

ATTO ExpressSAS® Host Adapter Installation and Operation Manual

ATTO ExpressSAS H1208 HBA
ATTO ExpressSAS H1280 HBA
ATTO ExpressSAS H120F HBA
ATTO ExpressSAS H12F0 HBA
ATTO ExpressSAS H1244 HBA
ATTO ExpressSAS H1288 HBA

ATTO ExpressSAS H1208 GT HBA
ATTO ExpressSAS H1280 GT HBA
ATTO ExpressSAS H120F GT HBA
ATTO ExpressSAS H12F0 GT HBA
ATTO ExpressSAS H1244 GT HBA

ATTO ExpressSAS H644 HBA
ATTO ExpressSAS H680 HBA



The Power Behind the Storage

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1 ATTO Provides Storage Solutions

The ATTO ExpressSAS low-profile HBA and adapters provide 6 Gb and 12 Gb SAS/SATA connectivity for IT and digital video environments.

Installation procedure

ExpressSAS adapter has a Getting Started Guide. If you have not used this guide or you are installing an ExpressSAS HBA, follow the instructions in this manual. You will need:

- ExpressSAS adapter.
 - Access to atto.com to obtain drivers, user manuals and utilities.
 - The optional low-profile bracket and its installation procedure.
 - A computer with an available x8 or x16 PCI Express expansion slot. The ExpressSAS adapter has been optimized for x8 electrical slots. Check your computer's documentation.
 - SAS/SATA storage, cables and connectors.
1. Download device drivers from the ATTO website for your operating system. Refer to [Driver Installation](#)
 2. Install the configuration software, the ATTO ConfigTool™, found on atto.com. Refer to the ATTO Utilities Installation and Operation Manual for details.



Note

The ConfigTool is not supported on FreeBSD, VMware, and illumos. The CLI tools which are provided in the FreeBSD, VMware, and illumos driver package may be used instead.

3. Install the adapter. Refer to [Install Hardware](#).

4. Attach SAS/SATA storage.
5. Configure your storage and adapter using the ConfigTool.



Note

Default settings are appropriate for most systems but you may change settings using the ConfigTool.



CAUTION

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

ExpressSAS features

- Point-to-point technology delivers full throughput to each connected storage device
- One-click installation
- User-friendly ConfigTool provides a simple host-based utility for effortless configuration; EFI setup utilities provide flexibility for custom applications
- ADS™ technology alleviates data transfer bottlenecks and moves data more efficiently while managing latency
- Support for passive copper and active optical cables
- Driver support for Windows®, Linux®, macOS™, FreeBSD, VMware® ESX/ESXi Server and illumos
- Fully support UEFI and UEFI HII interface
- RoHS compliant
- 3-year standard warranty

ExpressSAS 12Gb HBAs

ExpressSAS12Gb host bus adapters utilize 12 Gb/s SAS speeds to deliver low latency in real-time environments. They support a dense and efficient connection to storage from servers and workstations in datacenter, data warehousing, VOD and other high-availability, high-performance applications.

Power Center Pro

Power Center Pro is an integrated software RAID solution that brings the performance and protection of RAID to storage devices attached to your ATTO ExpressSAS 12 Gb host adapters with internal ports.

The ATTO Power Center Pro is a RAID 0, 1, 1e and 10 solution included for use with ExpressSAS 12 Gb SAS HBAs, providing a cost-effective option that adds performance and protection to your storage architecture.

To learn more about using and configuring Power Center Pro RAID groups, refer to the ATTO Utilities software manual.

H1208 technical specifications

- 8 internal SFF-8643 SAS ports to PCIe 3.0 host interface
- Up to 12Gb/s per port performance
- Conforms to PCIe low profile form factor
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-55 °C (32 °F-131 °F)
- Operating humidity: 10-90% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 0.9A; 3.3V @ 0.1A, 11W
- Airflow: 100 lf/m minimum



H1280 technical specifications

- 8 external SFF-8644 SAS ports to PCIe 3.0 host interface
- Up to 12Gb/s per port performance
- Conforms to PCIe low profile form factor
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-55 °C (32 °F-131 °F)
- Operating humidity: 10-90% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 0.9A; 3.3V @ 0.1A, 11W
- Airflow: 100 lf/m minimum



H120F technical specifications

- 16 internal SFF-8643 SAS ports to PCIe 3.0 host interface
- Up to 12Gb/s per port performance
- Conforms to PCIe low profile form factor
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-55 °C (32 °F-131 °F)
- Operating humidity: 10-90% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 1.2A; 3.3V @ 0.1A, 15W
- Airflow: 200 lf/m minimum



H12F0 technical specifications

- 16 external SFF-8644 SAS ports to PCIe 3.0 host interface
- Up to 12Gb/s per port performance
- Conforms to PCIe low profile form factor
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-55 °C (32 °F-131 °F)
- Operating humidity: 10-90% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 1.2A; 3.3V @ 0.1A, 15W
- Airflow: 200 lf/m minimum



H1244 technical specifications

- 4 external SFF-8644, 4 internal SFF-8643 SAS ports to PCIe 3.0 host interface
- Up to 12Gb/s per port performance
- Conforms to PCIe low profile form factor
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-55 °C (32 °F-131 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 1.2A; 3.3V @ 0.1A, 11W
- Airflow: 100 lf/m minimum
- Operating humidity: 10-90% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)



H1288 technical specifications

- 8 external SFF-8644, 8 internal SFF-8643 SAS ports to PCIe 3.0 host interface
- Up to 12Gb/s per port performance
- Conforms to PCIe low profile form factor
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-55 °C (32 °F-131 °F)
- Operating humidity: 10-90% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 1.2A; 3.3V @ 0.1A, 15W
- Airflow: 200 lf/m minimum



ExpressSAS 12Gb GT HBAs

ExpressSAS12Gb GT host bus adapters utilize 12 Gb/s SAS speeds to deliver low latency in real-time environments. They support a dense and efficient connection to storage from servers and workstations in datacenter, data warehousing, VOD and other high-availability, high-performance applications.

Power Center Pro

Power Center Pro is an integrated software RAID solution that brings the performance and protection of RAID to storage devices attached to your ATTO ExpressSAS 12 Gb GT host adapters with internal ports.

The ATTO Power Center Pro is a RAID 0, 1, 1e and 10 solution included for use with ExpressSAS 12 Gb GT SAS HBAs, providing a cost-effective option that adds performance and protection to your storage architecture.

To learn more about using and configuring Power Center Pro RAID groups, refer to the ATTO Utilities software manual (atto.com).

H1208 GT technical specifications

- 8 internal SFF-8643 SAS ports to PCIe 4.0 host interface
- Up to 12Gb/s per port performance
- Conforms to PCIe low profile form factor
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-55 °C (32 °F-131 °F)
- Operating humidity: 10-90% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 0.5A; 3.3V @ 0.2A, 6.6W
- Airflow: 100 lf/m minimum



H1280 GT technical specifications

- 8 external SFF-8644 SAS ports to PCIe 4.0 host interface
- Up to 12Gb/s per port performance
- Conforms to PCIe low profile form factor
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-55 °C (32 °F-131 °F)
- Operating humidity: 10-90% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 0.5A; 3.3V @ 0.1A, 6.3W
- Airflow: 100 lf/m minimum



H120F GT technical specifications

- 16 internal SFF-8643 SAS ports to PCIe 4.0 host interface
- Up to 12Gb/s per port performance
- Conforms to PCIe low profile form factor
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-55 °C (32 °F-131 °F)
- Operating humidity: 10-90% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 0.8A; 3.3V @ 0.25A, 10.4W
- Airflow: 200 lf/m minimum



H12F0 GT technical specifications

- 16 external SFF-8644 SAS ports to PCIe 4.0 host interface
- Up to 12Gb/s per port performance
- Conforms to PCIe low profile form factor
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-55 °C (32 °F-131 °F)
- Operating humidity: 10-90% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 0.8A; 3.3V @ 0.2A, 10.3W
- Airflow: 200 lf/m minimum



H1244 GT technical specifications

- 4 external SFF-8644, 4 internal SFF-8643 SAS ports to PCIe 4.0 host interface
- Up to 12Gb/s per port performance
- Conforms to PCIe low profile form factor
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-55 °C (32 °F-131 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 0.5A; 3.3V @ 0.15A, 6.5W
- Airflow: 100 lf/m minimum
- Operating humidity: 10-90% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)



ExpressSAS 6Gb HBAs

The ATTO ExpressSAS HBA features are engineered for the most stringent IT server and digital media workgroup environments and are compatible with multiple operating systems, applications, and drives.

Providing SAS/SATA II connectivity to up to 1,024 end devices, the ATTO SAS Host HBA is ideal for both IT and digital video environments that require a high level of performance.

H644 technical specifications

- Four internal SFF-8087, four external SFF-8088 ports
- Up to 6-Gb/sec per port performance
- Form factor conforms to PCI low-profile specification
- Length: 6.600"
- Height: 2.713"
- Operating temperature: 0-40 °C (32 °F-104 °F)
- Operating humidity: 5-95% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 0.6A; 3.3V @ 0.2A, 8W
- Airflow: 100 lf/m minimum



- Power (typ): 12V @ 0.6A; 3.3V @ 0.2A, 8W
- Airflow: 100 lf/m minimum



H608 technical specifications

- Eight internal SFF-8087 ports
- Up to 6-Gb/sec per port performance
- Form factor conforms to PCI low-profile specification
- Length: 5.600"
- Height: 2.713"
- Operating temperature: 0-40 °C (32 °F-104 °F)
- Operating humidity: 5-95% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing
- Power (typ): 12V @ 0.6A; 3.3V @ 0.2A, 8W
- Airflow: 100 lf/m minimum

H680 technical specifications

- Eight external SFF-8088 ports
- Up to 6-Gb/sec per port performance
- Length: 6.600"
- Height: 2.846"
- Operating temperature: 0-40 °C (32 °F-104 °F)
- Operating humidity: 5-95% non-condensing
- Storage temperature: -40-70 °C (-40 °F-157 °F)
- Storage humidity: 5-95% non-condensing



2 Install Drivers

The ATTO ExpressSAS adapters require a current device driver and hardware flash for proper operation. Your adapter was properly flashed before shipment. However, you must add ExpressSAS drivers to your computer before continuing with installation. If you already have one or more ExpressSAS 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 at <http://www.atto.com/downloads.php>. Log in, if previously registered, or register to proceed to the download pages. Once downloaded, continue with the driver installation procedures (below) for your operating system.

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

Windows

Installing from the ATTO Technology website

1. Power on your system.
2. Log on to Windows as the system administrator.
3. Locate the ATTO driver on your system 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 [Install Hardware](#).

Installing from a directory containing the ExpressSAS driver

1. Power on your system.
2. Log on as the system administrator.
3. Navigate to the directory containing the ExpressSAS driver.
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 [Install Hardware](#).

macOS

1. Power on your system.
2. Double-click the downloaded driver file to launch the installer

3. Follow the on-screen instructions.
4. Continue on to [Install Hardware](#).
5. Launch

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.



Note

ExpressSAS adapters are not supported under Linux kernel 2.4.

1. Power on your system.
2. Log in as root.
3. Verify that the kernel header files, usually included with the Linux kernel development package, are installed.
4. Locate the downloaded driver and copy the driver file to a directory such as /usr/src
5. Open a Terminal session and change to the directory where you stored the driver.
6. Open your File Browser and browse to /mnt/cdrom/Linux/Drivers.
7. Click on the driver:

- For the ExpressSAS HBA, the driver filename appears as `lnx_drv_esashba#_XXX.tgz` where # is the product family and XXX is the driver's current version number.
8. Copy the driver file to a directory such as /usr/src.
 9. Open a Terminal session.
 10. Change to the directory where you stored the driver.
 11. Extract the driver source:
 - For the ExpressSAS HBA: `tar xzf lnx_drv_esashba#_XXX.tgz`.
 12. The driver files are extracted to a directory called `lnx_drv_esashba_XXX`.
 13. Navigate to that directory.
 14. Compile and install the driver using `./install.sh`. The driver is now installed and ready to use.
 15. Add the following line to `/etc/modprobe.conf` after installing the driver:
 - For ExpressSAS HBA: `alias scsihostHBAX esashba` where X is the next available HBA number.
 16. Continue on to [Install Hardware](#).

VMware ESXi 7.0 and earlier

You can add an ATTO adapter and install the driver after installing VMware ESXi.



Note

Refer to [Driver Configuration](#) for additional information on configuring and managing ExpressSAS adapters in VMware

1. Download the Driver Bundle from the VMware or ATTO website for your ATTO adapter. Unzip the contents of the bundle on your local workstation. Within the bundle you will find the Driver VIB file (.vib) for your ATTO adapter.
2. Use the Datastore Browser in the vSphere Client to upload the VIB file to your ESXi host. Alternatively, you can use a program like winscp on Windows or scp on Linux to upload the file directly to your ESXi host.

3. Log in to the ESXi host on the Local Tech Support Console (ESXi), or through an SSH client.
4. Install the VIB using the following command on the ESXi host:

```
# esxcli software vib install -v <full path to VIB file>
```

Including Driver in boot image

VMware vSphere 5 includes the ability to dynamically construct boot images for your ESXi servers. This allows you to include ATTO drivers as part of a boot image and install or boot ESXi with that image. The end result is that your server(s) will boot and have ATTO drivers included without any additional steps. Consult the VMware vSphere documentation for more information on using vSphere Image Builder.

FreeBSD (ExpressSAS 12Gb adapters only)

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 **tarball** 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.
5. Change to the directory where you stored the driver
cd /usr/src
6. Extract the files from the driver tarball by executing the following command, where XXX is the driver's version number:
tar xvf fbsd_drv_esashba4_XXX.tgz
7. The driver files are extracted to a directory called **fbsd_drv_esashba4_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 fbsd_drv_esashba4_XXX
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](#)

illumos (ExpressSAS 12Gb adapters only)

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
5. Extract the driver package using the sample command
tar -xvf ilm_drv_esashba4_XXX.tgz
6. Navigate to the directory containing the extracted driver package
7. Install the driver using **pkgadd -d ilm_drv_esashba4_XXX.pkg**
8. Reboot. The driver is now installed and ready to use.
9. Continue on to [Install Hardware](#)

3 New Windows OS Installation



Note

When you install a new or different copy of the Windows operating system on a disk attached to an ATTO ExpressSAS adapter, you must reinstall the ATTO ExpressSAS drivers.

If you are changing the version of Windows you are using or installing a fresh copy of your current version onto your system, you must ensure Windows recognizes your ATTO ExpressSAS and uses its drivers.

You may create an installation media (disk, CD or USB flash drive) from a file from the ATTO website, then use that media to install the adapter and its driver to the new version of Windows.

Follow these procedures after you have completed installation of the ExpressSAS adapter and you have connected storage devices (refer to [Install Hardware](#)).

Adjusting Adapter settings with the EFI Configuration Utility

Depending on your configuration, it may be necessary to adjust adapter NVRAM settings prior to performing the Windows installation. For example, you may need to modify the device wait time. The EFI configuration utility can be launched from an EFI shell. A built-in EFI shell is included with many PC platforms. If your platform does not have a built-in EFI shell, one can be obtained at <http://tianocore.sourceforge.net>.

Once in the EFI shell, do the following to open the EFI Configuration Utility:

1. At the prompt, enter the drivers -b command. Scroll through the list of installed EFI drivers and find the ExpressSAS driver. There may be more than one entry based on the number and type of adapter(s). Note the two or three digit hexadecimal driver handle on the far left of the screen.
2. At the prompt, enter `drvcfg -s {handle}` where {handle} is the hexadecimal number from the previous step. This will launch the EFI Configuration Utility for the associated adapter.
3. Use the on-screen menus to configure your adapter. Help is available at the bottom of the screen.
4. When exiting the configuration utility, if you changed any settings, the system will restart the adapter so the new settings take effect.
5. At the prompt, enter `exit` to return to the EFI boot manager or `reset` to restart the system.

Power Center Pro HBA RAID Solution

Power Center Pro is an integrated software RAID solution that brings the performance and protection of RAID to storage devices attached to your ATTO ExpressSAS 12 Gb host adapters.

ATTO's Power Center Pro is a RAID 0, 1, 1e and 10 solution included for use with ExpressSAS 12 Gb SAS HBAs with internal connections, providing a cost-effective option that adds performance and protection to your storage architecture.

To learn more about using and configuring Power Center Pro RAID groups, refer to the EFI section ATTO Utilities Manual on setting up RG to install the OS (atto.com).

Creating ExpressSAS installation media from a file

1. Go to atto.com.
2. Put your cursor over Downloads then click on Downloads from the splash screen menu.
3. Register or log in if previously registered.
4. Select SAS/SATA Host & RAID adapters 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.

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.

9. Uncheck When done unzipping open \Setup.exe.
10. Select a destination folder and click Unzip to extract the driver files.
11. Run `makedisk.exe`.
12. Continue with [Install the Driver into a New Version of Windows](#).

Install the Driver into a New Version of Windows

Start Windows text mode setup as described by your Windows documentation.

1. Select Custom installation.
2. The Where do you want to install Windows message appears. Click Load Driver.
3. Insert the ExpressSAS installation media into the appropriate slot.
4. Click OK.
5. Windows Setup searches for drivers matching devices in your system. If the ExpressSAS adapter is not in the

Select the driver to be installed, click Browse and locate the driver.

6. Select the ExpressSAS adapter from the list.
7. Click Next.
8. The Where to you want to install Windows window appears. Your devices should be listed. Remove the ExpressSAS installation media.
9. Configure and select a partition for installing Windows.
10. Click Next.
11. Continue with the remainder of the Windows installation procedure.

4 New macOS Installation

Boot support is available on Intel-based systems only.

Adjusting Adapter settings with the EFI Configuration Utility



Note Depending on your configuration, it may be necessary to adjust adapter NVRAM settings prior to performing the macOS installation. For example, you may need to modify the device wait time or create a RAID group. The EFI configuration utility can be launched from an EFI shell. Unfortunately, an EFI shell is not included with Intel Macs. ATTO recommends rEFit, which is available for free from <http://refit.sourceforge.net>. Once you have downloaded the DMG for rEFit, do the following to open the EFI Configuration Utility:

1. Burn the rEFit DMG file to a CD. Do not remove the CD.
2. Shut down the system and insert the ExpressSAS adapter.
3. With the rEFit CD inserted, boot the system while pressing and holding the C key. This will boot the rEFit CD.
4. The rEFit boot menu will appear which contains a series of icons. Release the C key and use the arrows to highlight the Start EFI Shell icon. Press Return to enter the EFI Shell.
5. At the prompt, enter the drivers -b command. Scroll through the list of installed EFI drivers and find the ATTO ExpressSAS driver. There may be more than one entry based on the number and type of adapter(s). Note the two or three digit hexadecimal driver handle on the far left of the screen.
6. At the prompt, enter `drvcfg -s {handle}` where {handle} is the hexadecimal number from the previous step. This will launch the EFI Configuration Utility for the associated adapter.
7. Use the on-screen menus to configure your adapter. Help is available at the bottom of the screen.
8. When exiting the configuration utility, if you changed any settings, the system will restart the adapter so the new settings take effect.
9. At the prompt, enter `exit` to return to the rEFit boot menu or `reset` to restart the system.

macOS Driver Installation



Note If you already have one or more supported products installed and you are installing additional products, you do NOT need to perform this procedure unless you are updating a previously installed driver. Also, the driver may only be installed to the currently booted operating system. In addition, you must have system administrator privileges to perform driver installation. If you do not, you will be prompted for the username and password of a system administrator during the installation process.

1. Double-click the macOS Installer package (*.pkg) to begin installation.
2. Proceed through the installation wizard using the default settings.
3. When installation is complete, click 'Restart' to restart the system and load the driver.

Booting macOS from a disk attached to an ATTO product

1. With your hardware installed, boot your system to an existing macOS installation that you wish to boot from the ATTO-attached disk(s).
2. Install the ATTO driver using the procedure in the previous section.
3. Download the latest ConfigTool and flash bundle package from atto.com
4. Mount the flash bundle disk image (*.dmg).
5. Install and launch the ATTO ConfigTool to configure your product.
6. Click on your ATTO product in the left navigation panel.
7. In the Flash panel in the right pane, browse to the flash bundle from the mounted disk image.
8. Click 'Update' to flash the ATTO product.



Note For non-RAID products proceed to step 10.

9. In the RAID panel in the right pane, create RAID groups as necessary to expose a boot disk to the system.
10. For each ATTO product channel, in the NVRAM panel in the right pane, set the 'Boot Driver' option to 'Enabled' and commit the new settings.
11. Close the ATTO ConfigTool™.
12. Launch macOS Disk Utility.
13. Configure and partition the ATTO-attached disk(s) as you wish using the 'RAID' and 'Partition' panels to prepare a volume for booting.
14. Using the 'Restore' panel, copy the currently booted macOS volume to the ATTO-attached volume. Drag and drop the source and destination volumes from the left panel and click the 'Restore' button.
15. Close Disk Utility.
16. Launch macOS System Preferences and select the Startup Disk preference pane.
17. Select the ATTO-attached boot volume and click 'Restart...'
18. Your system is now booted from the ATTO-attached volume.

Driver Settings

Please reference the README for information on driver settings.

Changing Driver Settings in macOS

1. Open a Terminal window.
2. At the prompt, enter the command `'sudo nvram atto-args-esashba2="[options]"'` for H6xx products where [options] are listed above. If you are not the root user, you will be prompted for an administrator password.
3. Reboot the system for the changes to take effect.



Note *These options are stored in system NVRAM; therefore they persist across reboots.*



Note *Resetting the system NVRAM by pressing and holding Command+Option+P+R during boot will remove the options. You can view the current options in macOS by opening a Terminal window and entering `'nvram atto-args-esasraid2'` ('`'nvram atto-args-esashba2'` for H6xx). You can remove the options in macOS by opening a Terminal window and entering `'sudo nvram -d atto-args-esasraid2'` ('`'sudo nvram -d atto-args-esashba2'` for H6xx).*

Driver Events

The reporting of driver events is controlled by the event mask driver setting. See the Driver Settings section for information on how to set this mask. The hexadecimal mask value is the sum of the event type values for the events you would like to see.

The ATTO driver uses the system log to communicate driver events to the user. Each event begins with a driver and channel identifier, ATTOExpressSASRAID2 X.Y.Z

(ATTOExpressSASHBA2 X.Y.Z for H6xx products), where X is the PCI bus number, Y is the PCI device number and Z is the PCI function number. In general, only errors that are output for event type 'Fatal' are significant; all others are mostly for informational or diagnostic purposes. When turning on event logging, be aware that certain events reported as errors are expected. For example, a SCSI Check Condition error will be reported for the first command sent to a device after power on or a reset condition. Also, certain data underrun errors are expected by the software and are normal.

5 Install Hardware

Use this chapter as a guide to install the ATTO ExpressSAS adapter into a x8 or x16 PCI Express expansion slot on your computer. If you have followed the Getting Started Guide successfully, you do not need to read this chapter.

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

System requirements

The ATTO ExpressSAS adapter package contains:

- ExpressSAS adapter
- A low-profile or standard bracket and the installation procedure
- If any of these items are missing, contact your ATTO authorized sales representative.
- In addition you must have:
- A computer with an available x8 or x16 PCI Express 4.x/3.x/2.x/1.2 expansion slot. Check your computer's documentation.

Installing the Adapter

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

1. Install system drivers before you begin hardware installation. Refer to [Install Drivers](#).
 2. Power down the computer and unplug the computer from all power sources.
 3. Open the case.
 4. If applicable, attach the low profile or standard bracket to the adapter.
 5. Remove the original bracket from the adapter, being careful not to damage the board. Use an ESD-safe #1 Phillips screwdriver to remove the Phillips screws at the top and bottom edges of the board.
- **CAUTION** Make sure the screwdriver is centered in the top of the screw to prevent damage to the screw. Damaging the screw can void the warranty.
 - a. Set the bracket and screws aside.
 - b. Place the adapter on top of the replacement bracket, positioning the bracket so that the holes in the bracket are aligned with the openings in the board.
 - c. It is recommended that you dip the screws into Loctite® 242 to decrease the chance of the threads becoming loose.
 - d. Use an ESD-safe #1 Phillips torque screwdriver to tighten the screws. The screwdriver should be set to a maximum torque of 3.98 in/lbs (0.45N m).

- SAS/SATA storage, cables and connectors.

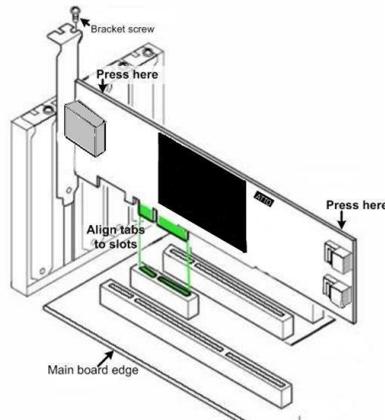
See [Bracket Details](#) and [Adapter Board Details](#) for details of the adapters and brackets.

SAS address

Each ATTO ExpressSAS adapter has a unique SAS address designated by the Institute of Electrical and Electronic Engineers which allows the system to recognize the ATTO ExpressSAS adapter as a unique part of your configuration.

The address is marked on the back of the board for easy identification. Please keep a reference copy of the number in a safe place.

- **CAUTION** Do not exceed the torque specification to avoid damaging the board, connectors or screws.
6. Insert the ATTO ExpressSAS adapter into 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.



7. Close the case on the computer and power it up.
8. Installed drivers are loaded.

For Windows:

1. Windows detects your adapter and automatically installs the required drivers. If drivers do not load, refer to page 9 for driver installation and troubleshooting.
2. Shut down the computer.

Bracket Details

Exhibit 1 ExpressSAS H1208/H1208 GT HBA brackets

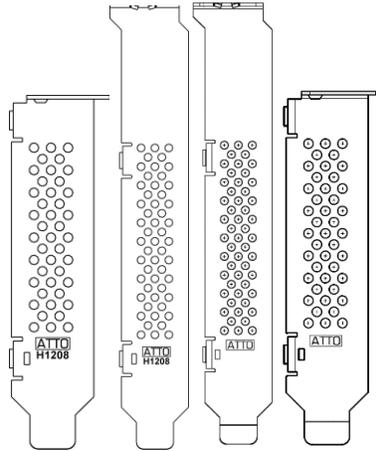


Exhibit 2 ExpressSAS H1280/H1280 GT HBA brackets

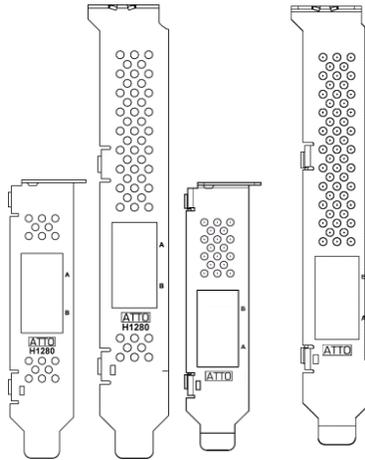


Exhibit 3 ExpressSAS H120F/H120F GT HBA brackets

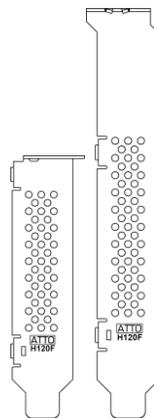


Exhibit 4 ExpressSAS H12F0/H12F0 GT HBA brackets

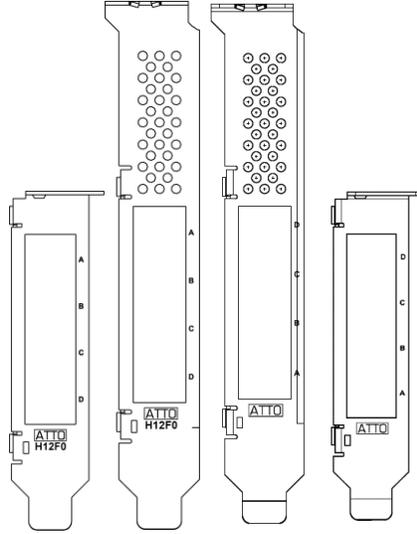


Exhibit 5 ExpressSAS H1288, H1248, and H1244/H1244 GT HBA brackets

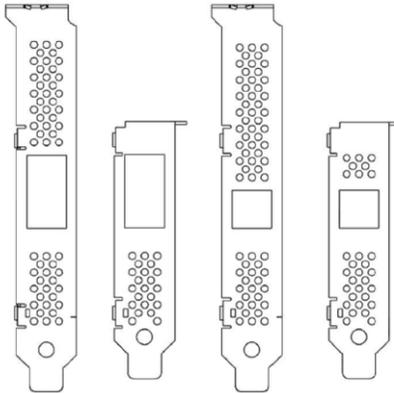


Exhibit 6 ExpressSAS H644 HBA brackets

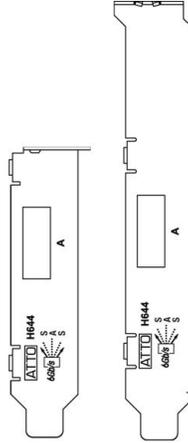
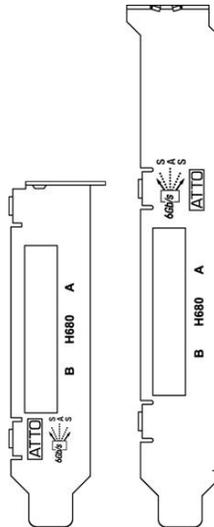


Exhibit 7 ExpressSAS H680 HBA brackets



Adapter Board Details

Exhibit 8 ExpressSAS H1208 HBA board.

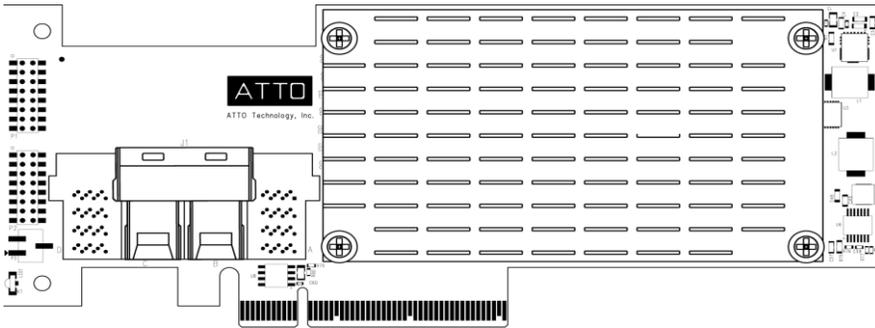


Exhibit 9 ExpressSAS H1280 HBA board.

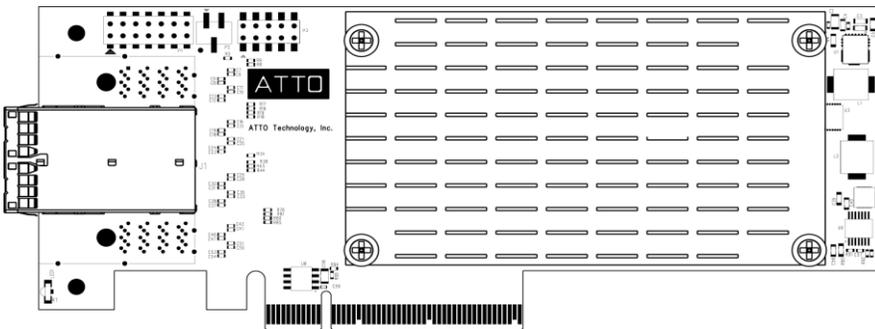


Exhibit 10 ExpressSAS H120F HBA board.

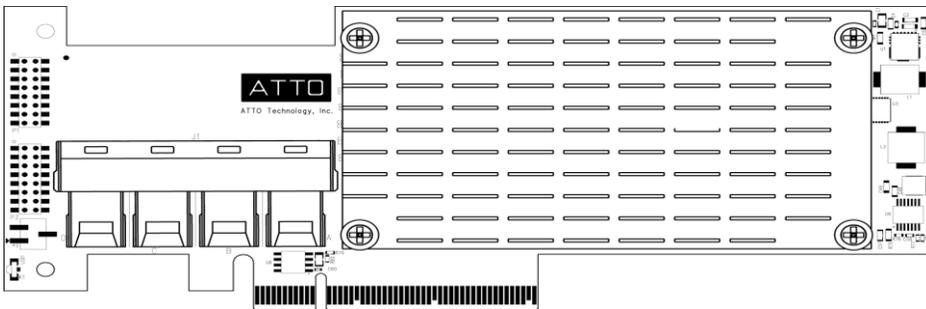


Exhibit 11 ExpressSAS H12F0 HBA board.

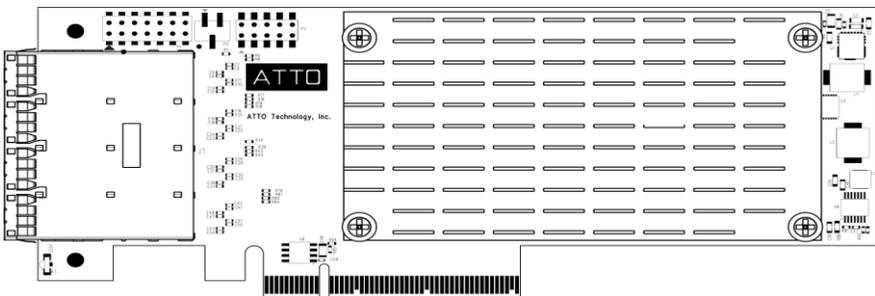


Exhibit 16 ExpressSAS H1280 GT board

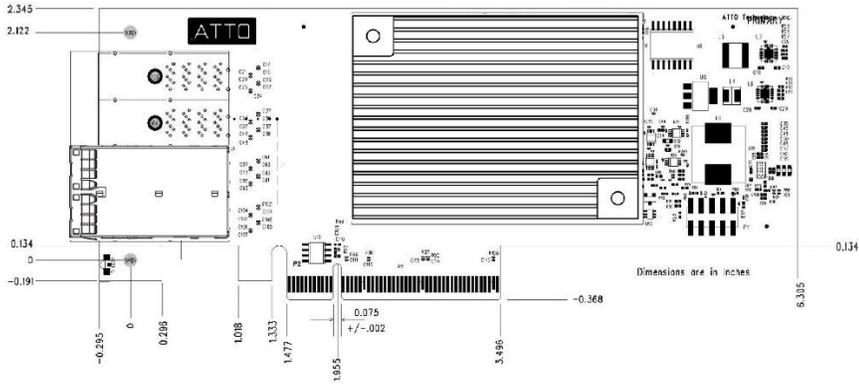


Exhibit 17 ExpressSAS H120F GT board

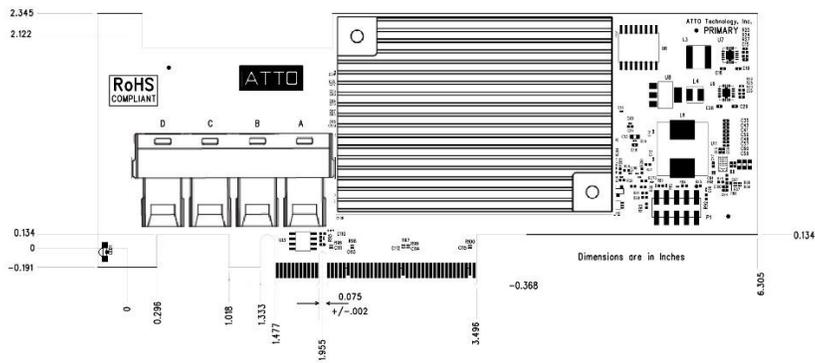


Exhibit 18 ExpressSAS H1208 GT board

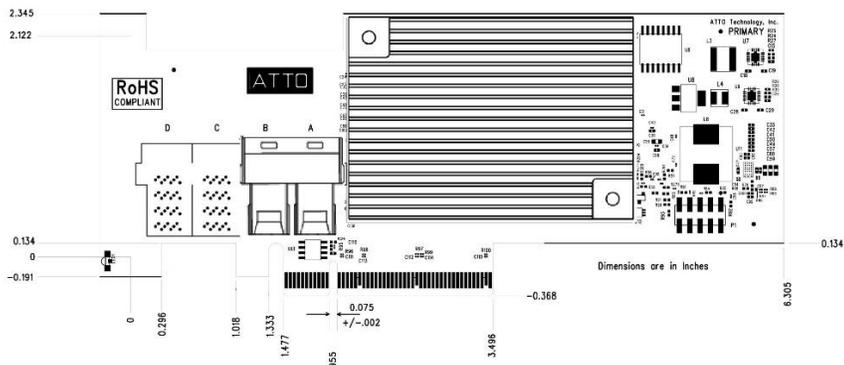


Exhibit 19 ExpressSAS H1244 GT board

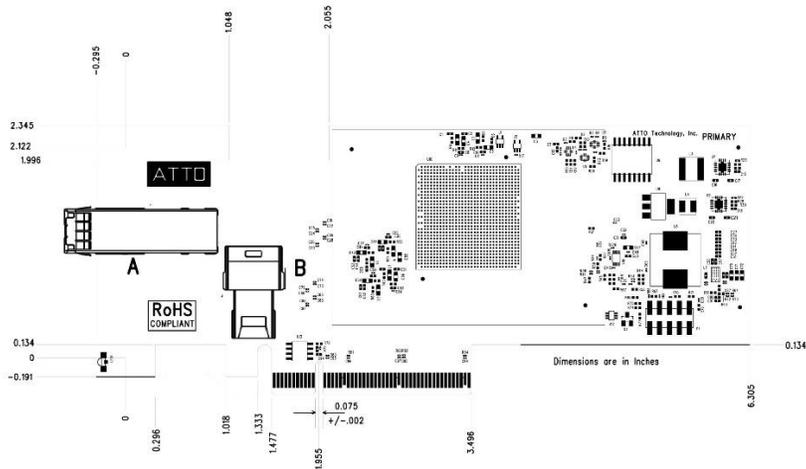


Exhibit 20 ExpressSAS H644 HBA board.

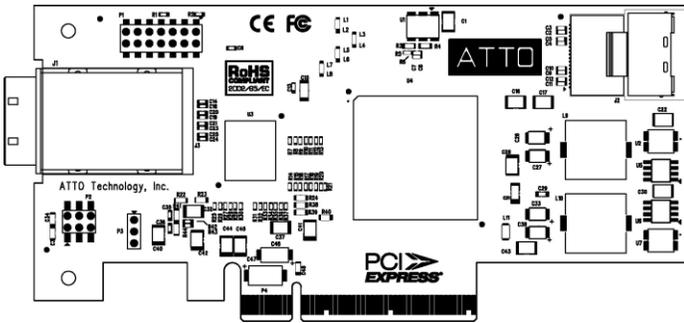
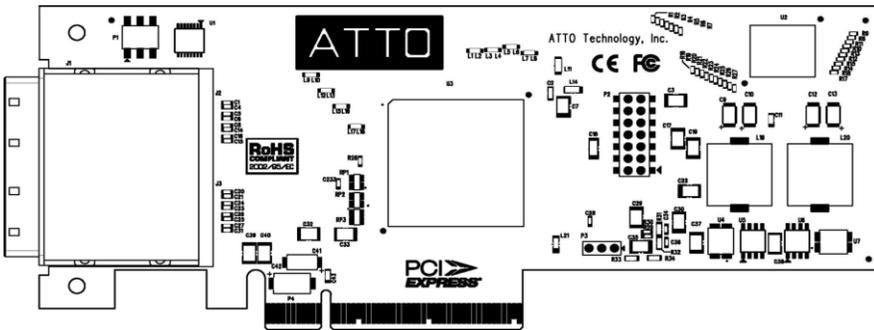


Exhibit 21 ExpressSAS H680 HBA board



6 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 or contact an ATTO Technology authorized 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 devices are plugged into an AC outlet and are turned on before you add power to your computer.
- Ensure you have the latest driver for your operating system and that the driver is installed (refer to [Driver Installation](#)).
- Ensure the ExpressSAS adapter is installed properly in the computer (refer to [Install Hardware](#)).

If the RAID adapter is not accessible

1. Open the ATTO ConfigTool from the ATTO Utilities which can be downloaded from the ATTO website. Refer to the *ATTO Utilities Installation and Operation Manual* for additional information.

 **Note** *Logging features are only available if the ATTO ConfigTool service is installed. We recommend installing the service as a minimum configuration.*

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.

 **Note** *If it is properly seated and devices are still not accessible, contact an ATTO Technology authorized representative.*

3. Verify the driver is loaded.
4. Click on the adapter name in the Device Listing to view the Basic Info screen.
5. If the Driver Information section indicates Unknown: driver not loaded, reinstall the driver (refer to [Driver Installation](#)).
6. If reinstalling the driver does not fix the problem, contact an ATTO authorized representative.
7. Reset the NVRAM for all channels to defaults and reboot. If the problem persists, contact an ATTO authorized representative.

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

illumos

1. Verify the esas4hba driver is loaded with the modinfo command. If modinfo 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 esas4hba driver creates status messages during initialization. Make sure all installed cards are properly detected and initialized.

 **Note** *Advanced users only. Refer to the driver README.txt included in the downloaded driver package for information on how to enable debugging information in the esas4hba.conf located in /kernel/drv. Upon loading, the esas4hba driver displays detailed debugging information which may help troubleshoot the problem.*

Appendix A Glossary

Some terms used in the SAS/SATA industry are defined below. More information is available through the ATTO Technology website (atto.com), or the Storage Area Networking Industry Association (www.snia.org).

Term	Definition
ANSI	American National Standards Institute
Auto Negotiation	Hardware senses and automatically responds depending on configuration
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
CPU	Central Processing Unit: the portion of the computer that actually performs computations
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)
Host	A processor, usually a CPU and memory, which communicates with devices over an interface
I2C	(Inter-Integrated Circuit) is a multi-master serial single-ended computer bus that is used to attach low-speed peripherals to a motherboard, backplane or embedded system
I2C Header	I2C header is a connector on the adapter used to connect an I2C cable
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
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

PHY	A physical connection between the adapter and a drive on the backplane. Each mini-SAS connector carries signals for four PHYs
Port	An access point in a device
Port Address	Also port number; the address, assigned by the PCI bus, through which commands are sent to an adapter board
Port Number	See port address
SCSI	Small Computer Systems Interface: a processor-independent standard for system-level interface between a computer and intelligent devices including hard disks, floppy disks, CD-ROM, printers, scanners, etc.
SEP	SCSI Enclosure Process. A SEP is a device, typically a backplane, that is capable of executing SCSI SES commands
SES	SCSI Enclosure Services. A SCSI specification that defines SCSI commands for controlling an enclosure. These commands include the capability to control LED indicators on an enclosure
SES-I2C	SES over I2C. I2C is used to transport the SES protocol instead of SCSI, SAS, Fibre Channel etc.
SGPIO	A serial GPIO protocol used to control LED indicators on a backplane
Sideband Connector	Connector on Mini-SAS cables used to carry an SGPIO signal
Transfer Rate	The rate at which bytes or bits are transferred, as in megabytes or gigabits per second

Appendix C Standards and Compliances

The equipment described in this manual generates and uses radio frequency energy. The Technical Specification sheet for the ATTO ExpressSAS adapter shows certifications for each model.



FCC standards: radio and television interference

This equipment has been tested and found to comply with the limits for a Class B digital device (ExpressSAS 12Gb HBAs) and Class A digital device (ExpressSAS 12Gb GT HBAs), 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 B digital apparatus complies with Canadian ICES-003 (ExpressSAS 12Gb HBAs)

This Class A digital apparatus complies with Canadian ICES-003 (ExpressSAS 12Gb GT HBAs)

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 ATTO ExpressSAS 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

EN55024:2002; EN55022:2002 CLASS A

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.



The ATTO ExpressSAS adapters 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 Safety and Warranty

All ATTO 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 adapter before installing and operating it in any computer system to ensure compatibility.

Installation

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

Operation

ATTO 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 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 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 (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.