# ConnectX®-4 VPI Single and Dual QSFP28 Port Adapter Card User Manual

P/N:

MCX453A-FCAT, MCX454A-FCAT, MCX455A-FCAT, MCX456A-FCAT, MCX455A-ECAT, MCX456A-ECAT

Rev 1.0

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Mellanox Technologies
350 Oakmead Parkway Suite 100
Sunnyvale, CA 94085
U.S.A.
www.mellanox.com
Tel: (408) 970-3400
Fax: (408) 970-3403

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# Revision History

This document was printed on June 23, 2015.

***Table 1 - Revision History Table***

| Date | Rev | Comments/Changes |
|:---:|:---:|:---|
| June 2015 | 1.0 | First Release |

# About this Manual

This *User Manual* describes Mellanox Technologies ConnectX®-4 VPI Single and Dual QSFP28 port PCI Express x8 and x16 adapter cards. 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 InfiniBand and Ethernet network and architecture specifications.

## Related Documentation

***Table 2 - Documents List***

| | |
|---|---|
| *Mellanox Firmware Tools (MFT) User Manual*<br>Document no. 2204UG | User Manual describing the set of MFT firmware management tools for a single node.<br>See http://www.mellanox.com => Products => Software => Firmware Tools |
| *IBTA Specification Release 1.3* | InfiniBand Architecture Specification |
| *IEEE Std 802.3 Specification* | This is the IEEE Ethernet specification<br>http://standards.ieee.org/getieee802 |
| *PCI Express 3.0 Specifications* | Industry Standard PCI Express 3.0 Base and Card Electromechanical 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.

## Technical Support

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• URL: http://www.mellanox.com => Support

• E-mail: support@mellanox.com

• Tel: +1.408.916.0055

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http://www.mellanox.com => Support

or use the following link to go directly to the Mellanox Support Download Assistant page,

http://www.mellanox.com/supportdownloader/.

# 1 Introduction

This is the User Guide for Mellanox Technologies 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:

## 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 FDR Adapter Cards*

| | |
|---|---|
| **Ordering Part Number (OPN)** | MCX453A-FCAT/MCX455A-FCAT- single-port card<br>MCX454A-FCAT/MCX456A-FCAT - dual-port card |
| **Data Transmission Rate** | InfiniBand: FDR (56 Gb/s)<br>Ethernet: 40/56Gb/s |
| **Network Connector Types** | single or dual-port QSFP28 |
| **PCI Express (PCIe) SerDes Speed** | MCX453A-FCAT/MCX454A-FCAT: PCIe 3.0 x8 8GT/s<br>MCX455A-FCAT/MCX456A-FCAT: PCIe 3.0 x16 8GT/s |
| **RoHS** | R6 |
| **Adapter IC Part Number** | MT27704A0-FDCF-FV<br>MT27708A0-FDCF-FV |

**Table 4 - Single and Dual-port EDR Adapter Cards**

| | |
|---|---|
| **Ordering Part Number (OPN)** | MCX455A-ECAT- single-port card<br>MCX456A-ECAT - dual-port card |
| **Data Transmission Rate** | InfiniBand: EDR (100 Gb/s)<br>Ethernet: 40/56/100Gb/s |
| **Network Connector Types** | single or dual-port QSFP28 |
| **PCI Express (PCIe) SerDes Speed** | PCIe 3.0 x16 8GT/s |
| **RoHS** | R6 |
| **Adapter IC Part Number** | MT27704A0-FDCF-EV<br>MT27708A0-FDCF-EV |

## 1.2    Features and Benefits

*Table 5 - Features*

| | |
|---|---|
| **100Gb/s Virtual Protocol Interconnect (VPI) Adapter** | ConnectX-4 offers the highest throughput VPI adapter, supporting EDR 100Gb/s InfiniBand and 100Gb/s Ethernet and enabling any standard networking, clustering, or storage to operate seamlessly over any converged network leveraging a consolidated software stack. |
| **InfiniBand Architecture Specification v1.3 compliant** | ConnectX-4 delivers low latency, high bandwidth, and computing efficiency for performance-driven server and storage clustering applications. ConnectX-4 is InfiniBand Architecture Specification v1.3 compliant. |
| **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** | Mellanox adapters comply with the following IEEE 802.3* standards:<br> 100GbE / 56GbE / 50GbE / 40GbE / 25GbE /10GbE / 1GbE<br>– IEEE 802.3bj, 802.3bm 100 Gigabit Ethernet<br>– 25G Ethernet Consortium 25, 50 GigabitEthernet<br>– IEEE 802.3ba 40 Gigabit Ethernet<br>– IEEE 802.3ae 10 Gigabit Ethernet<br>– IEEE 802.3az Energy Efficient Ethernet<br>– IEEE 802.3ap based auto-negotiation and KRstartup<br>– Proprietary Ethernet protocols (20/40GBASE-R2, 50/56GBASE-R4)<br>– IEEE 802.3ad, 802.1AX Link Aggregation<br>– IEEE 802.1Q, 802.1P VLAN tags and priority<br>– IEEE 802.1Qau (QCN) – Congestion Notification<br>– IEEE 802.1Qaz (ETS)<br>– IEEE 802.1Qbb (PFC)<br>– IEEE 802.1Qbg<br>– IEEE 1588v2<br>– Jumbo frame support (9.6KB) |
| **InfiniBand EDR** | A standard InfiniBand data rate, where each lane of a 4X port runs a bit rate of 25.0625Gb/s with a 64b/66b encoding, resulting in an effective bandwidth of 100Gb/s. |
| **InfiniBand FDR** | A standard InfiniBand data rate, where each lane of a 4X port runs a bit rate of 14.0625Gb/s with a 64b/66b encoding, resulting in an effective bandwidth of 54.54Gb/s. |
| **Memory** | PCI Express - stores and accesses InfiniBand and/or Ethernet fabric connection information and packet data<br>SPI - includes one16MB SPI Flash device (M25PX16-VMN6P device by ST Microelectronics)<br>EEPROM - accessible through the $I^2C$-compatible interface. The EEPROM capacity is 128Kb. |

**Table 5 - Features**

| | |
|---|---|
| **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. |
| **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 InfiniBand RDMA for high-performance storage access. |

## 1.3     Operating Systems/Distributions

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

## 1.4     Connectivity

- Interoperable with InfiniBand or 10/25/40/50/100Gb 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:

- "InfiniBand Interface"
- "Ethernet Interface"
- "PCI Express Interface"
- "I2C-compatible Interface"
- "LED Interface"

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

## 2.1    InfiniBand Interface

The network ports of the ConnectX®-4 adapter cards are compliant with the *InfiniBand Architecture Specification, Release 1.3* InfiniBand traffic is transmitted through the cards' QSFP28 connectors.

## 2.2    Ethernet Interface

The network ports of the ConnectX®-4 adapter cards are compliant with the IEEE 802.3 Ethernet standards listed in Table 5, "Features," on page 13. Ethernet traffic is transmitted through the cards' QSFP28 connectors.

## 2.3    PCI Express Interface

The ConnectX®-4 adapter cards support PCI Express 3.0 (1.1 and 2.0 compatible) through an x8/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 8.0GT/s link rate x16
- Auto-negotiates to x16, x8, x4, x2, or x1
- Support for MSI/MSI-X mechanisms

## 2.4    I$^2$C-compatible Interface

A three-pin header on the adapter cards is provided as the I$^2$C-compatible interface. See Figure 4, "Mechanical Drawing of the Dual-port MCX456A-[E/F]CAT Adapter Card," on page 54 for the location on the board.

## 2.5    LED Interface

There is a one bi-color I/O LED per port. For LED specifications please refer to Section 7.7, "Adapter LED Operation," on page 54.

# 3        Hardware Installation

## 3.1     System Requirements

### 3.1.1    Hardware

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

### 3.1.2    Operating Systems/Distributions

Please refer to Section 1.3, "Operating Systems/Distributions," on page 14.

### 3.1.3    Software Stacks

Mellanox OpenFabric software package - MLNX_OFED for Linux, WinOF-2 for Windows. See Chapter 4,"Driver Installation" on page 22.

## 3.2     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.

## 3.3     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.

## 3.4     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 3.5, "Card Installation Instructions," on page 18. If you need to replace it with the short bracket that is included in the shipping box, please follow the instructions in this section.

Note: 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

### 3.4.1   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.

### 3.4.2   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 lbs-in torque on the screws.

## 3.5   Card Installation Instructions

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. Place the adapter in an available PCI Express slot.

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

> Do not use excessive force when seating the card, as this may damage the system or the adapter.

5. Secure the adapter with the adapter clip or screw.

6. Close the system case.

## 3.6 Cables and Modules

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

### 3.6.1 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 7.7, "Adapter LED Operation," on page 54.

4. After plugging in a cable, lock the connector using the latching mechanism particular to the cable vendor. When a logical connection is made the Green LED will light. When data is being transferred the Green LED will blink. See Section 7.7, "Adapter LED Operation," on page 54.

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.

## 3.7    Identify the Card in Your System

### 3.7.1    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 **Device Instance Id** (Windows 2003) or **Hardware Ids** (Windows 2008/R2) from the Properties pull-down menu.

*Figure 1: PCI Device*
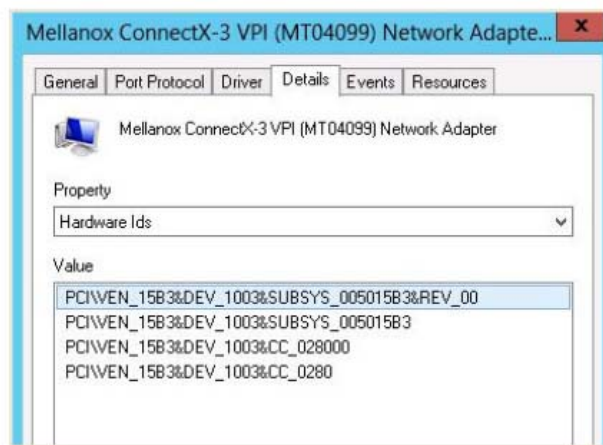


5. In the Value display box, check the fields VEN and DEV (fields are separated by '&'). In the display example above, notice the sub-string "PCI\VEN_15B3&DEV_1003": VEN is equal to 0x15B3 – this is the Vendor ID of Mellanox Technologies; and DEV is equal to 1003 – this is a valid Mellanox Technologies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

### 3.7.2 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 => InfiniBand/VPI Drivers => Download. This chapter describes how to install and test the Mellanox OFED for Linux package on a single host machine with Mellanox ConnectX-3 Pro adapter hardware installed

### 4.1.1    Hardware and Software Requirements

*Table 6 - Software and Hardware Requirements*

| Requirements | Description |
|---|---|
| Platforms | A server platform with an adapter card based on one of the following Mellanox Technologies' InfiniBand HCA devices:<br>• MT4115 ConnectX®-4 (VPI, IB, EN) (firmware: fw-ConnectX4)<br>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.<br>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
06:00.0 Network controller: Mellanox Technologies MT27500 Family [ConnectX-3]
Subsystem: Mellanox Technologies Device 0024
```

**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> InfiniBand 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 automatically[1] 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 an unsupported network adapter device, no firmware update will occur and the error message below will be printed. Please contact your hardware vendor for help on firmware updates.
>
> Error message:
> ```
> Device #1:
> ----------
>   Device:          0000:05:00.0
>   Part Number:
>   Description:
>   PSID:            MT_0DB0110010
>   Versions:        Current         Available
>      FW            2.9.1000        N/A
>   Status:          No matching image found
> ```

**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 | • Most of MLNX_OFED packages are installed under the "/usr" directory except for the following packages which are installed under the "/opt" directory:<br>  • openshmem, bupc, fca and ibutils<br>• The kernel modules are installed under<br>  • /lib/modules/`uname -r`/updates on SLES and Fedora Distributions<br>  • /lib/modules/`uname -r`/extra/mlnx-ofa_kernel on RHEL and other RedHat like Distributions<br>  • /lib/modules/`uname -r`/updates/dkms/ on Ubuntu |
|---|---|
| Firmware | • The firmware of existing network adapter devices will be updated if the following two conditions are fulfilled:<br>  • The installation script is run in default mode; that is, without the option '--without-fw-update'<br>  • The firmware version of the adapter device is older than the firmware version included with the Mellanox OFED ISO image<br>    **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.<br>• In case your machine has an unsupported network adapter device, no firmware update will occur and the error message below will be printed.<br>`-I- Querying device ...`<br>`-E- Can't auto detect fw configuration file: ...`<br>Please contact your hardware vendor for help on firmware updates. |

### 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

Table 7 lists the `mlnxofedinstall` script return codes and their meanings.

*Table 7 - mlnxofedinstall Return Codes*

| 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 `mst` driver |

## 4.1.4  Port Type Management

ConnectX®-4 ports can be individually configured to work as InfiniBand or Ethernet ports. By default both ConnectX ports are initialized as InfiniBand ports. If you wish to change the port type, use the mlxconfig script after the driver is loaded.

For further information on how to set the port type in ConnectX®-4, please refer to the MFT User Manual (www.mellanox.com -> Products --> Software --> InfiniBand/VPI Software --> Linux SW/Drivers).

## 4.1.5  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.

## 4.1.6  Installing MLNX_OFED using YUM

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

#### 4.1.6.1 Setting up MLNX_OFED YUM Repository

**Step 1.** Log into the installation machine as root.

**Step 2.** Mount the ISO image on your machine.

```
# 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> InfiniBand 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@mel-
lanox.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.** Install the createrepo.rpm package.

```
# yum install createrepo
```

**Step 7.** MLNX_OFED YUM repository using the "mlnx_create_yum_repo.sh" script located in the downloaded MLNX_OFED package.

```
# ./mlnx_create_yum_repo.sh --mlnx_ofed /mnt --target /repos
Creating MLNX_OFED_LINUX YUM Repository under /repos...
See log file /tmp/mlnx_yum.24250.log
comps file was not provided, going to build it...
Copying RPMS...
Building YUM Repository...
Creating YUM Repository settings file at: /tmp/mlnx_ofed.repo
Done.
Copy /tmp/mlnx_ofed.repo to /etc/yum.repos.d/ to use MLNX_OFED YUM Repository.
```

**Step 8.** Copy the created YUM repository configuration file to `/etc/yum.repos.d/`.

```
# cp /tmp/mlnx_ofed.repo /etc/yum.repos.d/
```

**Step 9.** 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 subscrip-
tion-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
```

### 4.1.6.2 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 grouplist | grep MLNX_OFED
   MLNX_OFED ALL
   MLNX_OFED BASIC
   MLNX_OFED GUEST
   MLNX_OFED HYPERVISOR
   MLNX_OFED VMA
   MLNX_OFED VMA-ETH
   MLNX_OFED VMA-VPI
```

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 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.
```

**Step 2.** Install the desired group.

```
# yum groupinstall 'MLNX_OFED ALL'
Loaded plugins: product-id, security, subscription-manager
This system is not registered to Red Hat Subscription Management. You can use subscrip-
tion-manager to register.
Setting up Group Process
Resolving Dependencies
--> Running transaction check
---> Package ar_mgr.x86_64 0:1.0-0.11.g22fff4a will be installed
...............
...............
  rds-devel.x86_64 0:2.0.6mlnx-1
  rds-tools.x86_64 0:2.0.6mlnx-1
  srptools.x86_64 0:0.0.4mlnx3-OFED.2.0.2.6.7.11.ge863cb7
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 the `mlnxofedinstall` script with the `"--fw-update-only"` flag

   or

• Update the firmware to the latest version available on Mellanox Technologies' Web site
  as described in Chapter 5,"Updating Adapter Card Firmware" on page 43.

### 4.1.6.3 Uninstalling Mellanox OFED using the YUM Tool

If MLNX_OFED was installed using the yum tool, then it can be uninstalled as follow:

```
yum groupremove '<group name>'ᵃ
```

     a. The "`<group name>`" must be the same group name that was previously used to install
       MLNX_OFED.

## 4.1.7 Installing MLNX_OFED using apt-get

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

### 4.1.7.1 Setting up MLNX_OFED apt-get Repository

**Step 1.** Log into the installation machine as root.

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

You can download it from http://www.mellanox.com > Products > Software> InfiniBand
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
```

### 4.1.7.2 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-all
    mlnx-ofed-basic
    mlnx-ofed-vma
    mlnx-ofed-vma-eth
    mlnx-ofed-vma-vpi
```

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-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
```

### 4.1.7.3 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.

## 4.1.8 Updating Firmware After Installation

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

### 4.1.8.1 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:      ConnectX3
Part Number:      MCX354A-FCA_A2-A4
Description:      ConnectX-3 VPI adapter card; dual-port QSFP; FDR IB (56Gb/s) and
40GigE;           PCIe3.0 x8 8GT/s; 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.
```

### 4.1.8.2  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.

## 4.1.9  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.

### 4.1.9.1  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`

### 4.1.9.2 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 massage 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 - taint-
ing 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 mes-

sage. 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
```

### 4.1.10 Performance Tuning

For further information on Linux performance, please refer to the Performance Tuning Guide for Mellanox Network Adapters.

## 4.2    Windows Driver

For Windows, download and install the latest Mellanox WinOF VPI for Windows software package available via the Mellanox web site at: http://www.mellanox.com => Products => Software => Infin Band/VPI 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 8 - Hardware and Software Requirements*

| Description[a] | Package |
|---|---|
| Windows Server 2012 R2 (64 bit only) | MLNX_WinOF2-1_10_All_x64.exe |
| Windows Server 2012 (64 bit only) | MLNX_WinOF2-1_10_All_x64.exe |

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

### 4.2.2    Installing Mellanox WinOF-2 Driver

> WinOF-2 supports adapter cards based on the Mellanox ConnectX®-4 family of adapter IC devices only. If you have ConnectX-3 and ConnectX-3 Pro on your server, you will need to install WinOF driver.
> For details on how to install WinOF driver, please refer to WinOF User Manual.

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.

#### 4.2.2.1 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_10_All_x64.exe /v"/l*vx [LogFile]"
```

**Step 3.** Click Next in the Welcome screen.
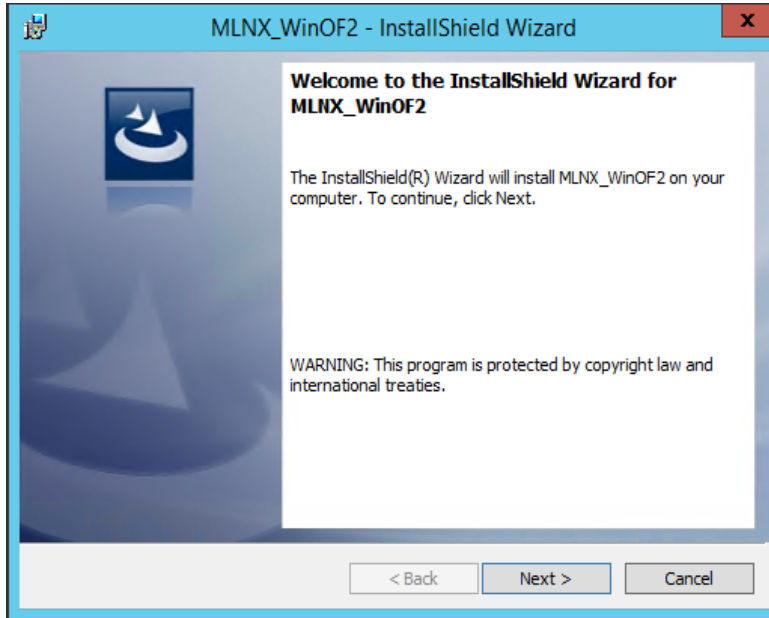
**Step 4.** Read then accept the license agreement and click Next.
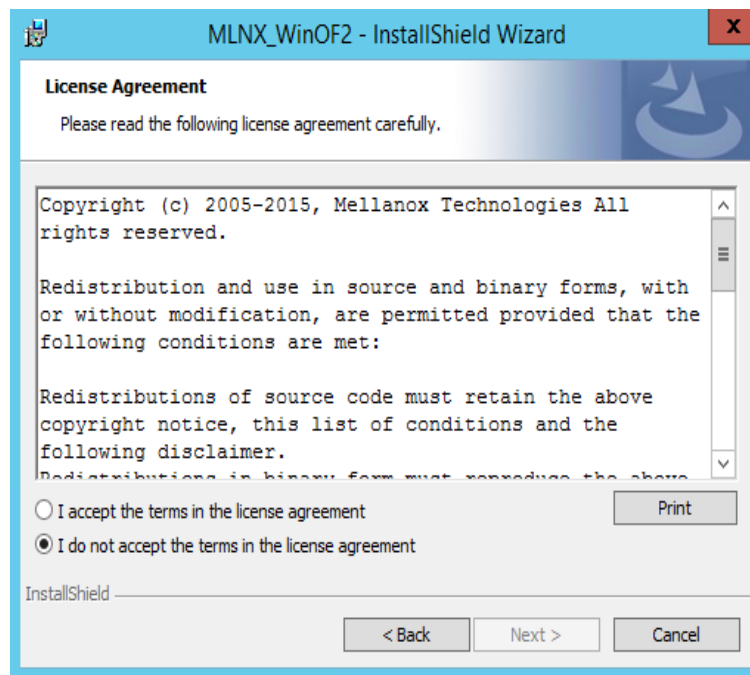


**Step 5.** Select the target folder for the installation.
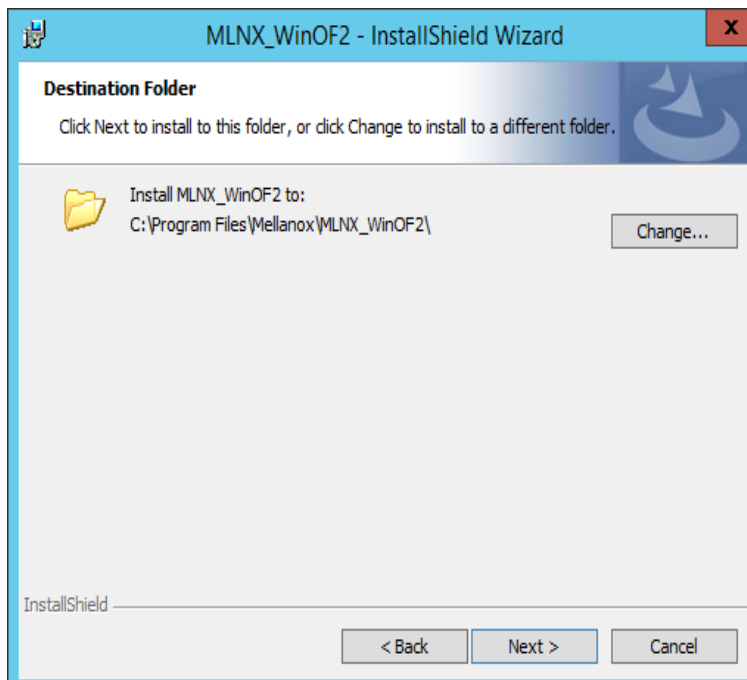
**Step 6.** Select a Complete or Custom installation, follow Step a and on, on page 36.
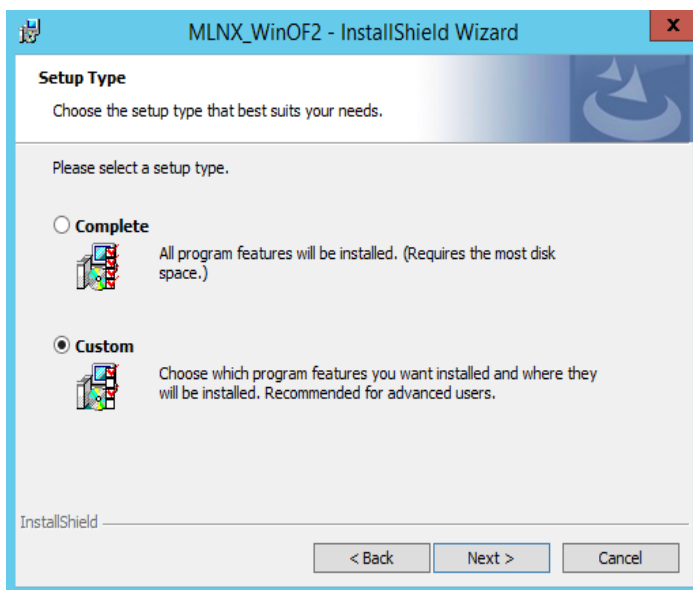


a.Select the desired feature to install:

- Performances tools - install the performance tools that are used to measure performance in user environment.

- Documentation - contains the User Manual and Release Notes.
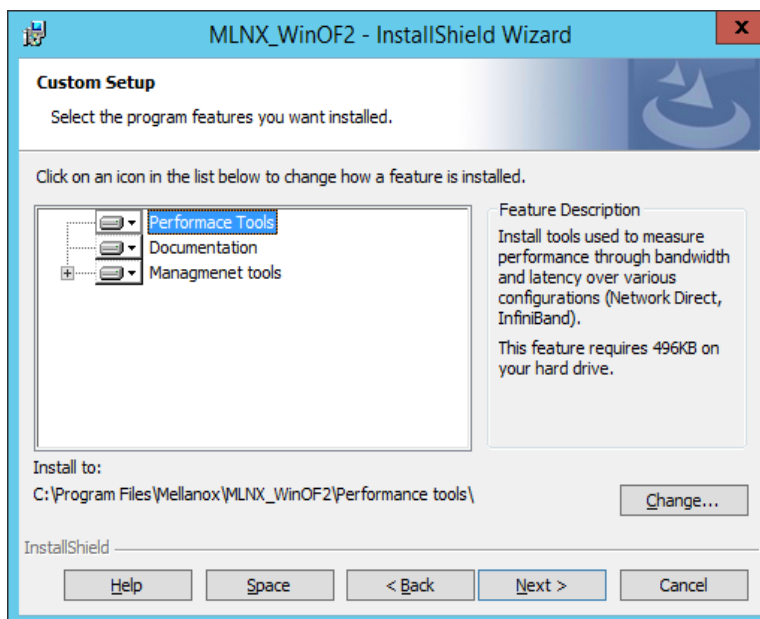
b. Click Install to start the installation.
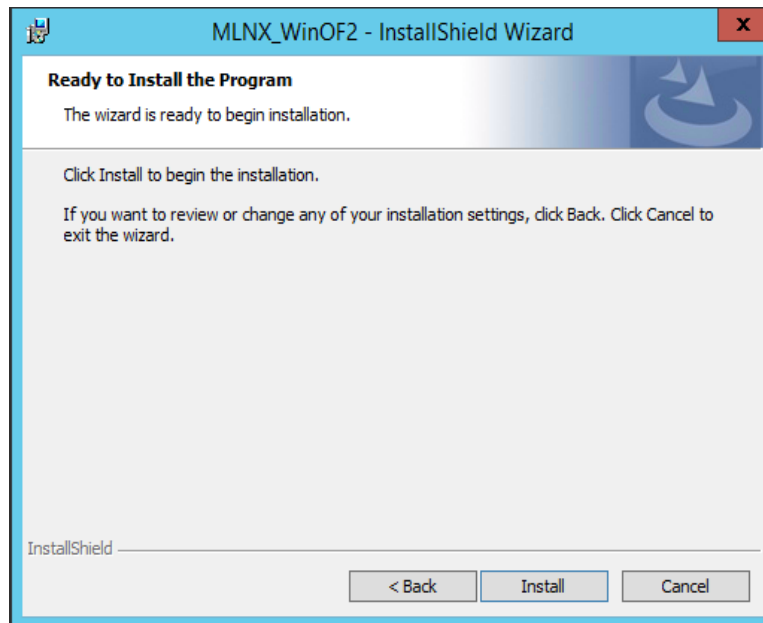


**Step 7.** Click Finish to complete the installation.

#### 4.2.2.2 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 **[Windows Server 2012 R2] -** Click Start --> Task Manager-->File --> Run new task --> and enter CMD.

**Step 2.** Install the driver. Run:

```
> MLNX_WinOF2-1_10_All_x64.exe /S /v"/qn"
```

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

```
> MLNX_WinOF2-1_10_All_x64.exe /S /v"/qn" /v"/l*vx [LogFile]"
```

**Step 4.** [Optional] if you want to control whether to install ND provider or not[1].

```
> MLNX_WinOF2_1_10_All_win2012_x64.exe /vMT_NDPROPERTY=1
```

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

### 4.2.3 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\ETH

To see the Mellanox network adapter device, and the Ethernet or IPoIB network device (depending on the used card) for each port, display the Device Manager and expand "Network adapters".

---

1. MT_NDPROPERTY default value is True

*Figure 2: Installation Results*
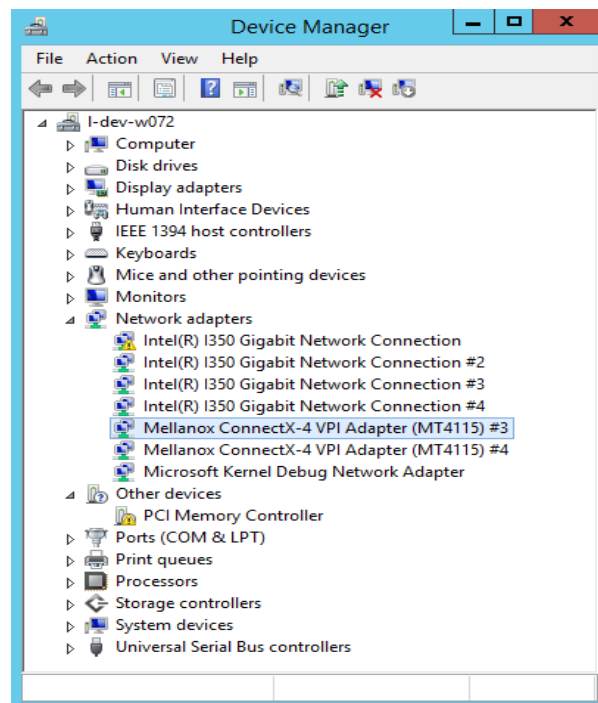


## 4.2.4   Extracting Files Without Running Installation

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

**Step 1.** Open a CMD console **[Windows Server 2012 R2] -** Click Start --> Task Manager-->File --> Run new task --> and enter CMD.

**Step 2.** Extract the driver and the tools:

```
> MLNX_WinOF2-1_10_All_x64 /a
```

- To extract only the driver files.

```
> MLNX_WinOF2-1_10_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.
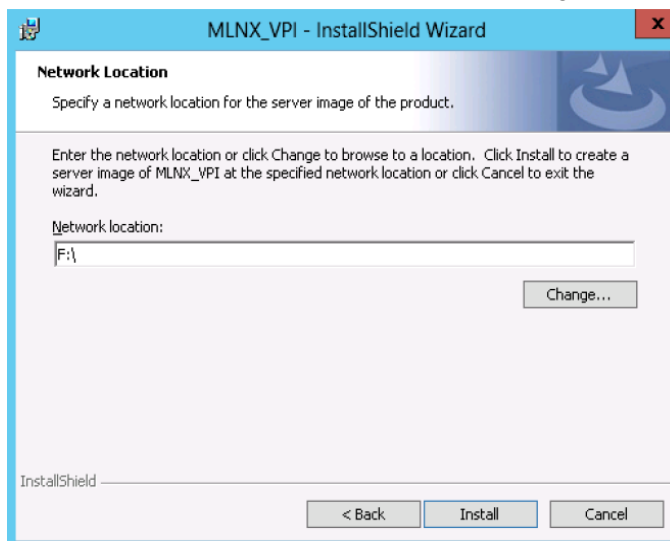
**Step 6.** To complete the extraction, click Finish.
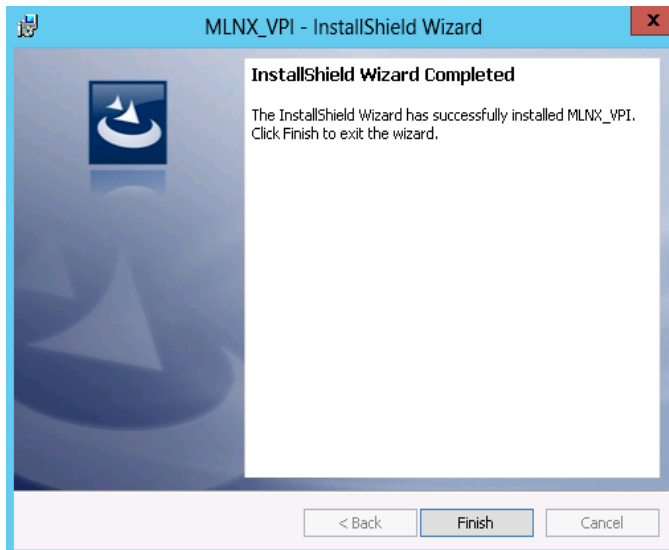


## 4.2.5   Uninstalling Mellanox WinOF-2 Driver
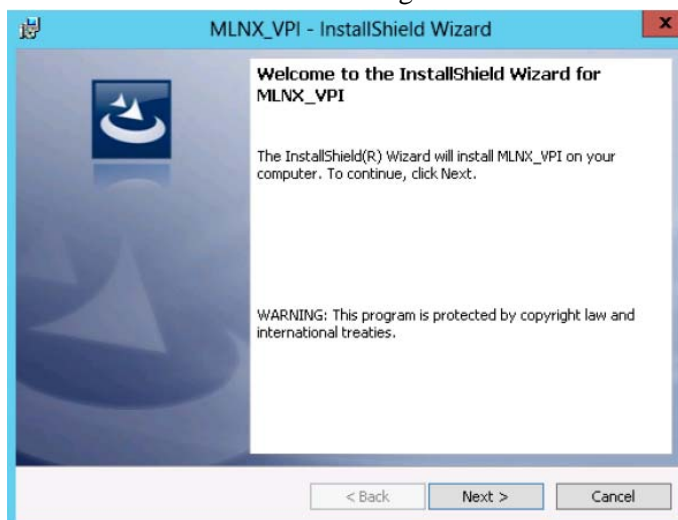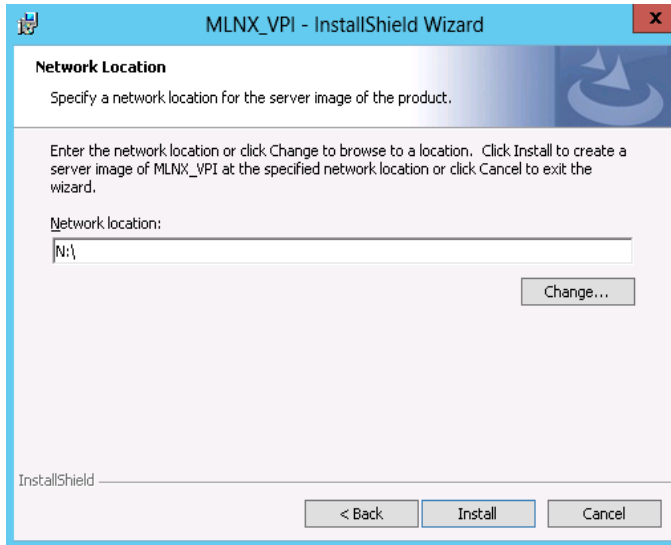
### 4.2.5.1  Attended Uninstallation

➢ *To uninstall MLNX_WinOF2 on a single node:*

Click Start-> Control Panel-> Programs and Features-> MLNX_WinOF2-> Uninstall.
(NOTE: This requires elevated administrator privileges – see Section 1.1, "Supplied Packages", on page 11 for details.)

### 4.2.5.2  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_WinOF in unattended mode:*

**Step 1.** Open a CMD console **[Windows Server 2012 R2] -** Click Start --> Task Manager-->File --> Run new task --> and enter CMD.

**Step 2.** Uninstall the driver. Run:

```
> MLNX_WinOF2-1_10_All_win2012_x64.exe /S /x /v"/qn"
```

## 4.2.6   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 -> InfiniBand/VPI Drivers -> Firmware Tools

The adapter card may not have been shipped with the latest firmware version. The section below describes how to update firmware.

# 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 and the most recent firmware can be obtained from: http://www.mellanox.com=> Support. Check that the firmware on your card is the latest found on the Mellanox site, if not update to the latest version found on the Mellanox web site.

Firmware can be updated on the stand-alone single card using the **flint** tool of the *Mellanox Firmware Tools (MFT)* package. This package is available for download, along with its user manual, from the Mellanox Firmware Tools page. See http://www.mellanox.com => Software => Firmware Tools.

The following steps describe how to retrieve the PSID (firmware identification) and programmed firmware version of your adapter card. They also describe how to update the card with the latest firmware version available.

1. Retrieve the PSID and firmware version:

    a. Install the MFT package. The package is available at http://www.mellanox.com => Products => Software => Firmware Tools. Make sure to download the package corresponding to your computer's operating system.

    b. Enter: mst start.

    c. Get the Mellanox *mst device name* using the command "mst status". The mst device name will be of the form: /dev/mst/mt4099_pci_cr0.

    d. Get the PSID (firmware identification) and programmed firmware version using the command.

Note: The shown versions and/or parameter values in the example below may not reflect the latest or actual values for this product, and are included here for illustration purposes only.

```
> flint -d /dev/mst/mt4103_pci_cr0  q
Image type:      ConnectX-4
FW Version:      2.9.4000
Device ID:       4103
Chip Revision:   0
Description:     Node                    Port1                   Port2
Sys image
GUIDs:                 000002c900000200 000002c900000201 000002c900000202
000002c900000203
MACs:
000002c90200         000002c90201
Board ID:        (MT_1020110019)
VSD:
PSID:                 MT_1020110019
```

1. Compare the programmed firmware version with the latest available.

    a. Go to Mellanox's web site: http://www.mellanox.com/supportdownloader. See Figure 3.

    b. Enter your card PSID to display the latest firmware file. The file name of the binary is composed by combining the firmware name, the firmware release version, and the card part number.

Note: Please contact Mellanox System Support if you cannot find the firmware binary for your adapter card.

*Figure 3: Support Download Assistant*



1.  If a newer firmware version exists for your adapter card on the Web, update the firmware as follows:

    a.  Download the firmware (image) zip file from the Support Downloader (see Step 2a above).

    b.  Unzip the firmware image.

    c.  Burn the firmware image. Enter:

```
> flint -d /dev/mst/mt4099_pci_cr0 -i <binary image> burn
```

    a.  Reboot the computer.

    b.  Enter: mst start.

    c.  Verify that the card firmware was updated successfully.

```
> flint -d /dev/mst/mt4103_pci_cr0  q
Image type:      ConnectX-4
FW Version:     2.9.4100
Device ID:         4103
...
```

# 6    Troubleshooting

## 6.1    General

| | |
|---|---|
| **Server unable to find the adapter** | • Ensure that the adapter is placed correctly<br>• Make sure the adapter slot and the adapter are compatible<br>• Install the adapter in a different PCI Express slot<br>• Use the drivers that came with the adapter or download the latest<br>• Make sure your motherboard has the latest BIOS<br>• Try to reboot the server |
| **The adapter no longer works** | • Reseat the adapter in its slot or a different slot, if necessary<br>• Try using another cable<br>• Reinstall the drivers for the network driver files may be damaged or deleted<br>• Reboot the server |
| **Adapters stopped working after installing another adapter** | • Try removing and re-installing all adapters<br>• Check that cables are connected properly<br>• Make sure your motherboard has the latest BIOS |
| **Link indicator light is off** | • Ensure that adapter driver/s is loaded<br>• Try another port on the switch<br>• Make sure the cable is securely attached<br>• Check your are using the proper cables that do not exceed the recommended lengths<br>• Verify that your switch and adapter port are compatible |
| **Link light is on, but with no communication established** | • Check that the latest driver is loaded<br>• Check that both the adapter and its link are set to the same speed and duplex settings |

## 6.2    Linux

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

## 6.3    Windows

| | |
|---|---|
| **Environment Information** | From the Windows desktop choose the Start menu and run:<br>msinfo32<br>To export system information to a text file, choose the Export option from the File menu.<br>Assign a file name and save. |
| **Mellanox Firmware Tool (MFT)** | Download and install MFT: http://www.mellanox.com/content/pages.php?pg=management_tools&menu_section=34<br>Refer to the User Manual for installation instructions.<br><br>Once installed, open a CMD window and run:<br>cd C:\Program Files\Mellanox\WinMFT<br>mst start<br>mst status<br>flint –d <mst_device> q |

| Ports Information | vstat |
|---|---|
| **Firmware Version Upgrade** | Download the latest firmware version using the PSID/board ID:<br>http://www.mellanox.com/supportdownloader/<br>flint –d <mst_device> –i <firmware_bin_file> b |
| **Collect log file** | • Event log viewer<br>• MST device logs:<br>  • mst start<br>  • mst status<br>  • C:\Users\Administrator> flint –d <mst_device> dc > dump_configuration.log<br>  • C:\Users\Administrator> mstdump <mst_device> dc > mstdump.log |

# 7 Specifications

## 7.1 MCX453A-FCAT Specifications

*Table 9 - MCX453A-FCAT Specifications Table*

| | |
|---|---|
| **Physical** | **Size:** 2.71 in. x5.6 in. (68.90mm x 142.24 mm) |
| | **Connector:** QSFP28 InfiniBand (Copper and optical) |
| **Protocol Support** | **InfiniBand:** IBTA v1.3<br>Auto-Negotiation[a]: 1X/2X/4X SDR (2.5Gb/s per lane), DDR (5Gb/s per lane), QDR (10Gb/s per lane), FDR10 (10.3125Gb/s per lane), FDR (14.0625Gb/s per lane) port |
| | **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:** Up to 56Gb/s FDR– InfiniBand<br>1/10/25/40/50/56Gb/s – Ethernet |
| | **PCI Express Gen3:** SERDES @ 8.0GT/s, 8 lanes (2.0 and 1.1 compatible) |
| **Power and Environmental** | **Voltage:** 12V, 3.3V |
| | **Typ Power:** Passive Cables 10.56W |
| | **Max Power:** Passive Cables 12.30W |
| | **Max power available through QSFP28 port:** 3.5W |
| | **Temperature:** Operational 0°C to 55°C<br>Non-operational -40°C to 70°C |
| | **Humidity:** 90% relative humidity[b] |
| | **Air Flow[c]:** 600LFM in case of 3.5W QSFP cable<br>350LFM in case of 1.5W QSFP cable |
| **Regulatory** | **Safety:** IEC/EN 60950-1:2006<br>ETSI EN 300 019-2-2<br>IEC 60068-2- 64, 29, 32 |
| | **RoHS:** RoHS-R6 |

a. The ConnectX-4 adapters supplement the IBTA auto-negotiation specification to get better bit error rates and longer cable reaches. This supplemental feature only initiates when connected to another Mellanox InfiniBand product.
b. For both operational and non-operational states.
c. Air flow is measured ~1" from the heat sink between the heat sink and the cooling air inlet.

## 7.2    MCX454A-FCAT Specifications

*Table 10 - MCX454A-FCAT Specifications Table*

| | |
|---|---|
| **Physical** | **Size:** 2.71 in. x5.6 in. (68.90mm x 142.24 mm) |
| | **Connector:** QSFP28 InfiniBand (Copper and optical) |
| **Protocol Support** | **InfiniBand:** IBTA v1.3<br>Auto-Negotiation[a]: 1X/2X/4X SDR (2.5Gb/s per lane), DDR (5Gb/s per lane), QDR (10Gb/s per lane), FDR10 (10.3125Gb/s per lane), FDR (14.0625Gb/s per lane) port |
| | **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:** Up to 56Gb/s FDR– InfiniBand<br>              1/10/25/40/50/56Gb/s – Ethernet |
| | **PCI Express Gen3:** SERDES @ 8.0GT/s, 8 lanes (2.0 and 1.1 compatible) |
| **Power and Environmental** | **Voltage:** 12V, 3.3V |
| | **Typ Power:** Passive Cables 12.46W |
| | **Max Power:** Passive Cables 14.20W |
| | **Max power available through QSFP28 port:** 3.5W |
| | **Temperature:** Operational 0°C to 55°C<br>              Non-operational -40°C to 70°C |
| | **Humidity:** 90% relative humidity[b] |
| | **Air Flow[c]:** 600LFM in case of 3.5W QSFP cable<br>              350LFM in case of 1.5W QSFP cable |
| **Regulatory** | **Safety:** IEC/EN 60950-1:2006<br>ETSI EN 300 019-2-2<br>IEC 60068-2- 64, 29, 32 |
| | **RoHS:** RoHS-R6 |

a. The ConnectX-4 adapters supplement the IBTA auto-negotiation specification to get better bit error rates and longer cable reaches. This supplemental feature only initiates when connected to another Mellanox InfiniBand product.

b. For both operational and non-operational states.

c. Air flow is measured ~1" from the heat sink between the heat sink and the cooling air inlet.

## 7.3    MCX455A-FCAT Specifications

*Table 11 - MCX455A-FCAT Specifications Table*

| | |
|---|---|
| **Physical** | **Size:** 2.71 in. x5.6 in. (68.90mm x 142.24 mm) |
| | **Connector:** QSFP28 InfiniBand (Copper and optical) |
| **Protocol Support** | **InfiniBand:** IBTA v1.3<br>Auto-Negotiation[a]: 1X/2X/4X SDR (2.5Gb/s per lane), DDR (5Gb/s per lane), QDR (10Gb/s per lane), FDR10 (10.3125Gb/s per lane), FDR (14.0625Gb/s per lane) port |
| | **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:** Up to 56Gb/s FDR– InfiniBand<br>1/10/40/56Gb/s – Ethernet |
| | **PCI Express Gen3:** SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible) |
| **Power and Environmental** | **Voltage:** 12V, 3.3V |
| | **Typ Power:** Passive Cables 13.76W |
| | **Max Power:** Passive Cables 15.63W |
| | **Max power available through QSFP28 port:** 3.5W |
| | **Temperature:** Operational 0°C to 55°C<br>Non-operational -40°C to 70°C |
| | **Humidity:** 90% relative humidity[b] |
| | **Air Flow[c]:** 600LFM in case of 3.5W QSFP cable<br>350LFM in case of 1.5W QSFP cable |
| **Regulatory** | **Safety:** IEC/EN 60950-1:2006<br>ETSI EN 300 019-2-2<br>IEC 60068-2- 64, 29, 32 |
| | **RoHS:** RoHS-R6 |

a. The ConnectX-4 adapters supplement the IBTA auto-negotiation specification to get better bit error rates and longer cable reaches. This supplemental feature only initiates when connected to another Mellanox InfiniBand product.
b. For both operational and non-operational states.
c. Air flow is measured ~1" from the heat sink between the heat sink and the cooling air inlet.

## 7.4    MCX456A-FCAT Specifications

*Table 12 - MCX456A-FCAT Specifications Table*

| | |
|---|---|
| **Physical** | **Size:** 2.71 in. x5.6 in. (68.90mm x 142.24 mm) |
| | **Connector:** QSFP28 InfiniBand (Copper and optical) |
| **Protocol Support** | **InfiniBand:** IBTA v1.3<br>Auto-Negotiation[a]: 1X/2X/4X SDR (2.5Gb/s per lane), DDR (5Gb/s per lane), QDR (10Gb/s per lane), FDR10 (10.3125Gb/s per lane), FDR (14.0625Gb/s per lane) port |
| | **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:** Up to 56Gb/s FDR– InfiniBand<br>1/10/40/56Gb/s – Ethernet |
| | **PCI Express Gen3:** SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible) |
| **Power and Environmental** | **Voltage:** 12V, 3.3V |
| | **Typ Power:** Passive Cables 15.66W |
| | **Max Power:** Passive Cables 17.86W |
| | **Max power available through QSFP28 port:** 3.5W |
| | **Temperature:** Operational 0°C to 55°C<br>Non-operational -40°C to 70°C |
| | **Humidity:** 90% relative humidity[b] |
| | **Air Flow[c]:** 600LFM in case of 3.5W QSFP cable<br>350LFM in case of 1.5W QSFP cable |
| **Regulatory** | **Safety:** IEC/EN 60950-1:2006<br>ETSI EN 300 019-2-2<br>IEC 60068-2- 64, 29, 32 |
| | **RoHS:** RoHS-R6 |

a. The ConnectX-4 adapters supplement the IBTA auto-negotiation specification to get better bit error rates and longer cable reaches. This supplemental feature only initiates when connected to another Mellanox InfiniBand product.
b. For both operational and non-operational states.
c. Air flow is measured ~1" from the heat sink between the heat sink and the cooling air inlet.

## 7.5 MCX455A-ECAT Specifications

*Table 13 - MCX455A-ECAT Specifications Table*

| | |
|---|---|
| **Physical** | **Size:** 2.71 in. x5.6 in. (68.90mm x 142.25 mm) |
| | **Connector:** QSFP28 InfiniBand (Copper and optical) |
| **Protocol Support** | **InfiniBand:** IBTA v1.3<br>Auto-Negotiation[a]: 1X/2X/4X SDR (2.5Gb/s per lane), DDR (5Gb/s per lane), QDR (10Gb/s per lane), FDR10 (10.3125Gb/s per lane), FDR (14.0625Gb/s per lane), EDR (25Gb/s per lane) port |
| | **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:** Up to 100Gb/s EDR– InfiniBand<br>1/10/40/56/100Gb/s – Ethernet |
| | **PCI Express Gen3:** SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible) |
| **Power and Environmental** | **Voltage:** 12V, 3.3V |
| | **Typ Power:** Passive Cables 14.25W |
| | **Max Power:** Passive Cables 16.48W |
| | **Max power available through QSFP28 port:** 3.5W |
| | **Temperature:** Operational 0°C to 55°C<br>Non-operational -40°C to 70°C |
| | **Humidity:** 90% relative humidity[b] |
| | **Air Flow**[c]**:** 600LFM in case of 3.5W QSFP cable<br>350LFM in case of 1.5W QSFP cable |
| **Regulatory** | **Safety:** IEC/EN 60950-1:2006<br>ETSI EN 300 019-2-2<br>IEC 60068-2- 64, 29, 32 |
| | **RoHS:** RoHS-R6 |

a. The ConnectX-4 adapters supplement the IBTA auto-negotiation specification to get better bit error rates and longer cable reaches. This supplemental feature only initiates when connected to another Mellanox InfiniBand product.
b. For both operational and non-operational states.
c. Air flow is measured ~1" from the heat sink between the heat sink and the cooling air inlet.

## 7.6     MCX456A-ECAT Specifications

*Table 14 - MCX456A-ECAT Specifications Table*

| | |
|---|---|
| **Physical** | **Size:** 2.71 in. x5.6 in. (68.90mm x 142.24 mm) |
| | **Connector:** QSFP28 InfiniBand (Copper and optical) |
| **Protocol Support** | **InfiniBand:** IBTA v1.3<br>Auto-Negotiation[a]: 1X/2X/4X SDR (2.5Gb/s per lane), DDR (5Gb/s per lane), QDR (10Gb/s per lane), FDR10 (10.3125Gb/s per lane), FDR (14.0625Gb/s per lane), EDR (25Gb/s per lane) port |
| | **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:** Up to 100Gb/s EDR– InfiniBand<br>1/10/40/56/100Gb/s – Ethernet |
| | **PCI Express Gen3:** SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible) |
| **Power and Environmental** | **Voltage:** 12V, 3.3V |
| | **Typ Power:** Passive Cables 16.17W |
| | **Max Power:** Passive Cables 18.43W |
| | **Max power available through QSFP28 port:** 3.5W |
| | **Temperature:** Operational 0°C to 55°C<br>Non-operational -40°C to 70°C |
| | **Humidity:** 90% relative humidity[b] |
| | **Air Flow[c]:** 600LFM in case of 3.5W QSFP cable<br>350LFM in case of 1.5W QSFP cable |
| **Regulatory** | **Safety:** IEC/EN 60950-1:2006<br>ETSI EN 300 019-2-2<br>IEC 60068-2- 64, 29, 32 |
| | **RoHS:** RoHS-R6 |

a. The ConnectX-4 adapters supplement the IBTA auto-negotiation specification to get better bit error rates and longer cable reaches. This supplemental feature only initiates when connected to another Mellanox InfiniBand product.
b. For both operational and non-operational states.
c. Air flow is measured ~1" from the heat sink between the heat sink and the cooling air inlet.

## 7.7    Adapter LED Operation

There is a one bi-color I/O LED per port. See Table 15.

*Table 15 - Physical and Logical Link Indications*

| LED | Function |
|---|---|
| Yellow - physical link | • Constant on indicates a good physical link<br>• Blinking indicates a problem with the physical link<br>• If neither LED is lit, then the physical link has not been established |
| Green - logical (data activity) link | • A constant green indicates a valid logical (data activity) link without data transfer.<br>• A blinking green indicates a valid logical link with data transfer<br>• If only the green LED is lit and the yellow LED is off, then the logical link has not been established |

## 7.8    Board Mechanical Drawing and Dimensions

All dimensions are in millimeters.
All the mechanical tolerances are +/- 0.1mm.

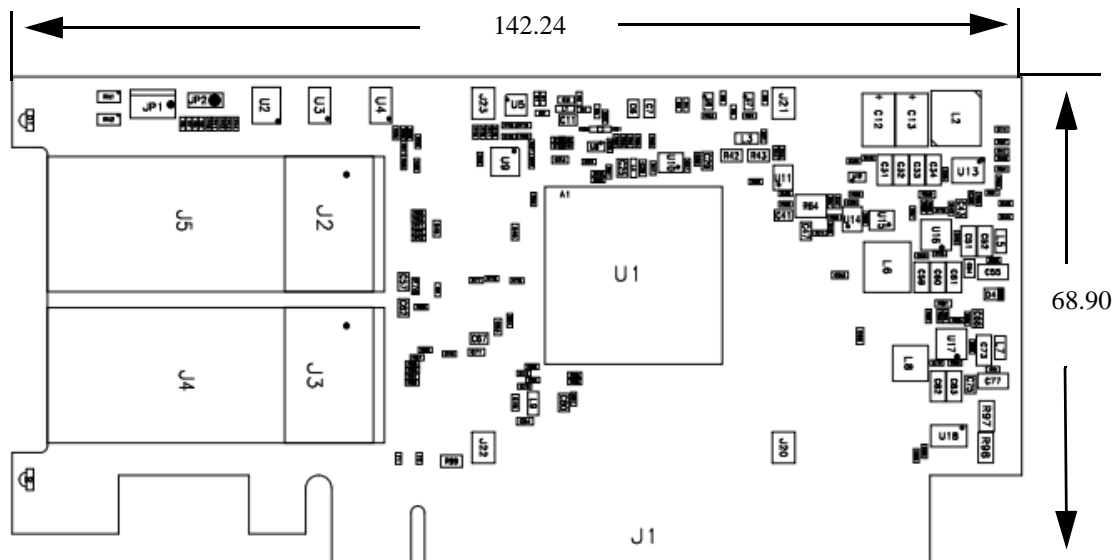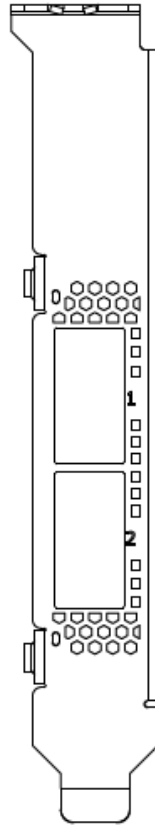*Figure 4: Mechanical Drawing of the Dual-port MCX456A-[E/F]CAT Adapter Card*

*Figure 5: Dual-port Bracket*

# Appendix A: Interface Connectors Pinout

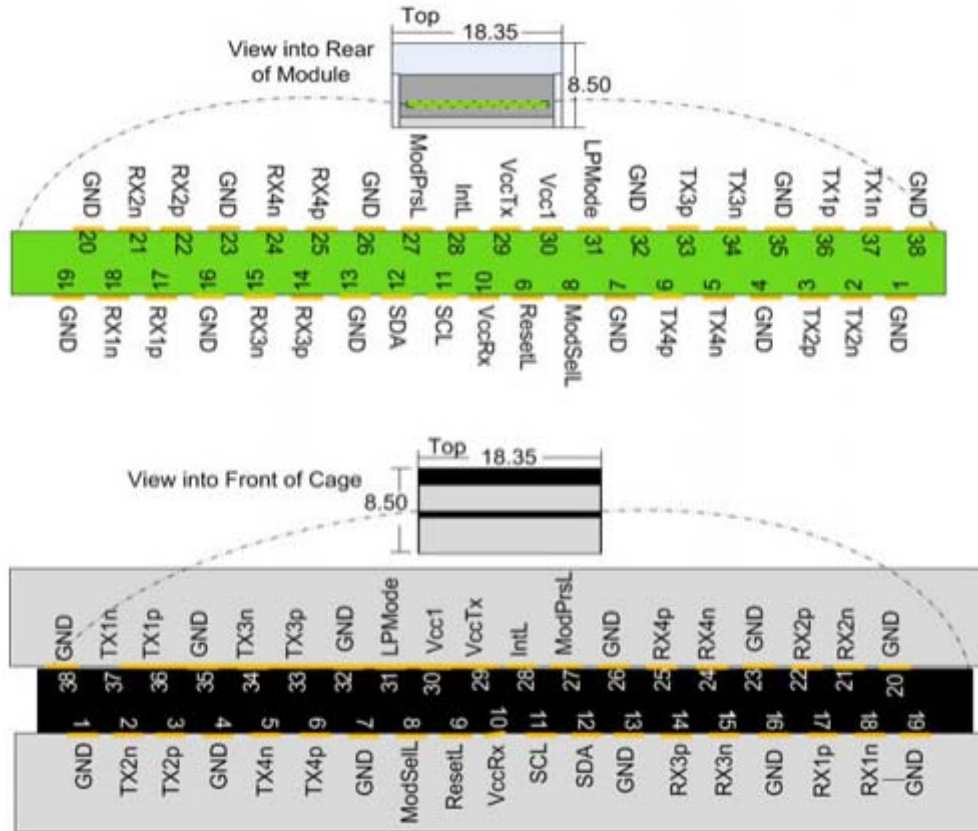## A.1 QSFP28 Connector Pinout

*Figure 6: Connector and Cage Views*



*Table 16 - 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 |

*Table 16 - Connector Pin Number and Name to Signal Name Map*

| Connector Pin Number | Connector Pin Name | Port A Signal Name |
|---|---|---|
| 12 | SDA | SDA |
| 13 | GND | GND |
| 14 | RXP_3 | Rx3p |
| 15 | RXN_3 | Rx3n |
| 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 |

## A.2 PCI Express x16/x16 or x8 Connector Pinout

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

**Figure 7: PCIe x8 Connector Pinout**

| A | | B | |
|---|---|---|---|
| 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 | REPCLK+ | GND-4 | B13 |
| A14 | REPCLK- | PETp0 | B14 |
| A15 | GND-21 | PETn0 | B15 |
| A16 | PERp0 | GND-7 | B16 |
| A17 | PERn0 | B17-NC-PRSNT2-1 | |
| A18 | GND-19 | GND-9 | B18 |
| 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 | |
| A32 | RSVD-3 | GND-23 | B32 |
| 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 |
| A44 | PERn6 | GND-35 | B44 |
| A45 | GND-25 | PETp7 | B45 |
| A46 | GND-12 | PETn7 | B46 |
| A47 | PERp7 | GND-37 | B47 |
| A48 | PERn7 | PRSNT2#-3 | B48 |
| A49 | GND-33 | GND-36 | B49 |

**Figure 8: PCIe x16 Connector Pinout**

## A.3    I²C-compatible Connector Pinout

*Figure 9: Compatible Connector Plug and Pinout*
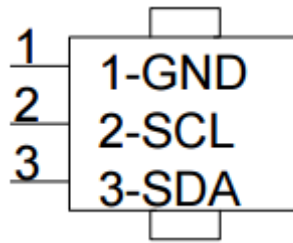


| Connector Pin Number | Signal Name |
|:---:|:---:|
| 1 | GND |
| 2 | SCL |
| 3 | SDA |

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

Each Mellanox adapter card has a different identifier printed on the label: serial number the card MAC for the Ethernet protocol. and the card GUID for the InfiniBand protocol. VPI cards have both a GUID and a MAC (derived from the GUID).

# 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 60 825-1:1993 + A1:1997 + A2:2001 et NE 60825-1:1994+A1:1996+ A2:2001

# 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 t

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. Strahlenkontak

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 60 825-1:1993 + A1:1997 + A2:2001 und EN 60825-1:1994+A1:1996+
A2:2001

# 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 60825-1:2007/03 y EN 60825-1:2007