NVIDIA Mellanox ConnectX-5 Ethernet Adapter Cards User Manual

100Gb/s Ethernet Adapter Cards; Intelligent RDMA (RoCE) enabled NICs. Supports 1, 10, 25, 50, and 100 Gigabit Ethernet speeds.

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About This Manual

This User Manual describes NVIDIA® Mellanox® ConnectX®-5 and ConnectX®-5 Ex Ethernet Single and Dual SFP28 and QSFP28 port PCI Express x8/x16 adapter cards. It provides details as to the interfaces of the board, specifications, required software and firmware for operating the board, and relevant documentation.

Ordering Part Numbers

The table below provides the ordering part numbers (OPN) for the available ConnectX-5 Ethernet adapter cards.

IC in Use	OPN	Marketing Description
ConnectX®-5	MCX512A-ACAT	ConnectX®-5 EN network interface card, 25GbE dual-port SFP28, PCIe Gen 3.0 x8, tall bracket
	MCX515A-CCAT	ConnectX®-5 EN network interface card, 100GbE single-port QSFP28, PCIe Gen 3.0 x16, tall bracket
	MCX516A-CCAT	ConnectX®-5 EN network interface card, 100GbE dual-port QSFP28, PCIe Gen 3.0 x16, tall bracket

Intended Audience

This manual is intended for the installer and user of these cards. The manual assumes basic familiarity with Ethernet network and architecture specifications.

Technical Support

Customers who purchased Mellanox products directly from Mellanox are invited to contact us through the following methods:

- URL: http://www.mellanox.com > Support
- E-mail: support@mellanox.com
- Tel: +1.408.916.0055

Customers who purchased Mellanox M-1 Global Support Services, please see your contract for details regarding Technical Support.
Customers who purchased Mellanox products through a Mellanox approved reseller should first seek assistance through their reseller.

Related Documentation

Mellanox OFED for Linux User Manual and Release Notes	User Manual describing OFED features, performance, band diagnostic, tools content and configuration. See Mellanox OFED for Linux Documentation.
WinOF-2 for Windows User Manual and Release Notes	User Manual describing WinOF-2 features, performance, Ethernet diagnostic, tools content and configuration. See WinOF-2 for Windows Documentation.
Mellanox VMware for Ethernet User Manual and Release Notes	User Manual describing the various components of the Mellanox ConnectX® NATIVE ESXi stack. See http://www.mellanox.com Products > Software > Ethernet Drivers > VMware Driver
Mellanox Firmware Utility (mlxup) User Manual and Release Notes	Mellanox firmware update and query utility used to update the firmware. See http://www.mellanox.com > Products > Software > Firmware Tools >mlxup Firmware Utility
Mellanox Firmware Tools (MFT) User Manual	User Manual describing the set of MFT firmware management tools for a single node. See MFT User Manual.
IEEE Std 802.3 Specification	IEEE Ethernet specification at http://standards.ieee.org/
PCI Express Specifications	Industry Standard PCI Express Base and Card Electromechanical Specifications at https://pcisig.com/specifications

Mellanox LinkX Interconnect Solutions	Mellanox LinkX Ethernet cables and transceivers are designed to maximize the performance of High-Performance Computing networks, requiring high-bandwidth, low-latency connections between compute nodes and switch nodes. Mellanox offers one of the industry's broadest portfolios of 40Gb/s, 56Gb/s and 100Gb/s cables, including Direct Attach Copper cables (DACs), copper splitter cables, Active Optical Cables (AOCs) and transceivers in a wide range of lengths from 0.5m to 10km. In addition to meeting Ethernet standards, Mellanox tests every product in an end-to-end environment ensuring a Bit Error Rate of less than 1E-15. Read more at LinkX® Ethernet Cables and Transceivers.

Document Conventions

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

Revision History

A list of the changes made to this document are provided in Document Revision History.

Introduction

Product Overview

This is the User Guide for Ethernet adapter cards based on the ConnectX®-5 and ConnectX®-5 Ex integrated circuit device. These adapters connectivity provide the highest performing low latency and most flexible interconnect solution for PCI Express Gen 3.0/4.0 servers used in Enterprise Data Centers and High-Performance Computing environments.

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

ConnectX-5 Ethernet 25Gb/s Adapter Cards

Model	ConnectX-5 Ethernet Adapter Cards
Part Number	MCX512A-ACAT
Ethernet Data Rate	1/10/25 Gb/s
Network Connector Type	Dual-port SFP28
PCI Express Connectors	PCIe Gen 3.0 x8 SerDes @ 8.0GT/s
Dimensions	2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile
Host Management	-

Model	ConnectX-5 Ethernet Adapter Cards
UEFI Enabled (x86/ Arm)	-
RoHS	RoHS Compliant
IC Part Number	MT27808A0-FCCF-EV

ConnectX-5 Ethernet 100Gb/s Adapter Cards

Model	ConnectX-5 Ethernet Adapter Cards	
Part Number	MCX515A-CCAT	MCX516A-CCAT
Ethernet Data Rate	10/25/40/50/100 Gb/s	
Network Connector Type	Single-port QSFP28	Dual-port QSFP28
PCI Express Connectors	PCIe Gen 3.0 x16 SerDes @ 8.0GT/s	
Dimensions	2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile	
Host Management	-	-
UEFI Enabled (x86/ Arm)	-	-
RoHS	RoHS Compliant	
IC Part Number	MT27808A0-FCCF-EV	

For more detailed information see Specifications.

Features and Benefits

This section describes hardware features and capabilities. Please refer to the relevant driver and/or firmware release notes for feature availability.

Feature	Description
PCI Express (PCIe)	Uses PCIe Gen 3.0 (8GT/s) through an x8 or x16 edge connector. Gen 1.1 and 2.0 compatible.
Up to 25 Gigabit Ethernet	Mellanox adapters comply with the following IEEE 802.3 standards: • 100GbE/ 50GbE / 40GbE / 25GbE / 10GbE / 1GbE • IEEE 802.3bj, 802.3bm 100 Gigabit Ethernet • IEEE 802.3by, Ethernet Consortium25, 50 Gigabit Ethernet, supporting all FEC modes • IEEE 802.3ba 40 Gigabit Ethernet • IEEE 802.3by 25 Gigabit Ethernet • IEEE 802.3ae 10 Gigabit Ethernet • IEEE 802.3ap based auto-negotiation and KR startup • Proprietary Ethernet protocols (20/40GBASE-R2, 50GBASE-R4) • IEEE 802.3ad, 802.1AX Link Aggregation • IEEE 802.1Q, 802.1P VLAN tags and priority • IEEE 802.1Qau (QCN) • Congestion Notification • IEEE 802.1Qaz (ETS) • IEEE 802.1Qbb (PFC) • IEEE 802.1Qbg • IEEE 1588v2 • Jumbo frame support (9.6KB)
Memory	• PCI Express - stores and accesses Ethernet fabric connection information and packet data. • SPI Quad - includes 128Mbit SPI Quad Flash device (W25Q128FVSIG device by ST Microelectronics). • FRU EEPROM - Stores the parameters and personality of the card. The EEPROM capacity is 128Kbit. FRU I2C address is (0x50) and is accessible through the PCIe SMBus. (Available in QSFP28 OPNs)
Overlay Networks	In order to better scale their networks, data center operators often create overlay networks that carry traffic from individual virtual machines over logical tunnels in encapsulated formats such as NVGRE and VXLAN. While this solves network scalability issues, it hides the TCP packet from the hardware offloading engines, placing higher loads on the host CPU. ConnectX-5 effectively addresses this by providing advanced NVGRE and VXLAN hardware offloading engines that encapsulate and de-capsulate the overlay protocol.
RDMA and RDMA over Converged Ethernet (RoCE)	ConnectX-5, utilizing IBTA RDMA (Remote Data Memory Access) and RoCE (RDMA over Converged Ethernet) technology, delivers low-latency and high-performance over Band and Ethernet networks. Leveraging data center bridging (DCB) capabilities as well as ConnectX-5 advanced congestion control hardware mechanisms, RoCE provides efficient low-latency RDMA services over Layer 2 and Layer 3 networks.

Feature	Description
Mellanox PeerDirect™	PeerDirect™ communication provides high-efficiency RDMA access by eliminating unnecessary internal data copies between components on the PCIe bus (for example, from GPU to CPU), and therefore significantly reduces application run time. ConnectX-5 advanced acceleration technology enables higher cluster efficiency and scalability to tens of thousands of nodes.
CPU Offload	Adapter functionality enabling reduced CPU overhead allowing more available CPU for computation tasks. Open vSwitch (OVS) offload using ASAP$^{2(TM)}$ • Flexible match-action flow tables • Tunneling encapsulation/decapsulation
Quality of Service (QoS)	Support for port-based Quality of Service enabling various application requirements for latency and SLA.
Hardware-based I/O Virtualization	ConnectX-5 provides dedicated adapter resources and guaranteed isolation and protection for virtual machines within the server.
Storage Acceleration	A consolidated compute and storage network achieves significant cost-performance advantages over multi-fabric networks. Standard block and file access protocols can leverage RDMA for high-performance storage access. • NVMe over Fabric offloads for the target machine • Erasure Coding • T10-DIF Signature Handover
SR-IOV	ConnectX-5 SR-IOV technology provides dedicated adapter resources and guaranteed isolation and protection for virtual machines (VM) within the server.
NC-SI	The adapter supports a Network Controller Sideband Interface (NC-SI), MCTP over SMBus and MCTP over PCIe - Baseboard Management Controller interface.
High-Performance Accelerations	• Tag Matching and Rendezvous Offloads • Adaptive Routing on Reliable Transport • Burst Buffer Offloads for Background Checkpointing

Operating Systems/Distributions

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

Connectivity

- Interoperable with 1/10/25/40/50/100 Gb/s Ethernet switches

- Passive copper cable with ESD protection
- Powered connectors for optical and active cable support

Interfaces

Ethernet SFP28 and QSFP28 Interfaces

The network ports of the ConnectX®-5 adapter card are compliant with the IEEE 802.3 Ethernet standards listed in Features and Benefits. Ethernet traffic is transmitted through the SFP28/QSFP28 connectors on the adapter card.

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

PCI Express Interface

The table below describes the supported PCIe interface in ConnectX-5 and ConnectX-5 Ex adapter cards.

IC Model	Supported PCIe Interface	Features
ConnectX-5	PCIe Gen 3.0 (1.1 and 2.0 compatible) through x8 or x16 edge connectors	Link Rates: 2.5. 5.0 or 8.0GT/s. Auto Negotiation to: x16, x8, x4, x2 or x1. Support for MSI/MSI-X mechanisms.

LED Interface

There is one bi-color I/O LED per port to indicate link status located on the adapter card.

Link Indications

State	Bi-color LED (Yellow/Green) - Link speed
Beacon command for locating the adapter card	1Hz blinking Yellow

<table>
<tr><th>State</th><th>Bi-color LED (Yellow/Green) - Link speed</th></tr>
<tr><td>Error</td><td>4Hz blinking Yellow Indicates an error with the link. The error can be one of the following:
<table>
<tr><th>Error Type</th><th>Description</th><th>LED Behavior</th></tr>
<tr><td>I^{2}C</td><td>I^{2}C access to the networking ports fails</td><td>Blinks until error is fixed</td></tr>
<tr><td>Over-current</td><td>Over-current condition of the networking ports</td><td>Blinks until error is fixed</td></tr>
</table></td></tr>
<tr><td>Link Activity</td><td>• A constant Green indicates a link with the maximum networking speed.
• A constant Yellow indicates a link with less than the maximum networking speed.</td></tr>
<tr><td>Link Up</td><td>• A constant Green indicates a link with the maximum networking speed.
• A constant Yellow indicates a link with less than the maximum networking speed.</td></tr>
</table>

Heat Sink Interface

A heatsink is attached to the ConnectX-5 IC in order to dissipate the heat from the ConnectX- 5 IC. It is attached either by using four spring-loaded push pins that insert into four mounting holes or by screws.

ConnectX-5 IC has a thermal shutdown safety mechanism which automatically shuts down the ConnectX-5 card in cases of a high-temperature event, improper thermal coupling or heatsink removal.

SMBus Interface

ConnectX-5 technology maintains support for manageability through a BMC. ConnectX-5 PCIe stand-up adapter can be connected to a BMC using MCTP over SMBus or MCTP over PCIe protocols as if it is a standard Mellanox PCIe stand-up adapter. For configuring the adapter for the specific manageability solution in use by the server, please contact Mellanox Support.

Voltage Regulators

The voltage regulator power is derived from the PCI Express edge connector 12V supply pins. These voltage supply pins feed onboard regulators that provide the necessary power to the various components on the card.

Thermal Sensors

The adapter card incorporates the ConnectX IC which operates in the range of temperatures between 0C and 105C.

There are three thermal threshold definitions which impact the overall system operation state:

- Warning – 105°C: On managed systems only: When the device crosses the 100°C threshold, a Warning Threshold message will be issued by the management SW, indicating to system administration that the card has crossed the Warning threshold. Note that this temperature threshold does not require nor lead to any action by hardware (such as adapter card shutdown).
- Critical – 120°C: When the device crosses this temperature, the firmware will automatically shut down the device.
- Emergency – 130°C: In case the firmware fails to shut down the device upon crossing the Critical threshold, the device will auto-shutdown upon crossing the Emergency (130°C) threshold.

The card's thermal sensors can be read through the system's SMBus. The user can read these thermal sensors and adapt the system airflow in accordance with the readouts and the needs of the above-mentioned IC thermal requirements.

Hardware Installation

Installation and initialization of ConnectX-5 adapter cards require attention to the mechanical attributes, power specification, and precautions for electronic equipment.

Safety Warnings

- Safety warnings are provided here in the English language. For safety warnings in other languages, refer to the Adapter Installation Safety Instructions document available on mellanox.com.

Please observe all safety warnings to avoid injury and prevent damage to system components. Note that not all warnings are relevant to all models.

Note that not all warnings are relevant to all models.

	General Installation Instructions Read all installation instructions before connecting the equipment to the power source.
	Jewelry Removal Warning Before you install or remove equipment that is connected to power lines, remove jewelry such as bracelets, necklaces, rings, watches and so on. Metal objects heat up when connected to power and ground and can meltdown, causing serious burns and/or welding the metal object to the terminals.
	Over-temperature This equipment should not be operated in an area with an ambient temperature exceeding the maximum recommended: 55°C (131°F). An airflow of 200LFM at this maximum ambient temperature is required for HCA cards and NICs. To guarantee proper airflow, allow at least 8cm (3 inches) of clearance around the ventilation openings.
	During Lightning - Electrical Hazard During periods of lightning activity, do not work on the equipment or connect or disconnect cables.
	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.
	Equipment Installation This equipment should be installed, replaced, or serviced only by trained and qualified personnel.
	Equipment Disposal Disposal of this equipment should be in accordance to all national laws and regulations.

	Local and National Electrical Codes This equipment should be installed in compliance with local and national electrical codes.
	Hazardous Radiation Exposure • Caution – Use of controls or adjustment or performance of procedures other than those specified herein may result in hazardous radiation exposure.For products with optical ports. • 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

Installation Procedure Overview

The installation procedure of ConnectX-5 adapter cards involves the following steps:

Step	Procedure
1	Check the system's hardware and software requirements.
2	Pay attention to the airflow consideration within the host system.
3	Unpack the product.
4	(Optional) Replace the full-height mounting bracket with the supplied short bracket.
5	Install the adapter card in the system.
6	Connect cables or modules to the card.
7	Identify ConnectX-5 adapter card in the system.

System Requirements

Hardware Requirements

☐ Unless otherwise specified, Mellanox products are designed to work in an environmentally controlled data center with low levels of gaseous and dust (particulate) contamination.

The operation environment should meet severity level G1 as per ISA 71.04 for gaseous contamination and ISO 14644-1 class 8 for cleanliness level.

A system with a PCI Express slot of corresponding bus width is required for installing the card.

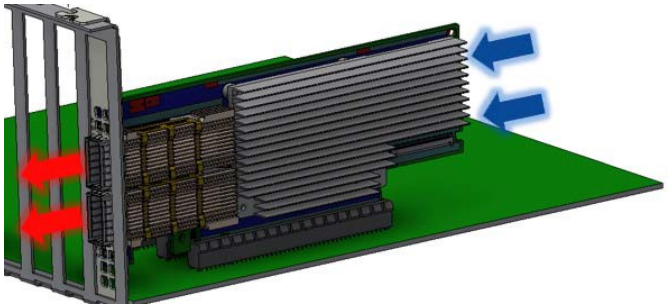
☐ For proper operation and performance, please make sure to use a PCIe slot with a corresponding bus width and that can supply sufficient power to your card. Refer to the Specifications section of the manual for more power requirements.

Airflow Requirements

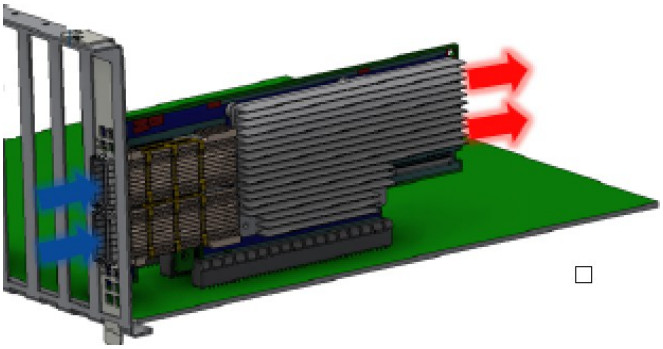
ConnectX-5 adapter cards are offered with two airflow patterns: from the heatsink to the network ports, and vice versa, as shown below.

Please refer to the Specifications section for airflow numbers for each specific card model.

Airflow *from the heatsink* to the network ports:



Airflow *from the network ports* to the heatsink:



- All cards in the system should be planned with the same airflow direction.

Software Requirements

- See Operating Systems/Distributions section under the Introduction section.
- Software Stacks - Mellanox OpenFabric software package MLNX_OFED for Linux, WinOF-2 for Windows, and VMware. See the Driver Installation section.

Unpacking the Product

☐ 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.

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

1. Unpack the adapter package and place them on an antistatic surface, and verify you have received the following items:
   a. ConnectX-5 Adapter Card, with a tall bracket assembled on the card.
   b. Short bracket (accessory)
2. Check the parts for visible damage that may have occurred during shipping.

   ☐ Please note that if the card is removed hastily from the antistatic bag, the plastic ziplock may harm the EMI fingers on the networking connector. Carefully remove the card from the antistatic bag to avoid damaging the EMI fingers.

3. Shut down your system if active:
   Turn off the power to the system, and disconnect the power cord. Refer to the system documentation for instructions. Before you install the ConnectX-5 card, make sure that the system is disconnected from power.

Bracket Replacement Instructions

The card is usually shipped with an assembled high-profile bracket. If this form factor is suitable for your requirements, you can skip the remainder of this section and move to Installation Instructions. If you need to replace the high-profile bracket with the short bracket that is included in the shipping box, please follow the instructions in this section.

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

To replace the bracket you will need the following parts:

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

Removing the Existing Bracket

1. Using a torque driver, remove the two screws holding the bracket in place.
2. Separate the bracket from the ConnectX-5 card.

   > ☐ Be careful not to put stress on the LEDs on the adapter card.

3. Save the two screws.

Installing the New Bracket

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

   > ☐ Do not force the bracket onto the adapter card.

2. Screw on the bracket using the screws saved from the bracket removal procedure above.

   > ☐ Use a torque driver to apply up to 2 lbs-in torque on the screws.

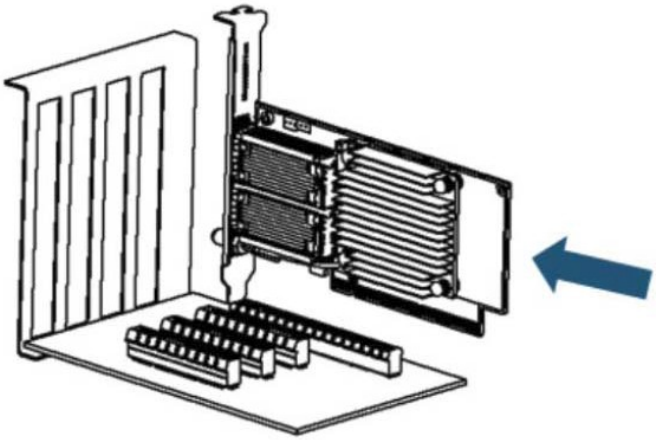
Installation Instructions

This section provides detailed instructions on how to install your adapter card in a system.

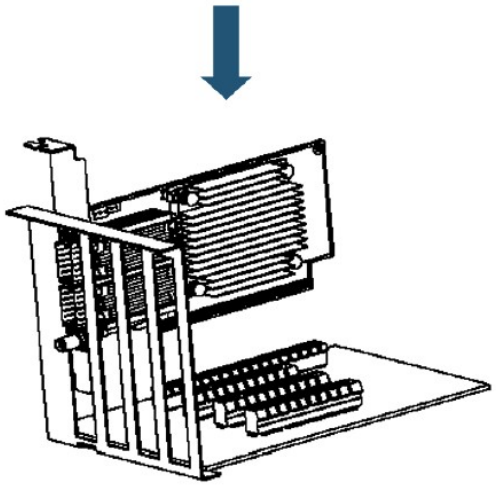
> ☐ Please note that the following figures are for illustration purposes only.

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.

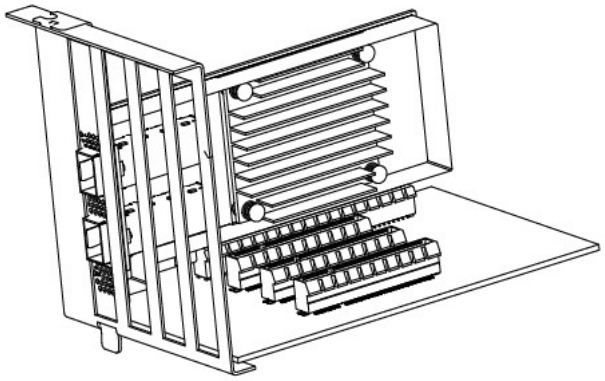
3. Place the adapter in an available PCI Express slot.



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



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



6. Secure the adapter with the adapter clip orscrew.

To uninstall the adapter card, see Uninstalling the Card.

Cables and Modules

To obtain the list of supported Mellanox cables for your adapter, please refer to the Cables Reference Table at http://www.mellanox.com/products/interconnect/cables-configurator.php.

Cable Installation

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

    When installing cables make sure that the latches engage.

    Always install and remove cables by pushing or pulling the cable and connector in a straight line with the card.
3. After inserting a cable into a port, the Green 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 LED Interface under the Interfaces section.
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 LED Interface under the Interfaces section.
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. The LED indicator will turn off when the cable is unseated.

Identifying the Card in Your System

On Linux

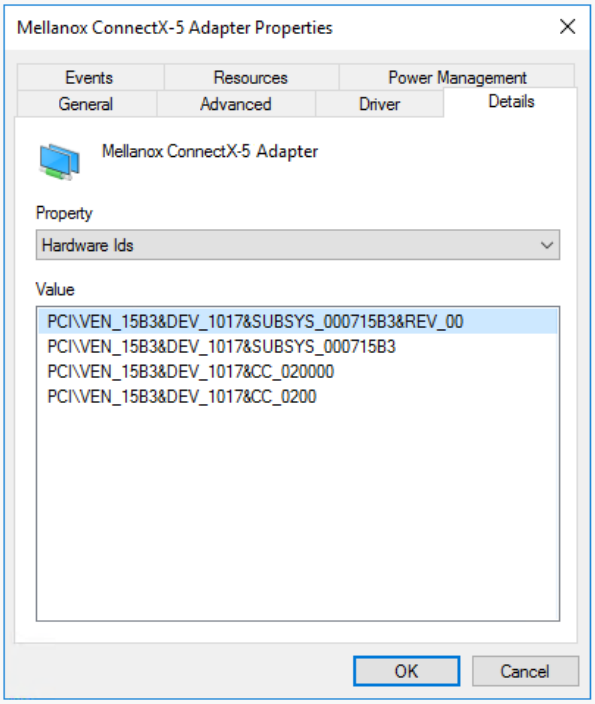
Get the device location on the PCI bus by running lspci and locating lines with the string “Mellanox Technologies”:

```
lspci |grep -i Mellanox
Network controller: Mellanox Technologies MT28800 Family [ConnectX-5]
```

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-5 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/R2/2016) from the Property pull-down menu.

   PCI Device (Example)



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 1018 (for ConnectX-5) – 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.

Uninstalling the Card

Safety Precautions

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

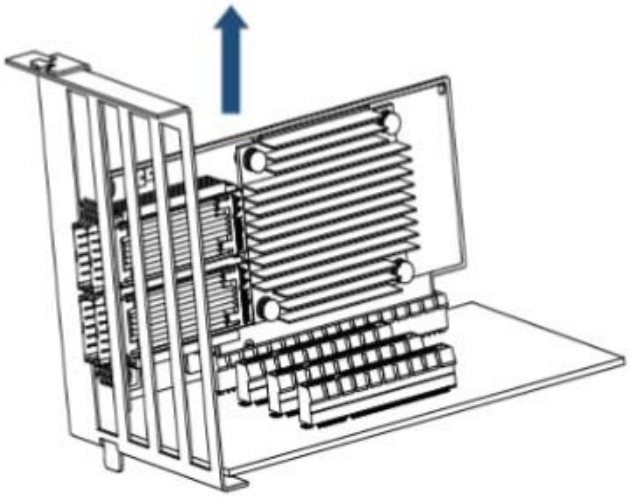
1. Remove any metallic objects from your hands and wrists.
2. It is strongly recommended to use an ESD strap or other antistatic devices.
3. Turn off the system and disconnect the power cord from the server.

Card Removal

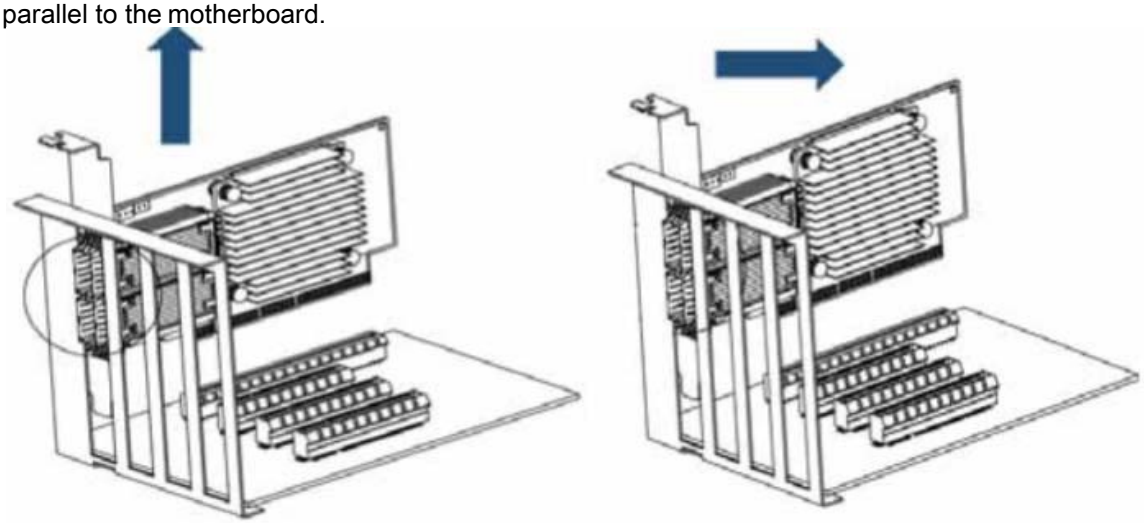
Please note that the following images are for illustration purposes only.

> ☐ 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 out of 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.



Driver Installation

Please use the relevant driver installation section.

- Linux Driver Installation
- Windows Driver Installation
- VMware Driver Installation

Linux Driver Installation

This section describes how to install and test the Mellanox OFED for Linux package on a single server with a Mellanox ConnectX-5 adapter card installed.

Prerequisites

Requirements	Description
Platforms	A server platform with one of the following Mellanox adapters installed: • ConnectX®-5 Ex (EN) (firmware: fw-ConnectX5) • ConnectX®-5 (EN) (firmware: fw-ConnectX5)
Required Disk Space for Installation	1GB
Device ID	For the latest list of device IDs, please visit the Mellanox website at http://www.mellanox.com/page/firmware_HCA_FW_identification.
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 (root) privileges on the target machine.

Downloading Mellanox OFED

1. Verify that the system has a Mellanox network adapter installed.
   The following example shows a system with an installed Mellanox adapter card:

   ```
   # 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
   ```

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 and install the latest OpenFabrics Enterprise Distribution (OFED) software package available via the Mellanox web site at http://www.mellanox.com > Products > Software > Ethernet Drivers > Linux SW/Drivers > Download..
   a. Scroll down to the Download wizard, and click the Download tab.
   b. Choose your relevant package depending on your host operating system.

c. Click the desired ISO/tgz package.
d. To obtain the download link, accept the End User License Agreement (EULA).

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.

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

Installing Mellanox OFED

Installation Script

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 upgrades the firmware.
  Note: The firmware will not be updated if you run the install script with the '--without-fw-update' option.
  Note: If you wish to perform a firmware upgrade using customized FW binaries, you can provide a path to the folder that contains the FW binary files, by running `--fw-image-dir`. Using this option, the FW version embedded in the MLNX_OFED package will be ignored. Example:

```
./mlnxofedinstall --fw-image-dir /tmp/my_fw_bin_files
```

Usage

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

☐ Pre-existing configuration files will be saved with the extension ".conf.rpmsave".

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.

- 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 inside the MLNX_OFED package.

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

  The "mlnx_add_kernel_support.sh" script can be executed directly from the mlnxofedinstall script. For further information, please see '--add-kernel-support' option below.

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

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 userspace 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.

For the list of installation options, run:

```
./mlnxofedinstall --h
```

The DKMS (on Debian based OS) and the weak-modules (RedHat OS) mechanisms rebuild the initrd/initramfs for the respective kernel in order to add the MLNX_OFED drivers.
When installing MLNX_OFED without DKMS support on Debian based OS, or without KMP support on RedHat or any other distribution, the initramfs will not be changed. Therefore, the inbox drivers may be loaded on boot. In this case, openibd service script will automatically unload them and load the new drivers that come with MLNX_OFED.

Installation Procedure

1. Login to the installation machine as root.
2. Mount the ISO image on your machine.

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

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, RDMA or Distribution IB packages will be removed.
Those packages are removed due to conflicts with MLNX_OFED_LINUX, do not reinstall them.
Starting MLNX_OFED_LINUX-x.x.x installation ...
--------
--------
Installation finished successfully.

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

- For unattended installation, use the --force installation option while running the MLNX_OFED installation script:

  ```
  /mnt/mlnxofedinstall --force
  ```

- MLNX_OFED for Ubuntu should be installed with the following flags in the root environment:

  ```
  ./mlnxofedinstall --without-dkms --add-kernel-support --kernel <kernel version in chroot> --without-fw-update --force
  ```

  For example:

  ```
  ./mlnxofedinstall --without-dkms --add-kernel-support --kernel 3.13.0-85-generic --without-fw-update --force
  ```

  Note that the path to kernel sources (--kernel-sources) should be added if the sources are not in their default location.

- 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-5
  Part Number:      MCX515A-CCAT
  Description:      ConnectX®-5 EN network interface card, 100GbE single-port QSFP28, PCIe3.0 x16, tall bracket
  PSID:             MT_2190110032
  PCI Device Name: 0b:00.0
  Base MAC:         0000e41d2d5cf810 Versions:
                    Current         Available
    FW              16.22.0228      16.22.0228
    Status:         Up to date
  ```

☐ In case your machine has an unsupported network adapter device, no firmware update will occur and one of the following error messages below will be printed. Please contact your hardware vendor for help on firmware updates.
Error message 1:

```
Device #1:
----------

Device Type:      ConnectX-5
Part Number:      MCX515A-CCAT
Description:      ConnectX®-5 EN network interface card, 100GbE single-port QSFP28, PCIe3.0
x16, tall bracket

PSID:             MT_2190110032
PCI Device Name:  0b:00.0
Base MAC:         0000e41d2d5cf810
Versions:         Current        Available
                  FW 16.22.0228  N/A
Status:           No matching image found
```

Error message 2:

```
The firmware for this device is not distributed inside Mellanox driver: 0000:01:00.0 (PSID:
IBM2150110033)
To obtain firmware for this device, please contact your HW vendor.
```

4. If the installation script has performed a firmware update on your network adapter, complete the step relevant to your adapter card type to load the firmware:
   - ConnectX-5/ConnectX-5 Ex - perform a standard reboot

   Otherwise, restart the driver by running: `/etc/init.d/openibd restart`

After installation completion, 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.

Installation Results

Software	• Most of MLNX_OFED packages are installed under the "/usr" directory except for the following packages which are installed under the "/opt" directory:
	  • fca and ibutils
	• The kernel modules are installed under
	  • /lib/modules/`uname -r`/updates on SLES and Fedora Distributions
	  • /lib/modules/`uname -r`/extra/mlnx-ofa_kernel on RHEL and other Red Hat like Distributions

Firmware	• The firmware of existing network adapter devices will be updated if the following two conditions are fulfilled:
	  • The installation script is run in default mode; that is, without the option '--without-fw-update'
	  • The firmware version of the adapter device is older than the firmware version included with the Mellanox OFED ISO image Note: If an adapter's flash was originally programmed with an Expansion ROM image, the automatic firmware update will also burn an Expansion ROM image.
	• In case that your machine has an unsupported network adapter device, no firmware update will occur and the error message below will be printed.
	The firmware for this device is not distributed inside Mellanox driver: 0000:01:00.0 (PSID: IBM2150110033)
	To obtain firmware for this device, please contact your HW vendor.

Installation Logs

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>.<PD>.logs`".

Example:

```
Logs dir: /tmp/MLNX_OFED_LINUX-4.4-1.0.0.0.63414.logs
```

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
```

An example of OPENIBD_POST_START script for activating all interfaces is provided in the MLNX_OFED package under the docs/scripts/openibd-post-start-configure-interfaces/ folder.

Driver Load Upon System Boot

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

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

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
```

2. Set “ONBOOT=no” in the "/etc/infiniband/openib.conf" file.
3. If the modules exist in the initramfs file, they can automatically be loaded by the kernel. To prevent this behavior, update the initramfs using the operating systems’ standard tools. Note: The process of updating the initramfs will add the blacklists from step 1, and will prevent the kernel from loading the modules automatically.

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 mst driver

Uninstalling MLNX_OFED

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

Installing MLNX_OFED Using YUM

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

Setting up MLNX_OFED YUM Repository

1. Log into the installation machine as root.
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
```

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]
```

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]:
```

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>)
```

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>/RPMS
enabled=1
gpgkey=file:///<path to the downloaded key RPM-GPG-KEY-Mellanox>
gpgcheck=1
```

7. Check that the repository was successfully added.

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

repolist: 8,351
```

Installing MLNX_OFED Using the YUM Tool

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

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.x8
6_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.fc2
1.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.fc2
1.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.x8
6_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.x8
6_64 (without KMP support)
mlnx-ofed-vma-eth-3.17.4-301.fc21.x86_64.noarch : MLNX_OFED vma-eth installer package for kernel 3.17.4-301.
fc21.x86_64 (without KMP support)
mlnx-ofed-vma-vpi-3.17.4-301.fc21.x86_64.noarch : MLNX_OFED vma-vpi installer package for kernel 3.17.4-301.
fc21.x86_64 (without KMP support)
```

If you have an operating system 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.

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-isert = 1.0-OFED.3.1.0.1.2.1.g832a737.rhel7u1 for package:
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
  sdpnetstat.x86_64 0:1.60-26
  srptools.x86_64 0:1.0.2-12

Complete!
```

Uninstalling MLNX_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.

Installing MLNX_OFED Using apt-get Tool

This type of installation is applicable to Debian and Ubuntu operating systems.

Setting up MLNX_OFED apt-get Repository

1. Log into the installation machine as root.
2. Extract the MLNX_OFED pacakge on a shared location in your network.
   You can download it from http://www.mellanox.com > Products > Software> Ethernet Drivers.
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>/DEBS ./
```

4. Download and install Mellanox Technologies GPG-KEY.

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

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
```

6. Update the apt-get cache.

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

Installing MLNX_OFED Using the apt-get Tool

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

1. View the available package groups by invoking:

```
<pre># 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.
```

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
  ```
  Or, update the firmware to the latest version available on Mellanox Technologies’ Web site as described in Updating Adapter Firmware.

Uninstalling MLNX_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 package.

Updating Firmware After Installation

The firmware can be updated either manually or automatically (upon system boot), as described in the sections below.

Updating the Device Online

To update the device online on the machine from the 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-5
Part Number:      MCX515A-CCAT
Description:      ConnectX®-5 EN network interface card, 100GbE single-port QSFP28, PCIe3.0 x16, tall bracket
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.
```

Updating the Device Manually

To update the device manually, please refer to the OEM Firmware Download page at http://www.mellanox.com/page/firmware_table_dell?mtag=oem_firmware_download.

In case that 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 that you wish to burn newer firmware that you have downloaded from Mellanox Technologies’ Web site (http://www.mellanox.com > Support > Firmware Download).

1. Get the device’s PSID.

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

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

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

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

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"
```

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.

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 that (1) The 'mokutil' package is installed on your system, and (2) The system is booted in UEFI mode.

1. Download the x.509 public key.

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

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

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

3. Reboot the system.

The pending MOK key enrollment request will be noticed by shim.efi and it will launch MokManager.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#

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. 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:

1. Remove the signature.

```
# rpm -qa | grep -E "kernel-ib|mlnx-ofa_kernel|iser|srp|knem|mlnx-rds|mlnx-nfsrdma|mlnx-nvme|mlnx-rdma-rxe"
  | 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 only presented once, upon first module boot that either has no signature or whose key is not in the kernel key ring. Therefore, this message may go unnoticed. Once the system is rebooted after unloading and reloading a kernel module, the message will appear. (Note that this message cannot be eliminated.)

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

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

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 that tuning is required,

please refer to the Performance Tuning Guide for Mellanox Network Adapters at https://community.mellanox.com/docs/DOC-2489.

Windows Driver Installation

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

> ☐ The snapshots in the following sections are presented for illustration purposes only. The installation interface may slightly vary, depending on the operating system in use.

Software Requirements

Description	Package
Windows Server 2012 R2	MLNX_WinOF2-2_10_All_x64.exe
Windows Server 2012	
Windows Server 2016	
Windows Server 2019	
Windows 8.1 Client (64 bit only)	
Windows 10 Client (64 bit only)	

Note: The Operating System listed above must run with administrator privileges.

Downloading Mellanox WinOF-2 Driver

To download the executable file according to your operating system, please follow the steps below:

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

```
echo %PROCESSOR_ARCHITECTURE%
```

   > ☐ On an x64 (64-bit) machine, the output will be “AMD64”.

2. Go to the Mellanox WinOF-2 web page at http://www.mellanox.com > Products > Ethernet Drivers > Windows SW/Drivers.
3. Download the exe image according to the architecture of your machine (see Step 1). The name of the .exe is in the following format: MLNX_WinOF2-<version>_x<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 executable file on a 32-bit machine, the wizard will display the following (or a similar) error message: “The installation package is not supported by this processor type. Contact your vendor.”

Installing Mellanox WinOF-2 Driver

The snapshots in the following sections are for illustration purposes only. The installation interface may slightly vary, depending on the used operating system.

This section provides instructions for two types of installation procedures, and both require administrator privileges:

- 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.

Attended Installation

The following is an example of an installation session.

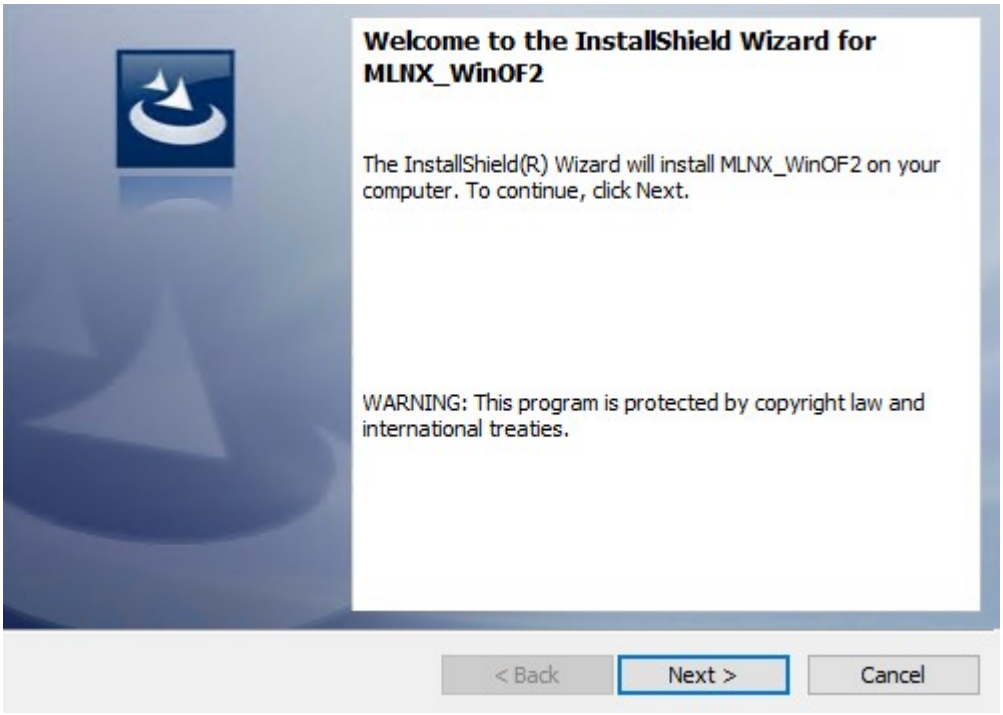
1. Double click the .exe and follow the GUI instructions to install MLNX_WinOF2.
2. [Optional] Manually configure your setup to contain the logs option (replace “LogFile” with the relevant directory):

```
MLNX_WinOF2-[Driver/Version]_<revision_version>_All_Arch.exe /v"/l*vx [LogFile]"
```

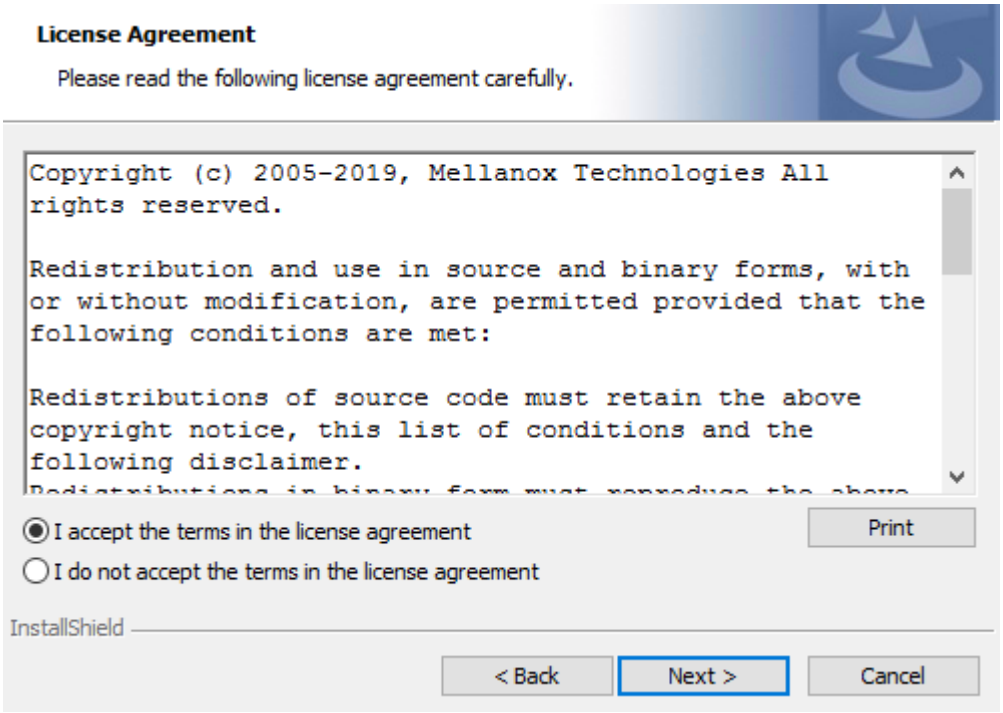
3. [Optional] If you do not want to upgrade your firmware version. (Note: MT_SKIPFWUPGRD default value is False.)

```
MLNX_WinOF2-2_10_50000_All_x64.exe /v"/l*vx MyLog.txt=1"
```

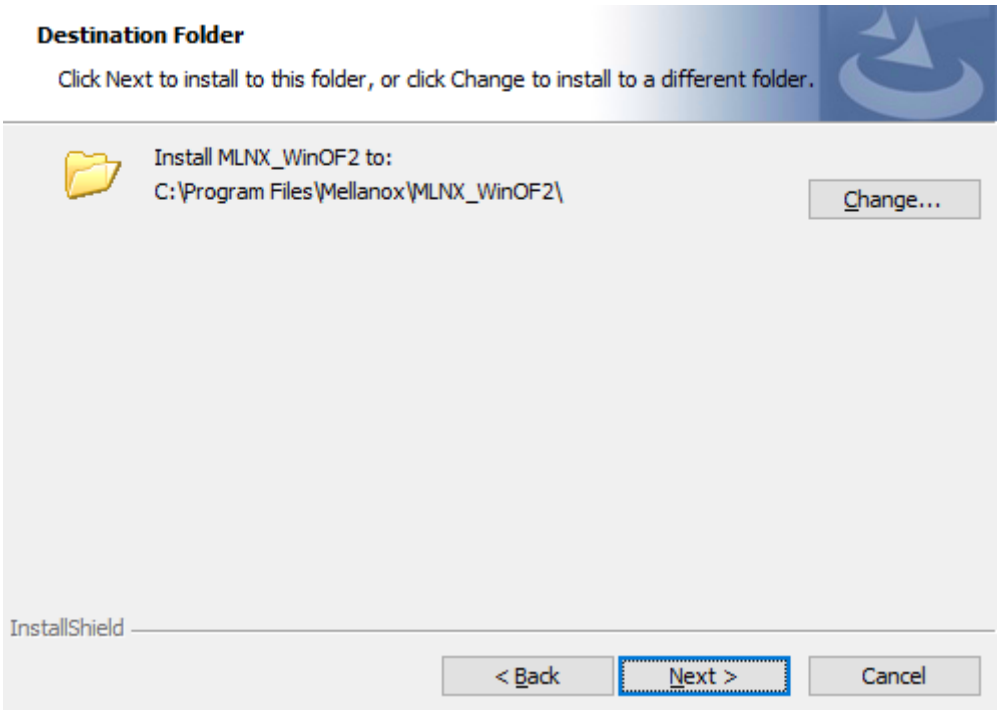
4. Click Next in the Welcome screen.



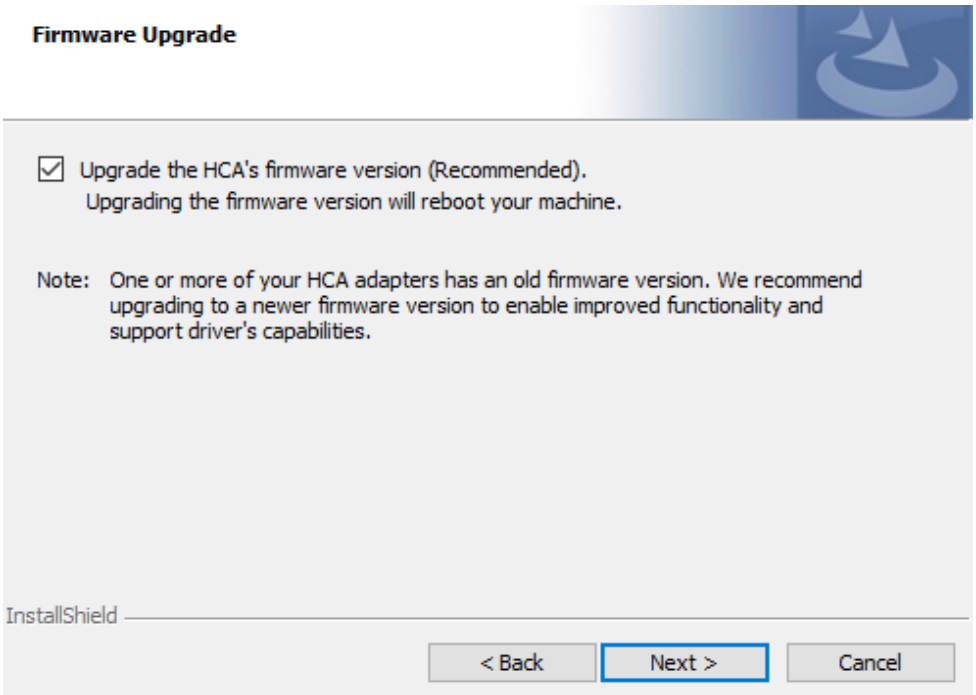
5. Read and accept the license agreement and click Next.



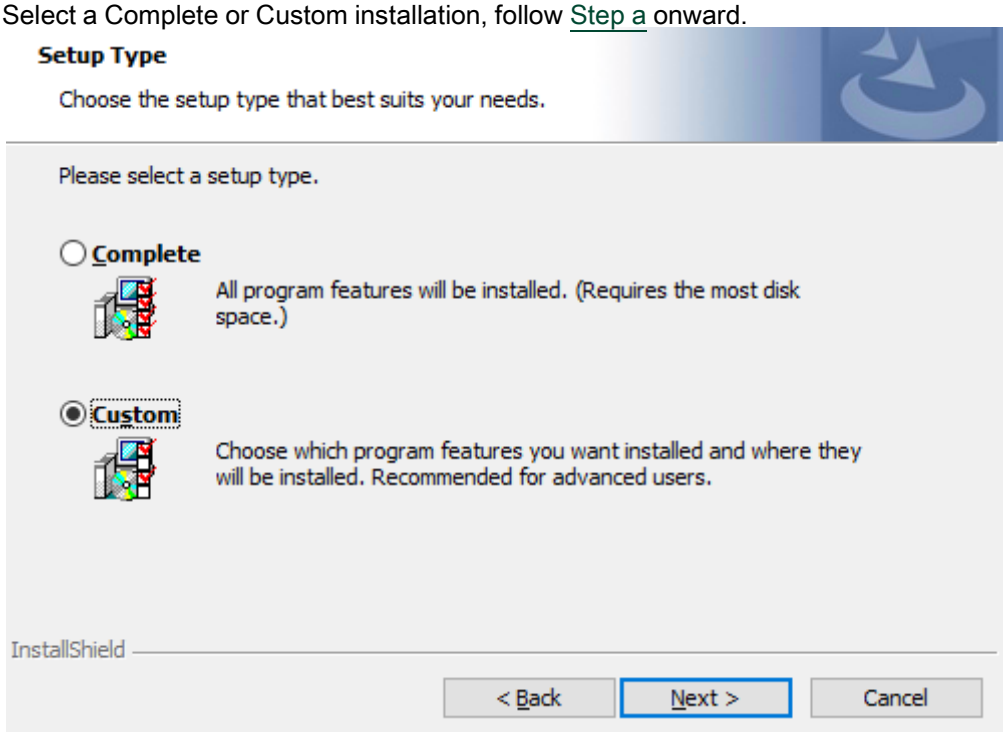
6. Select the target folder for the installation.



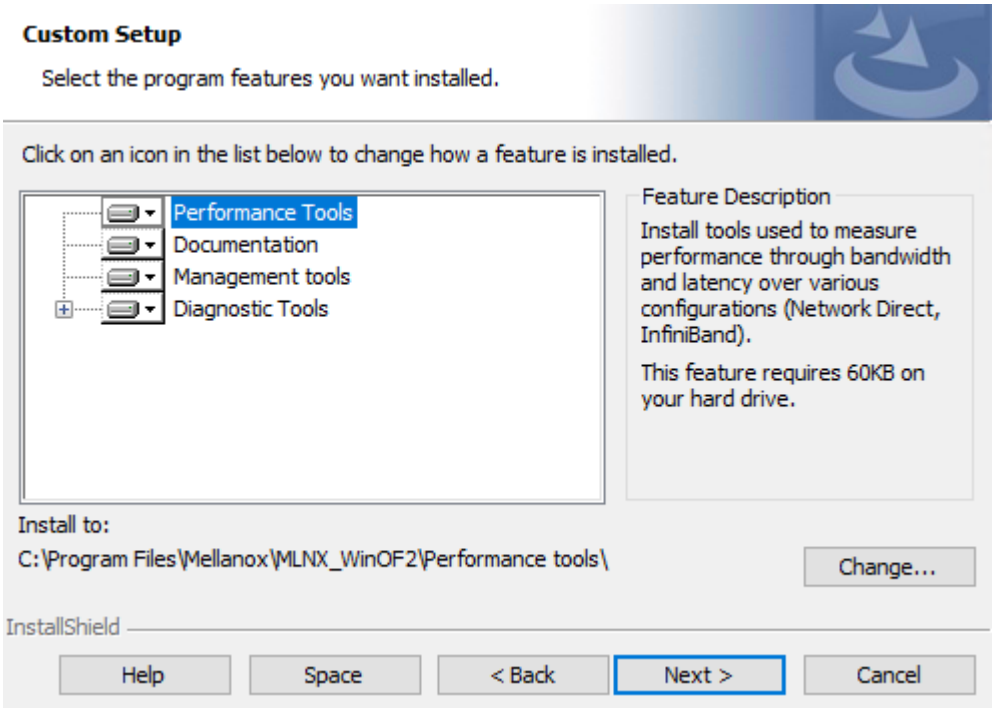
7. The firmware upgrade screen will be displayed in the following cases:
    - If the user has an OEM card. In this case, the firmware will not be displayed.
    - If the user has a standard Mellanox card with an older firmware version, the firmware will be updated accordingly. However, if the user has both an OEM card and a Mellanox card, only the Mellanox card will be updated.



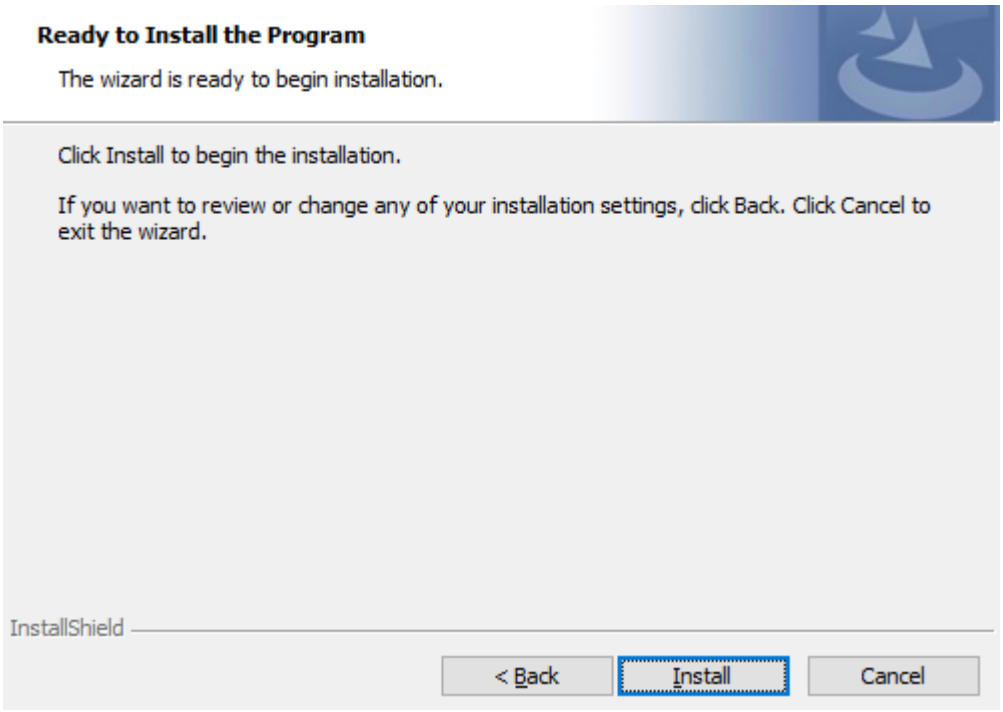
8. Select a Complete or Custom installation, follow Step a onward.



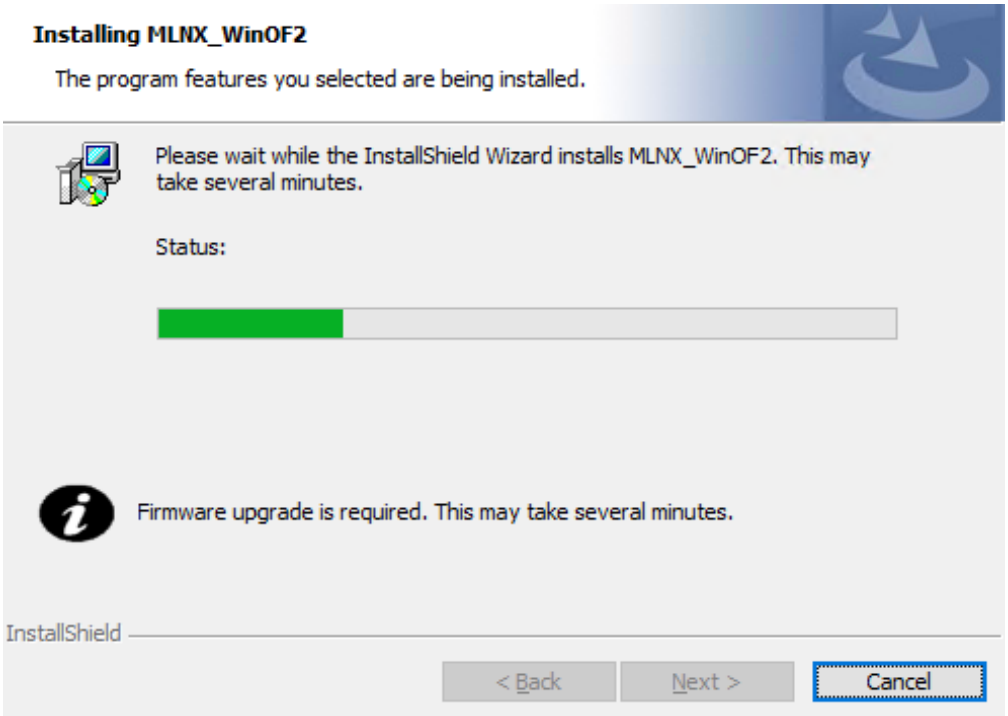
   a. Select the desired feature to install:
      - Performances tools - install the performance tools that are used to measure performance in user environment
      - Documentation - contains the User Manual and Release Notes
      - Management tools - installation tools used for management, such as mlxstat
      - Diagnostic Tools - installation tools used for diagnostics, such as mlx5cmd
   b. Click Next to install the desired tools.



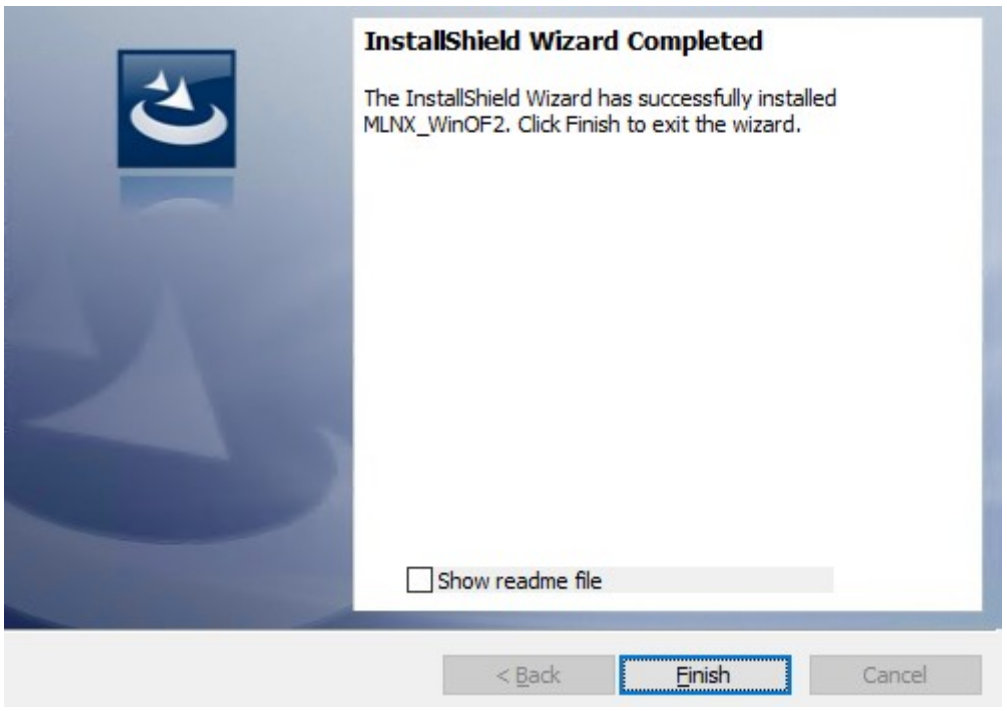
9. Click Install to start the installation.



10. In case firmware upgrade option was checked in Step 7, you will be notified if a firmware upgrade is required (see).



11. Click Finish to complete the installation.



1

Unattended Installation

If no reboot options are specified, the installer restarts the computer whenever necessary without displaying any prompt or warning to the user.
To control the reboots, use the */norestart* or */forcerestart* standard command-line options.

The following is an example of an unattended installation session.

1. Open a CMD console-> Click Start-> Task Manager File-> Run new task-> and enter CMD.
2. Install the driver. Run:

```
MLNX_WinOF2-[Driver/Version]_<revision_version>_All_Arch.exe /S /v/qn
```

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

```
_All_Arch.exe /S /v/qn /v"/l*vx [Log- File]"" v:shapes="_x0000_s1026">
```

4. [Optional] if you wish to control whether to install ND provider or not (i.e., *MT_NDPROPERTY default value is True*).

```
MLNX_WinOF2-[Driver/Version]_<revision_version>_All_Arch.exe /vMT_NDPROPERTY=1
```

5. [Optional] If you do not wish to upgrade your firmware version (i.e.,*MT_SKIPFWUPGRD default value is False*).

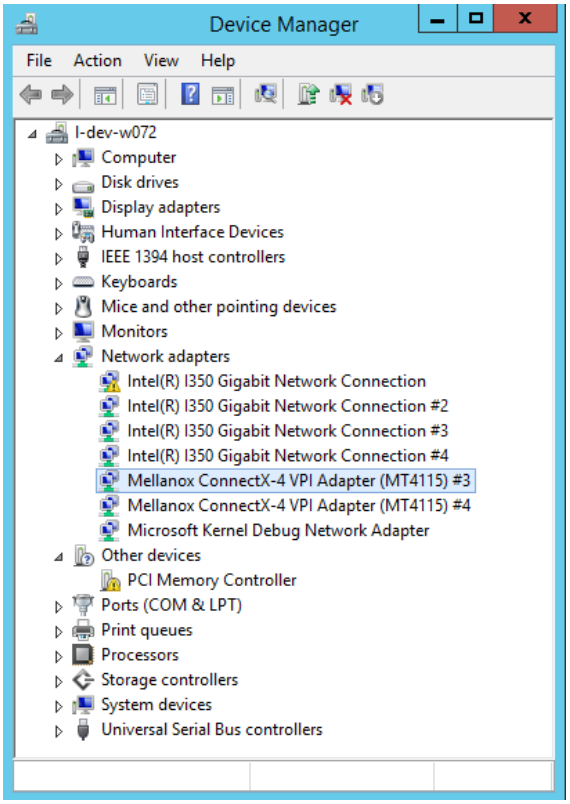
```
MLNX_WinOF2-[Driver/Version]_<revision_version>_All_Arch.exe /vMT_SKIPFWUPGRD=1
```

Installation Results

Upon installation completion, you can verify the successful addition of the network card(s) through the Device Manager. The inf files can be located at:

```
%ProgramFiles%\Mellanox\MLNX_WinOF2\Drivers\
```

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



Uninstalling Mellanox WinOF-2 Driver

Attended Uninstallation

To uninstall MLNX_WinOF2 on a single node:

1. Click Start > Control Panel > Programs and Features > MLNX_WinOF2 > Uninstall.
   (NOTE: This requires elevated administrator privileges)

Unattended Uninstallation

To uninstall MLNX_WinOF2 in unattended mode:

1. Open a CMD console. (Click Task Manager > File > Run new task, and enter CMD.)
2. To uninstall the driver, run:

```
MLNX_WinOF2-2_0_All_x64.exe /S /x /v"/qn"
```

Extracting Files Without Running Installation

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

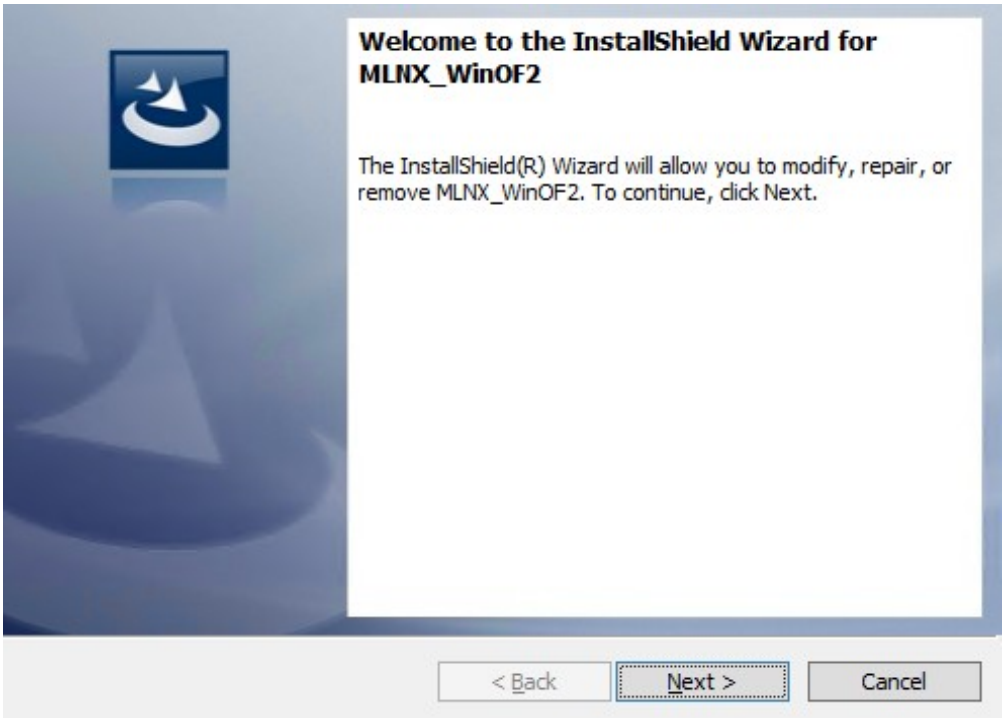
1. Open a CMD console-> Click Start-> Task Manager-> File-> Run new task-> and enter CMD.
2. Extract the driver and the tools:

```
MLNX_WinOF2-2_0_<revision_version>_All_x64 /a
```

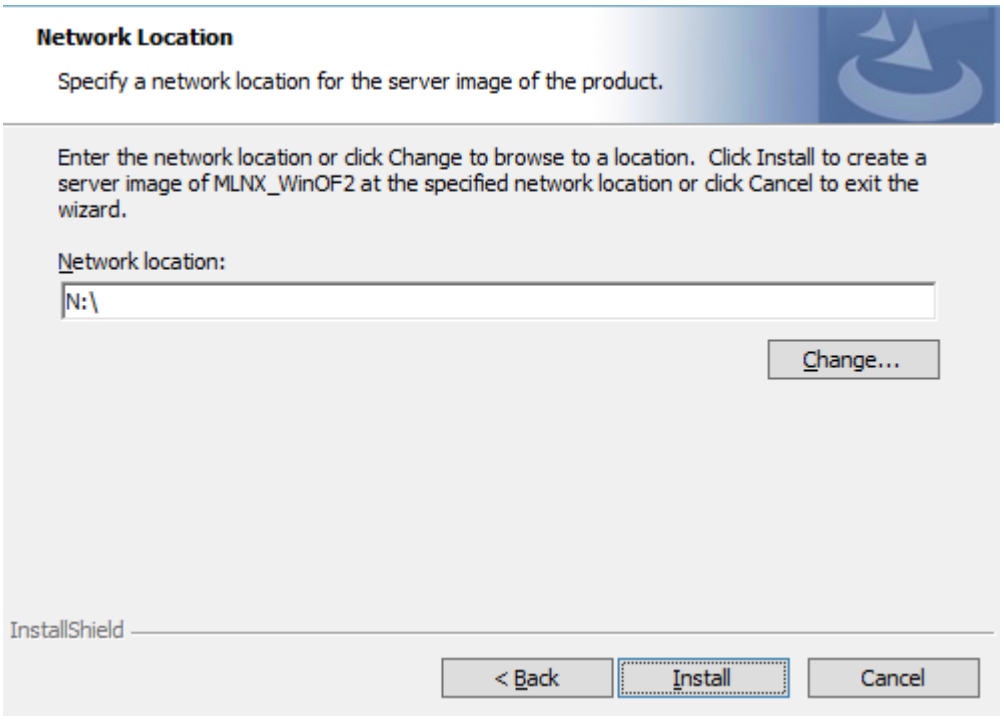
To extract only the driver file

```
MLNX_WinOF2-2_0_<revision_version>_All_x64 /a /vMT_DRIVERS_ONLY=1
```

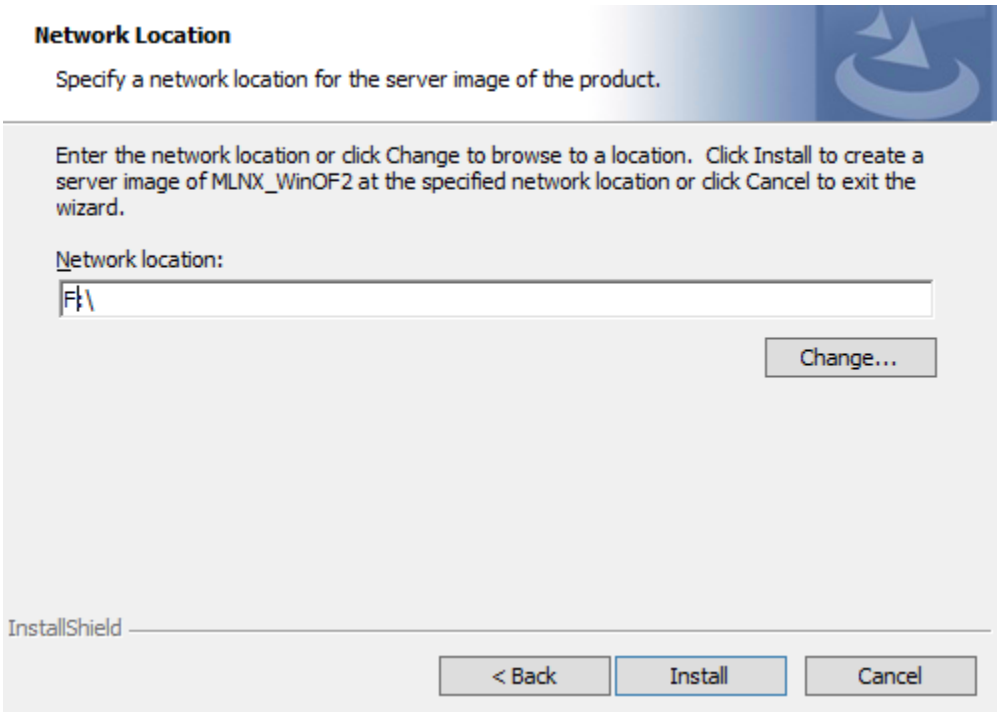
3. Click Next to create a server image.



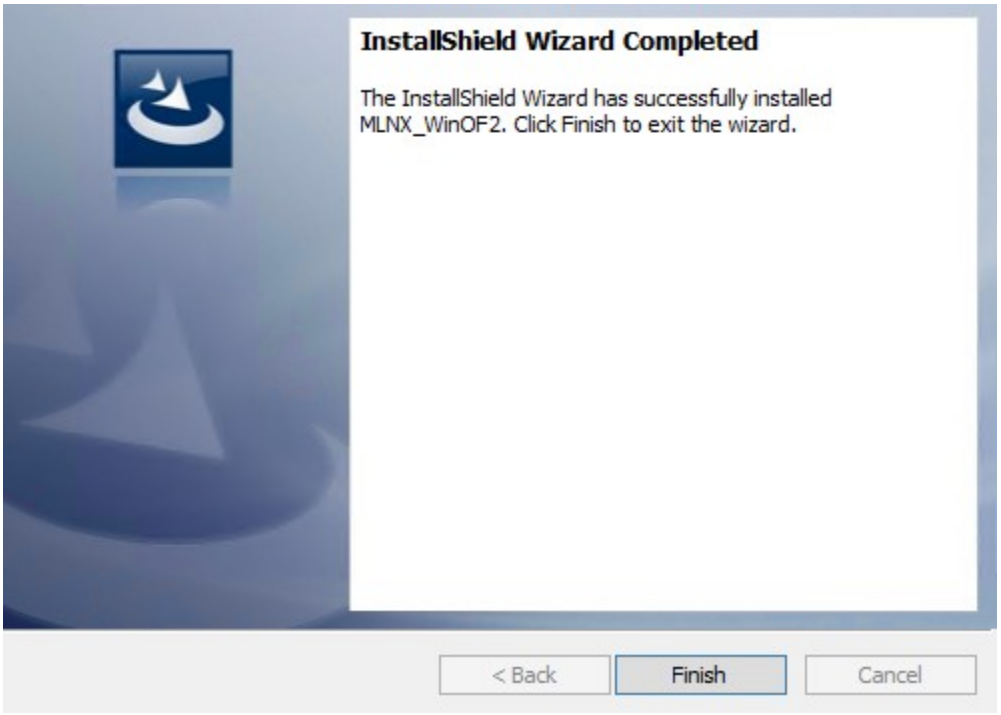
4. Click Change and specify the location in which the files are extracted to.



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



6. To complete the extraction, click Finish.



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 the MFT User Manual at www.mellanox.com >Products > Ethernet Drivers > Firmware Tools.

VMware Driver Installation

This section describes VMware Driver Installation.

Hardware and Software Requirements

Requirement	Description
Platforms	A server platform with an adapter card based on one of the following Mellanox Technologies' devices: • ConnectX®-5 (EN) (firmware: fw-ConnectX5) • ConnectX®-5 Ex (EN) (firmware: fw-ConnectX5)
Device ID	For the latest list of device IDs, please visit Mellanox's website.
Operating System	ESXi 6.5
Installer Privileges	The installation requires administrator privileges on the target machine.

Installing Mellanox NATIVE ESXi Driver for VMware vSphere

> Please uninstall all previous Mellanox driver packages prior to installing the new version. See Removing Earlier Mellanox Drivers for further information.

To install the driver:

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

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

   Example:

   ```
   #> esxcli software vib install -d /tmp/MLNX-NATIVE-ESX-ConnectX-4-5_4.16.8.8-10EM-650.0.0.4240417.zip
   ```
3. Reboot the machine.
4. Verify the driver was installed successfully.

   ```
   esxcli software vib list | grep nmlx
   nmlx5-core      4.16.8.8-1OEM.650.0.0.4240417   MEL     PartnerSupported 2017-01-31
   nmlx5-rdma      4.16.8.8-1OEM.650.0.0.4240417   MEL     PartnerSupported 2017-01-31
   ```

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

Removing Earlier Mellanox Drivers

> Please unload the previously installed drivers before removing them.

To remove all the drivers:

1. Log into the ESXi server with root permissions.
2. List all the existing NATIVE ESXi driver modules. (See Step 4 in Installing Mellanox NATIVE ESXi Driver for VMware vSphere.)
3. Remove each module:

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

   > To remove the modules, you must run the command in the same order as shown in the example above.
4. Reboot the server.

Firmware Programming

1. Download the VMware bootable binary images v4.6.0 from the Mellanox Firmware Tools (MFT) site.
   a. ESXi 6.5 File: mft-4.6.0.48-10EM-650.0.0.4598673.x86_64.vib
   b. MD5SUM: 0804cffe30913a7b4017445a0f0adbe1
2. Install the image according to the steps described in the MFT User Manual.

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

Updating Adapter Firmware

Each adapter 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.

Firmware Update Example

```
[server1]# ./mlxup
Querying Mellanox devices firmware ...
Device Type:      ConnectX-5
Part Number:      MCX516A-CDAT
Description:      ConnectX®-5 Ex EN network interface card, 100GbE dual-port QSFP28, PCIe4.0 x16, tall bracket
PSID:             MT_2190110032
PCI Device Name:  0000:06:00.0
Base GUID:        e41d2d0300fd8b8a
Versions:         Current                 Available
                  FW 16.23.1020           16.24.1000

Status:           Update required

Device Type:      ConnectX-5
Part Number:      MCX516A-CDAT
Description:      ConnectX®-5 Ex EN network interface card, 100GbE dual-port QSFP28, PCIe4.0 x16, tall bracket
PSID:             MT_2170110021
PCI Device Name: 0000:07:00.0
Base MAC:         0000e41d2da206d4
Versions:         Current                 Available
                  FW 16.24.1000           16.24.1000

Status:           Up to date

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

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

Troubleshooting

General Troubleshooting

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

Linux Troubleshooting

Environment Information	cat /etc/issue uname -a cat /proc/cupinfo | grep 'model name' | uniq ofed_info -s ifconfig -a ip link show ethtool <interface> ethtool -i <interface_of_Mellanox_port_num> ibdev2netdev
Card Detection	lspci | grep -i Mellanox

Mellanox Firmware Tool (MFT)	Download and install MFT: http://www.mellanox.com/content/pages.php?pg=management_tools&menu_section=34 Refer to the User Manual for installation instructions. Once installed, run: mst start mst status flint -d <mst_device> q
Ports Information	ibstat ibv_devinfo
Firmware Version Upgrade	To download the latest firmware version refer to http://www.mellanox.com/supportdownloader
Collect Log File	cat /var/log/messages dmesg >> system.log journalctl (Applicable on new operating systems) cat /var/log/syslog

Windows Troubleshooting

Environment Information	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.
Mellanox Firmware Tool (MFT)	Download and install MFT: http://www.mellanox.com/content/pages.php?pg=management_tools&menu_section=34 Refer to the User Manual for installation instructions. Once installed, open a CMD window and run: WinMFT mst start mst status flint –d <mst_device> q
Ports Information	vstat
Firmware Version Upgrade	Download the latest firmware version using the PSID/board ID: http://www.mellanox.com/supportdownloader/ flint –d <mst_device> –i <firmware_bin_file> b

Collect Log File	• Event log viewer
	• MST device logs:
	  • mst start
	  • mst status
	• flint –d <mst_device> dc > dump_configuration.log
	• mstdump <mst_device> dc > mstdump.log

Specifications

MCX512A-ACAT Specifications

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile Connector: Dual SFP28 Ethernet (copper and optical)		
Protocol Support	Ethernet: 25GBASE-CR/CR-S, 25GBASE-SR, 25GBASE-LR, 25G Ethernet Consortium, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, SGMII / 1000BASE-X Data Rate: 1/10/25 Gb/s Ethernet PCI Express Gen3: SERDES @ 8.0GT/s, 8 lanes (2.0 and 1.1 compatible)		
Power	Voltage: 12V		
	Power	Cable Type	
	Typical Power[a]	Passive Cable	9.5W
	Maximum Power	Passive Cable	11.8W
		1.5W Active Cable	15.1W
	Maximum power available through SFP28 port: 1.5W		
Environmental	Temperature	Operational	0°C to 55°C

		Non-operational	-40°C to 70°C
	Humidity	90% relative humidity[b]	
	Altitude (Operational)	3050m	
	Airflow	See Airflow Specifications.	
Regulatory	Safety	CB / cTUVus / CE	
	EMC	CE / FCC / VCCI / ICES / RCM	
	RoHS	RoHS-compliant	

Notes: a. Typical power for ATIS traffic load.
b. For both operational and non-operational states.

MCX515A-CCAT Specifications

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile Connector: Single QSFP28 (copper and optical)
Protocol Support	Ethernet: 100GBASE-CR4, 100GBASE-KR4, 100GBASE-SR4, 56GBASE-R4, 50G Ethernet Consortium, 40GBASE-CR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 25GBASE-CR/ CR-S, 25GBASE-SR, 25GBASE-LR, 25G Ethernet Consortium, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, SGMII, 1000BASE-X Data Rate: 1/10/25/40/50/100 Gb/s Ethernet PCI Express Gen3: SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible)

Power and Environmental	Voltage: 12V		
	Power	Cable Type	
	Typical Power[a]:	Passive Cable	14.2W
	Maximum Power:	Passive Cable	17.0W
		1.5W Active Cable	18.6W
		2.5W Active Cable	19.7W
	Maximum power available through QSFP28 port: 5W		
	Temperature:	Operational	0°C to 55°C
		Non-operational	-40°C to 70°C
	Humidity:	90% relative humidity[b]	
	Altitude (Operational)	3050m	
	Airflow:	See Airflow Specifications.	
Regulatory	Safety:	CB / cTUVus / CE	
	EMC:	CE / FCC / VCCI / ICES / RCM	
	RoHS:	RoHS-compliant	

Notes: a. Typical power for ATIS traffic load.
b. For both operational and non-operational states.

MCX516A-CCAT Specifications

Physical	Size: 2.71 in. x 5.6 in. (68.90mm x 142.24 mm) – low profile Connector: Dual QSFP28 (copper and optical)		
Protocol Support	Ethernet: 100GBASE-CR4, 100GBASE-KR4, 100GBASE-SR4, 56GBASE-R4, 50G Ethernet Consortium, 40GBASE-CR4, 40GBASE-SR4, 40GBASE-LR4, 40GBASE-ER4, 25GBASE-CR/ CR-S, 25GBASE-SR, 25GBASE-LR, 25G Ethernet Consortium, 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-CX4, SGMII, 1000BASE-X Data Rate: 1/10/25/40/50/100 Gb/s Ethernet PCI Express Gen3: SERDES @ 8.0GT/s, 16 lanes (2.0 and 1.1 compatible) *Note: PCIe 3.0 x16 bus can supply a maximum bandwidth of 128Gb/s only (=16 * 8GT/s, including overhead), and therefore cannot support 200Gb/s when both network ports of MCX516A-CCAT run at 100Gb/s.*		
Power and Environmental	Voltage: 12V		
	Power	Cable Type	
	Typical Power[a]:	Passive Cable	16.2W
	Maximum Power:	Passive Cable	19.0W

		1.5W Active Cable	22.3W
		2.5W Active Cable	24.6W
	Maximum power available through QSFP28 port: 5W		
	Temperature:	Operational	0°C to 55°C
		Non-operational	-40°C to 70°C
	Humidity:	90% relative humidity[(b)]	
	Altitude (Operational)	3050m	
	Airflow:	See Airflow Specifications.	
Regulatory	Safety:	CB / cTUVus / CE	
	EMC:	CE / FCC / VCCI / ICES / RCM	
	RoHS:	RoHS-compliant	

Notes: a. Typical power for ATIS traffic load.
b. For both operational and non-operational states.

Airflow Specifications

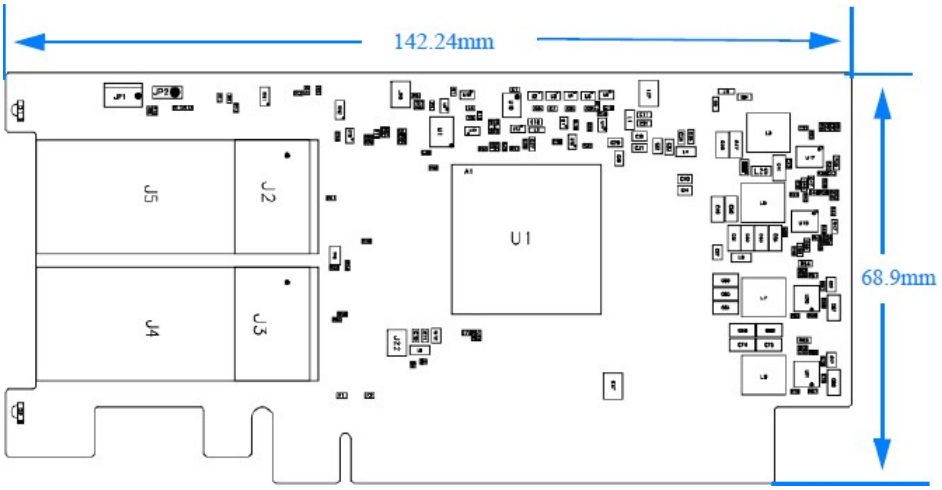
Airflow (LFM) with airflow direction from heatsink to port.

	Cable Type				
OPN	Passive	Active 1.5W	Active 2.5W	Active 3.5W	Active 5W
MCX512A-ACAT	150LFM	300LFM	N/A	N/A	N/A
MCX515A-CCAT	300LFM	350LFM	400LFM	400LFM	950LFM
MCX516A-CCAT	350LFM	500LFM	600LFM	650LFM	1300LFM

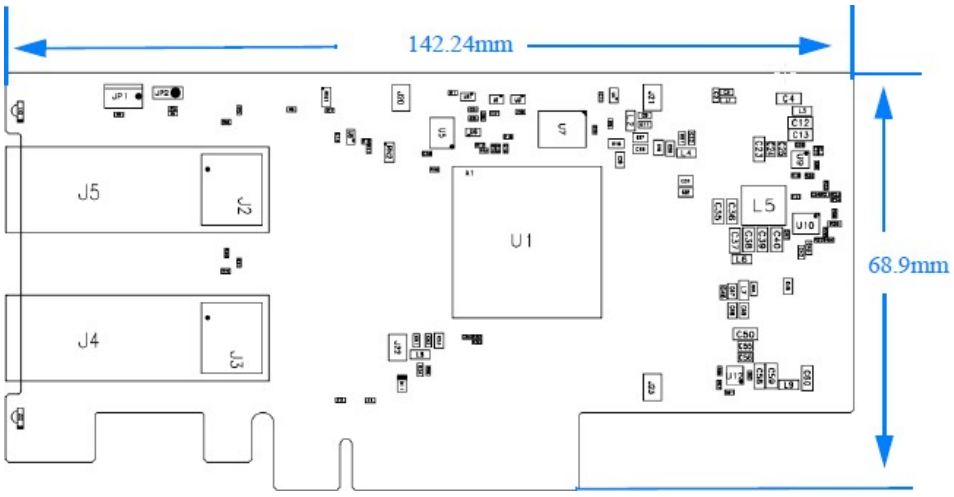
Board Mechanical Drawing and Dimensions

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

Mechanical Drawing of a Dual-Port x16 Card



Mechanical Drawing of a Dual-Port x8 Card

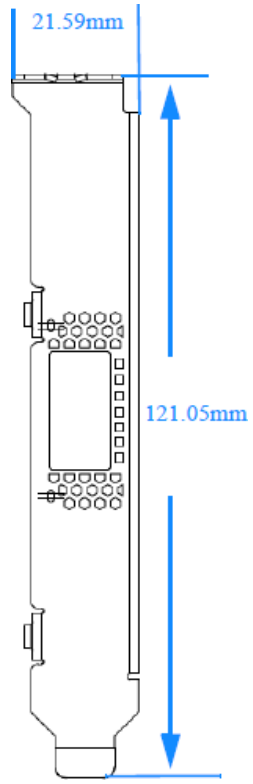


- For the 3D Model of the card, please refer to 3D Models at http://www.mellanox.com/page/3d_models.

Bracket Mechanical Drawing

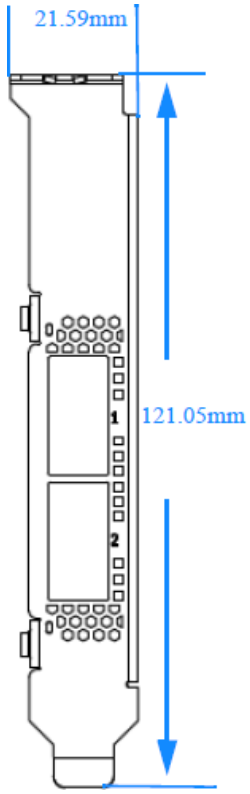
Single-port Tall Bracket

Dimensions in millimeters.



Dual-port Tall Bracket

Dimensions in millimeters.



Environmental

Finding the MAC on the Adapter Card

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

- The product revisions indicated on the labels in the following figures do not necessarily represent the latest revisions of the cards.

MCX512A- ACAT Board Label (Example)

MCX515A-CCAT Board Label (Example)

MCX516A-CCAT Board Label (Example)

Document Revision History

Date	Revision	Description of Changes
Oct. 2020	2.5	Updated board labels.
Feb. 2020	2.2	Added altitude criteria to "Specifications".
Oct. 2019	2.1	Updated the Ethernet supported protocols in "Specifications".
Dec. 2018	1.8	Migrated to online format; minor reorganization.
Nov. 2018	1.7	• Added MCX512A-ACAT support across the document
Jan. 2018	1.6	• Added a note to System Requirements.
Nov. 2017	1.5	• Updated Adapter Card LED Operations.

Sept. 2017	1.4	• Added the following:
		  • MCX512A-ACAT Board Label (Example)
		• Updated the following sections:
		  • Driver Installation: Linux
		  • MCX515A-CCAT Specifications
		  • MCX516A-CCAT Specifications
		  • Airflow Specifications

Aug. 2017	1.3	• Added the following:
		  • Mechanical Drawing of the Single-port Adapter Cards
		  • Single-port Tall Bracket
		  • MCX512A-ACAT Board Label (Example)
		• Updated the following specifications tables:
		  • MCX515A-CCAT Specifications
		  • MCX516A-CCAT Specifications
		  •

Date	Revision	Description of Changes

July 2017	1.2	• Updated the following specifications tables:
		  • MCX515A-CCAT Specifications
		  • MCX516A-CCAT Specifications
		• Updated Airflow Specifications

Apr. 2017	1.1	• Updated Product Overview • Updated Installation Instructions
Mar. 2017	1.0	First release

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