



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

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P/N:

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

Rev 2.6



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## Revision History

This document was printed on October 18, 2017.

**Table 1 - Revision History Table**

Date	Rev	Comments/Changes
October 2017	2.2	<ul style="list-style-type: none"> <li>Updated the following Specifications Tables:               <ul style="list-style-type: none"> <li>MCX453A-FCAT Specifications on page 55.</li> <li>MCX454A-FCAT Specifications on page 56.</li> <li>MCX455A-FCAT Specifications on page 57.</li> <li>MCX456A-FCAT Specifications on page 58.</li> <li>MCX455A-ECAT Specifications on page 59.</li> <li>MCX456A-ECAT Specifications on page 60.</li> </ul> </li> </ul>
June 2017	2.1	<ul style="list-style-type: none"> <li>Updated Single and Dual-port EDR Adapter Cards on page 13.</li> <li>Updated MCX456A-ECAT Specifications on page 60.</li> </ul>
December 2016	2.0	<ul style="list-style-type: none"> <li>Added Section 4.2, “Windows Driver,” on page 37</li> </ul>
September 2016	1.9	<ul style="list-style-type: none"> <li>Updated Adapter Card Installation Instructions on page 18.</li> <li>Added Adapter Card Un-installation Instructions on page 20.</li> <li>Updated Troubleshooting on page 52.</li> </ul>
August 2016	1.8	<ul style="list-style-type: none"> <li>Updated Adapter Card Installation Instructions on page 18</li> <li>Updated Cable Installation on page 19.</li> <li>Updated Airflow Specifications on page 61.</li> <li>Added the following figures:               <ul style="list-style-type: none"> <li>Mechanical Drawing of the Single-port x8 Adapter Cards on page 62.</li> <li>Mechanical Drawing of the Dual-port x8 Adapter Cards on page 62.</li> <li>Mechanical Drawing of the Single-port x16 Adapter Card on page 63.</li> </ul> </li> <li>Updated Safety Warnings on page 68.</li> </ul>
April 2016	1.7	<ul style="list-style-type: none"> <li>Updated Cable Installation on page 19.</li> <li>Updated Airflow Specifications on page 61.</li> </ul>
March 2016	1.6	<ul style="list-style-type: none"> <li>Removed I2C-compatible Interface from Interfaces on page 17</li> </ul>
February 2016	1.5	<ul style="list-style-type: none"> <li>Updated speed specifications in the following sections:               <ul style="list-style-type: none"> <li>Product Overview on page 12.</li> <li>Features and Benefits on page 14.</li> <li>MCX453A-FCAT Specifications on page 55.</li> <li>MCX454A-FCAT Specifications on page 56.</li> <li>MCX455A-FCAT Specifications on page 57.</li> <li>MCX456A-FCAT Specifications on page 58.</li> <li>MCX455A-ECAT Specifications on page 59.</li> <li>MCX456A-ECAT Specifications on page 60.</li> </ul> </li> </ul>

**Table 1 - Revision History Table**

Date	Rev	Comments/Changes
February 2016	1.4	<ul style="list-style-type: none"> <li>• Added 56GbE support to the following sections:               <ul style="list-style-type: none"> <li>• Product Overview on page 12.</li> <li>• OpenFabrics Windows Distribution (WinOF-2) on page 15.</li> <li>• MCX453A-FCAT Specifications on page 55.</li> <li>• MCX454A-FCAT Specifications on page 56.</li> <li>• MCX455A-FCAT Specifications on page 57.</li> <li>• MCX456A-FCAT Specifications on page 58.</li> </ul> </li> <li>• Updating Adapter Card Firmware on page 51.</li> <li>• Updated Installing the New Bracket on page 18.</li> <li>• Removed Windows from Operating Systems/Distributions on page 15.</li> <li>• Removed VMware from the following sections:               <ul style="list-style-type: none"> <li>• Operating Systems/Distributions on page 15.</li> </ul> </li> <li>• Updated Software Stacks on page 17.</li> <li>• Updated Linux Driver on page 24.</li> <li>• Added a note to Finding the GUID/MAC and Serial Number on the Adapter Card on page 65.</li> <li>• Updated the following Board Labels:               <ul style="list-style-type: none"> <li>• MCX453A-FCAT Board Label (Example) on page 70.</li> <li>• MCX454A-FCAT Board Label (Example) on page 70.</li> <li>• MCX455A-FCAT Board Label (Example) on page 71.</li> <li>• MCX456A-FCAT Board Label (Example) on page 71.</li> </ul> </li> </ul>
December 2015	1.3	<ul style="list-style-type: none"> <li>• Added port numbers to the specification tables. See Specifications on page 55.</li> <li>• Updated MCX456A-ECAT Specifications on page 60.</li> </ul>
December 2015	1.2	<ul style="list-style-type: none"> <li>• Updated the following tables:               <ul style="list-style-type: none"> <li>• MCX416A-CCAT Specifications on page 96.</li> <li>• MCX454A-FCAT Specifications on page 57.</li> <li>• MCX455A-FCAT Specifications on page 58.</li> <li>• MCX456A-FCAT Specifications on page 59.</li> <li>• MCX455A-ECAT Specifications on page 60.</li> <li>• MCX456A-ECAT Specifications on page 61.</li> </ul> </li> <li>• Updated on page 13.</li> <li>• Updated Section 3.8.1, “On Windows,” on page 22.</li> </ul>
November 2015	1.1	<ul style="list-style-type: none"> <li>• Updated power numbers in:               <ul style="list-style-type: none"> <li>• MCX453A-FCAT Specifications on page 56.</li> <li>• MCX454A-FCAT Specifications on page 57.</li> <li>• MCX455A-FCAT Specifications on page 58.</li> <li>• MCX456A-FCAT Specifications on page 59.</li> </ul> </li> <li>• Added Airflow Specifications on page 62.</li> <li>• Added VMware Driver.</li> <li>• Updated Updating Adapter Card Firmware on page 52.</li> </ul>
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 or x16 adapter cards. The User Manual provides details as to the interfaces of the adapter card, specifications, required software and firmware for operating the adapter card, 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 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 <a href="http://www.mellanox.com">http://www.mellanox.com</a> =&gt; Products =&gt; Software =&gt; 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 <a href="http://www.mellanox.com">http://www.mellanox.com</a> =&gt; Products =&gt; Software =&gt; Firmware Tools =&gt; 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 <a href="http://www.mellanox.com">http://www.mellanox.com</a> =&gt; Products =&gt; Software =&gt; InfiniBand/VPI drivers =&gt; Mellanox OpenFabrics Enterprise Distribution for Linux (MLNX_OFED)</p>
<p><i>Mellanox OFED for Linux Release Notes</i></p>	<p>Release Notes for Mellanox OFED for Linux driver kit for Mellanox adapter cards: See: <a href="http://www.mellanox.com">http://www.mellanox.com</a> =&gt; Products =&gt; Software =&gt; InfiniBand/VPI drivers =&gt; Linux SW/Drivers =&gt; Release Notes</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 <a href="http://www.mellanox.com">http://www.mellanox.com</a> =&gt; Products =&gt; Software =&gt; InfiniBand/VPI drivers =&gt; 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 <a href="http://www.mellanox.com">http://www.mellanox.com</a> =&gt; Products =&gt; Software =&gt; InfiniBand/VPI drivers =&gt; Windows SW/Drivers</p>
<p><i>IBTA Specification Release 1.3</i></p>	<p>InfiniBand Architecture Specification: <a href="http://www.infinibandta.org/content/pages.php?pg=technology_public_specification">http://www.infinibandta.org/content/pages.php?pg=technology_public_specification</a></p>
<p><i>IEEE Std 802.3 Specification</i></p>	<p>This is the IEEE Ethernet specification <a href="http://standards.ieee.org/getieee802">http://standards.ieee.org/getieee802</a></p>

### **Table 2 - Documents List**

PCI Express 3.0 Specifications

Industry Standard PCI Express 3.0 Base and Card Electromechanical Specifications

<https://pcisig.com/specifications>

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## **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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<http://www.mellanox.com/supportdownloader/>.

# 1 Introduction

This is the User Guide for Mellanox Technologies VPI 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 12
- 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 FDR Adapter Cards**

<b>Ordering Part Number (OPN)</b>	MCX453A-FCAT/ MCX455A-FCAT – Single-port card MCX454A-FCAT/ MCX456A-FCAT– Dual-port card
<b>Data Transmission Rate</b>	InfiniBand: SDR/DDR/QDR/FDR Ethernet: 1/10/25/40/56 Gb/s
<b>Network Connector Types</b>	Single or dual-port QSFP2
<b>PCI Express (PCIe) SerDes Speed</b>	MCX453A-FCAT/MCX454A-FCAT: PCIe 3.0 x8 8GT/s MCX456A-FCAT/MCX455A-FCAT: PCIe 3.0 x16 8GT/s
<b>RoHS</b>	R6
<b>Adapter IC Part Number</b>	MT27704A0-FDCF-FV MT27708A0-FDCF-FV
<b>Device ID</b>	4115 for Physical Function (PF) 4116 for Virtual Function (VF)

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

<b>Ordering Part Number (OPN)</b>	MCX455A-ECAT – Single-port card MCX456A-ECAT – Dual-port card
<b>Data Transmission Rate</b>	<b>MCX455A-ECAT:</b> InfiniBand: SDR/DDR/QDR/FDR/EDR Ethernet: 1/10/25/40/50/100 Gb/s  <b>MCX456A-ECAT:</b> InfiniBand: SDR/DDR/QDR/FDR/EDR Ethernet: 1/10/25/40/50/56/100 Gb/s
<b>Network Connector Types</b>	Single or Dual-port QSFP28
<b>PCI Express (PCIe) SerDes Speed</b>	PCIe 3.0 x16 8GT/s
<b>RoHS</b>	R6
<b>Adapter IC Part Number</b>	MT27704A0-FDCF-EV MT27708A0-FDCF-EV
<b>Device ID</b>	4115 for Physical Function (PF) 4116 for Virtual Function (VF)

## 1.2 Features and Benefits

**Table 5 - Features<sup>a</sup>**

<p><b>100Gb/s Virtual Protocol Interconnect (VPI) Adapter</b></p>	<p>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.</p>
<p><b>InfiniBand Architecture Specification v1.3 compliant</b></p>	<p>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.</p>
<p><b>PCI Express (PCIe)</b></p>	<p>Uses PCIe Gen 3.0 (1.1 and 2.0 compatible) through an x8 or x16 edge connector up to 8GT/s</p>
<p><b>Up to 100 Gigabit Ethernet</b></p>	<p>Mellanox adapters comply with the following IEEE 802.3 standards:</p> <ul style="list-style-type: none"> <li>- 100GbE / 50GbE / 40GbE / 25GbE / 10GbE</li> <li>- IEEE 802.3bj, 802.3bm 100 Gigabit Ethernet</li> <li>- 25G Ethernet Consortium 25,50 Gigabit Ethernet</li> <li>- IEEE 802.3ba 40 Gigabit Ethernet</li> <li>- IEEE 802.3by 25 Gigabit Ethernet</li> <li>- IEEE 802.3ae 10 Gigabit Ethernet</li> <li>- IEEE 802.3az Energy Efficient Ethernet</li> <li>- IEEE 802.3ap based auto-negotiation and KRstartup</li> <li>- IEEE 802.3ad, 802.1AX Link Aggregation</li> <li>- IEEE 802.1Q, 802.1P VLAN tags and priority</li> <li>- IEEE 802.1Qau (QCN)</li> <li>- Congestion Notification</li> <li>- IEEE 802.1Qaz (ETS)</li> <li>- IEEE 802.1Qbb (PFC)</li> <li>- IEEE 802.1Qbg</li> <li>- IEEE 1588v2</li> <li>- Jumbo frame support (9.6KB)</li> </ul>
<p><b>InfiniBand EDR</b></p>	<p>A standard InfiniBand data rate, where each lane of a 4X port runs a bit rate of 25.78125Gb/s with a 64b/66b encoding, resulting in an effective bandwidth of 100Gb/s.</p>
<p><b>Memory</b></p>	<p>PCI Express - stores and accesses InfiniBand and/or Ethernet fabric connection information and packet data.          SPI - includes one 16MB SPI Flash device (M25PX16-VMN6P device by ST Microelectronics)          EEPROM capacity is 128Kb.</p>
<p><b>Overlay Networks</b></p>	<p>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 decapsulate the overlay protocol.</p>

**Table 5 - Features<sup>a</sup>**

<b>RDMA and RDMA over Converged Ethernet (RoCE)</b>	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.
<b>Mellanox PeerDirect™</b>	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.
<b>CPU offload</b>	Adapter functionality enabling reduced CPU overhead allowing more available CPU for computation tasks.
<b>Quality of Service (QoS)</b>	Support for port-based Quality of Service enabling various application requirements for latency and SLA.
<b>Hardware-based I/O Virtualization</b>	ConnectX-4 provides dedicated adapter resources and guaranteed isolation and protection for virtual machines within the server.
<b>Storage Acceleration</b>	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.
<b>SR-IOV</b>	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 10.](#)

### 1.3 Operating Systems/Distributions

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

### 1.4 Connectivity

- Interoperable with EDR InfiniBand or 1/10/25/40/50/100 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:

- “InfiniBand Interface”
- “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 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 QSFP28 Interface

The network ports of the ConnectX®-4 adapter card are compliant with the IEEE 802.3 Ethernet standards listed in [Table 5, “Features,” on page 14](#). Ethernet traffic is transmitted through the cards' QSFP28 connectors.

### 2.3 PCI Express Interface

The ConnectX®-4 adapter card supports PCI Express 3.0 (1.1 and 2.0 compatible) through an 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

### 2.4 LED Interface

There is a one bi-color I/O LED per port located on the adapter card. For LED specifications, please refer to [Section 7.8, “Adapter Card LED Operations,” on page 61](#).

## 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, and WinOF-2 for Windows. 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.
5. Please note that the card must be placed on an antistatic surface.
6. Check the card for visible signs of damage. Do not attempt to install the card if damaged.

### 3.5 Bracket Installation Instructions

The adapter 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, “Adapter](#)

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.

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

### 3.5.1 Removing the Existing Bracket

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

### 3.5.2 Installing the New Bracket

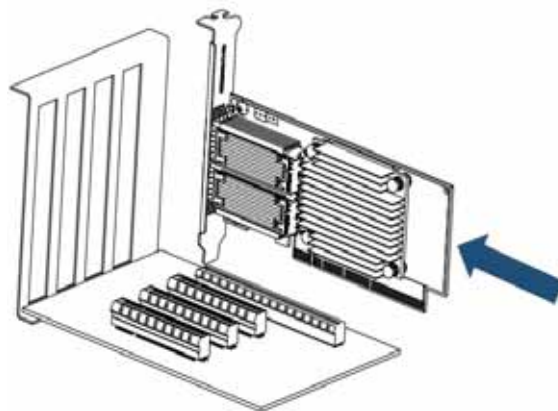
1. Place the bracket onto the adapter card until the screw holes line up.
2. Screw on the bracket using the screws saved from the bracket removal procedure above.
3. Make sure that the LEDs are aligned onto the bracket holes. Use a torque driver to apply up to 2.9 lbf-in torque on the screws.

## 3.6 Adapter Card Installation Instructions

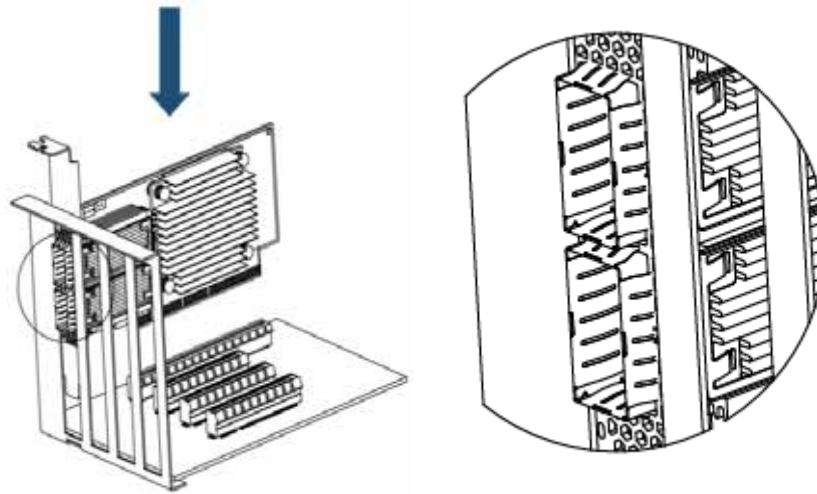


Please note that the following figures are for illustration purposes only.

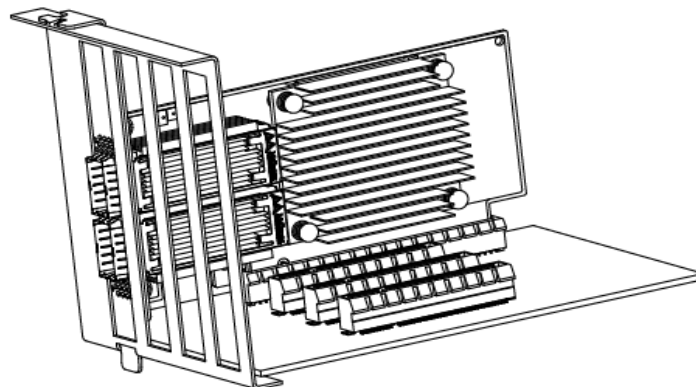
1. Before installing the card, make sure that the system is off and the power cord is not connected to the server. Please follow proper electrical grounding procedures.
2. Open the system case.
3. Locate an available PCI Express slot for the adapter card.



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:

<http://www.mellanox.com/products/interconnect/cables-configurator.php>

### 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 adapter 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 7.8, “Adapter Card LED Operations,”](#) on page 61.
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 7.8, “Adapter Card LED Operations,”](#) on page 61.
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.

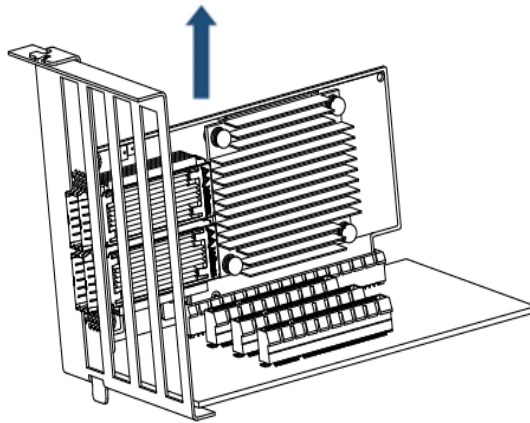
1. Remove any metallic objects from your hands and wrists.
2. It is strongly recommended to use an ESD strap or other antistatic devices.
3. Turn off the system and disconnect the power cord from the server.

### 3.8.2 Card Un-installation

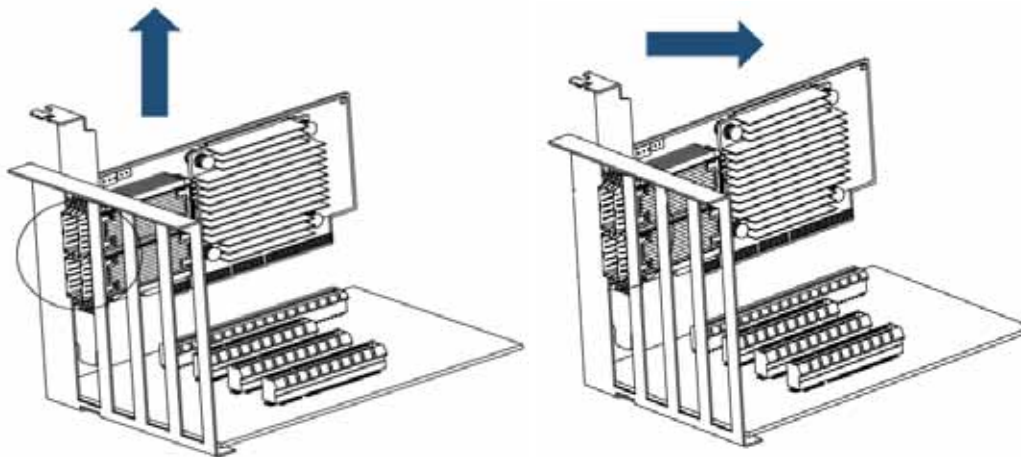


Please note that the following images are for illustration purposes only.

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.

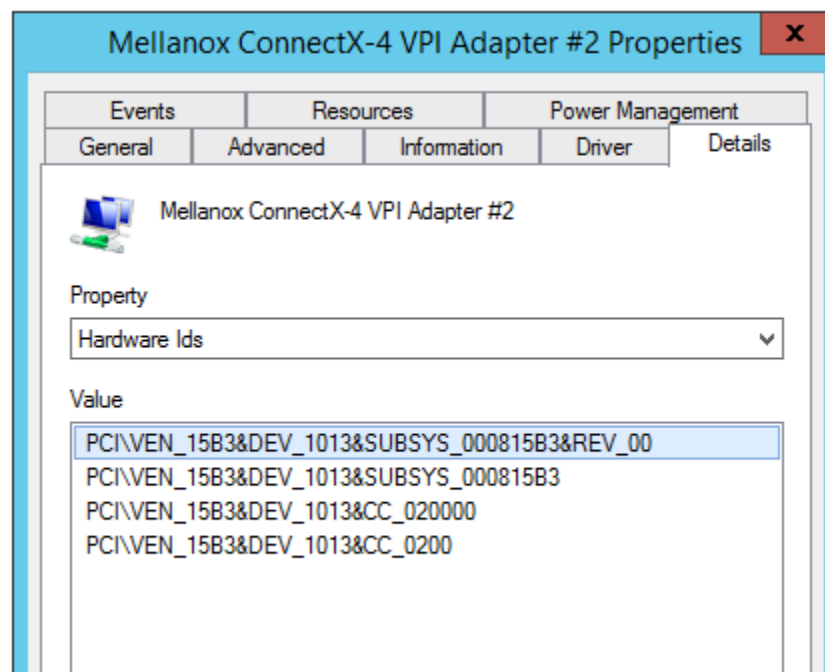


## 3.9 Identify the Card in Your System

### 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*



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>.

### 3.9.2 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 => 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-4 adapter hardware installed.

#### 4.1.1 Hardware and Software Requirements

*Table 6 - Hardware and Software Requirements*

Requirements	Description
Platforms	A server platform with an adapter card based on one of the following Mellanox Technologies' InfiniBandHCA devices: <ul style="list-style-type: none"> <li>MT4115 ConnectX®-4 (VPI, IB, EN) (firmware: fw-ConnectX4)</li> </ul> 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 => InfiniBand/VPI 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<sup>1</sup> 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.

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

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.

### 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:     MCX453A-FCAT
Description:     ConnectX@-4 VPI adapter card, FDR IB 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"> <li>• 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"> <li>• <code>openshmem</code>, <code>bupc</code>, <code>fca</code> and <code>ibutils</code></li> </ul> </li> <li>• The kernel modules are installed under             <ul style="list-style-type: none"> <li>• <code>/lib/modules/`uname -r`/updates</code> on SLES and Fedora Distributions</li> <li>• <code>/lib/modules/`uname -r`/extra/mlnx-ofa_kernel</code> on RHEL and other RedHat like Distributions</li> <li>• <code>/lib/modules/`uname -r`/updates/dkms/</code> on Ubuntu</li> </ul> </li> </ul>
Firmware	<ul style="list-style-type: none"> <li>• The firmware of existing network adapter devices will be updated if the following two conditions are fulfilled:             <ul style="list-style-type: none"> <li>• The installation script is run in default mode; that is, without the option ‘<code>--without-fw-update</code>’</li> <li>• The firmware version of the adapter device is older than the firmware version included with the Mellanox OFED ISO image  <b>Note:</b> If an adapter’s Flash was originally programmed with an Expansion ROM image, the automatic firmware update will also burn an Expansion ROM image.</li> </ul> </li> <li>• 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> </li> </ul>

#### 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 => Infini-Band/VPI 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 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
```

**4.1.5.2 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 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.rhel7ul 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 34.

**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 => Infini-Band/VPI 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:     MCX453A-FCAT
Description:
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 => InfiniBand/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 7 - Hardware and Software Requirements*

Description <sup>a</sup>	Package
Windows Server 2012 R2	MLNX_WinOF2-1_50_All_x64.exe
Windows Server 2012	MLNX_WinOF2-1_50_All_x64.exe
Windows Server 2016	MLNX_WinOF2-1_50_All_x64.exe
Windows 8.1 Client (64 bit only)	MLNX_WinOF2-1_50_All_x64.exe
Windows 10 Client (64 bit only)	MLNX_WinOF2-1_50_All_x64.exe

a. The Operating Systems 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**

1. To go to the Start menu, position your mouse in the bottom-right corner of the Remote Desktop of your screen.

2. Open a CMD console (Click Task Manager -->File --> Run new task, and enter CMD).

3. 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 => InfiniBand/VPIDrivers => Windows SW/Drivers.

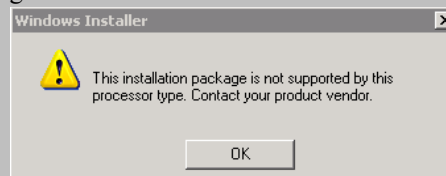
**Step 3.** Download the .exe image according to the architecture of your machine (see [step Step 1.](#)).

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.

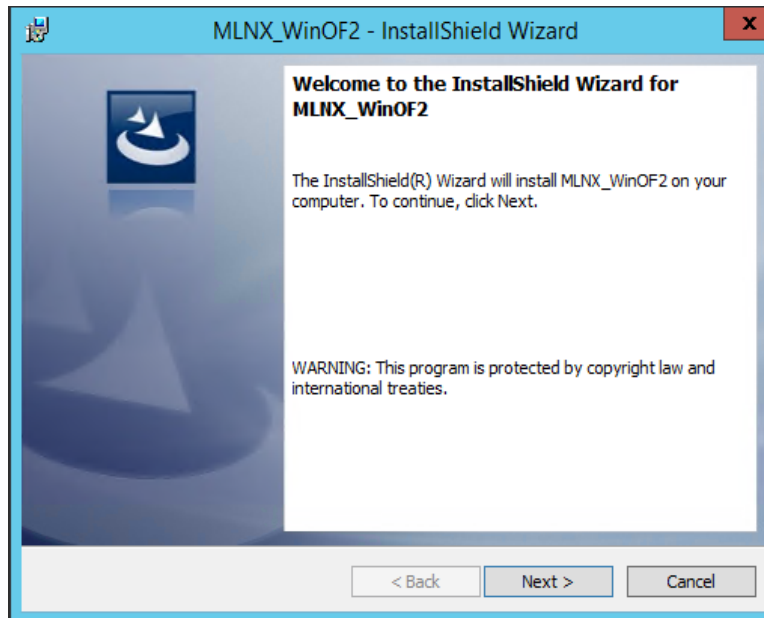
```
> MLNX_WinOF2-1_35_All_x64.exe /v"/l*vx [LogFile]"
```

**Step 3.** [Optional] If you do not want to upgrade your firmware version<sup>1</sup>.

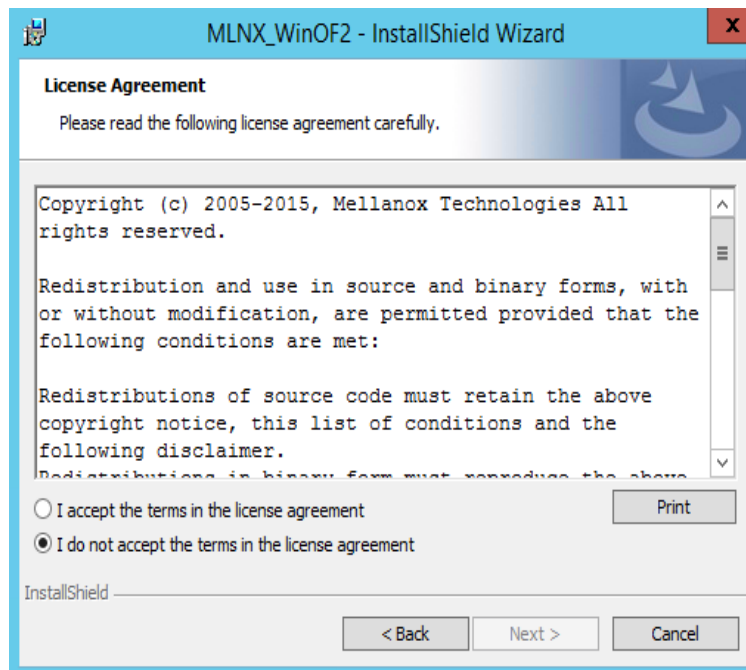
```
> MLNX_WinOF2-1_35_All_x64.exe /v" MT_SKIPFWUPGRD=1"
```

1. MT\_SKIPFWUPGRD default value is False

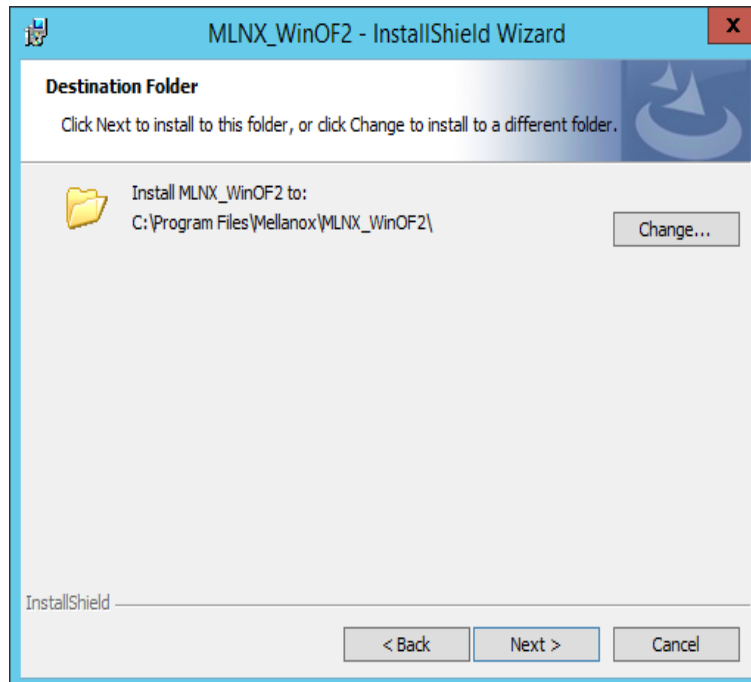
**Step 4.** Click Next in the Welcome screen.



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

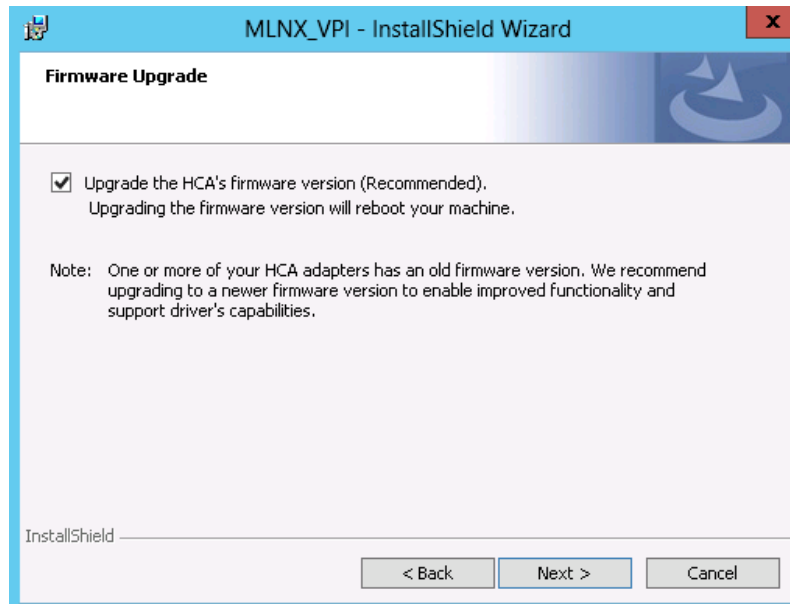


**Step 6.** Select the target folder for the installation.

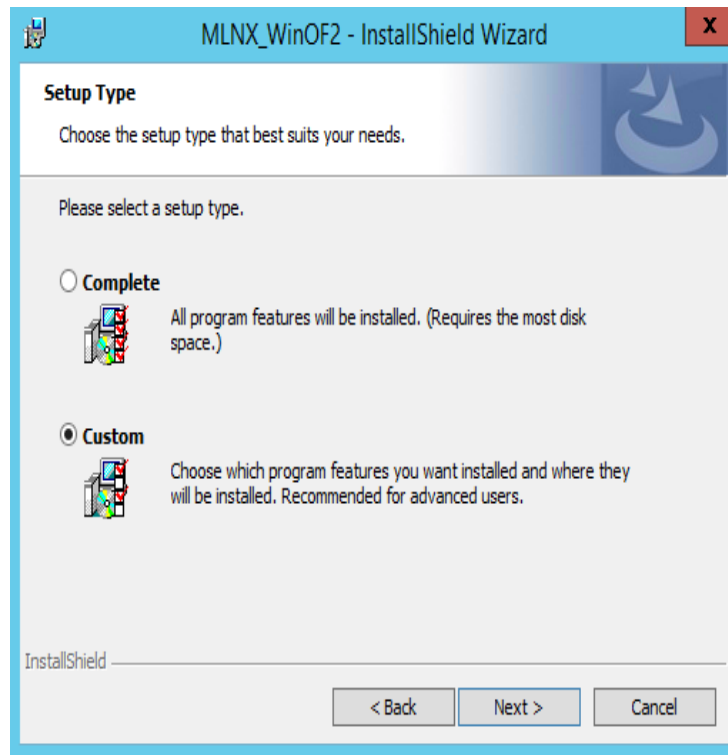


**Step 7.** The firmware upgrade screen will be displayed in the following cases:

- 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.



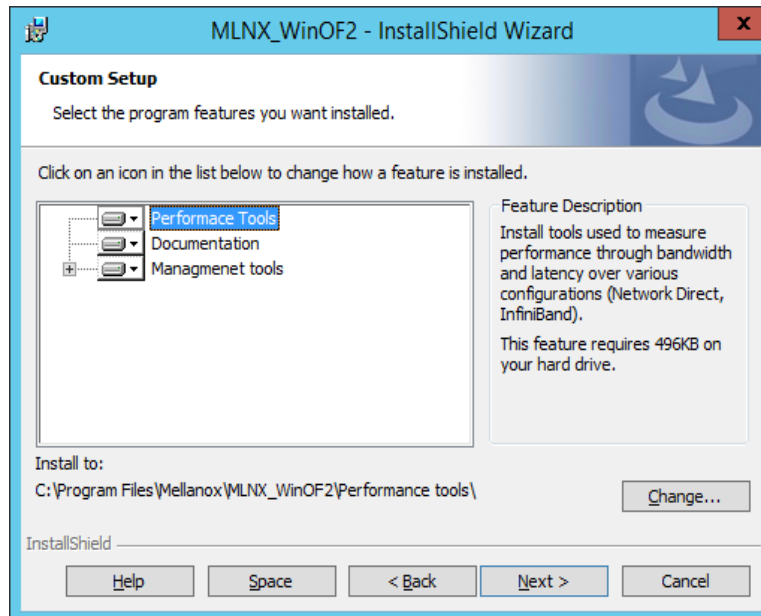
**Step 8.** Select a Complete or Custom installation, follow Step a and on.



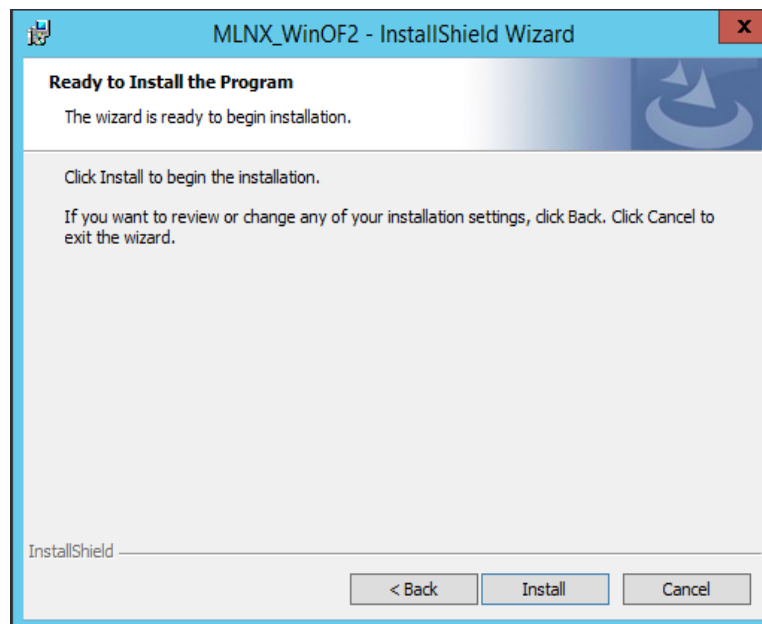
a. Select the desired feature to install:

- 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 diagnose or analyze the InfiniBand environment.
- SDK - contains the libraries and DLLs for developing InfiniBand application over IBAL.
- Documentation - contains the User Manual and Release Notes

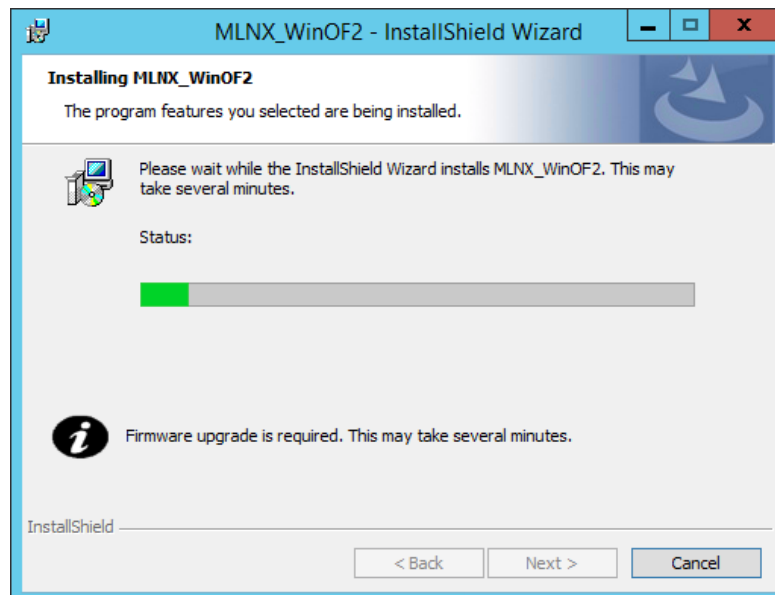
- Management tools - installation tools used for management, such as mlxstat.



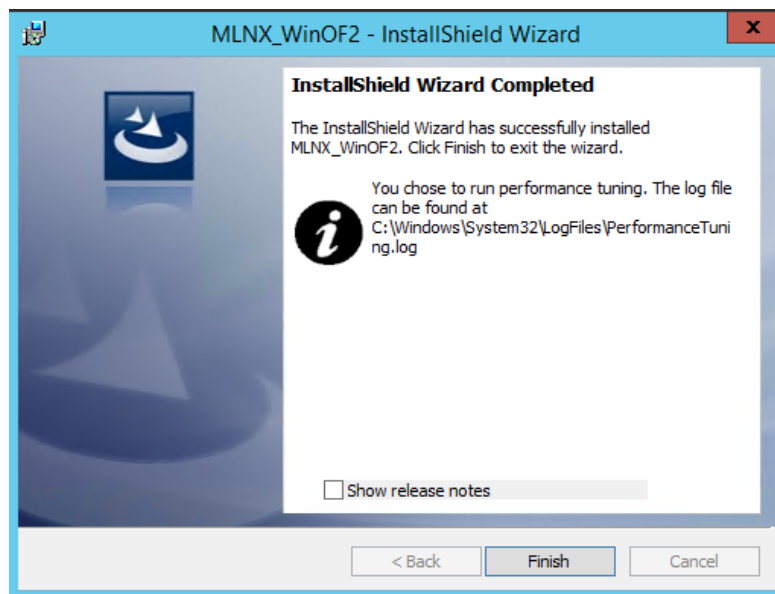
- b. Click Install to start the installation.



- Step 9.** In case firmware upgrade option was checked in step 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 not<sup>1</sup>.

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

**Step 5.** [Optional] If you do not wish to upgrade your firmware version<sup>2</sup>.

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



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:

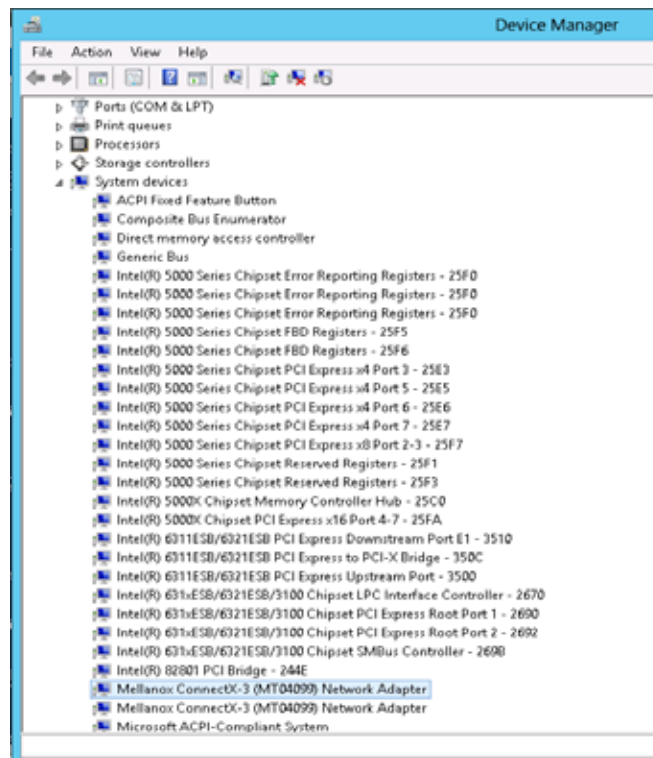
- %ProgramFiles%\Mellanox\MLNX\_WinOF2\Drivers\<OS>

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

---

1. MT\_NDPROPERTY default value is True  
2. MT\_SKIPFWUPGRD default value is False

**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.

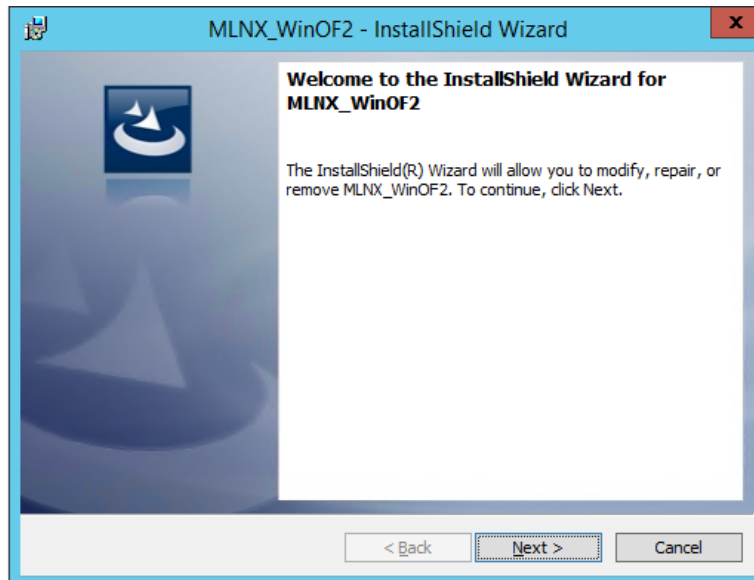
**Step 2.** Extract the driver and the tools:

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

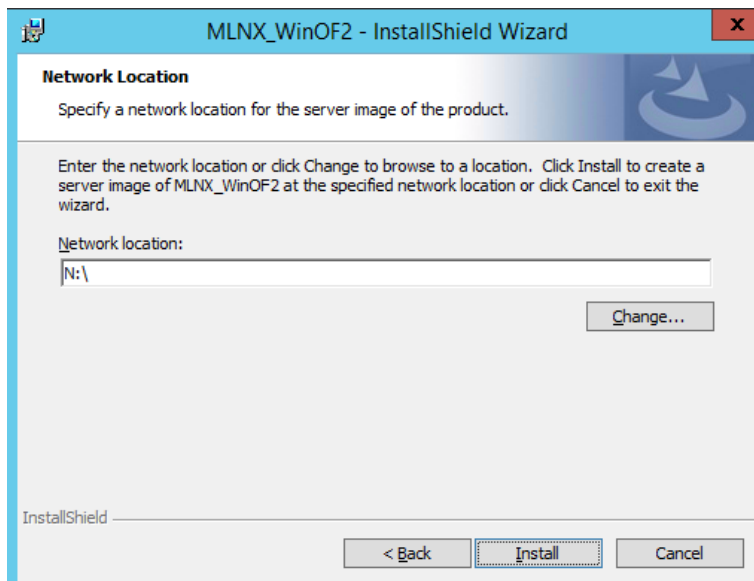
- To extract only the driver files.

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

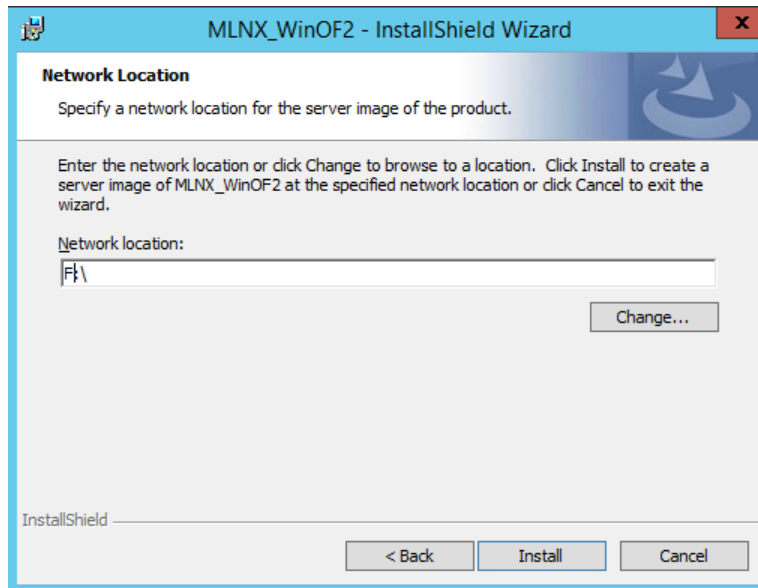
**Step 3.** Click Next to create a server image.



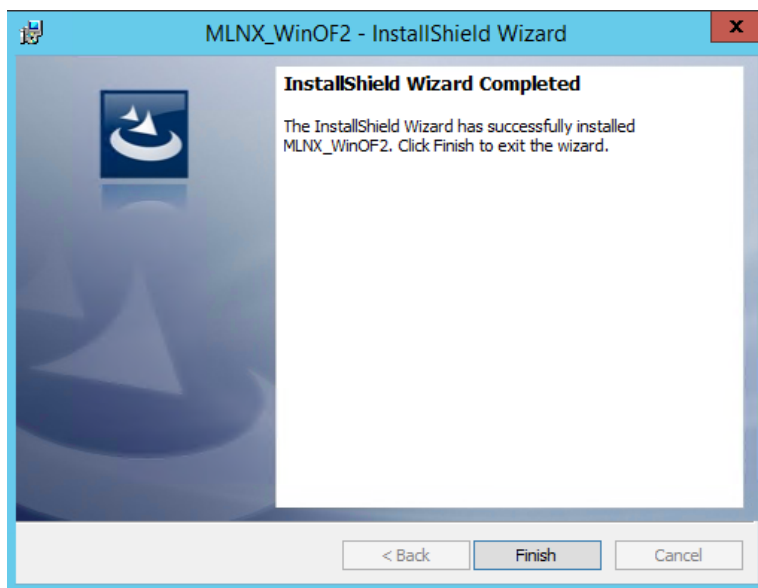
**Step 4.** Click Change and specify the location in which the files are extracted to.



**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:  
<http://www.mellanox.com> ->Products -> InfiniBand/VPI Drivers -> Firmware Tools

### 4.2.8 Deploying the Driver on a Nano Server

#### 4.2.8.1 Offline Installation

➤ *To deploy the Driver in Nano Server:*

**Step 1.** Go to the Mellanox WinOF web page at

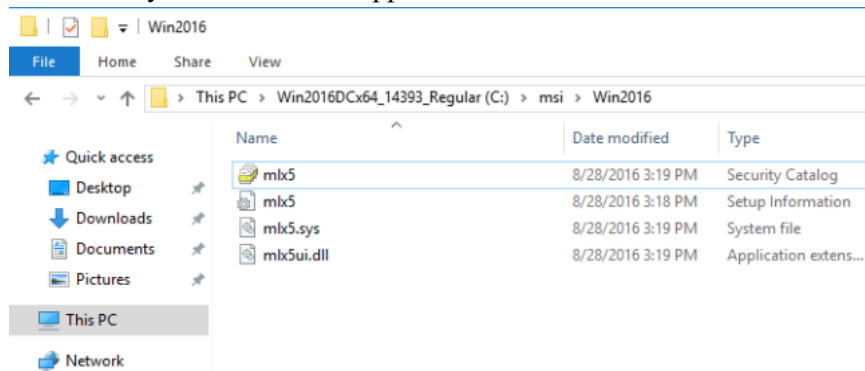
<http://www.mellanox.com> => Products => InfiniBand/VPI Drivers => Windows SW/Drivers.

**Step 2.** Download the driver (MLNX\_WinOF2\_MLNX\_WinOF2-1\_50\_mlx5\_All\_win2016\_x64\_fre\_1\_50\_15407.exe).

**Step 3.** Extract the driver to a local directory (see Section 4.2.5, “Extracting Files Without Running Installation,” on page 46).

Copy the contents of this directory to C:\WS2016TP5\_Drivers.

The directory contents should appear as follows:



This location should be specified for Drivers Path property when injecting driver into the Nano server image:

```
New-NanoServerImage -MediaPath \\Path\To\Media\en_us -BasePath .\Base -TargetPath  
.\InjectingDrivers.vhdx -DriversPath C:\WS2016TP5_Drivers
```

**Step 4.** Create the Nano server image.

Follow the instructions in the TechNet article for “Getting Started with Nano Server”  
<https://technet.microsoft.com/en-us/library/mt126167.aspx>

#### 4.2.8.2 Online Update

**Step 1.** Go to the Mellanox WinOF web page at  
<http://www.mellanox.com> => Products => InfiniBand/VPI Drivers => Windows SW/Drivers.

**Step 2.** Download the driver package.

**Step 3.** Extract the Mellanox drivers to a local directory (see Section 4.2.5, “Extracting Files Without Running Installation,” on page 47).

**Step 4.** Open a remote connection to the Nano server.

**Step 5.** Copy all the driver files to the Nano server

**Step 6.** Install the driver:

```
pnputil -I -a <Driver_Folder>\mlx5.inf
```



When upgrading the driver on a server where the remote connection was done over Mellanox device, there will be a loss of connectivity. To upgrade, it is recommended to run a script that will execute all the required upgrade commands.

#### 4.2.9 Performance Tuning

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

## 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:      MCX453A-FCAT
Description:      ConnectX®-4 VPI adapter card, FDR IB 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:      MCX453A-FCAT
Description:      ConnectX®-4 VPI adapter card, FDR IB 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

Perform cold reboot on 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.
Log File: /var/log/mlxup/mlxup-yyyymmdd.log
```

## 6 Troubleshooting

### 6.1 General

<p><b>Server unable to find the adapter</b></p>	<ul style="list-style-type: none"> <li>• Ensure that the adapter is placed correctly</li> <li>• Make sure the adapter slot and the adapter are compatible</li> <li>• Uninstall the adapter card. See <a href="#">Section 3.6, “Adapter Card Installation Instructions”</a>.</li> <li>• Install the adapter in a different PCI Express slot</li> <li>• Use the drivers that came with the adapter or download the latest</li> <li>• Make sure your motherboard has the latest BIOS</li> <li>• Try to reboot the server</li> </ul>
<p><b>The adapter no longer works</b></p>	<ul style="list-style-type: none"> <li>• Uninstall the adapter card. See <a href="#">Section 3.6, “Adapter Card Installation Instructions”</a>.</li> <li>• Reseat the adapter in its slot or a different slot, if necessary</li> <li>• Try using another cable</li> <li>• Reinstall the drivers for the network driver files may be damaged or deleted</li> <li>• Reboot the server</li> </ul>
<p><b>Adapters stopped working after installing another adapter</b></p>	<ul style="list-style-type: none"> <li>• Try removing and re-installing all adapters. See <a href="#">Section 3.6, “Adapter Card Installation Instructions”</a>. Check that cables are connected properly</li> <li>• Make sure your motherboard has the latest BIOS</li> </ul>
<p><b>Link indicator light is off</b></p>	<ul style="list-style-type: none"> <li>• Ensure that adapter driver/s is loaded</li> <li>• Try another port on the switch</li> <li>• Make sure the cable is securely attached</li> <li>• Check your are using the proper cables that do not exceed the recommended lengths</li> <li>• Verify that your switch and adapter port are compatible</li> </ul>
<p><b>Link light is on, but with no communication established</b></p>	<ul style="list-style-type: none"> <li>• Check that the latest driver is loaded</li> <li>• Check that both the adapter and its link are set to the same speed and duplex settings</li> </ul>

## 6.2 Linux

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

## 6.3 Windows

<p><b>Environment Information</b></p>	<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>
<p><b>Mellanox Firmware Tool (MFT)</b></p>	<p>Download and install MFT: <a href="http://www.mellanox.com/content/pages.php?pg=management_tools&amp;menu_section=34">http://www.mellanox.com/content/pages.php?pg=management_tools&amp;menu_section=34</a> Refer to the User Manual for installation instructions.</p> <p>Once installed, open a CMD window and run: WinMFT mst start mst status flint -d &lt;mst_device&gt; q</p>
<p><b>Ports Information</b></p>	<p>vstat</p>
<p><b>Firmware Version Upgrade</b></p>	<p>Download the latest firmware version using the PSID/board ID: <a href="http://www.mellanox.com/supportdownloader/">http://www.mellanox.com/supportdownloader/</a> flint -d &lt;mst_device&gt; -i &lt;firmware_bin_file&gt; b</p>
<p><b>Collect log file</b></p>	<ul style="list-style-type: none"> <li>• Event log viewer</li> <li>• MST device logs:             <ul style="list-style-type: none"> <li>• mst start</li> <li>• mst status</li> <li>• flint -d &lt;mst_device&gt; dc &gt; dump_configuration.log</li> <li>• mstdump &lt;mst_device&gt; dc &gt; mstdump.log</li> </ul> </li> </ul>

# 7 Specifications

## 7.1 MCX453A-FACT Specifications

**Table 8 - MCX453A-FACT Specifications**

<b>Physical</b>	<b>Size:</b> 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile			
	<b>Connector:</b> Single QSFP28 InfiniBand (Copper and optical)			
<b>Protocol Support</b>	<b>InfiniBand:</b> IBTA v1.3 Auto-Negotiation <sup>a</sup> : 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			
	<b>Ethernet:</b> 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			
	<b>Data Rate</b>	<b>Ethernet</b>	1/10/25/40/50/56 Gb/s	
		<b>InfiniBand</b>	SDR/DDR/QDR/FDR	
	<b>PCI Express Gen3:</b> SERDES @ 8.0GT/s, 8 lanes (2.0 and 1.1 compatible)			
<b>Power and Environmental</b>	<b>Voltage:</b> 12V, 3.3V			
	<b>Power</b>	<b>Cable</b>	<b>40Gb/s</b>	<b>FDR/56GbE</b>
	<b>Typical Power<sup>b</sup></b>	<b>Passive Cables</b>	TBD	10.0W
	<b>Maximum Power</b>	<b>Passive Cables</b>	TBD	12.5W
		<b>1.5W Active Cables</b>	TBD	14.2W
	<b>Maximum power available through QSFP28 port:</b> 3.5W			
	<b>Temperature</b>	<b>Operational</b>	0°C to 55°C	
		<b>Non-operational</b>	-40°C to 70°C	
	<b>Humidity:</b> 90% relative humidity <sup>c</sup>			
<b>Air Flow:</b> See <a href="#">Airflow Specifications</a> on page 68				
<b>Regulatory</b>	<b>Safety:</b> CB / cTUVus / CE			
	<b>EMC:</b> CE / FCC / VCCI / ICES / RCM			
	<b>RoHS:</b> 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. Typical power for ATIS traffic load.

c. For both operational and non-operational states.

## 7.2 MCX454A-FCAT Specifications

**Table 9 - MCX454A-FCAT Specifications Table**

<b>Physical</b>	<b>Size:</b> 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile			
	<b>Connector:</b> Dual QSFP28 InfiniBand (Copper and optical)			
<b>Protocol Support</b>	<b>InfiniBand:</b> IBTA v1.3 Auto-Negotiation <sup>a</sup> : 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			
	<b>Ethernet:</b> 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			
	<b>Data Rate</b>	<b>Ethernet</b>	1/10/25/40/50/56 Gb/s	
		<b>InfiniBand</b>	SDR/DDR/QDR/FDR	
	<b>PCI Express Gen3:</b> SERDES @ 8.0GT/s, 8 lanes (2.0 and 1.1 compatible)			
<b>Power and Environmental</b>	<b>Voltage:</b> 12V, 3.3V			
	<b>Power</b>	<b>Cable</b>	<b>40Gb/s</b>	<b>FDR/56GbE</b>
	<b>Typical Power<sup>b</sup></b>	<b>Passive Cables</b>	TBD	12.4W
	<b>Maximum Power</b>	<b>Passive Cables</b>	TBD	14.9W
		<b>1.5W Active Cables</b>	TBD	18.3W
	<b>Maximum power available through QSFP28 port:</b> 3.5W			
	<b>Temperature</b>	<b>Operational</b>	0°C to 55°C	
		<b>Non-operational</b>	-40°C to 70°C	
<b>Humidity:</b> 90% relative humidity <sup>c</sup>				
<b>Air Flow:</b> See <a href="#">Airflow Specifications on page 68</a>				
<b>Regulatory</b>	<b>Safety:</b> CB / cTUVus / CE			
	<b>EMC:</b> CE / FCC / VCCI / ICES / RCM			
	<b>RoHS:</b> 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. Typical power for ATIS traffic load.

c. For both operational and non-operational states.

## 7.3 MCX455A-FCAT Specifications

**Table 10 - MCX455A-FCAT Specifications Table**

<b>Physical</b>	<b>Size:</b> 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile		
	<b>Connector:</b> Single QSFP28 InfiniBand (Copper and optical)		
<b>Protocol Support</b>	<b>InfiniBand:</b> IBTA v1.3 Auto-Negotiation <sup>a</sup> : 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		
	<b>Ethernet:</b> 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		
	<b>Data Rate</b>	<b>Ethernet</b>	1/10/25/40/50/56 Gb/s
		<b>InfiniBand</b>	SDR/DDR/QDR/FDR
	<b>PCI Express Gen3:</b> SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible)		
<b>Power and Environmental</b>	<b>Voltage:</b> 12V, 3.3V		
	<b>Power</b>	<b>Cable</b>	<b>FDR/56GbE</b>
	<b>Typical Power<sup>b</sup></b>	<b>Passive Cables</b>	13.51W
	<b>Maximum Power</b>	<b>Passive Cables</b>	16.0W
		<b>1.5W Active Cables</b>	17.7W
	<b>Maximum power available through QSFP28 port:</b> 3.5W		
	<b>Temperature</b>	<b>Operational</b>	0°C to 55°C
		<b>Non-operational</b>	-40°C to 70°C
<b>Humidity:</b> 90% relative humidity <sup>c</sup>			
<b>Air Flow:</b> See <a href="#">Airflow Specifications on page 68</a>			
<b>Regulatory</b>	<b>Safety:</b> CB / cTUVus / CE		
	<b>EMC:</b> CE / FCC / VCCI / ICES / RCM		
	<b>RoHS:</b> 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. Typical power for ATIS traffic load.

c. For both operational and non-operational states.

## 7.4 MCX456A-FCAT Specifications

**Table 11 - MCX456A-FCAT Specifications Table**

<b>Physical</b>	<b>Size:</b> 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile			
	<b>Connector:</b> Dual QSFP28 InfiniBand (Copper and optical)			
<b>Protocol Support</b>	<b>InfiniBand:</b> IBTA v1.3 Auto-Negotiation <sup>a</sup> : 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			
	<b>Ethernet:</b> 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			
	<b>Data Rate</b>	<b>Ethernet</b>	1/10/25/40/50/56 Gb/s	
		<b>InfiniBand</b>	SDR/DDR/QDR/FDR	
<b>PCI Express Gen3:</b> SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible)				
<b>Power and Environmental</b>	<b>Voltage:</b> 12V, 3.3V			
	<b>Power</b>	<b>Cable</b>	<b>40GbE</b>	<b>FDR/56GbE</b>
	<b>Typical Power<sup>b</sup></b>	<b>Passive Cables</b>	TBD	15.9W
	<b>Maximum Power</b>	<b>Passive Cables</b>	TBD	18.5W
		<b>1.5W Active Cables</b>	TBD	21.8W
	<b>Maximum power available through QSFP28 port:</b> 3.5W			
	<b>Temperature</b>	<b>Operational</b>	0°C to 55°C	
		<b>Non-operational</b>	-40°C to 70°C	
<b>Humidity:</b> 90% relative humidity <sup>c</sup>				
<b>Air Flow:</b> See <a href="#">Airflow Specifications on page 68</a>				
<b>Regulatory</b>	<b>Safety:</b> CB / cTUVus / CE			
	<b>EMC:</b> CE / FCC / VCCI / ICES / RCM			
	<b>RoHS:</b> 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. Typical power for ATIS traffic load.

c. For both operational and non-operational states.

## 7.5 MCX455A-ECAT Specifications

**Table 12 - MCX455A-ECAT Specifications Table**

<b>Physical</b>	<b>Size:</b> 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile		
	<b>Connector:</b> Single QSFP28 InfiniBand (Copper and optical)		
<b>Protocol Support</b>	<b>InfiniBand:</b> IBTA v1.3 Auto-Negotiation <sup>a</sup> : 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		
	<b>Ethernet:</b> 100GBASE-CR4, 100GBASE-KR4, 100GBASE-SR4, 56GBASE-R4, 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASESR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASEKR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASEKR, SGMII		
	<b>Data Rate</b>	<b>Ethernet</b>	1/10/25/40/50/100 Gb/s
		<b>InfiniBand</b>	SDR/DDR/QDR/FDR/EDR
<b>PCI Express Gen3:</b> SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible)			
<b>Power and Environmental</b>	<b>Voltage:</b> 12V, 3.3V		
	<b>Power</b>	<b>Cable</b>	
	<b>Typical Power<sup>b</sup></b>	<b>Passive Cables</b>	14.0W
	<b>Maximum Power</b>	<b>Passive Cables</b>	16.6W
		<b>1.5W Active Cables</b>	18.3W
		<b>2.5W Active Cables</b>	19.4W
	<b>Maximum power available through QSFP28 port:</b> 3.5W		
	<b>Temperature</b>	<b>Operational</b>	0°C to 55°C
		<b>Non-operational</b>	-40°C to 70°C
<b>Humidity:</b> 90% relative humidity <sup>c</sup>			
<b>Air Flow:</b> See <a href="#">Airflow Specifications on page 68</a>			
<b>Regulatory</b>	<b>Safety:</b> CB / cTUVus / CE		
	<b>EMC:</b> CE / FCC / VCCI / ICES / RCM		
	<b>RoHS:</b> 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. Typical power for ATIS traffic load.

c. For both operational and non-operational states.

## 7.6 MCX456A-ECAT Specifications

**Table 13 - MCX456A-ECAT Specifications Table**

<b>Physical</b>	<b>Size:</b> 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile		
	<b>Connector:</b> Dual QSFP28 InfiniBand (Copper and optical)		
<b>Protocol Support</b>	<b>InfiniBand:</b> IBTA v1.3 Auto-Negotiation <sup>a</sup> : 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		
	<b>Ethernet:</b> 100GBASE-CR4, 100GBASE-KR4, 100GBASE-SR4, 56GBASE-R4, 50GBASE-R2, 50GBASE-R4, 40GBASE-CR4, 40GBASE-KR4, 40GBASESR4, 40GBASE-LR4, 40GBASE-ER4, 40GBASE-R2, 25GBASE-R, 20GBASEKR2, 1000BASE-CX, 1000BASE-KX, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, 10GBASE-KX4, 10GBASE-CR, 10GBASEKR, SGMII		
	<b>Data Rate</b>	<b>Ethernet</b>	1/10/25/40/50/100 Gb/s
		<b>InfiniBand</b>	SDR/DDR/QDR/FDR/EDR
<b>PCI Express Gen3:</b> SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible)			
<b>Power and Environmental</b>	<b>Voltage:</b> 12V, 3.3V		
	<b>Power</b>	<b>Cable</b>	
	<b>Typical Power<sup>b</sup></b>	<b>Passive Cables</b>	16.3W
	<b>Maximum Power</b>	<b>Passive Cables</b>	19.0W
		<b>1.5W Active Cables</b>	22.3W
		<b>2.5W Active Cables</b>	24.5W
	<b>Maximum power available through QSFP28 port:</b> 3.5W		
	<b>Temperature</b>	<b>Operational</b>	0°C to 55°C
		<b>Non-operational</b>	-40°C to 70°C
<b>Humidity:</b> 90% relative humidity <sup>c</sup>			
<b>Air Flow:</b> See <a href="#">Airflow Specifications on page 68</a>			
<b>Regulatory</b>	<b>Safety:</b> CB / cTUVus / CE		
	<b>EMC:</b> CE / FCC / VCCI / ICES / RCM		
	<b>RoHS:</b> 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. Typical power for ATIS traffic load.

c. For both operational and non-operational states.

## 7.7 Airflow Specifications

**Table 14 - Airflow Specifications**

Air Flow (LFM) <sup>a</sup>						
Air Flow Direction	Heat Sink to Port			Port to Heat Sink		
Cable Type	Passive	Active 1.5W	Active 3.5W	Passive	Active 1.5W	Active 3.5W
MCX453A-FCAT	400	450	–	400	400	–
MCX454A-FCAT	400	450	–	400	400	–
MCX455A-FCAT	400	450	–	400	400	–
MCX456A-FCAT	400	500	–	400	400	–
MCX455A-ECAT	400	–	700	400	–	600
MCX456A-ECAT	400	–	800	400	–	600

a. Cells marked with (–) are not applicable

## 7.8 Adapter Card LED Operations

There is one bi-color I/O LED per port to indicate physical and logical link status. See Table 15.

**Table 15 - Physical and Logical Link Indications**

LED Color and State	Description
Off	Physical link has not been established
Solid Amber	Indicates an active physical link
Blinking Amber <sup>a</sup>	6Hz Blinking Amber 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

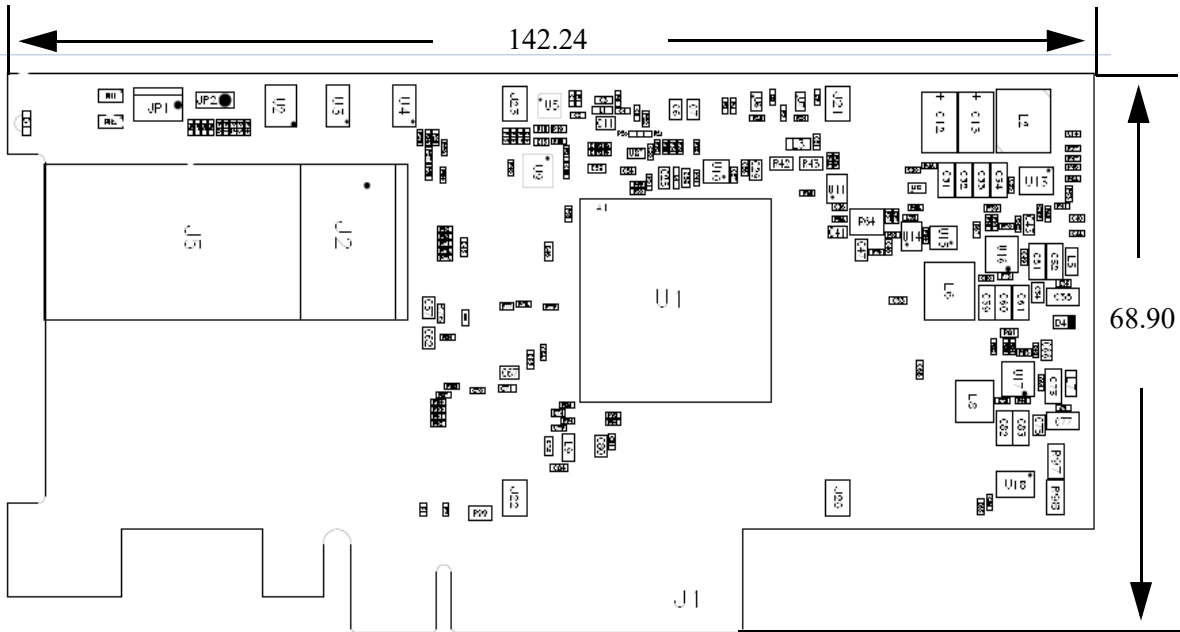
a. 1 Hz Blinking Amber occurs due to running a beacon command for locating the adapter card.

## 7.9 Board Mechanical Drawing and Dimensions

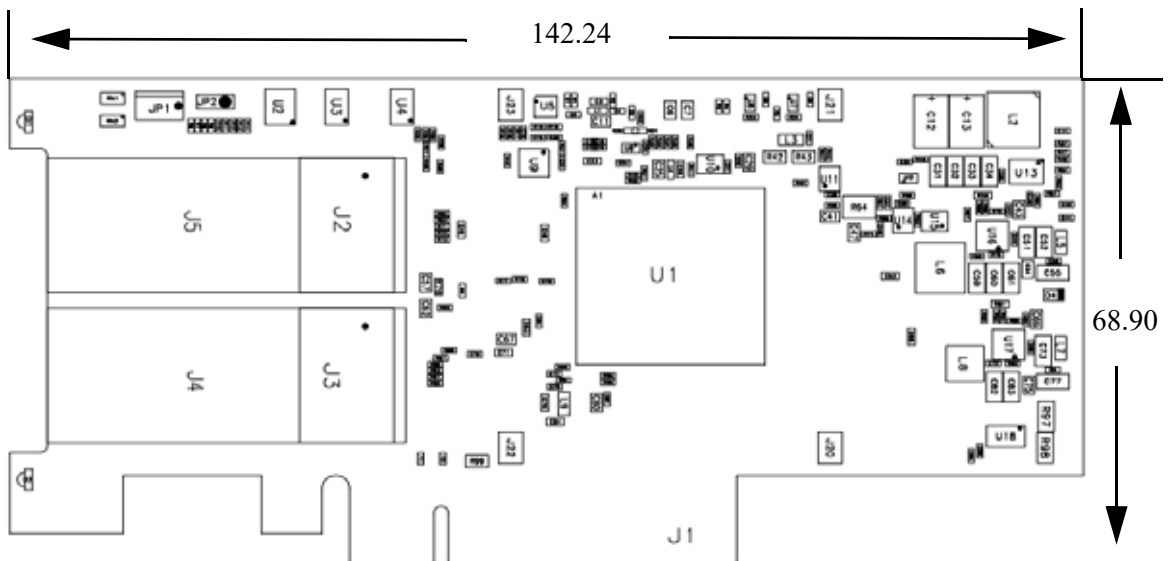


All dimensions are in millimeters.  
All the mechanical tolerances are +/- 0.1mm.

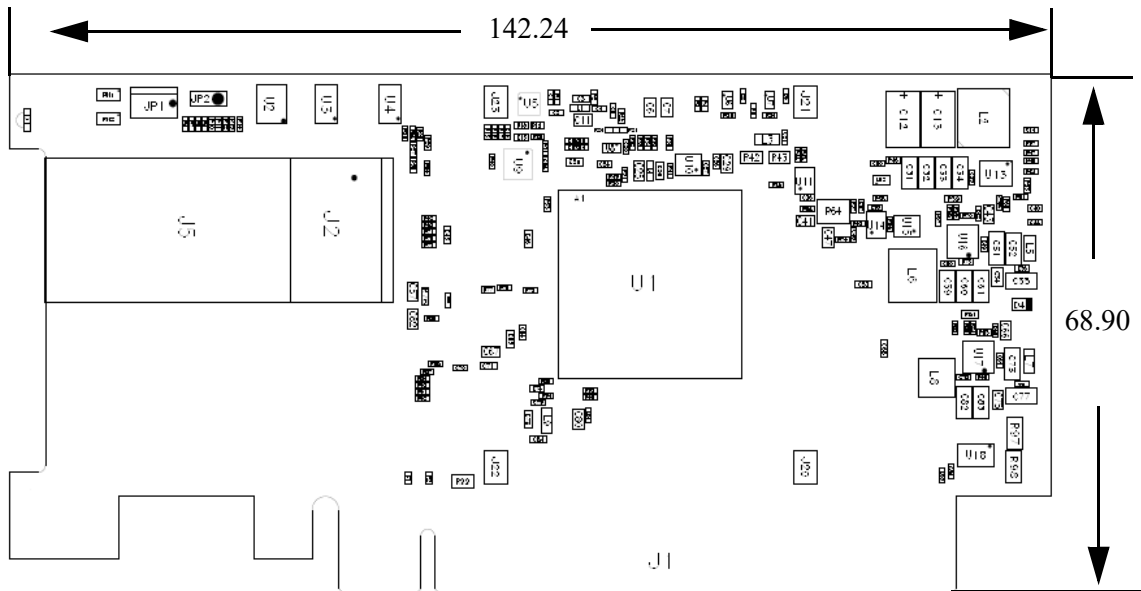
**Figure 3: Mechanical Drawing of the Single-port x8 Adapter Cards**



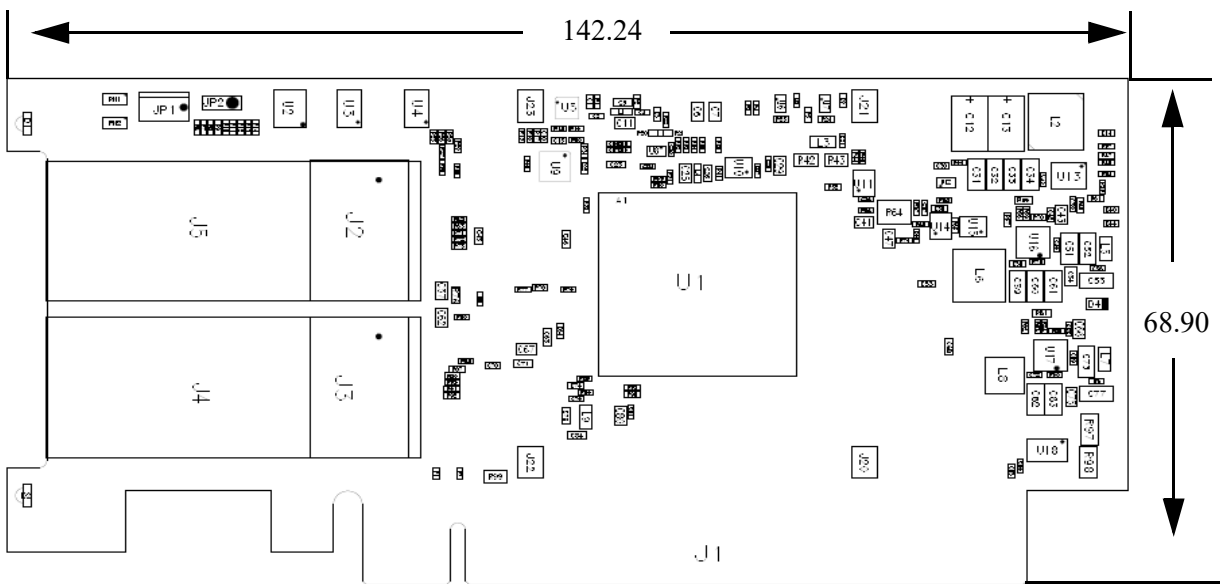
**Figure 4: Mechanical Drawing of the Dual-port x8 Adapter Cards**



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

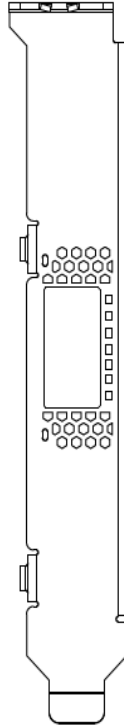


**Figure 6: Mechanical Drawing of the Dual-port x16 Adapter Card**

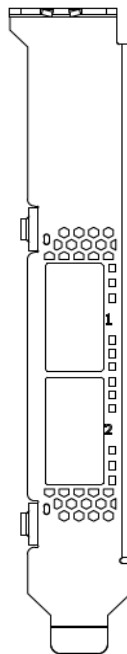


## 7.10 Bracket Mechanical Drawing

*Figure 7: Single-port Bracket*



*Figure 8: Dual-port Bracket*



## Appendix A: 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 and 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).



The revisions indicated on the labels in the following figure do not necessarily represent the latest revisions of the card.

*Figure 9: MCX453A-FCAT Board Label (Example)*



*Figure 10: MCX454A-FCAT Board Label (Example)*



Figure 11: MCX455A-FCAT Board Label (Example)



Figure 12: MCX456A-FCAT Board Label (Example)



Figure 13: MCX455A-ECAT Board Label (Example)



Figure 14: MCX456A-ECAT Board Label (Example)



## Appendix B: 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 C: 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 D: 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. Sobre calentamiento



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

## 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.

## 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