

Modular - Extensible IO (M-XIO) Base Specification

Part of the

Datacenter - Modular Hardware Systems (DC-MHS) Rev 1.0 family

Version 0.9

August 22, 2022

M-XIO Authors/Contributors:

Dell, Inc.: Charles Ziegler, Tim Lambert, Shawn Dube, Sanjiv Sinha

Google LLC: Nathan Folkner, Michael Branch, Siamak Tavallaei

Hewlett Packard Enterprise Company: Vincent Nguyen, Eason Chen, Binh Nguyen

Intel Corporation: Javier Lasa, Eduardo Estrada, Clifford Dubay, Brian Aspnes

Meta Platforms, Inc.: Todd Westhauser, Kiran Vemuri

Microsoft Corporation: Priya Raghu, Priscilla Lam

Advanced Micro Devices, Inc: Greg Sellman

Table of Contents

1. License **4**
1.1 Open Web Foundation (OWF) CLA 4
1.2 Acknowledgements 5

2. Version Table **6**

3. Scope **7**
3.1 Items not in Scope of Specification 7
3.2 Typical OCP Sections Not Applicable 7

4. M-XIO Ports Overview **9**
4.1 M-XIO Port Requirements 9
4.2 M-XIO Connector and Cable Options 9
4.3 M-XIO Sideband Scaling Strategy 10

5. M-XIO Port Signal List **12**
5.1 Power and Grounds 12
5.2 High Speed PCIe Signals 13
5.3 PCIE Reference Clock 13
5.4 PCIe Reset 14
5.5 2-wire Interface 14
5.5.1 SMBUS Mode 14
5.5.2 I3C Mode 14
5.6 Cable Present Detect & M-PESTI 14
5.6.1 PCIe Sideband Tunneling Interface (M-PESTI) 15
5.7 Flexible I/O 16
5.8 USB 2.0 17

6. Electrical Requirements **19**
6.1 Power Supply Requirements 19
6.1.1 3p3AUX_MGMT Power Supply Requirements 19
6.1.2 3.3V Logic Signal Requirements 19
6.1.3 Power Sequencing 19

7. Connectors & Pinout **21**
7.1 SFF-TA-1016 22
7.1.1 x4 M-XIO Source Connector Pinout (SFF-TA-1016) 22
7.1.2 x8 M-XIO Source Connector Pinout (SFF-TA-1016) 23
7.1.3 x16 M-XIO Source Connector Pinout (SFF-TA-1016) *24*
7.2 SFF-TA-1033 26
7.3 SFF-TA-1026 30

8. Supplemental Material: SFF-TA-1002 (Not Plan of Record) **31**
8.1 x16 M-XIO Source Connector Pinout (SFF-TA-1002) 31

Appendix A - Checklist for IC approval of this specification (to be completed by contributor(s) of this Spec) **34**

Appendix B - OCP Supplier Information and Hardware Product Recognition Checklist **35**

1. License

1.1 Open Web Foundation (OWF) CLA

Contributions to this Specification are made under the terms and conditions set forth in Open Web Foundation Modified Contributor License Agreement ("OWF CLA 1.0") ("Contribution License") by:

- Dell, Inc.
- Google LLC
- Hewlett Packard Enterprise Company
- Intel Corporation
- Meta Platforms, Inc.
- Microsoft Corporation
- Advanced Micro Devices, Inc:

Usage of this Specification is governed by the terms and conditions set forth in **Open Web Foundation Modified Final Specification Agreement ("OWFa 1.0") ("Specification License").**

You can review the applicable OWFa1.0 Specification License(s) referenced above by the contributors to this Specification on the OCP website at http://www.opencompute.org/participate/legal-documents/. For actual executed copies of either agreement, please contact OCP directly.

Notes:

1. The above license does not apply to the Appendix or Appendices. The information in the Appendix or Appendices is for reference only and non-normative in nature.

NOTWITHSTANDING THE FOREGOING LICENSES, THIS SPECIFICATION IS PROVIDED BY OCP "AS IS" AND OCP EXPRESSLY DISCLAIMS ANY WARRANTIES (EXPRESS, IMPLIED, OR OTHERWISE), INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY, NON-INFRINGEMENT, FITNESS FOR A PARTICULAR PURPOSE, OR TITLE, RELATED TO THE SPECIFICATION. NOTICE IS HEREBY GIVEN, THAT OTHER RIGHTS NOT GRANTED AS SET FORTH ABOVE, INCLUDING WITHOUT LIMITATION, RIGHTS OF THIRD PARTIES WHO DID NOT EXECUTE THE ABOVE LICENSES, MAY BE IMPLICATED BY THE IMPLEMENTATION OF OR COMPLIANCE WITH THIS SPECIFICATION. OCP IS NOT RESPONSIBLE FOR IDENTIFYING RIGHTS FOR WHICH A LICENSE MAY BE REQUIRED IN ORDER TO IMPLEMENT THIS SPECIFICATION. THE ENTIRE RISK AS TO IMPLEMENTING OR OTHERWISE USING THE SPECIFICATION IS ASSUMED BY YOU. IN NO EVENT WILL OCP BE LIABLE TO YOU FOR ANY MONETARY DAMAGES WITH RESPECT TO ANY CLAIMS RELATED TO, OR ARISING OUT OF YOUR USE OF THIS SPECIFICATION, INCLUDING BUT NOT LIMITED TO ANY LIABILITY FOR LOST PROFITS OR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, SPECIAL OR PUNITIVE DAMAGES OF ANY CHARACTER FROM ANY CAUSES OF ACTION OF ANY KIND WITH RESPECT TO THIS SPECIFICATION, WHETHER BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE), OR OTHERWISE, AND EVEN IF OCP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

1.2 Acknowledgements

The Contributors of this Specification would like to acknowledge the following companies for their feedback:

List all companies or individuals who may have assisted you with the specification by providing feedback and suggestions but did not provide any IP.

2. Version Table

Date	Version #	Description
04/27/22	v0.7	Initial public release
06/22/22	v0.8	Minor clarifications throughout the document. Updated section 5.7 FlexIO requirements. Swapped pins A8 and A9 on section 7.x Added requirements on x8 vs x16 routing for section 7.2 SFF-TA-1016 variant with split & power.
08/22/22	v0.9	Updates Section 5 and 5.1 regarding 3.3V AUX MGMT. Updates on Section 5.6 regarding 3.3V AUX MGMT. Update on Section 5.7 Flexible I/O requirements. Added section 6.1.3 power sequencing recommendations. Update on Section 7.2 to add SFF-TA-1033, pin naming and table orientation to match mechanical drawings.

3. Scope

This document defines technical specifications for the DC-MHS Modular Extensible I/O used in Open Compute Project. This document shall comprise the hardware product types base specification.

Any supplier seeking OCP recognition for a hardware product based on this spec must be 100% compliant with any and all features or requirements described in this specification.

The objective of this specification is to outline the Modular Extensible I/O (M-XIO) source connector hardware strategy. An M-XIO source connector enables entry and exit points between sources such as Motherboards, Host Processor Modules & RAID Controllers, and peripheral subsystems such as PCIe risers, backplanes, etc. M-XIO includes the connector, high speed and management signal interface details and supported pinouts.

An M-XIO source connector (M-XIO port) can be considered a universal hardware API intended to enable the connectivity (PCIe and Sideband) requirements of multiple different peripheral modules. SAS and SATA support has been deemed out of scope for M-XIO.

This specification does not require specific connector choices, allowing this specification to be used across multiple generations of products and connectors.

This specification covers the following elements for M-XIO source connectors:

- Requirements.
- Signal List.
- Addendums with specific pinouts for a selection of connector models.

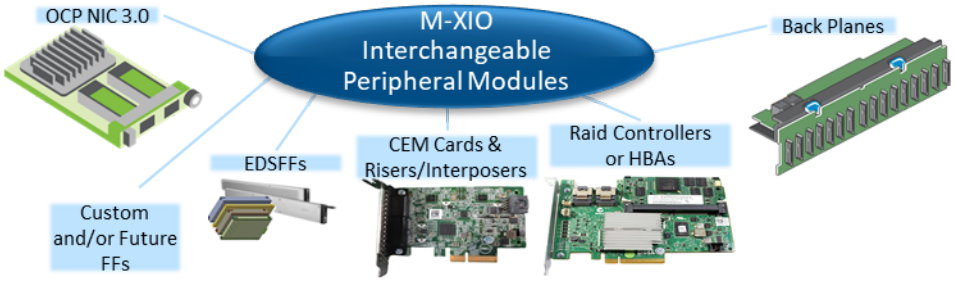


Figure 1: M-XIO's intended Peripheral Module Interconnect Portfolio

3.1 Items not in Scope of Specification

The following items are not explicitly supported via M-XIO specification:

Function
Power: Peripheral Module 12V Main, 3.3V Main, 3.3VAUX, etc.
SAS / SATA
x16 – to x4x4x4x4 on different destination cards
M-XIO use for external chassis cabling
Considerations for coupling to accelerator modules such as OAM or UBB
M-XIO cable hotplug, even in S5

Table 1: Not Explicitly Supported via M-XIO

3.2 Typical OCP Sections Not Applicable

This is a Base specification, requiring other MHS specifications to fully define a design. The following typical Sections of an OCP specification are not included because they are not applicable to this specification.

Rack Compatibility
Physical Spec
Thermal Design
Rear Side Power, I/O, Expansion
Mechanical
Onboard Power System
Environmental Regulations/Requirements
Prescribed Materials
Software Support
System Firmware
Hardware Management
Security

4. M-XIO Ports Overview

M-XIO “ports” (i.e., M-XIO connectors on a Host Processor Module (HPM)) contain a minimalist set of sideband signals which relies on circuitry to serialize/deserialize virtual wires that are tunneled over a 1-wire interface, called the “Modular-Peripheral Sideband Tunneling Interface” (M-PESTI).

This signal set, albeit minimalist in signal quantity, is an upgradable/pay-as-you-go hardware management architecture. This architecture propagates to/from many of today’s various peripheral modules and is fully extensible to accommodate more devices without adding physical signals/pins in a port. This management scheme is meant to withstand and manage several future generations of end-device upgrades/revisions with incremental firmware add-ons, where a “plug and extend” practice is leveraged.

4.1 M-XIO Port Requirements

A “port” refers to an IO connector on a Host Processor Module, intended to distribute PCIe/CXL lanes to devices.

- A port may connect to the following:
    - An “adaptor” that assists with power and sidebands prior to an end-point device (e.g., a “paddle-card”, a multi-cable connector)
    - A carrier/module that accepts multiple devices/media (e.g., Riser with multiple CEM slots, EDSFF backplane)
- All ports must support connections that are cabled; direct riser connections are optional
- All ports must support link subdivision down to x1 (exceptions noted for specific downstream facing controllers/switches/re-timers, etc.). Note that this is a statement of the intent for cabled or direct PCIe riser connection flexibility but not indicative of the capabilities of the HPM downstream facing port (or root port) sourcing this connector.
- All ports support the below example of device form factors and /interposer categories. This is purely to illustrate some major use cases and does not imply the M-XIO spec fully teaches what destinations/interposers should do locally to achieve such functionality.
    - PCIe CEM cards
    - Open Compute Project NIC 3.0
    - EDSFF devices, both NVMe (x4, x2, x1 in E.1 or E.3 form factors) and SCMs (storage class devices, such as CXL, x16, x8, x4)
    - Backplanes with distribution to U.2 and EDSFF devices, both directly attached to root complexes or with PCIe switches in between
    - Inline-able Host Bus Adapters or RAID controllers between HPM/Root ports and storage backplane for example
    - x16 ports must be able to support a mixture of device/form-factor classes (x8 to CEM + x8 to EDSFF backplane)
- All ports are scalable with the use of switches.
- Allowance for recombining x4 and x8 ports sourced contiguously by the same x16 source complex.
- All multi-device modules (e.g., EDSFF backplane) and paddle-cards with circuitry must support a discovery mechanism.
- All x16 ports must duplicate all sidebands if desired to support x8x8 at two different PCB destinations (i.e. via a physical cable split) intended to maximize flexibility. It is not required for a x16 to duplicate sidebands if, for example, a user has a known system configuration and knows they will only connect a x16 m-xio port to a x16 destination.

4.2 M-XIO Connector and Cable Options

Even though any homogeneous combination of link subdivisions are possible, the only physical cable split allowed is a x16 source to x8x8 at different PCB destinations OR x8x8 sources that combine to a x16 destination, if and only if the x16 connector(s) are plumbed with a duplicate of the x8 sidebands. It is important to note that all x16 destinations supported in platforms that provide any x8 capable source (standalone or as part of a 2 in 1 connector) must assume that sidebands only exist on the lower x8

(PCIE lanes 0-7). Also care must be made to ensure that the lanes in the x8x8 are in contiguous order as half bus lane reversal is not supported by PCIe.

Note that the splitter logic depicted below is indicative of necessary sideband fanout circuits with optional selective remote and autonomous local controls. This is typically but not limited to PERST, clock and device presence fan out / in / masking, override, etc. and not pcie switch(es).

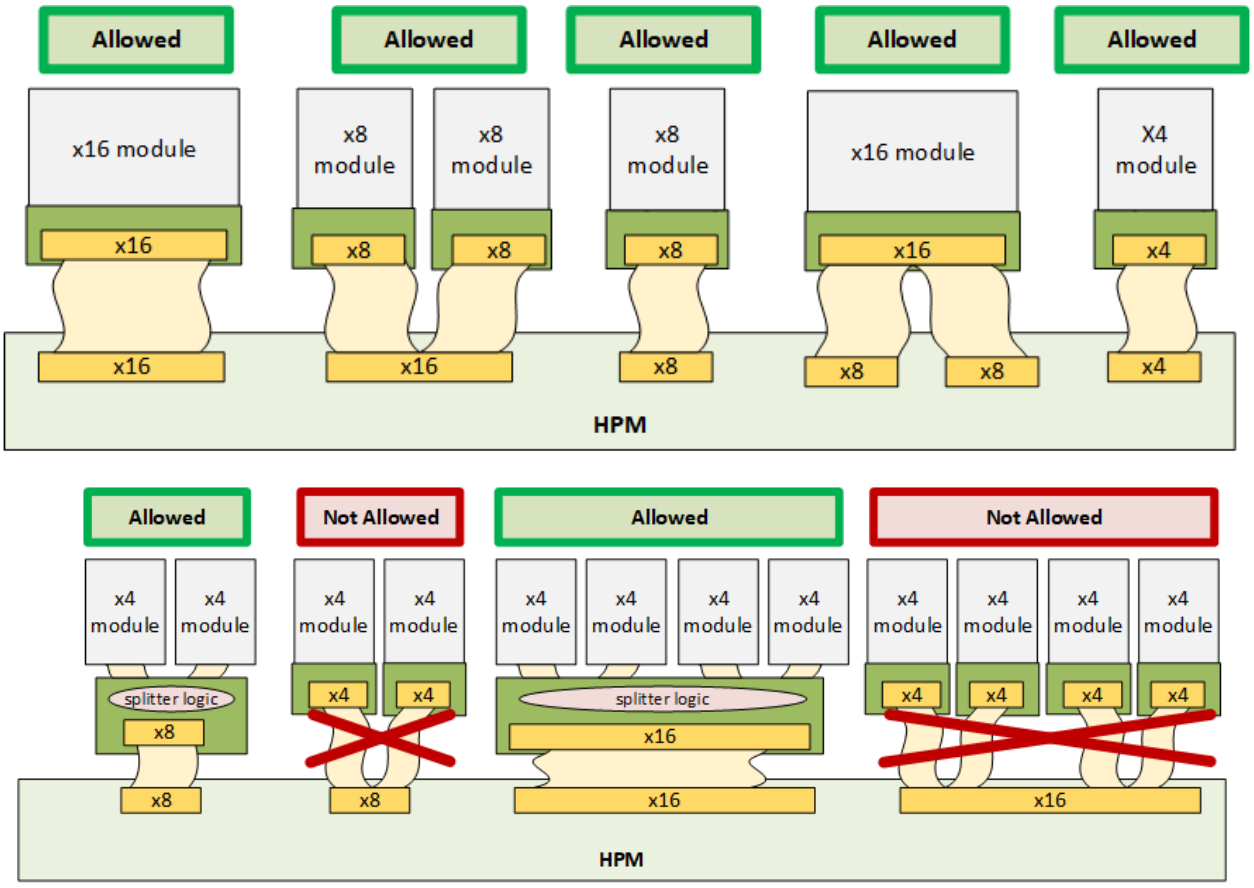


Figure 2: M-XIO Connector and Cable Options

Note that HPM stands for Host Processor Module as an example configuration. M-XIO is not limited to HPMs sourcing the downstream facing ports to the M-XIO source connector(s). The above is not an exhaustive list of possible or not possible cable/connector configurations, it is just meant to showcase what are considered common configurations.

4.3 M-XIO Sideband Scaling Strategy

M-XIO Sidebands are defined as Baseline and Extended groups, where x4 has Baseline only. x8 has Baseline plus extended sidebands. A HPM x16 source connector may be plumbed to duplicate all sidebands between the lower and upper x8 when maximum flexibility is desired such as splitting into x8x8 to different destination PCBs. Duplicating zero sidebands is acceptable when an HPM design is known to only need x16 interconnects to peripheral subsystems. Hybrids of duplicating some or excluding some interfaces is not advised.

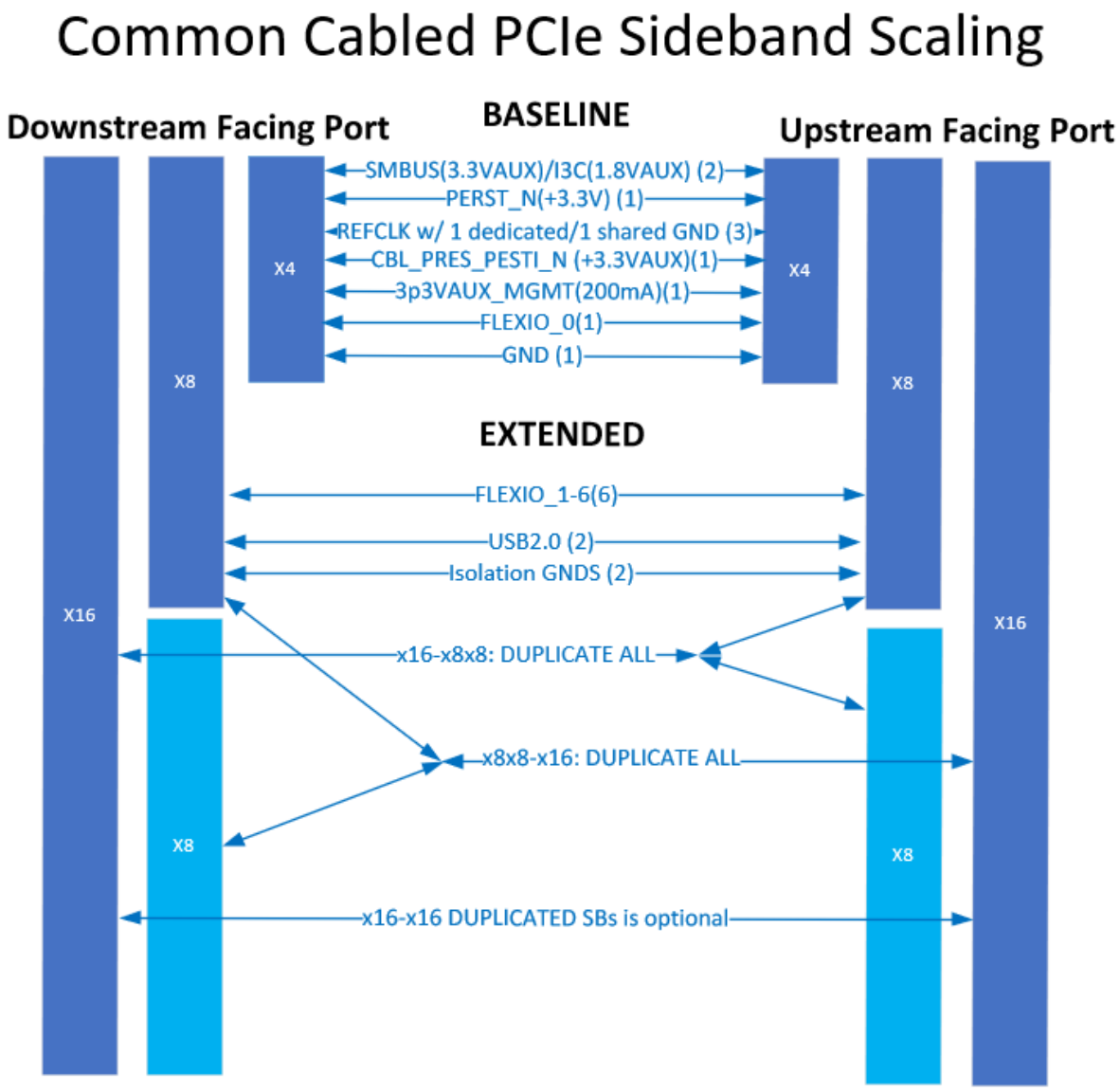


Figure 3: M-XIO sideband signal scale strategy

5. M-XIO Port Signal List

This chapter covers the signal summary and definitions for M-XIO ports. Signal directions (I/O) are with respect to the PCIe source (e.g., Downstream facing port such as a root complex on a HPM CPU socket). All signals are mandatory unless otherwise specified. Note that HPMs that are special purpose to support only x16 destinations may optionally choose to not connect the upper x8 sideband signals. Otherwise, duplicating the sidebands between a lower x8 and upper x8 connection section enables multi-cable/splits and/or multiple destinations/end-devices and/or reduced interposer fanout logic.

When baseline or extended signals are duplicated, such as in the x16 source to two x8 destinations on a different peripheral scenario, a signal name should insert A or B instance nomenclature after the primary function name and before polarity if applicable.

Interface	Signal Name	Input/ Output (HPM Perspective)	Function
PCIe	PER[p/n]	I	PCIe RX Differential signals defined by the PCI Express Base Specification.
	PET[p/n]	O	PCIe TX Differential signals defined by the PCI Express Base Specification.
Clocks	REFCLK_D[p/n]	O	PCIe Reference Clock signals (100 MHz) defined by the PCI Express Base Specification.
2Wire Bus	SMSCL / I3CSCL	O	SMBus Clock, Open Drain with pull-up on host. 3p3AUX_MGMT, Up to 400kHz. OR after discovery, I3C mode compliant with I3C Basic 1.1.1 @ +1.8VAUX; Note that this 2-wire bus is for the management (BMC) domain and not for Host domain (such as NVMe hotplug VPP, which can be performed via HPM FPGA emulation of hotplug I2C I/O expanders)
	SMSDA / I3CSDA	I/O	SMBus Data, Same as above
Reset	PERST_N	O	Active low, push-pull at source. A discrete functional reset to the peripheral module(s) as defined as PERST# by the PCI Express Base Specification. Override, fanout or blocking logic may be needed on destination cards such as in hot plug applications.
Destination card is attached + PESTI communication	CBL_PRES_PESTI_N	I/O	Signal used to indicate the attachment of a cable assembly and/or a module to a port. Optional use as bi-directional interface for form-factor specific sideband-tunneling/virtual-wires. This signal does not indicate endpoint presence.
Power and Grounds	3p3AUX_MGMT	O	Optional power for discovery on cables and interposers. If not used leave as not connected. Power limits are defined. Cross power domain isolation is the peripheral's duty and not explicitly defined here.
	GND	O	Isolation and return current path
FLEXIO	FLEXIO_[0:6]	I/O	Note: Implementers should note that some FLEXIO pins are pinned out as being high speed differential friendly for the best possible future proofing of future high speed interfaces. Example FLEXIO functions may be INT, Device presence, PWRBRK, etc. when PESTI is not used.
USB 2	USB2[p/n]	I/O	Universal Serial Bus 2.0 (meaning High Speed or Full Speed, but not Low Speed from USB 1.1)

Table 2: M-XIO Port Signal List

5.1 Power and Grounds

The M-XIO source connector optionally supports a 3p3AUX_MGMT power source to provide a limited 200mA of trickle power for discovery logic only, such as for FRU and cable identification. Cross power domain isolation is the duty of the peripheral/ interposer and not explicitly defined here.

3p3AUX_MGMT is enabled before de-assertion of PCIe Reset and PCIe clock activation. This power is NOT to be used by end form factor peripherals such as a PCIe CEM slots' pin B10 AUX power.

See the Power Supply Requirements section of this specification for electrical characteristics.

5.2 High Speed PCIe Signals

An M-XIO compliant source connector implements a minimum of four PCIe lanes, with link subdivision support down to X1. A lane consists of an input and output differential pair. Additional lanes are optional. Refer to the PCI Express Base Specification for more details on the functional requirements of the interface signals.

The PET signals on the host shall connect to the PET[p/n] signals on the connector and the PER signals on the Peripheral Module Logic. The PER signals on the host shall connect to the PER[p/n] signals on the connector and the PET signals on the Peripheral Module Logic. For a high-level wiring diagram, see Figure 4.

Lane Polarity Inversion is optional at a M-XIO port depending on host and end-device requirements. Polarity inversion is used to simplify host and device PCB trace routing constraints.

Lane reversal may be supported on both the host and device. If it is supported, then the transmitting and receiving lanes can be connected using reverse ordering at a M-XIO port. It is required that on the source side, any lane reversals match contiguously if the port is subdivided in any fashion (e.g. x4x4 at the source cannot lane reverse only one x4 and expect the same connector to work when link subdivided as one X8).

Lane speed: It is expected that the self-describing I/O (e.g., a paddle/interposer or cable identification) provide information to the system (BIOS and firmware) to cap training speeds when any channel element cannot guarantee the max speed of the entire channel. M-XIO port specification is intended as PCIE speed/generation neutral.

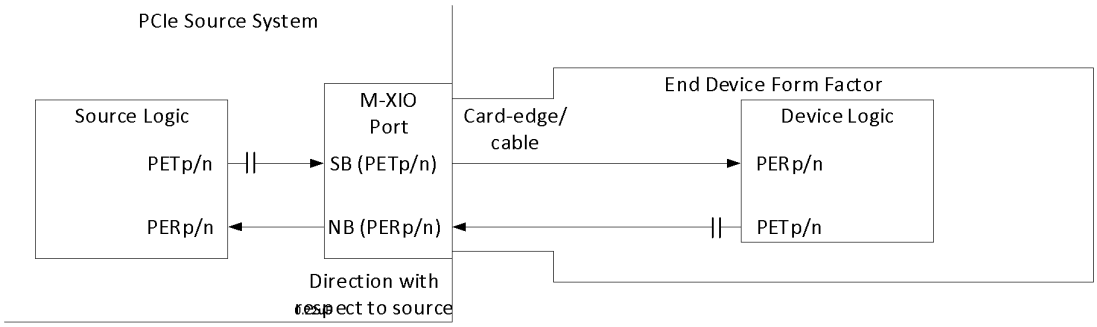


Figure 4: M-XIO Port Example – PET and PER

5.3 PCIE Reference Clock

The REFCLK_D[p/n] signals are used to assist the synchronization of legacy devices' PCI Express interface timing circuits with no SRIS/SRNS support. Refer to the PCI Express Card Base Specification for more details on the functional and tolerance requirements for the reference clock signals.

All M-XIO ports implement REFCLK_D[p/n]. If an end-device needs physical clock signals and supports bifurcation/lane-subdivision/dual-port mode, then the intermediary-board/paddle-card may buffer/fanout the remaining REFCLK signals. REFCLK_D[p/n] signals are required at every M-XIO port.

If SRIS or SRNS is supported by both the system and the device, then a reference clock is still required at the source connector. The required reference clock helps enable homogenous/universal M-XIO ports to enable a wide variety of peripheral hardware (i.e., multiple peripheral module connectivity enabled with any M-XIO port). Device's negotiating or entering SRIS/SRNS mode is outside the scope of this specification version.

It is optional and generally recommended that there are no free running clocks into missing or disabled peripheral modules. Methods for disabling clocks at the source or destination are out of scope

for this documentation. For unused clocks, it is optional and recommended, in most cases, that the end-device/paddle-card/intermediary-board terminates the reference clock signals at the closest coupled connector/termination/PCB.

5.4 PCIe Reset

All M-XIO ports shall implement PERST0_N for fundamental reset. Refer to the PCI Express Base Specification for more details on the functional requirements of PERST#.

5.5 2-wire Interface

5.5.1 SMBUS Mode

The SMBus interface shall be implemented within the baseline sidebands for all M-XIO (cabled PCIe) ports. The interface must default to SMBUS 3.1 compliant, 3.3VAUX, open drain mode. The pull-ups (~2.2KΩ) for SMDAT and SMCLK are required on the upstream system to ensure no floating inputs and proper bus operation. Note that 400KHz SMBUS support @ 3.3VAUX is required.

The destination subsystem is responsible for 1) electrical protection of local circuitry if say the peripheral/subsystem is unpowered, 2) any cross power domain isolation (such as when connecting MAIN powered only targets to the upstream AUX powered bus) and 3) any necessary voltage level translation in SMBUS mode.

Since the SMBUS interface often extends to legacy form factors that allow for any target address, it is imperative that the HPM not have any upstream targets on the bus where such addresses traverse the M-XIO. This could lead to addressing conflicts.

5.5.2 I3C Mode

I3C Basic 1.1.1 compliant mode of operation is optionally supportable on the 2 wire interface. Great care must be taken by system designers to ensure proper logical and electrical operation of this bus

All directly attached I3C capable targets must be +3.3V tolerant for the discovery phase.

Although supported in I3C Basic 1.1.1 with constraints such as glitch filtering and prohibiting clock stretching, for the sub-segment traversing M-XIO, SMBUS and I3C device mixing on the same bus is prohibited.

The I3C mode required low voltage is 1.8V. Exactly one low voltage level, such as 1.8V, must be the same on all downstream (sub)segment instances, including throughout the bus from initiator to the final target. This is because the I3C hub definition requires the same push-pull mode voltage level on the upstream and downstream subsegments.

Note: It is beyond the scope of this specification to dictate precise margin allowances on parameters like capacitance, or bus length for the 2-wire interface running in SMBUS mode or I3C Basic mode.

5.6 Cable Present Detect & M-PESTI

A cable assembly presence detection mechanism is specified and required through CBL_PRES_PESTI_N to indicate the attachment of a cable assembly and/or a peripheral card to a fixed-side module (e.g.,HPM PCB) with PCIe downstream facing port. If not using the optional PEripheral Sideband Tunneling Interface (M-PESTI) functionality, then the free-side (Cable/Interposer Side) should assert this signal low to indicate cable attachment, see figure below. It is recommended that it is asserted with a pull-down (< 500Ω) or an active driver. The fixed-side should provide a pull-up resistor (>7.5KΩ & < 200KΩ) on CBL_PRES_PESTI_N to System V_3P3_AUX typically sourced via P12V_PRIMARY and enabled in S5 (i.e before S0) to passively de-assert CBL_PRES_PESTI_N. However, to implement the optional PEripheral Sideband Tunneling Interface functionality of this signal please refer to the M-PESTI specification.

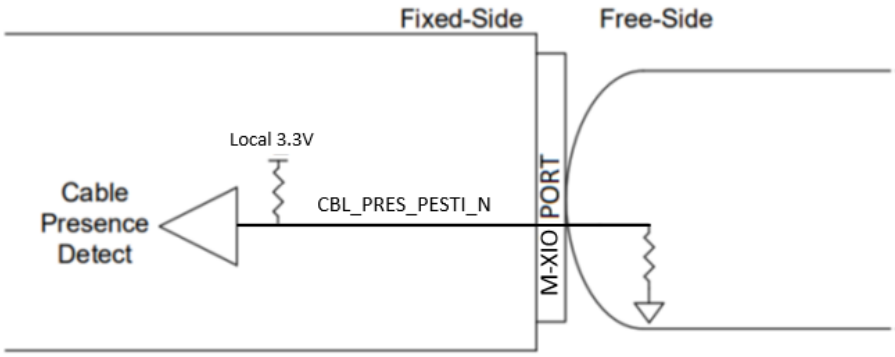


Figure 5: CBL_PRES_PESTI_N Circuit (when PESTI is not supported at the destination)

5.6.1 PCIe Sideband Tunneling Interface (M-PESTI)

The CBL_PRES_PESTI_N may also be used as dual-purpose, bidirectional M-PESTI wire where custom, standard, or future form-factor-specific sidebands become Virtual Wires (vWires).

- Supports bidirectional, low-latency, real-time virtual wires over this point-to-point interface between real-time link partners (CPLD/MCU/ASIC) without the loss of basic presence
- Decouples wires from higher level management operations like MCTP better suited for I2C and non-real time handlers.
- Payload + protocol contains self-describing I/O fields + virtual wires that surface as real or terminate as bidirectional control/status
- Future extensibility from cabled interposers to include peripheral modules over device presence wires. Carrier card / nested target handling is feasible.
- Includes update & optional immutable attestation of the out of band link partner's FW.

Reference M-PESTI spec for more details.

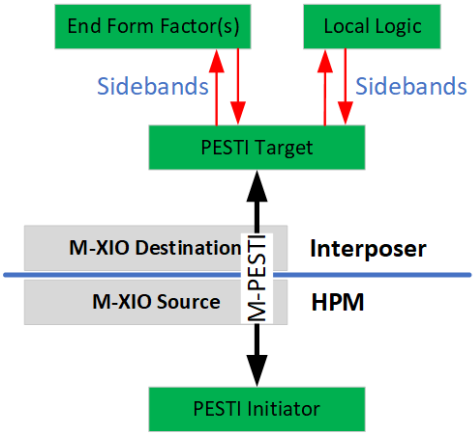


Figure 6: Example PESTI usage at destination

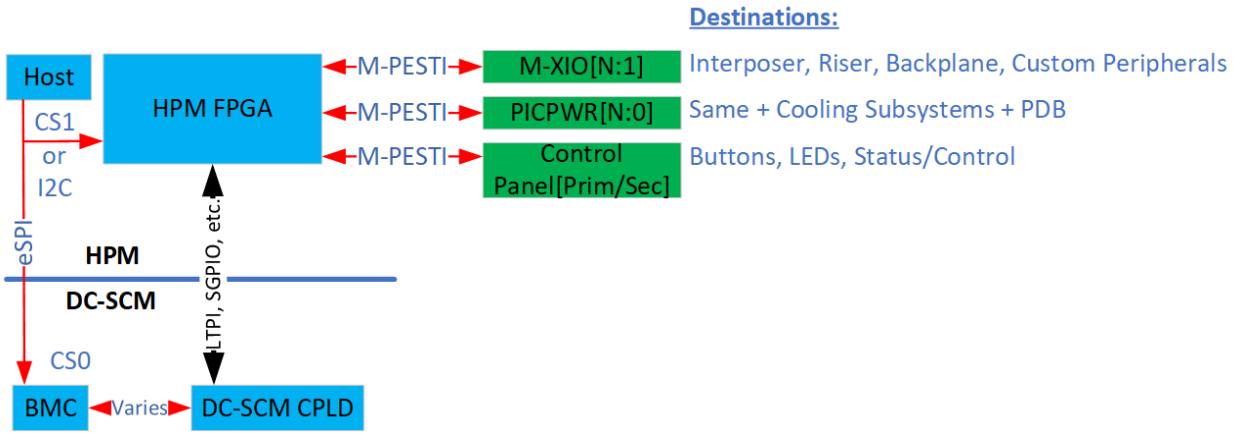


Figure 7: Example PESTI usage at destination

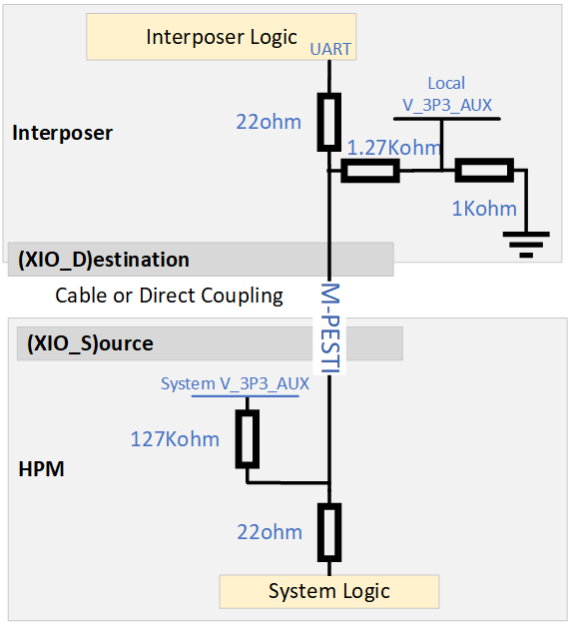


Figure 8: CBL_PRES_PESTI_N Example Diagram – PESTI functionality

Interposer/Target State	PESTI Initiator Observation
1) Nothing installed	Sees logic high
2) Present + No power	Bleed resistor pulls PESTI low; Assumes no local power
3) Power + Target HW Default	Target powered; HW defaults HiZ to induce rising edge; CMDs are NACKed
4) Power + Target app code	Target issues break (low pulse), then listens for incoming CMDs

Table 3: Expected PESTI Signal States

5.7 Flexible I/O

Due to the variable nature of system needs, M-XIO defines 7 signals within the baseline and extended sideband region, FLEXIO_[0:6]. There are assigned pins such that high speed differential links are

acceptable for these interfaces because they are surrounded by isolation grounds on the pinouts, but these do not need to be routed differentially on the HPM.
Flex I/O pins are configurable for different modes based on negotiation between the entities on either side of the cable. By default, FLEXIO_[1:2] signals must be pulled up to system V_3P3_AUX typically sourced via P12V_PRIMARY and enabled in S5 (i.e. before S0), see figure 9.
For FLEXIO_[1:2] the assumption is the default state until negotiation has happened and both HPM and paddle card have agreed on sideband usage. The mechanism of negotiation is out of the scope of this specification but could be done by either 2 wire management bus or 1 wire management bus.

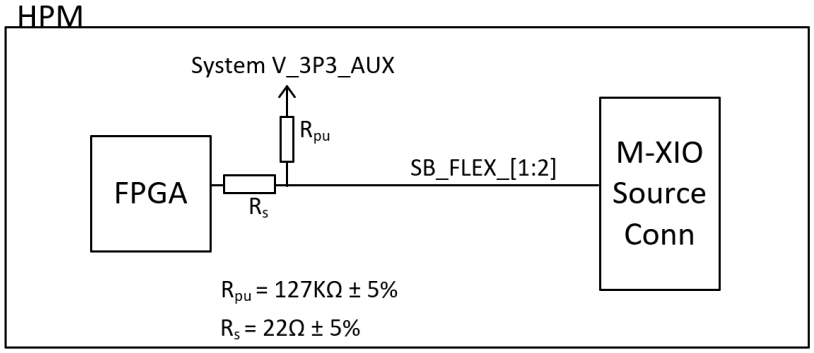


Figure 9: SB_FLEX[0:2] Default Configuration

For FLEXIO_[0,3:6] no bias is allowed at the M-XIO interface until after the discovery phase which guarantees electrically safe plug-ins, power-ups, etc. as relevant to these flex signals. FLEXIO_[0,3:6] are also assumed to take on functions as needed only after negotiation between HPM and paddle card have agreed on sideband usage. FLEXIO_[0,3:6] are not required to default connect to an HPM FPGA unlike FLEXIO_[1:2].

Signal name	Default initialization	Comments
FLEXIO_0	No Function & No Bias	Single Ended Optimized From M-XIO Pinout Perspective
FLEXIO_1	SB_FLEX_1	Differentially Coupled to FLEXIO_2 From M-XIO Pinout Perspective
FLEXIO_2	SB_FLEX_2	Differentially Coupled to FLEXIO_1 From M-XIO Pinout Perspective
FLEXIO_3	No Function & No Bias	Differentially Coupled to FLEXIO_4 From M-XIO Pinout Perspective
FLEXIO_4	No Function & No Bias	Differentially Coupled to FLEXIO_3 From M-XIO Pinout Perspective
FLEXIO_5	No Function & No Bias	Differentially Coupled to FLEXIO_6 From M-XIO Pinout Perspective
FLEXIO_6	No Function & No Bias	Differentially Coupled to FLEXIO_5 From M-XIO Pinout Perspective

Table 4: M-XIO's flexible I/O Selection Table

5.8 USB 2.0

Most identified use cases for this M-XIO USB 2.0 high-speed management interface are part of the BMC domain (e.g. NC-SI RBT replacement, Smart NIC management, fast image management to add-in cards, bridges, etc.). However, an HPM may choose to connect this interface to the HPM host domain, or perhaps arbitrate ownership with a MUX as use cases demand. The USB host(s) are to be on the M-XIO source connector side and not on the peripheral module (USB device side). On-the-go host negotiation is not expected to be needed.
For USB electrical requirements refer to the Universal Serial Bus 2.0 (meaning High Speed or Full Speed, but not Low Speed from USB 1.1). The method to interface USB2 to CEM cards is described in the PCI SIG CEM 5.0 proposal.

USB 2.0 is only required for certain connector widths and certain subsections, refer to connector pinouts for more details. HPM may no-connect USB[p/n]**B** if it is known that only USB[p/n]**A** will be used by the platform.

6. Electrical Requirements

This chapter covers the electrical requirements of an M-XIO port. Unless otherwise specified, follow the PCI Express Card Electromechanical Specification.

6.1 Power Supply Requirements

6.1.1 3p3AUX_MGMT Power Supply Requirements

Reference	Parameter	Value	Unit	Comment
3p3AUX_MGMT tolerance	3p3AUX_MGMT supply tolerance	3.3V +/- 5%	V	
3p3AUX_MGMT Maximum Supply Current	3p3AUX_MGMT maximum allowed current through each M-XIO port that the supply must provide	200	mA	Maximum Supply Current

Table 5: 3p3AUX_MGMT Power Supply Requirements

6.1.2 3.3V Logic Signal Requirements

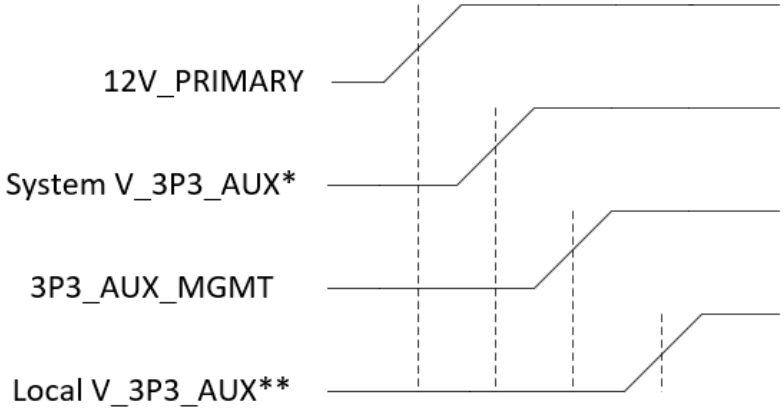
The M-XIO port logic levels for single-ended digital signals (PERST[B:A]_N, CBL_PRES[B:A]_PESTI_N) and FLEXIO are defined in the table directly below. For SMBus signals (SMCLK, SMDAT) logic levels, refer to the System Management Bus (SMBus) Specification, Version 3.1 unless otherwise specified. For USB, reference Universal Serial Bus Specification. Inputs and outputs are referenced from the signal destination's standpoint.

DC Specification for 3.3 V Logic Signaling

Symbol	Parameter	Min	Max	Unit	Notes
Vddsmb	SMBus Nominal bus voltage	3.135	3.465	V	
Vih	Input High Voltage	2.0	3.465	V	
Vil	Input Low Voltage	-0.3	0.8	V	
Voh	Output High Voltage		3.465	V	
Vol	Output Low Voltage		0.2	V	

Table 6: 3.3V Logic Signal Requirements

6.1.3 Power Sequencing



*System V_3P3_AUX is typically sourced via 12V_PRIMARY; however, System V_3P3_AUX can be up before 12V_PRIMARY and sourced via 12V from CRPS for various purposes such as compliance procedures for example.

**Local V_3P3_AUX here is referencing the 3P3_AUX rail located on intermediary boards and/or at peripheral device

Figure 10: Recommended Power Sequencing

7. Connectors & Pinout

For connectors referenced, these part-numbers/standards-references are current as of publication, please refer to connector vendors or [document TBD] for part numbers that best meet the application.

The below M-XIO connector requirements are intended to enhance cross compatibility between HPM and peripheral module subsystems by limiting connector options. These requirements also help prevent M-XIO from going stale when new and better connector designs are released into the market showing new connectors can be added while also filtering out exotic connector solutions.

Minimum connector requirements:

1. Correct number of pins to meet M-XIO high-speed and sideband requirements.
2. Supports cabled or directly-coupled subsystems, based on connector/cable capabilities and platform needs.
3. Support 30AWG or larger diameter twin-ax dual-drain cable.
4. Meets minimum SI capability metric/standard including any additional paddle design when used in a cabled application.
5. Multi-sourced.

Pinouts:

Users should take care of (cable / connector mating) adjustments required for mechanical and electrical (diff pair) compliance. All PCIe TX/RX (PET/PER) are from the perspective of the downstream source port (i.e. HPM's perspective).

7.1 SFF-TA-1016

Both cabled and card edge interconnection is assumed for SFF-TA-1016. M-XIO pinout attempts to follow the physical connector construction (i.e. connector datasheet with A1 at top left).

Only 38, 74 and 148 pin versions of the connector are listed for maximum flexibility.

The 124-pin option is not recommended since it does not have enough pins to enable 2x8 mode with all required sideband signals.

Separate power connector is required for both cabled or card edge cases unless using an M-XIO connector with integrated power. Refer to M-PIC specification for more details on power connectors, signal lists, and pinout.

7.1.1 x4 M-XIO Source Connector Pinout (SFF-TA-1016)

Assumes x4 SFF-TA-1016 (MCIO) – 38 Pins

Pinout Update v0.9

Pin	Signal	Signal	Pin
A1	GND	GND	B1
A2	PERp0	PETp0	B2
A3	PERn0	PETn0	B3
A4	GND	GND	B4
A5	PERp1	PETp1	B5
A6	PERn1	PETn1	B6
A7	GND	GND	B7
A8	3p3AUX_MGMT	SMSCL_A	B8
A9	FLEXIO0_A	SMSDA_A	B9
A10	GND	GND	B10
A11	REFCLK_A_Dp	PERST_A_N	B11
A12	REFCLK_A_Dn	CBL_PRES_A_PESTI_A_N	B12
A13	GND	GND	B13
A14	PERp2	PETp2	B14
A15	PERn2	PETn2	B15
A16	GND	GND	B16
A17	PERp3	PETp3	B17
A18	PERn3	PETn3	B18
A19	GND	GND	B19

7.1.2 x8 M-XIO Source Connector Pinout (SFF-TA-1016)

Assumes x8 SFF-TA-1016 – 74 Pins

Revision v0.9

Pin	Signal	Signal	Pin
A1	GND	GND	B1
A2	PERp0	PETp0	B2
A3	PERn0	PETn0	B3
A4	GND	GND	B4
A5	PERp1	PETp1	B5
A6	PERn1	PETn1	B6
A7	GND	GND	B7
A8	3p3AUX_MGMT	SMSCL_A	B8
A9	FLEXIO0_A	SMSDA_A	B9
A10	GND	GND	B10
A11	REFCLK_A_Dp	PERST_A_N	B11
A12	REFCLK_A_Dn	CBL_PRES_A_PESTI_A_N	B12
A13	GND	GND	B13
A14	PERp2	PETp2	B14
A15	PERn2	PETn2	B15
A16	GND	GND	B16
A17	PERp3	PETp3	B17
A18	PERn3	PETn3	B18
A19	GND	GND	B19
A20	PERp4	PETp4	B20
A21	PERn4	PETn4	B21
A22	GND	GND	B22
A23	PERp5	PETp5	B23
A24	PERn5	PETn5	B24
A25	GND	GND	B25
A26	FLEXIO1_A	FLEXIO3_A	B26
A27	FLEXIO2_A	FLEXIO4_A	B27
A28	GND	GND	B28
A29	USB2_A_Dp	FLEXIO5_A	B29
A30	USB2_A_Dn	FLEXIO6_A	B30
A31	GND	GND	B31
A32	PERp6	PETp6	B32
A33	PERn6	PETn6	B33
A34	GND	GND	B34
A35	PERp7	PETp7	B35
A36	PERn7	PETn7	B36
A37	GND	GND	B37

7.1.3 x16 M-XIO Source Connector Pinout (SFF-TA-1016)

Assumes x16 SFF-TA-1016 – 148 Pins

Pinout Update v0.9

Pin	Signal	Signal	Pin
A1	GND	GND	B1
A2	PERp0	PETp0	B2
A3	PERn0	PETn0	B3
A4	GND	GND	B4
A5	PERp1	PETp1	B5
A6	PERn1	PETn1	B6
A7	GND	GND	B7
A8	3p3AUX_MGMT	SMSCL_A	B8
A9	FLEXIO0_A	SMSDA_A	B9
A10	GND	GND	B10
A11	REFCLK_A_Dp	PERST_A_N	B11
A12	REFCLK_A_Dn	CBL_PRES_A_PESTI_A_N	B12
A13	GND	GND	B13
A14	PERp2	PETp2	B14
A15	PERn2	PETn2	B15
A16	GND	GND	B16
A17	PERp3	PETp3	B17
A18	PERn3	PETn3	B18
A19	GND	GND	B19
A20	PERp4	PETp4	B20
A21	PERn4	PETn4	B21
A22	GND	GND	B22
A23	PERp5	PETp5	B23
A24	PERn5	PETn5	B24
A25	GND	GND	B25
A26	FLEXIO1_A	FLEXIO3_A	B26
A27	FLEXIO2_A	FLEXIO4_A	B27
A28	GND	GND	B28
A29	USB2_A_Dp	FLEXIO5_A	B29
A30	USB2_A_Dn	FLEXIO6_A	B30
A31	GND	GND	B31
A32	PERp6	PETp6	B32
A33	PERn6	PETn6	B33
A34	GND	GND	B34
A35	PERp7	PETp7	B35
A36	PERn7	PETn7	B36
A37	GND	GND	B37
A38	GND	GND	B38
A39	PERp8	PETp8	B39
A40	PERn8	PETn8	B40
A41	GND	GND	B41
A42	PERp9	PETp9	B42
A43	PERn9	PETn9	B43
A44	GND	GND	B44
A45	3p3AUX_MGMT	SMSCL_B	B45

A46	FLEXIO0_B	SMSDA_B	B46
A47	GND	GND	B47
A48	REFCLK_B_Dp	PERST_B_N	B48
A49	REFCLK_B_Dn	CBL_PRES_B_PESTI_B_N	B49
A50	GND	GND	B50
A51	PERp10	PETp10	B51
A52	PERn10	PETn10	B52
A53	GND	GND	B53
A54	PERp11	PETp11	B54
A55	PERn11	PETn11	B55
A56	GND	GND	B56
A57	PERp12	PETp12	B57
A58	PERn12	PETn12	B58
A59	GND	GND	B59
A60	PERp13	PETp13	B60
A61	PERn13	PETn13	B61
A62	GND	GND	B62
A63	FLEXIO1_B	FLEXIO3_B	B63
A64	FLEXIO2_B	FLEXIO4_B	B64
A65	GND	GND	B65
A66	USB2_B_Dp	FLEXIO5_B	B66
A67	USB2_B_Dn	FLEXIO6_B	B67
A68	GND	GND	B68
A69	PERp14	PETp14	B69
A70	PERn14	PETn14	B70
A71	GND	GND	B71
A72	PERp15	PETp15	B72
A73	PERn15	PETn15	B73
A74	GND	GND	B74

7.2 SFF-TA-1033

Refer to connector manufacturer(s) for connector collateral. If using this connector with only a single x8 instead of the full x16 capability, then that single x8 and associated sideband signal set must route through the pin section 'L_x', i.e. closest to the power section. This is similar to PCI-SIG CEM slot pinout where the lower x8 lanes are closest to the power section.

Pinout Update v0.9

Pin	Signal	Signal	Pin
PB2	P12V_PRIMARY	P12V_PRIMARY	PA2
PB1	GND	GND	PA1
SB6	Refer to the latest M-PIC spec for more pinout details in this block		SA6
SB5			SA5
SB4			SA4
SB3			SA3
SB2			SA2
SB1			SA1
Mechanical Key			
L_B37	GND	GND	L_A37
L_B36	PETn0	PERn0	L_A36
L_B35	PETp0	PERp0	L_A35
L_B34	GND	GND	L_A34
L_B33	PETn1	PERn1	L_A33
L_B32	PETp1	PERp1	L_A32
L_B31	GND	GND	L_A31
L_B30	FLEXIO6_A	USB2_A_Dn	L_A30
L_B29	FLEXIO5_A	USB2_A_Dp	L_A29
L_B28	GND	GND	L_A28
L_B27	FLEXIO4_A	FLEXIO2_A	L_A27
L_B26	FLEXIO3_A	FLEXIO1_A	L_A26
L_B25	GND	GND	L_A25
L_B24	PETn2	PERn2	L_A24
L_B23	PETp2	PERp2	L_A23
L_B22	GND	GND	L_A22
L_B21	PETn3	PERn3	L_A21
L_B20	PETp3	PERp3	L_A20
L_B19	GND	GND	L_A19
L_B18	PETn4	PERn4	L_A18
L_B17	PETp4	PERp4	L_A17
L_B16	GND	GND	L_A16
L_B15	PETn5	PERn5	L_A15
L_B14	PETp5	PERp5	L_A14

L_B13	GND	GND	L_A13
L_B12	CBL_PRES_A_PESTI_A_N	REFCLK_A_Dn	L_A12
L_B11	PERST_A_N	REFCLK_A_Dp	L_A11
L_B10	GND	GND	L_A10
L_B9	SMSDA_A	FLEXIO0_A	L_A9
L_B8	SMSCL_A	3p3AUX_MGMT	L_A8
L_B7	GND	GND	L_A7
L_B6	PETn6	PERn6	L_A6
L_B5	PETp6	PERp6	L_A5
L_B4	GND	GND	L_A4
L_B3	PETn7	PERn7	L_A3
L_B2	PETp7	PERp7	L_A2
L_B1	GND	GND	L_A1
Mechanical Key			
U_B37	GND	GND	U_A37
U_B36	PETn8	PERn8	U_A36
U_B35	PETp8	PERp8	U_A35
U_B34	GND	GND	U_A34
U_B33	PETn9	PERn9	U_A33
U_B32	PETp9	PERp9	U_A32
U_B31	GND	GND	U_A31
U_B30	FLEXIO6_B	USB2_B_Dn	U_A30
U_B29	FLEXIO5_B	USB2_B_Dp	U_A29
U_B28	GND	GND	U_A28
U_B27	FLEXIO4_B	FLEXIO2_B	U_A27
U_B26	FLEXIO3_B	FLEXIO1_B	U_A26
U_B25	GND	GND	U_A25
U_B24	PETn10	PERn10	U_A24
U_B23	PETp10	PERp10	U_A23
U_B22	GND	GND	U_A22
U_B21	PETn11	PERn11	U_A21
U_B20	PETp11	PERp11	U_A20
U_B19	GND	GND	U_A19
U_B18	PETn12	PERn12	U_A18
U_B17	PETp12	PERp12	U_A17
U_B16	GND	GND	U_A16
U_B15	PETn13	PERn13	U_A15
U_B14	PETp13	PERp13	U_A14
U_B13	GND	GND	U_A13
U_B12	CBL_PRES_B_PESTI_B_N	REFCLK_B_Dn	U_A12

U_B11	PERST_B_N	REFCLK_B_Dp	U_A11
U_B10	GND	GND	U_A10
U_B9	SMSDA_B	FLEXIO0_B	U_A9
U_B8	SMSCL_B	3p3AUX_MGMT	U_A8
U_B7	GND	GND	U_A7
U_B6	PETn14	PERn14	U_A6
U_B5	PETp14	PERp14	U_A5
U_B4	GND	GND	U_A4
U_B3	PETn15	PERn15	U_A3
U_B2	PETp15	PERp15	U_A2
U_B1	GND	GND	U_A1

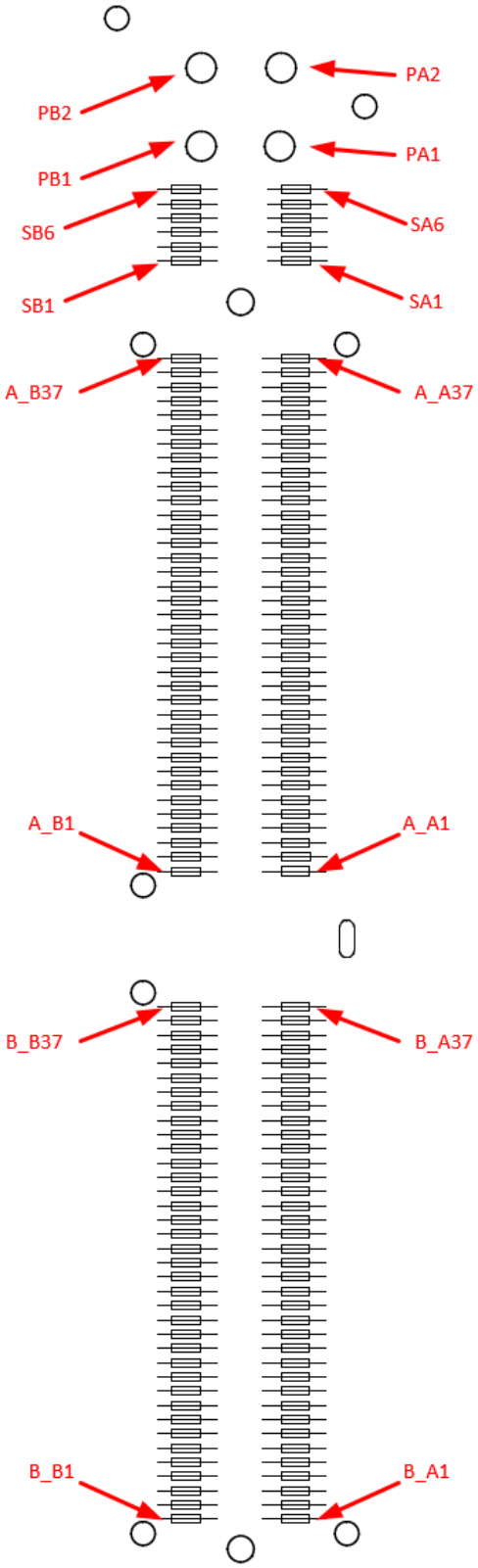


Figure 10: SFF-TA-1033 – Pinout Configuration

7.3 SFF-TA-1026

Pinout Update v0.9

Pin	Signal	Signal	Pin
1	GND	GND	72
2	PERp0	PETp0	71
3	PERn0	PETn0	70
4	GND	GND	69
5	PERp1	PETp1	68
6	PERn1	PETn1	67
7	GND	GND	66
8	PERp2	PETp2	65
9	PERn2	PETn2	64
10	GND	GND	63
11	PERp3	PETp3	62
12	PERn3	PETn3	61
13	GND	GND	60
14	PERp4	PETp4	59
15	PERn4	PETn4	58
16	GND	GND	57
17	PERp5	PETp5	56
18	PERn5	PETn5	55
19	GND	GND	54
20	PERp6	PETp6	53
21	PERn6	PETn6	52
22	GND	GND	51
23	PERp7	PETp7	50
24	PERn7	PETn7	49
25	GND	GND	48
26	REFCLK_A_Dp	USB2_A_Dp	47
27	REFCLK_A_Dn	USB2_A_Dn	46
28	GND	GND	45
29	GND	GND	44
30	CBL_PRES_A_PESTI_A_N	FLEXIO1_A	43
31	SMSCL_A	FLEXIO2_A	42
32	SMSDA_A	GND	41
33	GND	GND	40
34	PERST_A_N	FLEXIO3_A	39
35	3p3AUX_MGMT	FLEXIO4_A	38
36	FLEXIO0_A	GND	37

8. Supplemental Material: SFF-TA-1002 (Not Plan of Record)

8.1 x16 M-XIO Source Connector Pinout (SFF-TA-1002)

Assumes x16 SFF-TA-1002 4C+ or SFF-TA-1020 4C+

4C+ is a super set of 1C, 2C,4C connectors. Same pinout could be used to enable interoperability.

Power shall be interconnected through a separated connector when using 1C, 2C, 4C.

It is assumed 1.1A per power pin, even when using more than 6 power + 6 GND pins. It is required to confirm with connector suppliers any derating and temperature limitations.

Notice that since Dp/Dn array is different than SFF-TA-1016, this forces to scramble FLEXIO definition, also there are different amount of RFU available between the connector types.

Update Rev 0.54

Pin	Signal	Signal	Pin	
OB1	P12V	GND	OA1	Only for 4C+
OB2	P12V	GND	OA2	
OB3	P12V	GND	OA3	
OB4	P12V	GND	OA4	
OB5	P12V	GND	OA5	
OB6	P12V	GND	OA6	
OB7	P12V	GND	OA7	
OB8	P12V	RFU_PWR_OA8	OA8	
OB9	P12V	RFU_PWR_OA9	OA9	
OB10	P12V	CBL_PRES_PWR_PESTI_N	OA10	
OB11	P12V	PWR_ALLOWED	OA11	
OB12	P12V	2-W_PWR_CLK	OA12	
OB13	P12V	2-W_PWR_DATA	OA13	
OB14	P12V	GND	OA14	
Mechanical Key				
B1	FLEXIO_6B	FLEXIO_6A	A1	1Cx4 / 2Cx8 / 4Cx16 or 4C+x16 with Power
B2	PERSTB_N	PERSTA_N	A2	
B3	CBL_PRESB_PESTIB_N	CBL_PRESA_PESTIA_N	A3	
B4	3p3AUX_MGMT	3p3AUX_MGMT	A4	
B5	SMSCL_B	SMSCL_A	A5	
B6	SMSDA_B	SMSDA_A	A6	
B7	GND	GND	A7	
B8	USB2pB	USB2pA	A8	
B9	USB2nB	USB2nA	A9	
B10	GND	GND	A10	
B11	FLEXIO_3B	FLEXIO_3A	A11	
B12	FLEXIO_2B	FLEXIO_2A	A12	
B13	GND	GND	A13	
B14	REFCLKB_Dn	REFCLKA_Dn	A14	
B15	REFCLKB_Dp	REFCLKA_Dp	A15	
B16	GND	GND	A16	
B17	PETn0	PERn0	A17	
B18	PETp0	PERp0	A18	
B19	GND	GND	A19	
B20	PETn1	PERn1	A20	
B21	PETp1	PERp1	A21	
B22	GND	GND	A22	
B23	PETn2	PERn2	A23	
B24	PETp2	PERp2	A24	
B25	GND	GND	A25	
B26	PETn3	PERn3	A26	
B27	PETp3	PERp3	A27	
B28	GND	GND	A28	

Mechanical Key			
B29	GND	GND	A29
B30	PETn4	PERn4	A30
B31	PETp4	PERp4	A31
B32	GND	GND	A32
B33	PETn5	PERn5	A33
B34	PETp5	PERp5	A34
B35	GND	GND	A35
B36	PETn6	PERn6	A36
B37	PETp6	PERp6	A37
B38	GND	GND	A38
B39	PETn7	PERn7	A39
B40	PETp7	PERp7	A40
B41	GND	GND	A41
B42	RFUB_B42	RFUA_A42	A42
Mechanical Key			
B43	GND	GND	A43
B44	PETn8	PERn8	A44
B45	PETp8	PERp8	A45
B46	GND	GND	A46
B47	PETn9	PERn9	A47
B48	PETp9	PERp9	A48
B49	GND	GND	A49
B50	PETn10	PERn10	A50
B51	PETp10	PERp10	A51
B52	GND	GND	A52
B53	PETn11	PERn11	A53
B54	PETp11	PERp11	A54
B55	GND	GND	A55
B56	PETn12	PERn12	A56
B57	PETp12	PERp12	A57
B58	GND	GND	A58
B59	PETn13	PERn13	A59
B60	PETp13	PERp13	A60
B61	GND	GND	A61
B62	PETn14	PERn14	A62
B63	PETp14	PERp14	A63
B64	GND	GND	A64
B65	PETn15	PERn15	A65
B66	PETp15	PERp15	A66
B67	GND	GND	A67
B68	FLEXIO_1B	FLEXIO_1A	A68
B69	FLEXIO_0B	FLEXIO_0A	A69
B70	GND	GND	A70

Appendix A - Checklist for IC approval of this specification (to be completed by contributor(s) of this Spec)

Complete all the checklist items in the table with links to the section where it is described in this spec or an external document.

This will be filled out at v1.0.

Appendix B - OCP Supplier Information and Hardware Product Recognition Checklist

This is a Base Specification and no specific designs can be derived from this specification. Future Design Specifications will be established based on DC-MHS Rev 1.0 specifications, and supplier information and HW checklist will be applicable and filled by future contributors