



# **A33606-PCI-01**

## **SAS-2 Expander**

### User Manual

**Version:** C  
**Document Number:** 90-000186

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This document describes Astek's 36-port 6Gbit/s Serial-attached SCSI (SAS) expander and will remain the official reference source for all revisions/releases of this product until rescinded by an update.

To receive product literature, visit us at <http://www.astekcorp.com>.

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Note: The A33606-PCI has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These Limits are designed to provide reasonable protection against harmful interference when the equipment is operated in its installation. This equipment generates, uses, can radiate radio frequency energy, and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. If this equipment does cause harmful interference the user will be required to correct the interference.

The A33606-PCI has been tested and meets the safety requirements of IEC/EN 60950-1.

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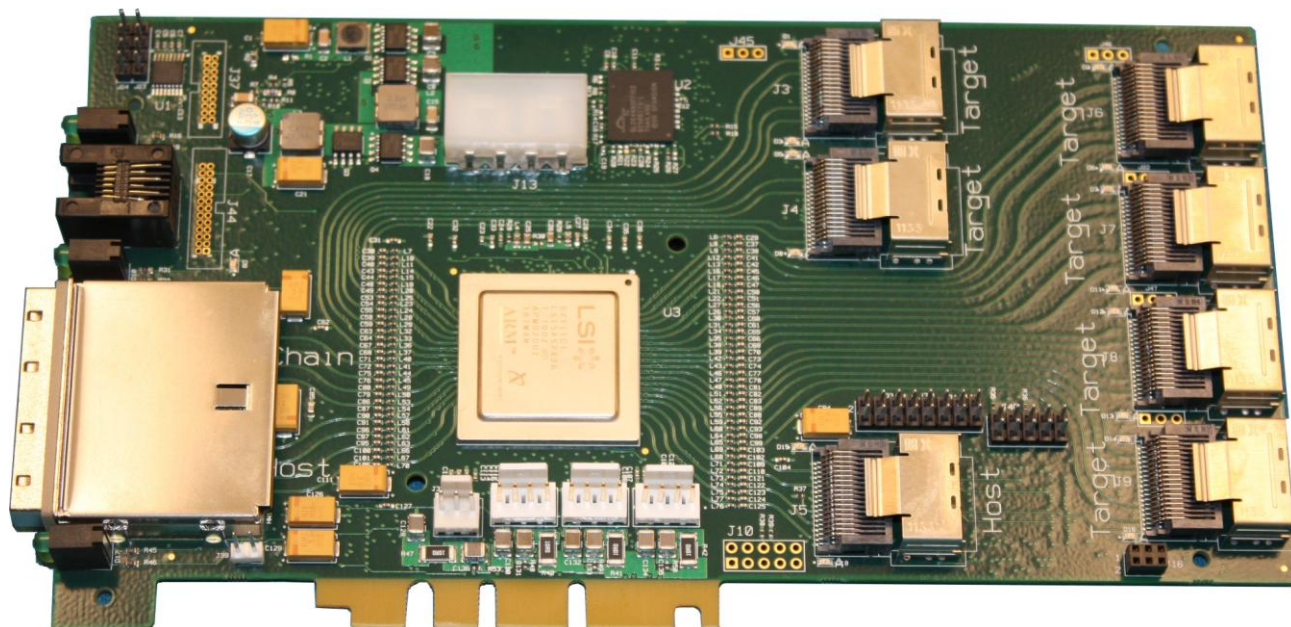


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# 1 Introduction

The Astek A33606-PCI-01 expander provides 36 lanes for connection to SAS/SATA devices and/or hosts. Each lane is capable of 1.5Gb/s, 3.0Gb/s, or 6Gb/s operation. The A33606-PCI-01 contains two SFF-8088 external miniSAS connectors and seven SFF-8087 internal miniSAS connectors. Each connector contains four SAS/SATA lanes. Each internal miniSAS connector also includes SGPIO sideband signals for the respective lanes on the connector.



The A33606-PCI-01P is designed to be installed in a PCI, PCI-X or PCIe slot. The PCI slot provides a mechanical mounting location for the board; no signal or power pins are used. The A33606-PCI-01 is also available without a PCI bracket for mounting directly to a chassis or with a 5.25" shell for mounting in a 5.25" bay on a traditional PC chassis.

The Astek expander SAS interface is compatible with the ANSI Serial Attached SCSI Specification, revision 2.0 and the Serial ATA Specification, revision 2.6. The functionality of the expander board comes from the LSISAS2X36 expander chip. The expander card makes it easy to add additional SAS/SATA drive support to RAID and JBOD systems. The expander card support narrow port and wide port operation. Wide port size is not limited by the expander. Typical port sizes are listed in the table below.

Number of SAS lanes	Speed
Narrow Port (1 lane)	600 MB/s
Wide Port (4 lanes)	2400 MB/s
Wide Port (8 lanes)	4800 MB/s

## 2 Installation Procedures

### Hardware Installation

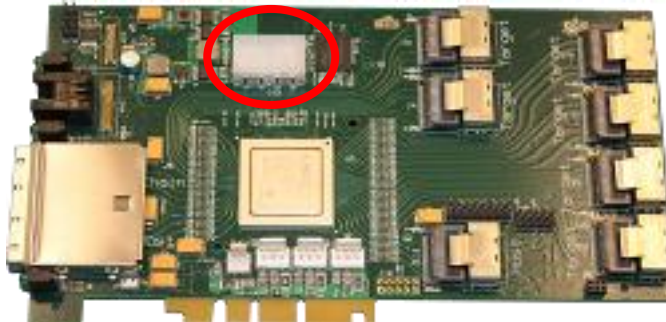
#### A33606-PCI-01P

The A33606-PCI-01P contains a PCI bracket and is intended to be installed in a PCI, PCI-X, or PCIe slot.

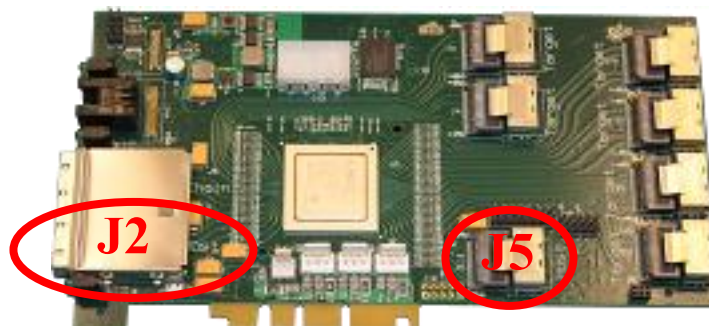
**CAUTION**

Ground yourself before removing any electronic equipment or parts.

- Step 1. Remove the A33606-PCI-01P from the ESD packaging and check that it is not damaged.
- Step 2. Insert the Expander card into a PCI, PCI-X, or PCIe slot on the motherboard per the motherboard manufacturer recommendations.
- Step 3. Attach a 4-pin power cable from the power supply to J13 (shown below). The A33606-PCI-01 utilizes 12V input power.



- Step 4. Attach the SAS HBA or RAID Card to the expander card.



For internal connection, connect the host to J5 using an SFF-8087 cable.

For external connection, connect the host to J2 using an SFF-8088 cable.

- Step 5. Attach drives to the expander card. The mapping of drive number to connector is shown below.

Connector	Drive Numbers
J3	1-4
J4	5-8
J6	9-12
J7	13-16
J8	17-20
J9	21-24

Drives can be attached via a backplane by using an SFF-8087 cable.

Drives may also be attached using an SFF-8087 to SATA fanout cable.

Step 6. Power on the system.

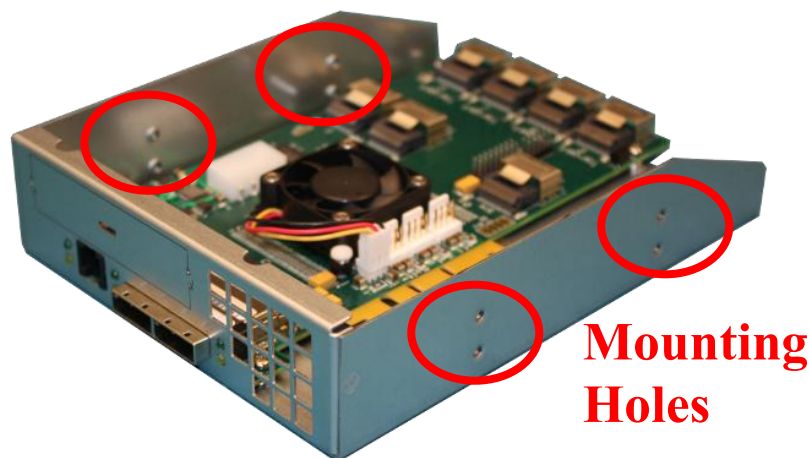
### A33606-PCI-01D

The A33606-PCI-01D is enclosed in a 5.25" mounting shell and is intended to be installed in a 5.25" bay in a PC.

#### CAUTION

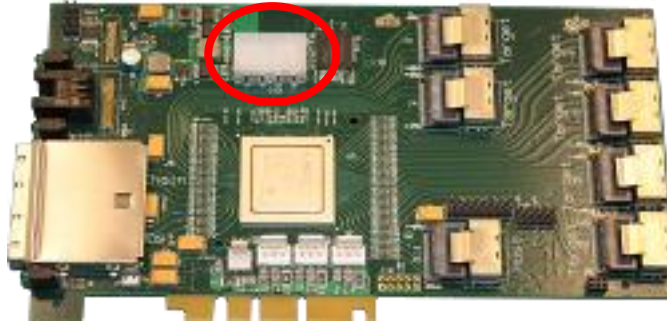
Ground yourself before removing any electronic equipment or parts.

- Step 1. Remove the A33606-PCI-01D from the ESD packaging and check that it is not damaged.
- Step 2. Insert the Expander with mounting shell into a 5.25" bay and secure it with the provided hardware.

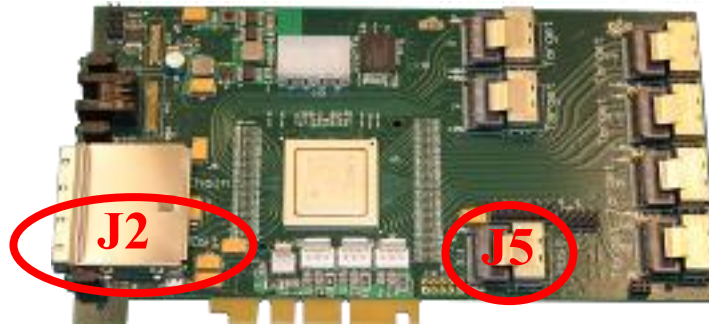


- Step 3. Attach a 4-pin power cable from the power supply to J13 (shown below). The A33606-PCI-01 utilizes 12V input power.





Step 4. Attach the SAS HBA or RAID Card to the expander card.



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Step 6. Power on the system.

### A33606-PCI-01

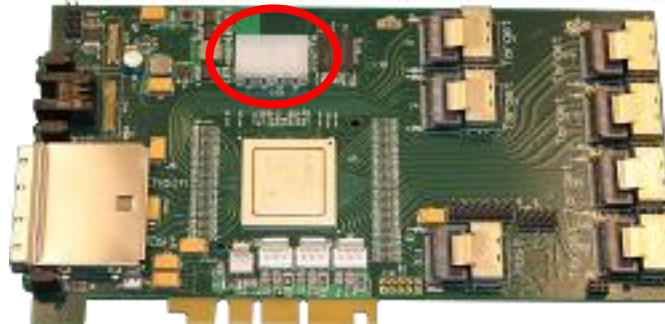
The A33606-PCI-01 is intended to be installed directly to a chassis or PC case.

#### CAUTION

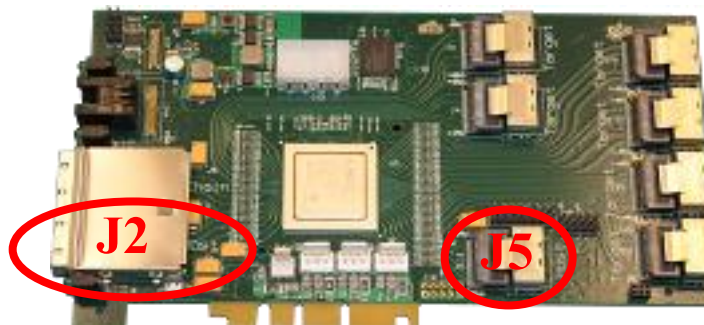
Ground yourself before removing any electronic equipment or parts.



- Step 1. Remove the A33606-PCI-01 from the ESD packaging and check that it is not damaged.
- Step 2. Insert the Expander card into the chassis. The mounting holes are sized to support M3 or 4-40 hardware. Board dimensions and mounting hole locations are defined in the Mechanical Specifications section.
- Step 3. Attach a 4-pin power cable from the power supply to J13 (shown below). The A33606-PCI-01 utilizes 12V input power.



- Step 4. Attach the SAS HBA or RAID Card to the expander card.



For internal connection, connect the host to J5 using an SFF-8087 cable.

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Drives may also be attached using an SFF-8087 to SATA fanout cable.

Step 6. Power on the system.

## Software Installation

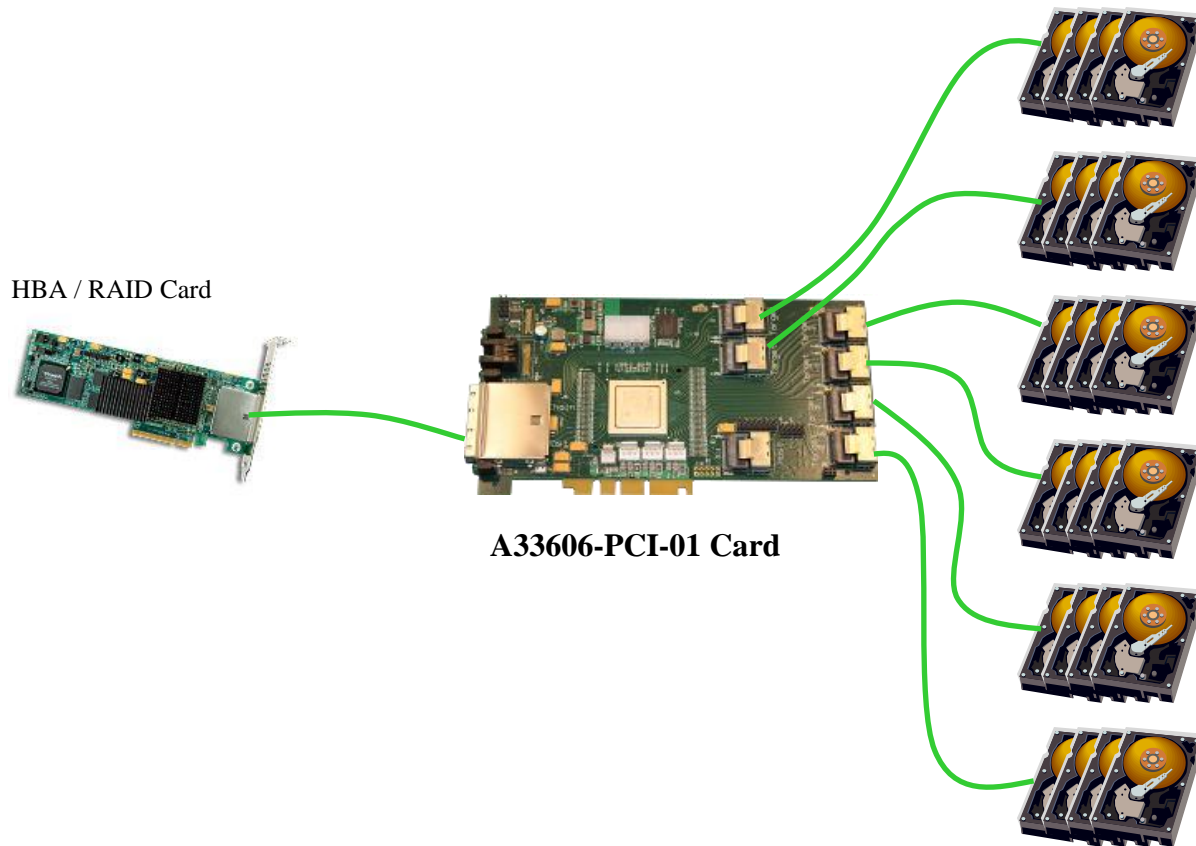
The A33606-PCI-01 does not require drivers or special software to operate the expander. The standard drivers for your HBA/RAID card contain the necessary support for expanders in the system.

Follow the recommended instructions for creating RAID arrays and disk arrays for the HBA or RAID card manufacturer.

## Typical Use Cases

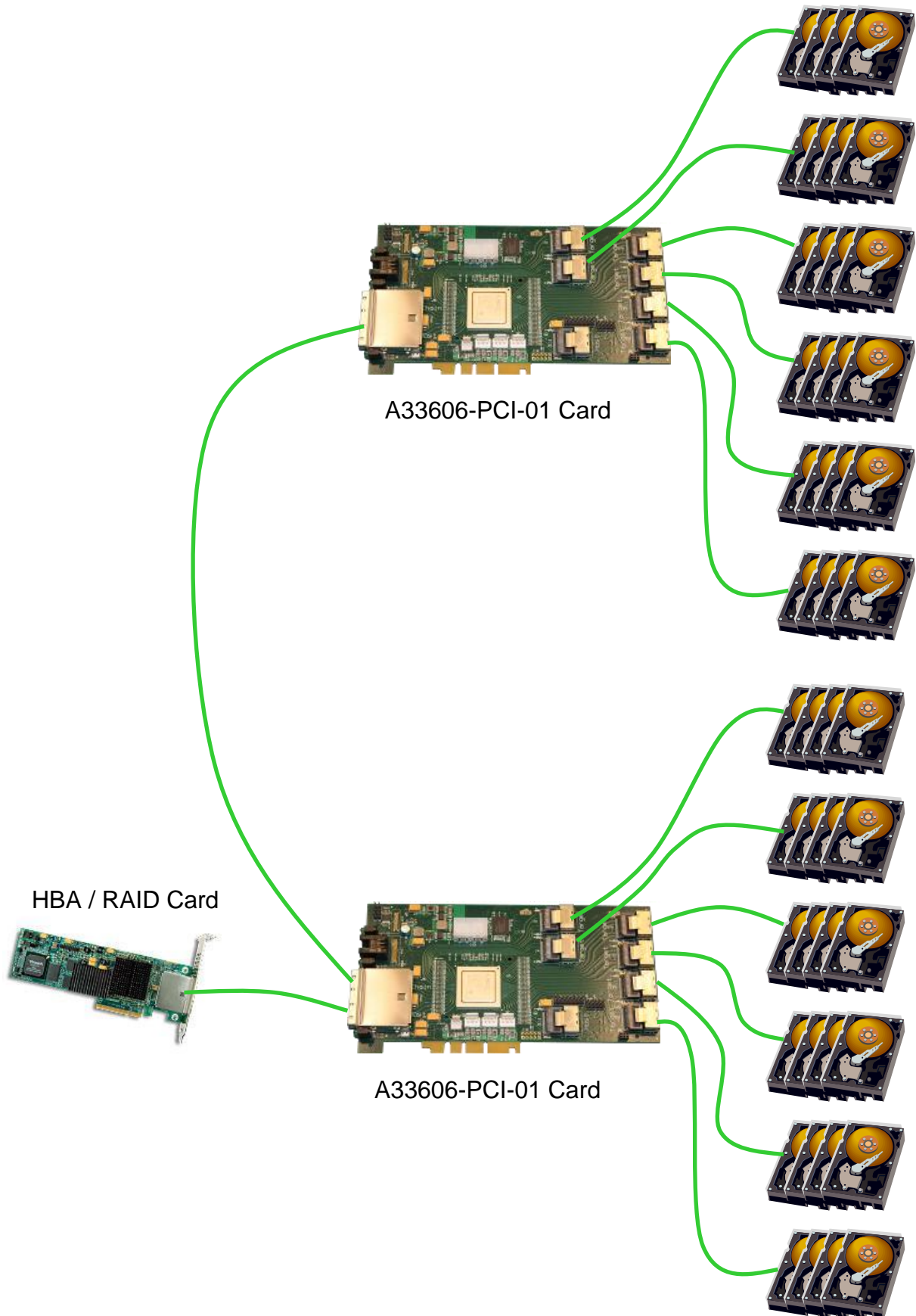
### HBA/RAID Expansion

Below illustrates how to connect 24 drives to an HBA/RAID card using the A33606-PCI-01 expander card.



### Cascaded Expanders

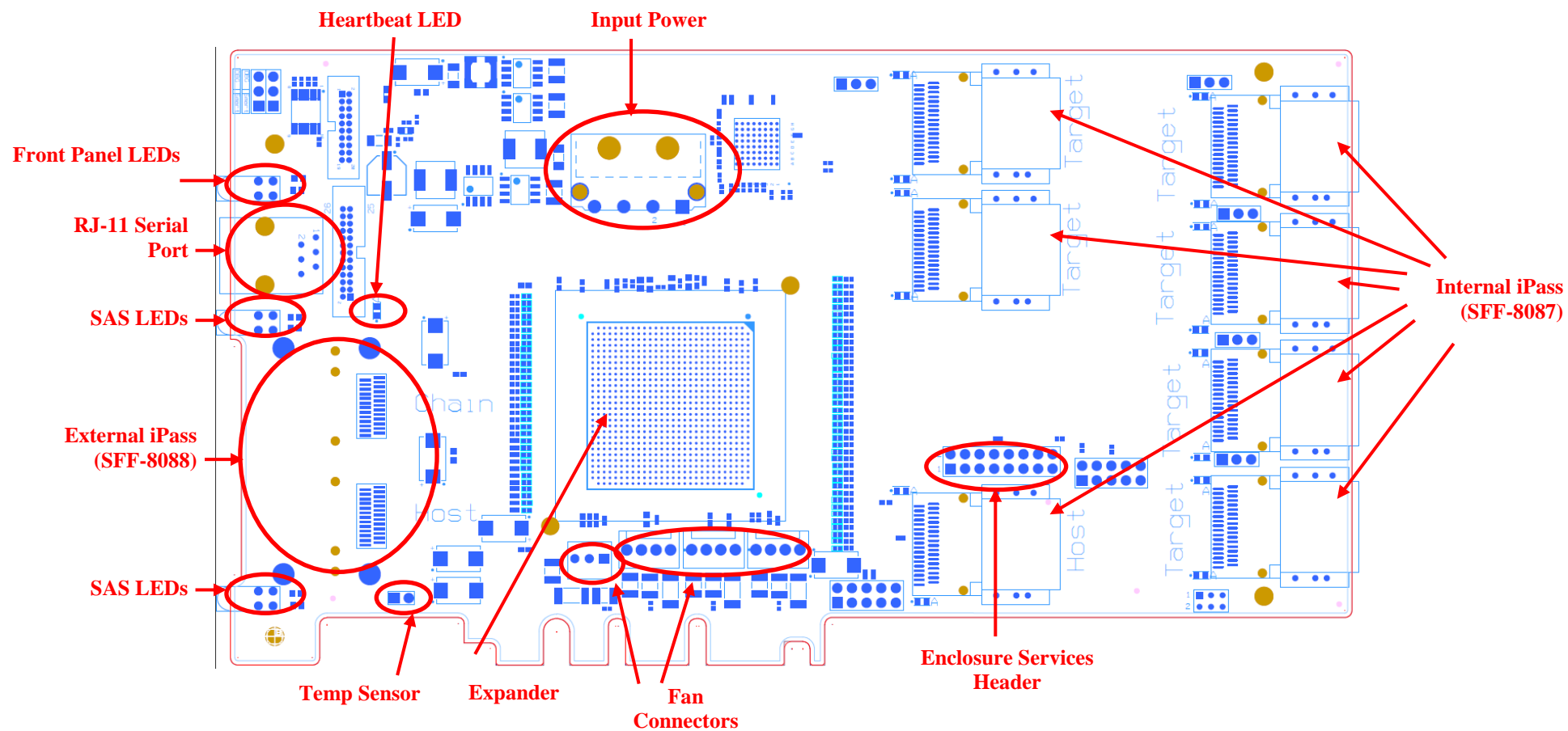
Below illustrates how to connect 48 drives to an HBA/RAID card using two A33606-PCI-01 expander cards. The Daisy-Chain port of the 1<sup>st</sup> expander is connected to the Host port on the 2<sup>nd</sup> expander. Additional drives can be added to the SAS topology by adding more expanders to the system in the same manner.



### 3 A33606-PCI-01 Characteristics

#### Board Outline

The A33606-PCI-01 board outline is shown below. Key interfaces are highlighted.





## Serial Port (RJ-11)

A Serial interface is available through a right angle RJ-11 connector (J42) accessible from the front panel. This interface can be utilized for re-programming and debug of the expander. The pinout of the RJ-11 is below.

Pin	Signal Name	Driver	DB9 Pin
1	NC		
2	NC		
3	Tx	A33606-AIC-01	2
4	Rx	PC	3
5	Ground		7
6	NC		

A compatible adapter for use with this interface is an Astek Corporation A40100-CBL-03. Other cables may be utilized as long as they conform to the above pinout.

## Heartbeat LED

When the system is powered on and the expander chip is functioning properly, the Heartbeat LED, D9, will blink continuously.

## External iPass (SFF-8088)

Two SFF-8088 ports are available on the front panel of the A33606-PCI-01 (J1 and J2). Each port supports up to 4 lanes of SAS-2 6Gb/s traffic.

The table below shows the pin assignments for SFF-8088.

Pin	Signal Name		Pin	Signal Name
A1	GND		B1	GND
A2	RX0_P		B2	TX0_P
A3	RX0_N		B3	TX0_N
A4	GND		B4	GND
A5	RX1_P		B5	TX1_P
A6	RX1_N		B6	TX1_N
A7	GND		B7	GND
A8	RX2_P		B8	TX2_P
A9	RX2_N		B9	TX2_N
A10	GND		B10	GND
A11	RX3_P		B11	TX3_P
A12	RX3_N		B12	TX3_N
A13	GND		B13	GND

J1 is utilized for daisy-chain connections.



J2 is utilized for host connections.

## SAS LEDs

A bi-level LED for each SFF-8088 port is located on the front panel. The LED definition is below.

LED	LED Color	Location
Activity	Green	Top
Error	Yellow	Bottom

LED operation is defined below.

LED	On	Off
Activity	Activity is occurring on one of the SAS lanes in the port.	There is no activity on any lane in the port.
Error	One of the SAS lanes in the port has failed.	All SAS lanes in the port are working.

## Front Panel LEDs

A bi-level LED for reporting general expander/enclosure status and is located on the front panel. The LED definition is below.

LED	LED Color	Location
Powered	Green	Top
Fault	Yellow	Bottom

LED operation is defined below.

LED	On	Off
Power	The board and expander are powered up.	The expander is not powered properly.
Fault	The SAS expander is reporting an enclosure fault.	The system is OK.

## Input Power

The A33606-PCI-01 requires 12V power through a standard 4-pin HDD connector.

The table below shows the pinout of the power connector.

Pin	Signal Name
1	+12VDC
2	Ground
3	Ground
4	+5VDC *

\* Not utilized by A33606-PCI-01.

## Internal iPass (SFF-8087)

Seven SFF-8088 ports are available on the A33606-PCI. Each port supports up to 4 lanes of SAS-2 6Gb/s traffic. The ports are numbered: J3, J4, J5, J6, J7, J8, and J9.

The table below shows the pin assignments for each SFF-8087.

Pin	Signal Name	Pin	Signal Name
A1	GND	B1	GND
A2	RX0_P	B2	TX0_P
A3	RX0_N	B3	TX0_N
A4	GND	B4	GND
A5	RX1_P	B5	TX1_P
A6	RX1_N	B6	TX1_N
A7	GND	B7	GND
A8	SIDEBAND 7	B8	SIDEBAND 0
A9	SIDEBAND 3	B9	SIDEBAND 1
A10	SIDEBAND 4	B10	SIDEBAND 2
A11	SIDEBAND 5	B11	SIDEBAND 6
A12	GND	B12	GND
A13	RX2_P	B13	TX2_P
A14	RX2_N	B14	TX2_N
A15	GND	B15	GND
A16	RX3_P	B16	TX3_P
A17	RX3_N	B17	TX3_N
A18	GND	B18	GND

Each SFF-8087 includes Serial GPIO control for 4 drives. SGPIO is utilized to drive LEDs on a backplane board. The A33606-PCI-01 conforms to the requirements in the SFF-8485 Specification for Serial GPIO (SGPIO) Bus.

Connector utilization is shown below

Connector	Utilization
J3	Drives 1-4
J4	Drives 5-8
J5	Host connector
J6	Drives 9-12
J7	Drives 13-16
J8	Drives 17-20
J9	Drives 21-24

## Enclosure Services Header

**The Enclosure Services Header provides connectivity for GPIO-type enclosure services on J34. Additional information on SCSI Enclosure Services is located in the Other Connectors**

Other connectors not listed above are reserved for Astek use or for future use.

SCSI Enclosure Services (SES) Section.

Pin	Signal Name	Pin	Signal Name
1	GND	2	GND
3	GPIO1	4	GPIO2
5	3.3V	6	3.3V
7	GND	8	GPIO3
9	GND	10	GPIO4
11	GND	12	HDD Fault LED <sup>2</sup>
13	GND	14	Power Fail LED <sup>2</sup>
15	GND	16	Power Fail <sup>1</sup>

<sup>1</sup> 5V tolerant input.

<sup>2</sup> A 220 $\Omega$  current limiting resistor is included on the A33606-PCI-01. Therefore, an external current limiting resistor is NOT required.

### Power Fail Input

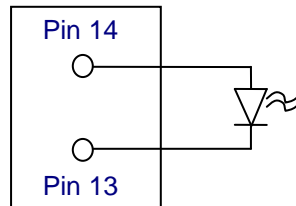
The Power Fail Input is a 5V tolerant input dedicated to indicate that a Power Failure has occurred. Many times, this indicates that one of the redundant supplies has reported a failure or has stopped functioning. When this signal is asserted high, the following events occur:

- The enclosure fault LED is asserted on the front panel of the A33606-PCI-01.
- The Power Fail LED signal is turned on.
- The FAIL bit in the power supply SES element is asserted.
- The status of the power supply SES element is changed to CRITICAL.
- The status of the enclosure SES element is changed to CRITICAL.

If the Power Fail Input returns to an unasserted state (low), the error conditions are removed and the A33606-PCI-01 stops reporting any errors (assuming no other error conditions exist).

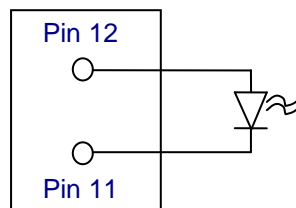
### Power Fail LED

When the Power Fail Input is asserted, the Power Fail LED output signal is asserted high, illuminating an LED. The LED, if utilized, should be connected as shown below. A 220 $\Omega$  current limiting resistor is included in the circuit.



### HDD Fault LED

If any of the hard drives connected to the A33606-PCI-01 enter a fault condition, the HDD Fault LED output signal is asserted high, illuminating an LED. The LED, if utilized, should be connected as shown below. A 220 $\Omega$  current limiting resistor is included in the circuit.



### GPIO1-GPIO4

GPIO1 – GPIO4 can be utilized for additional enclosure service I/O such as intrusion detection, additional LEDs, alarm, door lock, etc. Default firmware does not utilize these signals. Contact Astek with your requirements to obtain a customized configuration to utilize these pins.

## Temperature Sensor Header

An external temperature sensor can be connected to J39.

The table below shows the pinout of the temp sensor connector.

Pin	Signal Name
1	Temp +
2	Temp -

This header is designed work with remote diode sensors or diode-connected transistors such as substrate transistors on ICs. Astek provides a temperature probe cable, part number A40100-CBL-04, that is supported by the A33606-PCI-01. Alternately, temperature sensors on other boards in the system can be monitored if they contain a diode or transistor sensor.

The temperature sensors are monitored through SCSI Enclosure Services (SES). Additional information on SES is located in the SCSI Enclosure Services (SES) Section.

## Fan Headers

There are 4 connectors for fan attachment on the A33606-PCI. One of the connectors (J33) is reserved for the heatsink fan that cools the expander. The remaining 3 connectors (J14, J15, J20) support 3-pin fans with tachometer or 4-pin fans with tachometer and PWM control.

The fan speed is monitored by the expander and reported through SES. The fan speed is adjusted by the expander through SES control commands. The expander does not automatically adjust the fan speed. Connectors J14 and J15 also have fan detect circuitry to determine if a fan is attached to the connectors. This information is reported through SCSI Enclosure Services. J20 and J33 do not have this capability.

The table below shows the pinout of the fan connectors.

### J33: Heatsink Fan Connector

Pin	Signal Name
1	Ground
2	+12VDC
3	Tachometer

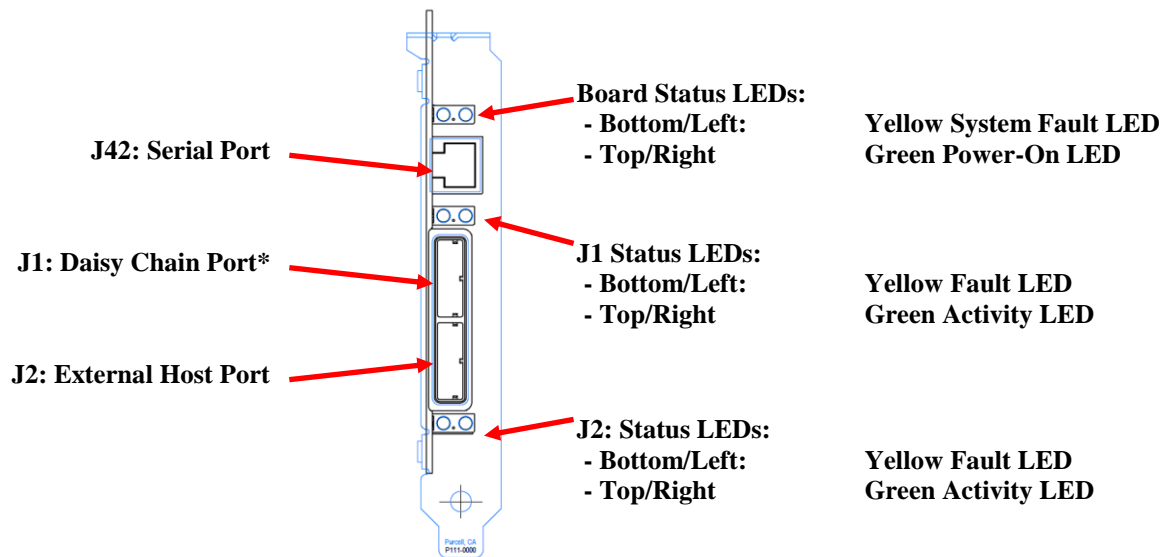
### J14, J15, J20: External Fan Connector

Pin	Signal Name
1	Ground
2	+12VDC
3	Tachometer
4	PWM / Speed Control

The fans can be monitored and controlled through SCSI Enclosure Services (SES). Additional information on SES is located in the SCSI Enclosure Services (SES) Section.

## Front Panel

The front panel of the A33606-PCI-01 contains two SAS ports, LEDs, and a serial port.



## Other Connectors

Other connectors not listed above are reserved for Astek use or for future use.

## 4 SCSI Enclosure Services (SES)

The A33606-PCI-01 comes pre-configured with the following enclosure services.

- Temperature sensors that monitor chip temperature and board temperature.
- Voltage monitors for on-board voltages.
- Fan monitoring and control.
- Slot mapping for 24 drives as numbered above.
- Enclosure naming.

Access to SCSI enclosure services is provided by the HBA or RAID card. Most RAID card manufacturers provide software that monitors the SCSI enclosure services and can be configured to generate messages (via a popup or email) if one of the elements exceeds a limit.

A SCSI enclosure element is a portion of an enclosure that is controlled, interrogated, or described through SCSI enclosure services. The A33606-PCI-01 conforms to the T10 SCSI Enclosure Services (SES-2) specification.

### Temperature Elements

SES will monitor and report on 3 temperature sensors.

- Expander Temperature
- PCB Temperature
- External temperature

Thresholds for high and low temperature limits can be set through SES. If a temperature threshold limit is exceeded, the expander will report a failure through SES and illuminate the ERROR LED on the front panel. The default thresholds are listed below.

Temperature	Low Critical	Low Warning	High Warning	High Critical
Expander	No limit set	No limit set	85°C	95°C
PCB	No limit set	No limit set	50°C	60°C
External	No limit set	No limit set	No limit set	No limit set

### Voltage Sensor Elements

The expander monitors four on-board voltages:

- 12V power input
- 3.3V expander voltage
- 1.8V expander voltage
- 1.0V expander voltage

Thresholds for high and low voltage limits can be set through SES. If a voltage threshold limit is exceeded, the expander will report a failure through SES and illuminate the ERROR LED on the front panel. The default thresholds are listed below.



Voltage	Low Critical	Low Warning	High Warning	High Critical
12V	10.8V (-10%)	11.4V (-5%)	12.6V (+5%)	13.2V (+10%)
3.3V	2.97V (-10%)	3.14V (-5%)	3.47V (+5%)	3.63V (+10%)
1.8V	1.62V (-10%)	1.71V (-5%)	1.89V (+5%)	1.98V (+10%)
1.0V	0.9V (-10%)	0.95V (-5%)	1.05V (+5%)	1.1V (+10%)

## Cooling Elements

SES will monitor fan speed on one connector and will monitor and control fan speed on three connectors.

There is a fan on the heatsink that cools the expander. The fan speed is monitored and reported through SES. If the fan stops, the expander will report a failure through SES and illuminate the ERROR LED on the front panel.

There are three fans that can be monitored and controlled through SES. The intent is for these three connectors to be used for external fan control/monitoring. If one of these fans stops running, the expander will NOT report a failure NOR illuminate the ERROR LED on the front panel.

## Power Supply Element

The expander will monitor the status of the Power Supply connected to pin 8 of the Enclosure Services Header. When/if this pin is driven low, the expander will report a failure through SES and illuminate the ERROR LED on the front panel.

## SAS Expander Element

The expander element contains information about the A33606-PCI-01 product such as product name, revision, firmware version, etc.

## Customization

Many of the SES settings and data can be customized to the application needs. Contact Astek to obtain a customized expander configuration to make your product stand out from the crowd.

## 5 Specifications

### Electrical Specifications

#### Power

- Operating Voltage: 12.0 V +/- 10% \*
- Typical Power Consumption: 12 W
- Maximum Power Consumption: 15 W
- Power Connector: 4-pin PC-AT

#### SAS/SATA

- SAS/SATA speeds: 1.5Gb/s 3.0Gb/s 6.0Gb/s
- Number of SAS/SATA ports: 36
- SFF-8087 Connectors: 7 w/ universal keying and SGPIO support
- SFF-8088 Connectors: 2

\* 5V and 18V configurations are available with certain limitations. Contact Astek for specific details.

### Environmental Specifications

#### Operating Conditions

- Temperature: 0 °C to +55 °C
- Humidity: 5 to 90% non-condensing

#### Storage Conditions

- Temperature: -45 °C to +55 °C
- Humidity: 5 to 90% non-condensing

#### Airflow

The A33606-PCI-01 contains a heatsink and fan for cooling the expander chip. No additional cooling is required.

#### CAUTION

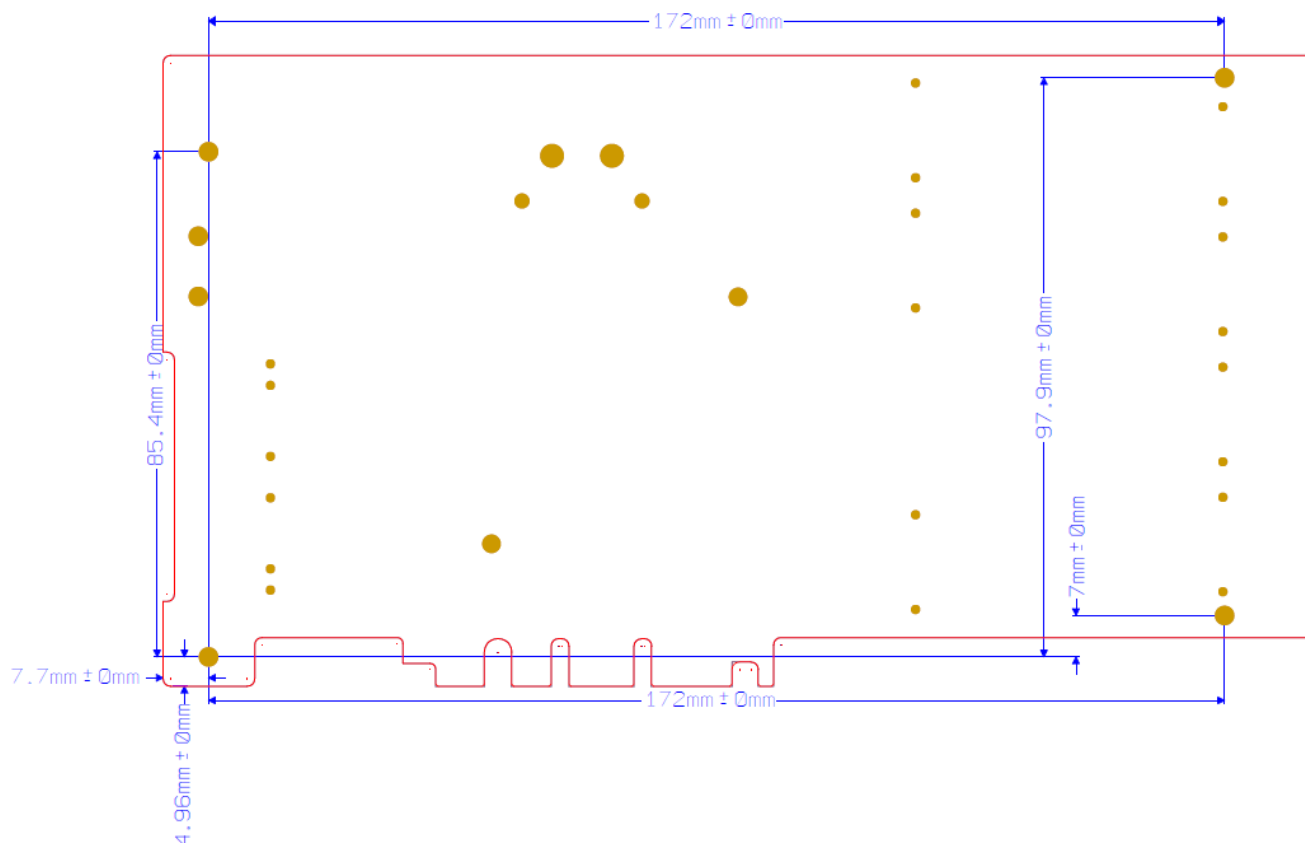
Do not operate the A33606-PCI-01 card if the fan stops operating.

### Mechanical Specifications

#### A33606-PCI-01

The expander contains no mounting brackets or shell. This expander can be mounted in a chassis or case using 4 mounting holes on the PCB. The dimensions of the board and location of mounting holes is located below. The mounting holes accept M3 or 4-40 hardware.

- Height: 106.7 mm (4.201 inches)
- Length: 195.0 mm (7.677 inches)



### A33606-PCI-01P

The expander comes with a PCI bracket for mounting in a PCI slot. The A33606-PCI-01P can be mounted in any of the following PCI slots.

- PCIe slot: x1, x4, x8, x16
- PCI-X slot: 32-bit or 64-bit
- PCI slot: 32-bit or 64-bit

The A33606-PCI-01 does not utilize signals or power from the PCI, PCI-X, or PCIe bus. The PCI socket provides a mechanical location to store the A33606-PCI-01 in a chassis. The card should be installed in a system by following the system manufacturer's recommended procedures.

### A33606-PCI-01D

The expander comes mounted in a 5.25" mounting shell for mounting in a Mounting holes accept hardware for a standard 5.25" bay in a computer chassis.

- Height: 41.53 mm (1.635 inches)
- Width: 146.05mm (5.75 inches)
- Length: 186.45 mm (7.34 inches)

## 6 Troubleshooting

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### Diagnostics

The following diagnostic tests may be helpful in the event that the A33606-PCI-01 expander is not operating as expected.

- Verify the green front-panel LED is illuminated to indicate that power is being supplied to the board.
- Verify the expander is not in a fault state. A fault is indicated by illuminating the yellow LED on the front panel of the board.
- Verify the expander is running by a blinking heartbeat LED, D9. The LED is located above the Daisy-Chain port, J1.
- Verify the fan on the expander heatsink is running.
- When connections are made to a port, the green LED associated with the port should flicker and blink to indicate that communications are occurring.

### Support

For additional support, contact your Product Manager or email [support@astekcorp.com](mailto:support@astekcorp.com).

Astek can be contacted at (719) 260-1625 or toll-free at (800) 850-9055.