Rates

A GAP module complying to the IMI CAN bus requirements ***shall*** support ISO 11898 bit timings for 1 Mbit/s CAN bus operation. For example, with a 16 MHz oscillator the CAN bus settings would be: nominal bit time = 1 µs, number of time quanta per bit = 8, length of time quantum = 125 ns, location of sample point = 6 t_q (750 ns), approximate Maximum bus length = 25 m. The GAP module *may* use another oscillator base with different time quanta settings compliant with 11898 and 1 Mbit/s operation.

11.3.2.2.2. Node ID Assignments

GAP modules ***shall*** support LSS from CANopen CiA 305 for automatic Node ID assignments. GAP modules are not required to support LSS configuration of CAN bitrates (GAP requires the use of 1Mb/s bitrate). The GME ***shall*** support LSS master functionality. The GME ***shall*** support assignment of unique Node IDs to other modules on the IMI bus using LSS CiA 305 functionality.

11.3.2.3. Error Handling

11.3.2.3.1. General

GAP Modules ***shall*** support the value structure of Emergency messages supported in CiA301.

11.3.2.3.2. Error Behavior

GAP Modules ***shall*** support the error behavior and handling specified in CiA301.

11.3.2.3.3. Additional Error Codes

No additional error codes specified at this time.

11.3.2.4. Operating Principles

11.3.2.4.1. General

The CANopen bus connects all active modules within a GAP housing onto the same communication channel. Different modules from different vendors are expected to be supported within the same GAP housing. All active modules ***shall*** support a CANopen interface for querying inventory and status information. Active modules *may* support extended, vendor-specific CANopen object dictionary entries.

The core concept of a CANopen network node is the Object Dictionary (OD), a “lookup table” or “register table” of datatypes. Each OD entry is indexed by a 16-bit Index and an 8-bit Subindex, allowing up to ~65,535 Indexed entries, with each Indexed entry supporting 256 Subentries. Each Index+Subindex is assigned a single datatype such as UNSIGNED8 or VISIBLE STRING, but datatypes *may* be mixed within an Index with each Subindex being a different datatype.

Reading and Writing the Object Dictionary is mediated through the Service Data Object (SDO) or Process Data Object (PDO) CANopen mechanisms. Network entry and health monitoring is mediated through the Network Management (NMT) mechanisms.

11.3.2.4.2. Device Classes

The GME module ***shall*** operate as the CANopen manager, as per CiA 302. The GME module ***shall*** operate as an NMT master, as per CiA 302. GME modules *should* support Flying Master defined in CiA 302-2. The GME module ***shall*** operate as a TIME producer, as per CiA 301.

Non-GME modules ***shall*** operate as NMT slaves, as per CiA 301/302. Non-GME modules *may* recover a non-realtime clock from the GME TIME producer.

11.3.2.5. Generic Object Dictionary

GAP modules ***shall*** comply with the CiA 301 required Object Dictionary entries. Some, but not all, of the standard fields are reproduced in Table 20 for informational purposes.

Table 20 – CiA 301 Object Dictionary (partial, informative)

Index	Name	Type	Description	Access
1000h	Device Type Information	UNSIGNED32	Per CiA.	RO
1008h	Manufacturer Device Name	VISIBLE_STRING	Per CiA .	RO
1009h	Manufacturer Hardware Version	VISIBLE_STRING	Per CiA.	RO
100Ah	Manufacturer Software Version	VISIBLE_STRING	Per CiA.	RO
1001h	Error Register	UNSIGNED8	Per CiA.	RO
1002h	Manufacturer Status Register	UNSIGNED8		RO
1018h **01h**	Vendor ID	UNSIGNED32	Per CiA. Set to Vendor OUI.	RO
1018h **02h**	Product Code	UNSIGNED32	Per CiA. Vendor defined	RO
1018h **03h**	Revision Number	UNSIGNED32	Per CiA. 0-15 bits Minor Rev 16-31 bits Major Rev	RO
1018h **04h**	Serial Number	UNSIGNED32	Per CiA.	RO
1017h	Heartbeat: Producer		Per CiA.	RW

1F50h	Download Program Data		Per CiA.	RW
1F51h	Program Control		Per CiA.	RW

11.3.2.6. GAP Module Object Dictionary

GAP compliant modules ***shall*** implement the GAP Module Object Dictionary. A summary of the Object Dictionary fields is provided in Table 21 for informational purposes.

Table 21 – GAP Module Object Dictionary (informative)

Index	Name	Type	Description	Access
6110h **01h**	Multislot Size	UNSIGNED8	Describes the slot width of the module	RO
6110h **02h**	Installed Slot(s)	UNSIGNED16	The GAP slot the module is installed into. Most Significant Bit (MSB) signifies installed into Base (1) or Lid (0). Remaining bits, starting at LSB, signify consumed slots of that module. Each consumed slot ***shall*** be set to 1.	RO
6110h **03h**	PCIe Backplane Lane Support	UNSIGNED8	Bitfield for supported PCIe Lanes. Starting from the LSB: a 1 indicates supported Lane, a 0 indicates no supported Lane.	RO
6110h **04h**	KR Backplane Lane Support	UNSIGNED8	Enumeration of supported KR backplane: • None (0) • 10GBASE-KR (1) • 25GBASE-KR (2)	RO
6110h **05h**	Mfg Unique ID	UNSIGNED48	Globally unique identifier for each manufactured module. MSB 3 octets ***shall*** be the Module vendor OUI. The LSB 3 octets are vendor defined.	RO
6110h **06h**	Is FRU (Field Replaceable)	BOOLEAN	Is the Module expected to be field replaceable?	RO

Index	Name	Type	Description	Access
6110h **07h**	Module Purpose	VISIBLE STRING	Vendor description of purpose of module.	RO
6110h **08h**	Module Class	UNSIGNED8	Enumeration of device class: • Unknown (0) • Chassis (1) • Backplane (2) • Container (3) • Power-Supply (4) • Fan (5) • Sensor (6) • Module (7) • Port (8) • Stack (9) • CPU (10) • EnergyObject (11) • Battery (12) • Storage (13)	RO
6110h **09h**	Module GAP Function	UNSIGNED8	Enumeration of GAP Function: • Unknown (0) • Other (1) • Wireline (2) • Wireless (3) • RF (4) • Optical (5) • Packet (6) • Power Supply (7) • Compute (8) • Lid Backplane (9) • Base Backplane (10)	RO
6110h **0A h**	Mfg Date Code	UNSIGNED32	Date of manufacture as seconds since an epoch of January 1st 1970 (“Unix Time”).	RO
6110h **0B h**	Alias	VISIBLE STRING255	Programmable Alias string. Module ***shall*** retain Alias in non-volatile memory.	RW
6110h **0C h**	Asset ID	VISIBLE STRING255	Programmable Asset ID string. Module ***shall*** retain Asset ID in non-volatile memory.	RW

Index	Name	Type	Description	Access
6110h **0D h**	Connected Slot	UNSIGNED16	The physically connected slot number, as read from the backplane. Most Significant Bit (MSB) signifies installed into Base (1) or Lid (0). Remaining bits are unsigned integer of Slot number, as read from backplane.	RO
6112h **01h**	Mfg Module Error Str	VISIBLE STRING	Vendor defined error string from last error code. Empty if no last error.	RO
6112h **02h**	Mfg Module Error Code	UNSIGNED32	Vendor defined error code from last error. 0 if no last error.	RO
6113h **01h**	Operational State	UNSIGNED4	Module reported operational state. Enumeration, consistent with ifOperStatus: • Up (1) • Down (2) • Testing (3) • Unknown (4) • Dormant (5) • Not-Present (6) • Lower-Layer-Down (7)	RO
6113h **02h**	Uptime	UNSIGNED32	Amount of time, in seconds, the module has been operational.	RO
6114h	Sensor Names	Array VISIBLE_STRING255	Array of sensor names. Each Subindex within this Index is correlated to the Sensor Value Subindex (below). The Sensor Names ***shall*** be static during runtime.	RO
6115h	Sensor Definitions	Array UNSIGNED32	Array of sensor definition metadata. Each Subindex within this Index is correlated to the Sensor Value Subindex (below). The Sensor Definitions metadata ***shall*** be static during runtime.	RO

Index	Name	Type	Description	Access
6116h	Sensor Values	Array UNSIGNED64	Array of sensor values, corresponding to the Sensor Definitions (above). The Subindex of the Sensor Value ***shall*** be correlated to the Sensor Definition metadata.	RO

11.3.2.6.1. Sensors

Each GAP module is envisioned to provide several sensor readings such as: temperatures, voltages, and byte counters. These counters *may* be used by the GME Module or other GAP Modules within the GAP housing or *may* be communicated to an external entity from the GME Module. The Object Dictionary communication of the sensor data is generally derived from the ENTITY-SENSOR-MIB [RFC 3433] and detailed in this section.

Each GAP module *may* populate 1 or more sensor readings through the three Sensor Object Dictionary Indexes:

1. The sensor ASCII string names are communicated through the “Sensor Names” OD Index. This index contains the name of the correlated Sensor Definitions and Sensor Values. These entries are static during the uptime of the GAP Module but *may* change across reboot life-cycles of the GAP Module.
2. The sensor metadata are communicated through the “Sensor Definitions” OD Index. This index contains all the metadata for the sensor values that are communicated from the GAP Module. These entries are static during the uptime of the GAP Module but *may* change across reboot life-cycles of the GAP Module.
3. The sensor readings are communicated through the “Sensor Values” OD Index. This index does not contain any metadata for the sensor, only the timestamp and a reading for a sensor. The sensor value Subindex is linked/mapped to the same Subindex from the Sensor Definitions and Names Indexes. The values of the sensors are dynamic during runtime.

A GAP Module that is consuming sensor readings from another GAP Module would first, and likely only once at boot time, read all the metadata from the “Sensor Names” and “Sensor Definitions” Indexes. Then the GAP Module would poll the Sensor Values for the actual readings during runtime.

A GAP Module implementing a Sensor ***shall*** ensure that the “Sensor Names”, “Sensor Definitions”, and “Sensor Values” Subindexes are all correlated. For example: a read of “Sensor Names”[5], “Sensor Definitions”[5], and “Sensor Values”[5] are all the same logical Sensor and the unification of those reads results in the Sensor Name, Definition, and Value respectively. This limits the total Sensors a single GAP module can communicate to 255.

A GAP Module *may* populate any number of sensors, up to the CANopen maximum of 255. A GAP Module ***shall*** populate at least 1 sensor reporting a temperature value relevant to the GAP Module.

11.3.2.6.1.1. Object Dictionary: Sensor Definitions

The Sensor Definitions metadata Subindex value ***shall*** be correlated and the same as the Subindex value for the associated Sensor Name and Value.

The Sensor Definitions Index is an array of Subindexes where each Subindex is a 32bit unsigned integer, where the metadata is encoded into the 32bit unsigned as follows:

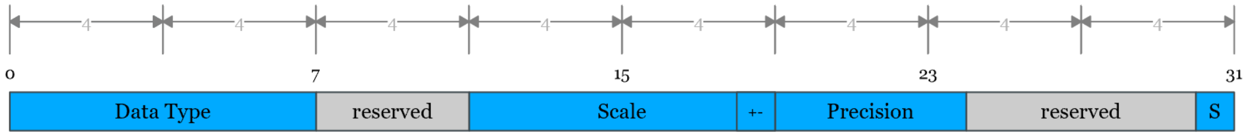

Figure 19 – Sensor Definition

- 0-7b : Enumeration Data Type of sensor:
    - Not present (0)
    - Other (1)
    - Unknown (2)
    - VoltsAC (3)
    - VoltsDC (4)
    - Amperes (5)
    - Watts (6)
    - Hertz (7)
    - Celsius (8)
    - PercentRH (9)
    - RPM (10)
    - CMM (11)
    - TruthValue (12)
    - bits (13)
    - Vendor Defined (14)
    - reserved (15+)
- 8-11b : Reserved, set to zero
- 12-19b : 8bit signed integer for scale of sensor value. As a signed power of 10. For example, -9 is 10^-9 or “nano” scale. -3 is 10^-3 or “milli” scale. +6 is 10^6 or “mega” scale.
- 20-24b: 5bit signed integer for precision of sensor value, valid range from (-8..9). 0 indicates sensor is an integer. A value in the range 1 to 9 represents the number of decimal places in the fractional part of the associated sensor value fixed-point number. A value in the range -8 to -1 represents the number of accurate digits in the associated sensor value fixed-point number.
- 25-30b: Reserved, set to zero
- 31b: Sign bit for Sensor Value. 0 is used to indicate the Sensor Value is Unsigned, 1 is used to indicate the Sensor Value is Signed.

11.3.2.6.1.2. Object Dictionary: Sensor Values

The Subindexes in the Sensor Definitions ***shall*** be directly correlated to the Subindexes in the Sensor Values, for example, the Sensor Definition at Subindex 5 has the associated sensor value at Subindex 5 of the Sensor Values Index. Sensor Values that have not (yet) been populated or are not valid ***shall*** exist at the appropriate Subindex offset, based on Sensor Definition and Name, but have a value of 0.

The Sensor Values Index ***shall*** be a list of 64bit unsigned integers representing the following bit allocations:

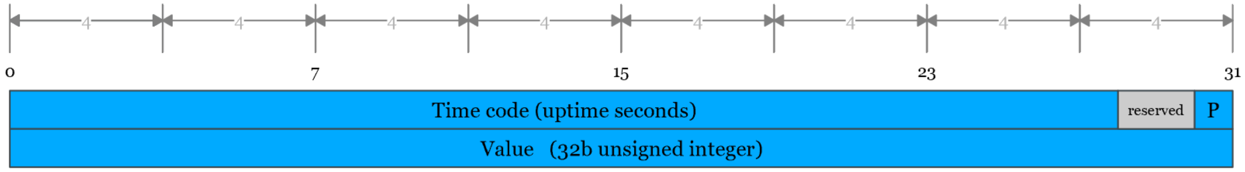

Figure 20 – Sensor Value

Where the fields are:

- Time code (29bit unsigned integer): ***Shall*** be the time that the value was read as the number of seconds since module boot. This time correlates to the Uptime value in the GAP Module Object Dictionary. It's likely that many GAP modules will not have access to a clock time-source so seconds since module boot is used as the time code. Correlation to a wallclock time frame from the uptime time code value is left to GME vendor implementation.
- P (1bit): ***Shall*** be set to 1 if the Sensor Value is Present and valid. Set to 0 if the Sensor Value at this Subindex is invalid. The Sensor Definitions and Sensor Values must be correlated, this bit allows Sensor Values Subindexes to be 'reserved' without a corresponding sensor read by setting the P-bit to 0.
- Value (32b unsigned* integer): ***Shall*** be the value of the sensor at the Time code seconds uptime time. The meaning of the value is defined in conjunction with the correlated Sensor Definitions metadata. Specifically, the Scale and Precision are used to interpret the value and the Data type is used to interpret the units; while the Sign bit is used to indicate if the 32bits should be interpreted as a signed or unsigned value.
- Without fragmentation, 64bits is the largest payload supported by the underlying CAN frame format in a single frame. To make optimal use of bus time sensor values ***shall*** be no more than 64 bits.

11.3.2.7. GAP Module CANopen Device Profiles

In addition to requirements from CiA 301/302, GAP modules ***shall*** implement the following standard CiA device profiles:

- GAP Power Supply modules ***shall*** implement CiA 453 – Device Profile for Power Supplies. GAP Power Supplies *may* restrict threshold configuration defined in CiA 543 to static values defined by the power supply vendor and implement the threshold values of CiA 543 as readonly (ro) fields.
- GAP modules ***should*** implement CiA 458 – Device Profile for Energy Measurements

11.3.2.8. GAP Module CANopen Vendor Specific Profiles

No specific requirements, beyond CiA compliance, are placed on GAP module vendors w.r.t. vendor-specific or additional Object Dictionary definitions. CANopen framework supports multiple device profiles on the same device.

11.3.2.9. Detailed GAP Module Object Dictionary Parameters

GAP Modules ***shall*** implement the CANopen Object Dictionary entries defined within this section (11.3.2.9).

11.3.2.9.1. 6110h : GAP Module Information

This object is an array of GAP Module inventorying information.

Object Definition:

Attribute	**Value**
Index	6110h
Name	GAP Module Inventorying information
Object Code	RECORD
Category	Mandatory

Entry Definition:

Attribute	**Value**
Sub-Index	00h
Description	Highest sub-index supported.
Category	Mandatory
Access	const
PDO Mapping	no
Value Range	0C h
Sub-Index	01h
Description	Multislot Size
Category	Mandatory
Access	Const
PDO Mapping	no
Data Type	UNSIGNED8
Sub-Index	02h
Description	Installed Slot(s)

Category	Mandatory
Access	Const
PDO Mapping	no
Data Type	UNSIGNED16. The GAP slot the module is installed into. Most Significant Bit (MSB) signifies installed into Base (1) or Lid (0). Remaining bits interpreted as a bitmap, starting at LSB, signify consumed slots of that module. Each consumed slot ***shall*** be set to 1. For clarity, a consumed slot is when the module occupies the physical space of a slot irrespective of the use of the backplane connector at that slot location.
Sub-Index	03h
Description	PCIe Backplane Lane Support
Category	Mandatory
Access	Const
PDO Mapping	no
Data Type	UNSIGNED8. Bitfield for support PCIe Lanes. Starting from LSB: a 1 indicates supported Lane, a 0 indicates no supported Lane.
Sub-Index	04h
Description	KR Backplane Lane Support
Category	Mandatory
Access	Const
PDO Mapping	no
Data Type	UNSIGNED8.

	Enumeration: - None (0) - 10GBASE-KR (1) - 25GBASE-KR (2)
Sub-Index	05h
Description	Mfg Unique ID
Category	Mandatory
Access	Const
PDO Mapping	no
Data Type	UNSIGNED48. Unique identifier for each manufactured module. MSB 3 octets ***shall*** be Module vendor OUI. The LSB 3 octets are vendor defined, but unique for each module.
Sub-Index	06h
Description	Is Field Replaceable Unit (FRU)
Category	Mandatory
Access	Const
PDO Mapping	no
Data Type	BOOLEAN
Sub-Index	07h
Description	Vendor defined module purpose.
Category	Mandatory
Access	Const
PDO Mapping	no

Data Type	VISIBLE_STRING255
Sub-Index	08h
Description	Module Class
Category	Mandatory
Access	Const
PDO Mapping	no
Data Type	UNSIGNED8. Enumeration: - Unknown (0) - Chassis (1) - Backplane (2) - Container (3) - Power-Supply (4) - Fan (5) - Sensor (6) - Module (7) - Port (8) - Stack (9) - CPU (10) - EnergyObject (11) - Battery (12) - Storage (13)
Sub-Index	09h
Description	Module GAP Function
Category	Mandatory
Access	Const
PDO Mapping	no
Data Type	UNSIGNED8. Enumeration:

	- Unknown (0) - Other (1) - Wireline (2) - Wireless (3) - RF (4) - Optical (5) - Packet (6) - Power Supply (7) - Compute (8) - Lid Backplane (9) - Base Backplane (10)
Sub-Index	0Ah
Description	Mfg Date Code
Category	Mandatory
Access	Const
PDO Mapping	no
Data Type	UNSIGNED32. Seconds since epoch of January 1st 1970.
Sub-Index	0Bh
Description	Alias
Category	Mandatory
Access	Read-Write
PDO Mapping	no
Data Type	VISIBLE_STRING255
Sub-Index	0Ch
Description	Asset ID
Category	Mandatory

Access	Read-Write
PDO Mapping	no
Data Type	VISIBLE_STRING255
Sub-Index	0Dh
Description	Connected Slot
Category	Mandatory
Access	Const
PDO Mapping	no
Data Type	UNSIGNED16 The physically connected slot number, as read from the backplane. Most Significant Bit (MSB) signifies installed into Base (1) or Lid (0). Remaining bits are unsigned integer of Slot number, as read from backplane.

11.3.2.9.2. 6112h : GAP Module Extended Error

This object contains extended error information.

Object Definition:

Attribute	**Value**
Index	6112h
Name	GAP Extended Error Information
Object Code	RECORD
Category	Optional

Entry Definition:

Attribute	**Value**
Sub-Index	00h

Description	Highest sub-index supported.
Category	Mandatory
Access	const
PDO Mapping	no
Value Range	0 - 2
Sub-Index	01h
Description	Vendor defined error string from last error
Access	readonly
PDO Mapping	no
Value Range	VISIBLE_STRING
Sub-Index	02h
Description	Vendor defined error code from last error
Access	readonly
PDO Mapping	no
Value Range	UNSIGNED32

11.3.2.9.3. 6113h : GAP Module Operational State

This object contains the operational status of the GAP Module.

Object Definition:

Attribute	**Value**
Index	6113h
Name	GAP Module Operational Status
Object Code	RECORD
Category	Mandatory

Entry Definition:

Attribute	**Value**
Sub-Index	00h
Description	Highest sub-index supported.
Category	Mandatory
Access	const
PDO Mapping	no
Value Range	2
Sub-Index	01h
Description	Operational State
Access	readonly
PDO Mapping	no
Value Range	UNSIGNED4 Enumeration: - Not Reported (0) - Up (1) - Down (2) - Testing (3) - Unknown (4) - Dormant (5) - Not-Present (6) - Lower-Layer-Down (7)
Sub-Index	02h
Description	Uptime
Access	readonly
PDO Mapping	no
Value Range	UNSIGNED32

	Time in seconds since the module became Operational.

11.3.2.9.4. 6114h : GAP Sensors Names

This object is an array of sensor names. The list ***shall not*** change during runtime but *may* change across module restarts.

Object Definition:

Attribute	**Value**
Index	6114h
Name	GAP Sensor Names
Object Code	ARRAY
Data Type	VISIBLE_STRING
Category	Mandatory

Entry Definition:

Attribute	**Value**
Sub-Index	00h
Description	Highest sub-index supported.
Category	Mandatory
Access	const
PDO Mapping	no
Value Range	0 - 255
Sub-Index	0***x***h (variable)
Description	Name of the sensor at this index
Access	readonly
PDO Mapping	no
Value Range	VISIBLE_STRING

11.3.2.9.5. 6115h : GAP Sensors Definitions

This object is an array of sensor definitions. The list ***shall not*** change during runtime but *may* change across module restarts. The sensor definition indexes ***shall*** be correlated to the GAP Sensor Names object dictionary array.

Object Definition:

Attribute	**Value**
Index	6115h
Name	GAP Sensor Definitions
Object Code	ARRAY
Data Type	UNSIGNED32
Category	Mandatory

Entry Definition:

Attribute	**Value**
Sub-Index	00h
Description	Highest sub-index supported.
Category	Mandatory
Access	const
PDO Mapping	no
Value Range	0 - 255
Sub-Index	0***x***h (variable – index correlated to the index of the Sensor Name)
Description	The definition of the sensor at this index (see 11.3.2.9.5).
Access	readonly
PDO Mapping	no
Value Range	n/a

11.3.2.9.6. 6116h : GAP Sensors Values

This object is an array of sensor values. The values of this array are expected to be updated during runtime but the order and length of this entry ***shall not*** change during runtime. The sub-index entries ***shall*** be correlated to the GAP Sensor Names indexes. Entries that have a GAP Sensor Name but no corresponding value (yet) are still present in the list but ***shall*** have their "Present" bit set to 0.

Object Definition:

Attribute	**Value**
Index	6116h
Name	GAP Sensor Value
Object Code	ARRAY
Data Type	UNSIGNED64
Category	Mandatory

Entry Definition:

Attribute	**Value**
Sub-Index	00h
Description	Highest sub-index supported.
Category	Mandatory
Access	const
PDO Mapping	no
Value Range	0 - 255
Sub-Index	0***x***h (variable – index correlated to the index of the Sensor Name)
Description	The value of the sensor at this index (see 11.3.2.9.6).
Access	readonly
PDO Mapping	Optional
Value Range	n/a