Dolphin
MXH94x / MXH95x Transparent Adapter Users Guide

Version 1.2

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Terms and acronyms

Important terms and acronyms used in this manual

BMC	Board Management Microcontroller on the adapter card.
eXpressWare	Dolphins software stack for PCIe clustering and IO. Please visit http://www.dolphinics.com/software for more information.
FireFly™	Optical fiber solution for PCIe over cable from Samtec Inc
Transparent Host mode	The card is installed in a root complex / Host PC and configured for Transparent operation.
Transparent Hot Add	Attaching an IO Expansion system after the server is booted.
Target mode	The card is installed in an expansion chassis or backplane for Transparent IO expansion.
Lane	One PCI Express Lane contains a differential pair for transmission and a differential pair for reception.
Link	A collection of one or more PCI Express Lanes providing the communication path between an Upstream and Downstream Port.
NTB mode	The card is configured for Non Transparent Bridge operations. Requires Dolphin eXpressWare or custom NTB drivers.
Port	PCIe Cable port. The adapter card, depending on the model, has up four x4 ports, named L0, L1, L2, L3. The physical ports are identified by text on the PCIe brackets.

High Level Specification

The MXH94x and MXH95x are a family of low profile, half-length PCIe adapters utilizing the Samtec FireFly™ optical transceivers. It is available in several variants to support various use cases and configurations. All boards are using a Gen4 PCIe switch from Microchip. The MXH94x boards are equipped with Samtec FireFly™ PCIe Gen4 optical transceivers. The MXH95x boards are equipped with the Samtec FireFly™ PCIe Gen3 optical transceivers.

This manual covers all transparent variants of these cards. Please reference the tables below for details. Some variants come with NTB enabled firmware and are bundled with Dolphins eXpressWare. Please reference the Dolphin
MXH94x / MXH95x NTB Adapter Users Guide if you have one of the NTB enabled variants.

Each card operates at the highest common speed shared between the slot and the card (Gen4) and the widest common link-width (x16).

PCIe Gen4 Link Transparent Product variants

The variants in the table below support PCIe Gen4 link speed, Transparent Host and Target operations and come with a license to use the eXpressWare Board Management Software. Each Model has different FireFly™ optical engines mounted depending on your use case and requirements:

SKU / Model	#FireFly™	PCIe Configurations	Required Fiber cable
MXH942	2 x8	Transparent x16 / 2 x8	2 units 24 fiber MPO
MXH945	4 x4	Transparent x16 / 2 x8 / 4 x4	4 units 12 fiber MPO
MXH946	1 x8	Transparent x8	1 unit 24 fiber MPO
MXH947	2 x4	Transparent x8 / 2 x4	2 units 12 fiber MPO
MXH948	1 x4	Transparent x4	1 unit 12 fiber MPO

NOTE: Please note that cards utilizing 24 fiber MPO cannot be connected to cards utilizing 12 fiber MPO.

PCIe Gen3 Link Transparent Product variants

The variants in the table below support PCIe Gen3 link speed, Transparent Host and Target operations and come with a license to use the eXpressWare Board Management Software. Each Model has different FireFly™ optical engines mounted depending on your use case and requirements:

SKU / Model	#FireFly™	PCIe Configurations	Required Fiber cable
MXH952	2 x8	Transparent x16 / 2 x8	2 units 24 fiber MPO
MXH955	4 x4	Transparent x16 / 2 x8 / 4 x4	4 units 12 fiber MPO
MXH956	1 x8	Transparent x8	1 unit 24 fiber MPO
MXH957	2 x4	Transparent x8 / 2 x4	2 units 12 fiber MPO
MXH958	1 x4	Transparent x4	1 unit 12 fiber MPO

NOTE: Please note that cards utilizing 24 fiber MPO cannot be connected to cards utilizing 12 fiber MPO.

Detailed specifications

- PCI Express Base Specification, Rev. 4.0.
- PCI Express CEM Specification, Rev. 4.0.
- PCI Express Gen4 16 GT/s per lane signaling – 256 GT/s total signaling. Variants utilizing Gen3 FireFly™ modules are limited to PCIe Gen3 8 GT/S signaling rate on the optical link.
- PCI Express Gen4 x16 edge connector. The card installs in any PCI Express slot that has a physical x16 connector.
- Compliant with PCI Express Gen1 through Gen4 computers and IO systems, auto detection.
- MPO cable connector

- Transparent Cable port configurations, up to
    - One x16
    - Two x8
    - Four x4 (Supported using MXH945 and MXH955 only)
- Pre-loaded firmware configurations, DIP switch selectable. Please reference the adapter card firmware release note for details.
- Microchip / Microsemi Switchtec PM40036B PFX PCI Express Gen4 chipset. (PM40052B used in Rev A and B cads)
- 100 nanosecond cut-through latency port to port.
- Support for optical patch cables up to 100 meters.
- Low profile, Half-length - PCI Express Electromechanical Specification, Rev 4.0.
- Dimensions 167.65mm (6.600 inches) x 68.90 mm (2.731 inches)
- Host clock isolation. Automatic support for host running CFC or SSC mode.
- VAUX powered board management controllers for flexible configuration and cable management.
- Flash recovery option. PFX Multi configuration support.
- Operating Temperature: 0°C - 55°C (32°F - 131°F), Air Flow: 600 LFM
- Relative Humidity: 5% - 95% (non- condensing)
- Regulatory
    - RoHS
    - CE and FCC Marks
- One year warranty

MXH94x Maximum DC current across input voltage ranges

MXH94X			
#FireFly™	12V	3.3V	VAUX
1	1.97 A	0.84 A	0.35 A
2	2.30 A	0.84 A	0.35 A
3	2.62 A	0.84 A	0.35 A
4	2.95 A	0.84 A	0.35 A

MXH95x Maximum DC current across input voltage ranges

MXH95X			
#FireFly™	12V	3.3V	VAUX
1	1.76 A	0.84 A	0.35 A
2	1.88 A	0.84 A	0.35 A
3	2.00 A	0.84 A	0.35 A
4	2.12 A	0.84 A	0.35 A

Note:
25 W Slot specification for +12V rail is 2.1 A max.
75 W slot specification for +12 V rail is 5.5 A max.

MXH94x MTBF by Temperature and Environment

The MTBF (in hours) for the MXH94x with 1, 2 or 4 Gen4 FireFly modules mounted can be found in the table below. The numbers are calculated using the Telcordia SR-332 issue 2 (2006) standard.

Ambient Temp. [°C]	MXH94x 1 FireFly mounted	MXH94x 2 FireFly mounted	MXH94x 4 FireFly mounted
0	3.695.205	3.043.158	2.249.339
5	3.085.401	2.497.241	1.807.952
10	2.555.388	2.037.075	1.449.193
15	2.100.911	1.653.639	1.159.806
20	1.716.081	1.337.251	927.674
25	1.393.934	1.078.290	742.173
30	1.126.968	867.705	594.276
35	907.657	697.322	476.485
40	728.823	559.986	382.683
45	583.891	449.592	307.936
50	467.021	361.019	248.302
55	373.156	290.036	200.648

Table 1: MXH94x MTBF vs. Temperature for Ground Fixed, Controlled (GB) Environment

MXH95x MTBF by Temperature and Environment

The MTBF (in hours) for the MXH95x with 1, 2 or 4 Gen3 FireFly modules mounted can be found in the table below. The numbers are calculated using the Telcordia SR-332 issue 2 (2006) standard.

Ambient Temp. [°C]	MXH95x 1 FireFly mounted	MXH95x 2 FireFly mounted	MXH95x 4 FireFly mounted
0	3.695.205	3.043.158	2.249.339
5	3.085.401	2.497.241	1.807.952
10	2.555.388	2.037.075	1.449.193
15	2.100.911	1.653.639	1.159.806
20	1.716.081	1.337.251	927.674
25	1.393.934	1.078.290	742.173
30	1.126.968	867.705	594.276
35	907.657	697.322	476.485
40	728.823	559.986	382.683
45	583.891	449.592	307.936
50	467.021	361.019	248.302
55	373.156	290.036	200.648

Table 2: MXH95x MTBF vs. Temperature for Ground Fixed, Controlled (GB) Environment

Packaging

The products are delivered includes the following components.

- Adapter Board with pre mounted FireFly™ modules and standard profile bracket.
- Anti-static bag
- Getting started guide with serial number for quick download of Dolphins PCIe software.

Pre-Installation Questions

Certain steps should be taken prior to installing the adapter card. You should determine the following configuration requirements.

- Which PCIe slot will the card be installed?
- What is the speed and link width of the installation slot?
- What is the operating environment around the installed card?
- What quantity, type, and length of patch cable will be used?
- Are the operational conditions proper - temperature and air-flow?

PCIe Slot Determination

The adapter card supports PCIe Gen1, Gen2, Gen3 and Gen4 speeds. The adapter card must be installed in physical x16 connector but supports x1, x2, x4, x8 and x16 electrical slot-widths. The slot width and speed will affect the performance of the adapter card. The adapter card will auto configure to the slot speed and width.

NOTE:

- Install the adapter card in a slot connecting directly to the CPU for optimal IO latency.
- Install the adapter card behind a PCIe switch in the IO system for optimal PCIe peer to peer performance (e.g. between GPUs, FPGAs)

Adapter Card Configuration

The adapter card has a DIP switch bank to control the main configuration of the card. The DIP switch labeled SW1 can be found close to the upper edge of the board. The default DIP switch setting is Transparent Host operation, singe, full width link.

Operating Environment

To maximize lifespan for the product and maintain the warranty, please honor the specified operating temperature, and make sure the specified air flow is present. Special care should be considered when the adapter card is used in office type cabinets in combination with other high energy consuming PCIe devices, e.g. not active cooled GPUs:

Operating Temperature: 0°C - 55°C (32°F - 131°F), Airflow: 600 LFM
Relative Humidity: 5% - 95% (non- condensing)

TIP: After installing the Dolphin management software, you can use the tool dis_diag to determine the actual adapter card temperatures (PCIe switch, FireFly™ etc.).

NOTE: The adapter card includes an overtemperature overheat protection. The BMC will automatically shut down the card if a PCIe switch temperature beyond 105°C (221°F) or a FireFly temperature beyond 70 °C (158°F) is detected. The automatic shutdown can be disabled by setting DIP-Switch OPT6.

NOTE: The adapter card link LEDs will start flashing yellow when a PCIe switch temperature of 95°C (203°F) is reached or when FireFly reports a temperature of 60°C (14°F).

Cable Connections

The adapter cards are designed for 12 or 24 fiber MPO optical patch cables. Please carefully select the 12 or 24 fiber path cables specified for each product variant.

NOTE: Please note that all cards utilizing 24 fiber MPO cannot be connected to cards utilizing 12 fiber MPO.

Installation

Step 1 - Unpack board

The adapter card is shipped in an anti-static bag to prevent static electricity damage. The card should only be removed from the bag after ensuring that anti-static precautions are taken. Static electricity from your clothes or work environment can damage your PCI Express adapter card or your PC. Always wear a grounded anti-static wrist strap while opening the PC and when the adapter card is removed from the anti-static bag.
Unpack the adapter card from the anti-static bag using proper anti-static procedures.

Step 3 - Configure the Board for Proper Operation

Set the DIP switch settings for proper operation depends on the firmware. Please refer to the section Configuration and DIP Switches on page 13 for details.

Step 4 - Install the Adapter Card

Before installing the adapter card, make sure you are properly grounded to avoid static discharges that may destroy your computer or the adapter card. Ensure you are properly grounded before opening your computer or the anti-static bag containing the adapter card. Please follow your computer's or expansion chassis manual on how to install a PCI Express card.

The adapter card can only be installed into any PCI Express x16 physical slot. The adapter card supports PCI Express Gen1, Gen2, Gen3 and Gen4 signaling. The adapter card supports hosts using either spread spectrum or constant frequency clocking. The card implements clock isolation.

## Step 5 - Installing and Removing Cables

Installing and removing cables in NTB or Transparent Hot Add mode can be done while the systems are running. Hot plugging / removing cables are fully supported. The fiber optic cable(s) are connected to the MPO connector(s) found on the PCIe bracket. The bracket will have one or two, single or dual MPO connectors depending on the board configuration.

Connecting Cables
Please carefully install the fiber patch cable connector into the connector housing on the adapter card. To install the cable, remove the protective cover on both the cable and the card, match the cable house keying with the MPO connector on the adapter card and use light pressure to insert the connector until it is latched. Cables should always use strain relief to protect the connected equipment from excessive force on the cable. This is especially important for cables between racks. Please always save the protective covers for future use if the cable is disconnected from the card.

Disconnecting Cables
Please carefully pull the release tab to release the cable from the locking. Always replace the protective cover on both the card and the cable after disconnecting the cable.
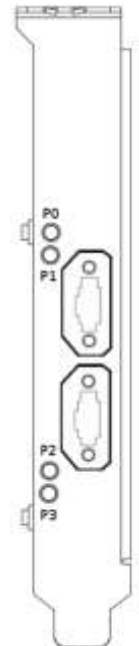
Step 6 - Installing the Dolphin Management Software

The adapter card is compliant with Dolphin's Board Management Software package for the MX product line. Please visit

http://www.dolphinics.com/mx

to register and download the latest documentation and software. It is recommended to follow the quick installation guide found on the web page above to install the software for your operating system.

Note to PXH84x users:

If you are migrating from any of the PCIe Gen3 PXH84x adapter cards to the MXH94x or MXH95x cards, you need to uninstall the PX software and install the MX software.

TIP: Dolphin provides software and documentation for several product families; **please remember to select the MX product family before downloading**. The MXH94x and MXH95x requires Dolphin software version DIS 5.18.0 or higher to operate.
The software download requires a password to log in. **The password will automatically be emailed to you if you follow the instructions found on the getting started document bundled with the adapter card.** If you fail to provide the correct serial number found on the getting started document, your request will be managed manually.

Step 7 – Verify Installation & LEDs

The adapter card comes with 4 bi-color LEDs which show the corresponding cable port status according to Table 3: LED below.

The LEDs are visible through cut-outs in the PCIe bracket on each side of the cable connector block.

LED color	Function
Off	No cable installed
Yellow	Cable installed, no link
Yellow blink	Link reset
Green	Cable installed; link operational
Blinking green	Link operating at lower speed
Blinking yellow	Temperature overheat warning, please immediately improve cooling to avoid thermal damages or system shutdown.

Table 3: LED behavior

Operation

Configuration and DIP Switches

The adapter card has one bank of 8 DIP switches for setting special modes or operations, the meaning of each DIP switch depends on the loaded firmware. Please carefully read the documentation shipping with the card before modifying any DIP switch settings. Please pay close attention to ON and OFF positions written on the DIP switch.

The default factory setting for the transparent MXH94x / MXH95x is x16 link connection suitable for a two-node configuration.

DIP Switch Bank – Configuration

Figure 1: DIP Switch shows the DIP switch for the adapter card. It is used to select the operational mode. Please leave all undocumented DIP switches in the default position. Table 4: DIP Switch settings shows all the various DIP switch NTB settings for the adapter card.

Figure 1: DIP Switch

DIP no.	Name	Description	ON	OFF	Default
1-5	OPT1-5	Configuration selector, details below			OFF
6	OPT6	Thermal Shutdown Disable.	Will disable thermal shutdown	Card will shut down on thermal overheat	OFF
7	MCU Reset	Holds the management processors in reset	Board management is held in reset	Normal operation	OFF
8	Recover	Enables the card to recover if the FLASH has been corrupted. Do NOT ACTIVATE without instructions from Dolphin.	Do not activate without instructions from Dolphin	Normal operation	Recover

Table 4: DIP Switch settings

Note: DIP switch configuration options may be changed in the future versions. Please always consult the latest user guide for details. The table above is valid for firmware version 1 prerelease.

Thermal shutdown

The adapter card includes an overtemperature overheat protection. The BMC will automatically shut down the card if a PCIe switch temperature beyond 105°C (221°F) or a FireFly temperature beyond 70 °C (158°F) is detected. The automatic shutdown can be disabled by setting DIP-Switch OPT6.

NOTE: The adapter card link LEDs will start flashing yellow when a PCIe switch temperature of 95°C (203°F) is reached or when FireFly reports a temperature of 60°C (14°F).

NOTE: The automatic shutdown can be disabled by setting DIP-Switch OPT6. Prior to disabling the automatic shutdown, please ensure you have established proper airflow.

Transparent Operation

The adapter card can operate as a transparent host and target adapter.

DIP Switch settings for Transparent Host operation

The following DIP Switch settings should be considered when configuring the adapter card **for Transparent Host** operation:

Use Case	Configuration Transparent Host	DIP ON	DIP switch view
A+D	Transparent Host One x16 downstream port (L0+L1+L2+L3)	**(all off)** (Shipping Default)	
B	Transparent Host Two x8 downstream ports (L0+L1, L2+L3)	**OPT-1**	
C	Transparent Host Four x4 downstream ports (L0, L1, L2, L3)	**OPT-2**	

DIP Switch settings for Transparent Target operation

The following DIP Switch settings should be considered when configuring the adapter for **Transparent Target** operation:

| Use Case	Configuration Transparent Target	DIP ON	DIP switch view
A	Transparent Target One x16 upstream port (L0+L1+L2+L3) One x16 downstream port	**OPT-1** **OPT-2**	

Transparent Use Cases

The transparent adapter card may be used as both a Transparent Host card and a Transparent Target card. A Host and Target card can be used as a pair or the Host card can be used with a compliant Target device. The supported use cases and the DIP switch settings are summarized in section "**Error! Reference source not found.**" on page **Error! Bookmark not defined.**.

Transparent Use Case A - 1 Host – Single Expansion Configuration

The Host system has an adapter card configured for Transparent Host operation and a direct x4, x8 or x16 link to an adapter card configured for Transparent Target operation or a compliant target device.

Connecting the cables for single expansion, x16 link

To establish an x16 link, a given port number should be connected to the same port number on the other card.
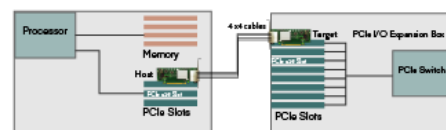
Always connect a cable from Port L#x to Port L#x

Host card	Target card
L0+L1	L0+L1
L2+L3	L2+L3

Table 5: Required x16 cabling

A failure connecting any of the cables will cause the link to re-train to x8 or x4.

Connecting the cables for single expansion, x8 link

To establish an x8 link, please connect a cable from port marked L0/L1 on the host card to port marked L0/L1 on the target card.

Transparent Use Case B – 1 Host - Dual Expansion Configuration

The host has an adapter card configured for Transparent Host operation and a direct x4 or x8 cable connection is used to connect one or two adapter cards configured for Transparent Target operation.

Connecting the cables for Single Node Dual expansion, x8 link

Connect a cable between any port on the host card to the selected expansion.

Transparent Use Case C – 1 Host - Quad Expansion Configuration

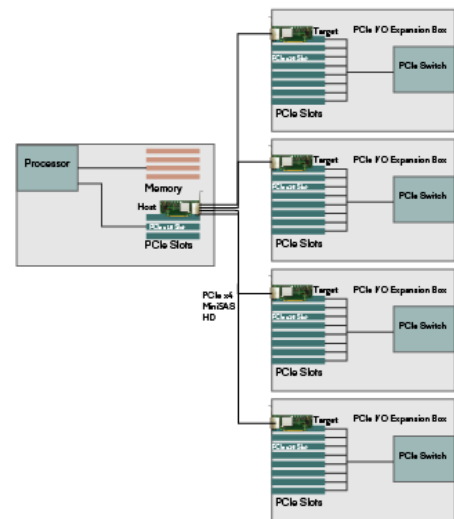This configuration is only available with the MXH945 and MXH955 adapter cards.

Figure 2: Use Case C

EEPROM and Firmware Upgrade

Dolphin may from time to time publish updated firmware for the Board Management Controller, PCIe switch or chip configuration data for the card. Please contact Dolphin for instructions on how to upgrade the adapter card.

WARNING: Please note that standard Microsemi tools (ChipLink) cannot be used to upgrade the firmware as this will violate the warranty. Please contact Dolphin for instructions on how to upgrade the adapter card firmware.

Note: Please consult the MXH94x/MXH95x transparent adapter firmware release note for details on supported configurations.

Identifying the Card

The card has a label-sticker with the serial number in the format 'MXH940-YY-ZZZZZZ', where YY denotes the card revision (e.g. CC) and ZZZZZZ denotes the serialized production number (e.g. 012345) – this whole string makes up the serial number of the card (i.e. MXH940-CC-012345).

You can also get this information using lspci in Linux:

First, identify the devices for the Dolphin Host card:

```
# lspci | grep "Device 4052"

09:00.0 PCI bridge: PMC-Sierra Inc. Device 4052
09:00.1 Bridge: PMC-Sierra Inc. Device 4052
0a:00.0 PCI bridge: PMC-Sierra Inc. Device 4052
```

Then run lspci and identify the card. It will show up as something like

```
# # lspci -s 9:0.0 -v

       09:00.0 PCI bridge: PMC-Sierra Inc. Device 4052 (prog-if 00 [Normal decode])
            Control: I/O+ Mem+ BusMaster+ SpecCycle- MemWINV- VGASnoop- ParErr- Stepping- SERR- FastB2B- DisINTx+
            Status: Cap+ 66MHz- UDF- FastB2B- ParErr- DEVSEL=fast >TAbort- <TAbort- <MAbort- >SERR- <PERR- INTx-
            Latency: 0
            Interrupt: pin ? routed to IRQ 34
            Bus: primary=09, secondary=0a, subordinate=0b, sec-latency=0
            I/O behind bridge: 00001000-00001fff
            Secondary status: 66MHz- FastB2B- ParErr- DEVSEL=fast >TAbort- <TAbort- <MAbort- <SERR- <PERR-
            BridgeCtl: Parity- SERR- NoISA- VGA- MAbort- >Reset- FastB2B-
                 PriDiscTmr- SecDiscTmr- DiscTmrStat- DiscTmrSERREn-
            Capabilities: [7f8 v1] Vendor Specific Information: ID=ffff Rev=1 Len=808 <?>
            Kernel driver in use: pcieport

       \ Deleted lines …
```

To identify the serial number, do

```
# lspci -s 9:0.0 -v | grep -E "Subsystem|Serial"
        Capabilities: [a4] Subsystem: Dolphin Interconnect Solutions AS Device 0940
        Capabilities: [100] Device Serial Number 00-00-42-42-00-00-00-0a
```

This shows the card as revision 0x4242 (hexadecimal values of the 'BB letters in the ASCII table), with the production number 0x0000000A (0000010 in decimal).

Support

More information about the product, support, and software downloads at http://www.dolphinics.com/mx. Please email pci-support@dolphinics.com if you have any questions.

Technical Information

Board revision history

The following table gives a general overview of the hardware revision history.

Adapter card revision	Capabilities
MXH940-AA /MH95x-AA	• Initial prototype, only support for FireFly™ Gen4 v1 and FireFly™ Gen3 • PM40052
MXH94x-BB /MH95x-BB	• Support for FireFly™ Gen3 and FireFly™ V2. • PM40052
MXH94x-CC /MH95x-CC	Same Form, Fit and Function as MXH94x-BB /MH95x-BB, optimized for volume manufacturing. • PM40036 • Current version.

Please reference the MXH94x_MH95x_PCN for details.

Simplified schematics

The figure below shows the adapter card simplified schematics. Only the main functions are shown. Number and type of FireFly™ 's mounted depends on the product variant.
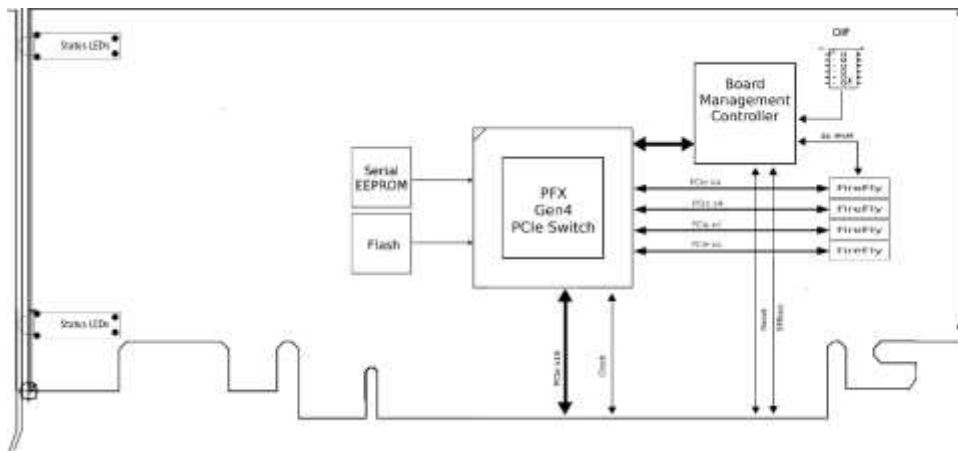

Figure 3: Adapter card simplified schematics

Compliance and Regulatory Testing

EMC

The adapter is tested to comply with the following relevant test standards for PCI Express cards, telecommunication and industry equipment installed in a standard PC:

> EN 55032:2015 + A11:2020
> EN 55035:2017
> EN 61000-3-2:2014
> EN 61000-3-3:2013
> 47 CFR Part 15. Subpart B (Clause 15.107 and 15.109) in conjunction with ANSI C63.4:2014
> CISPR 32:2015 / KS C 9832:2019
> CISPR 35:2017 / KS C 9835:2019

This does not ensure that it will comply with these standards in any random PC. It is the responsibility of the integrator to ensure that their products are compliant with all regulations where their product will be used. Please contact Dolphin for status.

RoHS

The adapter card is RoHS compliant. A Compliance certificate issued by the manufacturer is available upon request.

Laser Eye Safety

The MXH94x and MXH5x series are classified as a Class 1 laser.

Class 1 LASER PRODUCT
per IEC 60825-1 Ed. 2 (2007)

Complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.
Caution – Use of controls or adjustment or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Limited Warranty

Dolphin Interconnect Solutions warrants this product to be free from manufacturing defects under the following terms:

Warranty Period

Dolphin warrants the product for one (1) year from the date of purchase. Extended warranties are available.

Coverage

To the extent permitted by applicable law, this warranty does not apply to:

- Damages caused by operator error or non-compliance with instructions available for the product.
- Use or attempt to use or program firmware not approved by Dolphin.
- Damage which results from accident, abuse, misuse, neglected improper handling or improper installation, moisture, corrosive environments, high voltage surges, shipping or abnormal working conditions.
- Damages which result from violating the specified operating or storage temperatures and airflow.
- Damages caused by acts of nature, e.g., floods, storms, fire, or earthquakes.
- Damage caused by any power source out of range or not provided with the product.
- Normal wear and tear.
- Attempts to add or remove any FireFly™ module, repair, modify, open, or upgrade the product by personnel or agents not authorized by Dolphin.
- Products that have had the product serial number tampered with or removed.
- Damage to the product caused by products not supplied by Dolphin.

Service Procedure

If the product proves defective during the Warranty Period, you should contact the seller that supplied you with the product, or if you purchased it directly from Dolphin, email returnrequests@dolphinics.com to obtain a valid RMA number and instructions. Products returned to Dolphin without a proper RMA number will not be serviced under this warranty.