SFF-8665

Specification for

QSFP+ 4X Pluggable Transceiver Solutions

Rev 1.9.8~~6~~ ~~July~~March 24~~8~~, 2025~~4~~

SECRETARIAT: ~~-~~SFF ~~TA~~ TWG

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The description of the connector in this specification does not assure that the specific component is available from connector suppliers. If such a connector is supplied, it should comply with this specification to achieve interoperability between suppliers.

ABSTRACT: ~~-~~This specification defines the physical interface, low speed electrical, and management interface requirements of QSFP+ 4X pluggable transceiver solutions including: QSFP10, QSFP14, QSFP28, QSFP56,~~ and~~ QSFP112 and QSFP224.

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FOREWORD

The development work on this specification was done by the SFF ~~TA~~ TWG, an industry group. Since its formation as the SFF Committee in August 1990, as well as since SFF's transition to SNIA in 2016, the membership has included a mix of companies which are leaders across the industry.

For those who wish to participate in the activities of the SFF ~~TA~~ TWG, the signup for membership can be found at https://www.snia.org/~~sff/~~join.

REVISION HISTORY

Rev 1.6
- Moved reference SFF specs to 2.1 Industry Documents and expanded the list
- Moved SFF-8672 and SFF-8683 to Figure 3-1 plus complementary sections
- Added using interfaces to Application Specific Criteria

Rev 1.7
- Clarified introductory paragraph of SFF-8662 and SFF-8672

Rev 1.8
- Add multiple generations to Abstract

Rev 1.9
- Modified Figure 3-1 to include explanatory details

Rev 1.9.1 *February 2, 2022*:
- Incorporated figures for all generations of QSFP pluggable transceiver solutions

Rev 1.9.2 *February 8, 2022*:
- Additional updates based on discussion

Rev 1.9.3 *March 25, 2022*:
- Additional editorial changes based on review ballot comments

Rev 1.9.4 *April 1, 2022*:
- Additional changes based on comment resolution discussion

Rev 1.9.5 *July 1, 2024*:
- Added chart for QSFP224
Additional changes based on comment resolution discussion
-

Rev 1.9.6 July 8, 2024

Rev 1.9.7 February 28, 2025:
- Implemented editorial comments from review ballot

Rev 1.9.8 March 24, 2025
- Added SFF-TA-1027 to QSFP28 and QSFP56 Pluggable Transceiver solution Figure

~~Additional changes based on comment resolution discussion~~ ~~**Rev 1.9.5** *July 1, 2024*:~~
~~- Added chart for QSFP224~~
~~- Additional changes based on comment resolution discussion~~

CONTENTS

FIGURES

~~**TABLES**~~

1. Scope

This specification defines the physical interface, low speed electrical, and management interface requirements of QSFP+ 4X pluggable transceiver solutions including: QSFP10, QSFP14, QFSP28, QSFP56, QSFP112~~,~~ and QSFP224.

Other standards (e.g., IEEE, FC-PI-6, etc.) define the performance requirements for QSFP connectors used to transmit signals at various data rates using optical modules or cable assemblies.

2. References and Conventions

2.1 Industry Documents

The following documents are relevant to this specification:

- OIF CMIS — Common Management Interface
- SFF-8636 — Management Interface for 4-lane Modules and Cables
- SFF-8661 — QSFP+ 4X Pluggable Module
- SFF-8662 — QSFP+ 28 Gb/s 4X Connector (Style A)
- SFF-8663 — QSFP+ 28 Gb/s Cage (Style A)
- SFF-8672 — QSFP+ 4X 28 Gb/s Connector (Style B)
- SFF-8679 — QSFP+ 4X Hardware and Electrical Specification
- SFF-8682 — Serial Attachment 2X Unshielded Connector
- SFF-8683 — QSFP+ Cage
- SFF-TA-1027 — QSFP2 Connector, Cage, and Module
- ~~SFF-TA-1029 — QSFP Cabled Cage and Connector~~

2.2 Sources

The complete list of SFF documents which have been published, are currently being worked on, or that have been expired by the SFF Committee can be found at https://www.snia.org/sff/specifications. Suggestions for improvement of this specification ~~will be~~are welcome~~, they~~ and should be submitted to https://www.snia.org/feedback.

Other standards may be obtained from the organizations listed below:

Standard	Organization	Website
IEEE	Institute of Electrical and Electronics Engineers (IEEE)	https://*standards*~~www~~.ieee.org/*access-standards*
Fibre Channel standards	International committee for Information Technology Standards (INCITS)	https://www.incits.org
OIF	Optical Internetworking Forum (OIF)	https://www.oiforum.com

2.3 Conventions

The following conventions are used throughout this document:

DEFINITIONS:

Certain words and terms used in this standard have a specific meaning beyond the normal English meaning. These words and terms are defined either in the definitions or in the text where they first appear.

ORDER OF PRECEDENCE:

If a conflict arises between text, tables, or figures, the order of precedence to resolve the conflicts is text; then tables; and finally figures. Not all tables or figures are fully described in the text. Tables show data format and values.

LISTS:

Lists sequenced by lowercase or uppercase letters show no ordering relationship between the listed items.

EXAMPLE 1 – The following list shows no relationship between the named items:

a. red (i.e., one of the following colors):
    A. crimson; or
    B. pink;
b. blue; or
c. green.

Lists sequenced by numbers show an ordering relationship between the listed items.

EXAMPLE 2 -The following list shows an ordered relationship between the named items:

1. top;
2. middle; and
3. bottom.

Lists are associated with an introductory paragraph or phrase and are numbered relative to that paragraph or phrase (i.e., all lists begin with an a. or 1. Entry).

DIMENSIONING CONVENTIONS:

The dimensioning conventions are described in ASME-Y14.5, Geometric Dimensioning and Tolerancing. All dimensions are in millimeters, which are the controlling dimensional units (if inches are supplied, they are for guidance only).

NUMBERING CONVENTIONS:

The ISO convention of numbering is used (i.e., the thousands and higher multiples are separated by a space and a period is used as the decimal point). This is equivalent to the English/American convention of a comma and a period.

American	French	ISO
0.6	0,6	0.6
1,000	1 000	1 000
1,323,462.9	1 323 462,9	1 323 462.9

3. Keywords, Acronyms, and Definitions

For the purposes of this document, the following keywords, acronyms, and definitions apply.

3.1 Keywords

May: Indicates flexibility of choice with no implied preference.

May or may not: Indicates flexibility of choice with no implied preference.

Optional: Describes features which are not required by the SFF specification. However, if any feature defined by the SFF specification is implemented, it shall be done in the same way as defined by the specification. Describing a feature as optional in the text is done to assist the reader.

Reserved: Defines the signal on a connector contact. Its actual function is set aside for future standardization. It is not available for vendor specific use. Where this term is used for bits, bytes, fields, and code values; the bits, bytes, fields, and code values are set aside for future standardization. The default value shall be zero. The originator is required to define a Reserved field or bit as zero, but the receiver should not check Reserved fields or bits for zero.

Shall: Indicates a mandatory requirement. Designers are required to implement all such mandatory requirements to ensure interoperability with other products that conform to this specification.

Should: Indicates flexibility of choice with a strongly preferred alternative.

Vendor specific: Indicates something (e.g., a bit, field, code value) that is not defined by this specification. Specification of the referenced item is determined by the manufacturer and may be used differently in various implementations.

3.2 Acronyms and Abbreviations

There are no acronyms or abbreviations defined for this document.

3.3 Definitions

Connector: Each half of an interface that, when joined together, establish electrical contact and mechanical retention between two components. In this specification, the term connector does not apply to any specific gender; it is used to describe the receptacle, the plug or the card edge, or the union of receptacle to plug or card edge. Other common terms include: connector interface, mating interface, and separable interface.

Module: In this specification, module may refer to a plug assembly at the end of a copper (electrical) cable (passive or active), an active optical cable assembly, an optical transceiver, or a loopback.

4. General Description

This specification provides references to the required SFF specifications necessary to implement QSFP pluggable transceiver modules that operate at various speeds. It includes mechanical specifications required by the host i.e., the host connector, the host card cage, and mechanical specifications of the pluggable module.

The specifications provide a common solution for combined four-channel ports that may support: Ethernet, Fibre Channel, InfiniB~~b~~and, SAS, or SONET/SDH specifications. The connectors used in such applications are subject to the requirements of the appropriate standard. This specification encompasses design(s) capable of supporting multimode and single mode modules, passive copper, active copper, and active optical cables.

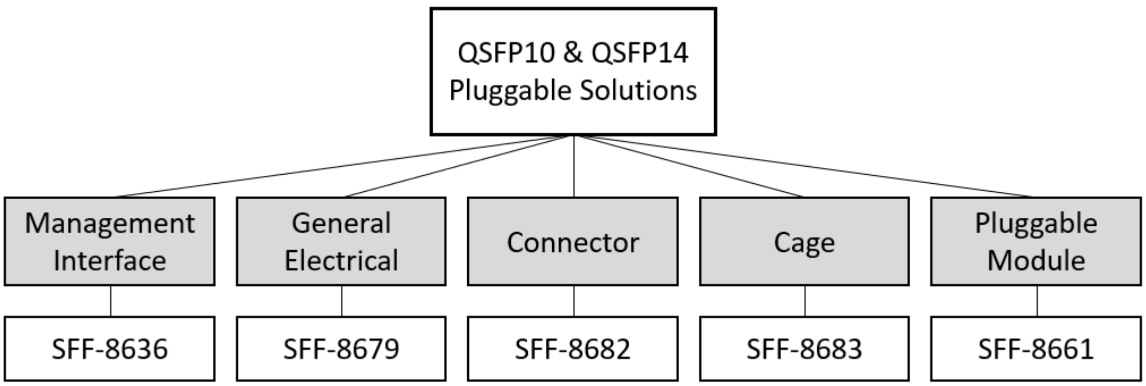
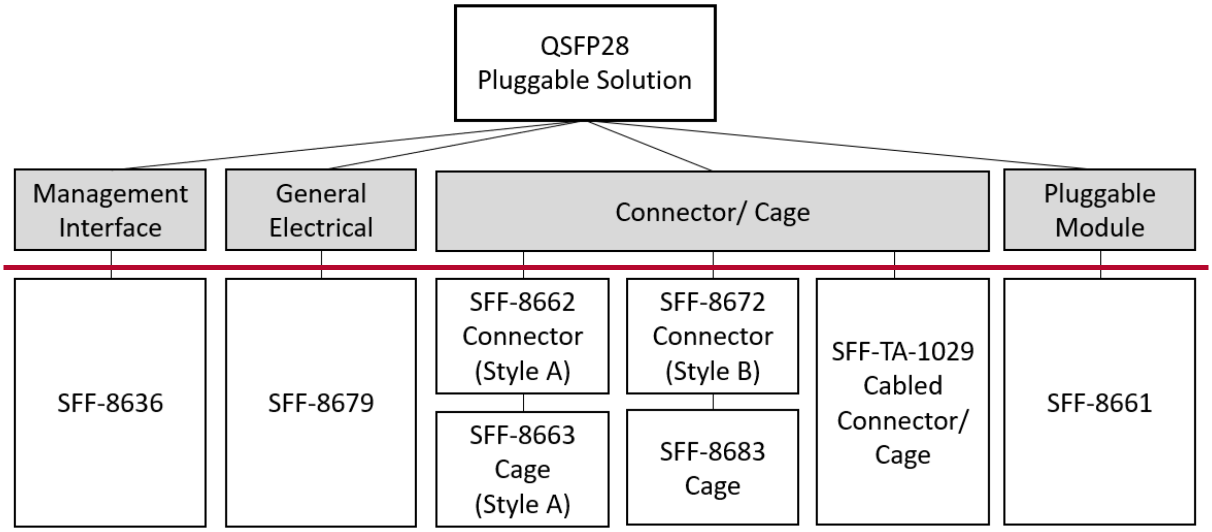


Figure 4-1~~4-1~~ QSFP10 and QSFP14 Pluggable Transceiver Solutions



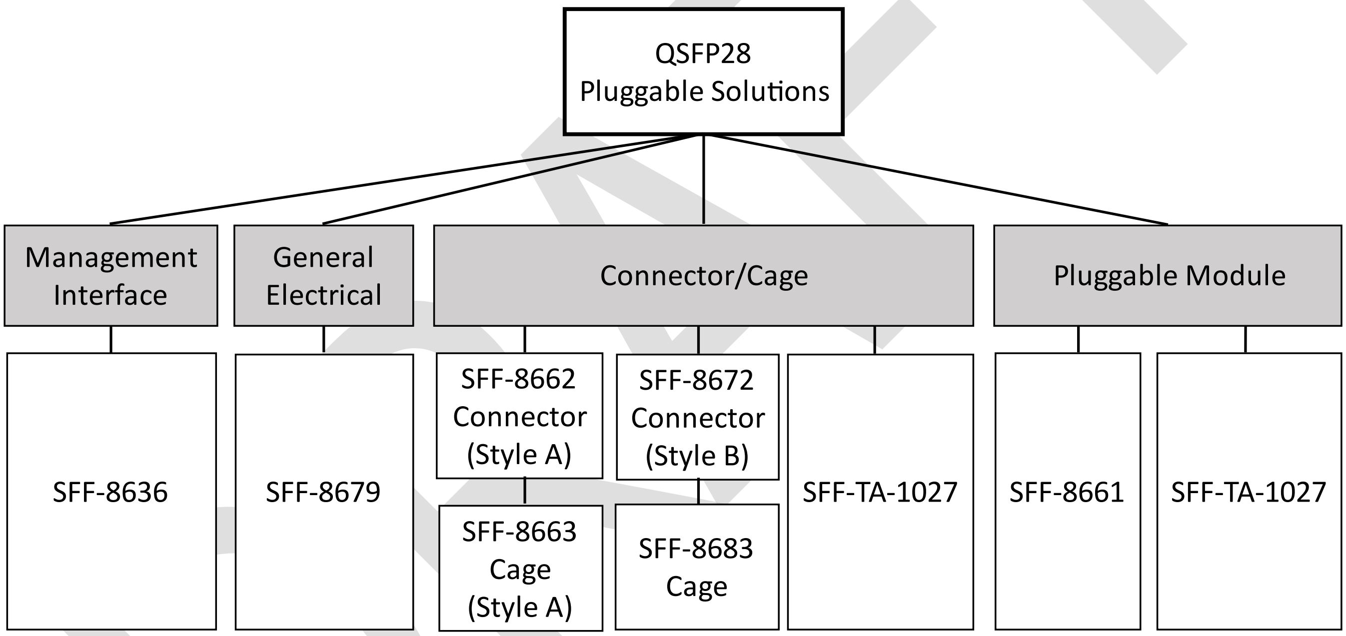
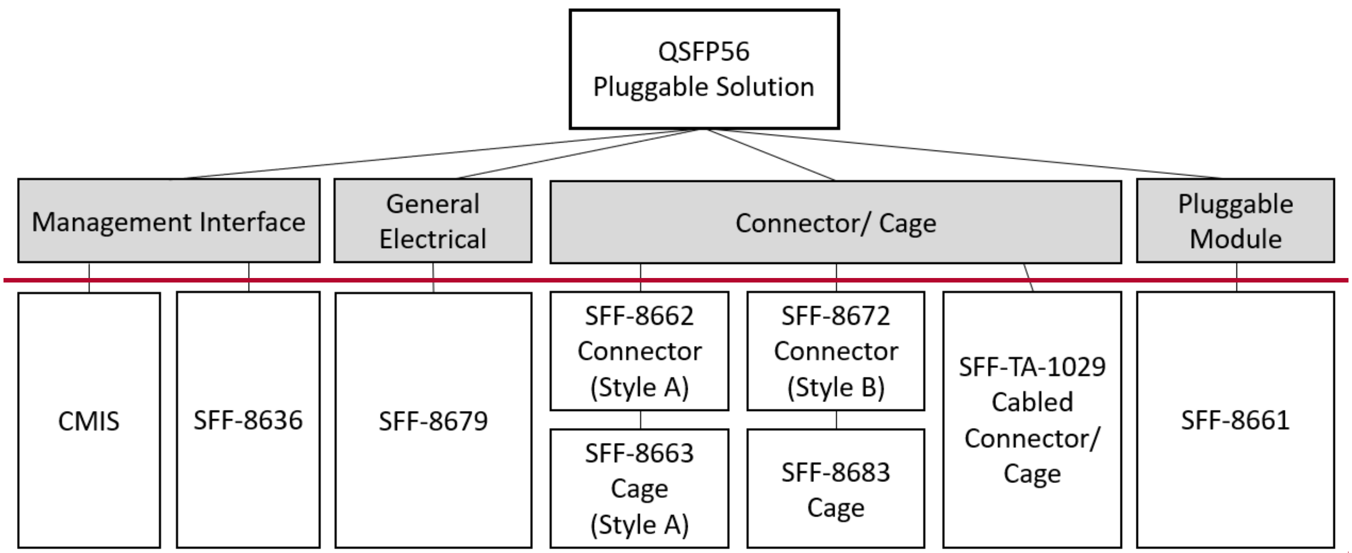


Figure 4-2~~4-2~~ QSFP28 Pluggable Transceiver Solution



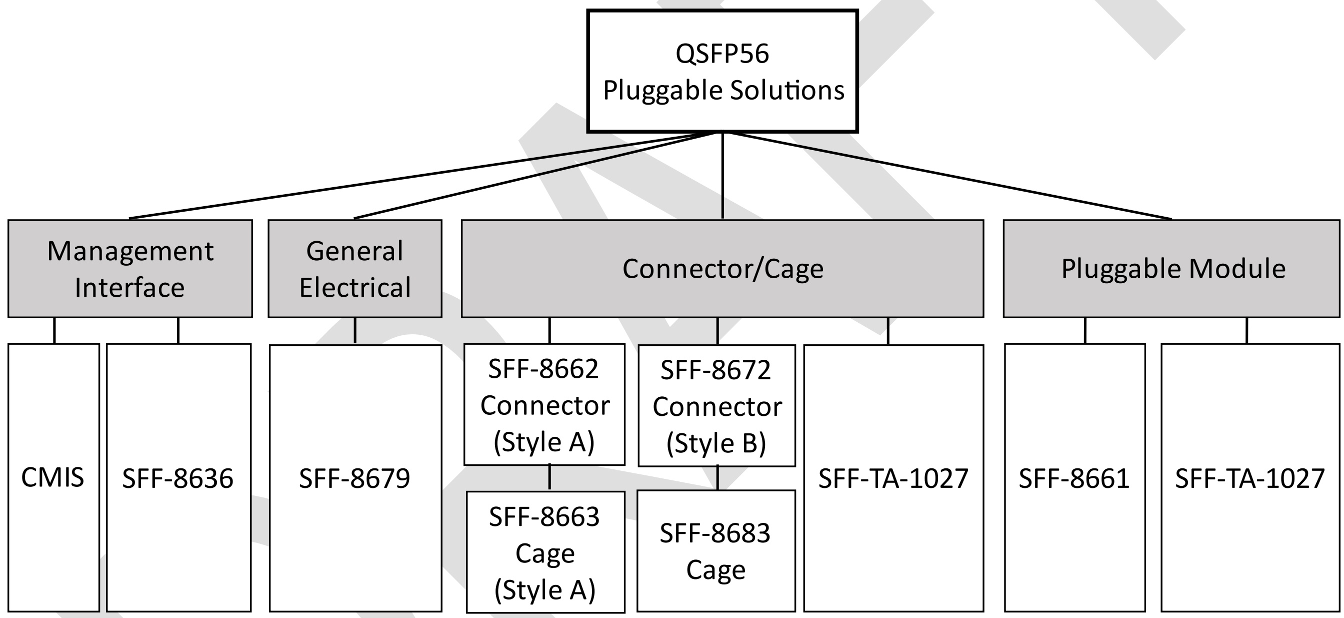
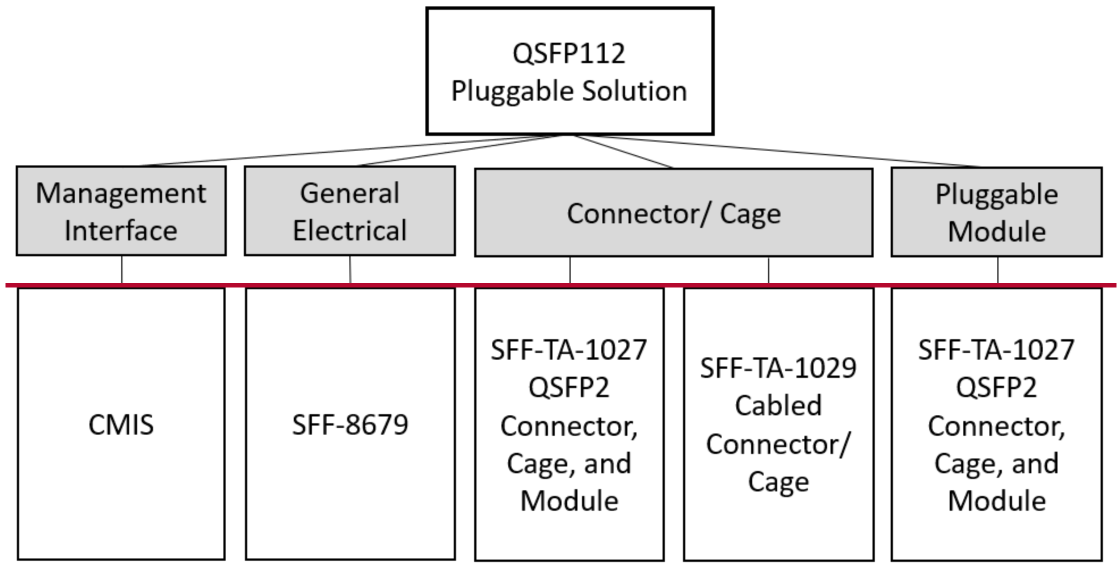


Figure 4-3~~4-3~~ QSFP56 Pluggable Transceiver Solution



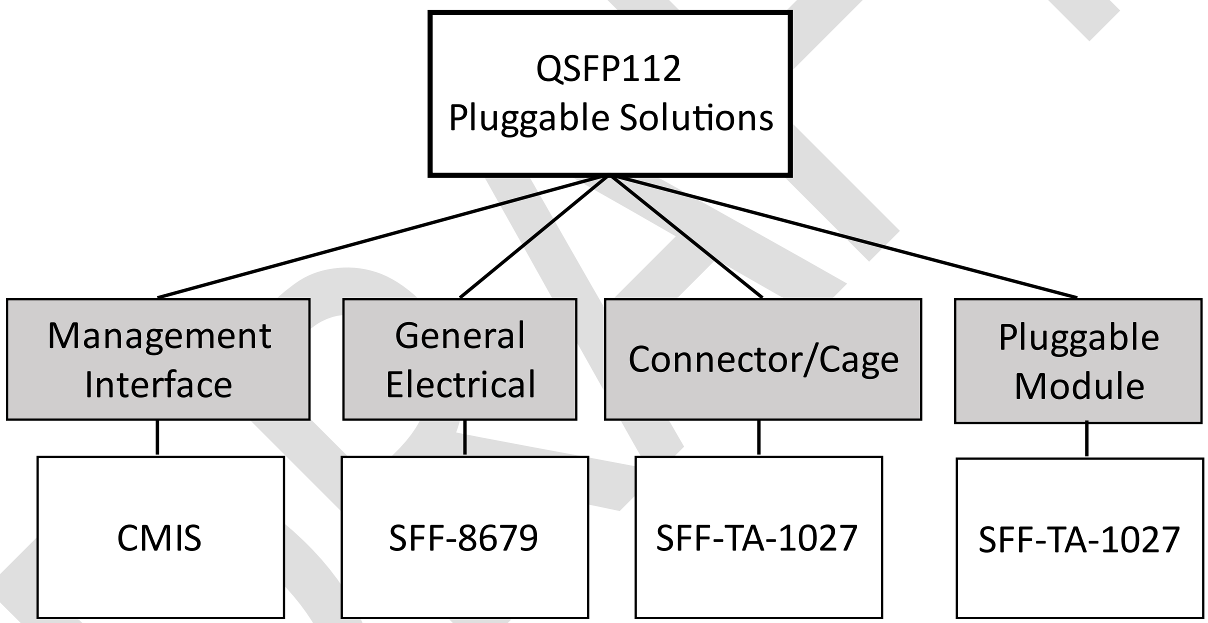
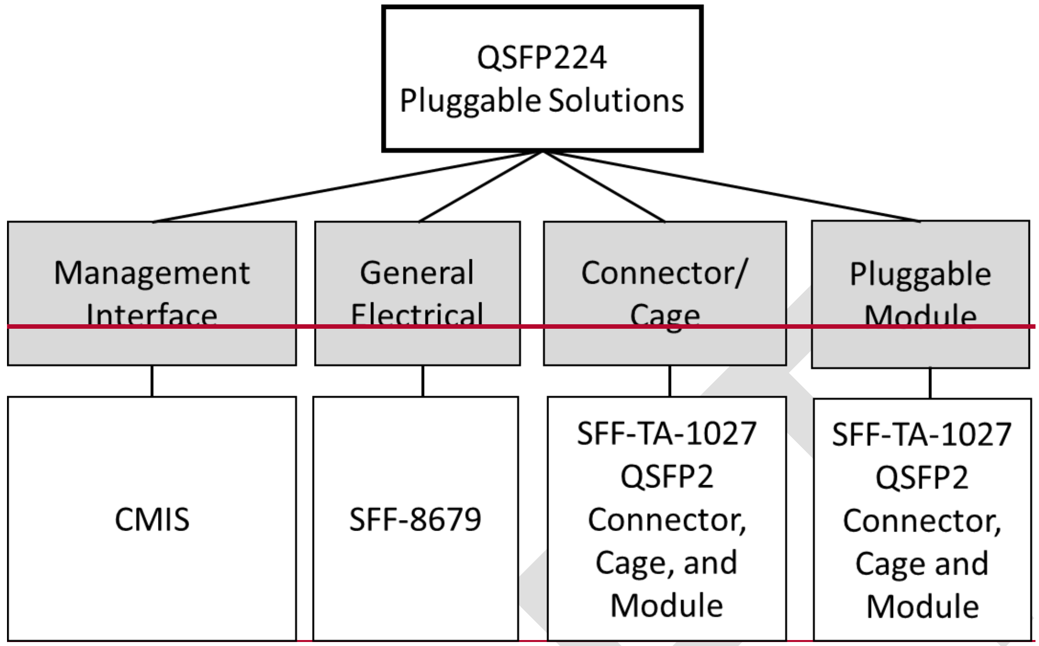


Figure 4-4~~4-4~~ QSFP112 Pluggable Transceiver Solution



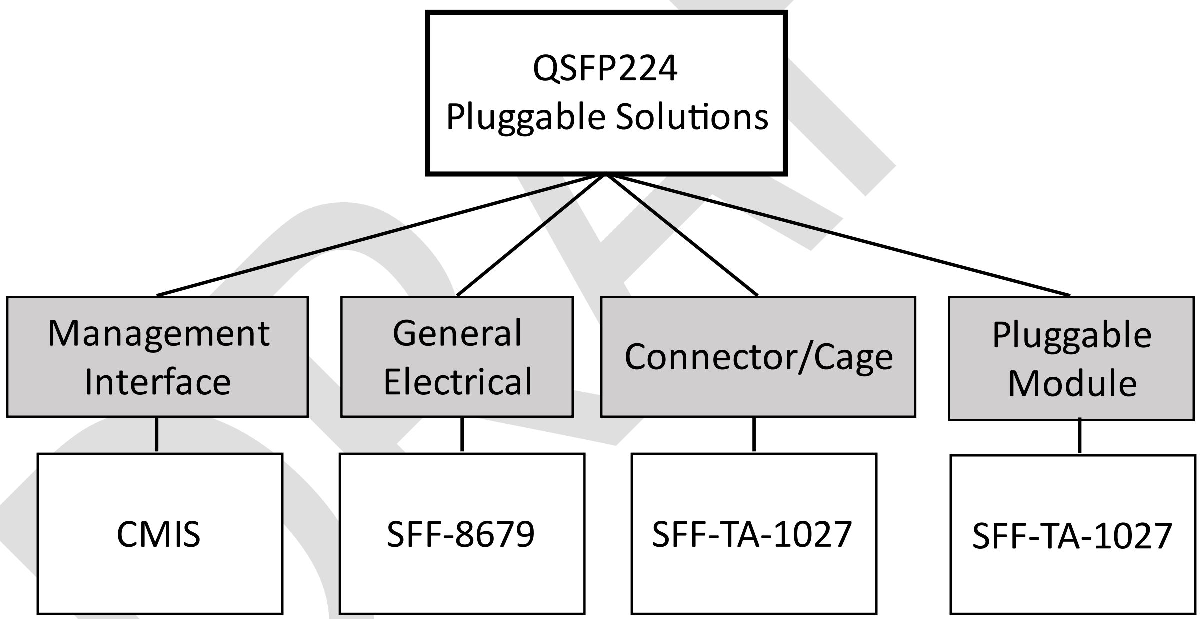


Figure 4-5 QSFP224 Pluggable Transceiver Solution

~~**Figure 4-5 QSFP224 Pluggable Transceiver Solution**~~

5. Overview of Referenced Specifications

5.1 Management Interfaces

These specifications define a common management interface for 4-lane cable assemblies. They define a common non-volatile memory map and protocol utilized for managed external cable interface implementations based on a Two-Wire-Interface (TWI) as described on https://www.i2c-bus.org/twi-bus.

Memory map details and communication protocol used to transfer the information are described within this specification. This approach facilitates a common memory map and management interface for applications with different mechanical, physical layer and otherwise different implementations.

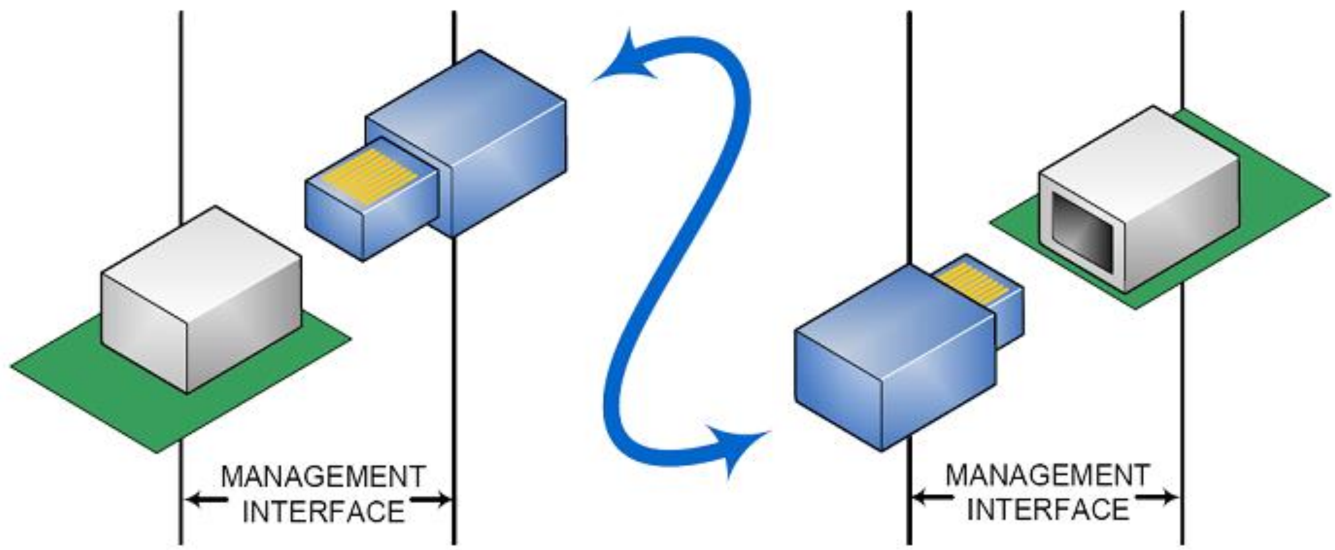


Figure 5-1~~5-1~~ Management Interface

5.1.1 SFF-8636

The 'Management Interface for 4-lane Modules and Cables Specification' is intended for use by modules at 56 Gbps and below. It is backwards compatible to 1 Gbps modules.

SFF-8636 defines a common memory map and protocol that can be used to manage both 4-channel pluggable transceiver modules and 4-channel managed external cable interface implementations. Physical layer and mechanical details of the interface are outside the scope of the document. Memory map details and communication protocol used to transfer the information are described in the document. This approach facilitates a common memory map and management interface for modules or cable assemblies with different mechanical, physical layer, and other characteristics. Examples include the QSFP+ family and mini multilane connectors for SAS (see REF-TA-1011).

This specification does not apply to the CFP MSA family of modules, which use the MDIO interface and a different memory map.

5.1.2 CMIS

The Common Management Interface Specification (CMIS) defines a generic management communication interface together with a generic management interaction protocol between hosts and managed modules.

The CMIS specification was developed to allow host and module software implementers to utilize a common code base across a variety of form factors and across a variety of module capabilities, and to foster the possibility of vendor agnostic management for standardized module functions.

To this end CMIS specifies a small core of basic functionality that all modules must implement and a larger evolving set of optional features whose implementation is advertised in the so-called management memory map of a module. This advertisement approach allows host software to adapt to optional module capabilities at runtime while ensuring interoperability with all modules at a basic level.

CMIS-compliant modules transfer a well-defined set of management operations for an associated data over a CMIS-defined Management Communication Interface (MCI); e.g., an I2C-based interface. The basic management operations are simple and allow the host to access a 256 byte addressable memory window, with mechanisms to dynamically switch 128 byte sized data pages of a much larger management memory space into the upper half of that host addressable memory window.

Note: This limited set of basic operations and the very small byte-oriented memory window are traced back to SFF-8636 and allow simple transducers or transceivers to be CMIS managed. For complex modules, extension mechanisms are implemented on top of these basic elements.

~~The physical form factor scope of CMIS includes pluggable or onboard form factors such as QSFP-DD, OSFP, or COBO. However, CMIS is developed as a generic management interface specification and can be implemented in a variety of existing form factors, such as QSFP, or also in future form factors.~~ Generic advertisement fields in the management memory map inform the host about the particular form factor and whether a module can be managed in a CMIS compliant fashion.

The functional scope of CMIS includes module types which may range from electrical cable assemblies (also referred to as modules, unless cable assemblies are specifically mentioned) and active transceiver modules to versatile coherent DWDM modules with integrated framers.

~~The following classifications can be used to distinguish functional module types or module applications:~~

~~a. **Data agnostic** ("basic") **system interfaces** map bit streams from host lanes to media lanes and vice versa, without knowledge of data formats and without participation in any communication protocol for that bit stream. Examples include cable assemblies and transceivers at lower lane data rates, e.g., 100GBASE-SR4 modules~~

~~b. **Data format aware** ("complex") **system interfaces** perform interface related single of multi-lane data processing (such as lane de-skewing and FEC coding); e.g., 400ZR modules~~

~~c. **Client encapsulation** ("multiplex") **applications** encapsulate one or more (single or multi-lane) host signals into a newly framed (single or multi-lane) network signal that may be transmitted and monitored independent of the host signals. Such modules employ framers with additional overhead for independent media side data link termination, encapsulating host signals as payload, and comprising functionality like framing, mapping, aggregation (multiplexing), switching, or distribution (inverse multiplex) functionality~~

~~The specification scope of this CMIS revision covers both system interface modules and client encapsulation modules with at most (multiples of) eight host lanes and with management communication based on I2C.~~

~~Additional Information:~~

~~a. The management memory map defines registers and memory locations that are accessible to the host.~~

~~b. Versatile modules may be programmed to behave like modules of different classes~~

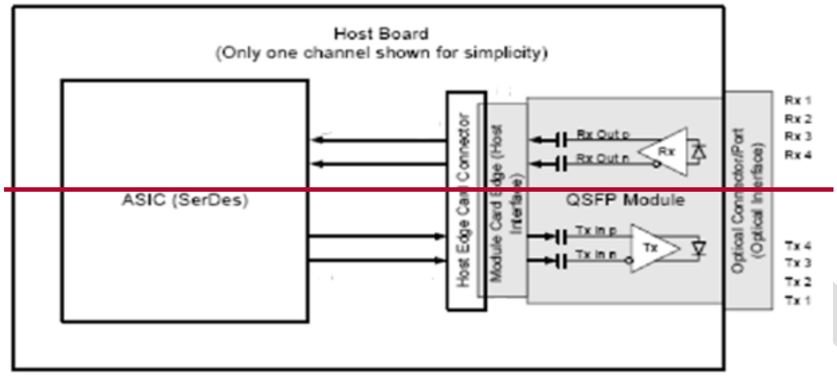
~~c. System interfaces employing network side forward error correction (FEC) merely for media channel~~

~~enhancement, not for independent network link operation, are not considered to be client encapsulating.~~

~~d. Link training may be used to optimize parameters of a signal shaping filter in the upstream transmit SerDes, based on requests from the downstream receive SerDes (of any type: adaptive or not).~~

5.2 General Electrical

SFF-8679 defines the pin outs, the electrical, the optical, the power supply, the ESD and the thermal characteristics of the cable plugs and pluggable modules.



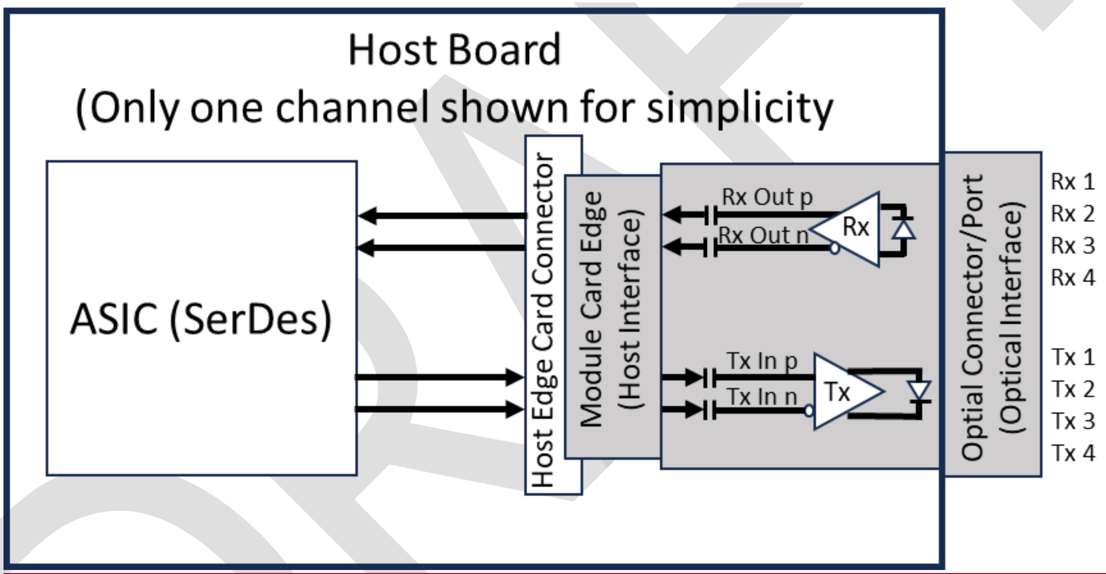


Figure 5-2~~5-2~~ Application Reference Model

5.3 Connector, Cage, and Module Specifications

5.3.1 Connectors

There are multiple SFF specifications (SFF-8662, SFF-8672, SFF-8682, and SFF-TA-1027~~, and SFF-TA-1029~~) that define the physical interface and general performance requirements of QSFP connector variants. ~~Table 5-1~~ Figure 4-1, Figure 4-2, Figure 4-3, Figure 4-4, and Figure 4-5 summarize~~s~~ the connectors and cages that make up QSFP+ pluggable transceiver solutions and shows which cages are used with specific connectors. All QSFP connector variants are backward~~-s~~ compatible mechanically, though later versions enable use at higher data rates. ~~SFF-TA-1029 defines a cabled QSFP connector variant.~~

5.3.1.1 QSFP10 and QSFP14 connector

The QSFP10 and QSFP14 connector is defined in SFF-8682. It defines the terminology and physical requirements for the mating interface and physical embodiment of the 0.8 mm connector. The connector intermates with previous generations of lower speed QSFP connectors. The requirements on the characteristic impedance and ability to transmit multi-gigabit signals for cable assemblies and backplanes is defined in the appropriate standard.

5.3.1.2 QSFP28 and QSFP56 connector

The connector variants for QSFP28 and QSFP56 ~~connector~~ are defined in SFF-8672, and SFF-8662~~ and SFF-TA-1029~~. The connector specifications define the complete mechanical dimensions of the 28 GBd 0.8 mm connector. The connector system has a nominal 100 ohm differential impedance with a common mode impedance of 32.5 ohm.~~.~~ SFF-8672 defines the Type B connector~~,~~ and SFF-8662 defines the Type A connector~~ and SFF-TA-1029 defines the cabled connector~~.

5.3.1.3 QSFP112 connector

The QSFP112 connector is defined in SFF-TA-1027~~ and SFF-TA-1029~~. SFF-TA-1027 defines a 1x1 connector with footprint Styles A~~,~~ & B~~, & C~~ and a 2x1 connector with footprint Styles A, B, C, & D. ~~SFF-TA-1029 defines a cabled connector.~~ The requirements on the differential impedance and the common mode impedance are defined in the appropriate standard.

5.3.1.4 QSFP224 connector

The QSFP224 connector is defined in SFF-TA-1027~~ and SFF-TA-1029~~. SFF-TA-1027 defines a 1x1 connector with QSFP224 footprint ~~SFF-TA-1029 defines a cabled connector.~~ The requirements on the differential impedance and the common mode impedance are defined in the appropriate standard.

Examples of QSFP connectors are shown in Figure 5-3 through Figure 5-6.

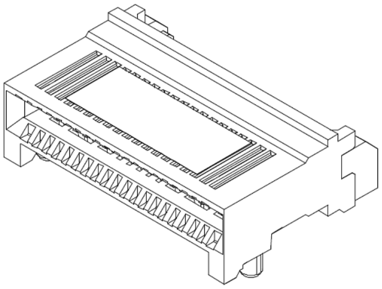


Figure 5-3~~5-3~~ SFF-8662 Connector

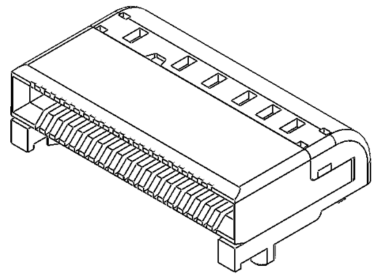


Figure 5-4~~5-4~~ SFF-8672 Connector

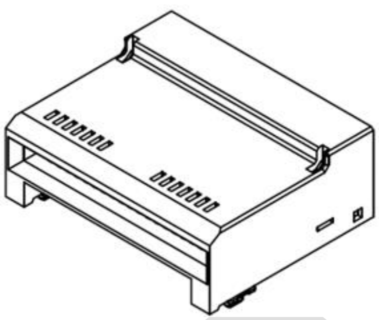


Figure 5-5~~5-5~~ SFF-TA-1027 Connector

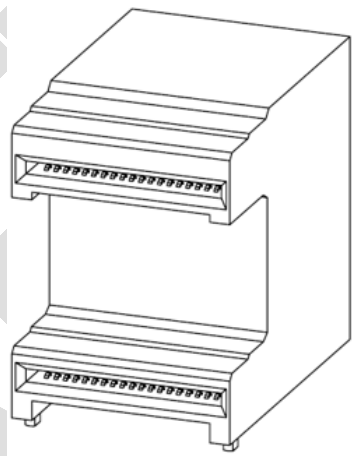
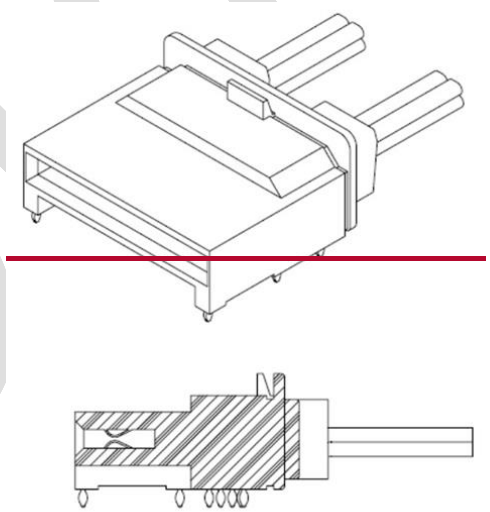


Figure 5-6~~5-6~~ SFF-TA-1027 Stacked Connector



~~**Figure 5-7 SFF-TA-1029 Cabled Connector**~~

5.3.2 Cages

There are multiple SFF specifications (SFF-8663, SFF-8683, and SFF-TA-1027~~, and SFF-TA-1029~~) that define the physical interface and general performance requirements of QSFP cage variants.

5.3.2.1 QSFP10 and QSFP14 cage

The SFF-8683 specification defines the complete mechanical dimensions of the QSFP10 and QSFP14 cage. The cage system provides several implementation alternatives in terms of interoperability and EMI control that provide the ~~increased~~ data rate capability required for high speed applications. The cage system supports optional heat sink attachment and spring finger, elastomeric gasket and behind the bezel cages for EMI control.

5.3.2.2 QSFP28 and QSFP56 cage

The QSFP28 and QSFP56 cage is defined in SFF-8663~~ and SFF-TA-1029~~. The SFF-8663 specification defines the terminology and mechanical requirements for a 28 Gb/s cage. The specification is also intended to facilitate the implementation of 1 x "n" ganged cages and the 2 x "n" stacked cage configurations. The specification has enhanced EMI characteristics when mated with a cage designed for the 28 Gb/s module. There are ~~new~~ cage dimensional requirements specified in this document to enable assembly with the 28 Gb/s Mini Multilane connector specified in SFF-8662. These ~~new~~ requirements do not affect the mating compatibility of QSFP+ modules with these~~ new 28 Gb/s~~ cages.

5.3.2.3 QSFP112 cage

The QSFP112 cage is defined in SFF-TA-1027~~ and SFF-TA-1029~~. SFF-TA-1027 defines 1x1 and 2x1 stacked cages with or without a riding heatsink. ~~Both a legacy latch design and angled latch design are supported.~~
~~SFF-TA-1029 defines a cabled cage design.~~
These specifications facilitate the implementation of 1 x "n" ganged cages and the 2 x "n" stacked cage configurations. Examples of QSFP cages are shown in Figure 5-7 through Figure 5-9.

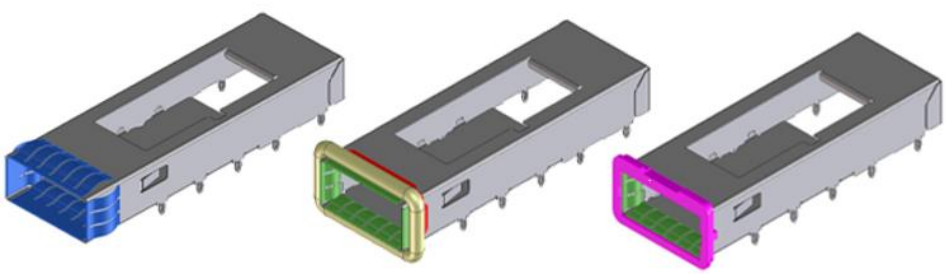


Figure 5-7~~5-8~~ SFF-8663 and SFF-8683 Cages

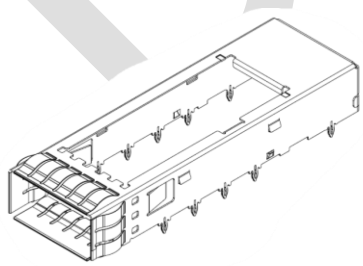


Figure 5-8~~5-9~~ SFF-TA-1027 Cage

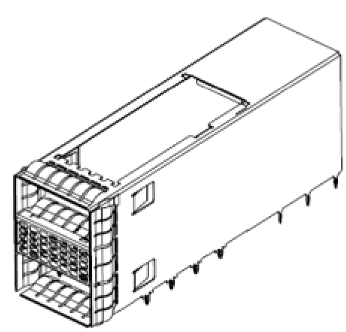
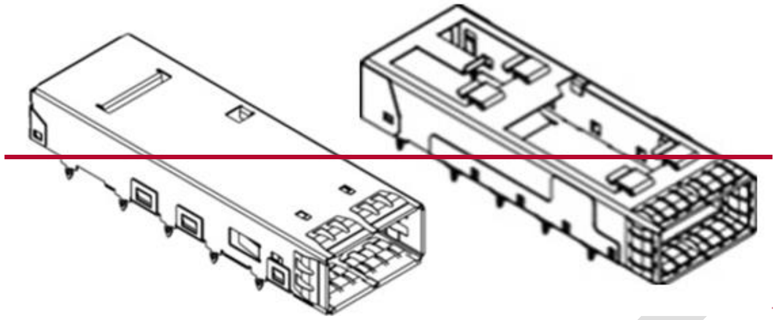


Figure 5-9~~5-10~~ SFF-TA-1027 Stacked Cage



~~Figure 5-11 SFF-TA-1029 Cages~~

5.3.3 Modules

SFF-8661 and SFF-TA-1027~~6~~ define the terminology and mechanical requirements for a pluggable transceiver module / plug. These two specifications define modules / plugs that are backwards compatible mechanically, though SFF-TA-1027~~6~~ enables use at higher data rates.

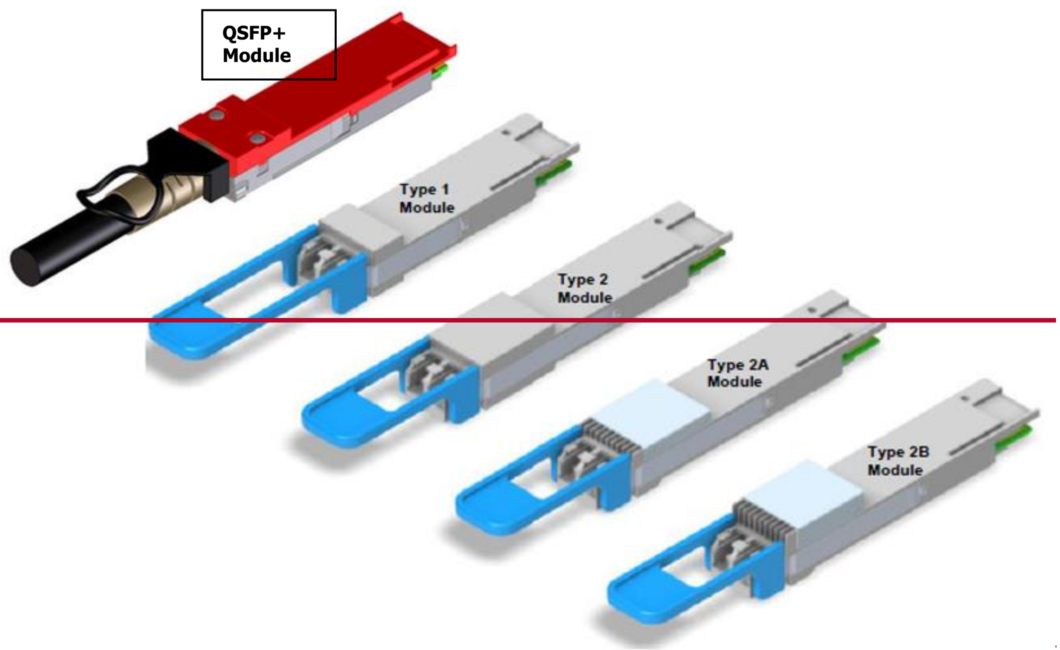
5.3.3.1 QSFP10, QSFP14, QSFP28 and QSFP56 module

SFF-8661 defines the complete mechanical dimensions of the QSFP+ 4x module. This module provides interoperability and EMI control for the QSFP system. The QSFP+ module contains a printed circuit board that mates with an appropriately designed connector.

5.3.3.2 QSFP112 module

The QSFP112 module is defined in SFF-TA-1027~~ and SFF-TA-1029~~. SFF-TA-1027 defines module mechanical dimensions that are identical to QSFP+ and QSFP28 modules unless specified otherwise (refer to SFF-8661). For QSFP112 modules, the bottom surface of the module within the cage shall be flat without a pocket.

These specifications also facilitate the implementation of 1 x "n" ganged and the 2 x "n" stacked cage configurations based on the mechanical form factor defined in cage specifications listed in Section 5.3.2. Examples of QSFP modules are shown in Figure 5-10.



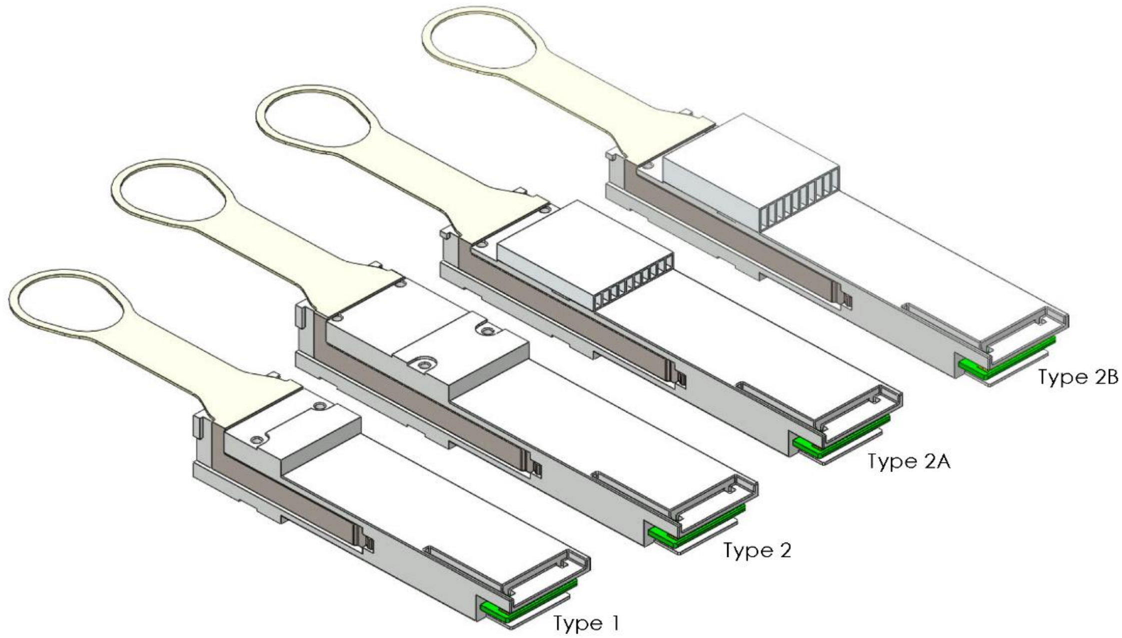


Figure 5-10~~5-12~~ Typical Cable Plug and Pluggable Modules~~ (replace DD modules)~~

6. QSFP Thermal Recommendations

High performance network environments need to cool pluggable optical modules efficiently. Higher power modules for QSFP systems must dissipate this heat effectively to ensure operational performance of the modules. Prudent module, cage, heat sink and overall system design for QSFP modules is shown to be effective. A future whitepaper will explain techniques that can be used to achieve this goal in QSFP module design and QSFP system design and provide both experimental and simulation studies to demonstrate their efficacy. (See www.qsfp-dd.com for thermal white paper).