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New



ConnectX[®]-4 Ethernet Single and Dual QSFP28 Adapter Card User Manual

P/N:

MCX413A-BCAT, MCX414A-BCAT, MCX415A-BCAT, MCX416A-BCAT, MCX413A-GCAT, MCX414A-GCAT, MCX415A-GCAT, MCX416A-GCAT, MCX415A-CCAT, MCX416A-CCAT

Rev 2.4

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Revision History

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Table 1 - Revision History Table

Date	Rev	Comments/Changes
September 2016	2.4	<ul style="list-style-type: none"> Updated Card Installation Instructions on page 19. Added Adapter Card Un-installation Instructions on page 21. Updated Troubleshooting on page 52.
August 2016	2.3	<ul style="list-style-type: none"> Updated Adapter Card LED Operations on page 65. Updated Cable Installation on page 20.
July 2016	2.2	<ul style="list-style-type: none"> Updated Card Installation Instructions on page 19. Added the following mechanical drawings: <ul style="list-style-type: none"> Mechanical Drawing of the Single-port x8 Adapter Cards on page 63. Mechanical Drawing of the Dual-port x8 Adapter Cards on page 66. Mechanical Drawing of the Single-port x16 Adapter Cards on page 67. Updated PCIe x8 Connector Pinout on page 71.
June 2016	2.1	<ul style="list-style-type: none"> Added Mellanox logo "25 is the New 10™" in the Cover page on page 1. Updated Safety Warnings on page 77.
April 2016	2.0	<ul style="list-style-type: none"> Updated the following specification tables: <ul style="list-style-type: none"> MCX413A-BCAT Specifications on page 55 MCX414A-BCAT Specifications on page 56 MCX415A-BCAT Specifications on page 57 MCX416A-BCAT Specifications on page 58
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Date	Rev	Comments/Changes
February 2016	1.6	<ul style="list-style-type: none"> • Added 56GbE support to the following sections: <ul style="list-style-type: none"> • Product Overview on page 13. • OpenFabrics Windows Distribution (WinOF-2) on page 14. • MCX413A-BCAT Specifications on page 55. • MCX414A-BCAT Specifications on page 56. • MCX415A-BCAT Specifications on page 57. • MCX416A-BCAT Specifications on page 58. • Updated Installing the New Bracket on page 18. • Updated Linux Driver on page 24. • Updated Windows Driver on page 37. • Updated VMware Driver on page 48. • Added a note to Finding the MAC and Serial Number on the Adapter Card on page 73. • Updated the following Board Labels: <ul style="list-style-type: none"> • MCX413A-BCAT Board Label on page 73 • MCX414A-BCAT Board Label on page 73 • MCX415A-BCAT Board Label on page 74 • MCX416A-BCAT Board Label on page 74.
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December 2015	1.4	<ul style="list-style-type: none"> • Updated MCX414A-GCAT Specifications on page 60. • Updated Airflow Specifications on page 65.
December 2015	1.3	<ul style="list-style-type: none"> • Added port numbers to the specification tables. See Specifications on page 55. • Updated MCX416A-CCAT Specifications on page 64.
December 2015	1.2	<ul style="list-style-type: none"> • Updated the following tables: <ul style="list-style-type: none"> • MCX413A-BCAT Specifications on page 55. • MCX414A-BCAT Specifications on page 56. • MCX415A-BCAT Specifications on page 57. • MCX416A-BCAT Specifications on page 58. • MCX413A-GCAT Specifications on page 59. • MCX414A-GCAT Specifications on page 60. • MCX415A-GCAT Specifications on page 61. • MCX416A-GCAT Specifications on page 62. • MCX415A-CCAT Specifications on page 63. • MCX416A-CCAT Specifications on page 64. • Updated Features and Benefits on page 13. • Updated Section 3.9.1, “On Windows,” on page 22.
November 2015	1.1	<ul style="list-style-type: none"> • Updated power numbers in: <ul style="list-style-type: none"> • MCX413A-BCAT Specifications on page 55. • MCX414A-BCAT Specifications on page 56. • MCX415A-BCAT Specifications on page 57. • MCX413A-GCAT Specifications on page 59. • MCX416A-GCAT Specifications on page 62. • Added Airflow Specifications on page 65. • Added VMware Driver on page 45. • Updated Updating Adapter Card Firmware on page 51.
November 2015	1.0	First Release

Date	Rev	Comments/Changes
August 2016	1.8	<ul style="list-style-type: none">• Updated Card Installation Instructions on page 19• Updated Cable Installation on page 20.• Updated on page 65.• Added the following figures:<ul style="list-style-type: none">• Mechanical Drawing of the Single-port x8 Adapter Cards on page 66.• Mechanical Drawing of the Dual-port x8 Adapter Cards on page 66.• Mechanical Drawing of the Single-port x16 Adapter Cards on page 67.• Updated Safety Warnings on page 77.

About this Manual

This *User Manual* describes Mellanox Technologies ConnectX®-4 Ethernet Single and Dual QSFP28 ports PCI Express x8 and x16 adapter card. It provides details as to the interfaces of the board, specifications, required software and firmware for operating the board, and relevant documentation.

Intended Audience

This manual is intended for the installer and user of these cards.

The manual assumes basic familiarity with Ethernet network and architecture specifications.

Related Documentations

Table 2 - Documents List

<p><i>Mellanox Firmware Tools (MFT) User Manual</i> Document no. 2204UG</p>	<p>User Manual describing the set of MFT firmware management tools for a single node. See http://www.mellanox.com => Products => Software => Firmware Tools</p>
<p><i>Mellanox Firmware Utility (mlxup) User Manual and Release Notes</i></p>	<p>Mellanox firmware update and query utility used to update the firmware. See http://www.mellanox.com => Products => Software => Firmware Tools => mlxup Firmware Utility</p>
<p><i>Mellanox OFED for Linux User Manual</i> Document no. 2877</p>	<p>User Manual describing OFED features, performance, InfiniBand diagnostic, tools content and configuration. See http://www.mellanox.com => Products => Software => Ethernet Drivers => Mellanox OpenFabrics Enterprise Distribution for Linux (MLNX_OFED)</p>
<p><i>WinOF-2 for Windows User Manual</i> Document no. MLX-15-3280</p>	<p>User Manual describing WinOF-2 features, performance, Ethernet diagnostic, tools content and configuration. See http://www.mellanox.com => Products => Software => Windows SW/Drivers</p>
<p><i>Mellanox OFED for Windows Driver Release Notes</i></p>	<p>Release notes for Mellanox Technologies' MLNX_EN for Linux driver kit for Mellanox adapter cards: See http://www.mellanox.com => Products => Software => Ethernet Drivers => Mellanox OFED for Windows => WinOF-2 Release Notes</p>
<p><i>Mellanox EN for Linux Driver Release Notes</i></p>	<p>Release notes for Mellanox Technologies' MLNX_EN for Linux driver kit for Mellanox adapter cards: See http://www.mellanox.com => Products => Software => Ethernet Drivers => Mellanox EN for Linux</p>
<p><i>Mellanox VMware for Ethernet User Manual</i> Document no. MLNX-15-4896</p>	<p>User Manual describing the various components of the Mellanox ConnectX®-4 NATIVE ESXi stack: See => http://www.mellanox.com Products => Software => Ethernet Drivers => VMware Driver => User Manual v4.15.2.0</p>

<i>Mellanox VMware for Ethernet Release Notes</i>	Release notes for Mellanox ConnectX®-4 NATIVE ESXi stack: See => http://www.mellanox.com Software => Ethernet Drivers => VMware Driver => Release Notes
<i>IEEE Std 802.3 Specification</i>	This is the IEEE Ethernet specification http://standards.ieee.org/getieee802
<i>PCI Express 3.0 Specifications</i>	Industry Standard PCI Express 3.0 Base and Card Electromechanical Specifications https://pcisig.com/specifications

Document Conventions

When discussing memory sizes, MB and MBytes are used in this document to mean size in mega Bytes. The use of Mb or Mbits (small b) indicates size in mega bits. In this document PCIe is used to mean PCI Express.

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1 Introduction

This is the User Guide for Mellanox Technologies Ethernet adapter cards based on the ConnectX®-4 integrated circuit device. These adapters connectivity provide the highest performing and most flexible interconnect solution for PCI Express Gen3 servers used in Enterprise Data Centers, High-Performance Computing, and Embedded environments.

This chapter covers the following topics:

- [Section 1.1, “Product Overview,” on page 13](#)
- [Section 1.2, “Features and Benefits,” on page 14](#)
- [Section 1.3, “Operating Systems/Distributions,” on page 15](#)
- [Section 1.4, “Connectivity” on page 15](#)

1.1 Product Overview

The following section provides the ordering part number, port speed, number of ports, and PCI Express speed. Each adapter comes with two bracket heights - short and tall.

Table 3 - Single and Dual-port Ethernet Adapter Cards

Ordering Part Number (OPN)	<p>Single-port cards: MCX413A-BCAT / MCX413A-GCAT / MCX415A-BCAT MCX415A-GCAT / MCX415A-CCAT</p> <p>Dual-port cards: MCX414A-BCAT / MCX414A-GCAT / MCX416A-BCAT MCX416A-GCAT / MCX416A-CCAT</p>
Data Transmission Ratez	<p>MCX413A-BCAT / MCX414A-BCAT / MCX415A-BCAT / MCX416A-BCAT- 1/10/25/40/56GbE</p> <p>MCX413A-GCAT/ MCX414A-GCAT / MCX415A-GCAT / MCX416A-GCAT- 1/10/25/40/50GbE</p> <p>MCX415A-CCAT/MCX416A-CCAT - 1/10/25/40/50/100GbE</p>
Network Connector Types	Single and dual-port QSFP28
PCI Express (PCIe) SerDes Speed	<p>PCIe 3.0 x8 8GT/s: MCX413A-BCAT / MCX414A-BCAT / MCX413A-GCAT / MCX414A-GCAT</p> <p>PCIe 3.0 x16 8GT/s: MCX415A-BCAT / MCX416A-BCAT / MCX415A-GCAT / MCX416A-GCAT / MCX415A-CCAT / MCX416A-CCAT</p>
RoHS	R6
Adapter IC Part Number	MT27708A0-FDCF-CE
Device ID (decimal)	4115 for Physical Function (PF) 4116 for Virtual Function (VF)

1.2 Features and Benefits

Table 4 - Features^a

PCI Express (PCIe)	Uses PCIe Gen 3.0 (1.1 and 2.0 compatible) through an x8 or x16 edge connector up to 8GT/s
Up to 100 Gigabit Ethernet	<p>Mellanox adapters comply with the following IEEE 802.3 standards:</p> <ul style="list-style-type: none"> – 100GbE / 56GbE / 50GbE / 40GbE / 25GbE / 10GbE / 1GbE – IEEE 802.3bj, 802.3bm 100 Gigabit Ethernet – 25G Ethernet Consortium, 50 Gigabit Ethernet – IEEE 802.3ba 40 Gigabit Ethernet – IEEE 802.3by 25 Gigabit Ethernet – IEEE 802.3ae 10 Gigabit Ethernet – IEEE 802.3az Energy Efficient Ethernet – IEEE 802.3ap based auto-negotiation and KRstartup – IEEE 802.3ad, 802.1AX Link Aggregation – IEEE 802.1Q, 802.1P VLAN tags and priority – IEEE 802.1Qau (QCN) – Congestion Notification – IEEE 802.1Qaz (ETS) – IEEE 802.1Qbb (PFC) 802.1Qbg – IEEE 1588v2 – Jumbo frame support (9.6KB)
Overlay Networks	In order to better scale their networks, data center operators often create overlay networks that carry traffic from individual virtual machines over logical tunnels in encapsulated formats such as NVGRE and VXLAN. While this solves network scalability issues, it hides the TCP packet from the hardware offloading engines, placing higher loads on the host CPU. ConnectX-4 effectively addresses this by providing advanced NVGRE and VXLAN hardware offloading engines that encapsulate and de-capsulate the overlay protocol.
RDMA and RDMA over Converged Ethernet (RoCE)	ConnectX-4, utilizing IBTA RDMA (Remote Data Memory Access) and RoCE (RDMA over Converged Ethernet) technology, delivers low-latency and high-performance over InfiniBand and Ethernet networks. Leveraging data center bridging (DCB) capabilities as well as ConnectX-4 advanced congestion control hardware mechanisms, RoCE provides efficient low-latency RDMA services over Layer 2 and Layer 3 networks.
Mellanox PeerDirect™	PeerDirect™ communication provides high efficiency RDMA access by eliminating unnecessary internal data copies between components on the PCIe bus (for example, from GPU to CPU), and therefore significantly reduces application run time. ConnectX-4 advanced acceleration technology enables higher cluster efficiency and scalability to tens of thousands of nodes.
CPU offload	Adapter functionality enabling reduced CPU overhead allowing more available CPU for computation tasks.
Quality of Service (QoS)	Support for port-based Quality of Service enabling various application requirements for latency and SLA.
Hardware-based I/O Virtualization	ConnectX-4 provides dedicated adapter resources and guaranteed isolation and protection for virtual machines within the server.

Table 4 - Features^a

Storage Acceleration	A consolidated compute and storage network achieves significant cost-performance advantages over multi-fabric networks. Standard block and file access protocols can leverage RDMA for high-performance storage access.
SR-IOV	ConnectX-4 SR-IOV technology provides dedicated adapter resources and guaranteed isolation and protection for virtual machines (VM) within the server.

- a. This section describes hardware features and capabilities. Please refer to the driver release notes for feature availability. See [Table 2, “Documents List,” on page 11.](#)

1.3 Operating Systems/Distributions

- RHEL/CentOS
- Windows
- FreeBSD
- VMware
- OpenFabrics Enterprise Distribution (OFED)
- OpenFabrics Windows Distribution (WinOF-2)

1.4 Connectivity

- Interoperable with 1/10/25/40/50/56/100 Gb/s Ethernet switches
- Passive copper cable with ESD protection
- Powered connectors for optical and active cable support

2 Interfaces

Each adapter card includes the following interfaces:

- “Ethernet QSFP28 Interface”
- “PCI Express Interface”
- “LED Interface”

The adapter cards include special circuits to protect from ESD shocks to the card/server when plugging copper cables.

2.1 Ethernet QSFP28 Interface

The network ports of the ConnectX®-4 adapter card are compliant with the IEEE 802.3 Ethernet standards listed in [Table 4, “Features,” on page 14](#). Ethernet traffic is transmitted through the cards' QSFP28 connectors.

2.2 PCI Express Interface

The ConnectX®-4 adapter card supports PCI Express 3.0 (1.1 and 2.0 compatible) through x8 or x16 edge connector. The device can be either a master initiating the PCI Express bus operations, or a slave responding to PCI bus operations. The following lists PCIe interface features:

- PCIe Gen 3.0 compliant, 1.1 and 2.0 compatible
- 2.5, 5.0, or 8.0 GT/s link rate x8/x16
- Auto-negotiates to x16, x8, x4, x2, or x1
- Support for MSI/MSI-X mechanisms

2.3 LED Interface

There is a one bi-color I/O LED per port. For LED specifications, please refer to [Section 7.12, “Adapter Card LED Operations,” on page 65](#).

3 Hardware Installation

3.1 System Requirements

3.1.1 Hardware

A system with a PCI Express x8 or x16 slot is required for installing the card.

3.2 Operating Systems/Distributions

Please refer to [Section 1.3, “Operating Systems/Distributions,”](#) on page 15.

3.2.1 Software Stacks

Mellanox OpenFabric software package MLNX_OFED for Linux, WinOF -2 for Windows and VMware. See [Chapter 4, “Driver Installation”](#) on page 24.

3.3 Safety Precautions



The adapter is being installed in a system that operates with voltages that can be lethal. Before opening the case of the system, observe the following precautions to avoid injury and prevent damage to system components.

1. Remove any metallic objects from your hands and wrists.
2. Make sure to use only insulated tools.
3. Verify that the system is powered off and is unplugged.
4. It is strongly recommended to use an ESD strap or other antistatic devices.

3.4 Pre-installation Checklist

1. Verify that your system meets the hardware and software requirements stated above.
2. Shut down your system if active.
3. After shutting down the system, turn off power and unplug the cord.
4. Remove the card from its package. Please note that the card must be placed on an antistatic surface.
5. Check the card for visible signs of damage. Do not attempt to install the card if damaged.

3.5 Bracket Installation Instructions

The card is usually shipped with a tall bracket installed. If this form factor is suitable for your requirements, you can skip the remainder of this section and move to [Section 3.6, “Card Installation Instructions,”](#) on page 19. If you need to replace it with the short bracket that is included in the shipping box, please follow the instructions in this section.



Due to risk of damaging the EMI gasket, it is not recommended to replace the bracket more than three times.

To replace the bracket you will need the following parts:

- The new bracket of the proper height
- The 2 screws saved from the removal of the bracket
- The 2 fiber washers saved from the removal of the bracket

3.5.1 Removing the Existing Bracket

1. Remove the two screws holding the bracket in place. The bracket comes loose from the card.



Be careful not to put stress on the LEDs.

2. Save the two screws and the two fiber washers.

3.5.2 Installing the New Bracket

1. Place the bracket onto the card until the screw holes line up.



Do not force the bracket onto the card. You may have to gently push the LEDs using a small screwdriver to align the LEDs with the holes in the bracket.

2. Screw on the bracket using the screws and washers saved from the bracket removal procedure above.
3. Make sure that the LEDs are aligned onto the bracket holes.
4. Use a torque driver to apply up to 2.9 lbf-in torque on the screws.

3.6 Card Installation Instructions

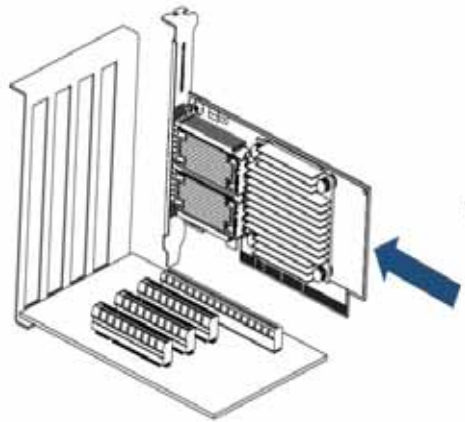


Please note that the following figures are for illustration purposes only.

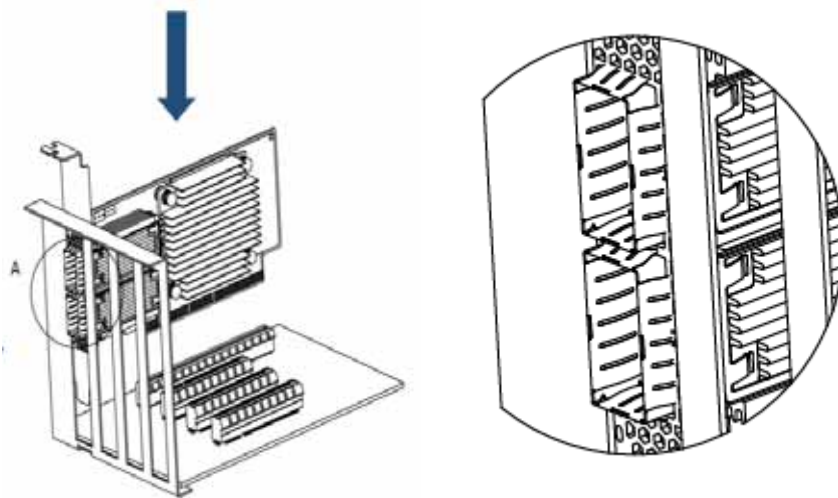
1. Before installing the card, make sure that the system is off and the power cord is not connected to the server. Please follow proper electrical grounding procedures.
2. Open the system case.
3. Locate an available PCI Express slot for the adapter card.



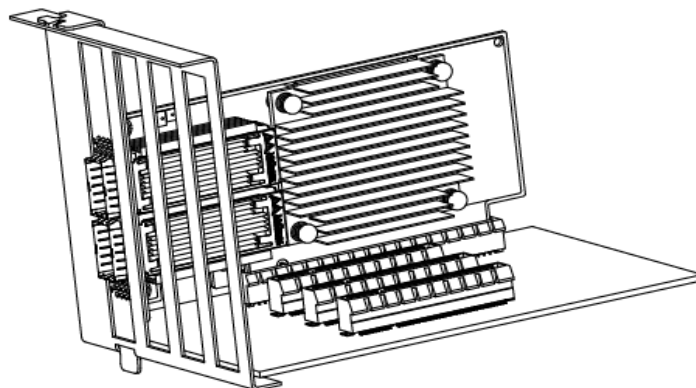
A lesser width adapter can be seated into a greater width slot (x8 in a x16), but a greater width adapter cannot be seated into a lesser width slot (x16 in a x8). Align the adapter connector edge with the PCI Express connector slot.



4. Applying even pressure at both corners of the card, insert the adapter card into the PCI Express slot until firmly seated.



5. When the adapter is properly seated, the port connectors are aligned with the slot opening, and the adapter faceplate is visible against the system chassis.



6. Secure the adapter with the adapter clips or screws.
7. Close the system case.

3.7 Cables and Modules

To obtain the list of supported cables for your adapter, please refer to www.mellanox.com => Products => Cables and Transceivers.

3.7.1 Cable Installation

1. All cables can be inserted or removed with the unit powered on.
2. To insert a cable, press the connector into the port receptacle until the connector is firmly seated.
 - a. Support the weight of the cable before connecting the cable to the adapter card. Do this by using a cable holder or tying the cable to the rack.
 - b. Determine the correct orientation of the connector to the card before inserting the connector. Do not try and insert the connector upside down. This may damage the adapter card.
 - c. Insert the connector into the adapter card. Be careful to insert the connector straight into the cage. Do not apply any torque, up or down, to the connector cage in the adapter card.
 - d. Make sure that the connector locks in place.



When installing cables make sure that the latches engage.



Always install and remove cables by pushing or pulling the cable and connector in a straight line with the card.

3. After inserting a cable into a port, the Yellow LED indicator will light when the physical connection is established (that is, when the unit is powered on and a cable is plugged into the port

- with the other end of the connector plugged into a functioning port). See [Section 7.12, “Adapter Card LED Operations,”](#) on page 65.
4. After plugging in a cable, lock the connector using the latching mechanism particular to the cable vendor. When data is being transferred the Green LED will blink. See [Section 7.12, “Adapter Card LED Operations,”](#) on page 65.
 5. Care should be taken as not to impede the air exhaust flow through the ventilation holes. Use cable lengths which allow for routing horizontally around to the side of the chassis before bending upward or downward in the rack.
 6. To remove a cable, disengage the locks and slowly pull the connector away from the port receptacle. LED indicator will turn off when the cable is unseated.

3.8 Adapter Card Un-installation Instructions

3.8.1 Safety Precautions



The adapter is installed in a system that operates with voltages that can be lethal. Before un-installing the adapter card, please observe the following precautions to avoid injury and prevent damage to system components.

1. Remove any metallic objects from your hands and wrists.
2. It is strongly recommended to use an ESD strap or other antistatic devices.
3. Turn off the system and disconnect the power cord from the server.

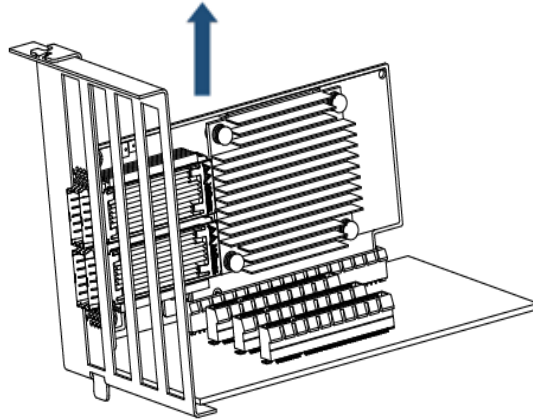
3.8.2 Card Un-installation



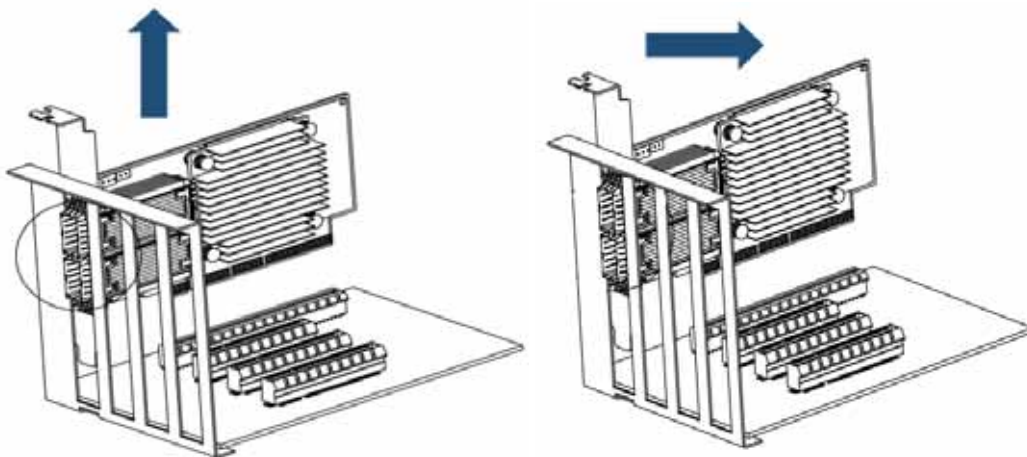
Please note that the following images are for illustration purposes only.

1. Verify that the system is powered off and unplugged.
2. Wait 30 seconds.
3. To remove the card, disengage the retention mechanisms on the bracket (clips or screws).

4. Holding the adapter card from its center, gently pull the adapter card from the PCI Express slot.



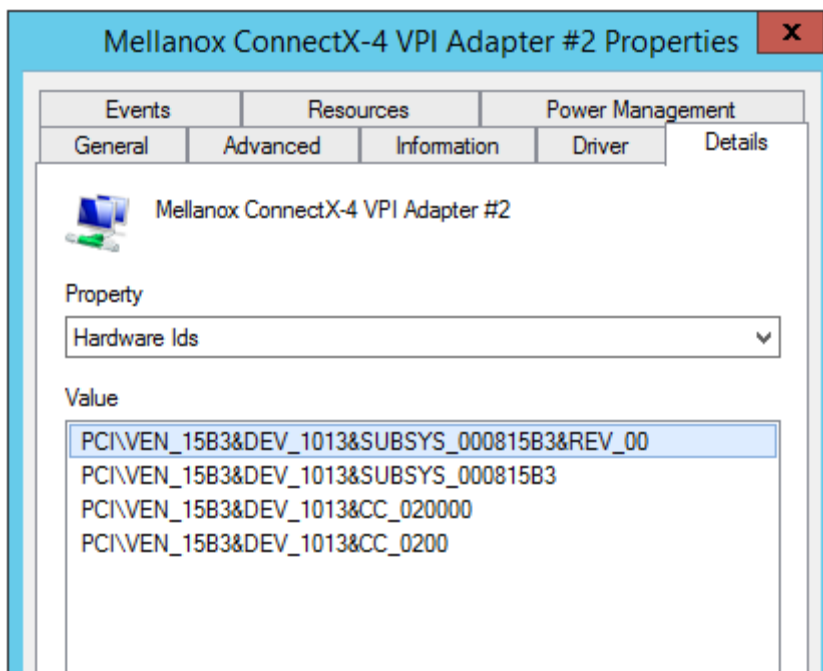
5. When the port connectors reach the top of the chassis window, gently pull the adapter card in parallel to the motherboard.



3.9 Identify the Card in Your System

3.9.1 On Windows

1. Open Device Manager on the server. Click start => Run, and then enter “devmgmt.msc”.
2. Expand System Devices and locate your Mellanox ConnectX-4 adapter card.
3. Right click the mouse on your adapter's row and select properties to display the adapter card properties window.
4. Click the Details tab and select **Hardware Ids** (Windows 2012/R2) from the Properties pull-down menu.

Figure 1: PCI Device (Example)

- In the Value display box, check the fields VEN and DEV (fields are separated by '&'). In the display example above, notice the sub-string “PCI\VEN_15B3&DEV_1003”: VEN is equal to 0x15B3 – this is the Vendor ID of Mellanox Technologies; and DEV is equal to 1003 – this is a valid Mellanox Technologies PCI Device ID.



If the PCI device does not have a Mellanox adapter ID, return to Step 2 to check another device.



The list of Mellanox Technologies PCI Device IDs can be found in the PCI ID repository at <http://pci-ids.ucw.cz/read/PC/15b3>.

3.9.2 On Linux

Get the device location on the PCI bus by running `lspci` and locating lines with the string “Mellanox Technologies”:

```
> lspci |grep -i Mellanox
Network controller: Mellanox Technologies MT4115 Family [ConnectX-4]
```

4 Driver Installation

4.1 Linux Driver

For Linux, download and install the latest OpenFabrics Enterprise Distribution (OFED) software package available via the Mellanox web site at: <http://www.mellanox.com> => Products => Software => Ethernet Drivers => Download. This chapter describes how to install and test the Mellanox OFED for Linux package on a single host machine with Mellanox ConnectX-4 adapter hardware installed.

4.1.1 Hardware and Software Requirements

Table 5 - Hardware and Software Requirements

Requirements	Description
Platforms	A server platform with an adapter card based on one of the following Mellanox Technologies' Ethernet HCA devices: <ul style="list-style-type: none"> MT4115 ConnectX®-4 (EN) (firmware: fw-ConnectX4) For the list of supported architecture platforms, please refer to the Mellanox OFED Release Notes file.
Required Disk Space for Installation	1GB
Device ID	For the latest list of device IDs, please visit Mellanox website.
Operating System	Linux operating system. For the list of supported operating system distributions and kernels, please refer to the Mellanox OFED Release Notes file.
Installer Privileges	The installation requires administrator privileges on the target machine.

4.1.2 Downloading Mellanox OFED

Step 1. Verify that the system has a Mellanox network adapter (HCA/NIC) installed.

The following example shows a system with an installed Mellanox HCA:

```
# lspci -v | grep Mellanox
86:00.0 Network controller [0207]: Mellanox Technologies MT27620 Family
      Subsystem: Mellanox Technologies Device 0014
86:00.1 Network controller [0207]: Mellanox Technologies MT27620 Family
      Subsystem: Mellanox Technologies Device 0014
```

Step 2. Download the ISO image to your host.

The image's name has the format `MLNX_OFED_LINUX-<ver>-<OS label><CPU arch>.iso`. You can download it from <http://www.mellanox.com> => Products => Software => Ethernet Drivers.

- Step 3.** Use the md5sum utility to confirm the file integrity of your ISO image. Run the following command and compare the result to the value provided on the download page.

```
host1$ md5sum MLNX_OFED_LINUX-<ver>-<OS label>.iso
```

4.1.3 Installing Mellanox OFED

The installation script, `mlnxofedinstall`, performs the following:

- Discovers the currently installed kernel
- Uninstalls any software stacks that are part of the standard operating system distribution or another vendor's commercial stack
- Installs the MLNX_OFED_LINUX binary RPMs (if they are available for the current kernel)
- Identifies the currently installed InfiniBand and Ethernet network adapters and automatically¹ upgrades the firmware

Usage

```
./mnt/mlnxofedinstall [OPTIONS]
```

The installation script removes all previously installed Mellanox OFED packages and re-installs from scratch. You will be prompted to acknowledge the deletion of the old packages.



Pre-existing configuration files will be saved with the extension “.conf.rpmsave”.

- If you need to install Mellanox OFED on an entire (homogeneous) cluster, a common strategy is to mount the ISO image on one of the cluster nodes and then copy it to a shared file system such as NFS. To install on all the cluster nodes, use cluster-aware tools (such as `pdsh`).
- If your kernel version does not match with any of the offered pre-built RPMs, you can add your kernel version by using the “`mlnx_add_kernel_support.sh`” script located under the `docs/` directory.



On Redhat and SLES distributions with errata kernel installed there is no need to use the `mlnx_add_kernel_support.sh` script. The regular installation can be performed and weak-updates mechanism will create symbolic links to the MLNX_OFED kernel modules.

The “`mlnx_add_kernel_support.sh`” script can be executed directly from the `mlnxofedinstall` script. For further information, please see ‘`--add-kernel-support`’ option below.



On Ubuntu and Debian distributions drivers installation use Dynamic Kernel Module Support (DKMS) framework. Thus, the drivers' compilation will take place on the host during MLNX_OFED installation.

Therefore, using “`mlnx_add_kernel_support.sh`” is irrelevant on Ubuntu and Debian distributions.

1. The firmware will not be updated if you run the install script with the ‘`--without-fw-update`’ option.

Example

The following command will create a MLNX_OFED_LINUX ISO image for RedHat 6.3 under the /tmp directory.

```
# ./MLNX_OFED_LINUX-x.x-x-rhel6.3-x86_64/mlnx_add_kernel_support.sh -m /tmp/MLNX_OFED_
-LINUX-x.x-x-rhel6.3-x86_64/ --make-tgz
Note: This program will create MLNX_OFED_LINUX TGZ for rhel6.3 under /tmp directory.
All Mellanox, OEM, OFED, or Distribution IB packages will be removed.
Do you want to continue?[y/N]:y
See log file /tmp/mlnx_ofed_iso.21642.log

Building OFED RPMs. Please wait...
Removing OFED RPMs...
Created /tmp/MLNX_OFED_LINUX-x.x-x-rhel6.3-x86_64-ext.tgz
```

- The script adds the following lines to /etc/security/limits.conf for the userspace components such as MPI:
 - * soft memlock unlimited
 - * hard memlock unlimited
 - These settings set the amount of memory that can be pinned by a user space application to unlimited. If desired, tune the value unlimited to a specific amount of RAM.

For your machine to be part of the InfiniBand/VPI fabric, a Subnet Manager must be running on one of the fabric nodes. At this point, Mellanox OFED for Linux has already installed the OpenSM Subnet Manager on your machine.

4.1.3.1 Installation Procedure

Step 1. Login to the installation machine as root.

Step 2. Mount the ISO image on your machine.

```
host1# mount -o ro,loop MLNX_OFED_LINUX-<ver>-<OS label>-<CPU arch>.iso /mnt
```

Step 3. Run the installation script.

```
./mnt/mlnxofedinstall
Logs dir: /tmp/MLNX_OFED_LINUX-x.x-x.logs
This program will install the MLNX_OFED_LINUX package on your machine.
Note that all other Mellanox, OEM, OFED, or Distribution IB packages will be removed.
Uninstalling the previous version of MLNX_OFED_LINUX

Starting MLNX_OFED_LINUX-x.x.x installation ...
.....
.....
Installation finished successfully.

Attempting to perform Firmware update...
Querying Mellanox devices firmware ...
```



In case your machine has the latest firmware, no firmware update will occur and the installation script will print at the end of installation a message similar to the following:

```
Device #1:
-----
Device Type:      ConnectX-4
Part Number:     MCX413A-BCAT
Description:     ConnectX@-4 EN network interface card, 40/56 GbE single-
port QSFP28, PCIe3.0 x8, tall bracket, ROHS R6
PSID:           MT_2190110032
PCI Device Name: 0b:00.0
Base MAC:       0000e41d2d5cf810
Versions:      Current      Available
FW             12.14.0114    12.14.0114
FW (Running)  12.14.0094    N/A

Status:        Up to date
```

Step 4. Reboot the machine **if** the installation script performed firmware updates to your network adapter hardware. Otherwise, restart the driver by running: `"/etc/init.d/openibd restart"`

Step 5. (InfiniBand only) Run the `hca_self_test.ofed` utility to verify whether or not the InfiniBand link is up. The utility also checks for and displays additional information such as:

- HCA firmware version
- Kernel architecture
- Driver version
- Number of active HCA ports along with their states
- Node GUID

For more details on `hca_self_test.ofed`, see the file `hca_self_test.readme` under `docs/`.

After the installer completes, information about the Mellanox OFED installation such as prefix, kernel version, and installation parameters can be retrieved by running the command `/etc/infiniband/info`.

Most of the Mellanox OFED components can be configured or reconfigured after the installation by modifying the relevant configuration files. See the relevant chapters in this manual for details.

The list of the modules that will be loaded automatically upon boot can be found in the `/etc/infiniband/openib.conf` file.

4.1.3.2 Installation Results

Software	<ul style="list-style-type: none"> Most of MLNX_OFED packages are installed under the “/usr” directory except for the following packages which are installed under the “/opt” directory: <ul style="list-style-type: none"> openshmem, bupc, fca and ibutils The kernel modules are installed under <ul style="list-style-type: none"> /lib/modules/<code>uname -r</code>/updates on SLES and Fedora Distributions /lib/modules/<code>uname -r</code>/extra/mlnx-ofa_kernel on RHEL and other RedHat like Distributions /lib/modules/<code>uname -r</code>/updates/dkms/ on Ubuntu
Firmware	<ul style="list-style-type: none"> The firmware of existing network adapter devices will be updated if the following two conditions are fulfilled: <ul style="list-style-type: none"> The installation script is run in default mode; that is, without the option ‘--without-fw-update’ The firmware version of the adapter device is older than the firmware version included with the Mellanox OFED ISO image <p>Note: If an adapter’s Flash was originally programmed with an Expansion ROM image, the automatic firmware update will also burn an Expansion ROM image.</p> In case your machine has an unsupported network adapter device, no firmware update will occur and the error message below will be printed. <pre>-I- Querying device ... -E- Can't auto detect fw configuration file: ... Please contact your hardware vendor for help on firmware updates.</pre>

4.1.3.3 Installation Logging

While installing MLNX_OFED, the install log for each selected package will be saved in a separate log file.

The path to the directory containing the log files will be displayed after running the installation script in the following format: "Logs dir: /tmp/MLNX_OFED_LINUX-<version>.<PID>.logs".

Example:

```
Logs dir: /tmp/MLNX_OFED_LINUX-x.x-x.logs
```

4.1.3.4 openibd Script

As of MLNX_OFED v2.2-1.0.0 the `openibd` script supports pre/post start/stop scripts:

This can be controlled by setting the variables below in the `/etc/infiniband/openibd.conf` file.

```
OPENIBD_PRE_START
OPENIBD_POST_START
OPENIBD_PRE_STOP
OPENIBD_POST_STOP
```

Example:

```
OPENIBD_POST_START=/sbin/openibd_post_start.sh
```

4.1.3.5 Driver Load Upon System Boot

Upon system boot, the Mellanox drivers will be loaded automatically.

➤ *To prevent automatic load of the Mellanox drivers upon system boot:*

Step 1. Add the following lines to the `"/etc/modprobe.d/mlnx.conf"` file.

```
blacklist mlx4_core
blacklist mlx4_en
blacklist mlx5_core
blacklist mlx5_ib
```

Step 2. Set `"ONBOOT=no"` in the `"/etc/infiniband/openib.conf"` file.

4.1.3.6 mlnxofedinstall Return Codes

The table below lists the `mlnxofedinstall` script return codes and their meanings.

Return Code	Meaning
0	The Installation ended successfully
1	The installation failed
2	No firmware was found for the adapter device
22	Invalid parameter
28	Not enough free space
171	Not applicable to this system configuration. This can occur when the required hardware is not present on the system.
172	Prerequisites are not met. For example, missing the required software installed or the hardware is not configured correctly.
173	Failed to start the <code>mst</code> driver

4.1.4 Uninstalling Mellanox OFED

Use the script `/usr/sbin/ofed_uninstall.sh` to uninstall the Mellanox OFED package. The script is part of the `ofed-scripts` RPM.

4.1.5 Installing MLNX_OFED using YUM

This type of installation is applicable to RedHat/OEL, Fedora, XenServer Operating Systems.

4.1.5.1 Setting up MLNX_OFED YUM Repository

Step 1. Log into the installation machine as root.

Step 2. Mount the ISO image on your machine and copy its content to a shared location in your network.

```
# mount -o ro,loop MLNX_OFED_LINUX-<ver>-<OS label>-<CPU arch>.iso /mnt
```

You can download it from <http://www.mellanox.com> => Products => Software => Ethernet Drivers.

Step 3. Download and install Mellanox Technologies GPG-KEY:

The key can be downloaded via the following link:

<http://www.mellanox.com/downloads/ofed/RPM-GPG-KEY-Mellanox>

```
# wget http://www.mellanox.com/downloads/ofed/RPM-GPG-KEY-Mellanox
--2014-04-20 13:52:30-- http://www.mellanox.com/downloads/ofed/RPM-GPG-KEY-Mellanox
Resolving www.mellanox.com... 72.3.194.0
Connecting to www.mellanox.com|72.3.194.0|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1354 (1.3K) [text/plain]
Saving to: ?RPM-GPG-KEY-Mellanox?

100%[=====] 1,354      --.-K/s   in 0s

2014-04-20 13:52:30 (247 MB/s) - ?RPM-GPG-KEY-Mellanox? saved [1354/1354]
```

Step 4. Install the key.

```
# sudo rpm --import RPM-GPG-KEY-Mellanox
warning: rpmts_HdrFromFdno: Header V3 DSA/SHA1 Signature, key ID 6224c050: NOKEY
Retrieving key from file:///repos/MLNX_OFED/<MLNX_OFED file>/RPM-GPG-KEY-Mellanox
Importing GPG key 0x6224C050:
  Userid: "Mellanox Technologies (Mellanox Technologies - Signing Key v2) <support@mellanox.com>"
  From : /repos/MLNX_OFED/<MLNX_OFED file>/RPM-GPG-KEY-Mellanox
  Is this ok [y/N]:
```

Step 5. Check that the key was successfully imported.

```
# rpm -q gpg-pubkey --qf '%{NAME}-%{VERSION}-%{RELEASE}\t%{SUMMARY}\n' | grep Mellanox
gpg-pubkey-a9e4b643-520791ba      gpg(Mellanox Technologies <support@mellanox.com>)
```

Step 6. Create a yum repository configuration file called `"/etc/yum.repos.d/mlnx_ofed.repo"` with the following content:

```
[mlnx_ofed]
name=MLNX_OFED Repository
baseurl=file:///<path to extracted MLNX_OFED package>
enabled=1
gpgkey=file:///<path to the downloaded key RPM-GPG-KEY-Mellanox>
gpgcheck=1
```

Step 7. Check that the repository was successfully added.

```
# yum repolist
Loaded plugins: product-id, security, subscription-manager
This system is not registered to Red Hat Subscription Management. You can use subscription-manager to register.
repo id          repo name          status
mlnx_ofed        MLNX_OFED Repository      108
rpmforge         RHEL 6Server - RPMforge.net - dag      4,597

repolist: 8,351
```

4.1.5.2 Installing MLNX_OFED using the YUM Tool

After setting up the YUM repository for MLNX_OFED package, perform the following:

Step 1. View the available package groups by invoking:

```
# yum search mlnx-ofed-
mlnx-ofed-all.noarch : MLNX_OFED all installer package (with KMP support)
mlnx-ofed-basic.noarch : MLNX_OFED basic installer package (with KMP support)
mlnx-ofed-guest.noarch : MLNX_OFED guest installer package (with KMP support)
mlnx-ofed-hpc.noarch : MLNX_OFED hpc installer package (with KMP support)
mlnx-ofed-hypervisor.noarch : MLNX_OFED hypervisor installer package (with KMP support)
mlnx-ofed-vma.noarch : MLNX_OFED vma installer package (with KMP support)
mlnx-ofed-vma-eth.noarch : MLNX_OFED vma-eth installer package (with KMP support)
mlnx-ofed-vma-vpi.noarch : MLNX_OFED vma-vpi installer package (with KMP support)
```

Where:

mlnx-ofed-all	Installs all available packages in MLNX_OFED.
mlnx-ofed-basic	Installs basic packages required for running Mellanox cards.
mlnx-ofed-guest	Installs packages required by guest OS.
mlnx-ofed-hpc	Installs packages required for HPC.
mlnx-ofed-hypervisor	Installs packages required by hypervisor OS.
mlnx-ofed-vma	Installs packages required by VMA.
mlnx-ofed-vma-eth	Installs packages required by VMA to work over Ethernet.
mlnx-ofed-vma-vpi	Installs packages required by VMA to support VPI.

Note: MLNX_OFED provides kernel module RPM packages with KMP support for RHEL and SLES. For other Operating Systems, kernel module RPM packages are provided only for the Operating Systems' default kernel. In this case, the group RPM packages have the supported kernel version in their package's name.

Example:

```
mlnx-ofed-all-3.17.4-301.fc21.x86_64.noarch : MLNX_OFED all installer package for kernel
3.17.4-301.fc21.x86_64 (without KMP support)
mlnx-ofed-basic-3.17.4-301.fc21.x86_64.noarch : MLNX_OFED basic installer package for
kernel 3.17.4-301.fc21.x86_64 (without KMP support)
mlnx-ofed-guest-3.17.4-301.fc21.x86_64.noarch : MLNX_OFED guest installer package for
kernel 3.17.4-301.fc21.x86_64 (without KMP support)
mlnx-ofed-hpc-3.17.4-301.fc21.x86_64.noarch : MLNX_OFED hpc installer package for kernel
3.17.4-301.fc21.x86_64 (without KMP support)
mlnx-ofed-hypervisor-3.17.4-301.fc21.x86_64.noarch : MLNX_OFED hypervisor installer
package for kernel 3.17.4-301.fc21.x86_64 (without KMP support)
mlnx-ofed-vma-3.17.4-301.fc21.x86_64.noarch : MLNX_OFED vma installer package for kernel
3.17.4-301.fc21.x86_64 (without KMP support)
mlnx-ofed-vma-eth-3.17.4-301.fc21.x86_64.noarch : MLNX_OFED vma-eth installer package
for kernel 3.17.4-301.fc21.x86_64 (without KMP support)
mlnx-ofed-vma-vpi-3.17.4-301.fc21.x86_64.noarch : MLNX_OFED vma-vpi installer package
for kernel 3.17.4-301.fc21.x86_64 (without KMP support)
```

If you have an Operating Systems different than RHEL or SLES, or you have installed a kernel that is not supported by default in MLNX_OFED, you can use the `mlnx_add_kernel_support.sh` script to build MLNX_OFED for your kernel.

The script will automatically build the matching group RPM packages for your kernel so that you can still install MLNX_OFED via yum.

Please note that the resulting MLNX_OFED repository will contain unsigned RPMs, therefore, you should set 'gpgcheck=0' in the repository configuration file.

Step 2. Install the desired group.

```
# yum install mlnx-ofed-all
Loaded plugins: langpacks, product-id, subscription-manager
Resolving Dependencies
--> Running transaction check
---> Package mlnx-ofed-all.noarch 0:3.1-0.1.2 will be installed
--> Processing Dependency: kmod-iser = 1.0-OFED.3.1.0.1.2.1.g832a737.rhel7u1 for pack-
age: mlnx-ofed-all-3.1-0.1.2.noarch
.....
.....
qperf.x86_64 0:0.4.9-9
rds-devel.x86_64 0:2.0.7-1.12
rds-tools.x86_64 0:2.0.7-1.12
sdpnstat.x86_64 0:1.60-26
srptools.x86_64 0:1.0.2-12

Complete!
```

Installing MLNX_OFED using the YUM tool does not automatically update the firmware.

To update the firmware to the version included in MLNX_OFED package, you can either:

- Run `# yum install mlnx-fw-updater`
or
- Update the firmware to the latest version available on Mellanox Technologies' Web site as described in [Section 4.1.7, "Updating Firmware After Installation," on page 33.](#)

4.1.5.3 Uninstalling Mellanox OFED using the YUM Tool

Use the script `/usr/sbin/ofed_uninstall.sh` to uninstall the Mellanox OFED package. The script is part of the `ofed-scripts` RPM.

4.1.6 Installing MLNX_OFED using apt-get

This type of installation is applicable to Debian and Ubuntu Operating Systems.

4.1.6.1 Setting up MLNX_OFED apt-get Repository

Step 1. Log into the installation machine as root.

Step 2. Extract the MLNX_OFED package on a shared location in your network.

You can download it from <http://www.mellanox.com> => Products => Software => Ethernet Drivers.

Step 3. Create an apt-get repository configuration file called `" /etc/apt/sources.list.d/mlnx-ofed.list"` with the following content:

```
deb file:<path to extracted MLNX_OFED package> ./
```

Step 4. Download and install Mellanox Technologies GPG-KEY.

```
# wget -qO - http://www.mellanox.com/downloads/ofed/RPM-GPG-KEY-Mellanox | sudo apt-key
add -
```


Step 5. Check that the key was successfully imported.

```
# apt-key list
pub 1024D/A9E4B643 2013-08-11
uid Mellanox Technologies <support@mellanox.com>
sub 1024g/09FCC269 2013-08-11
```

Step 6. Update the apt-get cache.

```
# sudo apt-get update
```

4.1.6.2 Installing MLNX_OFED using the apt-get Tool

After setting up the apt-get repository for MLNX_OFED package, perform the following:

Step 1. View the available package groups by invoking:

```
# apt-cache search mlnx-ofed-
mlnx-ofed-vma-eth - MLNX_OFED vma-eth installer package (with DKMS support)
mlnx-ofed-hpc - MLNX_OFED hpc installer package (with DKMS support)
mlnx-ofed-vma-vpi - MLNX_OFED vma-vpi installer package (with DKMS support)
mlnx-ofed-basic - MLNX_OFED basic installer package (with DKMS support)
mlnx-ofed-vma - MLNX_OFED vma installer package (with DKMS support)
mlnx-ofed-all - MLNX_OFED all installer package (with DKMS support)
```

Where:

mlnx-ofed-all	MLNX_OFED all installer package.
mlnx-ofed-basic	MLNX_OFED basic installer package.
mlnx-ofed-vma	MLNX_OFED vma installer package.
mlnx-ofed-hpc	MLNX_OFED HPC installer package.
mlnx-ofed-vma-eth	MLNX_OFED vma-eth installer package.
mlnx-ofed-vma-vpi	MLNX_OFED vma-vpi installer package.

Step 2. Install the desired group.

```
apt-get install '<group name>'
```

Example:

```
apt-get install mlnx-ofed-all
```



Installing MLNX_OFED using the "apt-get" tool does not automatically update the firmware.

To update the firmware to the version included in MLNX_OFED package, run:

```
# apt-get install mlnx-fw-updater
```

4.1.6.3 Uninstalling Mellanox OFED using the apt-get Tool

Use the script `/usr/sbin/ofed_uninstall.sh` to uninstall the Mellanox OFED package. The script is part of the `ofed-scripts` RPM.

4.1.7 Updating Firmware After Installation

The firmware can be updated in one of the following methods.

4.1.7.1 Updating the Device Online

To update the device online on the machine from Mellanox site, use the following command line:

```
mlxfwmanager --online -u -d <device>
```

Example:

```
mlxfwmanager --online -u -d 0000:09:00.0
Querying Mellanox devices firmware ...

Device #1:
-----
Device Type:      ConnectX-4
Part Number:      MCX413A-BCAT
Description:      ConnectX@-4 EN network interface card, 40/56 GbE single-port QSFP28,
PCIe3.0 x8, tall bracket, ROHS R6
PSID:             MT_1020120019
PCI Device Name:  0000:09:00.0
Port1 GUID:       0002c9000100d051
Port2 MAC:        0002c9000002
Versions:         Current      Available
FW                2.32.5000      2.33.5000

Status:           Update required
-----
Found 1 device(s) requiring firmware update. Please use -u flag to perform the update.
```

4.1.7.2 Updating the Device Manually

In case you ran the `mlnxofedinstall` script with the `--without-fw-update` option or you are using an OEM card and now you wish to (manually) update firmware on your adapter card(s), you need to perform the steps below. The following steps are also appropriate in case you wish to burn newer firmware that you have downloaded from Mellanox Technologies' Web site (<http://www.mellanox.com> => Support => Firmware Download).

Step 1. Get the device's PSID.

```
mlxfwmanager_pci | grep PSID
PSID:             MT_1210110019
```

Step 2. Download the firmware BIN file from the Mellanox website or the OEM website.

Step 3. Burn the firmware.

```
mlxfwmanager_pci -i <fw_file.bin>
```

Step 4. Reboot your machine after the firmware burning is completed.

4.1.7.3 Updating the Device Firmware Automatically upon System Boot

As of MLNX_OFED v3.1-x.x.x, firmware can be automatically updated upon system boot.

The firmware update package (`mlnx-fw-updater`) is installed in the `"/opt/mellanox/mlnx-fw-updater"` folder, and `openibd` service script can invoke the firmware update process if requested on boot.

If the firmware is updated, the following message is printed to the system's standard logging file:

```
fw_updater: Firmware was updated. Please reboot your system for the changes to take effect.
```

Otherwise, the following message is printed:

```
fw_updater: Didn't detect new devices with old firmware.
```

Please note, this feature is disabled by default. To enable the automatic firmware update upon system boot, set the following parameter to "yes" "RUN_FW_UPDATER_ONBOOT=yes" in the openibd service configuration file "/etc/infiniband/openib.conf".

You can opt to exclude a list of devices from the automatic firmware update procedure. To do so, edit the configurations file "/opt/mellanox/mlnx-fw-updater/mlnx-fw-updater.conf" and provide a comma separated list of PCI devices to exclude from the firmware update.

Example:

```
MLNX_EXCLUDE_DEVICES="00:05.0,00:07.0"
```

4.1.8 UEFI Secure Boot

All kernel modules included in MLNX_OFED for RHEL7 and SLES12 are signed with x.509 key to support loading the modules when Secure Boot is enabled.

4.1.8.1 Enrolling Mellanox's x.509 Public Key On your Systems

In order to support loading MLNX_OFED drivers when an OS supporting Secure Boot boots on a UEFI-based system with Secure Boot enabled, the Mellanox x.509 public key should be added to the UEFI Secure Boot key database and loaded onto the system key ring by the kernel.

Follow these steps below to add the Mellanox's x.509 public key to your system:



Prior to adding the Mellanox's x.509 public key to your system, please make sure:

- the 'mokutil' package is installed on your system
- the system is booted in UEFI mode

Step 1. Download the x.509 public key.

```
# wget http://www.mellanox.com/downloads/ofed/mlnx_signing_key_pub.der
```

Step 2. Add the public key to the MOK list using the mokutil utility.

You will be asked to enter and confirm a password for this MOK enrollment request.

```
# mokutil --import mlnx_signing_key_pub.der
```

Step 3. Reboot the system.

The pending MOK key enrollment request will be noticed by `shim.efi` and it will launch `Mok-Manager.efi` to allow you to complete the enrollment from the UEFI console. You will need to enter the password you previously associated with this request and confirm the enrollment. Once done, the public key is added to the MOK list, which is persistent. Once a key is in the MOK list, it will be automatically propagated to the system key ring and subsequent will be booted when the UEFI Secure Boot is enabled.



To see what keys have been added to the system key ring on the current boot, install the 'keyutils' package and run: `#keyctl list %:.system_keyring`

4.1.8.2 Removing Signature from Kernel Modules

The signature can be removed from a signed kernel module using the 'strip' utility which is provided by the 'binutils' package.

```
# strip -g my_module.ko
```

The strip utility will change the given file without saving a backup. The operation can be undo only by resigning the kernel module. Hence, we recommend backing up a copy prior to removing the signature.

➤ *To remove the signature from the MLNX_OFED kernel modules:*

Step 1. Remove the signature.

```
# rpm -qa | grep -E "kernel-ib|mlnx-ofa_kernel|iser|srp|knem" | xargs rpm -ql | grep "\.ko$" | xargs strip -g
```

After the signature has been removed, a message as the below will no longer be presented upon module loading:

```
"Request for unknown module key 'Mellanox Technologies signing key: 61feb074fc7292f958419386ffdd9d5ca999e403' err -11"
```

However, please note that a similar message as the following will still be presented:

```
"my_module: module verification failed: signature and/or required key missing - tainting kernel"
```

This message is presented once, only for each boot for the first module that either has no signature or whose key is not in the kernel key ring. So it's much easier to miss this message. You won't see it on repeated tests where you unload and reload a kernel module until you reboot. There is no way to eliminate this message.

Step 2. Update the initramfs on RHEL systems with the stripped modules.

```
mkinitrd /boot/initramfs-$(uname -r).img $(uname -r) --force
```

4.1.9 Performance Tuning

Depending on the application of the user's system, it may be necessary to modify the default configuration of network adapters based on the ConnectX® adapters. In case tuning is required, please refer to the [Performance Tuning Guide for Mellanox Network Adapters](#).

4.2 Windows Driver

For Windows, download and install the latest Mellanox WinOF-2 for Windows software package available via the Mellanox web site at: <http://www.mellanox.com> => Products => Software => Ethernet Drivers => Windows SW/Driver => Download. Follow the installation instructions included in the download package (also available from the download page).

4.2.1 Hardware and Software Requirements

Table 6 - Hardware and Software Requirements

Description ^a	Package
Windows Server 2012 R2 (64 bit only)	MLNX_WinOF2-1_35_All_x64.exe
Windows Server 2012 (64 bit only)	MLNX_WinOF2-1_35_All_x64.exe
Windows 8.1 Client (64 bit only)	MLNX_WinOF2-1_35_All_x64.exe

a. The Operating System listed above must run with administrator privileges.

4.2.2 Downloading Mellanox WinOF-2 Driver

To download the .exe according to your Operating System, please follow the steps below:

Step 1. Obtain the machine architecture.

For Windows Server 2012 / 2012 R2 / 8.1 Client

- To go to the Start menu, position your mouse in the bottom-right corner of the Remote Desktop of your screen.
- Open a CMD console (Click Task Manager -->File --> Run new task, and enter CMD).
- Enter the following command.

```
> echo %PROCESSOR_ARCHITECTURE%
```

On an x64 (64-bit) machine, the output will be "AMD64".

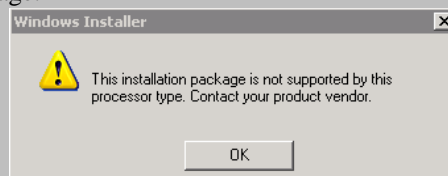
Step 2. Go to the Mellanox WinOF-2 web page at:

<http://www.mellanox.com> => Products => Ethernet Drivers => Windows SW/Drivers.

Step 3. Download the .exe image according to the architecture of your machine (see [Step 1.](#)). The name of the .exe is in the following format
MLNX_WinOF2-<version>_<arch>.exe.



Installing the incorrect .exe file is prohibited. If you do so, an error message will be displayed. For example, if you try to install a 64-bit .exe on a 32-bit machine, the wizard will display the following (or a similar) error message:



4.2.3 Installing Mellanox WinOF-2 Driver

This section provides instructions for two types of installation procedures:

- “Attended Installation”

An installation procedure that requires frequent user intervention.

- “Unattended Installation”

An automated installation procedure that requires no user intervention.



Both Attended and Unattended installations require administrator privileges.

4.2.3.1 Attended Installation

The following is an example of an installation session.

Step 1. Double click the .exe and follow the GUI instructions to install MLNX_WinOF2.

Step 2. [Optional] Manually configure your setup to contain the logs option.

```
> MLNX_WinOF2-1_35_All_x64.exe /v"/l*vx [LogFile]"
```

Step 3. [Optional] If you do not want to upgrade your firmware version¹.

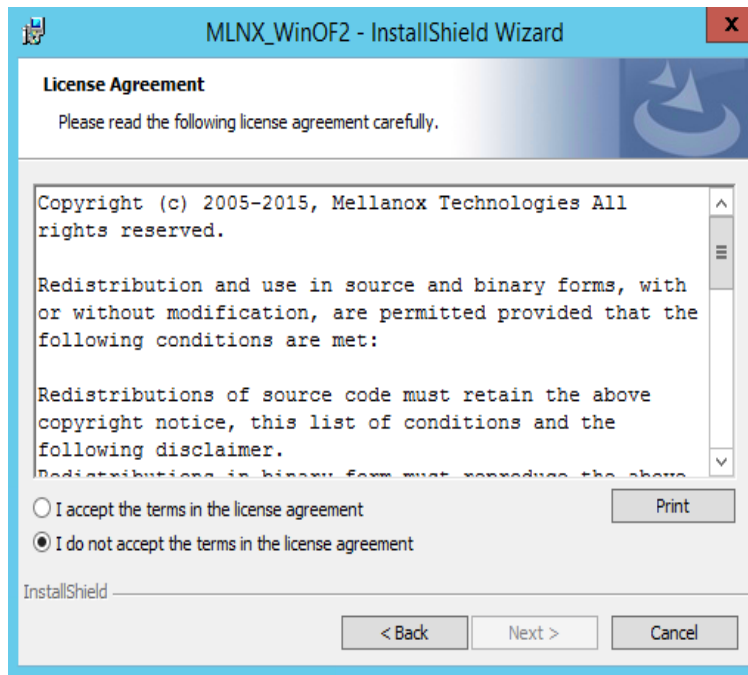
```
> MLNX_WinOF2-1_35_All_x64.exe /v" MT_SKIPFWUPGRD=1"
```

Step 4. Click Next in the Welcome screen.

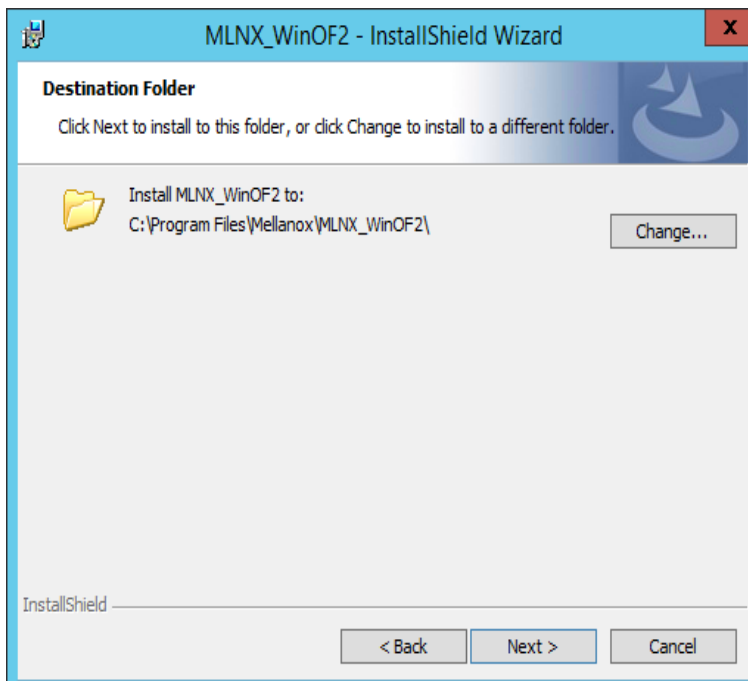


1. MT_SKIPFWUPGRD default value is False

Step 5. Read then accept the license agreement and click Next.

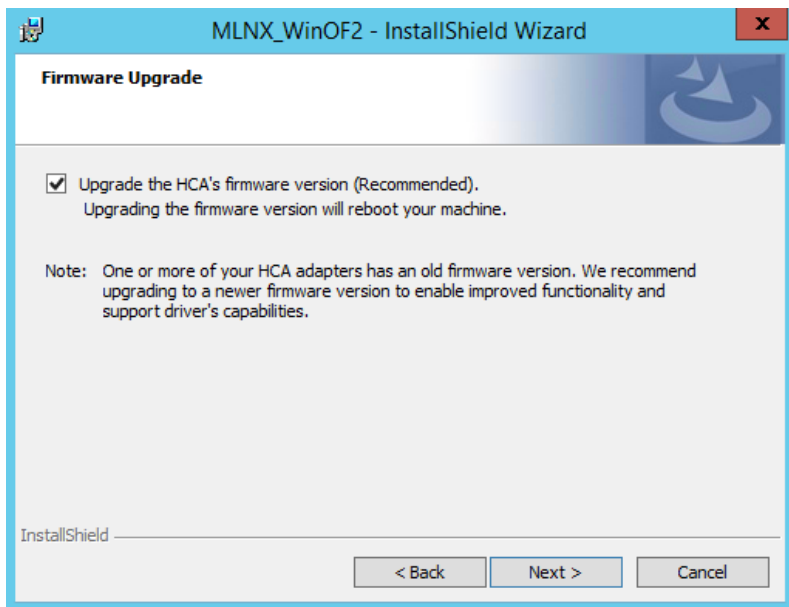


Step 6. Select the target folder for the installation.

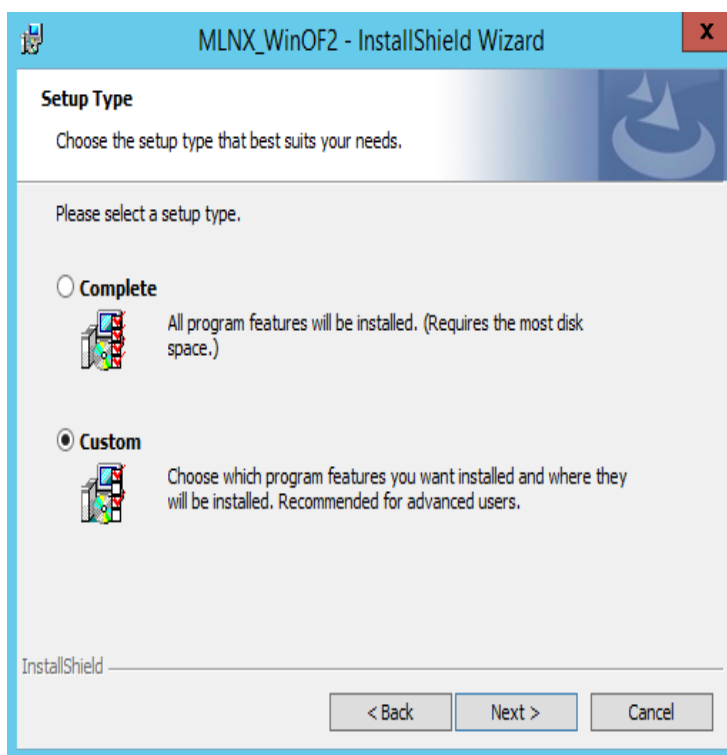


Step 7. The firmware upgrade screen will be displayed in the following cases:

- If the user has an OEM card. In this case, the firmware will not be displayed.
- If the user has a standard Mellanox card with an older firmware version, the firmware will be updated accordingly. However, if the user has both an OEM card and a Mellanox card, only the Mellanox card will be updated.

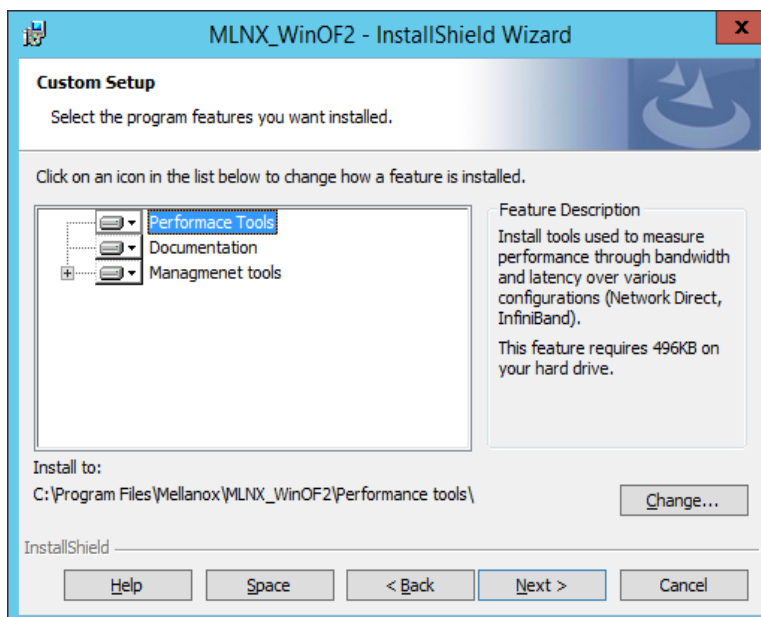


Step 8. Select a Complete or Custom installation, follow Step a and on.

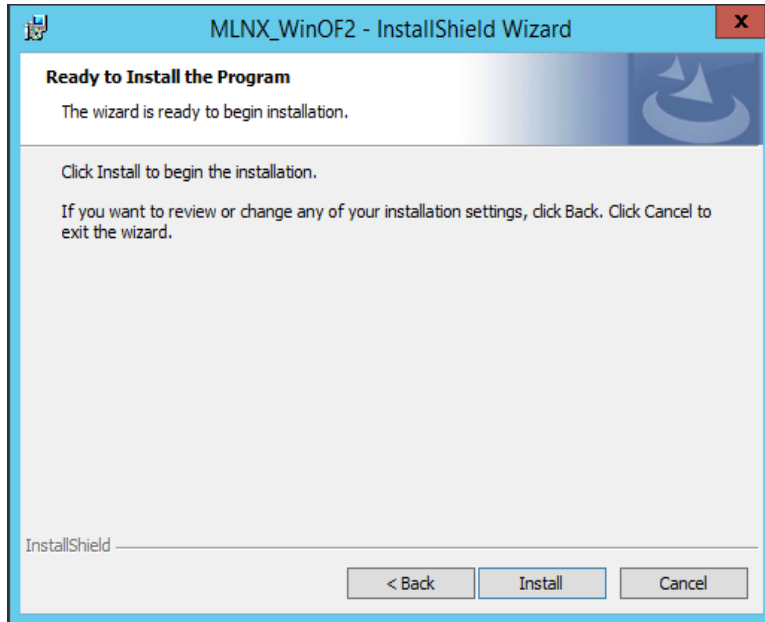


a. Select the desired feature to install:

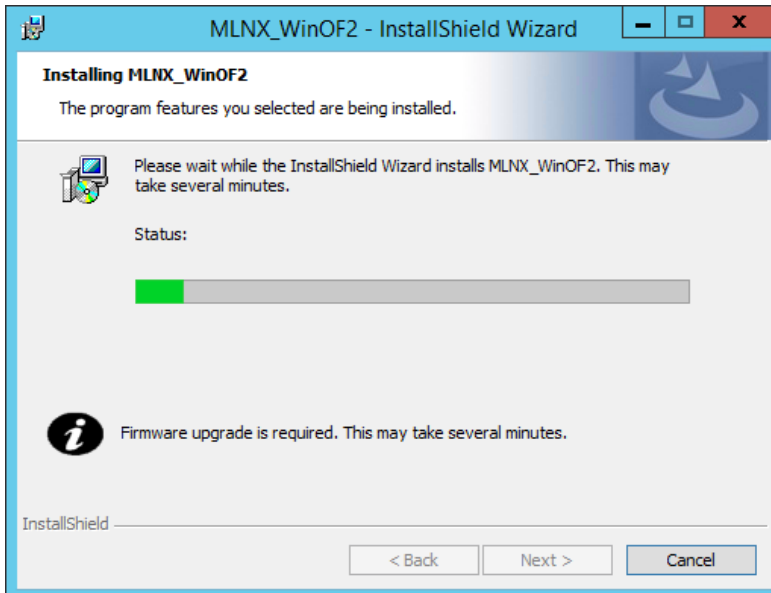
- OpenSM - installs Windows OpenSM that is required to manage the subnet from a host. OpenSM is part of the driver and installed automatically.
- Performances tools - install the performance tools that are used to measure performance in user environment.
- Analyze tools - install the tools that can be used either to diagnosed or analyzed the InfiniBand environment.
- SDK - contains the libraries and DLLs for developing InfiniBand application over IBAL.
- Documentation - contains the User Manual and Release Notes
- Management tools - installation tools used for management, such as mlxstat.



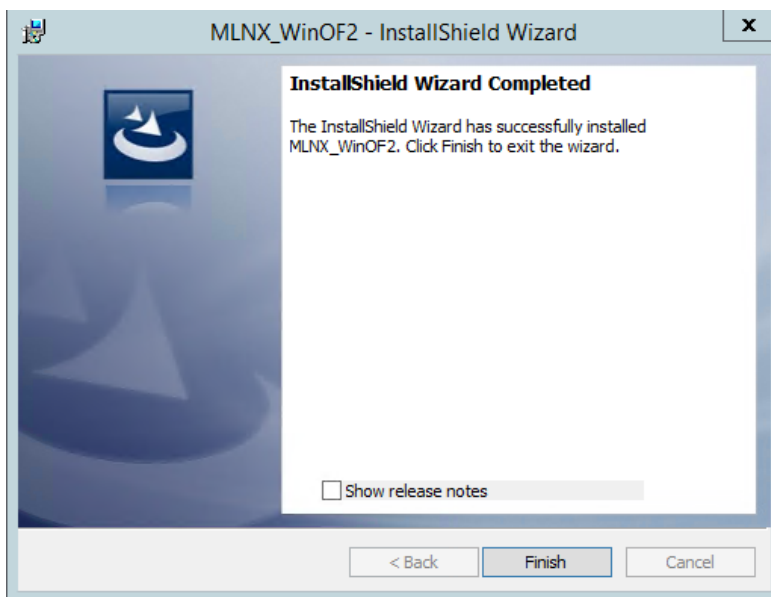
- b. Click Install to start the installation.



- Step 9.** In case firmware upgrade option was checked in Step 7., you will be notified if a firmware upgrade is required.



Step 10. Click Finish to complete the installation.



4.2.3.2 Unattended Installation



If no reboot options are specified, the installer restarts the computer whenever necessary without displaying any prompt or warning to the user.

Use the `/norestart` or `/forcerestart` standard command-line options to control reboots.

The following is an example of an unattended installation session.

Step 1. Open a CMD console -> Click Start -> Task Manager -> File -> Run new task-> and enter CMD.

Step 2. Install the driver. Run:

```
> MLNX_WinOF2-1_35_All_x64.exe /S /v"/qn"
```

Step 3. [Optional] Manually configure your setup to contain the logs option:

```
> MLNX_WinOF2-1_35_All_x64.exe /S /v"/qn" /v"/l*vx [LogFile]"
```

Step 4. [Optional] if you want to control whether to install ND provider or not¹.

```
> MLNX_WinOF2-1_35_All_x64.exe /vMT_NDPROPERTY=1
```

Step 5. [Optional] If you do not wish to upgrade your firmware version².

```
> MLNX_WinOF2-1_35_All_x64.exe /v" MT_SKIPFWUPGRD=1"
```

1. MT_NDPROPERTY default value is True
2. MT_SKIPFWUPGRD default value is False



Applications that hold the driver files (such as ND applications) will be closed during the unattended installation.

4.2.4 Installation Results

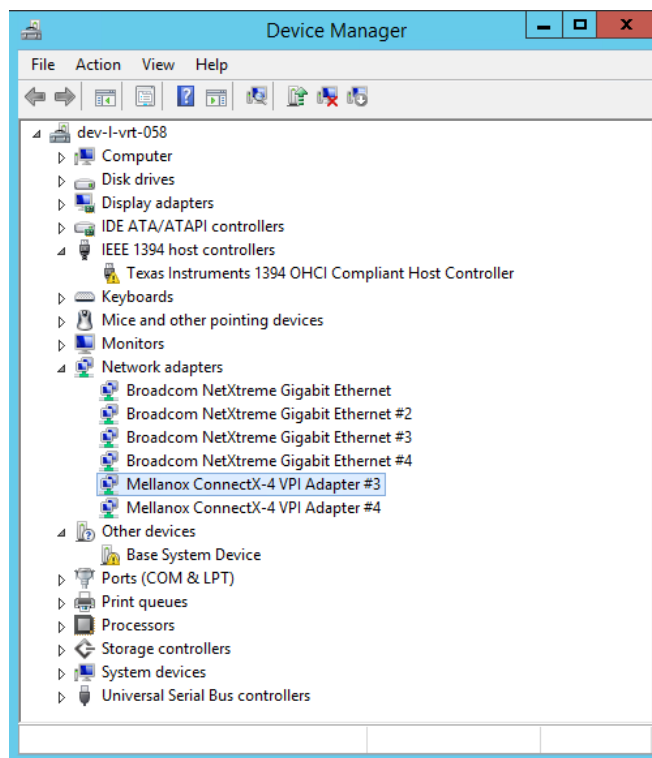
Upon installation completion, you can verify the successful addition of the network card(s) through the Device Manager.

Upon installation completion, the inf files can be located at:

- %ProgramFiles%\Mellanox\MLNX_WinOF2\Drivers\<OS>

To see the Mellanox network adapters, display the Device Manager and pull down the “Network adapters” menu.

Figure 2: Installation Results (Example)



4.2.5 Extracting Files Without Running Installation

To extract the files without running installation, perform the following steps.

Step 1. Open a CMD console-> Click Start-> Task Manager-> File-> Run new task-> and enter CMD.

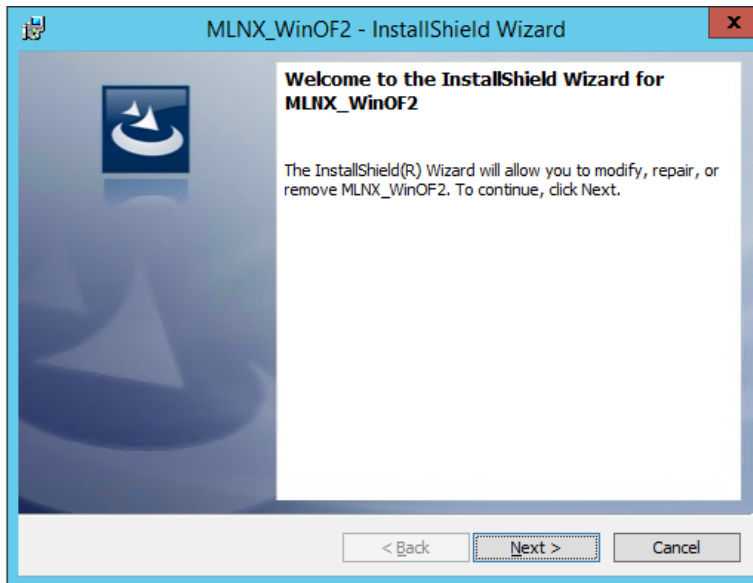
Step 2. Extract the driver and the tools:

```
> MLNX_WinOF2-1_35_All_x64 /a
```

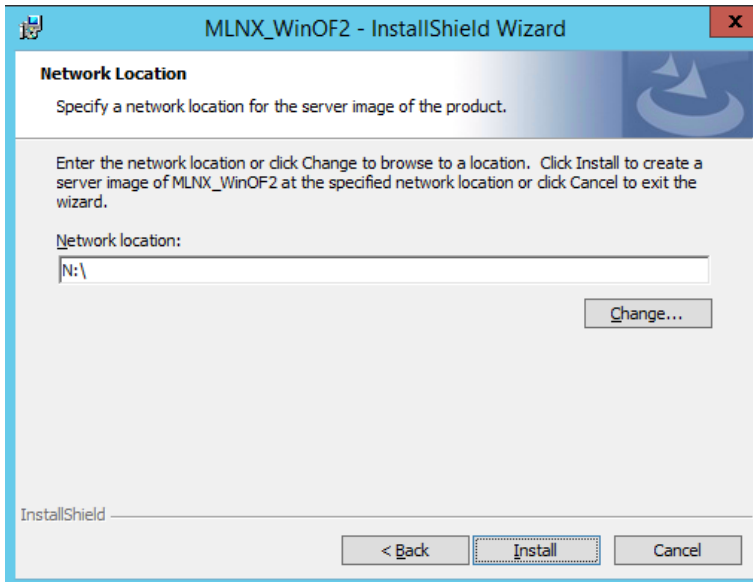
- To extract only the driver files.

```
> MLNX_WinOF2-1_35_All_x64 /a /vMT_DRIVERS_ONLY=1
```

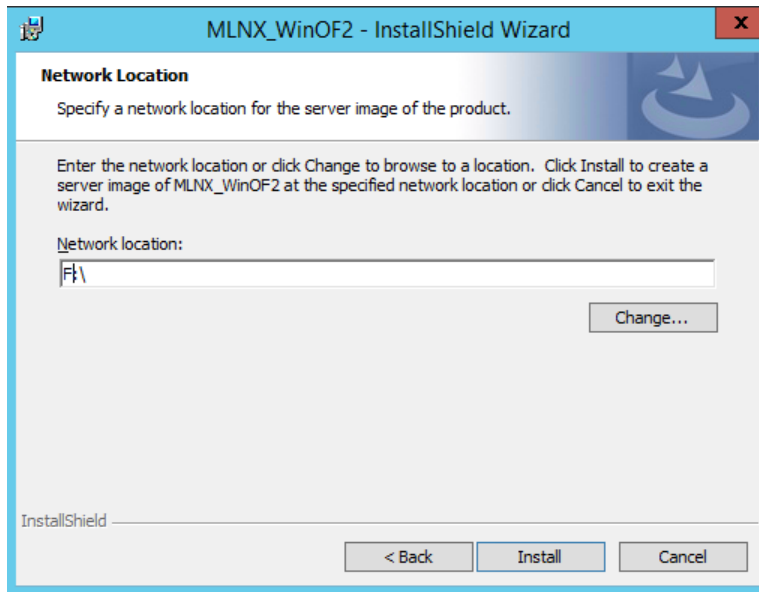
Step 3. Click Next to create a server image.



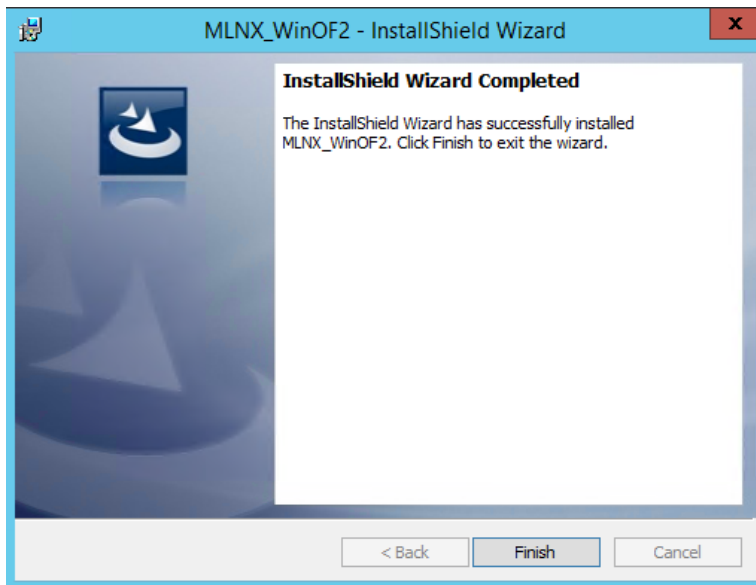
Step 4. Click Change and specify the location in which the files are extracted to.



Step 5. Click Install to extract this folder, or click Change to install to a different folder.



Step 6. To complete the extraction, click Finish.



4.2.6 Uninstalling Mellanox WinOF-2 Driver

4.2.6.1 Attended Uninstallation

➤ *To uninstall MLNX_WinOF2 on a single node:*

Click Start -> Control Panel -> Programs and Features -> MLNX_WinOF2 -> Uninstall.

4.2.6.2 Unattended Uninstallation



If no reboot options are specified, the installer restarts the computer whenever necessary without displaying any prompt or warning to the user.

Use the `/norestart` or `/forcerestart` standard command-line options to control reboots.

➤ **To uninstall MLNX_WinOF2 in unattended mode:**

Step 1. Open a CMD console-> Click Start-> Task Manager-> File-> Run new task-> and enter CMD.

Step 2. Uninstall the driver. Run:

```
> MLNX_WinOF2-1_35_All_x64.exe /S /x /v"/qn"
```

4.2.7 Firmware Upgrade

If the machine has a standard Mellanox card with an older firmware version, the firmware will be automatically updated as part of the WinOF-2 package installation.

For information on how to upgrade firmware manually, please refer to MFT User Manual:

www.mellanox.com ->Products -> Ethernet Drivers -> Firmware Tools

Performance Tuning For further information on WinOF-2 performance, please refer to the [Performance Tuning Guide for Mellanox Network Adapters.](#)

4.3 VMware Driver

For VMware, download and install the latest Mellanox ConnectX-4 NATIVE ESXi Driver for VMware vSphere software package available via the Mellanox web site at: <http://www.mellanox.com> => Products => Adapter Ethernet SW => Download. This chapter describes how to install and test Mellanox ConnectX-4 NATIVE ESXi Driver for VMware vSphere on a single host machine with Mellanox Ethernet adapter hardware installed.

4.3.1 Hardware and Software Requirements

Table 7 - Hardware and Software Requirements

Requirements	Description
Platforms	A server platform with an adapter card based on one of the following Mellanox Technologies' HCA devices: <ul style="list-style-type: none"> MT27700 ConnectX®-4 (EN) (firmware: fw-ConnectX4)
Device ID	For the latest list of device IDs, please visit Mellanox website.
Operating System	ESXi 5.5/6.0 operating system.
Installer Privileges	The installation requires administrator privileges on the target machine.

4.3.2 Installing VMware



Please uninstall any previous Mellanox driver packages prior to installing the new version.

➤ *To install the driver:*

1. Log into the ESXi server with root permissions.
2. Install the driver.

```
#> esxcli software vib install -d <path>/<bundle_file>
```

Example:

```
#> esxcli software vib install -d <path>/<bundle_file>
```

3. Reboot the machine.
4. Verify the driver was installed successfully.

```
# esxcli software vib list | grep mlx
ESX 5.5:
nmlx5-core          4.5.2.0-10EM.550.0.0.1391871    MEL    PartnerSupported  2016-02-01
ESX 6.0:
nmlx5-core          4.15.4.0-10EM.600.0.0.2768847    MEL    PartnerSupported  2016-02-01
```



After the installation process, all kernel modules are loaded automatically upon boot.

4.3.3 Removing Previous Mellanox Driver



Please unload the driver before removing it.

➤ *To remove all the drivers:*

1. Log into the ESXi server with root permissions.
2. List the existing ConnectX-4 NATIVE ESX driver modules. (see [4.](#) in [Installing VMware on page 48](#)).
3. Remove each module.

```
#> esxcli software vib remove -n nmlx5-core
```



To remove the modules, the command must be run in the same order as shown in the example above.

4. Reboot the server.

4.3.4 Loading/Unloading Driver Kernel Modules

➤ *To unload the driver:*

```
esxcfg-module -u nmlx5_core
```

➤ *To load the driver:*

```
/etc/init.d/sfcbd-watchdog stop
esxcfg-module nmlx5_core
/etc/init.d/sfcbd-watchdog start
kill -POLL $(cat /var/run/vmware/vmkdevmgr.pid)
```

➤ *To restart the driver:*

```
/etc/init.d/sfcbd-watchdog stop
esxcfg-module -u nmlx5_core
esxcfg-module nmlx5_core
/etc/init.d/sfcbd-watchdog start
kill -POLL $(cat /var/run/vmware/vmkdevmgr.pid)
```

4.3.5 Firmware Programming

1. Download the VMware images v4.3.0 from the [Mellanox Firmware Tools \(MFT\)](#) site.
 - **ESX 5.5 File:** mft-4.3.0.25-10EM-550.0.0.1391871.x86_64.vib
MD5SUM: 62f953b77f4ea49c420ff4e1ce8b925b
 - **ESX 6.0 File:** mft-4.3.0.25-10EM-600.0.0.2768847.x86_64.vib
MD5SUM: 6a3bd63882f2ca3f696c1a96d62112df

2. Install the image according to the steps described in the [MFT User Manual](#).



The following procedure requires custom boot image downloading, mounting and booting from a USB device.

5 Updating Adapter Card Firmware

Each card is shipped with the latest version of qualified firmware at the time of manufacturing. However, Mellanox issues firmware updates occasionally that provide new features and bug fixes. To check that your card is programmed with the latest available firmware version, download the mlxup firmware update and query utility. The utility can query for available Mellanox adapters and indicate which adapters require a firmware update. If the user confirms, mlxup upgrades the firmware using embedded images. The latest mlxup executable and documentation are available from <http://www.mellanox.com> => Products => Software => Firmware Tools.

5.1 Firmware Update Example

```
[server1]# ./mlxup
Querying Mellanox devices firmware ...

Device Type:      ConnectX4
Part Number:      MCX413A-BCAT
Description:      ConnectX®-4 EN network interface card, 40/56 GbE single-port QSFP28,
PCIe3.0 x8, tall bracket, ROHS R6
PSID:             MT_2190110032
PCI Device Name:  0000:06:00.0
Base GUID:        e41d2d0300fd8b8a
Versions:         Current      Available
FW                12.12.1100    12.12.1100

Status:           Up to date

Device Type:      ConnectX4
Part Number:      MCX413A-BCAT
Description:      ConnectX®-4 EN network interface card, 40/56 GbE single-port QSFP28,
PCIe3.0 x8, tall bracket, ROHS R6
PSID:             MT_2170110021
PCI Device Name:  0000:07:00.0
Base MAC:         0000e41d2da206d4
Versions:         Current      Available
FW                12.12.0780    12.12.1100

Status:           Update required

Perform FW update? [y/N]: y
Device #1: Up to date
Device #2: Updating FW ... Done

Restart needed for updates to take effect.
Log File: /var/log/mlxup/mlxup-yyyyymmdd.log
```

6 Troubleshooting

6.1 General

<p>Server unable to find the adapter</p>	<ul style="list-style-type: none"> • Ensure that the adapter is placed correctly • Make sure the adapter slot and the adapter are compatible • Uninstall the adapter card. See Section 3.8, “Adapter Card Un-installation Instructions”. • Install the adapter in a different PCI Express slot • Use the drivers that came with the adapter or download the latest • Make sure your motherboard has the latest BIOS • Try to reboot the server
<p>The adapter no longer works</p>	<ul style="list-style-type: none"> • Uninstall the adapter card. See Section 3.8, “Adapter Card Un-installation Instructions”. • Reseat the adapter in its slot or a different slot, if necessary • Try using another cable • Reinstall the drivers for the network driver files may be damaged or deleted • Reboot the server
<p>Adapters stopped working after installing another adapter</p>	<ul style="list-style-type: none"> • Try removing and re-installing all adapters. See Section 3.8, “Adapter Card Un-installation Instructions”. • Check that cables are connected properly • Make sure your motherboard has the latest BIOS
<p>Link indicator light is off</p>	<ul style="list-style-type: none"> • Ensure that adapter driver/s is loaded • Try another port on the switch • Make sure the cable is securely attached • Check your are using the proper cables that do not exceed the recommended lengths • Verify that your switch and adapter port are compatible
<p>Link light is on, but with no communication established</p>	<ul style="list-style-type: none"> • Check that the latest driver is loaded • Check that both the adapter and its link are set to the same speed and duplex settings

6.2 Linux

Environment Information	<pre>cat/etc/issue uname -a cat/proc/cupinfo grep 'model name' uniq ofed_info head -1 ifconfig -a ethtool <interface> ethtool -i <interface_of_Mellanox_port_num> ibdev2netdev</pre>
Card Detection	<pre>lspci grep -i Mellanox</pre>
Mellanox Firmware Tool (MFT)	<p>Download and install MFT: http://www.mellanox.com/content/pages.php?pg=management_tools&menu_section=34 Refer to the User Manual for installation instructions.</p> <p>Once installed, run:</p> <pre>mst start mst status flint -d <mst_device> q</pre>
Ports Information	<pre>ibstat lsv_devinfo</pre>
Firmware Version Upgrade	<p>To download the latest firmware version refer to http://www.mellanox.com/supportdownloader</p>
Collect Log File	<pre>/var/log/messages dmesg > system.logF</pre>

6.3 Windows

Environment Information	<p>From the Windows desktop choose the Start menu and run: msinfo32 To export system information to a text file, choose the Export option from the File menu. Assign a file name and save.</p>
Mellanox Firmware Tool (MFT)	<p>Download and install MFT: http://www.mellanox.com/content/pages.php?pg=management_tools&menu_section=34 Refer to the User Manual for installation instructions.</p> <p>Once installed, open a CMD window and run: cd C:\Program Files\Mellanox\WinMFT mst start mst status flint -d <mst_device> q</p>
Ports Information	vstat
Firmware Version Upgrade	<p>Download the latest firmware version using the PSID/board ID: http://www.mellanox.com/supportdownloader/ flint -d <mst_device> -i <firmware_bin_file> b</p>
Collect log file	<ul style="list-style-type: none"> • Event log viewer • MST device logs: <ul style="list-style-type: none"> • mst start • mst status • C:\Users\Administrator> flint -d <mst_device> dc > dump_configuration.log • C:\Users\Administrator> mstdump <mst_device> dc > mstdump.log

7 Specifications

7.1 MCX413A-BCAT Specifications

Table 8 - MCX413A-BCAT Specifications Table

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile
	Connector: Single QSFP28 (Copper and optical)
Protocol Support	Ethernet: 56GBASE-R4, 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASE-KR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASE-KR, SGMII
	Data Rate: 1/10/25/40/56 Gb/s– Ethernet
	PCI Express Gen3: SERDES @ 8.0GT/s, 8 lanes (2.0 and 1.1 compatible)
Power and Environmental	Voltage: 12V, 3.3V
	Typical Power^a: Passive Cables: 40GbE – 10.18W 56GbE – 10.42W
	Maximum Power: Passive Cables: 40GbE – 11.79W 56GbE – 12.09W 1.5W Active Cables: 40GbE – 13.45W 56GbE – 13.76W
	Maximum power available through QSFP28 port: 3.5W
	Temperature: Operational 0°C to 55°C Non-operational -40°C to 70°C
	Humidity: 90% relative humidity ^b
	Air Flow: See Airflow Specifications on page 65
Regulatory	Safety: CB / cTUVus / CE
	EMC: CE / FCC / VCCI / ICES / RCM
	RoHS: RoHS-R6

a. Typical power for ATIS traffic load.

b. For both operational and non-operational states.

7.2 MCX414A-BCAT Specifications

Table 9 - MCX414A-BCAT Specifications Table

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile
	Connector: Dual QSFP28 (Copper and optical)
Protocol Support	Ethernet: 56GBASE-R4, 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASE-KR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASE-KR, SGMII
	Data Rate: 1/10/25/40/56 Gb/s – Ethernet
	PCI Express Gen3: SERDES @ 8.0GT/s, 8 lanes (2.0 and 1.1 compatible)
Power and Environmental	Voltage: 12V, 3.3V
	Typical Power^a: Passive Cables: 40GbE – 11.86W 56GbE – 12.26W
	Maximum Power: Passive Cables: 40GbE – 13.50W 56GbE – 13.98W 1.5W Active Cables: 40GbE – 16.83W 56GbE – 17.31W
	Maximum power available through QSFP28 port: 3.5W
	Temperature: Operational 0°C to 55°C Non-operational -40°C to 70°C
	Humidity: 90% relative humidity ^b
	Air Flow: See Airflow Specifications on page 65
Regulatory	Safety: CB / cTUVus / CE
	EMC: CE / FCC / VCCI / ICES / RCM
	RoHS: RoHS-R6

a. Typical power for ATIS traffic load.

b. For both operational and non-operational states.

7.3 MCX415A-BCAT Specifications

Table 10 - MCX415A-BCAT Specifications Table

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile
	Connector: Single QSFP28 (Copper and optical)
Protocol Support	Ethernet: 56GBASE-R4, 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASE-KR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASE-KR, SGMII
	Data Rate: 1/10/25/40/56 Gb/s – Ethernet
	PCI Express Gen3: SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible)
Power and Environmental	Voltage: 12V, 3.3V
	Temperature: Operational 0°C to 55°C Non-operational -40°C to 70°C
	Humidity: 90% relative humidity ^a
Regulatory	Safety: CB / cTUVus / CE
	EMC: CE / FCC / VCCI / ICES / RCM
	RoHS: RoHS-R6

a. For both operational and non-operational states.

7.4 MCX416A-BCAT Specifications

Table 11 - MCX416A-BCAT Specifications Table

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile
	Connector: Dual QSFP28 (Copper and optical)
Protocol Support	Ethernet: 56GBASE-R4, 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASE-KR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASE-KR, SGMII
	Data Rate: 1/10/25/40/56 Gb/s – Ethernet
	PCI Express Gen3: SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible)
Power and Environmental	Voltage: 12V, 3.3V
	Typical Power^a: Passive Cables: 40GbE – 14.95W 56GbE – 15.36W
	Maximum Power: Passive Cables: 40GbE – 16.69W 56GbE – 17.17W 1.5W Active Cables: 40GbE – 20.02W 56GbE – 20.51W
	Maximum power available through QSFP28 port: 3.5W
	Temperature: Operational 0°C to 55°C Non-operational -40°C to 70°C
	Humidity: 90% relative humidity ^b
	Air Flow: See Airflow Specifications on page 65
Regulatory	Safety: CB / cTUVus / CE
	EMC: CE / FCC / VCCI / ICES / RCM
	RoHS: RoHS-R6

a. Typical power for ATIS traffic load.

b. For both operational and non-operational states.

7.5 MCX413A-GCAT Specifications

Table 12 - MCX413A-GCAT Specifications Table

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile
	Connector: Single QSFP28 (Copper and optical)
Protocol Support	Ethernet: 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASE-KR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASE-KR, SGMII
	Data Rate: 1/10/25/40/50 Gb/s – Ethernet
	PCI Express Gen3: SERDES @ 8.0GT/s, 8 lanes (2.0 and 1.1 compatible)
Power and Environmental	Voltage: 12V, 3.3V
	Typical Power^a: Passive Cables – 9.81W
	Maximum Power: Passive Cables – 11.52W 3.5W Active Cables – 15.41W
	Maximum power available through QSFP28 port: 3.5W
	Temperature: Operational 0°C to 55°C Non-operational -40°C to 70°C
	Humidity: 90% relative humidity ^b
	Air Flow: See Airflow Specifications on page 65
Regulatory	Safety: CB / cTUVus / CE
	EMC: CE / FCC / VCCI / ICES / RCM
	RoHS: RoHS-R6

a. Typical power for ATIS traffic load.

b. For both operational and non-operational states.

7.6 MCX414A-GCAT Specifications

Table 13 - MCX414A-GCAT Specifications Table

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile
	Connector: Dual QSFP28 (Copper and optical)
Protocol Support	Ethernet: 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASE-KR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASE-KR, SGMII
	Data Rate: 1/10/25/40/50 Gb/s – Ethernet
	PCI Express Gen3: SERDES @ 8.0GT/s, 8 lanes (2.0 and 1.1 compatible)
Power and Environmental	Voltage: 12V, 3.3V
	Typical Power^a: Passive Cables – 11.10W
	Maximum Power: Passive Cables – 12.81W 3.5W Active Cables – 20.58W
	Maximum power available through QSFP28 port: 3.5W
	Temperature: Operational 0°C to 55°C Non-operational -40°C to 70°C
	Humidity: 90% relative humidity ^b
	Air Flow: See Airflow Specifications on page 65
Regulatory	Safety: CB / cTUVus / CE
	EMC: CE / FCC / VCCI / ICES / RCM
	RoHS: RoHS-R6

a. Typical power for ATIS traffic load.

b. For both operational and non-operational states.

7.7 MCX415A-GCAT Specifications

Table 14 - MCX415A-GCAT Specifications Table

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile
	Connector: Single QSFP28 (Copper and optical)
Protocol Support	Ethernet: 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASE-KR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASE-KR, SGMII
	Data Rate: 1/10/25/40/50 Gb/s – Ethernet
	PCI Express Gen3: SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible)
Power and Environmental	Voltage: 12V, 3.3V
	Temperature: Operational 0°C to 55°C Non-operational -40°C to 70°C
	Humidity: 90% relative humidity ^a
Regulatory	Safety: CB / cTUVus / CE
	EMC: CE / FCC / VCCI / ICES / RCM
	RoHS: RoHS-R6

a. For both operational and non-operational states.

7.8 MCX416A-GCAT Specifications

Table 15 - MCX416A-GCAT Specifications Table

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile
	Connector: Dual QSFP28 (Copper and optical)
Protocol Support	Ethernet: 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASE-KR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASE-KR, SGMII
	Data Rate: 1/10/25/40/50 Gb/s – Ethernet
	PCI Express Gen3: SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible)
Power and Environmental	Voltage: 12V, 3.3V
	Typical Power^a: Passive Cables – 14.19W
	Maximum Power: Passive Cables – 16.00W 3.5W Active Cables – 23.78
	Maximum power available through QSFP28 port: 3.5W
	Temperature: Operational 0°C to 55°C Non-operational -40°C to 70°C
	Humidity: 90% relative humidity ^b
	Air Flow: See Airflow Specifications on page 65
Regulatory	Safety: CB / cTUVus / CE
	EMC: CE / FCC / VCCI / ICES / RCM
	RoHS: RoHS-R6

a. Typical power for ATIS traffic load.

b. For both operational and non-operational states.

7.9 MCX415A-CCAT Specifications

Table 16 - MCX415A-CCAT Specifications Table

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile
	Connector: Single QSFP28 (Copper and optical)
Protocol Support	Ethernet: 100GBASE-CR4, 100GBASE-KR4, 100GBASE-SR4, 56GBASE-R4, 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASE-KR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASE-KR, SGMII
	Data Rate: 1/10/25/40/50/100 Gb/s – Ethernet
	PCI Express Gen3: SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible)
Power and Environmental	Voltage: 12V, 3.3V
	Typical Power^a: Passive Cables – 13.91W
	Maximum Power: Passive Cables – 15.70W 3.5W Active Cables – 19.59W
	Maximum power available through QSFP28 port: 3.5W
	Temperature: Operational 0°C to 55°C Non-operational -40°C to 70°C
	Humidity: 90% relative humidity ^b
	Air Flow: See Airflow Specifications on page 65
Regulatory	Safety: CB / cTUVus / CE
	EMC: CE / FCC / VCCI / ICES / RCM
	RoHS: RoHS-R6

a. Typical power for ATIS traffic load.

b. For both operational and non-operational states.

7.10 MCX416A-CCAT Specifications

Table 17 - MCX416A-CCAT Specifications Table

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile
	Connector: Dual QSFP28 (Copper and optical)
Protocol Support	Ethernet: 100GBASE-CR4, 100GBASE-KR4, 100GBASE-SR4, 56GBASE-R4, 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASE-KR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASE-KR, SGMII
	Data Rate: 1/10/25/40/50/100 Gb/s– Ethernet
	PCI Express Gen3: SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible)
Power and Environmental	Voltage: 12V, 3.3V
	Typical Power^a: Passive Cables – 16.12W
	Maximum Power: Passive Cables – 18.04W 3.5W Active Cables – 24.80W
	Maximum power available through QSFP28 port: 3.5W
	Temperature: Operational 0°C to 55°C Non-operational -40°C to 70°C
	Humidity: 90% relative humidity ^b
	Air Flow: See Airflow Specifications on page 65
Regulatory	Safety: CB / cTUVus / CE
	EMC: CE / FCC / VCCI / ICES / RCM
	RoHS: RoHS-R6

a. Typical power for ATIS traffic load.

b. For both operational and non-operational states.

7.11 Airflow Specifications

Air Flow (LFM) ^a						
Air Flow Direction	Heat Sink to Port			Port to Heat Sink		
	Cable Type	Passive	Active 1.5W	Active 3.5W	Passive	Active 1.5W
MCX413A-BCAT	400	450	–	400	400	–
MCX414A-BCAT	400	450	–	400	400	–
MCX416A-BCAT	400	500	–	400	400	–
MCX413A-GCAT	400	400	–	400	400	–
MCX414A-GCAT	400	450	700	400	400	600
MCX416A-GCAT	400	500	–	400	400	–
MCX415A-CCAT	400	–	700	400	–	600
MCX416A-CCAT	400	–	850	400	–	600

a. Cells marked with (–) are not applicable

7.12 Adapter Card LED Operations

There is one bi-color I/O LED per port to indicate physical and logical link status. See [Table 18](#).

Table 18 - Physical and Logical Link Indications

LED Color and State	Description
Off	Physical link has not been established
Solid Yellow	Indicates an active physical link
Blinking Yellow	Indicates a problem with the physical link
Solid Green	Indicates a valid logical (data activity) link with no active traffic
Blinking Green	Indicates a valid logical link with active traffic

7.13 Board Mechanical Drawing and Dimensions

Figure 3: Mechanical Drawing of the Single-port x8 Adapter Cards

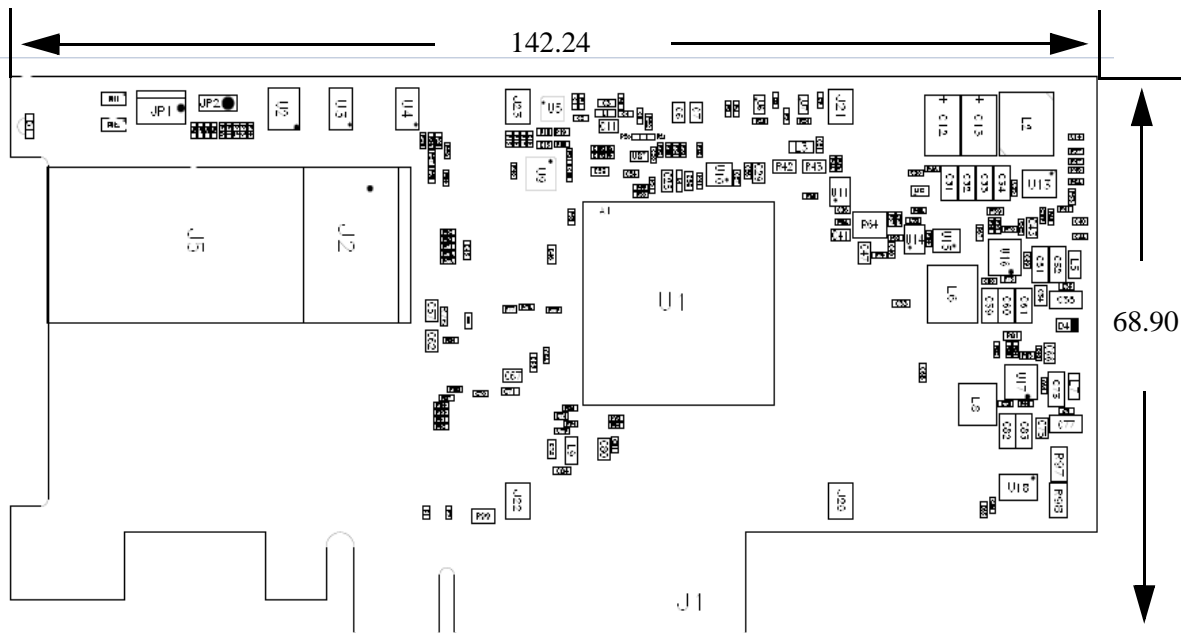


Figure 4: Mechanical Drawing of the Dual-port x8 Adapter Cards

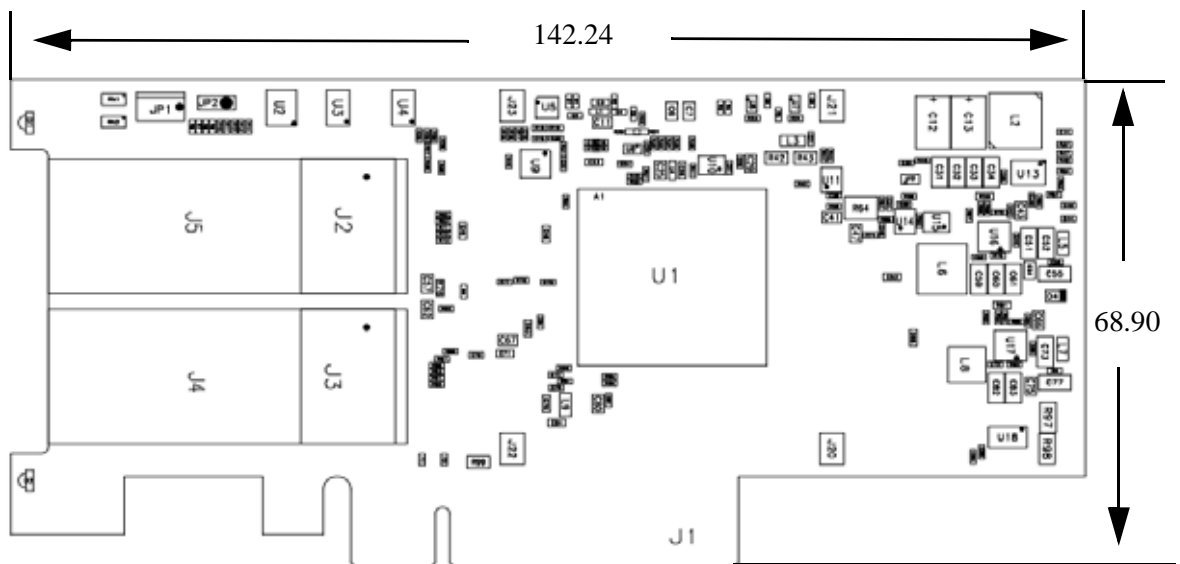


Figure 5: Mechanical Drawing of the Single-port x16 Adapter Cards

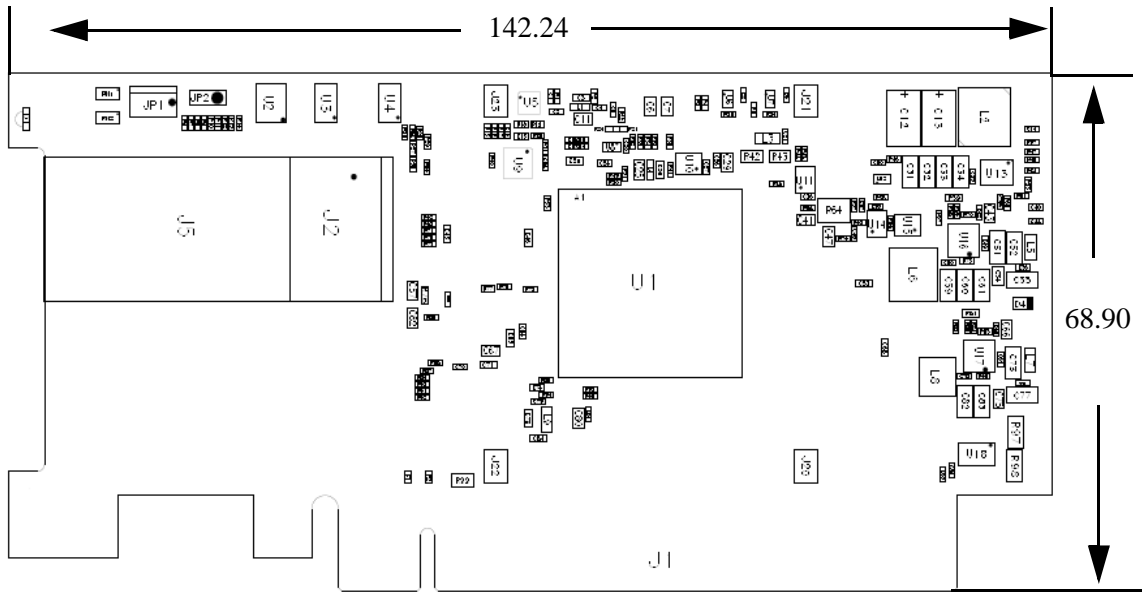
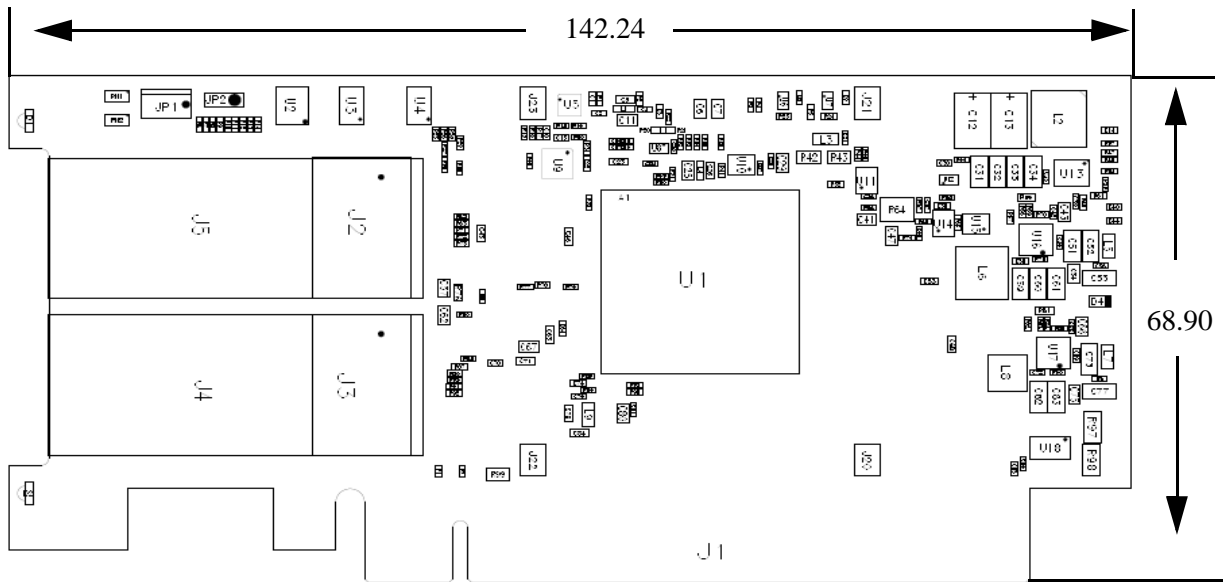


Figure 6: Mechanical Drawing of the Dual-port x16 Adapter Card



7.14 Bracket Mechanical Drawings

Figure 7: Single-port Bracket

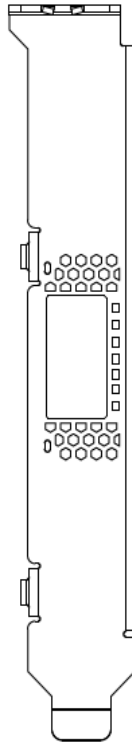
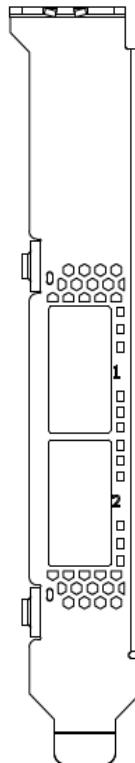


Figure 8: Dual-port Bracket



Appendix A: Interface Connectors Pinout

A.1 QSFP28 Connector Pinout

Figure 9: Connector and Cage Views

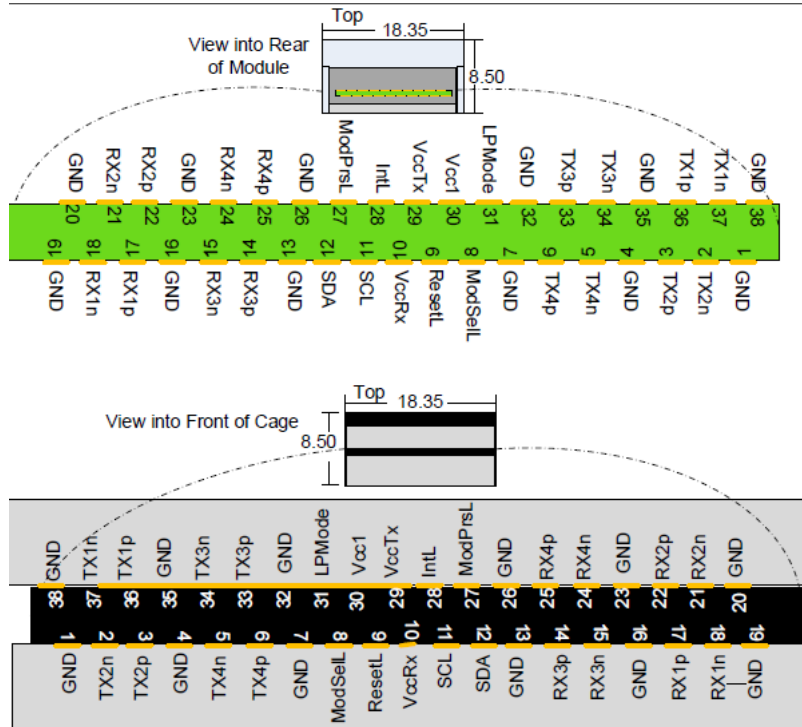


Table 19 - Connector Pin Number and Name to Signal Name Map

Connector Pin Number	Connector Pin Name	Port A Signal Name
1	GND	GND
2	TXN_2	Tx2n
3	TXP_2	Tx2p
4	GND	GND
5	TXN_4	Tx4n
6	TXP_4	Tx4p
7	GND	GND
8	ModSelL_Port0	ModSelL
9	ResetL_Port0	ResetL
10		VccRx
11	SCL	SCL
12	SDA	SDA
13	GND	GND
14	RXP_3	Rx3p
15	RXN_3	Rx3n

Table 19 - Connector Pin Number and Name to Signal Name Map

Connector Pin Number	Connector Pin Name	Port A Signal Name
16	GND	GND
17	RXP_1	Rx1p
18	RXN_1	Rx1n
19	GND	GND
20	GND	GND
21	RXN_2	Rx2n
22	RXP_2	Rx2p
23	GND	GND
24	RXN_4	Rx4n
25	RXP_4	Rx4p
26	GND	GND
27	ModPrsl_Port0	Mod PrsL
28	IntL	IntL
29		VccTx
30		Vcc1
31	LPMODE_Port0	LPMODE
32	GND	GND
33	TXP_3	Tx3p
34	TXN_3	Tx3n
35	GND	GND
36	TXP_1	Tx1p
37	TXN_1	Tx1n
38	GND	GND

7.15 PCI Express x8 or x16 Edge Connector Pinout

The adapter cards support PCI Express 3.0 x8 or x16 edge connector and the PCI Express x8 or x16 pinout according to the PCI Express 3.0 specification.

Figure 10: PCIe x8 Connector Pinout

J1		J18	
A1	PRSNT1#	+12V-1	B1
A2	+12V-5	+12V-2	B2
A3	+12V-4	+12V-3	B3
A4	GND-28	GND-29	B4
A5	TCK	SMCLK	B5
A6	TDI	SMDAT	B6
A7	TDO	GND-11	B7
A8	TMS	+3.3V-3	B8
A9	+3.3V-1	TRST#	B9
A10	+3.3V-2	3.3Vaux	B10
A11	PERST#	WAKE#/OBFF	B11
A12	GND-22	RSVD-5	B12
A13	REFCLK+	GND-4	B13
A14	REFCLK-	PETp0	B14
A15	GND-21	PETn0	B15
A16	PERp0	GND-7	B16
A17	PERn0	B17-NC-PRSNT2-1	B18
A18	GND-19	GND-9	
A19	RSVD-4	PETp1	B19
A20	GND-18	PETn1	B20
A21	PERp1	GND-32	B21
A22	PERn1	GND-13	B22
A23	GND-15	PETp2	B23
A24	GND-14	PETn2	B24
A25	PERp2	GND-16	B25
A26	PERn2	GND-17	B26
A27	GND-24	PETp3	B27
A28	GND-10	PETn3	B28
A29	PERp3	GND-20	B29
A30	PERn3	RSVD-2	B30
A31	GND-8	B31-NC-PRSNT2-1	B32
A32	RSVD-3	GND-23	
A33	RSVD-1	PETp4	B33
A34	GND-6	PETn4	B34
A35	PERp4	GND-26	B35
A36	PERn4	GND-27	B36
A37	GND-5	PETp5	B37
A38	GND-3	PETn5	B38
A39	PERp5	GND-30	B39
A40	PERn5	GND-31	B40
A41	GND-2	PETp6	B41
A42	GND-1	PETn6	B42
A43	PERp6	GND-34	B43

Figure 11: PCIe x16 Connector Pinout

A1	PRSENT1#	+12V-5	B1
A2	+12V-3	+12V-1	B2
A3	+12V-4	+12V-2	B3
A4	GND-44	GND-49	B4
A5	TCK	SMCLK	B5
A6	TDI	SMDAT	B6
A7	TDO	GND-21	B7
A8	TMS	+3.3V-3	B8
A9	+3.3V-1	TRST#	B9
A10	+3.3V-2	3.3Vaux	B10
A11	PERST#	WAKE#/OBFF	B11
A12	GND-52	RSVD-3	B12
A13	REFCLK+	GND-4	B13
A14	REFCLK-	PETp0	B14
A15	GND-55	PETn0	B15
A16	PERp0	GND-7	B16
A17	PERn0	B17- NC-PRSENT2#	B17
A18	GND-58	GND-9	B18
A19	RSVD-7	PETp1	B19
A20	GND-60	PETn1	B20
A21	PERp1	GND-12	B21
A22	PERn1	GND-13	B22
A23	GND-63	PETp2	B23
A24	GND-64	PETn2	B24
A25	PERp2	GND-16	B25
A26	PERn2	GND-17	B26
A27	GND-67	PETp3	B27
A28	GND-66	PETn3	B28
A29	PERp3	GND-20	B29
A30	PERn3	RSVD-6	B30
A31	GND-65	B31-NC-PRSENT2#	B31
A32	RSVD-2	GND-23	B32
A33	RSVD-1	PETp4	B33
A34	GND-62	PETn4	B34
A35	PERp4	GND-26	B35
A36	PERn4	GND-27	B36
A37	GND-61	PETp5	B37
A38	GND-59	PETn5	B38
A39	PERp5	GND-30	B39
A40	PERn5	GND-31	B40
A41	GND-57	PETp6	B41
A42	GND-56	PETn6	B42
A43	PERp6	GND-34	B43
A44	PERn6	GND-35	B44
A45	GND-54	PETp7	B45
A46	GND-53	PETn7	B46
A47	PERp7	GND-38	B47
A48	PERn7	B48-NC-PRSENT2#	B48
A49	GND-51	GND-40	B49
A50	RSVD-5	PETp8	B50
A51	GND-48	PETn8	B51
A52	PERp8	GND-50	B52
A53	PERn8	GND-19	B53
A54	GND-47	PETp9	B54
A55	GND-46	PETn9	B55
A56	PERp9	GND-18	B56
A57	PERn9	GND-15	B57
A58	GND-45	PETp10	B58
A59	GND-41	PETn10	B59
A60	PERp10	GND-14	B60
A61	PERn10	GND-11	B61
A62	GND-39	PETp11	B62
A63	GND-37	PETn11	B63
A64	PERp11	GND-10	B64
A65	PERn11	GND-8	B65
A66	GND-36	PETp12	B66
A67	GND-33	PETn12	B67
A68	PERp12	GND-6	B68
A69	PERn12	GND-5	B69
A70	GND-32	PETp13	B70
A71	GND-29	PETn13	B71
A72	PERp13	GND-3	B72
A73	PERn13	GND-2	B73
A74	GND-28	PETp14	B74
A75	GND-25	PETn14	B75
A76	PERp14	GND-1	B76
A77	PERn14	GND-42	B77
A78	GND-24	PETp15	B78
A79	GND-22	PETn15	B79
A80	PERp15	GND-43	B80
A81	PERn15	PRSENT2#-3	B81
A82	GND-68	RSVD-4	B82

Appendix B: Finding the MAC and Serial Number on the Adapter Card

Each Mellanox adapter card has a different identifier printed on the label: serial number and the card MAC for the Ethernet protocol.



The revision indicated on the labels in the following figures do not necessarily represent the latest revision of the card.

Figure 12: MCX413A-BCAT Board Label



Figure 13: MCX414A-BCAT Board Label



Figure 14: MCX415A-BCAT Board Label*Figure 15: MCX416A-BCAT Board Label**Figure 16: MCX413A-GCAT Board Label*

Figure 17: MCX414A-GCAT Board Label*Figure 18: MCX415A-GCAT Board Label**Figure 19: MCX415A-CCAT Board Label*

Figure 20: MCX416A-GCAT Board Label*Figure 21: MCX416A-CCAT Board Label*

Appendix C: Safety Warnings

1. Installation Instructions



Read all installation instructions before connecting the equipment to the power source.

2. Over-temperature



This equipment should not be operated in an area with an ambient temperature exceeding the maximum recommended: 55°C (131°F).

To guarantee proper air flow, allow at least 8cm (3 inches) of clearance around the ventilation openings.

3. During Lightning - Electrical Hazard



During periods of lightning activity, do not work on the equipment or connect or disconnect cables.

4. Copper Cable Connecting/Disconnecting



Some copper cables are heavy and not flexible, as such they should be carefully attached to or detached from the connectors. Refer to the cable manufacturer for special warnings and instructions.

5. Equipment Installation



This equipment should be installed, replaced, or serviced only by trained and qualified personnel.

6. Equipment Disposal



Disposal of this equipment should be in accordance to all national laws and regulations.

7. Local and National Electrical Codes



This equipment should be installed in compliance with local and national electrical codes.

8. Hazardous Radiation Exposure



Caution – Use of controls or adjustment or performance of procedures other than those specified herein may result in hazardous radiation exposure.



CLASS 1 LASER PRODUCT and reference to the most recent laser standards:
IEC 60 825-1:1993 + A1:1997 + A2:2001 and EN 60825-1:1994+A1:1996+A2:20.

Appendix D: Avertissements de sécurité d'installation (Warnings in French)

1. Instructions d'installation



Lisez toutes les instructions d'installation avant de brancher le matériel à la source d'alimentation électrique.

2. Température excessive



Ce matériel ne doit pas fonctionner dans une zone avec une température ambiante dépassant le maximum recommandé de 55°C (131°F). Un flux d'air de 200LFM à cette température ambiante maximale est nécessaire. En outre, pour garantir un bon écoulement de l'air, laissez au moins 8 cm (3 pouces) d'espace libre autour des ouvertures de ventilation.

3. Orages – dangers électriques



Pendant un orage, il ne faut pas utiliser le matériel et il ne faut pas brancher ou débrancher les câbles.

4. Branchement/débranchement des câbles en cuivre



Les câbles en cuivre sont lourds et ne sont pas flexibles, il faut donc faire très attention en les branchant et en les débranchant des connecteurs. Consultez le fabricant des câbles pour connaître les mises en garde et les instructions spéciales.

5. Installation du matériel



Ce matériel ne doit être installé, remplacé ou entretenu que par du personnel formé et qualifié.

6. Elimination du matériel



L'élimination de ce matériel doit s'effectuer dans le respect de toutes les législations et réglementations nationales en vigueur.

7. Codes électriques locaux et nationaux



Ce matériel doit être installé dans le respect des codes électriques locaux et nationaux.

8. Exposition au rayonnement grave



Mise en garde – l'utilisation de commandes ou de réglages ou l'exécution de procédures autres que ce qui est spécifié dans les présentes peut engendrer une exposition au rayonnement grave.



PRODUIT LASER DE CLASSE 1 » et références aux normes laser les plus récentes CEI 60 825-1

Appendix E: Sicherheitshinweise (Warnings in German)

1. Installationsanleitungen



Lesen Sie alle Installationsanleitungen, bevor Sie das Gerät an die Stromversorgung anschließen.

2. Übertemperatur



Dieses Gerät sollte nicht in einem Bereich mit einer Umgebungstemperatur über der maximal empfohlenen Temperatur von 55°C (131°F) betrieben werden. Es ist ein Luftstrom von 200 LFM bei maximaler Umgebungstemperatur erforderlich. Außerdem sollten mindestens 8 cm (3 in.) Freiraum um die Belüftungsöffnungen sein, um einen einwandfreien Luftstrom zu gewährleisten.

3. Bei Gewitter - Elektrische Gefahr



Arbeiten Sie während eines Gewitters und Blitzschlag nicht am Gerät, schließen Sie keine Kabel an oder ab.

4. Anschließen/Trennen von -Kupferkabel



Kupferkabel sind schwer und nicht flexible. Deshalb müssen sie vorsichtig an die Anschlüsse angebracht bzw. davon getrennt werden. Lesen Sie die speziellen Warnungen und Anleitungen des Kabelherstellers.

5. Geräteinstallation



Diese Gerät sollte nur von geschultem und qualifiziertem Personal installiert, ausgetauscht oder gewartet werden.

6. Geräteentsorgung



Die Entsorgung dieses Geräts sollte unter Beachtung aller nationalen Gesetze Bestimmungen erfolgen.

7. Regionale und nationale elektrische Bestimmungen



Dieses Gerät sollte unter Beachtung der regionalen und nationalen elektrischen Bestimmungen installiert werden.



This equipment should be installed in compliance with local and national electrical codes.

8. Strahlenkontakt



Achtung – Nutzung von Steuerungen oder Einstellungen oder Ausführung von Prozeduren, die hier nicht spezifiziert sind, kann zu gefährlichem Strahlenkontakt führen.



Klasse 1 Laserprodukt und Referenzen zu den aktuellsten Lasterstandards :
ICE 60 825-1

Appendix F: Advertencias de seguridad para la instalación (Warnings in Spanish)

1. Instrucciones de instalación



Antes de conectar el equipo a la fuente de alimentación, leer todas las instrucciones de instalación.

2. Sobrecalentamiento



No se debe utilizar el equipo en un área con una temperatura ambiente superior a la máxima recomendada: 55°C(131°F). Además, para garantizar una circulación de aire adecuada, se debe dejar como mínimo un espacio de 8 cm (3 pulgadas) alrededor de las aberturas de ventilación.

3. Cuando hay rayos: peligro de descarga eléctrica



No utilizar el equipo ni conectar o desconectar cables durante períodos de actividad de rayos.

4. Conexión y desconexión del cable Copper



Dado que los cables de cobre son pesados y no son flexibles, su conexión a los conectores y su desconexión se deben efectuar con mucho cuidado. Para ver advertencias o instrucciones especiales, consultar al fabricante del cable.

5. Instalación de equipos



La instalación, el reemplazo y el mantenimiento de este equipo estarán a cargo únicamente de personal capacitado y competente.

6. Eliminación de equipos



La eliminación definitiva de este equipo se debe efectuar conforme a todas las leyes y reglamentaciones nacionales.

7. Códigos eléctricos locales y nacionales



Este equipo se debe instalar conforme a los códigos eléctricos locales y nacionales.

8. Exposición a niveles de radiación peligrosos



Precaución: el uso de controles o ajustes o la realización de procedimientos distintos de los que aquí se especifican podrían causar exposición a niveles de radiación peligrosos.



PRODUCTO LÁSER DE CLASE 1 y referencia a las normas de láser más recientes:
IEC 60825-1