User Manual - English

FUJITSU

PRIMERGY

InfiniBand Host Channel Adapter (56Gb) FDR V6.0 (Linux®, Windows®)

Edition February 2014

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Contents

1 Introduction 7

1.1 Notational Conventions 7
1.2 Target Group 8
1.3 Documentation Overview 8
1.4 Overview 9
1.5 Product Prerequisites 10

2 Adapter Card Hardware 11

2.1 Adapter Cards Covered in this Manual 11
2.2 Finding the GUID and Serial Number on the Adapter Cards 12
2.3 Safety instructions 13
2.4 ENERGY STAR 19
2.5 CE conformity 19
2.6 Adapter Card Interfaces 20
2.6.1 I/O Interfaces 20
2.6.2 InfiniBand Interface 20
2.6.3 PCI Express Interface 21
2.6.4 LED Assignment 21
2.7 Adapter Card Installation 22
2.7.1 Hardware and Software Requirements 22
2.7.2 Installation Instructions 22
2.7.3 Cables 23
2.7.3.1 Cable Installation 23
2.7.3.2 Inserting a Cable into the Adapter Card 24
2.7.3.3 Removing a Cable from the Adapter Card 24

3 Linux Installation 25

3.1 Overview 25

3.2 Software Requirements 25

3.3 OFED Installation 26
3.3.1 OFED installation on RHEL5 26
3.3.2 OFED installation on RHEL6 29
3.3.3 Post-installation Notes 31
3.3.4 OFED uninstallation 35
3.3.5 OFED installation procedure when applying errata kernel 36
3.3.5.1 How to apply the errata kernel when OFED is already installed 36
3.3.5.2 How to install OFED when the errata kernel is already applied 41
3.3.6 OFED installation on RHEL HPC Compute Node 42

3.4 Updating Firmware after Installation 44

3.5 Subnet Manager 44
3.5.1 Functions of OpenSM 44
3.5.2 Confirmation that OpenSM is Running 45
3.5.3 Confirmation of the master SM 45

4 Windows Installation 47

4.1 Overview 47

4.2 Software Requirements 47

4.3 WinOF Installation 48
4.3.1 WinOF installation on Windows Server 2008 R2 SP1 48
4.3.2 WinOF installation on Windows Server 2012 58
4.3.3 WinOF Upgrade Notes 59

5 Troubleshooting 61

5.1 Checking the Log File of OpenSM (Linux only) 61

5.2 IB HCA 64

6 Appendix A 75

6.1 A.1 EMC Certification Statements 75
6.1.1 FCC Statements (USA) 75
6.1.2 EN Statements (Europe) 76
6.1.3 ICES Statements (Canada) 76
6.1.4 VCCI Statements (Japan) 77
6.1.5 KCC Certification (Korea) 77
6.2 S26361-F4533-L102 Specifications 78
6.3 S26361-F4533-L202 Specifications 79

7 Appendix B 81

7.1 Replacing a full height bracket with a low profile bracket . . 81
7.2 Replacing a Bracket 81
7.3 Removing the Existing Bracket from the Adapter Card . . . 82
7.4 Installing the New Bracket 83

Index 87

1 Introduction

This manual describes the hardware, software and adapter card installation and basic use of the InfiniBand Host Channel Adapter (IB HCA).

HCA card name	Product name
IB HCA 56Gb 1 port FDR	S26361-F4533-E102/L102
IB HCA 56Gb 2 port FDR	S26361-F4533-E202/L202

Table 1: Product names

It also describes the installation of OFED (OpenFabrics Enterprise Distribution) for Linux and Win OpenFabrics installation for Windows.

1.1 Notational Conventions

The following notational conventions are used in this manual:

 **Caution**	This symbol points out hazards that can lead to personal injury, loss of data, or damage to equipment.
	This symbol highlights important information and tips.
►	This symbol refers to a step that you must carry out in order to continue with the procedure.
italic	Commands, menu items, names of buttons, options, file names, and path names are written in *italic* letters in the text.
<variable>	Marked variables that must be replaced by current values.
`fixed font`	System output is written using a fixed font.
`semi-bold fixed font`	Commands to be entered through the keyboard are written in a semi-bold fixed font.
Key symbols	Keys are presented according to their representation on the keyboard. If capital letters are to be entered explicitly, then the Shift key is shown, e.g. SHIFT - A for A. If two keys need to be pressed at the same time, then this is indicated by placing a hyphen between the two key symbols.

Fujitsu Support

Please contact your Fujitsu Technical Support if you require assistance:

http://support.ts.fujitsu.com/com/support/index.html

If you purchased the products from Fujitsu Japan, please consult a system engineer.

1.2 Target Group

This manual is intended for users, developers, and system administrators responsible for setting up and maintaining switch system platforms using InfiniBand fabrics and networks. The switch system platforms must have a management server or client, in order for the package to work.

The manual assumes familiarity with the InfiniBand® Architecture Specification.

1.3 Documentation Overview

PRIMERGY manuals are available in PDF format on the ServerView Suite DVD 2. The ServerView Suite DVD 2 is part of the ServerView Suite supplied with every server.

If you no longer have the ServerView Suite DVDs, you can obtain the relevant current version using the order number U15000-C289 (the order number for Fujitsu Japan: please refer to the configurator of the server *http://jp.fujitsu.com/platform/server/primergy/system/*.

The PDF files of the manuals can also be downloaded free of charge from the internet. The overview page showing the online documentation available on the internet can be found using the URL (for EMEA market): *http://manuals.ts.fujitsu.com*. The PRIMERGY server documentation can be accessed using the *Industry standard servers* navigation option.

If you purchased the products from Fujitsu Japan, please use the URL: *http://jp.fujitsu.com/platform/server/primergy/manual/*.

1.4 Overview

This document is a user manual for InfiniBand Host Channel Adapters (IB HCA) card in rack servers. The card described in this manual has the following features:

- Single and Dual Port 56Gb/s IB HCA card
- Low Profile PCIe form factor with exchangeable Full Height (FH) or Low Profile (LP) bracket
- Based on the IB controller chip Mellanox ConnectX-3
- PCIe interface
  - PCIe x8 bus interface
  - PCIe 3.0 (8GT/s)
  - Auto-negotiates to x8, x4, x2, or x1 (x4, x2 or x1 will decrease the performance)
- IBTA Specification 1.3 compliant (plan)
- Hardware-based congestion control
- Connectivity
  - Interoperable with InfiniBand switches
  - QSFP connectors
  - 1m, 3m (56Gb/s) of passive copper cable

1.5 Product Prerequisites

System Class	Subsegment	Systems	Max.No.	Bracket LP/FH
All-round Server		TX300 S7/S8	2	FH
Rack Server	Sub-entry	RX200 S7/S8	2	LP
	Entry	RX300 S7/S8	2	LP
		RX350 S7/S8	2	FH
	Midrange	RX500 S7	2	FH
	High-end	PQ2000 Series	24	LP/FH
Cloud Server		CX250 S1/S2	1	LP
		CX270 S1/S2	1	LP

LP = Low Profile bracket
FH = Full Height bracket

2 Adapter Card Hardware

2.1 Adapter Cards Covered in this Manual

The following table lists the adapter cards described in this manual:

HCA card name	PCI Express SERDES Speed	Data Trans-mission Rate/ port	Bracket type	RoHS
IB HCA 56Gb Single port FDR	PCIe Gen3 8.0 GT/s	56Gb/s	Low profile and Full height	R-6
IB HCA 56Gb Dual port FDR	PCIe Gen3 8.0 GT/s	56Gb/s	Low profile and Full height	R-6

Table 2: Single and Dual Port Card

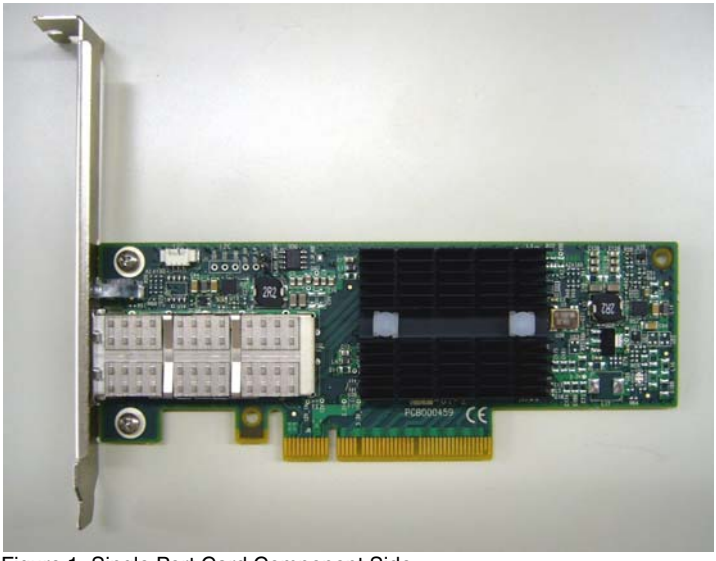


Figure 1: Single Port Card Component Side

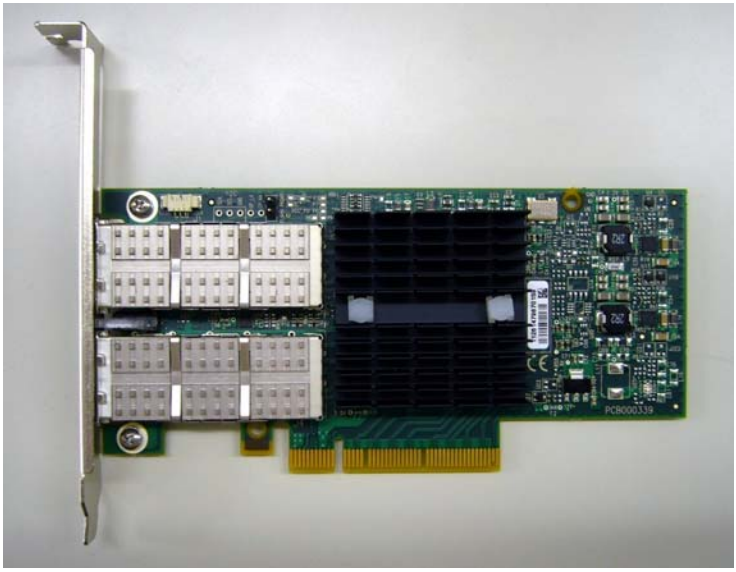


Figure 2: Dual Port Card Component Side

2.2 Finding the GUID and Serial Number on the Adapter Cards

All adapter cards have a label on the printed side of the adapter card that has the card serial number and the card GUID for InfiniBand protocol.

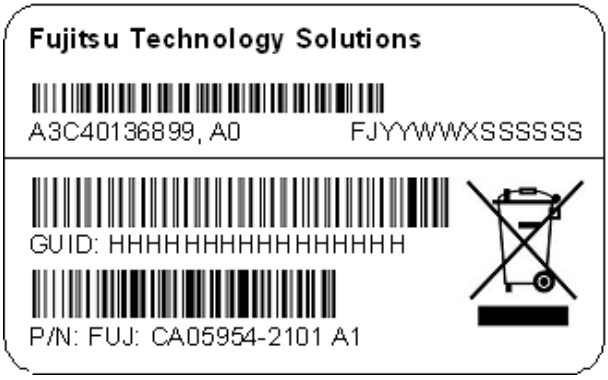


Figure 3: Card Product Label (e.g. IB HCA 1port FDR)

2.3 Safety instructions

The following safety instructions are also provided in the manual "Safety notes and other important information".

This device meets the relevant safety regulations for IT equipment. If you have any questions about whether you can install the server in the intended environment, please contact your sales outlet or our customer service team.

CAUTION!

- The actions described in this manual shall be performed by technical specialists. A technical specialist is a person who is trained to install the server including hardware and software.
- Repairs to the device that do not relate to CSS failures shall be performed by service personnel. Please note that unauthorized interference with the system will void the warranty and exempt the manufacturer from all liability.
- Any failure to observe the guidelines in this manual, and any improper repairs could expose the user to risks (electric shock, energy hazards, fire hazards) or damage the equipment.
- Before installing/removing internal options to/from the server, turn off the server, all peripheral devices, and any other connected devices. Also unplug all power cords from the power outlet. Failure to do so can cause electric shock.

Before starting up

CAUTION!

- During installation and before operating the device, observe the instructions on environmental conditions for your device.
- If the device is brought in from a cold environment, condensation may form both inside and on the outside of the device.

  Wait until the device has acclimatized to room temperature and is absolutely dry before starting it up. Material damage may be caused to the device if this requirement is not observed.
- Transport the device only in the original packaging or in packaging that protects it from knocks and jolts.

Installation and operation

CAUTION!

- This unit should not be operated in ambient temperatures above 35 °C.
- If the unit is integrated into an installation that draws power from an industrial power supply network with an IEC309 connector, the power supply's fuse protection must comply with the requirements for non-industrial power supply networks for type A connectors.
- The unit automatically adjusts itself to a mains voltage in a range of 100 V - 240 V. Ensure that the local mains voltage lies within these limits.
- This device must only be connected to properly grounded power outlets or insulated sockets of the rack's internal power supply with tested and approved power cords.
- Ensure that the device is connected to a properly grounded power outlet close to the device.

CAUTION!

- Ensure that the power sockets on the device and the properly grounded power outlets are freely accessible.
- The On/Off button or the main power switch (if present) does not isolate the device from the mains power supply. To disconnect it completely from the mains power supply, unplug all network power plugs from the properly grounded power outlets.
- Always connect the server and the attached peripherals to the same power circuit. Otherwise you run the risk of losing data if, for example, the server is still running but a peripheral device (e.g. memory subsystem) fails during a power outage.
- Data cables must be adequately shielded.
- Route the cables in such a way that they do not create a potential hazard (make sure no-one can trip over them) and that they cannot be damaged. When connecting the server, refer to the relevant instructions in this manual.
- Never connect or disconnect data transmission lines during a storm (risk of lightning hazard).
- Make sure that no objects (e.g. jewelry, paperclips etc.) or liquids can get inside the server (risk of electric shock, short circuit).
- In emergencies (e.g. damaged casing, controls or cables, penetration of liquids or foreign bodies), switch off the server immediately, remove all power plugs and contact your sales outlet or customer service team.

CAUTION!

- Proper operation of the system (in accordance with IEC 60950-1/2 resp. EN 60950-1/2) is only ensured if the casing is completely assembled and the rear covers for the installation slots have been fitted (electric shock, cooling, fire protection, interference suppression).
- Only install system expansions that satisfy the requirements and rules governing safety and electromagnetic compatibility and those relating to telecommunication terminals. If you install other expansions, they may damage the system or violate the safety regulations. Information on which system expansions are approved for installation can be obtained from our customer service center or your sales outlet.
- The components marked with a warning notice (e.g. lightning symbol) may only be opened, removed or exchanged by authorized, qualified personnel. Exception: CSS components can be replaced.
- The warranty is void if the server is damaged during installation or replacement of system expansions.
- Only set screen resolutions and refresh rates that are specified in the operating manual for the monitor. Otherwise, you may damage your monitor. If you are in any doubt, contact your sales outlet or customer service center.
- Before installing/removing internal options to/from the server, turn off the server, all peripheral devices, and any other connected devices. Also unplug all power cords from the outlet. Failure to do so can cause electric shock.
- Do not damage or modify internal cables or devices. Doing so may cause a device failure, fire, or electric shock.
- Devices inside the server remain hot after shutdown. Wait for a while after shutdown before installing or removing internal options.
- The circuit boards and soldered parts of internal options are exposed and can be damaged by static electricity. Before handling them, first touch a metal part of the server to discharge static electricity from your body.
- Do not touch the circuitry on boards or soldered parts. Hold the metallic areas or the edges of the circuit boards.

CAUTION!

- Install the screw removed during installation/detaching Internal Options in former device/position. To use a screw of the different kind causes a breakdown of equipment.
- The installation indicated on this note is sometimes changed to the kind of possible options without notice.

Batteries

CAUTION!

- Incorrect replacement of batteries may lead to a risk of explosion. The batteries may only be replaced with identical batteries or with a type recommended by the manufacturer (see the technical manual for the system board).
- Do not throw batteries into the trash can. They must be disposed of in accordance with local regulations concerning special waste.
- Replace the lithium battery on the system board in accordance with the instructions in the technical manual for the system board.
- All batteries containing pollutants are marked with a symbol (a crossed-out garbage can). In addition, the marking is provided with the chemical symbol of the heavy metal decisive for the classification as a pollutant:

  Cd Cadmium
  Hg Mercury
  Pb Lead

Disposal

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

Modules with Electrostatic-Sensitive Devices

Modules with electrostatic-sensitive devices are identified by the following sticker:

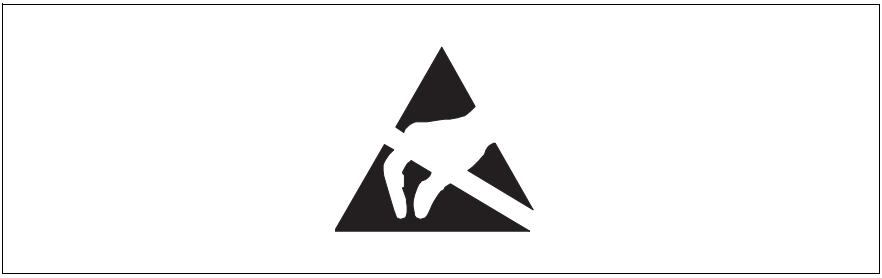


Figure 4: ESD label

When you handle components fitted with ESDs, you must always observe the following points:

- Switch off the system and remove the power plugs from the power outlets before installing or removing components with ESDs.
- You must always discharge static build-up (e.g. by touching a grounded object) before working with such components.
- Any devices or tools that are used must be free of electrostatic charge.
- Wear a suitable grounding cable that connects you to the external chassis of the system unit.
- Always hold components with ESDs at the edges or at the points marked green (touch points).
- Do not touch any connectors or conduction paths on an ESD.
- Place all the components on a pad which is free of electrostatic charge.

For a detailed description of how to handle ESD components, see the relevant European or international standards (EN 61340-5-1, ANSI/ESD S20.20).

Other important information:

- Keep this operating manual and the other documentation (such as the Technical Manual, DVD) close to the device. All documentation must be included if the equipment is passed on to a third party.

2.4 ENERGY STAR

Products that have been certified compliant with ENERGY STAR and identified as such are in full compliance with the specification at shipping. Note that energy consumption can be affected by software that is installed or any changes that are made to the BIOS or energy options subsequently. In such cases, the properties guaranteed by ENERGY STAR can no longer be assured.

The "ServerView Operations Manager" user guide contains instructions for reading out measurement values, including those relating to current energy consumption and air temperatures. Either the Performance Monitor or the Task Manager can be used to read out CPU utilization levels.

A specific model of this product is recognized in United States EPA, and registered. The model based on this is not sold in the Japanese market.

2.5 CE conformity

The system complies with the requirements of the EC directives 2004/108/EC regarding "Electromagnetic Compatibility" and 2006/95/EC "Low Voltage Directive". This is indicated by the CE marking (CE = Communauté Européenne).

2.6 Adapter Card Interfaces

2.6.1 I/O Interfaces

Each adapter card includes the following interfaces:

– QSFP ports

– PCI Express x8 edge connector

– I/O panel LEDs

For dual port cards, port 1 connects to connector 1 of the device, while port 2 connects to connector 2 of the device.

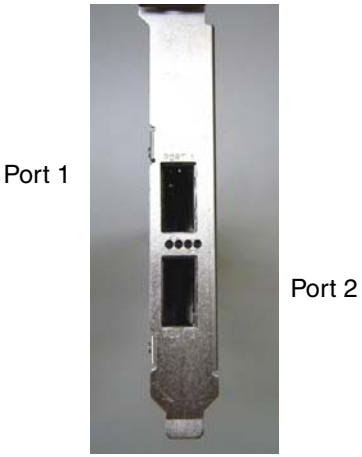


Figure 5: Port numbering (e.g. IB HCA 2port FDR)

2.6.2 InfiniBand Interface

The ConnectX®-3 device is compliant with the InfiniBand Architecture Specification, Release 1.3 (plan)
Adapter cards (listed in table 2 on page 11) based on this device provide access to its ports by means of QSFP connectors.

2.6.3 PCI Express Interface

The ConnectX®-3 adapter cards support PCI Express 3.0 (1.1, 2.0 compatible) through an x8 edge connector. The device can be either a master initiating the PCI Express bus operations or a slave responding to PCI bus operations.

2.6.4 LED Assignment

The board has I/O LEDs located on the I/O panel - 2 LEDs per port. The green LED, when lit, indicates that the driver is running and a valid physical connection between nodes exists. If the green LED is flashing, it indicates a problem with the physical link. The yellow LED, when lit, indicates a valid data activity link; this is the logical link. The yellow LED lights up when the network is discovered over the physical link. A valid data activity link without data transfer is indicated by a constant yellow LED. A valid data activity link with data transfer is indicated by a flashing yellow LED. If the LEDs are not active, either the physical link or the logical link (or both) connections have not been established.

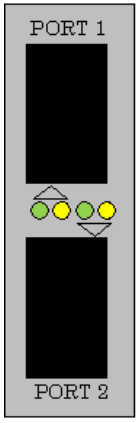
Port Number	LED Name	
Port 1	Physical Link - Green Constant on indicates a good physical link Flashing indicates a problem with the physical link	
	Data Activity - Yellow Flashing indicates data transfer Constant on indicates no data transfer	
Port 2	Physical Link - Green Constant on indicates a good physical link Flashing indicates a problem with the physical link	
	Data Activity - Yellow Flashing indicates data transfer Constant on indicates no data transfer	

Table 3: LEDs - port association (e.g. IB HCA 2port FDR)

2.7 Adapter Card Installation

2.7.1 Hardware and Software Requirements

Before installing the IB HCA card, please make sure that the system meets the hardware and software requirements listed in table 4. Refer to chapter “Linux Installation” on page 25 for download and installation instructions.

Requirement	Description
Hardware	– Minimum 3 GB of memory – PCI Express x8 or x16 slots
Software Operating Systems/Distributions	For Linux, the InfiniBand drivers are in the Open Fabrics Enterprise Distribution (OFED) software package which is available at *http://support.ts.fujitsu.com/com/support/downloads.html* Drivers & Downloads If you purchased the products from Fujitsu Japan, you can download it from *http://primeserver.fujitsu.com/primergy/downloads*

Table 4: Hardware and software requirements

2.7.2 Installation Instructions

To change a full height bracket to a low profile bracket see chapter “Appendix B” on page 81.

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

The adapter cards listed in table 2 on page 11 are standard PCI Express cards, each with a standard x8 edge connector. Please consult the host machine documentation for instructions on how to install a PCI Express card.

Warning

When more than one PCI slot is available make sure you use the PCI slot with the proper configuration.

Any PCI slot with the proper configuration is acceptable for connection. If the card is installed in a PCI slot with less lanes than the card requires, then the adapter card will not provide optimum data transfer.

2.7.3 Cables

The QSFP port can be connected to InfiniBand passive copper and active optical cables.

2.7.3.1 Cable Installation

All cables can be inserted or removed with the unit powered on. To insert a cable, press the connector into the port receptacle until the connector is firmly seated. 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). After plugging in a cable, lock the connector using the latching mechanism particular to the cable vendor. When a logical connection is made the YELLOW LED will come on. When data is being transferred the yellow led will flash

Warning

When installing cables make sure that the latches engage.

Warning

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

Care should be taken not to impede the air exhaust flow through the ventilation holes. Cable lengths should be used which allow for routing horizontally around to the side of the chassis before bending upward or downward in the rack.

To remove a cable, disengage the locks and slowly pull the connector away from the port receptacle. Both LED indicators will turn off when the cable is unseated.

Warning

Cables, especially long copper cables, can weigh a substantial amount. Make sure that the weight of the cable is supported on its own and is not hanging from IB HCA card.

2.7.3.2 Inserting a Cable into the Adapter Card

1. 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.
2. 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.
3. 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.
4. Make sure that the connector locks in place.

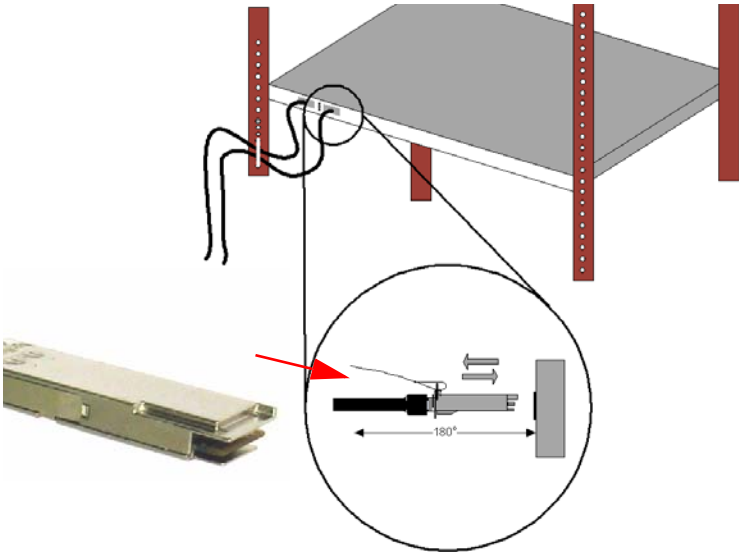


Figure 6: Connector orientation

2.7.3.3 Removing a Cable from the Adapter Card

1. Pull on the latch release mechanism to unlatch the connector and pull the connector out of the cage.
2. Do not apply torque to the connector when removing it from the adapter card.
3. Remove any cable supports that were used to support the cable's weight.

3 Linux Installation

3.1 Overview

This chapter describes how to install a single host machine with Fujitsu InfiniBand hardware installed. A server can be properly installed with all required InfiniBand drivers and software during Red Hat Enterprise Linux installation or afterwards by using the OpenFabrics Enterprise Distribution (OFED). In the first case, the correct packages must be selected during setup and should only be performed by an advanced user. For simple complete installation, use the OFED drivers.

If you purchased the products from Fujitsu Japan, you can download it from *http://primeserver.fujitsu.com/primergy/downloads/*.

Please note that only **Red Hat Enterprise Linux Version 5.7 or higher**, and **6.1 or higher** are supported.

The chapter includes the following sections:

- "OFED Installation" on page 26
- "Updating Firmware after Installation" on page 44
- "Subnet Manager" on page 44

3.2 Software Requirements

Required Disk Space for Linux Installation

400 MB

Operating System

Linux operating system (x86_64 only)

Installer Privileges

The installation requires administrator privileges on the target machine.

3.3 OFED Installation

Please install OFED by the following steps after the OS installation by SVIM (Server Installation Manager).

- Download OFED from Fujitsu Technology Solutions Web site *http://support.ts.fujitsu.com/*
- If you purchased the products from Fujitsu Japan, you download it from *http://jp.fujitsu.com/platform/server/primergy/downloads/*.

Warning

This software is the driver package of ConnectX-3 IB HCA card (56Gbps).

This package driver does not support ConnectX-2 IB HCA card (40Gbps).

When OFED downloaded from the above is being used, please don't apply the RHEL native OFED at the time of RHEL update.

3.3.1 OFED installation on RHEL5

Warning!

The following is an example of RHEL5.8.
Operation may change by the version of OFED.
Please refer to the operation manual of OFED attachment for details.
When especially an environment variable (LANG) is a Japanese locale, a problem may occur.

1. Mount *iso* file and move to */mnt*.

   In the following example, the OFED is *MLNX_OFED_LINUX-1.5.3-3.3.0.0-rhel5.8-x86_64.iso*

   ```
   [root@localhost ]# mount -ro loop MLNX_OFED_LINUX-1.5.3-
   3.0.0-rhel5.8-x86_64.iso /mnt
   [root@ localhost ]# cd /mnt/
   [root@ localhost mnt]#
   ```

2. Execute Installer and enter *y*

```
[root@localhost ]# ./mlnxofedinstall --without-32bit
--without-fw-update
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.
Do you want to continue?[y/N]:y
```

3. The following messages are displayed. Add an option (*--nodeps*) and uninstall the package.

   Please remove OFED RPMs coming from the Distribution.

   Run:

   ```
   rpm -e --allmatches openmpi libcxgb4 ofed-docs-1.4.1-2.el5
   openib-1.4.1-6.el5 libibverbs libibverbs-utils libmthca
   libmlx4 libcxgb3 libnes libipathverbs libibcm libibumad
   libibmad librdmacm librdmacm-utils libsdp opensm-libs
   compat-dapl compat-dapl-devel dapl dapl-devel dapl-utils
   perftest rds-tools ibutils infiniband-diags qperf
   libibverbs libibverbs-utils libmthca libmlx4 libcxgb3
   libnes libipathverbs libibcm libibumad libibmad librdmacm
   librdmacm-utils libsdp opensm-libs compat-dapl compat-dapl-
   devel compat-dapl-utils dapl dapl-devel dapl-utils perftest
   rds-tools infiniband-diags qperf ofed-docs openib opensm-
   libs openmpi openmpi-libs ibutils ibutils-libs mpitests-
   openmpi ofed-docs-1.4.1-2.el5
   ```

   Some RPMs may depend on the RPMs above. Please uninstall them manually.

   Uninstall the Packages.

   ```
   [root@localhost mnt]# rpm -e --nodeps --allmatches openmpi
   libcxgb4 ofed-docs-1.4.1-2.el5 openib-1.4.1-6.el5
   libibverbs libibverbs-utils libmthca libmlx4 libcxgb3
   libnes libipathverbs libibcm libibumad libibmad librdmacm
   librdmacm-utils libsdp opensm-libs compat-dapl compat-dapl-
   devel dapl dapl-devel dapl-utils perftest rds-tools ibutils
   infiniband-diags qperf libibverbs libibverbs-utils libmthca
   libmlx4 libcxgb3 libnes libipathverbs libibcm libibumad
   libibmad librdmacm librdmacm-utils libsdp opensm-libs
   compat-dapl compat-dapl-devel compat-dapl-utils dapl dapl-
   ```

```
devel dapl-utils perftest rds-tools infiniband-diags qperf
ofed-docs openib opensm-libs openmpi openmpi-libs ibutils
ibutils-libs mpitests-openmpi ofed-docs-1.4.1-2.el5
```

4. Execute Installer again and enter *y*.

```
[root@localhost mnt]# ./mlnxofedinstall --without-32bit
--without-fw-update
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.
Do you want to continue?[y/N]:y
Starting MLNX_OFED_LINUX-1.5.3-3.0.0 installation ...
Installing mlnx-ofa_kernel RPM
Preparing...##########################################
mlnx-ofa_kernel ##########################################
Installing kmod-mlnx-ofa_kernel RPM 3
:

Installation finished successfully.
Configuring /etc/security/limits.conf.
Please reboot your system for the changes to take effect.
[root@localhost mnt]#
```

5. Unmount */mnt* directory

```
[root@localhost mnt]# cd /
[root@localhost /]# umount /mnt/
[root@localhost /]#
```

6. Restart the OS

```
[root@localhost /]# reboot
```

7. Check the modification of *limits.conf* file.

```
[root@localhost /]# tail -2 /etc/security/limits.conf
* soft memlock unlimited
* hard memlock unlimited
[root@localhost /]#
```

   Please re-install from step3 when the 2 messages above were not displayed.

8. Check the version of OFED.

```
[root@localhost /]# ofed_info
```

3.3.2 OFED installation on RHEL6

Warning!

The following is an example of RHEL6.2.
Operation may change by the version of OFED.
Please refer to the operation manual of OFED attachment for details.
When especially an environment variable (LANG) is a Japanese locale, a problem may occur.

1. Mount *iso* file and move to */mnt*.

```
[root@localhost /]# mount -ro loop MLNX_OFED_LINUX-1.5.3-
3.0.0-rhel6.2-x86_64.iso /mnt/
[root@localhost /]#
[root@localhost /]#cd /mnt/
```

2. Execute Installer and enter *y*

```
[root@localhost mnt]# ./mlnxofedinstall --without-32bit
--without-fw-update
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.
Do you want to continue?[y/N]:y
```

3. The following messages are displayed. Add an option (--*nodeps*). Delete *scsi-target-utils* from the package currently displayed, and uninstall a package.

   Please remove OFED RPMs coming from the Distribution.

   Run:

```
rpm -e --allmatches rdma rdma-1.0-14.el6.noarch libibverbs
libibverbs-utils libmthca libmlx4 libcxgb3 libnes
libipathverbs libibcm libibumad libibmad ibsim librdmacm
librdmacm-utils opensm-libs dapl rds-tools ibutils
infinipath-psm libibverbs libibverbs-utils libmthca libmlx4
libcxgb3 libnes libipathverbs libibcm libibumad libibmad
ibsim librdmacm librdmacm-utils opensm-libs compat-opensm-
libs dapl rds-tools infinipath-psm opensm-libs
libipathverbs dapl libibcm libibmad libibumad ibsim ibutils
ibutils-libs fcoe-utils scsi-target-utils compat-openmpi
compat-openmpi-psm fcoe-utils scsi-target-utils
```

Some RPMs may depend on the RPMs above. Please uninstall them manually.

Uninstall the packages.

```
[root@localhost mnt]#
[root@localhost mnt]# rpm -e --nodeps --allmatches rdma
rdma-1.0-14.el6.noarch libibverbs libibverbs-utils libmthca
libmlx4 libcxgb3 libnes libipathverbs libibcm libibumad
libibmad ibsim librdmacm librdmacm-utils opensm-libs dapl
rds-tools ibutils infinipath-psm libibverbs libibverbs-
utils libmthca libmlx4 libcxgb3 libnes libipathverbs
libibcm libibumad libibmad ibsim librdmacm librdmacm-utils
opensm-libs compat-opensm-libs dapl rds-tools infinipath-
psm opensm-libs libipathverbs dapl libibcm libibmad
libibumad ibsim ibutils ibutils-libs fcoe-utils compat-
openmpi compat-openmpi-psm fcoe-utils
```

4. Execute Installer again and enter *y*

```
[root@localhost mnt]# ./mlnxofedinstall  --without-32bit
--without-fw-update
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.
Do you want to continue?[y/N]:y

Starting MLNX_OFED_LINUX-1.5.3-3.0.0 installation ...

Installing mlnx-ofa_kernel RPM
Preparing...     ########################################
mlnx-ofa_kernel        ################################
Installing kmod-mlnx-ofa_kernel RPM
 :
 :
Installation finished successfully.
Configuring /etc/security/limits.conf.
Please reboot your system for the changes to take effect.
Following RPMs, coming with the Linux Distribution, were
removed due to dependencies,
please reinstall them if required: scsi-target-utils
[root@ localhost mnt]#
```

5. Unmount */mnt* directory.

```
[root@localhost mnt]# cd /
[root@localhost /]# umount /mnt
[root@localhost /]#
```

6. Restart the OS.

```
[root@localhost /]# reboot
```

7. Check the modification of *limits.conf* file.

```
[root@ localhost /]# tail -2 /etc/security/limits.conf
* soft memlock unlimited
* hard memlock unlimited
[root@localhost /]#
```

   Please re-install from step3 when the 2 messages above were not displayed.

8. Check the version of OFED.

```
[root@localhost /]# ofed_info
```

3.3.3 Post-installation Notes

This section describes how to set *mlx4* parameters.

Please add the following *mlx4* parameters to the file. After the parameter has been changed, you will need to reboot.

In the case of the combination of RHEL5 or 6 system + MellanoxOFED, please add line to

/etc/modprobe.d/mlx4.conf.

If there is no *mlx4.conf*, please create the file. In addition, when *mlx4.conf* has not been created, a setup by the default value of each parameter is performed.

How to set *mlx4* parameters

```
options mlx4_core <parameter>=<value>
```

How to change amount of memory which can be registered for RDMA

log_num_mtt

Set the number of page table entries which HCA uses (Default is 20; max is 24).

log_mtts_per_seg

Set the minimum unit (segment) of the address translation table which a driver manages (Default is 3; max is 7).

A setup of the amount of memory which can be registered for RDMA can be changed. Calculation of the amount of memory is as follows. (Set the twice of main memory)

4KB x 2^(log_num_mtt + log_num_per_seg)

The following table shows the recommended values of *log_num_mtt* and *log_num_per_seg*. (A value changes with main memory capacity).

Main memory capacity	16GB	32GB	64GB	128GB	256GB	512GB	1 TB
log_num_mtt	19	20	21	22	23	24	24
log_mtts_per_seg	4	4	4	4	4	4	5

How to change QP number of HCA

log_num_qp

Set the maximum number of QP number per HCA (default is 18).

This parameter creates 256K QP(s) by the default value 18. The maximum which can set up Mellanox HCA is 24 and can create 16M QP(s). However, because it consumes the available memory by setting a larger value, please do not set the value unnecessarily large. By changing parameter values into 21 from 18, the memory which can be used decreases by 2 GB.

The recommended value of parameter values is not decided in order to change with system configurations (the number of nodes). Please calculate QP number by the following formulas, and if it is over the default value, change a parameter setting.

(Number of MPI processes per node)^2 x number of nodes x MPI implementation-dependent constant

Number of MPI processes per node: number of logical cores

Number of nodes: Number of nodes in the group to communicate with each other

MPI implementation-dependent constant : FJ-MPI=3, Intel-MPI=2, Other MPI=2

Set value is the value of a power of 2

QP number	26,2144 (256K)	52,4288 (512K)	104,8576 (1M)	209,7152 (2M)	419,4304 (4M)	838,8608 (8M)	1677,7216 (16M)
log_num_qp	18	19	20	21	22	23	24

configuration

<configuration file>

/etc/modprobe.d/mlx4.conf

<configuration parameters>

log_num_mtt=A
log_mtts_per_seg=B
log_num_qp=C

<configuration example>

options ***mlx4_core log_num_mtt=A log_mtts_per_seg=B log_num_qp***=C

IPoIB adapters parameter limitation

This section describes the limitation of OS (RHEL6 system) and IPoIB parameters. Please note that the setting is different depending on the OS version. Although RHEL5 system also sets up IPoIB by an *ifcfg-ib** file, there are no following limitations.

1. RHEL6.0 to 6.2

   If you create (or edit) the *ifcfg-ib** files to configure an IPoIB, the parameter 'NM_CONTROLLED' should be set to 'no'.

   Example: */etc/sysconfig/network-scripts/ifcfg-ib0*

   ```
   DEVICE="ib0"
   IPADDR="192.168.210.100"
   NETMASK="255.255.255.0"
   BROADCAST=192.168.210.255
   NM_CONTROLLED="no"
   ONBOOT="yes"
   ```

2. Only RHEL6.1

   Since there is a problem peculiar to RHEL6.1, communication by IPoIB may not be able to be performed.

Please add the following parameters:

`PREFIX=<value>` value is corresponding to that of NETMASK

Example:

```
PREFIX="24"
```

3. Only RHEL6.3

   RHEL6.3 can set the parameter of *NM_CONTROLLED* as *yes*. However, since a different network interface may get the same IP address, please add the following parameters.

   In addition, in order to check *HWADDR*, please specify the execution result of the *ib addr* command.

   NM_CONTROLLED="yes"
   TYPE="InfiniBand"
   HWADDR=<MAC-Address>

   Example:

   DEVICE="ib0"
   TYPE="InfiniBand"
   IPADDR="192.168.210.100"
   NETMASK="255.255.255.0"
   PREFIX="24"
   BROADCAST="192.168.210.255"
   NM_CONTROLLED="yes"
   ONBOOT="yes"
   HWADDR= 80:00:00:48:fe:80:00:00:00:00:00:00:00:02:c9:03:00:fa:11:81

   Check the *HWADDR* is as follows:

   MAC-Address is output to the result of executing the command *ip addr show ib **.

   Example:

```
# ip addr show ib0
10: ib0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 65520 qdisc
pfifo_fast state UP qlen 1024
   link/infiniband
80:00:00:48:fe:80:00:00:00:00:00:00:00:02:c9:03:00:fa:11:81 brd
00:ff:ff:ff:ff:12:40:1b:ff:ff:00:00:00:00:00:00:ff:ff:ff:ff
   inet 192.168.210.100/24 brd 192.168.210.255 scope global ib0
```

The parameter value of SACK (*net.ip4.tcp_sack*)

SACK (*net.ipv4.tcp_sack*) parameter value is set to "0" by installing Mellanox OFED.

In addition, the default configuration value on RHEL native OFED is "1".

The difference in the communication control by SACK setup is as follows.

1. SACK=0:OFF

   When one data is divided into multiple packets and it transmits, even if only one packet detects an error, all the packets are transmitted again.

2. SACK=1:ON

   On the same communication condition as the above, processing time is shortened because only the packet in which the error was made transmits again.

   However, if this parameter is set to "1", access of the packet by SACK control will occur at random. As compared with a setup of SACK=0, a CPU usage rate is high.

3.3.4 OFED uninstallation

Uninstallation of OFED executes the following commands.

Please refer to the operation manual of OFED attachment for details.

```
[root@localhost ~]# /usr/sbin/ofed_uninstall.sh
This program will uninstall all MLNX_OFED_LINUX-*.*-*.*.*
packages on your machine.
Do you want to continue?[y/N]:y
```

Reboot the system.

```
[root@localhost ~]# reboot
[root@localhost ~]#
```

When you upgrade OFED, please install new OFED after uninstallation.

3.3.5 OFED installation procedure when applying errata kernel

This chapter describes how to install OFED when applying the errata kernel. There are the following two procedures:

- How to apply the errata kernel when OFED is already installed.
- How to install OFED when the errata kernel is already applied.

3.3.5.1 How to apply the errata kernel when OFED is already installed

This chapter explains errata kernel application procedure when OFED is already installed. This is not the procedure of initial OFED installation.

The procedure is as follows.

1. Uninstall OFED.
2. Apply errata kernel.
3. Create OFED ISO image for the errata kernel.
4. Install OFED with the created ISO image.

1. OFED Uninstallation

   1) Download OFED ISO image in advance. This can be downloaded from the following Fujitsu Technology Solutions web site:
   http://support.ts.fujitsu.com/download/index.asp?level1=20966&lng=com&LNID=4

   2) Confirm whether the scsi-target-utils is installed or not. If it is installed, uninstall it before uninstall OFED. If it is not installed, go to *3)*.

```
[root@RX200S7-1 ~]# rpm -q scsi-target-utils
scsi-target-utils-1.0.14-4.el6.x86_64
[root@RX200S7-1 ~]# rpm -e scsi-target-utils-1.0.14-
4.el6.x86_64
[root@RX200S7-1 ~]#
```

3) Uninstall OFED as follows with the ISO image downloaded at *1)*. (Enter *y* during the uninstallation.) Uninstallation of OFED can be performed also by the */usr/sbin/ofed_uninstall.sh*.

```
[root@RX200S7-1 ~]# mount -ro loop MLNX_OFED_LINUX-1.5.3-
3.1.0-rhel6.2-x86_64.iso /mnt
[root@RX200S7-1 ~]# cd /mnt/
[root@RX200S7-1 mnt]# ./uninstall.sh

This program will uninstall all OFED packages on your
machine.

Do you want to continue?[y/N]:y
Running /usr/sbin/vendor_pre_uninstall.sh

Removing OFED Software installations

Running /bin/rpm -e mpitests_mvapich_gcc-3.2-923.x86_64
Running /bin/rpm -e mpitests_openmpi_gcc-3.2-923.x86_64

:
:

Stopping IB Subnet Manager..-.[  OK  ]
Running /tmp/7096-ofed_vendor_post_uninstall.sh
[root@RX200S7-1 mnt]#
```

4) Unmount */mnt*.

```
[root@RX200S7-1 mnt]# cd
[root@RX200S7-1 ~]# umount /mnt
[root@RX200S7-1 ~]#
```

5) Reboot the system.

```
[root@RX200S7-1 ~]# reboot
[root@RX200S7-1 ~]#
```

2. Errata kernel application

   1) Apply the errata kernel by *yum* or *rpm* command.

   2) Reboot the system.

3. OFED ISO image creation for the errata kernel

   1) Check the kernel version after reboot.

```
[root@RX200S7-1 ~]# uname -r
2.6.32-220.23.1.el6.x86_64
```

2) Create the mounted directory other than */mnt*, for example, */work*. (Because the ISO image creation command doesn't work if */mnt* directory is mounted.)

```
[root@RX200S7-1 ~]# mkdir /work
[root@RX200S7-1 ~]#
```

3) Mount the ISO image used at "1. OFED Uninstallation".

```
[root@RX200S7-1 ~]# mount -ro loop MLNX_OFED_LINUX-1.5.3-
3.1.0-rhel6.2-x86_64.iso /work/
```

4) Execute the command to create the ISO image.

(Enter *y* during the command execution.) The new ISO image is created under */tmp* directory. We recommend moving the created ISO image to the other directory.

```
[root@RX200S7-1 ~]# /work/mlnx_add_kernel_support.sh -i
MLNX_OFED_LINUX-1.5.3-3.1.0-rhel6.2-x86_64.iso
Note: This program will create MLNX_OFED_LINUX ISO for
rhel6.2 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.9510.log

Building OFED RPMs. Please wait...
Removing OFED RPMs...
Running mkisofs...
Created /tmp/MLNX_OFED_LINUX-1.5.3-3.1.0-rhel6.2-
x86_64.iso
```

The option of *add_kernel_support.sh* has been changed

(OFED1.5.3: 1.5.3-4.0.42 or higher)

(OFED2.0: 2.0 or higher).

```
# mlnx_add_kernel_support.sh --mlnx_ofed <path to
MLNX_OFED directory> --make-iso
```

5) Unmount */work*.

```
[root@RX200S7-1 ~]# umount /work/
[root@RX200S7-1 ~]#
```

4. OFED installation with the created ISO image

   1) Install OFED with the created ISO image. (Enter *y* during the installation.)

```
[root@RX200S7-1 ~]# mount -ro loop /tmp/MLNX_OFED_LINUX-
1.5.3-3.1.0-rhel6.2-x86_64.iso /mnt
[root@RX200S7-1 ~]# cd /mnt/
[root@RX200S7-1 mnt]# ./mlnxofedinstall --without-32bit --
without-fw-update
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.
Do you want to continue?[y/N]:y


Starting MLNX_OFED_LINUX-1.5.3-3.1.0 installation ...

Installing kernel-ib RPM
Preparing...
################################################
kernel-ib
################################################

:
:

Installation finished successfully.

Please reboot your system for the changes to take effect.
```

   2) Unmount */mnt*.

```
[root@RX200S7-1 mnt]# cd
[root@RX200S7-1 ~]# umount /mnt
[root@RX200S7-1 ~]#
```

3. If you uninstalled the scsi-target-utils at "1. OFED Uninstallation", re-install the scsi-target-utils. The scsi-target-utils package is in the installation disk of Red Hat Enterprise Linux.

   rpm package

   scsi-target-utils-1.0.14-4.el6.x86_64.rpm

```
[root@RX200S7-1 ~]# mount /dev/cdrom /mnt
mount: block device /dev/sr0 is write-protected, mounting
read-only
[root@RX200S7-1 ~]# cd /mnt/Packages/
[root@RX200S7-1 Packages]# rpm -ivh scsi-target-utils-
1.0.14-4.el6.x86_64.rpm
warning: scsi-target-utils-1.0.14-4.el6.x86_64.rpm: Header
V3 RSA/SHA256 Signature, key ID fd431d51: NOKEY
Preparing...
########################################### [100%]
1:scsi-target-utils
########################################### [100%]
[root@RX200S7-1 Packages]# rpm -q scsi-target-utils
scsi-target-utils-1.0.14-4.el6.x86_64
```

4) Unmount */mnt* and eject the installation disk.

```
[root@RX200S7-1 Packages]# cd
[root@RX200S7-1 ~]# umount /mnt
[root@RX200S7-1 ~]#
```

5) Reboot the system.

```
[root@RX200S7-1 ~]# reboot
[root@RX200S7-1 ~]#
```

6) After the OS boot up, confirm the following two lines are included in *limits.conf* file.

```
[root@RX200S7-1 ~]# tail -2 /etc/security/limits.conf
* soft memlock unlimited
* hard memlock unlimited
```

7) Confirm the IB drivers are loaded.

```
[root@RX200S7-1 ~]# /etc/init.d/openibd status

HCA driver loaded

Configured IPoIB devices:
ib0 ib1

Currently active IPoIB devices:
```

```
The following OFED modules are loaded:

rdma_ucm
rdma_cm
ib_addr
ib_ipoib
mlx4_core
mlx4_ib
mlx4_en
ib_mthca
ib_uverbs
ib_umad
ib_ucm
ib_sa
ib_cm
ib_mad
ib_core
iw_nes
```

3.3.5.2 How to install OFED when the errata kernel is already applied

This chapter describes how to install OFED after installing OS and applying the errata kernel. This is not the initial OFED installation procedure.

The flow of OFED installation is as follows:

1. Install OS.
2. Apply the errata kernel.
3. Create OFED ISO image for the errata kernel.
4. Install OFED with the created ISO image.

1. OS installation

   Install OS.

2. Applying the errata kernel

   Follow the step 2 Errata kernel application in 3.3.5.1 How to apply the errata kernel when OFED is already installed.

3. OFED ISO image creation for the errata kernel

   Follow the step 3 OFED ISO image creation for the errata kernel in 3.3.5.1 How to apply the errata kernel when OFED is already installed.

4. OFED installation with the created ISO image

   Follow the step 4 OFED installation with the created ISO image in 3.3.5.1 How to apply the errata kernel when OFED is already installed.

   If packages remove messages are displayed, add an option (*--nodeps*). Delete *scsi-target-utils* from the package currently displayed, and uninstall a package. Then, execute installer again. Depending on the version of OFED, some packages are uninstalled automatically.

   Please refer to chapter 3.3.1 OFED installation on RHEL5 or chapter 3.3.2 OFED installation on RHEL6.

3.3.6 OFED installation on RHEL HPC Compute Node

RHEL HPC Compute Node and RHEL Server have a difference in the package to install. RHEL HPC Compute Node is less than RHEL Server. Therefore, installation of OFED is not complete normal. Please install OFED after installing a required package in advance.

1. Required packages and RHEL package set

   The package required for OFED installation is as follows. (It is shown that the check mark is contained in the target package set.)

RHEL Server	RHEL HPC Compute Node	Required package	Package name (e.g. RHEL6.4)
✓	✓	gcc	gcc-4.4.7-3.el6.x86_64
✓	✓	glib	glib2-2.22.5-7.el6.x86_64
✓		glib-devel	glib2-devel-2.22.5-7.el6.x86_64
✓	✓	glibc	glibc-2.12-1.107.el6.x86_64
✓	✓	glibc-devel	glibc-devel-2.12-1.107.el6.x86_64
✓	✓	glibc-devel-32bit	glibc-devel-2.12-1.107.el6.i686
✓		zlib-devel	zlib-devel-1.2.3-29.el6.x86_64
✓		libstdc++-devel	libstdc++-devel-4.4.7-3.el6.x86_64
✓	✓	gdb	gdb-7.2-60.el6.x86_64
✓		rpm-build	rpm-build-4.8.0-32.el6.x86_64
✓		redhat-rpm-config	redhat-rpm-config-9.0.3-42.el6.noarch
✓	✓	libgfortran	libgfortran-4.4.7-3.el6.x86_64

Table 5: Required packages

RHEL Server	RHEL HPC Compute Node	Required package	Package name (e.g. RHEL6.4)
✓	✓	gcc-g77	gcc-gfortran-4.4.7-3.el6.x86_64
✓	✓	Tcl	tcl-8.5.7-6.el6.x86_64
✓		tcl-devel	tcl-devel-8.5.7-6.el6.x86_64
✓	✓	Tk	tk-8.5.7-5.el6.x86_64
✓		gcc-c++	gcc-c++-4.4.7-3.el6.x86_64
✓	✓	genisoimage	genisoimage-1.1.9-12.el6.x86_64

Table 5: Required packages

2. Getting insufficient packages

   Please check the installation situation of the above-mentioned packages after installing RHEL HPC Compute Node. Please get the insufficient packages from Red Hat Network (RHN).

   If you cannot get the package from RHN, copy the target package from an installation image. The packages are in the Packages folder of an installation image.

3. Installation of an insufficient packages

   Install some packages using the *rpm* command. (Log in as root user)

   ```
   # rpm -ivh PACKAGE_FILE
   ```

   There is a dependency in a package. Therefore, an order to install has restrictions. Please see Table 5 and install an insufficient package in an order from a top.

   Please install OFED, when you finish the installation of the insufficient packages.

3.4 Updating Firmware after Installation

If you wish to burn newer firmware, you have to download it from Fujitsu Technology Solutions Web site (*http://support.ts.fujitsu.com/com/support/downloads.html* > *Drivers* & *Downloads*).
If you purchased the products from Fujitsu Japan, you download it from *http://jp.fujitsu.com/platform/server/primergy/downloads/*.

3.5 Subnet Manager

At least one Subnet Manager(SM) is present on each subnet. Each SM resides on a port of host channel adapter (HCA) or an InfiniBand Switch. When there are multiple SMs on a subnet, the master SM is one, and the remaining SMs becomes standby SMs. The master SM has a role to initialize and configure an InfiniBand subnet.

OpenSM is an InfiniBand compliant SM. The following sections describe how to use OpenSM.

3.5.1 Functions of OpenSM

OpenSM is one of Subnet Manager distributed with RedHat.

This chapter describes how to configure which servers becomes the master SM. Please set up the server which will be the master using the following reference. Regarding the other settings of OpenSM, please refer to the command help of *opensmd*.

Basically, a server with the lowest GUID will be the master SM within a subnet. if you intend to choose the master SM, you can configure the priority which range is from 0 to 15. 0 is the lowest and 15 is the highest.

Example for RHEL5:

```
# /etc/init.d/opensmd start -p 15
```

3.5.2 Confirmation that OpenSM is Running

Enter the following command to confirm that OpenSM is running:

```
# /etc/init.d/opensmd status
```

If OpenSM is running properly, the result of this command displays *running*.

Enter the following command to run OpenSM, if the result displays *stopped*:

```
# /etc/init.d/opensmd start
```

3.5.3 Confirmation of the master SM

Enter *ibstat* command on the system server, then "Base LID" and "SM LID" are displayed.

The IB HCA card on which these two LIDs are the same is the master SM.

4 Windows Installation

4.1 Overview

This chapter describes how to install a single host machine with Fujitsu InfiniBand hardware installed. A server can be properly installed with all required InfiniBand drivers and software during Windows Server installation or afterwards by using the Win OpenFabrics installation or OpenSM setup.

Please note that only **Windows Server 2008 R2** and **Windows Server 2012** are supported!

4.2 Software Requirements

Required Disk Space for Windows Installation

100 MB

Operating System

Windows Server 2008 R2

Windows Server 2012

Installer Privileges

Installation requires administrator privileges on the target machine.

4.3 WinOF Installation

Please install WinOF by the following steps after the OS installation.

Download OFED from Fujitsu Technology Solutions Web site *http://support.ts.fujitsu.com/*.

If you purchased the products from Fujitsu Japan, you download it from *http://jp.fujitsu.com/platform/server/primergy/downloads/*

4.3.1 WinOF installation on Windows Server 2008 R2 SP1

1. After inserting InfiniBand cards, make sure that *InfiniBand device* is shown in Device Manager.

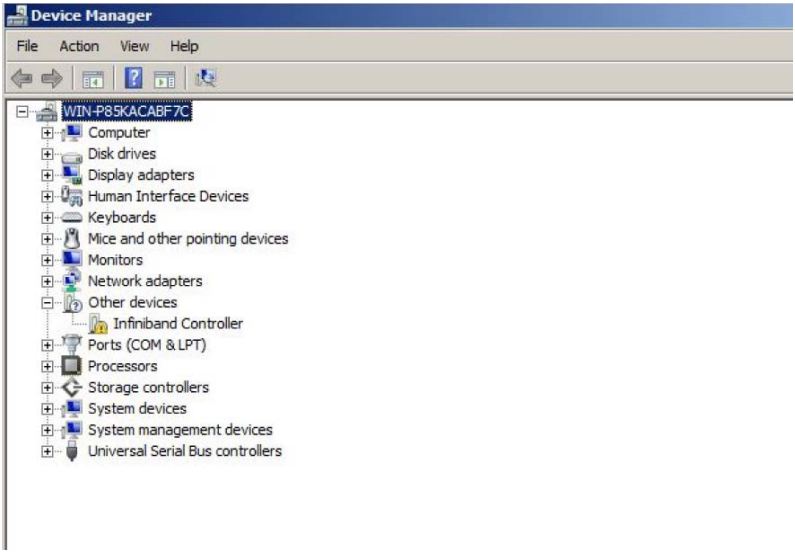


Figure 7: Display of InfiniBand devices before installation of WinOF

2. Double click the *InfiniBand device*. Click *Details* tab and select *Hardware Ids* in *Property*. Make sure there are “VEN_153B” and “DEV_1003” in *Value*, which shows the device is an InfiniBand card.
3. Log in to Windows as administrator, and then double-click the file of downloaded WinOF.

4. Click [Next>] after the following window appears.

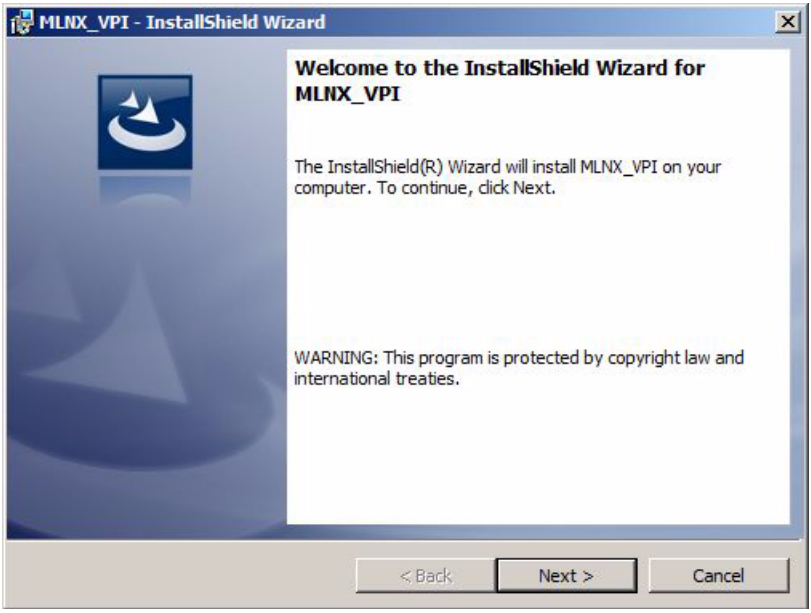


Figure 8: InstallShield Wizard

5. After the following window appears, read License Agreement carefully. If you accept, tick "I accept the terms in the license agreement" and then click [Next>].

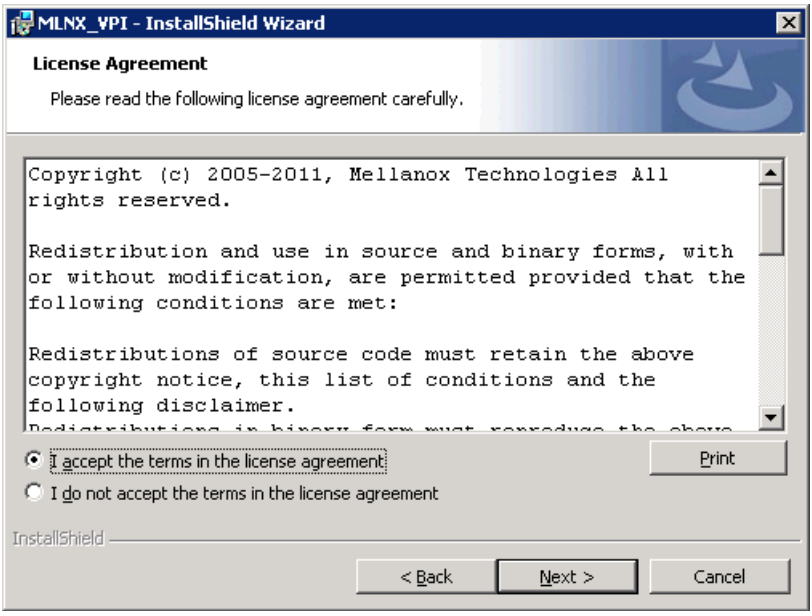


Figure 9: License Agreement

6. Click [Next>] after the following window appears. (If you want to change the installation folder, specify the folder you want to install on by clicking [Change…]).

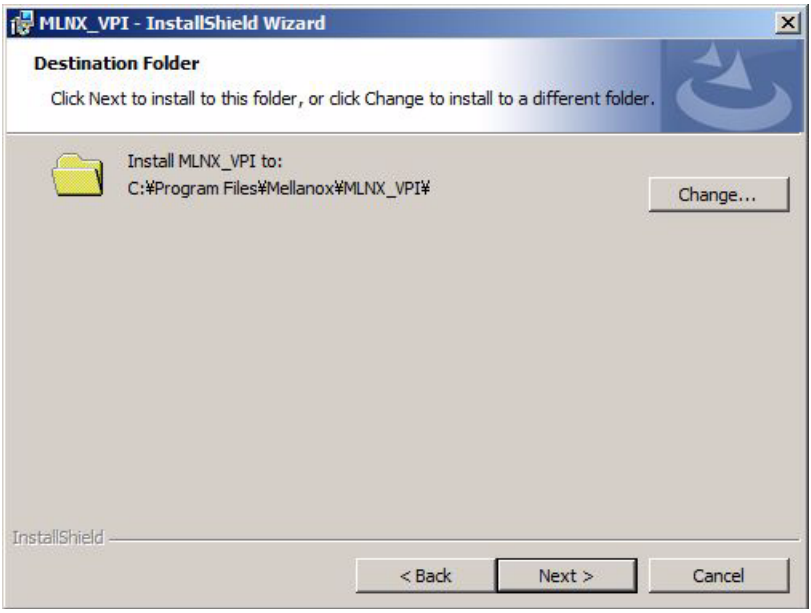


Figure 10: Destination Folder

7. After the following window appears, untick "Check this box to configure your system for maximum 10GigE performance (Recommended)", and then click [Next>].

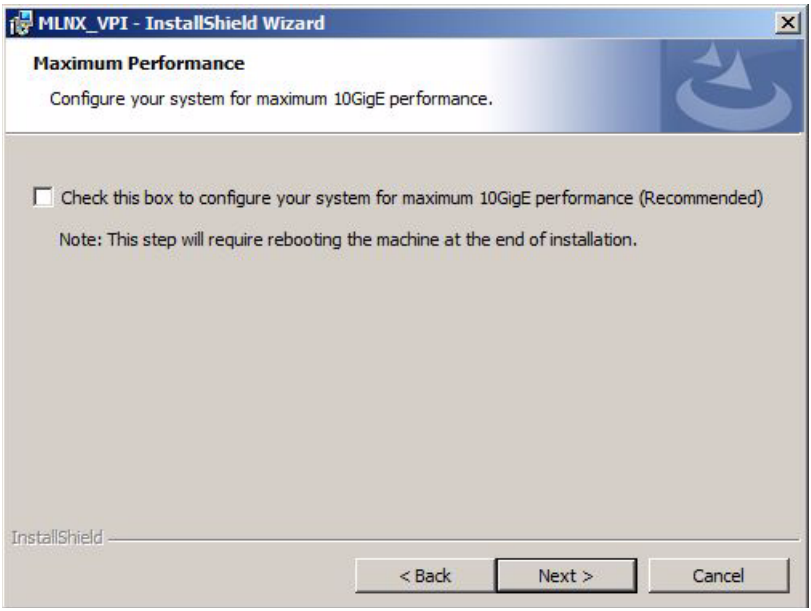


Figure 11: Maximum performance

8. Click [Install] after the following window appears.

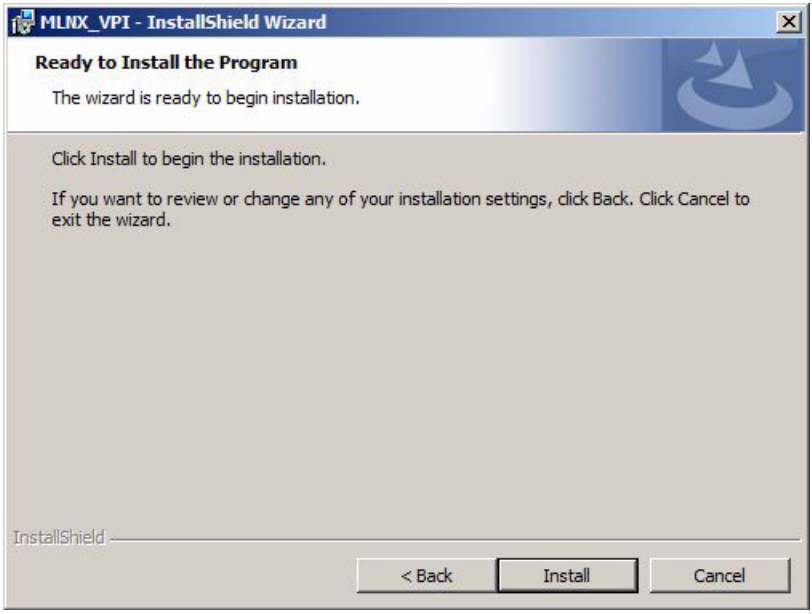


Figure 12: Installation

9. The following window appears after the installation process is finished. Click [Finish] without checking any boxes.

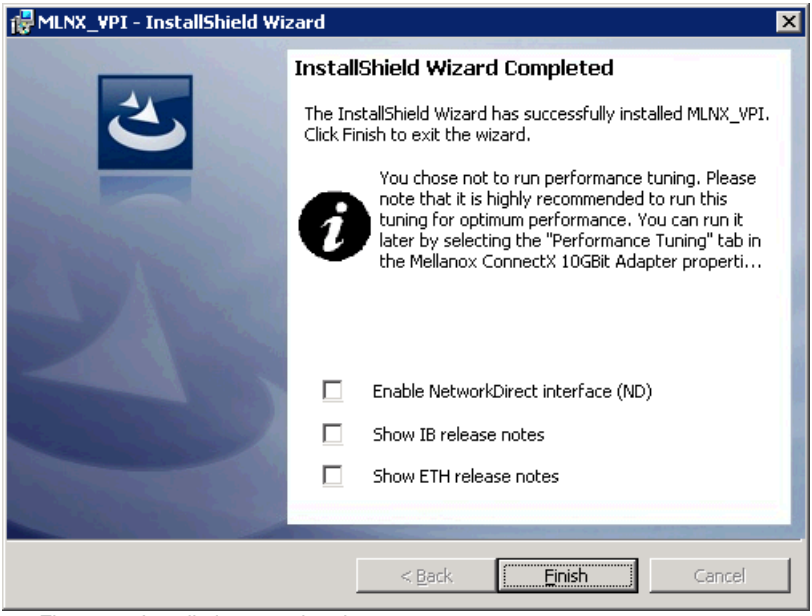


Figure 13: Installation completed

10. Make sure that InfiniBand devices are recognized properly in Device Manager.

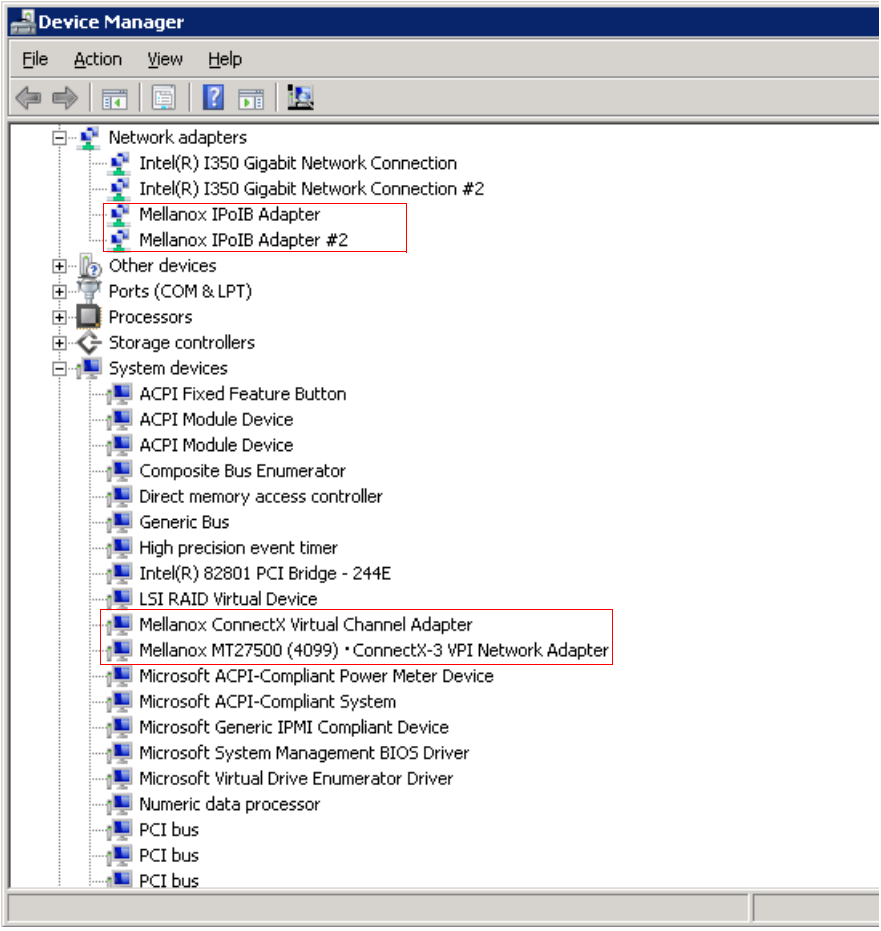


Figure 14: InfiniBand devices

11. After WinOF installation, OpenSM should be set up.

    OpenSM is an InfiniBand compliant Subnet Manager (SM). At least one OpenSM is present on the InfiniBand network. OpenSM has a role to initialize and configure an InfiniBand network. If HPC Cluster will consist of up to 16 nodes or less, OpenSM can run on the head node computer.

    The 'OpenSM' service is registered to the **[Services]** Window after WinOF installation.

    Double-click 'OpenSM' to open properties.

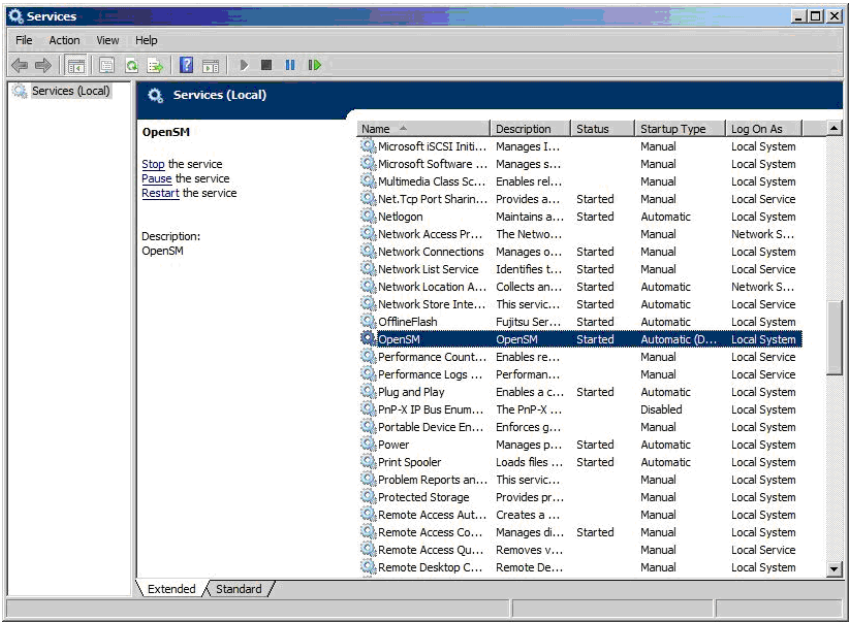


Figure 15: Configuration of OpenSM

12. Change 'Startup type' from *Manual* to *Automatic* (Delay Start)

13. Click the 'Start' button to start the OpenSM service.

14. Open the 'Network Connections' Window to check if IPoIB networks are linked up.

    Disable the unused IPoIB adapters.

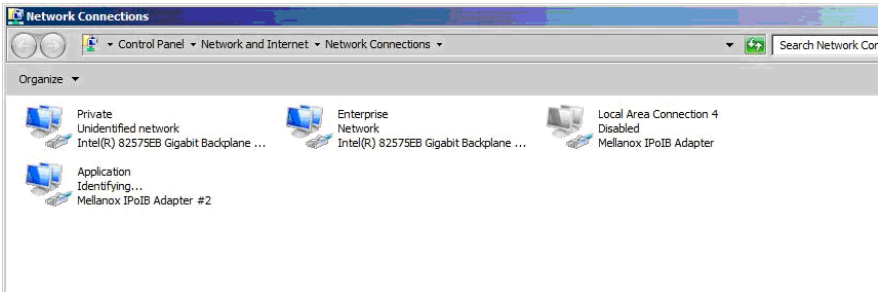


Figure 16: Network status

15. Since no IP address is assigned to this new IPoIB adapter, assign an IP address to it.

16. Run the command prompt as the Administrator privilege and execute the following command to enable 'Network Direct'.

```
> ndinstall -i
```

Figure 17: Installation of Network Direct 1

17. In order to check if 'Network Direct' is enabled properly, execute the same command again.

    The message 'Installing IBAL provider: already installed' is shown if it is enabled properly.

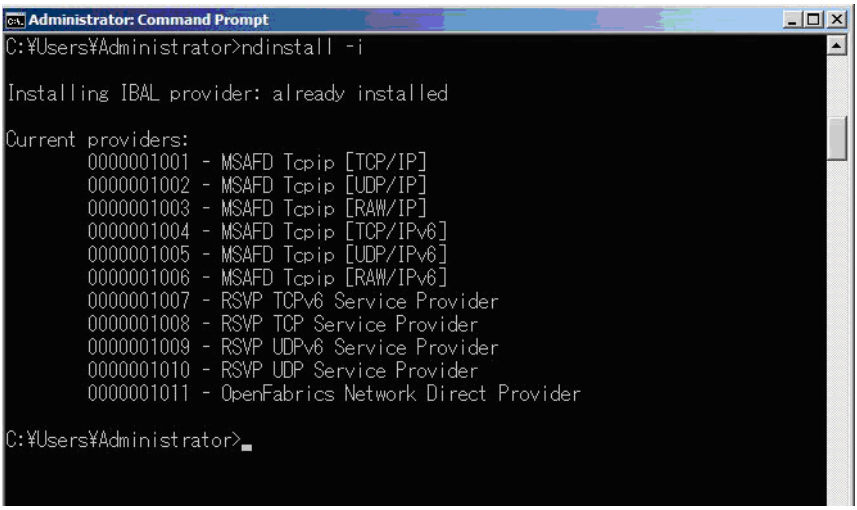


Figure 18: Installation of Network Direct 2

4.3.2 WinOF installation on Windows Server 2012

Download OFED from Fujitsu Technology Solutions Web site

http://support.ts.fujitsu.com/

If you purchased the products from Fujitsu Japan, you download it from below.

http://jp.fujitsu.com/platform/server/primergy/downloads/

1. After inserting InfiniBand cards, make sure that InfiniBand device is shown in the device manager.

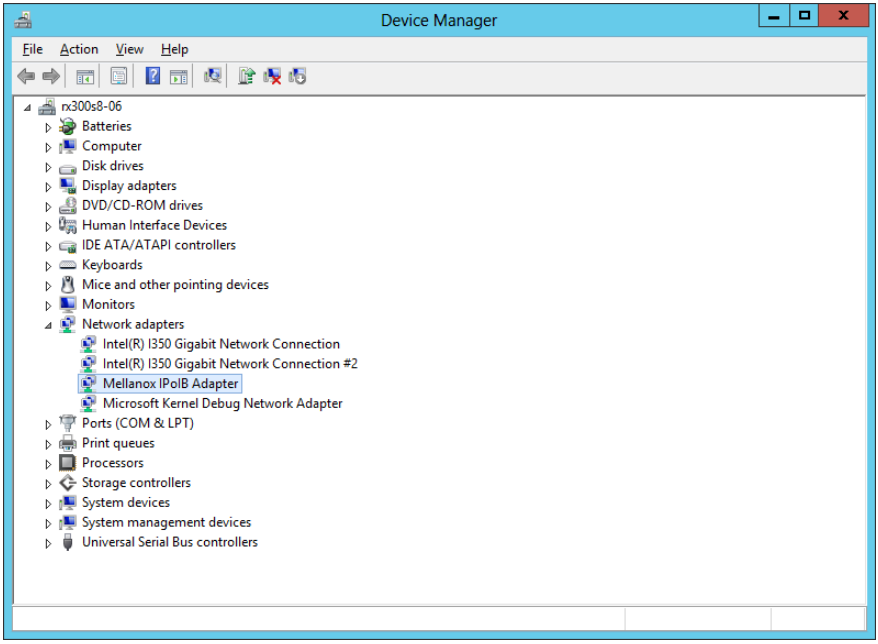


Figure 19: InfiniBand device before WinOF installation (Windows Server 2012)

2. Copy the downloaded WinOF file to a server.
3. Log in to Windows as administrator, and then double-click the file of downloaded WinOF.

4.3.3 WinOF Upgrade Notes

1. WinOF 4.40 Notes

   A difference may occur in Network Direct Provider which is installed as compared with new installation of WinOF4.40 in upgrade from the old edition WinOF. In the environment where they are intermingled, a problem may occur in MPI communication.

   Network Direct Provider installed in each case is as follows. The check of Network Direct Provider executes the following command, after opening a command prompt window by administrator authority.

   ```
   >ndinstall
   ```

- In the case of upgrade from the old edition WinOF

  OpenFabrics Network Direct

  OpenFabrics NDv1 Provider for Mellanox ConnectX

  OpenFabrics NDv2 Provider for Mellanox ConnectX

- In the case of WinOF 4.40 new installation

  OpenFabrics NDv1 Provider for Mellanox ConnectX

  OpenFabrics NDv2 Provider for Mellanox ConnectX

When Network Direct Provider has a difference, remove OpenFabrics Network Direct from the server updated from the old edition WinOF. Removal of Network Direct Provider executes the following command.

```
>ndinstall -r ibal
```

Please reconfirm the situation of Network Direct Provider by the *ndinstall* command after removing Network Direct Provider.

5 Troubleshooting

This chapter describes what to do if an InfiniBand Switch is not working properly.

Please contact your Fujitsu Technical Support, if you require assistance: *http://support.ts.fujitsu.com/com/support/index.html*

If you purchased the products from Fujitsu Japan, please consult your system engineer.

5.1 Checking the Log File of OpenSM (Linux only)

Check the log file in the server (*/var/log/opensm.log*) that started up the Subnet Manager(OpenSM) as Master.

- Check list : Are any of the following logs contained in the */var/log/opensm.log*
  - SM port is down
  - Removed port with GUID:GUID number PRIx64 LID range [LID number, LID number] of node:
  - Reporting Generic Notice type:1 num:128 (Link state change) from LID:LID number GUID:GUID number

SM port is down

SubnetManager's master port was disconnected.

How to solve the problem: The following changes are required. Please contact the repair center.

1. IB HCA
   You need to change the IB HCA that ran as the Master of the SubnetManager.
2. System Server
   If you have changed the IB HCA and you still see the same messages, you need to change the system server that installed the IB HCA.
3. InfiniBand Switch
   If you have changed the above system server and still receive the same messages, you need to change InfiniBand Switch.

Removed port with GUID:GUID number PRIx64 LID range [LID number, LID number] of node:

How to solve the problem: The following changes are required. Please contact the repair center.

1. IB HCA

   You need to change the relevant IB HCA. You obtain the relevant IB HCA from GUID (or LID) information in the error messages and the output of *ibnetdiscover*.

   For example:

   ```
   Jul 30 23:34:18 600287 [4CD0D940] 0x02 ->
   __osm_drop_mgr_remove_port: Removed port with
   GUID:0x0002c90300041306 PRIx64 LID range [2, 2] of
   node:localhost HCA-2
   ```

   In this case, Error Card has the GUID 0x0002c90300041306 and the LID is 2 of HCA).

2. InfiniBand Switch

   You need to change the relevant InfiniBand Switch. You obtain the relevant Infiniband Switch from GUID (or LID) information in the error messages and the output of *ibnetdiscover*.

   For example:

   ```
   Jul 30 23:34:18 600424 [4CD0D940] 0x02 ->
   __osm_drop_mgr_remove_port: Removed port with
   GUID:0x0002c9020040c790 PRIx64 LID range [21, 21] of
   node:(none) SW-1
   ```

   In this case, Error InfiniBand Switch has the GUID 0x0002c9020040c790 and the LID is 21.

3. IB cable

   If you have changed the above InifiniBand Switch and you still receive the messages, all IB cables connected to the InfiniBand Switch need to be changed.

Reporting Generic Notice type:1 num:128 (Link state change) from LID:LID number GUID:GUID number:

the port of InfiniBand Switch was disconnected in the subnet.

How to solve the problem: The following changes are required. Please contact the repair center.

1. IB cable

   You need to change the IB cable. You specify the IB cables using the following procedure.

   1. You specify the relevant InfiniBand Switch from the LID information in the error messages.

      For example:

      ```
      Jul 31 22:56:46 264171 [42E93940] 0x02 ->
      osm_report_notice: Reporting Generic Notice
      type:1 num:128 (Link state change) from LID:32
      GUID:fe80::2:c902:40:c790
      ```

      In this case, LID 32's InfiniBand Switch is corresponding.

   2. The target port is the one that removed the port number from the original *ibnetdiscover* command output when the system was set up normally.

2. InfiniBand Switch

   If you have changed the above IB cable and still receive the same messages, you need to change the IB Switch.

5.2 IB HCA

You can confirm the place and time the error occurred by referring to the following items on a system server.

No.	Confirmation item
1	IB HCA card's physical link and data activity LED
2	IB HCA card driver message

IB HCA card's physical link and data activity LED

You can confirm the place where the error occurred using the following confirmation contents.

No.	Confirmation item	Judgment	To do
1	Is the server blade turned on?	YES	Go to No.2
		NO	Turn on the server blade.
2	Is the IB HCA card mounted rigidly?	YES	Go to No.3
		NO	Mount the IB HCA card more rigidly.
3	Is the IB cable rigidly connected?	YES	Go to No.4
		NO	Connect the IB cable more rigidly.

Table 6: Physical link LED (green) turned off or flashing

No.	Confirmation item	Judgment	To do
4	Is InfiniBand Switch connected working normally?	YES	1. Replace the IB HCA card. 2. If the LED is still turned off after replacing the IB HCA , replace the system server. 3. If the LED is still turned off after replacing the system server, replace the IB cable. 4. If the LED is still turned off, please consult *technical.support@ts.fujitsu.com* If you purchased the products from Fujitsu Japan, please consult your system engineer.
		NO	Replace the InfiniBand Switch.

Table 6: Physical link LED (green) turned off or flashing

No.	Confirmation Item	Judgment	To do
1	Is the data activity link LED (yellow) turned off?	YES	Confirm OpenSM running on the MASTER OpenSM server.
		NO	Confirm the place where the error occurred using the above confirmation contents (table 6 Physical Link LED (green) turned off or flashing)

Table 7: Data activity LED (yellow) turned off

IB HCA card driver message (Linux)

Confirm the error message of the IB HCA card driver by referring to the */val/log/messages* log file. You refer to the log file using the text editor, etc.

No.	Classification	To do
1	Installed FW has unsupported command interface revision %d. (Installed FW version is %d.%d.%03d). This driver version supports only revisions %d to %d.	The IB HCA card must be replaced. Please consult *technical.support@ts.fujitsu.com* . If you purchased the products from Fujitsu Japan, please consult your system engineer.
2	This driver version supports only revisions %d to %d.	
3	Internal error detected: buf[%02x]: %08x	
4	Failed to initialize user access region table, aborting.	
5	Couldn't map EQ doorbell for EQN 0x%06x	(note1)
6	Couldn't map interrupt clear register, aborting.	
7	Couldn't allocate FW area, aborting.	
8	Failed to map MCG context memory, aborting.	
9	Failed to allocate driver access region, aborting.	The IB HCA card must be replaced. Please consult *technical.support@ts.fujitsu.com* . If you purchased the products from Fujitsu Japan, please consult your system engineer.
10	Failed to initialize memory region table, aborting.	
11	Failed to initialize event queue table, aborting.	
12	Failed to switch to event-driven firmware commands, aborting.	
13	NOP command failed to generate interrupt (IRQ %d), aborting.	
14	Failed to initialize completion queue table, aborting.	
15	Failed to initialize shared receive queue table, aborting.	

Table 8: Error messages of IB HCA card driver (Red Hat Enterprise Linux)

No.	Classification	To do
16	Failed to initialize queue pair table, aborting.	The IB HCA card must be replaced. Please consult *technical.support@ts.fujitsu.com* . If you purchased the products from Fujitsu Japan, please consult your system engineer.
17	Failed to initialize multicast group table, aborting.	
18	Failed to reset HCA, aborting.	
19	Failed to init command interface, aborting.	
20	Only %d UAR pages (need more than 128)	(note1)
21	Profile requires 0x%llx bytes; won't fit in 0x%llx bytes of context memory.	
22	Couldn't allocate memory to save HCA PCI header, aborting.	The IB HCA card must be replaced. Please consult *technical.support@ts.fujitsu.com* . If you purchased the products from Fujitsu Japan, please consult your system engineer.
23	Couldn't save HCA PCI header, aborting.	
24	Couldn't map HCA reset register, aborting.	
25	PCI device did not come back after reset, aborting.	
26	Couldn't restore HCA PCI Express Device Control register, aborting.	
27	Couldn't restore HCA PCI Express Link control register, aborting.	
28	Couldn't restore HCA reg %x, aborting.	
29	Couldn't restore HCA COMMAND, aborting.	

Table 8: Error messages of IB HCA card driver (Red Hat Enterprise Linux)

note1: When a message occurs frequently, confirm the following:

No	Confirmation contents	Judgment	To do
1	Is the IB HCA card mounted surely?	YES	The IB HCA card must be replaced. When the message is displayed after the IB HCA card has been replaced, it is necessary to replace the system server.
		NO	Place the IB HCA card again.

Work after IB HCA card has been exchanged (Linux)

1. Turn on the server.
2. Linux is started, */sbin/lspci* command is executed by the root account, and it is confirmed that the IB HCA card is recognized.

   Execution result:

```
10:00.0 InfiniBand: Mellanox Technologies MT27500 Family [ConnectX-3]
Subsystem: Mellanox Technologies MT27500 Family [ConnectX-3]
30:00.0 InfiniBand: Mellanox Technologies MT27500 Family [ConnectX-3]
Subsystem: Mellanox Technologies MT27500 Family [ConnectX-3]~
```

IB HCA card driver message (Windows Server 2008 R2 SP1)

Confirm the message of the IB HCA card driver by referring to the event log. You refer to the event log using the Event Viewer.

Event ID Error Level	Classification	To do
0x0041 Error	xxx: Failed to open Channel Adapter.	The IB HCA card must be replaced. Please consult *technical.support@ts.fujitsu.com* If you purchased the products from Fujitsu Japan, please consult the system engineer.
0x0042 Error	xxx: Failed to allocate Protection Domain.	
0x0043 Error	xxx: Failed to create receive Completion Queue.	
0x0044 Error	xxx: Failed to create send Completion Queue.	
0x0045 Error	xxx: Failed to create Queue Pair.	
0x0046 Error	xxx: Failed to get Queue Pair number.	
0x0047 Error	xxx: Failed to create DMA Memory Region.	
0x0048 Error	xxx: Failed to create receive descriptor pool.	
0x0049 Error	xxx: Failed to create NDIS_PACKET pool to receive indications.	
0x004A Error	xxx: Failed to create NDIS_BUFFER pool to receive indications.	
0x004B Error	xxx: Failed to create NDIS_PACKET pool to send processing.	

Table 9: [source:ipoib]

Event ID Error Level	Classification	To do
0x004C Error	xxx: Failed to create NDIS_BUFFER pool to send processing.	The IB HCA card must be replaced. Please consult *technical.support@ts.fujitsu.com* If you purchased the products from Fujitsu Japan, please consult the system engineer.
0x004D Error	xxx: Failed to allocate receive indication array.	
0x004E Error	xxx: Subnet Administrator query for port information timed out. Make sure the SA is functioning properly. Increasing the number of retries and retry timeout adapter parameters may solve the problem.	
0x004F Error	xxx: Subnet Administrator failed the query for port information. Make sure the SA is functioning properly and compatible.	
0x0050 Error	xxx: Subnet Administrator query for port information failed.	
0x0055 Error	xxx: Subnet Administrator failed query for broadcast group information.	
0x0056 Error	xxx: Subnet Administrator failed request to joining broadcast group.	
0x0057 Error	xxx: The local port rate is too slow for the existing broadcast MC group.	
0x0058 Error	xxx: Incorrect value or non-existing registry for the required IPoIB parameter %3, overriding it by default value: %4	

Table 9: [source:ipoib]

Event ID Error Level	Classification	To do
0x005B Error	xxx: Pkey index not found for partition, change switch pkey configuration.	The IB HCA card must be replaced. Please consult *technical.support@ts.fujitsu.com* If you purchased the products from Fujitsu Japan, please consult the system engineer.
0x005C Error	xxx: Connected Mode failed to initialize, disabled. Interface will use default UD QP transport.	
0x005E Error	xxx: SetDeviceRegistra-tionAttributes failed.	
0x005F Error	xxx: SetAdapterRegistra-tionAttributes failed.	
0x0060 Error	xxx: SetOffloadAttributes failed.	
0x0061 Error	xxx: ipoib_create_adapter failed.	
0x0062 Error	xxx : ipoib_start_adapter failed.	

Table 9: [source:ipoib]

Event ID Error Level	Classification	To do
0x0003 Error	xxx	The IB HCA card must be replaced. Please consult *technical.support@ts.fujitsu.com* If you purchased the products from Fujitsu Japan, please consult the system engineer.
0x0004 Error	mlx4_bus has started in non-operational mode.	
0x0005 Error	mlx4_bus has failed to start even in non-operational mode.%n Look into the the previous error messages.	
0x0007 Error	MAP_FA command failed with error %2.%n The adapter card is non-functional.%n Most likely a FW problem.%n Please burn the last FW and restart the mlx4_bus driver.	
0x0008 Error	RUN_FW command failed with error %2.%n The adapter card is non-functional.%n Most likely a FW problem.%n Please burn the last FW and restart the mlx4_bus driver.	
0x0009 Error	QUERY_FW command failed with error %2.%n The adapter card is non-functional.%n Most likely a FW problem.%n Please burn the last FW and restart the mlx4_bus driver.	

Table 10: [source: mlx4_bus]

Event ID Error Level	**Classification**	**To do**
0x000B Error	QUERY_DEV_CAP command failed with error %2.%n The adapter card is non-functional.%n Most likely a FW problem.%n Please burn the last FW and restart the mlx4_bus driver.	The IB HCA card must be replaced. Please consult *technical.support@ts.fujitsu.com* If you purchased the products from Fujitsu Japan, please consult the system engineer.
0x000C Error	QUERY_ADAPTER command failed with error %2.%n The adapter card is non-functional.%n Most likely a FW problem.%n Please burn the last FW and restart the mlx4_bus driver.	
0x000D Error	Too few QPs were requested (requested %2, reserved for FW %3).%n The adapter card is non-functional.%n Please increase the Registry LogNumQp parameter under HKLM\System\CurrentControlSet\Services\mlx4_bus\Parameters.	
0x0011 Error	Failed to move location string '%2', status %3.	
0x0012 Error	WdfDeviceAllocAndQueryProperty failed, status %2.	

Table 10: [source: mlx4_bus]

Event ID Error Level	Classification	To do
0x0003 Error	xxx	The IB HCA card must be replaced. Please consult *technical.support@ts.fujitsu.com* or your system engineer.

Table 11: [source: ibbus]

Work after IB HCA card has been exchanged (Windows Server 2008 R2 SP1)

1. Turn on the server.
2. Make sure that the InfiniBand devices are recognized properly in Device Manager.

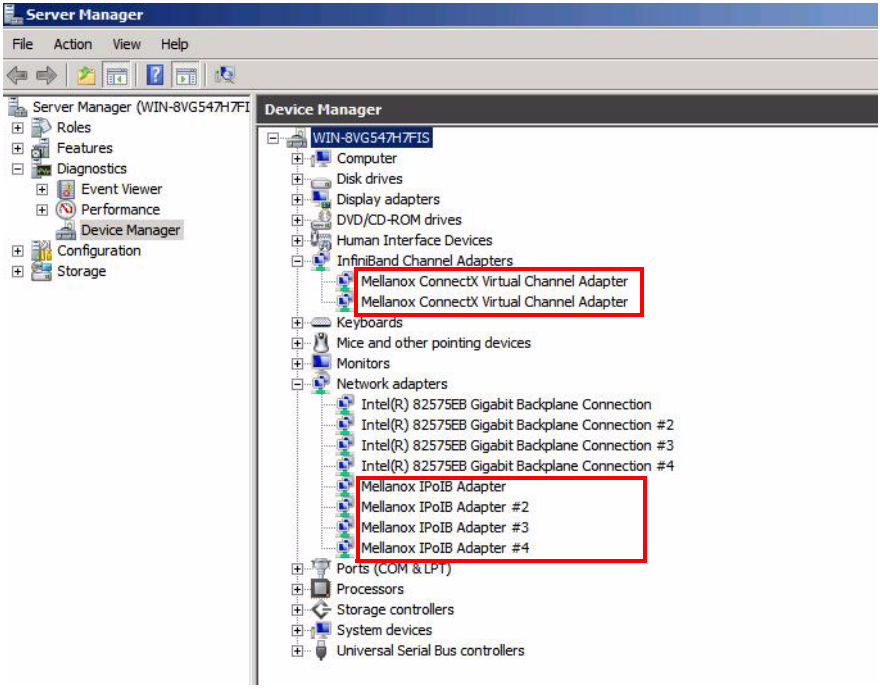


Figure 20: Device manager

6 Appendix A

6.1 A.1 EMC Certification Statements

HCACard P/N	FCC	VCCI	EN	ICES	CE	CB	cTUV us	KCC	C-TICK	CCC	GOST-R
IB HCA 56Gb 1 port FDR	YES	YES	YES	YES	YES	YES	YES	YES	YES	exemp-tion	YES

Table 12: Single port card certification status

HCACard P/N	FCC	VCCI	EN	ICES	CE	CB	cTUV us	KCC	C-TICK	CCC	GOST-R
IB HCA 56Gb 2 port FDR	YES	YES	YES	YES	YES	YES	YES	YES	YES	exemp-tion	YES

Table 13: Dual port card certification status

6.1.1 FCC Statements (USA)

Class A Statements:

- **§15.21**

  Statement

  Warning

  Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

- **§15.105(a)**

  Statement

  This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

6.1.2 EN Statements (Europe)

EN55022 Class A Statement:

Warning

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

6.1.3 ICES Statements (Canada)

Class A Statement:

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

6.1.4 VCCI Statements (Japan)

Class A Statement:

この装置は、情報処理装置等電波障害自主規制協議会（ＶＣＣＩ）の基準に基づくクラスＡ情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。

Translation - This is a Class A product based on the standard of the Voluntary Control Council for Interference by Information Technology Equipment (VCCI). If this equipment is used in a domestic environment, radio interference may occur, in which case the user may be required to take corrective actions.

6.1.5 KCC Certification (Korea)

Korea's "Regulation for Certification of Information and Communication Equipment," requires EMC testing and certification for many electronic products. Korean EMC certifications are issued by Radio Research Laboratory (RRL), which is organized under the Ministry of Information and Communications (KCC). EMC testing includes electromagnetic emissions (EMI) and susceptibility (EMS). Certified equipment is labeled with the KCC mark and certification number.

이 기기는 업무용으로 전자파적합등록을 한 기기이오니 판매자 또는 사용자는 이 점을 주의하시기 바라며 만약 잘못 판매 또는 구입하였을 때에는 가정용으로 교환하시기 바랍니다.

Translation:
Class A Device
This device is registered for EMC requirements for industrial use. The seller or buyer should be aware of this. If this type was sold or purchased by mistake, it should be replaced with a residential-use type.

6.2 S26361-F4533-L102 Specifications

Physical		Power and Environmental	
Size:	2.12in x 5.6in (53.95mm x 142.24mm)	Voltage:	12V, 3.3V
Air Flow:	200LFM @55°C	Typ. Power:	Passive cables 6.71W Active cables 8.41W
QSFP 56Gb/s Connector:	InfiniBand (copper and optical) max. power per port 2.0W.	Maximum Power:	Passive cables 8.13W Active cables 10.13W
		Temperature:	0°C to 55°C

Table 14: Specifications 1 for Single port Card

Protocol Support		Regulatory	
InfiniBand:	IBTA v1.3 (plan), Auto-Negotiation (56Gb/s, 14Gb/s per lane) or (40Gb/s, 10Gb/s per lane) or (20Gb/s, 5Gb/s per lane) or (10Gb/s, 2.5Gb/s per lane)	EMC:	FCC 47 CFR part 15:2006, subpart B, class A ICES-003:2004 Issue 4, class A VCCI V-3/2007.04, class A EN 55022:1998+A1:2000+A2:2003 class A, EN 61000-3-2:2000+A2:2005, EN61000-3-3:1995+A2:2005, EN 55024:1998 + A1:2001+A2:2003 standards, harmonized under EMC Directive 2004/108/EC Article 6(2); AS/NZS 3548
QoS:	8 InfiniBand Virtual	Safety:	IEC/EN 60950-1:2006 ETSI EN 300 019-2-2 IEC 60068-2- 64, 29, 32
RDMA Support:	Yes, All Ports	RoHS:	RoHS-R6
Data Rate:	Up to 56 Gb/s FDR – InfiniBand		
PCI Express:	SERDES @ 8.0GT/s, 8 lanes		

Table 15: Specifications 2 for Single port Card

6.3 S26361-F4533-L202 Specifications

Physical		Power and Environmental	
Size:	2.71in. x 5.6in. (68.90mm x 142.25mm)	Voltage:	12V, 3.3V
Air Flow:	200LFM @55°C	Typ. Power:	Passive cables 7.94W Active cables 11.34W
QSFP 56Gb/s Connector:	InfiniBand (copper and optical) max. power per port 2.0W.	Maximum Power:	Passive cables 9.35W Active cables 13.35W
		Temperature:	0°C to 55°C

Table 16: Specifications 1 for Dual port Card

Protocol Support		Regulatory	
InfiniBand:	IBTA v1.3 (plan), Auto-Negotiation (56Gb/s, 14Gb/s per lane) or (40Gb/s, 10Gb/s per lane) or (20Gb/s, 5Gb/s per lane) or (10Gb/s, 2.5Gb/s per lane)	EMC:	FCC 47 CFR part 15:2006, subpart B, class A ICES-003:2004 Issue 4, class A VCCI V-3/2007.04, class A EN 55022:1998+A1:2000+A2:2003 class A, EN 61000-3-2:2000+A2:2005, EN61000-3-3:1995+A2:2005, EN 55024:1998 + A1:2001+A2:2003 standards, harmonized under EMC Directive 2004/108/EC Article 6(2); AS/NZS 3548
QoS:	8 InfiniBand Virtual	Safety:	IEC/EN 60950-1:2006 ETSI EN 300 019-2-2 IEC 60068-2- 64, 29, 32
RDMA Support:	Yes, All Ports	RoHS:	RoHS-R6
Data Rate:	Up to 56 Gb/s FDR – InfiniBand		
PCI Express:	SERDES @ 8.0GT/s, 8 lanes		

Table 17: Specifications 2 for Dual port Card

7 Appendix B

7.1 Replacing a full height bracket with a low profile bracket

This section provides instructions on how to remove the full height bracket of a standard IB HCA card and replace it with a low profile one. It includes the following sections:

- Removing a bracket
- Installing new bracket

7.2 Replacing a Bracket

To replace the bracket you will need the following parts:

- the new bracket of the proper height
- one new square gasket for each of the ports
- the 2 screws saved when the bracket is removed
- the 2 fiber washers saved when the bracket is removed

7.3 Removing the Existing Bracket from the Adapter Card

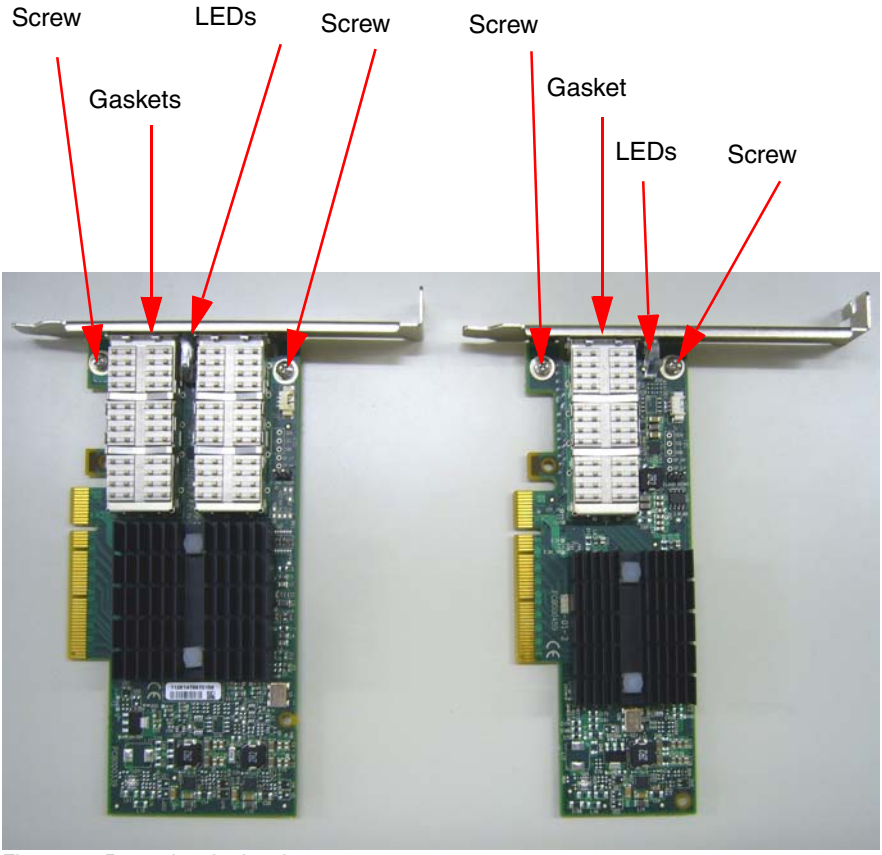


Figure 21: Removing the bracket

1. Remove the two screws holding the bracket in place.
2. The bracket will come loose from the card.

   Warning

   Be careful not to put stress on the LEDs.
3. Save the two screws and the two fiber washers.

7.4 Installing the New Bracket

1. Remove the paper to expose the adhesive on the gasket.
2. Place the gasket for each port onto the new bracket. Make sure to align the gasket correctly with the hole in the bracket.
3. If the old gaskets are still on the card, remove them before installing the new bracket. Make sure that only one gasket is used per port.

Figure 22: Gasket Installation

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

Warning

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

5. Screw on the bracket using the screws and washers saved from the procedure in Step 1 above.

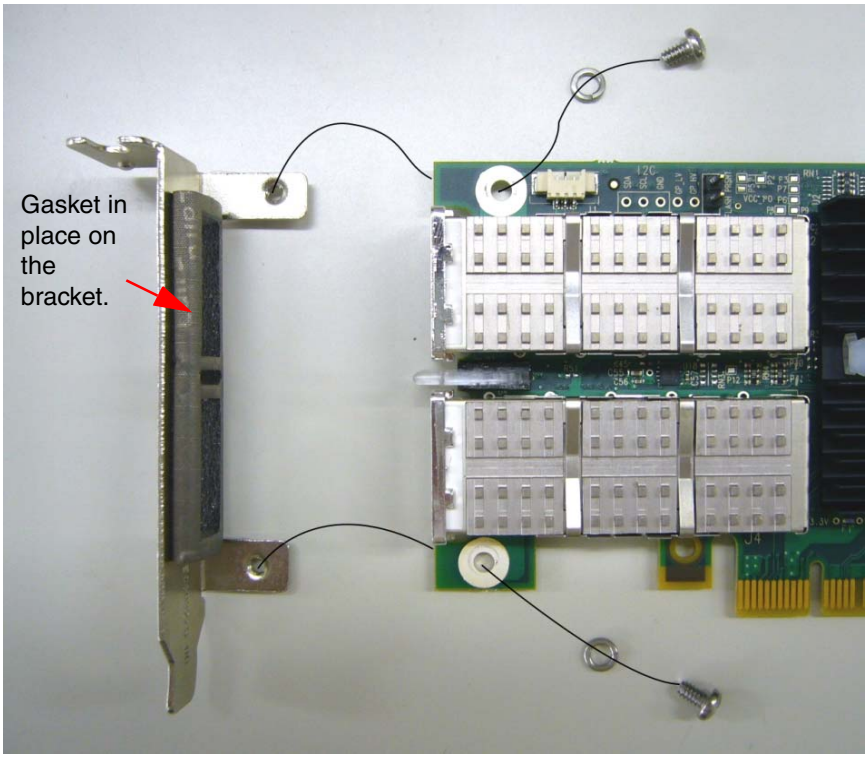


Figure 23: Placing the bracket on a dual port card

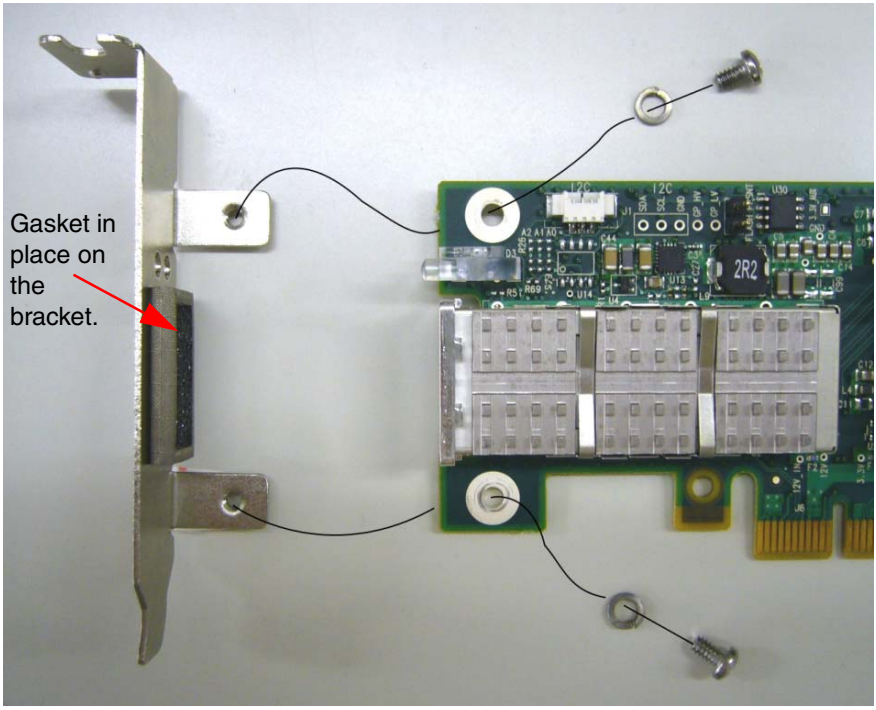


Figure 24: Placing the bracket on a single port card

6. Make sure that the LEDs are aligned to the bracket holes.
7. Screw the bracket.

Index

A
active link LED
  data activity 64
  physical link 64
adapter cards 11

C
CE marking 19

D
disk space
  for installation 25, 47
disposal 17

E
electromagnetic compatibility 19
electrostatic-sensitive devices
  (ESD) 17
ENERGY STAR 19

H
hardware requirements 22
HCA adapter card 22

I
ibstat 45
installer privileges 25, 47

L
Linux 25
lithium battery 17
log file 61
Low Voltage Directive 19

M
master 45

N
notational conventions 7

O
OFED 7
  installation 26
Open Fabrics Enterprise
  Distribution 7
OpenSM 44, 45, 47, 61
operating system 25

R
repair center 61

S
safety instructions 13
software requirements 22, 25, 47
subnet manager
  Linux 44
  OpenSM 61
support 61

T
technical support 61

W
Win OpenFabrics 47
Windows 47