NAT-MCH-G4

MICROTCA CARRIER HUB – GENERATION 4

DESIGNED BY N.A.T. GMBH

UPLINK GUIDE V1.3

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1. INTRODUCTION

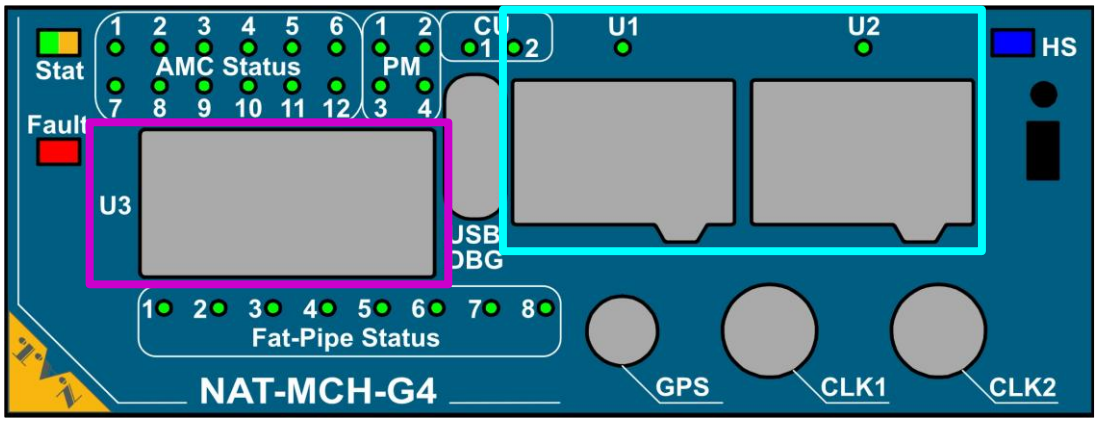
The **NAT-MCH-G4** features a variety of front uplink options on the base board and optional HUB modules. This document gives an overview of the available options.

It shows which combinations of interfaces are possible and which options are supported in each case. Moreover, it provides information about which cables are useful or even mandatory to connect the **NAT-MCH-G4** to peripheral devices.

As the front uplink options for most parts are equivalent for both base board variants, this documentation refers for reasons of clarity to the labelling **NAT-MCH-G4** only. Differences to the double-width **NAT-MCH-S4** are described if mandatory.

The following figure shows the **NAT-MCH-G4** front panel with all available options.

Figure 1 – Front Panel NAT-MCH-G4 / Clock Mezzanine / HUB Module



The blue square indicates the base board uplink, whereas the pink marking shows the uplink of the HUB module.

For the base board uplink, the user can choose from different options (SFP, iX, RJ45) which are described in chapter 3 NAT-MCH-G4 Base Ethernet Front Uplink.

Every **NAT-MCH-G4-HUB** module provides a fixed QSFP-(DD) front uplink option, which means that there is no assembly option available but, of course, the interface is configurable via GUI, script, or console.

2. (Q)-SFP-(DD) BASICS

This chapter gives some basic information about the SFP-based front uplinks of the **NAT-MCH-G4**.

Please note: All transceivers mentioned in this document are designed for one particular data rate. Using them for another data rate can work but is neither guaranteed nor recommended.

A list of validated transceivers and appropriate cables for each uplink type and speed can be found in chapter 7 Transceiver Recommendations.

2.1. SFP

SFP (Small Form-factor Pluggable) is a versatile interface format which supports several communication standards. It consists of a so-called cage, which is assembled to the PCB, and an interchangeable transceiver (receptable). This may be an optical interface as well as an electrical one. Also, the use of a common RJ45 interface is possible.

Several variants of the SFP interface can be used for different fields of application. An overview is given in Table 1 – SFP / SFP+ / SFP28 / SFP-DD Capabilities.

SFP+ and SFP28 are enhanced versions of the normal SFP standard supporting a higher data rate with the same mechanical build.

SFP-DD is another variant featuring two rows of electrical pins instead of one. So, the SFP-DD (double density) cage and receptable offer doubled port density and increased data transfer rates within a small form factor. Data rates up to 25G per port are supported, which results in 4x 25G in total. Please consider, that these four ports cannot be combined to one port.

By replacing a SFP-28 with a SFP-DD interface, the amount of electrical high-speed interfaces doubles:

SFP28: 1 lane @ 25G => SFP-DD: 2 lanes @ 25G

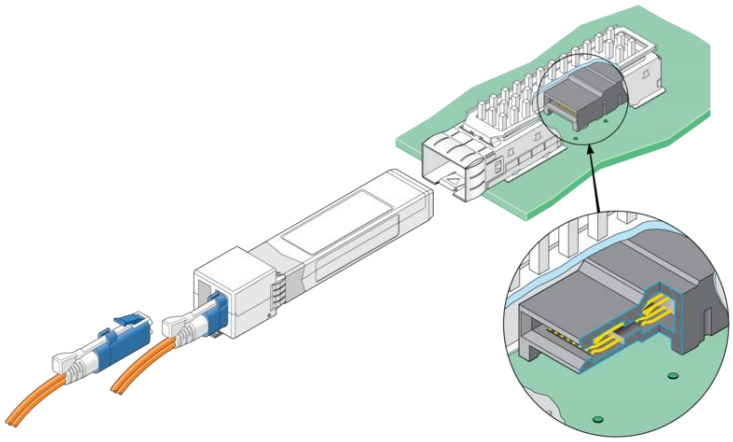
Important: SFP-DD connects to two ***physically separated ports***! So, a combination of both ports is ***not*** possible on the **NAT-MCH-G4**!

Example: high-speed interface 1 connects to switch port #0
high-speed interface 2 connects to switch port #1

Figure 2 – SFP-DD Transceiver Cage

Detailed information can be found in the manufacturer's datasheet: https://www.te.com/commerce/DocumentDelivery/DDEController?Action=showdoc&DocId=Data+Sheet%7F8-1773983-7%7F820%7Fpdf%7FEnglish%7FENG_DS_8-1773983-7_820.pdf%7FN-A

Figure 3 – SFP-DD Detail



The SFP-DD cages offer backwards compatibility to existing SFP / SFP+ / SFP28 receptables. Please keep in mind that it is important to differentiate between these transceiver types to ensure optimal performance.

Depending on the field of application, speed, and distance, the customer can choose from different options. At lower speeds (≤ 10G), optical transceivers (via LC connectors), copper-based DACs (Direct Attached Cable), or copper-based transceivers with RJ45 interface are supported. For higher speeds (≥ 10G), only DAC and fibre are recommended.

Table 1 – SFP / SFP+ / SFP28 / SFP-DD Capabilities

	Supported Speeds	Supported Cables	Fits Base Board	Fits HUB Module
SFP	1G	LC / DAC / RJ45	yes	yes*
SFP+	10G	LC / DAC / RJ45	yes	yes*
SFP28	25G	LC / DAC	yes	yes*
SFP-DD	2x 25G	LC / DAC	yes	no

** with converter*

Additionally, the cable length has an important influence on the recommended transceiver type and communication medium.

Table 2 – Suitable Transceiver Types depending on Range

	Range	Medium	Transceiver Type
<3m		copper / fibre	• multimode / single-mode fibre • RJ45 • DAC
<100m	Short Range	fibre	• multimode / single-mode fibre
>100m	Long Range	fibre	• single-mode fibre

Examples of cable and transceiver types are shown in the following pictures.

Figure 4 – SFP28 Transceiver with LC-LC Cable

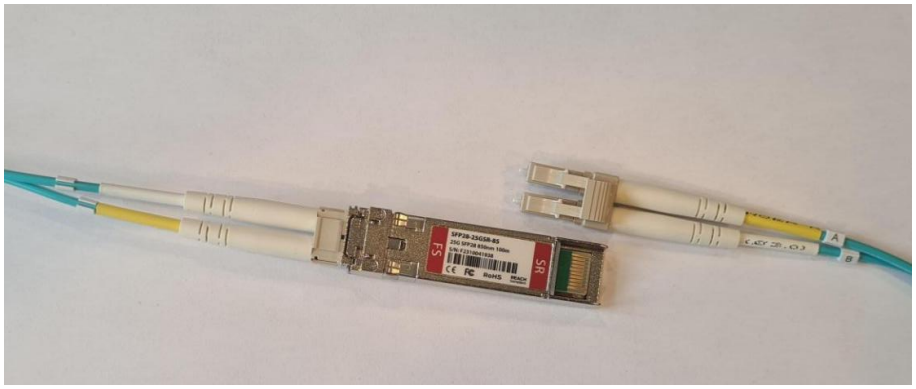
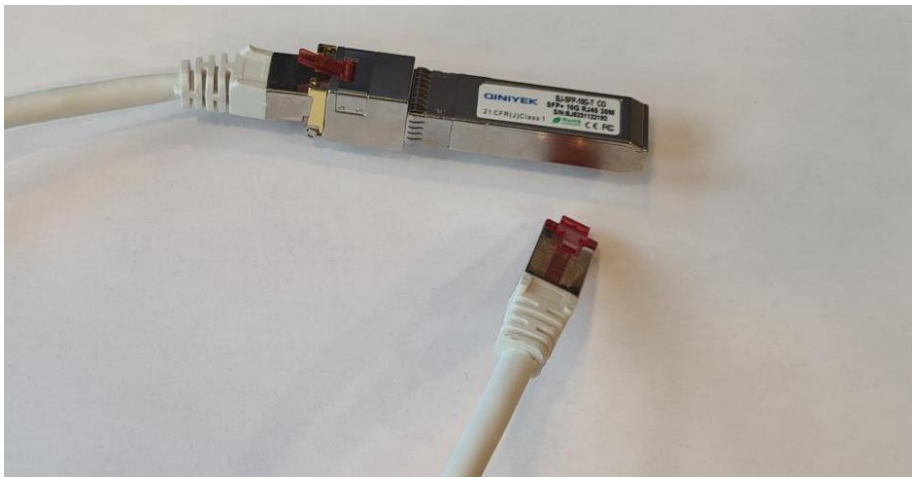


Figure 5 – SFP28 Direct Attached Cable

Figure 6 – SFP+ Transceiver with RJ45 Cable



2.2. QSFP

Another derivative of the SFP standard are the QSFP interfaces which own four lanes instead of one. So, a QSFP / QSFP28 interface quadruples the speed of an SFP / SFP28 interface by implementing four RX and four TX lanes:

SFP:	1 lane @ 10G	=>	QSFP:	4 lanes @ 10G
SFP28:	1 lane @ 25G	=>	QSFP28:	4 lanes @ 25G

Also, for the QSFP standard, a double density option is available which doubles the amount of electrical high-speed interfaces:

QSFP28:	4 lanes @ 25G	=>	QSFP-DD:	8 lanes @ 25G

The other way round, one QSFP or QSFP28 port can be split into four single lanes; a QSFP-DD port can be split into eight single lanes. For more information on this topic, please refer to chapter 4.1 Splitting Options.

Figure 7 – QSFP-DD Transceiver Cage

The QSFP-DD interface offers backwards compatibility and supports standard QSFP receptables.

Table 3 – QSFP / QSFP28 / QSFP-DD Capabilities

	Supported Ethernet Speeds	Supported PCIe Speeds	Supported Cables	Fits Base Board	Fits HUB Module
QSFP	1x 40G (SR4) 4x 10G (SR)	PCIe x4 Gen3 (8G per lane)	• MPO – MPO • 4x LC	no	yes
QSFP28	1x 100G (SR4) 4x 25G (SR)	PCIe x4 Gen4 (16G per lane)	• MPO – MPO • 4x LC	no	yes
QSFP-DD	2x 100G (SR4) 8x 10G (SR) 8x 25G (SR)	PCIe x8 Gen4 (16G per lane)	• MPO – MPO • 8x LC – MPO Patch Field	no	yes

Important: QSFP-DD connects to two ***physically separated port groups***! So, a combination of both port groups is ***not*** possible!

The specifications given in Table 2 – Suitable Transceiver Types depending on Range are also valid for QSFP interfaces.

The following pictures show various connection options like cables and a break-out-box.

Figure 8 – QSFP+ to QSFP+ Connection (MPO – MPO)

Figure 9 – Fan-out Cable QSFP28 (MPO) to 4x SFP28 (LC)

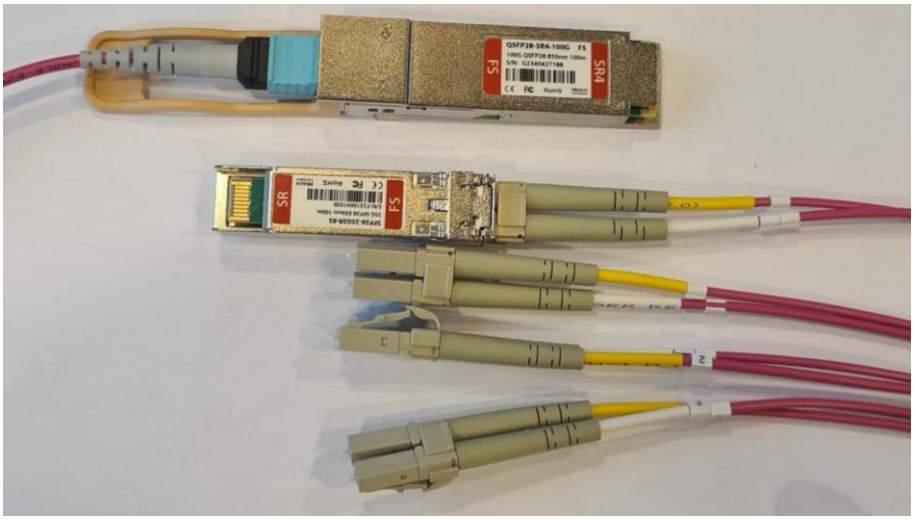


Figure 10 – Converter Module 100G QSFP28 to 25G SFP28 Single Port

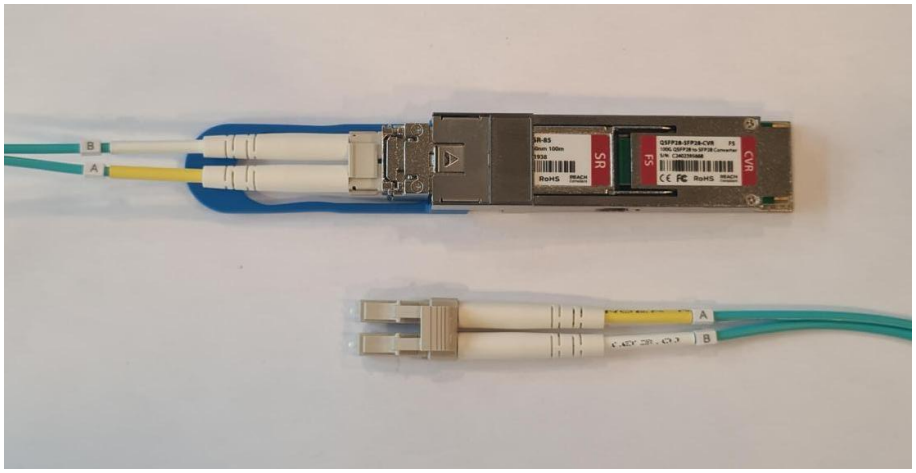


Figure 11 – QSFP28-DD connected to two QSFP28 Link Partners

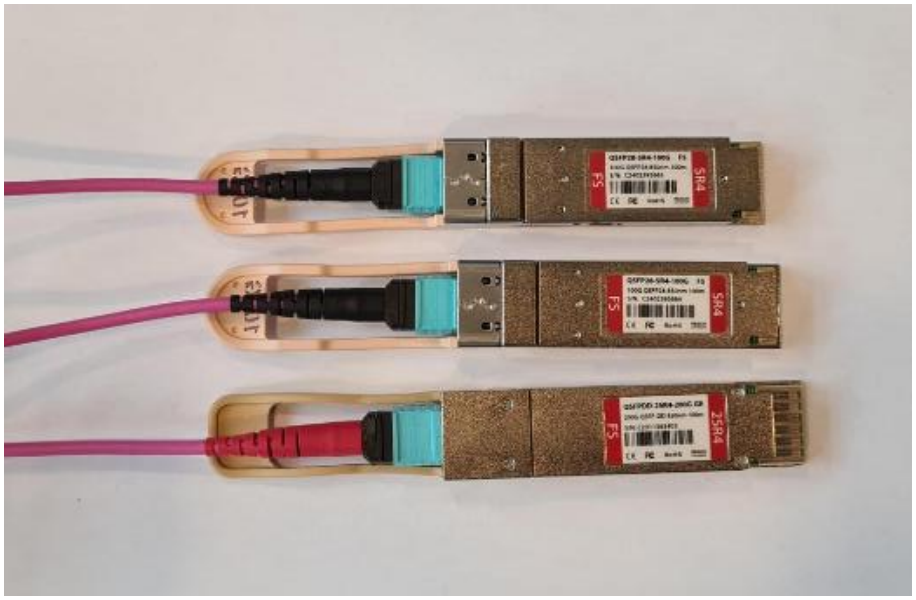


Figure 12 – Direct Attached Cable (DAC)

Figure 13 – QSFP-DD connected to a Break-Out-Box (Patch Field)

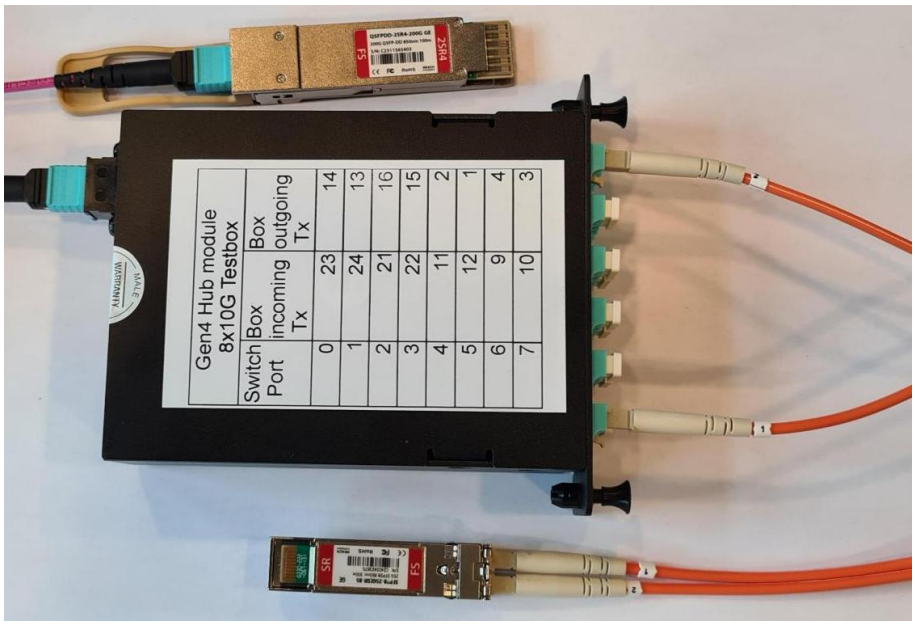
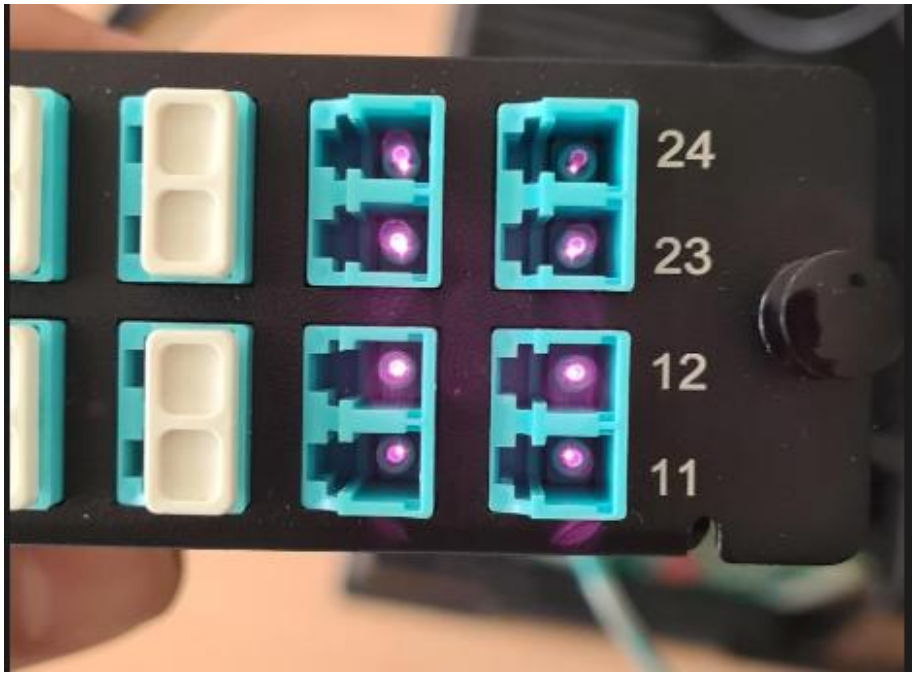


Figure 14 – All eight TX-Signals coming from the QSFP-DD Transceiver



3. NAT-MCH-G4 BASE ETHERNET FRONT UPLINK

Basically, the **NAT-MCH-G4's** Microchip SparX-5 Ethernet Switch provides up to 4x 25G / 2x 10G (depending on assembly option) to the front uplink. The number of uplinks and the available uplink speed depend on the chosen interface option.

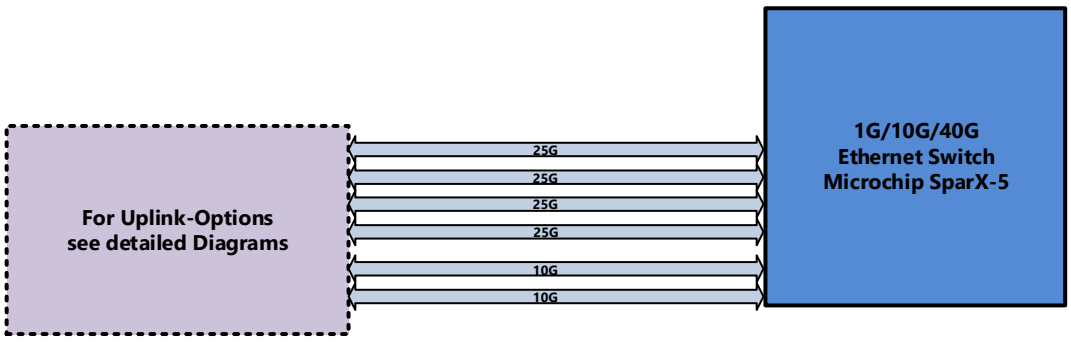
The following table provides an overview of the most important attributes; more details are given in the chapters below.

Table 4 – Base Board Front Ethernet Uplink Overview

	SFP-DD*	ix	RJ45
Flexibility	+++	-	-
Reliability	++	+++	+
Speed	+++	+	+
Commonness	+++	+	+++

*Features depend on chosen transceiver type

Figure 15 – Base Board Front Ethernet Uplink Overview



Important: Depending on the chosen uplink interface, the **NAT-MCH-G4** supports up to 4x 25G ***or*** 2x 10G. The uplink interface is an ***assembly option*** and ***cannot*** be changed after production!

3.1. Base Ethernet Front Uplink Option #1: SFP(-DD)

Figure 16 – Front Panel NAT-MCH-G4 Base Board with SFP(-DD) Front Uplink

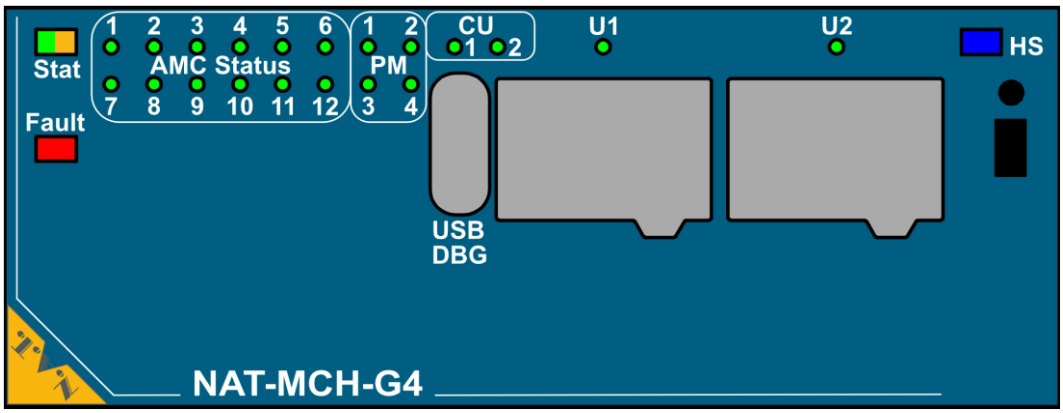
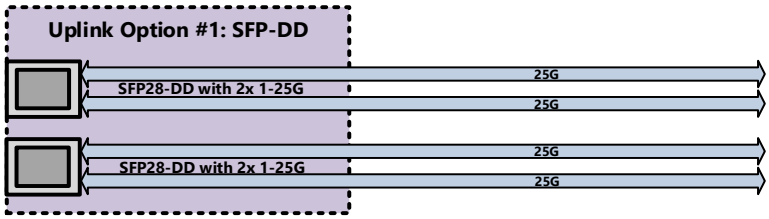


Figure 17 – Base Board Front Ethernet Uplink Option #1: SFP(-DD)



This interface is the most versatile: an SFP-DD cage is mounted on the PCB and can be populated with any supported receptable. This may be an optical interface as well as an electrical one. Also, the use of a common RJ45 interface is possible.

More information about the SFP standard and its enhancements can be found in chapter 2 (Q)-SFP-(DD) Basics.

3.2. Base Ethernet Front Uplink Option #2: ix

Figure 18 – Front Panel NAT-MCH-G4 Base Board with iX Front Uplink

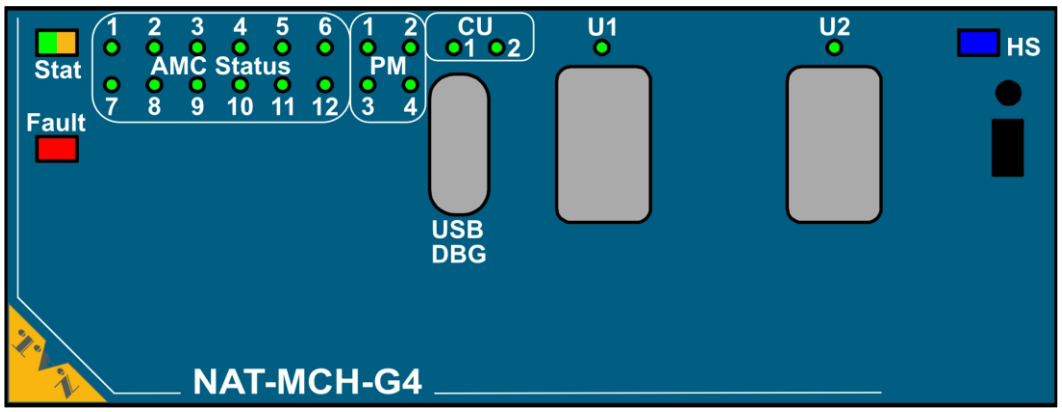
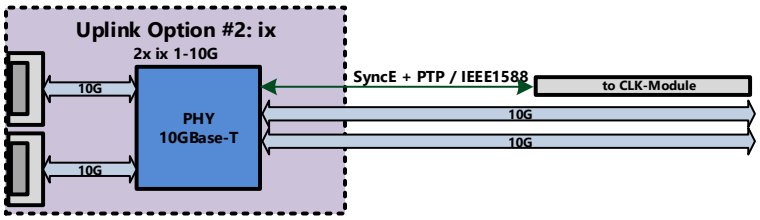


Figure 19 –Base Board Front Ethernet Uplink Option #2: iX



The ix connector is a robust alternative to the standard RJ45 connector. It requires much less space, and at the same time ensures a more reliable connection by two metal retention hooks snapping in the socket.

As both interfaces are electrically fully compatible, adapter cables are available (see figure below).

The PHY located between Ethernet switch and connectors auto-negotiates transmission rates of 1G / 2.5G / 10G.

Figure 20 – iX Connectors and Adapter Cable iX-RJ45

Detailed information can be found on the manufacturer's website:

https://www.harting.com/AT/en-gb/ix-Industrial

3.3. Base Ethernet Front Uplink Option #3: RJ45

Figure 21 – Front Panel NAT-MCH-G4 Base Board with RJ45 Front Uplink

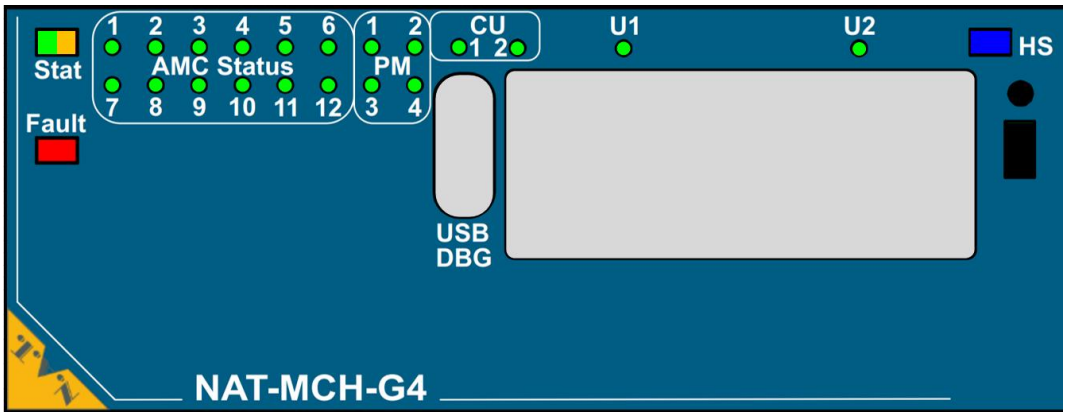
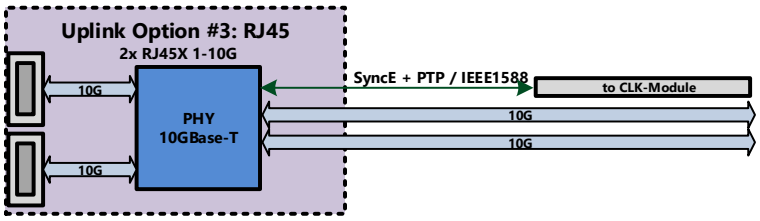


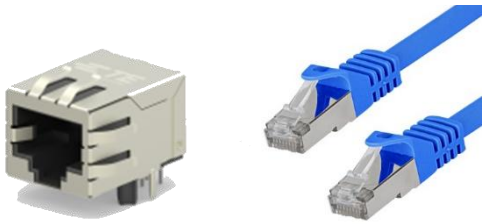
Figure 22 – Base Board Front Ethernet Uplink Option #3: RJ45



The RJ45 connector is a well-established Ethernet interface standard.

The hardware assembled on the PCB is the same as with the ix option, only with a different connector interface at the front, so transmission rates of 1G / 2.5G / 10G are supported as well.

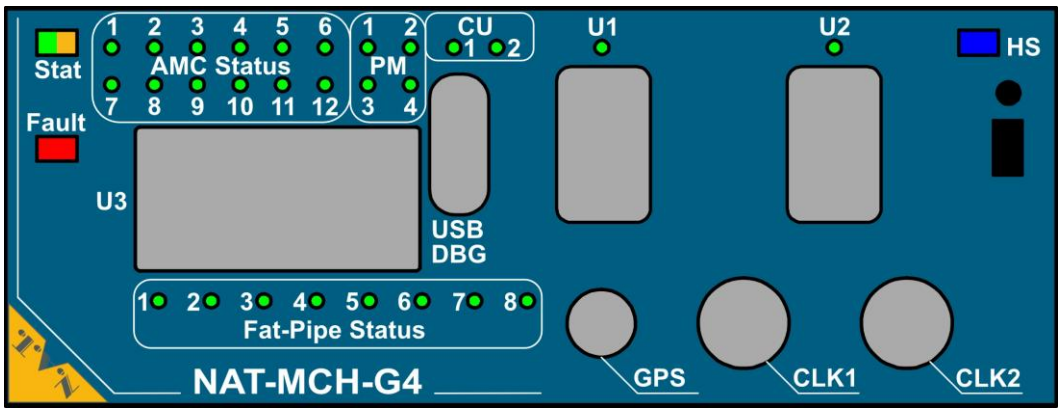
Figure 23 – RJ45 Connectors and Cable



4. NAT-MCH-G4-HUB-EX FAT PIPE ETHERNET FRONT UPLINK

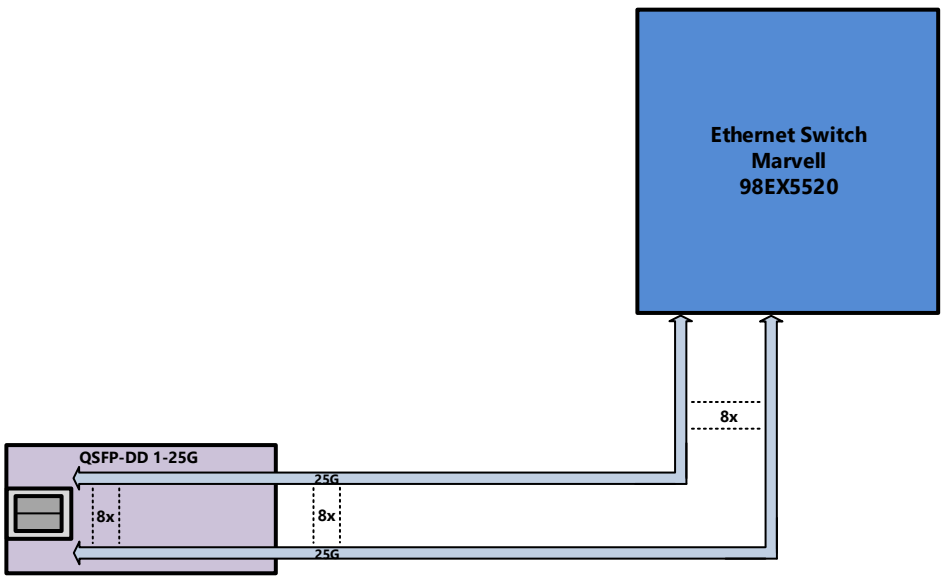
The Marvell 98EX5520 Fat Pipe Ethernet Switch of the **NAT-MCH-G4-HUB-EX** HUB module features an additional optical front uplink via an QSFP-DD cage. Depending on the chosen transceiver, the interface supports transmission rates up to 100G. Multiple configuration options are possible.

Figure 24 – Front Panel NAT-MCH-G4 Base Board with iX Front Uplink / Clock Mezzanine / HUB Module



Note: all Base Board uplink options can be combined with every HUB Module. So, this figure is exemplarily for all variants.

Figure 25 – NAT-MCH-G4-HUB-EX Fat Pipe Ethernet Uplink



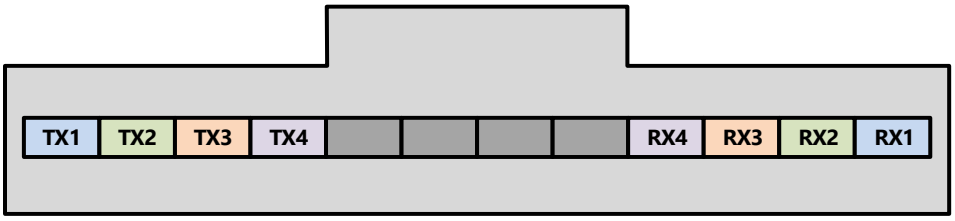
4.1. Splitting Options

One QSFP or QSFP28 port can be split into four single lanes; a QSFP-DD port can be split into eight single lanes. By software, the ports must be configured to single connections (e.g. 4 x 25G), the interface mode changes from SR4 to SR. Examples are shown in the figures below.

It is possible to use standard SFP receptables at the HUB module's uplink. For this use case, an adapter from QSFP to SFP needs to be attached.

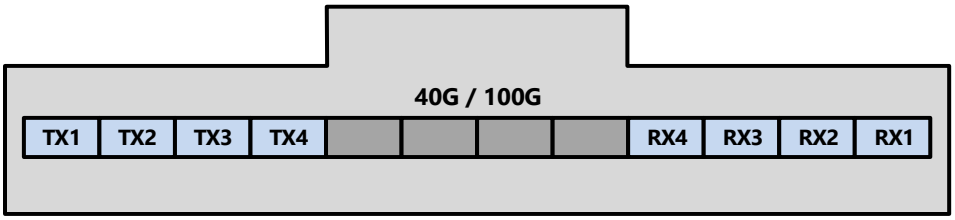
Four lanes can be operated as ***single*** 10G / 25G uplink each:

Figure 26 – NAT-MCH-G4: Four 10G/25G Uplinks with QSFP/QSFP28 (4x SR)



Four lanes can be combined to ***one*** 40G / 100G uplink ports

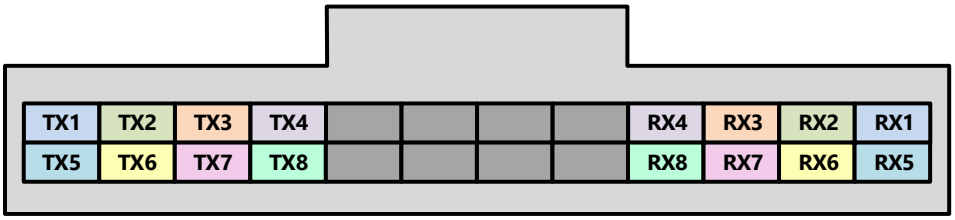
Figure 27 – NAT-MCH-G4: One 40G/100G Uplink with QSFP/QSFP28 (1x SR4)



With a QSFP-DD transceiver, the number of available ports doubles:

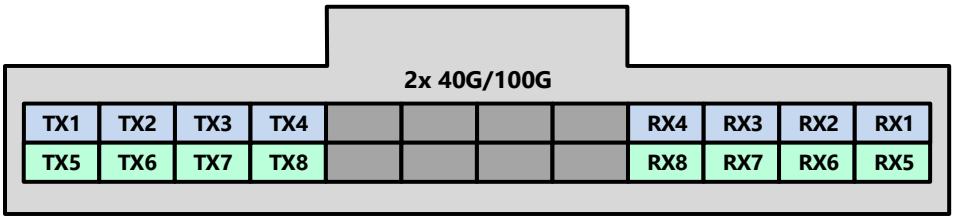
Eight lanes can be operated as ***single*** 10G / 25G uplink each:

Figure 28 – NAT-MCH-G4: Eight 10G/25G Uplinks with QSFP-DD (8x SR)



2x four lanes can be combined to ***two*** 40G / 100G uplink ports

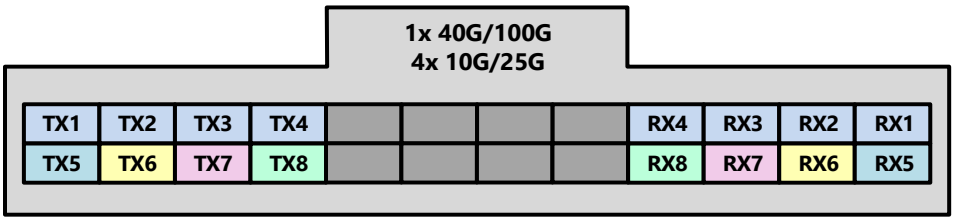
Figure 29 – NAT-MCH-G4: Two 40G/100G Uplinks with QSFP-DD (2x SR4)



Please keep in mind, that the two rows of a QSFP-DD receptable represent two physically independent port groups. A combination is not possible.

However, each row can be configured individually as shown exemplarily in the following figure.

Figure 30 – NAT-MCH-G4: Combined Front Uplink with QSFP-DD (1x SR4 + 4x SR)



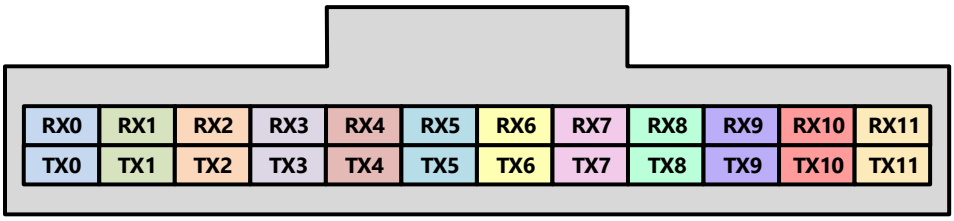
4.2. Important Differences between NAT-MCH-G3 and -G4

The **NAT-MCH-G3** 40G Ethernet HUB module with BOA transceiver provides an MPO front uplink interface. Equipped with the appropriate QSFP / QSFP-DD receptable, the **NAT-MCH-G4** can offer an MPO front uplink as well.

Due to the QSFP standards the port assignment differs, so previously used cables from the 3rd generation ***do not fit*** to the **NAT-MCH-G4's** front uplink!

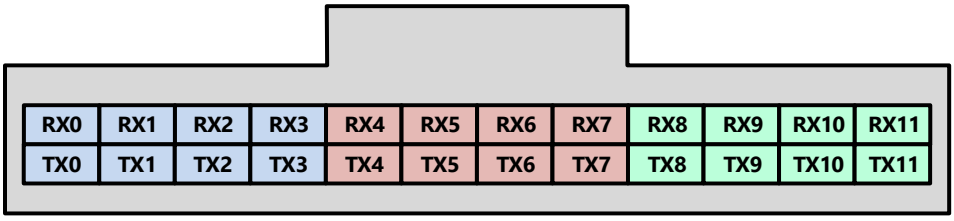
Twelve lanes can be operated as ***single*** 10G uplink each:

Figure 31 – NAT-MCH-G3: Twelve x1 Uplinks (12x SR)



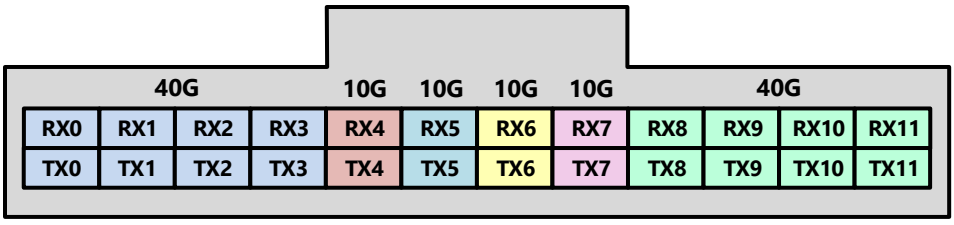
3x four lanes be combined to ***three*** 40G uplink ports:

Figure 32 – NAT-MCH-G3: Three x4 Uplinks (3x SR4)



Moreover, a combination of different operation modes is possible e.g., 2x 40G + 4x 10G.

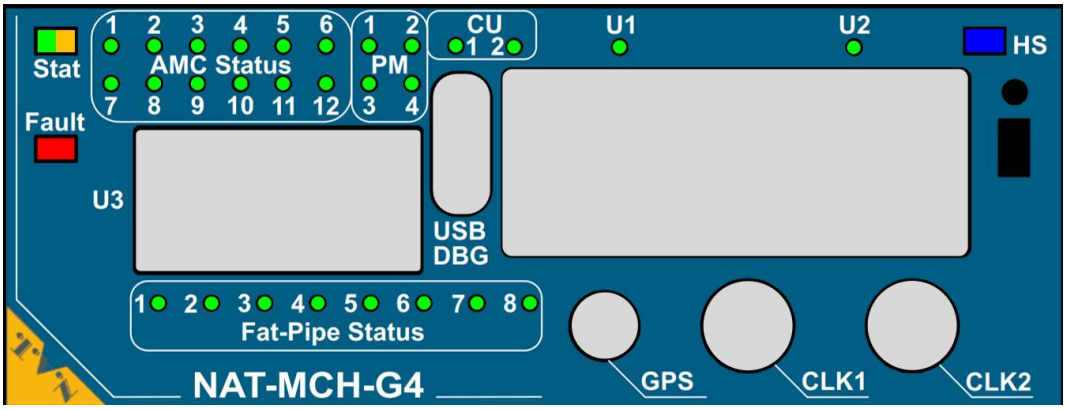
Figure 33 – NAT-MCH-G3: Combined Uplink (2x SR4 + 4x SR)



5. NAT-MCH-G4-HUB-Px52 FAT PIPE PCIE FRONT UPLINK

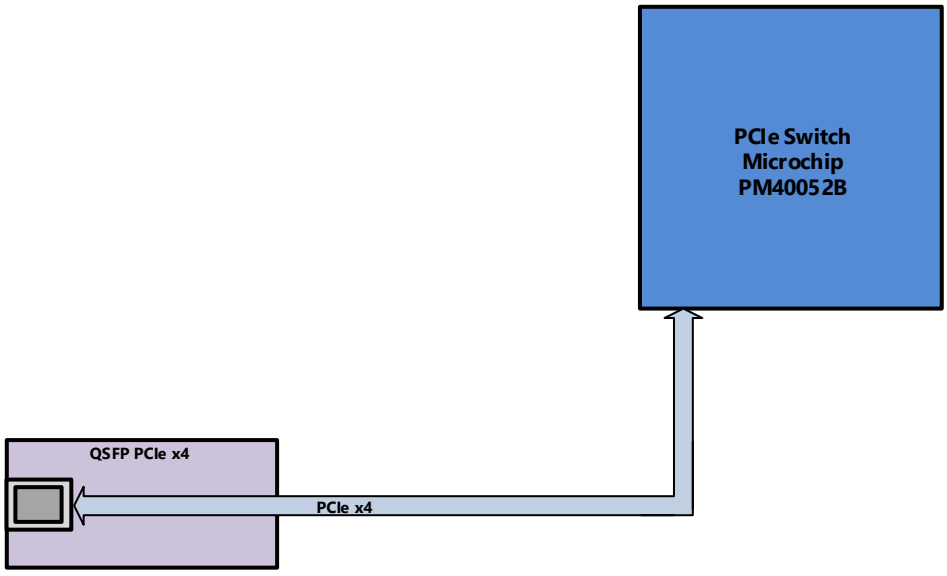
The **NAT-MCH-G4-HUB-Px52** HUB module is equipped with a latest generation Microchip PM40052B PCIe fat pipe switch supporting 52 ports.

Figure 34 – Front Panel NAT-MCH-G4 Base Board with RJ45 Front Uplink / Clock Mezzanine / HUB Module



Note: all Base Board uplink options can be combined with every HUB Module. So, this figure is exemplarily for all variants.

Figure 35 – NAT-MCH-G4-HUB-Px52 Front Uplink



5.1. Uplink Options

A couple of possible connections between one or more **NAT-MCH-G4-HUB-Px52** module(s) and one or more **NPCIe-Uplink-Q** card(s) mounted on a PC mainboard are shown below.

Figure 36 – NAT-MCH-G4-HUB-Px52 to one NPCIe-Uplink-Q (x4 link)

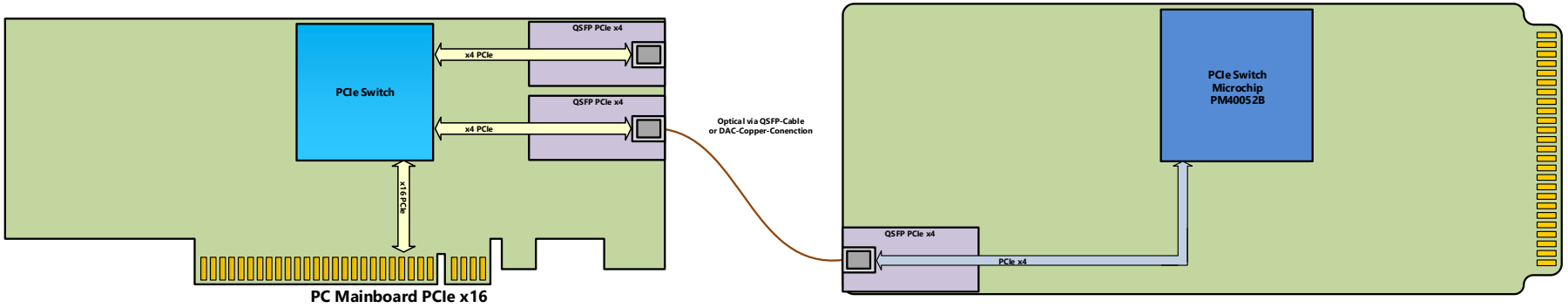
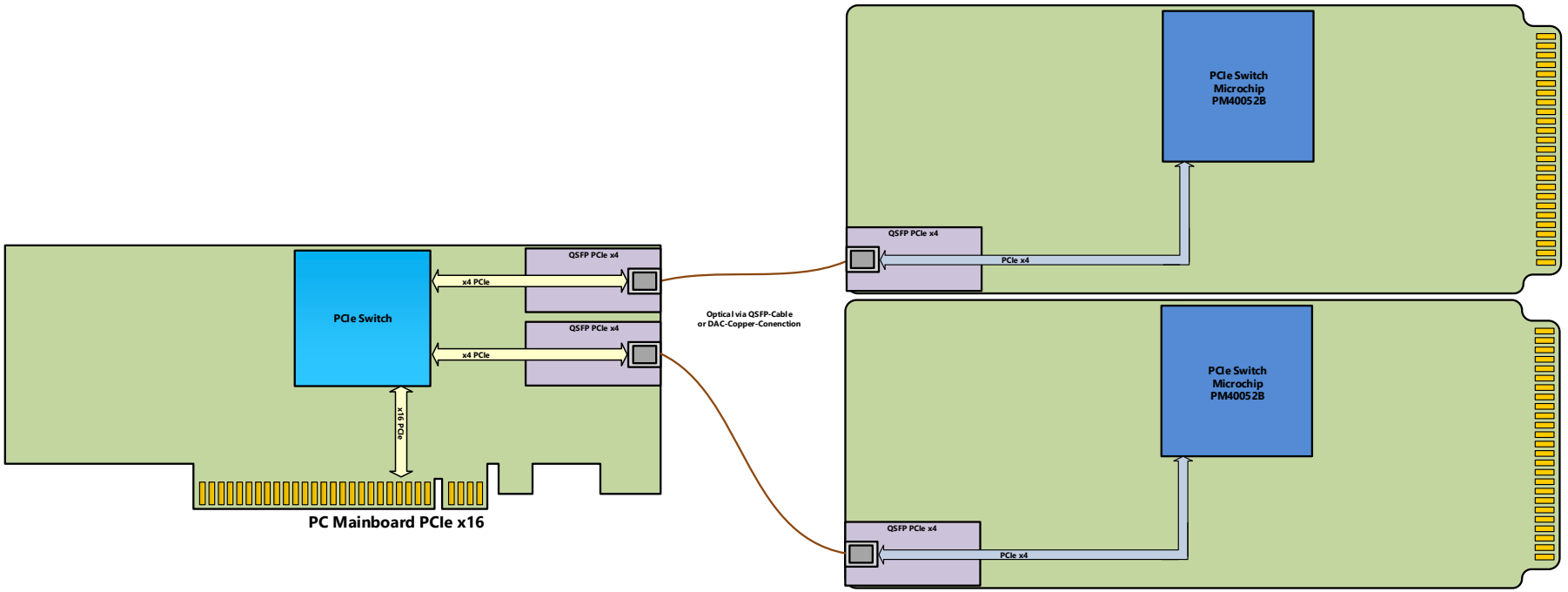


Figure 37 – Two NAT-MCH-G4-HUB-Px52 to one NPCIe-Uplink-Q (two x4 links)



In most use cases, the **NAT-MCH-G4-HUB-Px52** modules belong to two separate MTCA systems. Technically, this option works also with both modules in the same MTCA system.

6. NAT-MCH-G4-HUB-PX84 FAT PIPE PCIE FRONT UPLINK

The **NAT-MCH-G4-HUB-Px84** HUB module provides a Microchip Switchtec PFX PCIe Gen5 switch supporting 84 lanes. The module features two PCIe Gen4 x8 front uplinks, which can be combined to one PCIe Gen4 x16 interface.

Please note: essentially, the information in this chapter is valid for the **NAT-MCH-G3** and its HUB module **NAT-MCH-PCIEx80-Q** as well, as it provides the same front uplink interface.

Figure 38 – Front Panel NAT-MCH-G4 Base Board with RJ45 Front Uplink / Clock Mezzanine / HUB Module

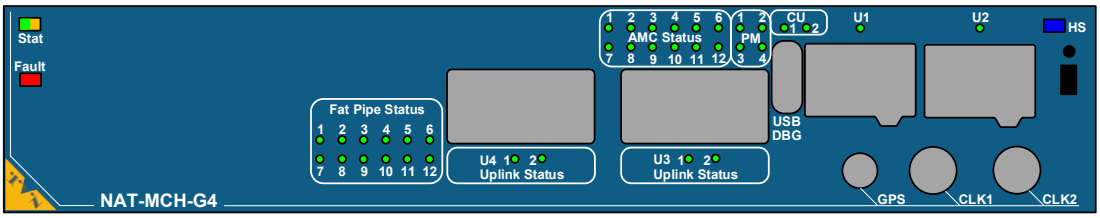
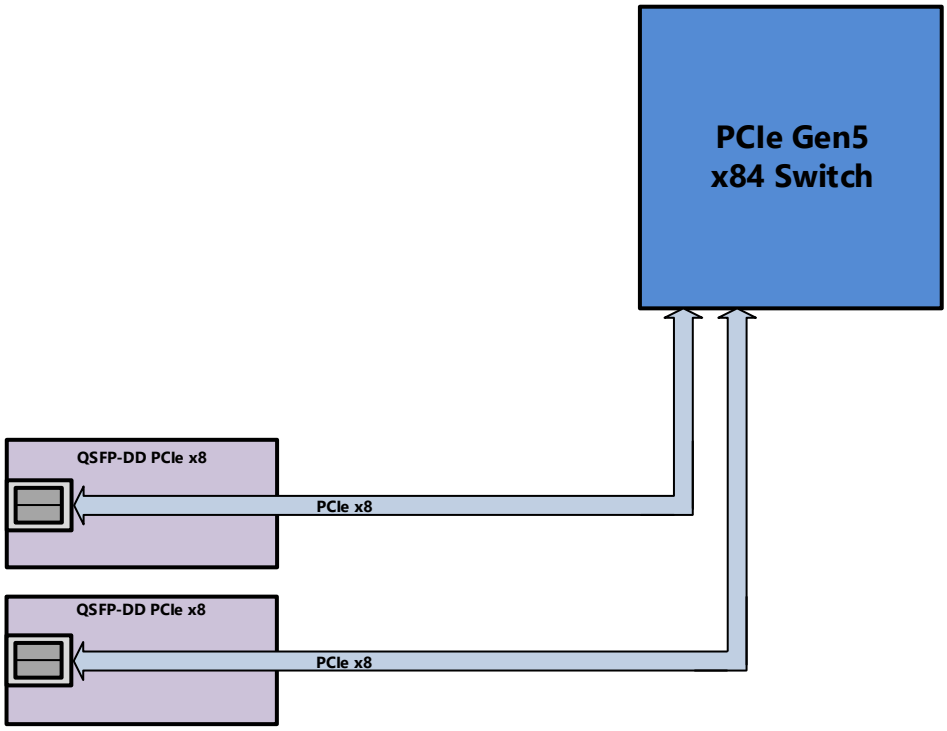


Figure 39 – NAT-MCH-G4-HUB-Px84 Front Uplink



The transmission standard supported by the **NAT-MCH-G4-HUB-Px84** module is NAT proprietary and so the front uplink functionality is available in combination with the **NPCIe-Uplink-Q** card only.

Connections can be either optical or copper-based via a Direct Attached Cable (DAC), both standards shall not be mixed.

6.1. Uplink Options

A couple of possible connections between one or more **NAT-MCH-G4-HUB-Px84** module(s) and one or more **NPCIe-Uplink-Q** card(s) mounted on a PC mainboard are shown below.

Figure 40 – One NAT-MCH-G4-HUB-Px84 to one NPCIe-Uplink-Q (x16 link)

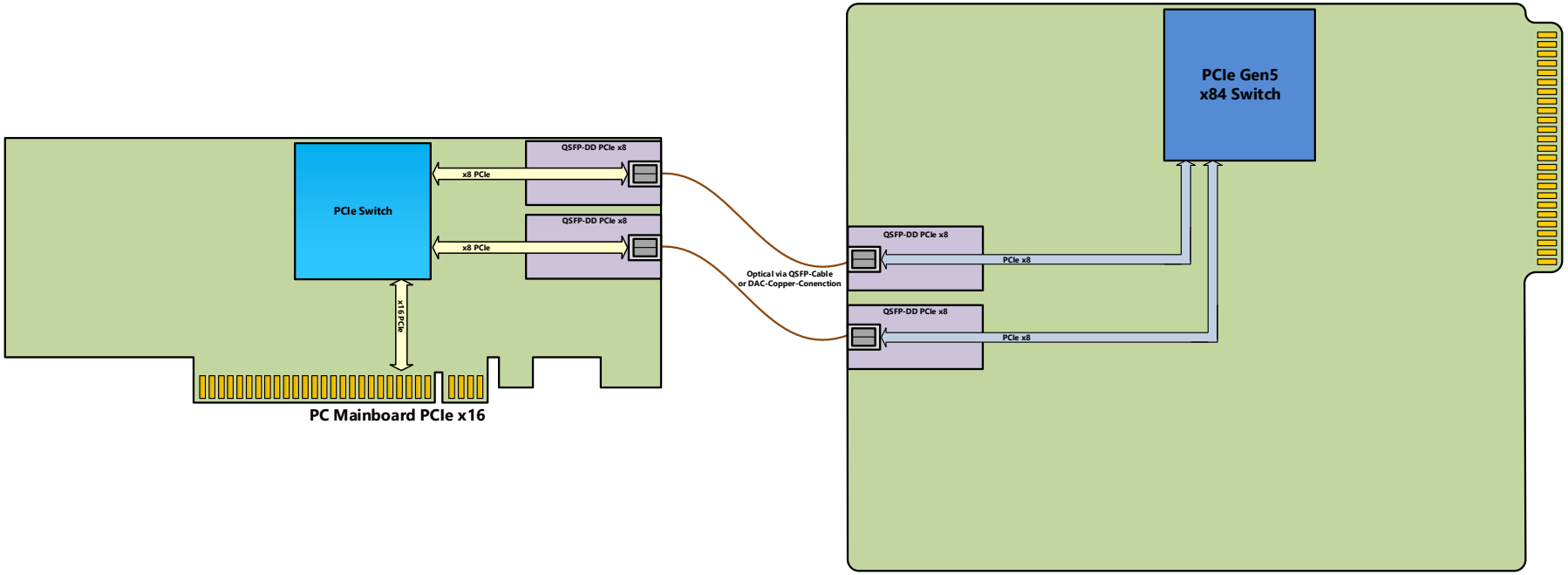


Figure 41 – One NAT-MCH-G4-HUB-Px84 to one NPCIe-Uplink-Q (x8 link)

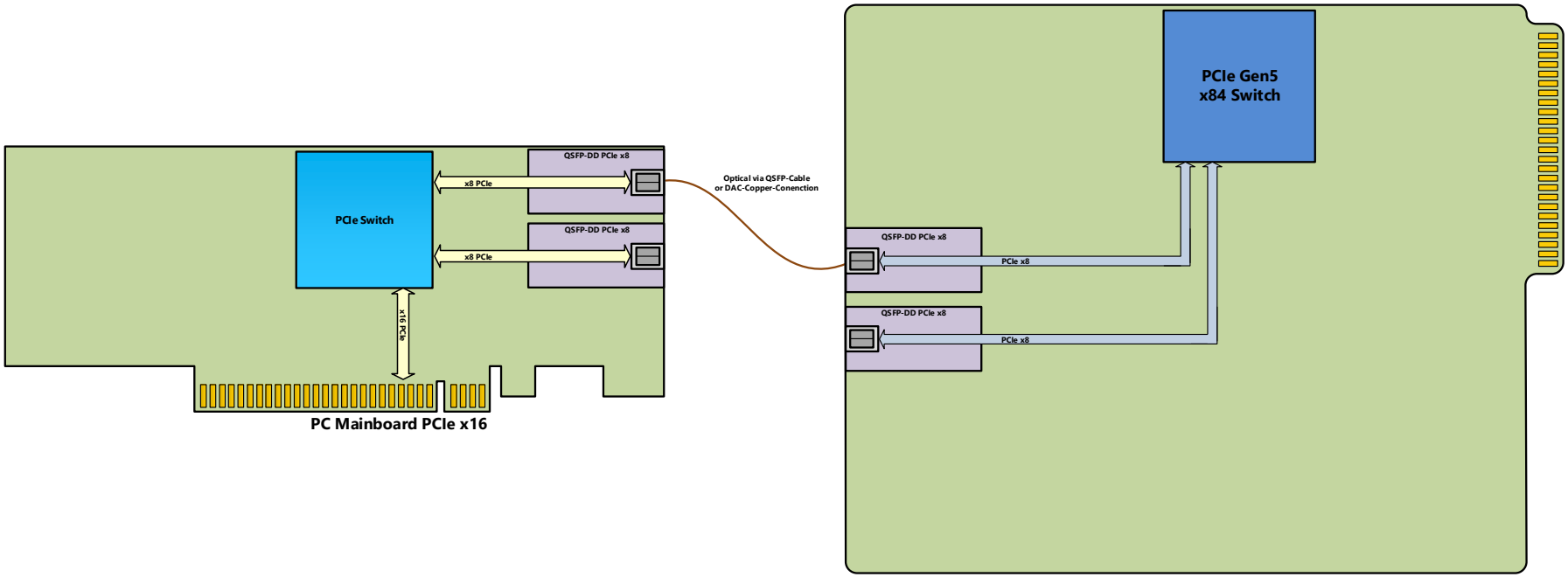


Figure 42 – One NAT-MCH-G4-HUB-Px84 to two NPCIe-Uplink-Q (two x8 links)

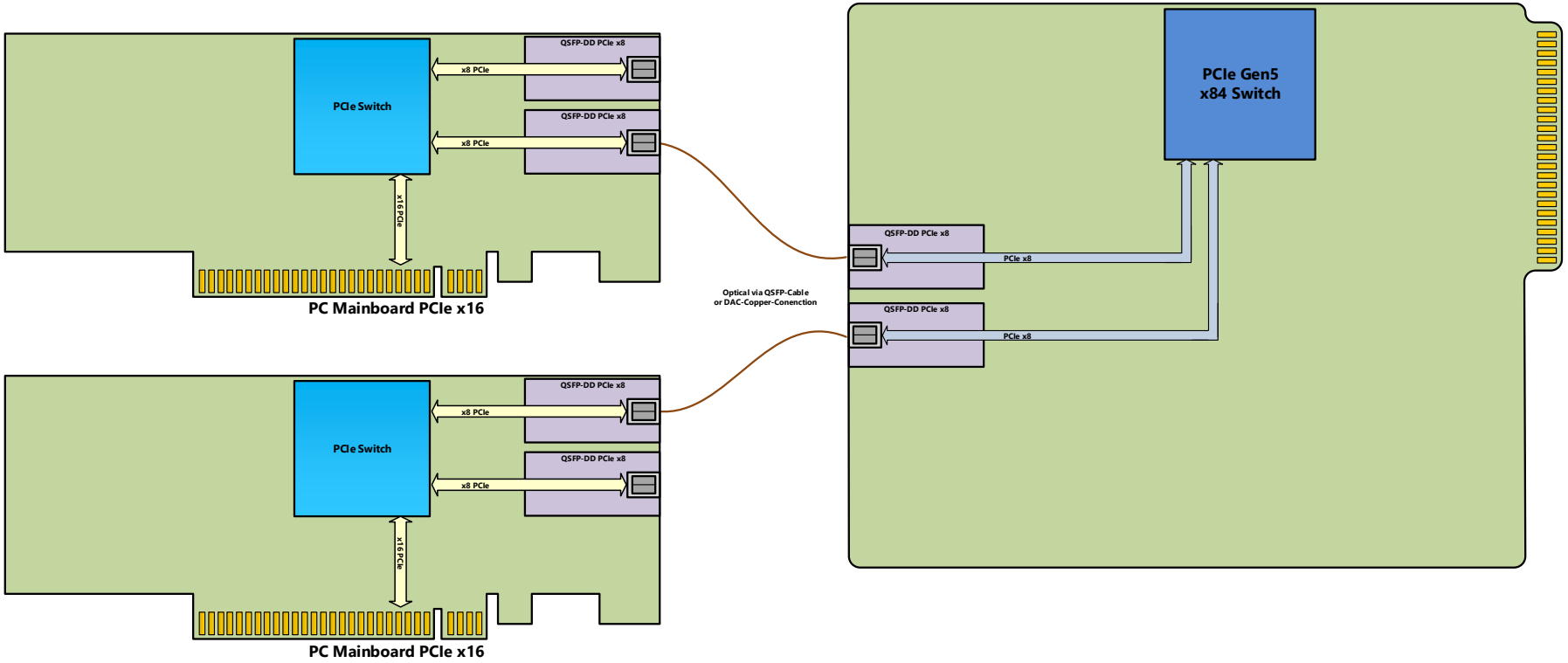
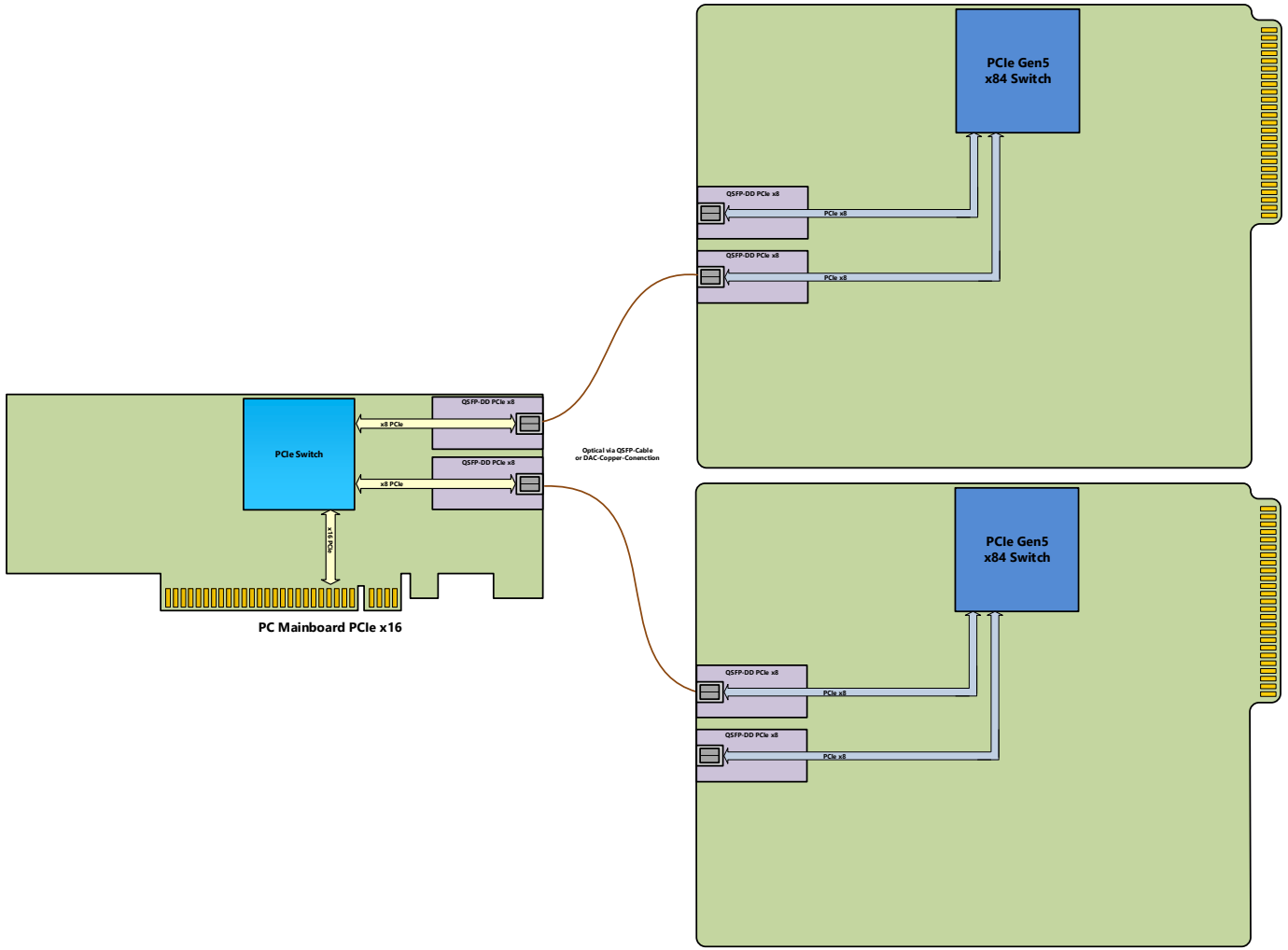


Figure 43 – Two NAT-MCH-G4-HUB-Px84 to one NPCIe-Uplink-Q (two x8 links)



7. TRANSCEIVER RECOMMENDATIONS

NAT has validated several transceiver types for all available uplink variants. Other types may work but proper functionality cannot be guaranteed.

This list will be expanded continuously, as with further development of the **NAT-MCH-G4** firmware, more transceivers will be included.

Please note: NAT is not responsible for external links. This list is intended to provide an overview of available accessories for the customer's convenience.

7.1. Base Ethernet Front Uplink

1. SFP RJ45 copper transceiver 10/100/1000Mbit, fs.com:
   https://www.fs.com/de/products/177936.html
2. SFP 10G multimode transceiver, fs.com:
   https://www.fs.com/de/products/11552.html
3. SFP 10G singlemode transceiver, Finisar:
   FTLX1475D3BCL Coherent | Optoelektronik | DigiKey
4. SFP 10G singlemode transceiver, fs.com:
   https://www.fs.com/de/products/11555.html

7.2. Fat Pipe Ethernet Front Uplink

1. QSFP-DD optical multimode transceiver, 850nm, 100m reach, 8x 25G, 2x 100G, fs.com:
   https://www.fs.com/de/products/185400.html
2. QSFP-DD optical multimode transceiver, 850nm, 100m reach, x8, fibermall.com:
   2x 100GBASE-SR4 Optical Transceiver Module | FiberMall

   The following cables can be used with this transceiver type:

   - Cable for MTP16 <-> 8x LC (fan-out of 8x 10/25G):
     https://www.fs.com/de/products/118110.html
   - Cable for MTP16 <-> 2x MTP8 (fan-out of 2x 40/100G):
     16 Fibers Low Insertion Loss OM3 MM LSZH MPO Cable 3M | FiberMall
   - Cable for MTP16 <-> 2x MTP8, fs.com:
     https://www.fs.com/de/products/221899.html
3. QSFP+ optical multimode transceiver, 850nm, 100m reach, x4, fs.com (1x 40G):
   https://www.fs.com/de/products/36395.html
4. QSFP28 optical multimode transceiver, 850nm, 100m reach, x4, fs.com (1x 100G):
   https://www.fs.com/de/products/35182.html

5. QSFP+ 40G -> SFP+ 10G converter, fs.com:
   https://www.fs.com/de/products/178052.html

6. QSFP28 100G -> SFP28 25G converter, fs.com:
   https://www.fs.com/de/products/178070.html

7. SFP28 multimode transceiver, 850nm, 100m reach, 25G, fs.com:
   https://www.fs.com/de/products/71007.html

7.3. Fat Pipe PCIex52 Front Uplink

The validation process for this module is pending.

7.4. Fat Pipe PCIex84 Front Uplink

Please note: the transceivers listed in this section are also a proper fit for the 3rd generation **NAT-MCH-PHYS80-Q** front uplink.

1. QSFP-DD DAC Cable Assembly, 3m, x8, fs.com:
   https://www.fs.com/de/products/82457.html

2. QSFP-DD optical multimode transceiver, 850nm, 100m reach, x8, fs.com:
   https://www.fs.com/de/products/185400.html

   The following cable can be used with this transceiver type:

   - Trunk-Cable OM4 MTP®(Female) to MTP®(Female), Pol. B, 24-Core, 2 m
     https://shop.fiber24.net/FOPC-F2-O4-MT24F-PB-MT24F-020/en

8. DOCUMENT'S HISTORY

Table 5 – Document's History

Rev	Date	Description	Author
1.0	04.06.2024	• Initial Release	Se
	27.11.2024	• Minor changes	Se
1.1	27.02.2025	• Reworked document • Added NAT-MCH-G4-HUB-PR option	Se
1.2	03.11.2025	• Updated PCIe HUB module sections • Rearranged whole document	Se
1.3	10.11.2025	• Editorial changes • Added chapter 7 Transceiver Recommendations	se