

ATTO Celerity Gen 6 and 7 Fibre Channel Host Adapters

Installation and Operation Manual

Celerity FC-324P

32Gb FC Gen 7 quad-channel PCIe 3.0 host adapter

Celerity FC-322P

32Gb FC Gen 7 dual-channel PCIe 4.0 host adapter

Celerity FC-321P

32Gb Gen 7 single-channel PCIe 4.0 host adapter

Celerity FC-324E

32Gb FC Gen 6 quad-channel PCIe 3.0 host adapter

Celerity FC-322E

32Gb FC Gen 6 dual-channel PCIe 3.0 host adapter

Celerity FC-321E

32Gb Gen 6 single-channel PCIe 3.0 host adapter

Celerity FC-164P

16Gb Gen 6 quad-channel PCIe 3.0 host adapter

Celerity FC-162P

16Gb Gen 6 dual-channel PCIe 3.0 host adapter

Celerity FC-161P

16Gb Gen 6 single-channel PCIe 3.0 host adapter



The Power Behind the Storage

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1 ATTO Celerity HBA Features & Overview

The ATTO Celerity Fibre Channel family of storage products provides connectivity, intelligence and scalability.

Celerity FC host adapters simplify advanced storage networking needs such as switching, backup and data management. Specifically designed to enhance the functionality of third party fabric hardware and software, Celerity FC products are the industry-leading platform for storage connectivity.

Fibre Channel is a serial communications technology designed to transfer large amounts of data among a variety of hardware systems over long distances. It is a key technology for applications that require shared, high bandwidth access to storage.

Fibre Channel provides a logical, point-to-point, serial channel for the transfer of data between a buffer at a source device and a buffer at a destination device. It moves buffer contents from one port to another, without regard to the format or meaning of the data so different upper level protocols are able to run over Fibre Channel hardware.

The Fibre Channel architecture is structured as a hierarchical set of protocol layers. Defined within these layers are rules for signal interfaces, serial encoding and decoding, error control, frame format and communications protocols.

Getting Started

In general, to install the ATTO Celerity FC host adapter, you must:

1. Ensure you have the equipment and software you need for the installation:
 - Celerity FC adapter
 - ATTO Celerity drivers, downloaded from the ATTO website (<https://www.atto.com/>)
 - A computer with an available expansion slot
 - Storage, cables and connectors
2. Install drivers for your operating system. Refer to [Install Drivers](#).

3. Install the configuration software from the ATTO download pages.
4. Install the Celerity adapter. Refer to [Hardware Installation](#).
5. Attach storage.
6. If required, configure your Celerity adapter using the ATTO Configuration Tool.



Note

Default settings are appropriate for most systems but you may change settings using the ATTO Configuration Tool.

Celerity Gen 7 Fibre Channel 32Gb Adapter

The ATTO Celerity 32Gb HBAs leverage two next-generation storage technologies: PCIe 4.0 interconnect and 32-Gigabit Fibre Channel. 32Gb Celerity adapters support the most demanding application requirements, including high-definition video, rich content databases and other high-bandwidth environments. ATTO Celerity host adapters are an integrated family of advanced storage connectivity solutions that are designed to provide reliable connectivity, intelligence and scalability.

FC-324P technical specifications

- Four independent Fibre Channel ports
- 32Gb data transfer rates
- x16 PCIe 3.0
- 6400 MB/sec. maximum full-duplex throughput per channel
- Supports FC topologies: fabric and point-to-point
- ANSI Fibre Channel: FC-FS, FCP
- FC Class 3 support
- Local management and diagnostics
- Buffer credits: 80
- ATTO Advanced Data Streaming (ADS™) Technology
- Length: 6.600 inches
- Height: 2.713 inches
- Operating temperature and Airflow: 0-55 °C (32-132 °F) 250lfm minimum recommended
- Storage temperature: -20 to 85 °C (-4 to 185 °F)
- Relative humidity: 10 to 90% non-condensing
- 24.9W
- RoHS compliant



FC-322P technical specifications

- Two independent Fibre Channel ports
- 32Gb data transfer rates
- x8 PCIe 4.0
- 6400 MB/sec. maximum full-duplex throughput per channel
- Supports FC topologies: fabric and point-to-point
- ANSI Fibre Channel: FC-FS, FCP
- FC Class 3 support
- Local management and diagnostics
- Buffer credits: 80
- ATTO Advanced Data Streaming (ADS™) Technology
- Length: 6.600 inches
- Height: 2.713 inches
- The Relative Humidity is:
 - 10% to 90% (operating), non-condensing, 22 C wet bulb
 - 5% to 95% (storage), non-condensing, 22 C wet bulb
- The Operating Temperature (and airflow) is:
 - PCIe Gen3: 0 to 55 C, Operating, 150 LFM
 - PCIe Gen4: 0 to 55 C, Operating, 200 LFM
- The Storage Temperature is -20 to 85 C.
- 10.6W
- RoHS compliant



Voltage Rail - PCIe	Power with 32Gb Optics (Typ) - W	Power with 32Gb Optics (Max) - W
12V DC / PCIe Gen 3	9.9	11.0
12V DC / PCIe Gen 4	10.7	11.8

Single-Mode Optics (32Gb): (Long-wave)

Voltage Rail - PCIe	Power with 32Gb Optics (Typ) - W	Power with 32Gb Optics (Max) - W
12V DC / PCIe Gen 3	10.2	11.3
12V DC / PCIe Gen 4	11.0	12.1

FC-321P Technical specifications

- One Fibre Channel port
- 32Gb data transfer rates
- x8 PCIe 4.0
- 6400 MB/sec. maximum full-duplex throughput per channel
- Supports FC topologies: fabric and point-to-point
- ANSI Fibre Channel: FC-FS, FCP
- FC Class 3 support
- Local management and diagnostics
- Buffer credits: 80
- ATTO Advanced Data Streaming (ADS™) Technology
- Length: 6.600 inches
- Height: 2.713 inches
- The Relative Humidity is:
 - 10% to 90% (operating), non-condensing, 22 C wet bulb
 - 5% to 95% (storage), non-condensing, 22 C wet bulb

The Operating Temperature (and airflow) is:

- PCIe Gen3: 0 to 55 C, Operating, 150 LFM
- PCIe Gen4: 0 to 55 C, Operating, 200 LFM
- The Storage Temperature is -20 to 85 C.
- RoHS compliant



Voltage Rail - PCIe	Power with 32Gb Optics (Typ) - W	Power with 32Gb Optics (Max) - W
12V DC / PCIe Gen 3	8.8	9.9
12V DC / PCIe Gen 4	9.6	10.7

Single-Mode Optics (32Gb): (Long-wave)

Voltage Rail - PCIe	Power with 32Gb Optics (Typ) - W	Power with 32Gb Optics (Max) - W
12V DC / PCIe Gen 3	8.9	10.1
12V DC / PCIe Gen 4	9.7	10.9

Celerity Gen 6 Fibre Channel 32Gb Adapters

The ATTO Celerity 32Gb HBAs leverage two next-generation storage technologies: PCIe 3.0 interconnect and 32-Gigabit Fibre Channel.

32Gb Celerity adapters support the most demanding application requirements, including high-definition video, rich content databases and other high-bandwidth environments.

ATTO Celerity host adapters are an integrated family of advanced storage connectivity solutions that are designed to provide reliable connectivity, intelligence and scalability.

- Local management and diagnostics
- Buffer credits: 80
- ATTO Advanced Data Streaming (ADS™) Technology
- Length: 6.595 inches
- Height: 4.376 inches
- Operating temperature and Airflow: 0-55 °C (32-132 °F) 250lfm minimum recommended
- Storage temperature: -20 to 85 °C (-4 to 185 °F)
- Relative humidity: 10 to 90% non-condensing
- 24.9W
- RoHS compliant

FC-324E technical specifications

- Four independent Fibre Channel ports
- 32Gb data transfer rates
- x16 PCIe 3.0
- 6400 MB/sec. maximum full-duplex throughput per channel
- Supports FC topologies: fabric and point-to-point
- ANSI Fibre Channel: FC-FS, FCP
- FC Class 3 support



FC-322E technical specifications

- Two independent Fibre Channel ports
- 32Gb data transfer rates
- x8 PCIe 3.0
- 6400 MB/sec. maximum full-duplex throughput per channel
- Supports FC topologies: fabric and point-to-point
- ANSI Fibre Channel: FC-FS, FCP
- FC Class 3 support
- Local management and diagnostics
- Buffer credits: 80
- ATTO Advanced Data Streaming (ADS™) Technology
- Length: 6.595 inches
- Height: 2.709 inches
- Operating temperature and Airflow: 0-55 °C (32-132 °F) 150lfm minimum recommended
- Storage temperature: -20 to 85 °C (-4 to 185 °F)
- Relative humidity: 10 to 90% non-condensing
- 10.6W
- RoHS compliant



FC-321E Technical specifications

- One Fibre Channel port
- 32Gb data transfer rates
- x8 PCIe 3.0
- 6400 MB/sec. maximum full-duplex throughput per channel
- Supports FC topologies: fabric and point-to-point
- ANSI Fibre Channel: FC-FS, FCP
- FC Class 3 support
- Local management and diagnostics
- Buffer credits: 80
- ATTO Advanced Data Streaming (ADS™) Technology
- Length: 6.595 inches
- Height: 2.709 inches
- Operating temperature and Airflow: 0-55 °C (32-132 °F) 150lfm minimum recommended
- Storage temperature: -20 to 85 °C (-4 to 185 °F)
- Relative humidity: 10 to 90% non-condensing
- 9.8W
- RoHS compliant



Celerity Gen 6 Fibre Channel 16Gb Adapters

The ATTO Celerity 16Gb HBAs leverage two next-generation storage technologies: PCIe 3.0 interconnect and 16Gigabit Fibre Channel.

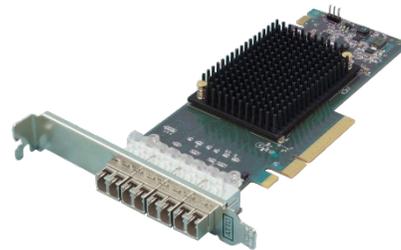
16Gb Celerity adapters support the most demanding application requirements, including high-definition video, rich content databases and other high-bandwidth environments.

ATTO Celerity host adapters are an integrated family of advanced storage connectivity solutions that are designed to provide reliable connectivity, intelligence and scalability.

FC-164P technical specifications

- Four independent Fibre Channel ports
- 16Gb data transfer rates
- x8 PCIe 3.0
- 3200 MB/sec. maximum full-duplex throughput per channel
- Supports FC topologies: fabric and point-to-point
- ANSI Fibre Channel: FC-FS, FCP

- FC Class 3 support
- Local management and diagnostics
- Buffer credits: 40
- ATTO Advanced Data Streaming (ADS™) Technology
- Length: 6.600 inches
- Height: 2.708 inches
- Operating temperature and Airflow: 0-55 °C (32-132 °F) 200lfm minimum recommended
- Storage temperature: -20 to 85°C (-4 to 185 °F)
- Relative humidity: 10 to 90% non-condensing
- 11.9W
- RoHS compliant



FC-162P Technical specifications

- Two independent Fibre Channel ports
- 16Gb data transfer rates
- x8 PCIe 3.0
- 3200 MB/sec. maximum full-duplex throughput per channel
- Supports FC topologies: fabric and point-to-point
- ANSI Fibre Channel: FC-FS, FCP
- FC Class 3 support
- Local management and diagnostics
- Buffer credits: 80
- ATTO Advanced Data Streaming (ADS™) Technology
- Length: 6.595 inches
- Height: 2.709 inches
- Operating temperature and Airflow: 0-55 °C (32-132 °F) 150lfm minimum recommended
- Storage temperature: -20 to 85 °C (-4 to 185 °F)
- Relative humidity: 10 to 90% non-condensing
- 10.3W
- RoHS compliant



FC-161P Technical specifications

- One Fibre Channel port
- 16Gb data transfer rates
- x8 PCIe 3.0
- 3200 MB/sec. maximum full-duplex throughput per channel
- Supports FC topologies: fabric and point-to-point
- ANSI Fibre Channel: FC-FS, FCP
- FC Class 3 support
- Local management and diagnostics
- Buffer credits: 80
- ATTO Advanced Data Streaming (ADS™) Technology
- Length: 6.595 inches
- Height: 2.709 inches
- Operating temperature and Airflow: 0-55 °C (32-132 °F) 150lfm minimum recommended
- Storage temperature: -20 to 85°C (-4 to 185 °F)
- Relative humidity: 10 to 90% non-condensing
- 9.6W
- RoHS compliant



Selection guide: Celerity 32Gb Gen 7 Adapters

Product Features	FC-324P	FC-322P	FC-321P
Fibre Channel Ports	4	2	1
FC protocol	32Gb	32Gb	32Gb
Maximum Transfer Rate per adapter (full duplex)	25600 MB/sec	12800 MB/sec	6400 MB/sec
Bus type	x16 PCIe 3.0	x8 PCIe 4.0	x8 PCIe 4.0
Optical interface	SFP+ LC	SFP+ LC	SFP+ LC
Low profile form factor	✓	✓	✓
Advanced Data Streaming (ADS™) Technology	✓	✓	✓
Developer's kit (Target Mode & API)	✓	✓	✓
Windows support	✓	✓	✓
Linux driver support	✓	✓	✓
macOS driver support	✓	✓	✓
FreeBSD driver support	✓	✓	✓
Illumos support	✓	✓	✓
FC-NVMe (Linux only)	✓	✓	✓
VMware ESXi Server	✓	✓	✓
Windows Hyper-V	✓	✓	✓

Selection guide: Celerity 32Gb Gen 6 adapters

Product Features	FC-324E	FC-322E	FC-321E
Fibre Channel Ports	4	2	1
FC protocol	32Gb	32Gb	32Gb
Maximum Transfer Rate per adapter (full duplex)	25600 MB/sec	12800 MB/sec	6400 MB/sec
Bus type	x16 PCIe 3.0	x8 PCIe 3.0	x8 PCIe 3.0
Optical interface	SFP+ LC	SFP+ LC	SFP+ LC
Low profile form factor		✓	✓
Advanced Data Streaming (ADS™) Technology	✓	✓	✓
Developer's kit (Target Mode & API)	✓	✓	✓
Windows support	✓	✓	✓
Linux driver support	✓	✓	✓
macOS driver support	✓	✓	✓
FreeBSD driver support	✓	✓	✓
Illumos support	✓	✓	✓
FC-NVMe (Linux only)	✓	✓	✓
VMware ESXi Server	✓	✓	✓
Windows Hyper-V	✓	✓	✓

Selection guide: Celerity 16Gb Gen 6 adapters

Product Features	FC-164P	FC-162P	FC-161P
Fibre Channel Ports	4	2	1
FC protocol	16Gb	16Gb	16Gb
Maximum Transfer Rate (full duplex)	12800 MB/sec	6400 MB/sec	3200 MB/sec.
Bus type	x8 PCIe 3.0	x8 PCIe 3.0	x8 PCIe 3.0
Optical interface	SFF	SFP+ LC	SFP+ LC
Low profile form factor	✓	✓	✓
Advanced Data Streaming (ADS™) Technology	✓	✓	✓
Developer's kit (Target Mode & API)	✓	✓	✓
Windows support	✓	✓	✓
Linux driver support	✓	✓	✓
macOS driver support	✓	✓	✓
FreeBSD driver support	✓	✓	✓
Illumos support	✓	✓	✓
FC-NVMe (Linux only)	✓	✓	✓
VMware ESXi Server	✓	✓	✓
Windows Hyper-V	✓	✓	✓

2 Install Drivers

Before installing your Celerity adapter, you must configure your system to recognize and use it by installing drivers for your operating system.

Your adapter was properly flashed before shipment. However, you must add Celerity drivers to your computer before continuing with installation.

If you already have one or more Celerity adapters installed and you have the latest drivers found on the ATTO website,

or you followed the instructions in the Getting Started Guide, you do not need to perform any of these procedures.

Drivers are provided on the [ATTO website](#). Once downloaded, continue with the driver installation procedures (below) for your operating system.

Downloading driver package from the ATTO website

Use this procedure if you need to update drivers. The latest driver for your adapters can be found on the ATTO website.

1. Go to www.atto.com.
2. On the home page menu, put your cursor over **SUPPORT** then click on **Downloads**.
3. Register or log in if previously registered.
4. Select **Fibre Channel HBAs** from the product list.
5. Select your model.
6. From the table, find your Operating System.
7. Click on the entry for the latest driver.

8. A download window appears. Follow the instructions for downloading the driver package.

- Internet Explorer users may select **Run** to automatically run the downloaded self-extracting executable file.
- All other browser users select a download destination and run the self-extracting executable file.
- Continue with the driver installation as described on the following pages for your Operating System.

Windows®

Installing from the ATTO website

1. Power on your system.
2. Log on to Windows as the system administrator.
3. Locate the ATTO driver package on your system, double click the driver and **click unzip**. The driver files are extracted and the driver installer is launched.
4. If you have **User Account Control** enabled, you are asked for permission for the installer to continue. If you do not have administrator privileges, you are also asked for an administrator user name and password. Fulfill the required fields and click **Continue**.
5. Click **Install**.
6. Follow the on-screen instructions to complete the driver installation.
7. Continue on to [Hardware Installation](#).

Installing from a directory containing the Celerity driver

1. Power on your system.
2. Log on as the system administrator.
3. Navigate to the directory containing the Celerity driver installer.
4. Run **Setup.exe**.
5. Click **Install**.
6. If you have **User Account Control** enabled, you are asked for permission for the installer to continue. If you do not have administrator privileges, you are also asked for an administrator user name and password. Fulfill the required fields and click **Continue**.
7. Follow the on-screen instructions to complete the installation.
8. Continue on to [Hardware Installation](#).

macOS®

 **Note** *At this time users cannot see more than 256 LUNs in macOS*

 **Note** *Some ATTO Celerity FC drivers are included on the macOS Distribution DVD and do not require additional installation steps, however we recommend you visit the ATTO website to check for, and download, the latest drivers and firmware.*

Linux®

 **Note** *Newer PCs may ship with UEFI firmware with Secure Boot enabled. With Secure Boot the operating system boot loaders, Linux kernel, and all kernel modules must be signed with a private key and authenticated with a corresponding public key.*

When trying to load an unsigned ATTO driver on a secure boot system, you will see the following error: **modprobe: ERROR: could not insert '<driver-name>': Required key not available** Refer to the Linux driver read me file (readme.html) contained in the driver bundle for instructions on signing and authenticating your ATTO Linux drivers.

1. Power on your system.
2. Log in as **root**.

VMware® ESXi™

Including driver in boot image

 **Note** *16Gb and 32Gb Celerity support.*

VMware vSphere includes the ability to dynamically construct boot images for your ESXi servers using vCenter. This allows you to include ATTO drivers as part of a boot image, then using PXE boot you can start an ESXi host with that image. The end result is that your server(s) will boot and have ATTO drivers included without any additional steps. Consult the

FreeBSD®

1. Power on your system.
2. Login as root using the **su** command. You will be prompted to enter root's password.
3. Verify the kernel header files are installed.
4. Locate the downloaded driver package and copy it to a directory such as **/usr/src/**. Make sure that none of the directories in the path have any spaces in their names.

Driver Installation (for all ATTO FC host adapters)

1. Power on your system.
 2. Double-click the downloaded driver package to launch the installer
 3. Follow the on-screen instructions.
 4. Continue on to [Hardware Installation](#).
-
3. Verify that the kernel header files, usually included with the Linux kernel development package, are installed.
 4. Locate the downloaded package and copy the driver package to a directory such as **/root**
 5. Open a Terminal session and change to the directory where you stored the package.
 6. Extract the driver source using the sample command **tar xzf <file-name>**
 7. Navigate to the directory containing the extracted driver source.
 8. Compile and install the driver using **./install.sh**. The driver is now installed and ready to use.
 9. Continue on to [Hardware Installation](#).

VMware vSphere documentation for more information on this feature.

1. ATTO recommends our customers use the latest drivers available. If you require the latest version, please download via the VMware Compatibility Guide.
2. Select your version of ESXi in the Product Release Version.
3. Select ATTO Technology from the Brand list.
4. Within the IO Device type field select the proper protocol.

5. Change to the directory where you stored the driver package **cd /usr/src**
6. Extract the files from the driver package by executing the following command, where XXX is the driver's version number:

```
tar xvf fbsd_drv_cltryfc16-32_XXX.txz
```

7. The driver files are extracted to a directory called **fbzd_drv_cltryfc16-32_XXX** where XXX is the driver's version number.
8. Change to the directory created by the tar command as follows, where XXX is the driver's version number:

```
cd fbzd_drv_cltryfc16-32_XXX
```

illumos

1. Power on your system.
2. Login as root using the **su** command. You will be prompted to enter root's password.
3. Locate the downloaded driver package and copy it to a directory such as **/root**
4. Open a terminal session and change to the directory where you stored the package

9. Compile and install the driver by executing the install script as follows:

```
./install.sh
```
10. You will be prompted a number of times to provide the installer with your installation options. Answer each of the questions until the installation is complete.
11. Continue on to [Install Hardware](#)

5. Extract the driver package using the sample command **tar -xvf ilm_drv_celerity_16-32_XXX.tgz**
6. Navigate to the directory containing the extracted driver package.
7. Install the driver using **pkgadd -d ilm_drv_celerity16-32_XXX.pkg**
8. Reboot. The driver is now installed and ready to use.
9. Continue on to [Install Hardware](#)

Specialized configurations

Some specialized applications may benefit from modification of adapter settings. The ATTO Utilities Installation and Operation Manual provides detailed information on using ATTO Technology configuration utilities available for download from the [ATTO website](#).

Port Trunking

Multi-ported Gen 7 adapters support port trunking. Port trunking aggregates all physical links on the adapter into one logical port. The combined speed of all links is used to transfer data which may result in improved performance depending on your FC topology.



Note

Port trunking is only supported when connected to Brocade switches with a trunking license.

Trunked ports may only connect to other trunked ports. Consult your switch documentation to enable trunking in the switch.

Trunking is disabled by default on the adapter. To enable, run the following CLI tool packaged with the driver and reboot:

```
atfccfg -t enable
```

When trunking is enabled, the adapter appears as a single channel to the system.

A trunked port will function with any number of physical links between the adapter and switch.

3 Hardware Installation

You need a basic understanding of Fibre Channel before installing the Celerity FC host adapter. Please refer to Appendix A for a list of related websites.

 **CAUTION** Back up your system data before changing or installing any hardware.

System requirements

To install and use the Celerity Fibre Channel host adapter you need:

- A computer with an available PCI Express expansion slot
- The complete Celerity FC host adapter package

 **Note** The Celerity FC-324E adapter uses a x16 electrical PCIe bus and may not work properly when installed in a x8 electrical PCIe slot. We recommend only using the FC-324E in a x16 PCIe slot.

Fibre Channel address

Celerity FC adapters are configured with a unique address designated by the Institute of Electrical and Electronic Engineers. The WorldWide Port Name (WWN) and Node Name are the two components of the address assigned to Fibre Channel products. This address, stored in flash memory, allows the system to recognize the Celerity host adapter as a unique part of your configuration. The address is clearly marked on the back of the board for easy identification. Please keep a reference copy of the number in a safe place.

Celerity FC host adapter WWNs are assigned for each channel. The WWN listed on your host adapter is assigned to the first channel (1). Sequential WWNs apply for additional channels.

WWN 1:	All Celerity adapters
WWN 2:	All dual and quad-port adapters
WWN 3:	Quad-port adapters
WWN 4:	Quad-port adapters

Installation

 **CAUTION** Celerity FC host adapters contain components that are sensitive to electrostatic discharge (ESD). ESD can cause damage to the Celerity FC host adapter. Please follow standard methods to avoid ESD.

1. Install the latest drivers. Refer to [Install Drivers](#).
2. Power down the computer and unplug the computer from all power sources.
3. Open the case.
4. Install the Celerity FC host adapter in any open PCI Express expansion slot. If you have questions about how to install an expansion card in your system, consult your computer's documentation.
5. Connect Fibre Channel devices by inserting a Fibre Channel cable from the devices to the connectors on the Celerity FC host adapter until you hear a click.
6. Close the case on the computer and power it up.

Bracket details

Exhibit 1 FC324P Full Height and Low Height

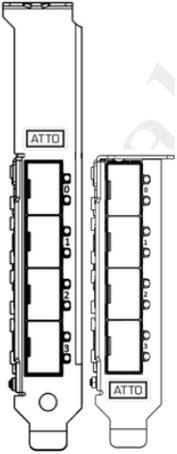


Exhibit 2 FC-322P Full Height and Low Height

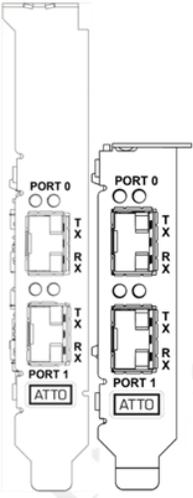


Exhibit 3 FC-321P Full Height and Low Height

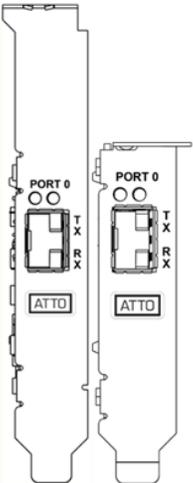


Exhibit 4 FC-324E Full Height

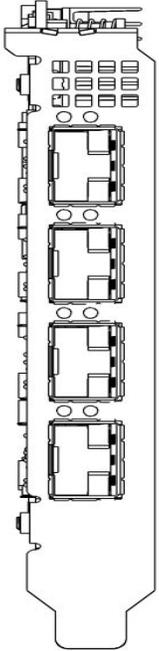


Exhibit 2 FC-322E Full Height and Low Height

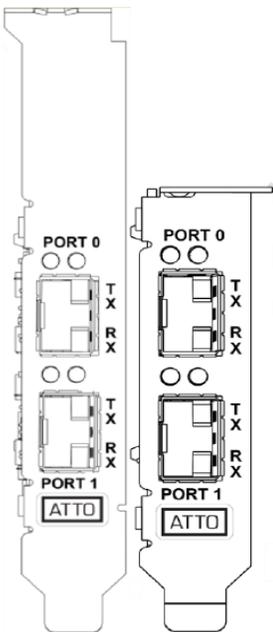


Exhibit 5 FC-321E Full Height and Low Height

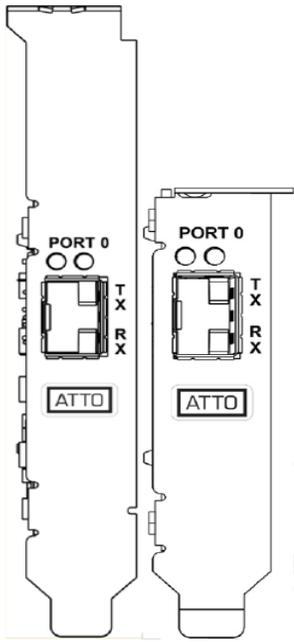


Exhibit 6 FC-164P Full Height and Low Height

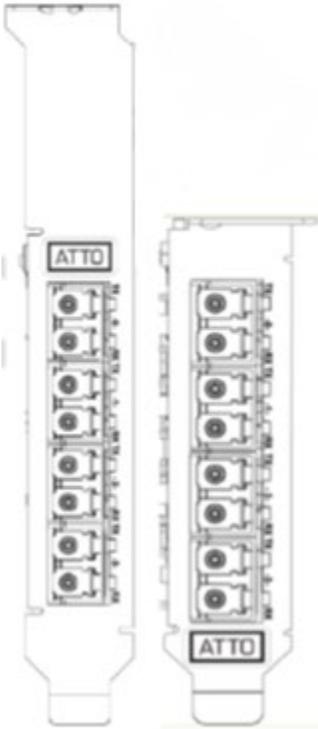


Exhibit 7 FC-162P Full Height and Low Height

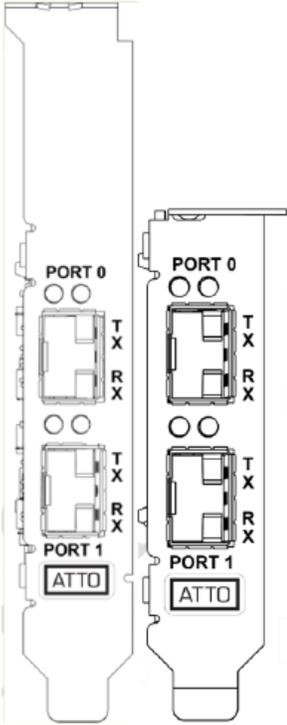
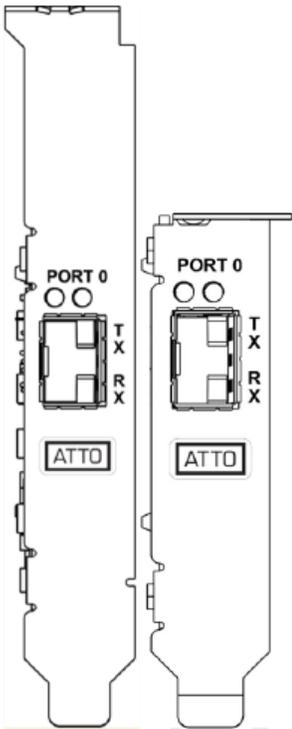


Exhibit 8 FC-161P Full Height and Low Height



Adapter board details

Exhibit 9 FC-324P

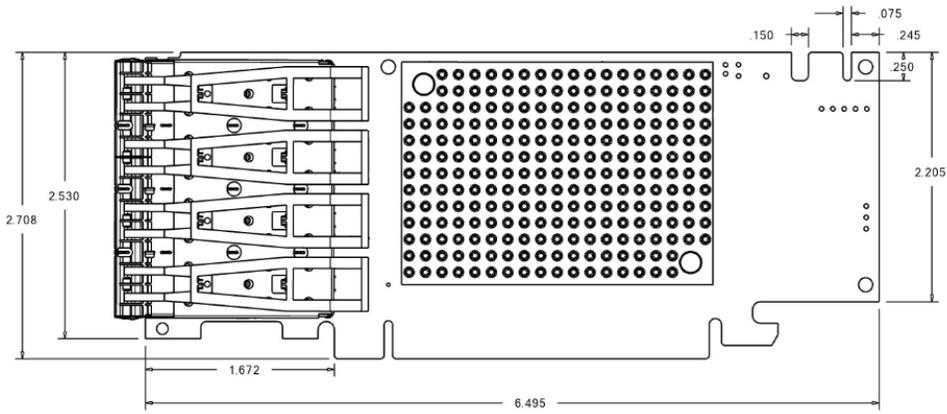


Exhibit 10 FC-322P

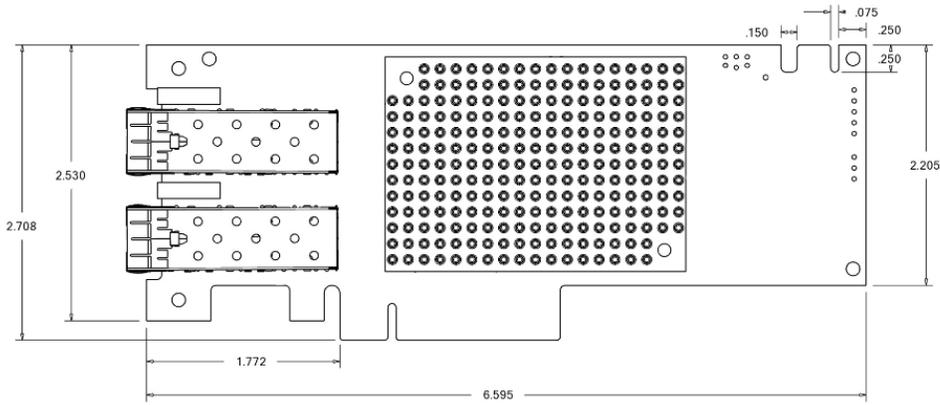


Exhibit 11 FC-321P

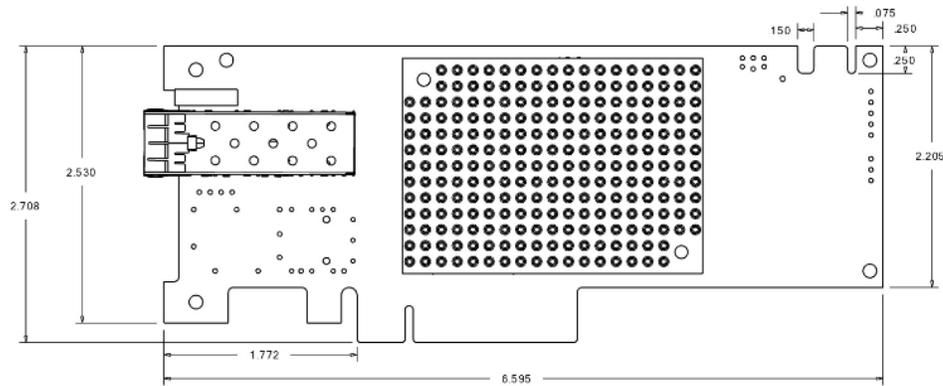


Exhibit 12 FC-324E

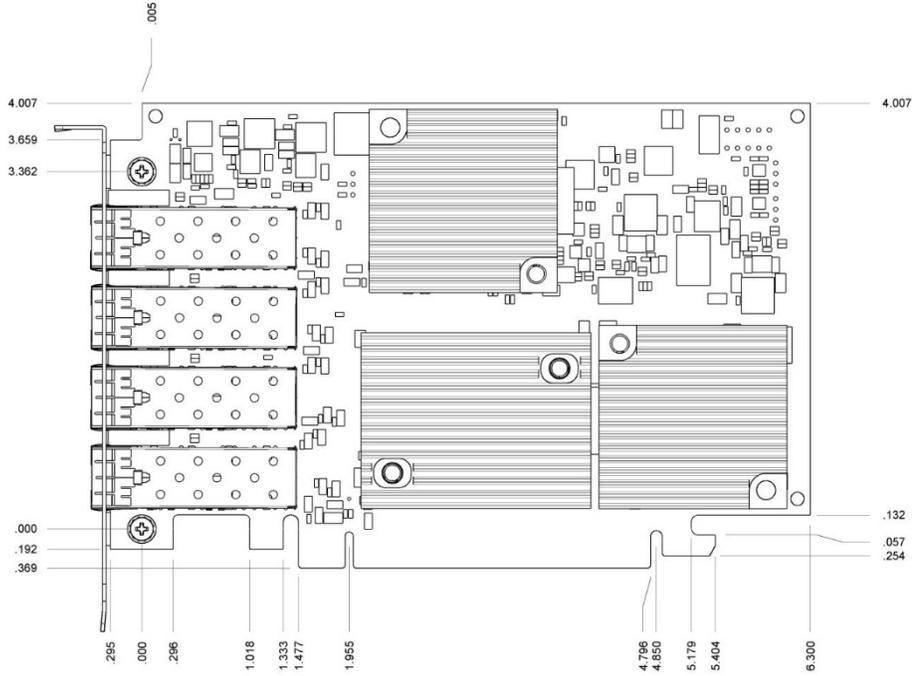


Exhibit 13 FC-322E

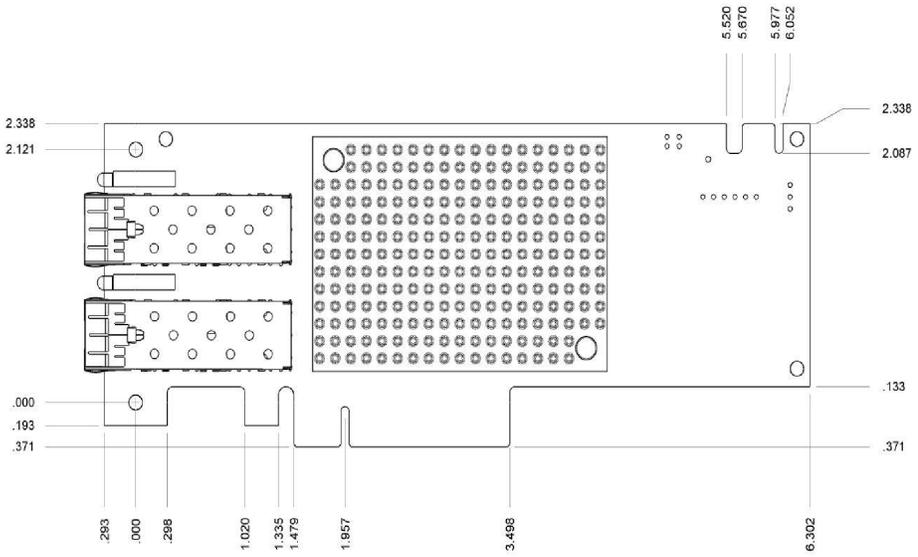


Exhibit 14 FC-321E

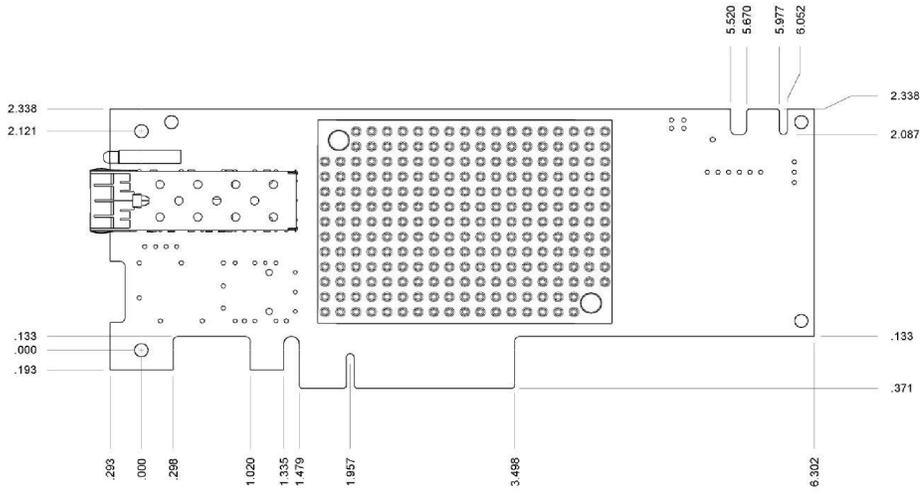


Exhibit 15 FC-161P

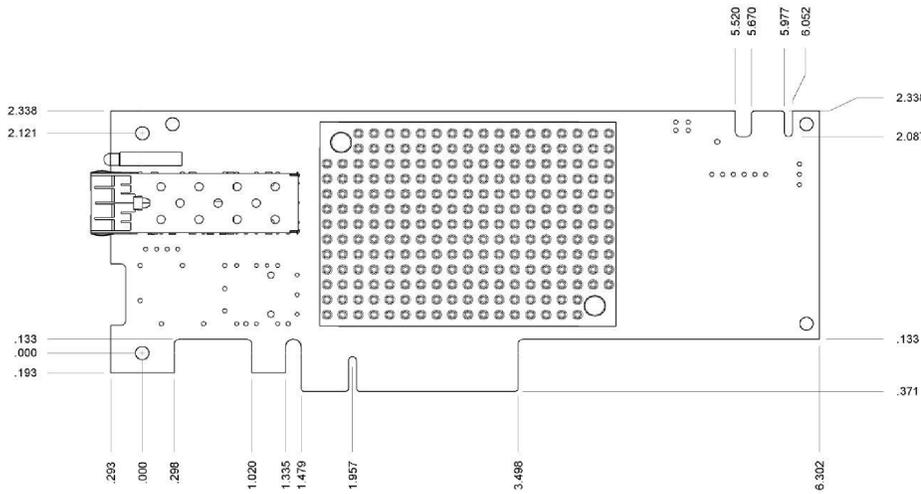


Exhibit 16 FC-162P

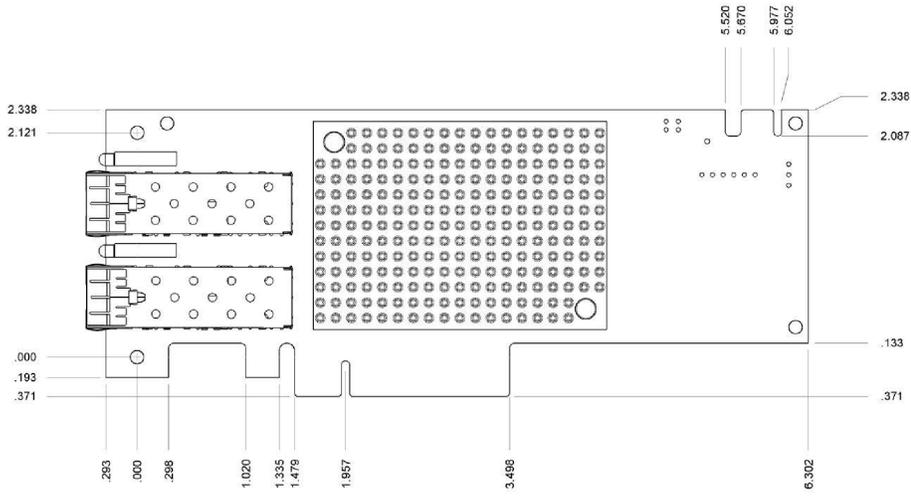
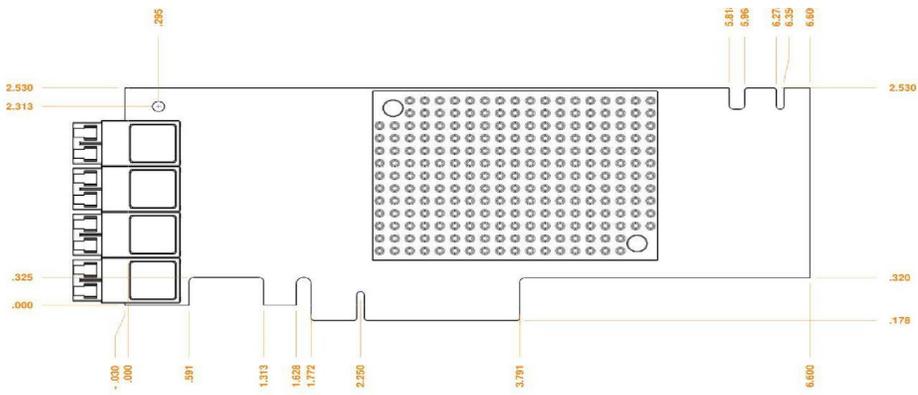


Exhibit 17 FC-164P



4 Troubleshooting

This chapter contains solutions for the most common problems you might encounter. If you need additional assistance, please refer to the ATTO Technology website, www.atto.com, or contact an authorized ATTO Technology representative.

General suggestions

- Check each cable connection on every device.
- Verify all cables are in proper working condition. Loose or broken cables are often the cause of errors or problems.
- Check that Fibre Channel devices are plugged into an AC outlet and are turned on before you add power to your computer.

macOS

1. Download the ATTO ConfigTool from the ATTO website. Refer to the ATTO Utilities manual for additional information on using this tool.
2. If the adapter does not appear in the Device Listing, make sure it is properly seated in the PCI slot.
 - a. Remove power from the PC.
 - b. Remove the case.
 - c. Check the PCI slot.
 - d. Replace the case.
 - e. Apply power.
3. Verify the driver is loaded.
 - a. Click on the adapter name in the Device Listing to view the Basic Info screen.
 - b. If the Driver Information section indicates Unknown: driver not loaded, reinstall the driver. Refer to [Install Drivers](#).
 - c. If reinstalling the driver does not fix the problem, contact an authorized ATTO representative.
4. Reset the NVRAM for all channels to defaults and reboot. If the problem persists, contact an authorized ATTO representative.

 **Note** *If the Celerity adapter is properly seated and devices are still not accessible, contact an authorized ATTO representative.*

 **Note** *When calling ATTO Technical Support, please have a printout of the IOreg listing and output from the Apple System Profiler available.*

Windows

All of the external devices connected to the host adapter should be identified. If they do not appear in the Device Manager, the external devices or connection may not be working properly.

For Intel-based PCs, check the computer CMOS setup and verify that the PCI slots are configured correctly.

Procedures vary greatly: refer to the manual supplied with your system or call the computer supplier for configuration assistance.

Windows OS are plug and play operating systems: be sure your computer's BIOS is set accordingly.

If these do not solve the problem, re-flash the host adapter and re-install the Windows driver. See [Install Drivers](#).

If the devices connected to the Celerity FC host adapter are not accessible

1. Click on the Start button.
2. Click Control Panel.
3. Double click on Administrative Tools.
4. Double click on Computer Management.
5. Select Device Manager.
6. If the Celerity FC host adapter does not appear under the SCSI and RAID controllers, remove power from the PC, open the case, and check that the Celerity FC adapter is properly seated in the PCI slot. Replace the case and apply power.
7. If the adapter has been identified but there is an exclamation point (!) on the listing, right click on the listing and select Uninstall.
8. Reload the driver (see [Install Drivers](#)).
9. Reboot the system and repeat the installation process.
10. If problems persist, contact your authorized ATTO Technology representative.

Linux

1. Verify the celerity16fc driver is loaded with the lsmod command. If lsmod does not show the driver, refer to the installation instructions to install and load the driver in [Install Drivers](#).
2. Check the system log with the command dmesg. The celerity16fc driver creates status messages during initialization. Make sure that all installed cards are properly detected and initialized.

3. Examine the contents of the file(s) /proc/scsi/celerity16fc/X, where X is the adapter's host number. This file contains details such as link status, connection speed and discovered devices.



Note *Advanced users only. Modify the driver makefile to enable debugging information. Upon loading, the celerity16fc driver displays detailed debugging information which may help troubleshoot the problem.*

VMware

After driver installation, you must reboot the host. Once the host is back online, go to Storage and create a VMFS datastore. If storage does not appear, perform a rescan using

the VMware Storage option. If your storage does not present itself, please contact your SAN administrator.

FreeBSD

1. Verify the clrty16fc.ko driver is loaded with the kldstat command. If kldstat does not show the driver, refer to the installation instructions to install and load the driver in [Install Drivers](#).
2. Check the system log with the command dmesg. The clrty16fc.ko driver creates status messages during

initialization. Make sure all installed cards are properly detected and initialized.



Note *Advanced users only. Modify the driver makefile to enable debugging information. Upon loading, the clrty16fc.ko driver displays detailed debugging information which may help troubleshoot the problem.*

illumos

3. Verify the clrty16fc driver is loaded with the modinfo command. If lsmod does not show the driver, refer to the installation instructions to install and load the driver in [Install Drivers](#).
4. Check the system log with the command dmesg. The clrty16fc driver creates status messages during

initialization. Make sure all installed cards are properly detected and initialized.



Note *Advanced users only. Modify the driver configuration found in /kernel/drv/clrty16fc.conf to enable debugging information. Upon loading, the clrty16fc driver displays detailed debugging information which may help troubleshoot the problem.*

5 Supplemental Guide for VMware ESX/ESXi

The following information should be used by advanced users only. Please consult with our Technical Support Department before applying any of the following information.

Driver Configuration

Use the commands documented below to query and configure the ATTO adapter driver parameters. In the examples that follow, <driver name> should be replaced with the ATTO driver name.

To obtain a list of available driver parameters:

```
# esxcli system module parameters list -m=<driver-name>
```

To list the driver parameters that have been set:

```
# esxcli system module parameters list -m=<driver-name>
```

To set a driver parameter:

```
# esxcli system module parameters set -m <driver-name> -p param=value
```

The driver parameter settings are persistent across system reboots. However, the changes will not take effect until the system is rebooted.

Adapter Management

On VMware ESX/ESXi you can identify and manage ATTO adapters using the VMware vSphere Client, or the Service Console. On ESXi, the Service Console is referred to as Local Tech Support Mode.

2.1 vSphere Client

With VMware vSphere Client, you can identify ATTO adapters on a VMware ESX/ESXi system, and view the attached storage devices.

1. Start vSphere Client from your local workstation and select the host containing one or more ATTO adapters.
2. Click the Configuration tab, and then select Storage Adapters under Hardware in the left pane.
3. A list of all storage adapters in the system is displayed. The Model, Identifier (WWN) and Targets are shown for each adapter channel.

2.2 Service Console

Using the Service Console, information about each adapter channel can be found in the /proc/scsi/filesystem, under /proc/scsi/<driver name>.

To view details on a specific adapter channel, run the following command:

```
# cat /proc/scsi/<driver name>/<channel>
```

This command displays the following information:

“Adapter type

“Driver, BIOS and Firmware versions

“Driver Parameters

“Adapter Model and Identifier (WWN)

“Virtual Port Information

“Discovered Targets

“Driver Statistics

A sample output is shown below:

```
~ # cat /proc/scsi/celerity16fc/14
```

ATTO Celerity 16GB Fibre Channel Adapter

Driver version 1.65

BIOS version 08/14/2017

Firmware version 11.2.286.0

Copyright 2001-2017

<http://www.attotech.com>

Driver Parameters:

```
quick_init=0, port_retry_delay=0, max_logins=256, private_els_timeout=2, port_retry_count=0, topology_override=-1, speed_override=-1, max_e_q=12, num_w_q=12, num_w_q_pgs=1, num_r_q=2, num_r_q_pgs=1, num_m_q_pgs=1, num_r_q_2k=32, num_r_q_128=256, num_rpi=2048, reg_slg_pcmt=30, per_cpu_msix_cnt=1, eq_delay=-1, login_to_targets_only=0, target_mode=0, target_mode_mask=0x0, initiator_mode=1, initiator_mode_mask=0xffffffff, target_mode_link_delay=0, target_link_delay_mask=0x0, num_xcb=512, num_scb=1024, sgl_page_size=128, addr_override=, use_transport_layer=1, rport_timeout=30, cpu_affinity=0, event_log_mask=0x1, cmd_per_lun=16, can_queue=512, num_sg_lists=256, sg_tablesize=128, atto_max_sectors=65535, cmd_retry_count=20, io_time_out=30, old_device_reset=0, interrupt_mode=2
```

Adapter Information:

Model: ATTO Celerity FC-324E

WWNN: 20000010:86DDF596

WWPN: 10000010:86DDF596

Target Mode is disabled

Link up, connected at 8GB/s

Discovered Ports:

#	TargID	PortWWN	PortId	IT
---	--------	---------	--------	----

1 0 207000C0:FF143263 0x817100 1 1

Statistics:

Time elapsed (ms) : 64906194

Commands completed : 65837

Outstanding commands : 0

Max outstanding commands: 28

6 Virtual Ports (NPIV)

N_Port Virtualization (NPIV) is an extension to the Fibre Channel industry standard. NPIV allows a single, physical adapter port to function as multiple virtual ports (VPorts), each having a unique Fibre Channel World-Wide-Name in the SAN. This allows a Storage Administrator to follow SAN best practices, such as zoning and masking, to control LUN access.

For more information on NPIV, including usage, please see the [ATTO Utilities manual](#).

Appendix A Glossary

Some terms used in the Fibre Channel industry are defined below. More information is available through the ATTO Technology website (www.atto.com), the Fibre Channel Industry Association (www.fibrechannel.com), Cern (www.cern.ch), the Storage Area Networking Industry Association (www.snia.org), and the Fibre Channel Consortium (www.iol.unh.edu/consortiums, click on FC).

Term	Definition
ANSI	American National Standards Institute
auto negotiation	hardware senses and automatically responds depending on configuration
BER	Bit Error Rate: a measure of transmission accuracy; the ratio of bits received in error to bits sent
bit	smallest unit of data a computer can process: a single binary digit with a value of either 0 or 1
bus	a collection of unbroken signal lines used to transmit information from one part of a computer system to another; taps on the lines connect devices to the bus
byte	an ordered set of 8 bits
channel	a point-to-point link which transports data from one point to another
CPU	Central Processing Unit: the portion of the computer that actually performs computations
CRC	Cyclic Redundancy Check: an error-correcting code which calculates a numeric value for received and transmitted data; if no error has occurred during transmission, the CRC for both received and transmitted data should be the same
destination address	a value in the frame header of each frame which identifies the port in the node where the frame is being sent
device driver	a program that allows a microprocessor to direct the operation of a peripheral device
DMA	Direct Memory Access: a way to move data from a storage device directly to RAM without using the CPU's resources
DMA bus master	allows a peripheral to control the flow of data to and from system memory by block as opposed to allowing the processor to control the data by bytes (PIO or programmed I/O)
fabric	a Fibre Channel switch of two or more Fibre Channel switches interconnected to physically transmit data between any two N_Ports on the switch or switches
FC	Fibre Channel
F_port	a port in the Fibre Channel fabric where a N_port may attach
frame	an indivisible unit for transfer of information in Fibre Channel

frame header	the first field in the frame containing the address and other control information about the frame
full-duplex	a communication protocol which allows transmission in both directions at the same time
half duplex	a communication protocol which allows transmission in both directions, but only one direction at a time
host	a processor, usually a CPU and memory, which communicates with devices over an interface
initiator device	a component which originates a command
LED	Light-emitting diode: a type of diode that emits light when current passes through it; visible LEDs are used as indicator lights on all sorts of electronic devices
LUN	Logical Unit Number: an identifier for a logical unit
multi-mode fiber	an optical fiber which can carry several beams of light at once
N_port	a port attached to a node used with point to point or fabric configurations
NL_port	a port attached to a node in Fibre Channel arbitrated loop or fabric loop configuration
originator	an initiating device; a component which originates a command
parity checking	a method which verifies the accuracy of data transmitted over the SCSI bus by adding one bit in the transfer to make the sum of all the bits either odd or even (for odd or even parity); an error message occurs if the sum is not correct
PCI	Peripheral Component Interconnect. Allows peripherals to be connected directly to computer memory, bypassing the slower ISA and EISA busses
point-to-point	a topology where two ports communicate
port	an access point in a device: see N_port, NL_port, etc.
port address	also port number; the address, assigned by the PCI bus, through which commands are sent to a host adapter board
port number	see port address
receiver	the ultimate destination of data transmission; a terminal device
scatter/gather	a device driver feature which allows the host adapter to modify a transfer data pointer so that a single host adapter can access many segments of memory, minimizing interrupts and transfer overhead

SCSI	Small Computer Systems Interface: a processor-independent standard for system-level interface between a computer and intelligent devices including hard disks, floppy disks, -ROM, printers, scanners, etc.
single-mode fiber	an optical fiber with a small core which supports one wavelength (ray of light); the core radius is nearly equal to the wavelength of the source
SNMP	Simple Network Management Protocol: a standard for monitoring network-attached devices
topology	logical layout of the parts of a computer system or network and their interconnections
transceiver	a transmitter/receiver module
transfer rate	the rate at which bytes or bits are transferred, as in megabytes or gigabits per second

Appendix B Accessories

The following Fibre Channel accessories are available through ATTO Technology and authorized resellers. Contact an ATTO Technology authorized sales representative to order.

Optical Cables and SFPs

- CBL-LCLC-R03 Cable, Fibre Channel, Optical, LC to LC, 3 m
- CBL-LCLC-R10 Cable, Fibre Channel, Optical, LC to LC, 10 m
- SFPA-0016-000 SFP+, 16Gb Fibre Channel, ATTO-Branded, Short-wave
- SFPA-0032-000 SFP+, 32Gb Fibre Channel, ATTO-Branded, Short-wave
- SFPL-0016-R20 SFP+, 16Gb Fibre Channel, ATTO-Branded, Long-wave Single mode*
- SFPL-0032-R00 SFP+, 32Gb Fibre Channel, ATTO-Branded, Long-wave*



Note

Gen 6 technology necessitates that all optics must be a fully certified ATTO-branded SFP

A variety of Ethernet, Fibre Channel, SAS and Thunderbolt products are also available from ATTO Technology. Please contact your ATTO sales representative for product descriptions and part number information.

Software

- ATTO Utilities - Configuration and management software

Appendix C Standards, Compliances: 32Gb adapters

The Technical Specification sheet for each Celerity FC host adapter lists certifications for that model. Models covered by this page include the Celerity FC-324E, FC-322E, and FC-321E.



FCC standards: radio and television interference

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

Canadian standards



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.

European standards



Declaration of Conformity

This following statement applies to the Celerity FC host adapter.

This device has been tested in the basic operating configuration and found to be compliant with the following European Union standards: Application of Council Directive: 89/336/EEC

Standard(s) to which conformity is declared: EN55024:2002; EN55022:2002 CLASS B.

This Declaration will only be valid when this product is used in conjunction with other CE approved devices and when the entire system is tested to the applicable CE standards and found to be compliant.

Some ATTO Celerity cards comply with Directive 2011/65/EU on the Restriction of the Use of Hazardous Substances in Electrical and Electronic Equipment (RoHS). Contact your ATTO representative regarding RoHS compliant products.

Appendix D Standards, Compliances: 16Gb adapters

The Technical Specification sheet for each Celerity FC host adapter lists certifications for that model. Models covered by this page include the Celerity FC-164P, FC-162P, FC-161P

FCC standards: radio and television interference



This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna

Increase the separation between the equipment and receiver

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected

Consult the dealer or an experienced radio/TV technician for help

Canadian standards



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.

European standards



Declaration of Conformity

This following statement applies to the Celerity FC host adapter.

This device has been tested in the basic operating configuration and found to be compliant with the following European Union standards: Application of Council Directive: 89/336/EEC

Standard(s) to which conformity is declared: EN55024:2002; EN55022:2002 CLASS B.

This Declaration will only be valid when this product is used in conjunction with other CE approved devices and when the entire system is tested to the applicable CE standards and found to be compliant.

Some ATTO Celerity cards comply with Directive 2011/65/EU on the Restriction of the Use of Hazardous Substances in Electrical and Electronic Equipment (RoHS). Contact your ATTO representative regarding RoHS compliant products.

Appendix E Safety, Warranty

All ATTO host adapter products have been tested to meet applicable safety standards when operated in proper electrical and thermal environments.

Safety

Please review the specifications for your specific host adapter before installing and operating it in any computer system to ensure compatibility.

Installation

Before installing an ATTO host adapter product into your computer system, unplug the computer from its electrical power source and allow adequate time for electrical discharge and the internal components to cool down before removing the computer system cover. This will decrease the risk of personal injury from electrical shock or touching the hot surface of an electrical component.

Once an ATTO host adapter is installed in a computer system, the computer cover must be reinstalled properly before turning the computer system back on.

Operation

ATTO host adapters require adequate cooling to function properly. If you have any questions as to the airflow provided by your computer system, please refer to your computer system manual or contact your computer system manufacturer.

To facilitate proper air circulation, ATTO host adapters should never be operated in a computer system without the cover installed or with an inoperable fan as this may cause safety or thermal problems which could damage the ATTO host adapter and void the warranty.

ATTO Technology, Inc. limited warranty

ATTO Technology, Inc. ("ATTO") warrants to the original purchaser of this product ("Product") that the Product is free from defects in material and workmanship for the term described for this specific Product on ATTO's website (www.atto.com). ATTO's liability shall be limited to replacing or repairing any defective product at ATTO's option. There is no charge for parts or labor if ATTO determines that this product is defective.

PRODUCTS WHICH HAVE BEEN SUBJECT TO ABUSE, MISUSE, ALTERATION, NEGLIGENCE, OR THOSE PRODUCTS THAT HAVE BEEN SERVICED, REPAIRED OR INSTALLED BY UNAUTHORIZED PERSONNEL WILL NOT BE COVERED UNDER THIS WARRANTY. DAMAGE RESULTING FROM INCORRECT CONNECTION OR AN INAPPROPRIATE APPLICATION OF THIS PRODUCT SHALL NOT BE THE RESPONSIBILITY OF ATTO. LIABILITY UNDER THIS LIMITED WARRANTY IS LIMITED TO ATTO PRODUCT(S). DAMAGE TO OTHER EQUIPMENT CONNECTED TO ATTO PRODUCT(S) IS THE CUSTOMER'S RESPONSIBILITY. THIS LIMITED WARRANTY IS MADE IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. ATTO DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TO THE EXTENT IMPLIED WARRANTIES CANNOT BE EXCLUDED, SUCH IMPLIED WARRANTIES ARE LIMITED IN DURATION TO THE EXPRESS WARRANTY PERIOD APPLICABLE TO THE PRODUCT. BECAUSE SOME STATES OR JURISDICTIONS DO NOT ALLOW LIMITATIONS ON THE DURATION OF IMPLIED WARRANTIES, THE ABOVE MAY NOT BE APPLICABLE. ATTO'S RESPONSIBILITY TO REPAIR OR REPLACE A DEFECTIVE PRODUCT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY.

ATTO IS NOT RESPONSIBLE FOR DAMAGE TO OR LOSS OF ANY DATA, PROGRAMS OR ANY MEDIA. THE PRODUCTS ARE NOT INTENDED FOR USE IN: (I) MEDICAL DEVICES OR THE MEDICAL FIELD; OR (II) USE IN RUGGED APPLICATIONS.

ATTO IS NOT LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, IRRESPECTIVE OF WHETHER ATTO HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. NO ATTO DEALER, AGENT OR EMPLOYEE IS AUTHORIZED TO MAKE ANY MODIFICATION, EXTENSION OR ADDITION TO THIS WARRANTY.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.