



# **Intel® I/O Expansion Modules for Intel® Platforms based on Intel® Xeon® Processor E5- 4600/2600/2400 Product Families**

## ***Hardware Specification***

*Intel order number: G30021-004*

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**November 2012**

**Enterprise Platforms and Services Division**

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## **Revision History**

Date	Revision Number	Modifications
March, 2011	0.5	Initial Release.
August, 2011	0.9	Added the following sections: <ul style="list-style-type: none"> <li>▪ Section 2.4 – Intel® I350 Gb Ethernet Controller</li> <li>▪ Section 3.4 – Intel® X540 10Gb Ethernet Controller</li> <li>▪ Section 4.4 – Intel® 82599 10Gb Ethernet Controller</li> <li>▪ Section 5.4 - ConnectX*-3 Single/Dual-Port Adapter Silicon with VPI</li> <li>▪ Section 6 – FDR InfiniBand* ConnectX*-3 I/O Module (AXX1FDRIOIM)</li> </ul>
August, 2011	0.91	Added figures for port identification.
January, 2012	1.0	Deleted Section 5 - QDR InfiniBand* ConnectX*-3 I/O Module, and added new section for Dual Port FDR InfiniBand* ConnectX*-3 I/O Module.
November, 2012	1.1	<ul style="list-style-type: none"> <li>▪ Added AXX10GBTWLHW.</li> <li>▪ Updated Table 1.</li> </ul>

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# 1. Introduction

The Intel® Server Boards support a variety of Intel® I/O Expansion Module options using x4 or x8 PCI Express\* Mezzanine connectors on the server board. Each mezzanine connector is a 2 x 40-pin, surface mount, and 0.8 mm pitch header.

Intel® I/O Expansion Modules for Intel® Platforms based on Intel® Xeon® processor E5-4600/2600/2400 product families includes:

- Quad Port Intel® I350 GbE I/O Module
- Dual Port Intel® X540 10GbE I/O Module
- Dual Port Intel® 82599 10GbE I/O Module
- Single Port FDR InfiniBand\* ConnectX\*-3 I/O Module
- Dual Ports FDR InfiniBand\* ConnectX\*-3 I/O Module

Intel® I/O Expansion Modules for Intel® Platforms based on Intel® Xeon® processor E5-4600/2600/2400 product families are designed to fit Intel® Server Boards based on Intel® Xeon® processor E5-4600/2600/2400 product families. The table below shows the support matrix for the Intel® I/O Expansion Modules.

Table 1. I/O Module Support Matrix

Intel® I/O Expansion Modules	S1400SP	S1600JP	S2400BB	S2600GZ/GL	S2600JP	S2600JF	S2600WP	S4600LH2/LT2
Quad Port Intel® I350 GbE I/O Module - AXX4P1GBPWL IOM	✓	✓	✓	✓	✓	✓	✓	✓
Dual Port Intel® X540 10GbE I/O Module - AXX10GBTWL IOM	✓	×	✓	✓	✓	×	×	✓
Dual Port Intel® X540 10GbE I/O Module - AXX10GBTWLHW	×	✓	×	×	×	✓	✓	×
Dual Port Intel® 82599 10GbE I/O Module - AXX10GBNIA IOM	✓	✓	✓	✓	✓	✓	✓	✓
Single Port FDR InfiniBand* ConnectX*-3 I/O Module - AXX1FDRIB IOM	✓	✓	✓	✓	✓	✓	✓	✓
Dual Port FDR InfiniBand* ConnectX*-3 I/O Module - AXX2FDRIB IOM	✓	✓	✓	✓	✓	✓	✓	✓

**Note:**

1. Intel® I/O Expansion Modules for Intel® Platforms based on Intel® Xeon® processor E5-4600/2600/2400 product families are not supported on previous generation Intel® Server Boards.
2. For the latest support information on each Intel® Server Platform, please go to [http://serverconfigurator.intel.com/sct\\_app.aspx](http://serverconfigurator.intel.com/sct_app.aspx).



The following table details the pin-out of the I/O module connector:

Table 2. 80-pin I/O Module Connector Pin-Out

Pin	Signal	Signal	Pin
1	3.3V	12V	2
3	3.3V	12V	4
5	3.3V	12V	6
7	3.3V	12V	8
9	RSVD	FRU/TEMP ADDR [A0]	10
11	GND	5VSB	12
13	RSVD+	FM_IO_MODULE_EN	14
15	RSVD-	3.3VSTBY	16
17	GND	LED_GLOBAL_ACT#	18
19	RSVD	FM_IOM_PRESENT_N	20
21	RSVD	WAKE#	22
23	GND	PERST#	24
25	SMB_CLK	GND	26
27	SMB_DAT	rIOM_REFCLK+ [0]	28
29	GND	rIOM_REFCLK- [0]	30
31	PCIe Gen3 Tn [7]	GND	32
33	PCIe Gen3 Tp [7]	PCIe Gen3 Rn [7]	34
35	GND	PCIe Gen3 Rp [7]	36
37	PCIe Gen3 Tn [6]	GND	38
39	PCIe Gen3 Tp [6]	PCIe Gen3 Rn [6]	40
41	GND	PCIe Gen3 Rp [6]	42
43	PCIe Gen3 Tn [5]	GND	44
45	PCIe Gen3 Tp [5]	PCIe Gen3 Rn [5]	46
47	GND	PCIe Gen3 Rp [5]	48
49	PCIe Gen3 Tn [4]	GND	50
51	PCIe Gen3 Tp [4]	PCIe Gen3 Rn [4]	52
53	GND	PCIe Gen3 Rp [4]	54
55	PCIe Gen3 Tn [3]	GND	56
57	PCIe Gen3 Tp [3]	PCIe Gen3 Rn [3]	58
59	GND	PCIe Gen3 Rp [3]	60
61	PCIe Gen3 Tn [2]	GND	62
63	PCIe Gen3 Tp [2]	PCIe Gen3 Rn [2]	64
65	GND	PCIe Gen3 Rp [2]	66
67	PCIe Gen3 Tn [1]	GND	68
69	PCIe Gen3 Tp [1]	PCIe Gen3 Rn [1]	70
71	GND	PCIe Gen3 Rp [1]	72
73	PCIe Gen3 Tn [0]	GND	74
75	PCIe Gen3 Tp [0]	PCIe Gen3 Rn [0]	76
77	GND	PCIe Gen3 Rp [0]	78
79	RSVD	GND	80

**Note:** There are several pins reserved for future use.

## 2. Quad Port Intel® I350 GbE I/O Module (AXX4P1GBPWL10M)

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The Quad Port Intel® I350 GbE I/O Module provides four additional 10/100/1000Mbit external connections. This section provides a high-level description of the implementation of this I/O module.

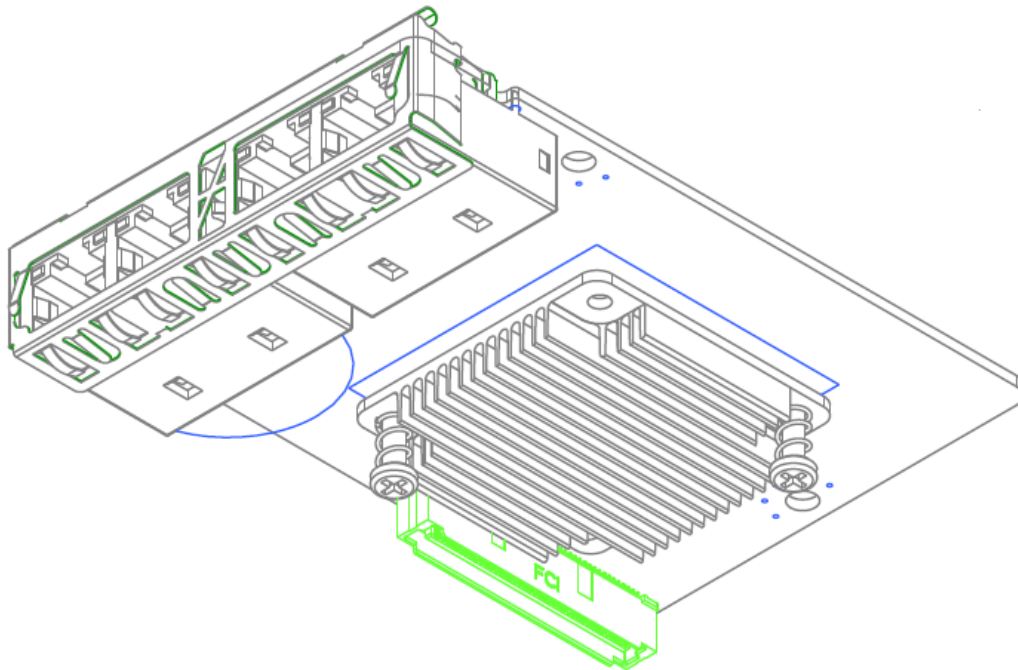


Figure 1. Quad Port Intel® I350 GbE I/O Module

### 2.1 Feature Set

The Quad Port Intel® I350 GbE I/O Module supports the following feature set:

- Intel® I350 Controller 17x17mm chip
- Quad 1Gb RJ45 Ethernet external connections
- Speed and Link/Act LEDs for each RJ45 connection
- Onboard 1.0V VR off of 12V and 5V\_SB Rails
- One WOL port operating in 1 GB mode is supported (Port 2)
- 1.8V\_SB linear VR off 3.3V\_SB
- 256kb LAN EEPROM and 1Mb SPI Flash (SPI Flash unstuffed as baseboard BIOS will provide OpROM for PXE and iSCSI support)
- Three loose screws to mount IOM directly to sheet metal chassis. It's recommended to use same screws as used to install the baseboard
- 256Byte FRU EEPROM and TMP75 temp sensor

## 2.2 Functional Block Diagram

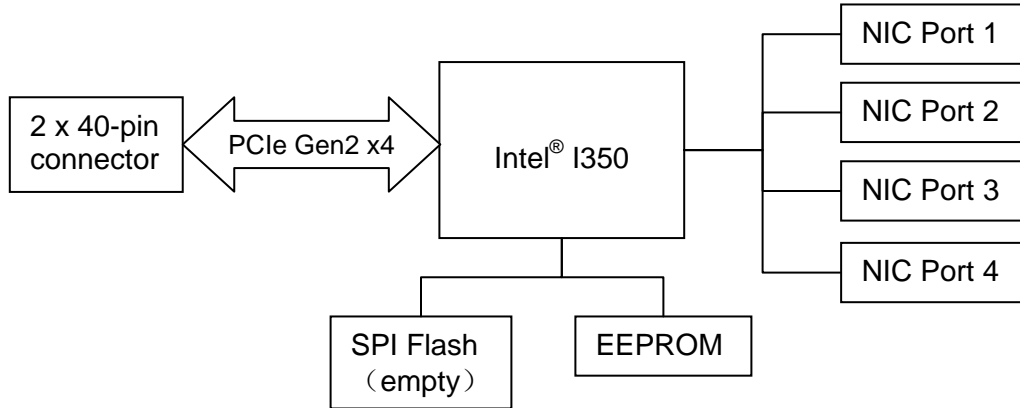


Figure 2. Quad Port Intel® I350 GbE I/O Module Block Diagram

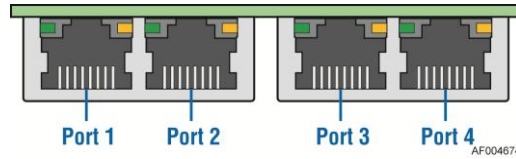


Figure 3. Quad Port Intel® I350 GbE I/O Port Identification

### 2.3 Mechanical Dimensions

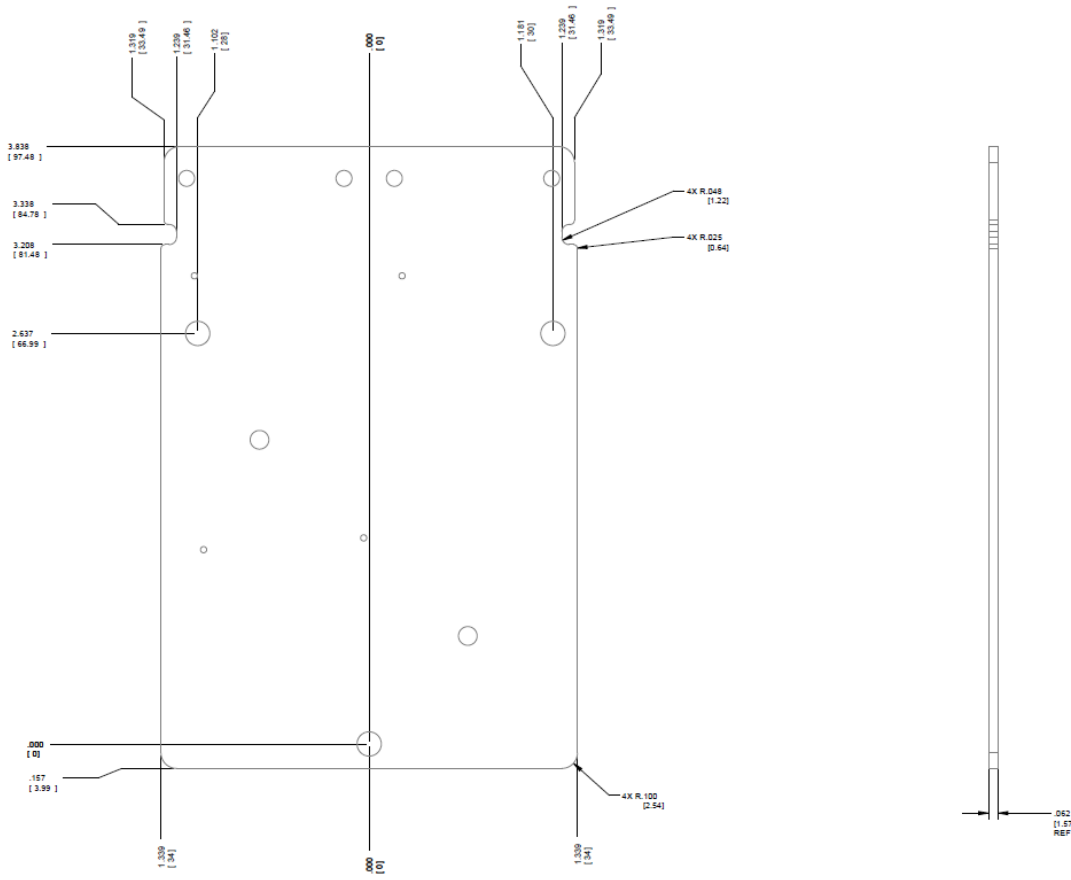


Figure 4. Quad Port Intel® I350 GbE I/O Module Dimensions; Top and Side Views

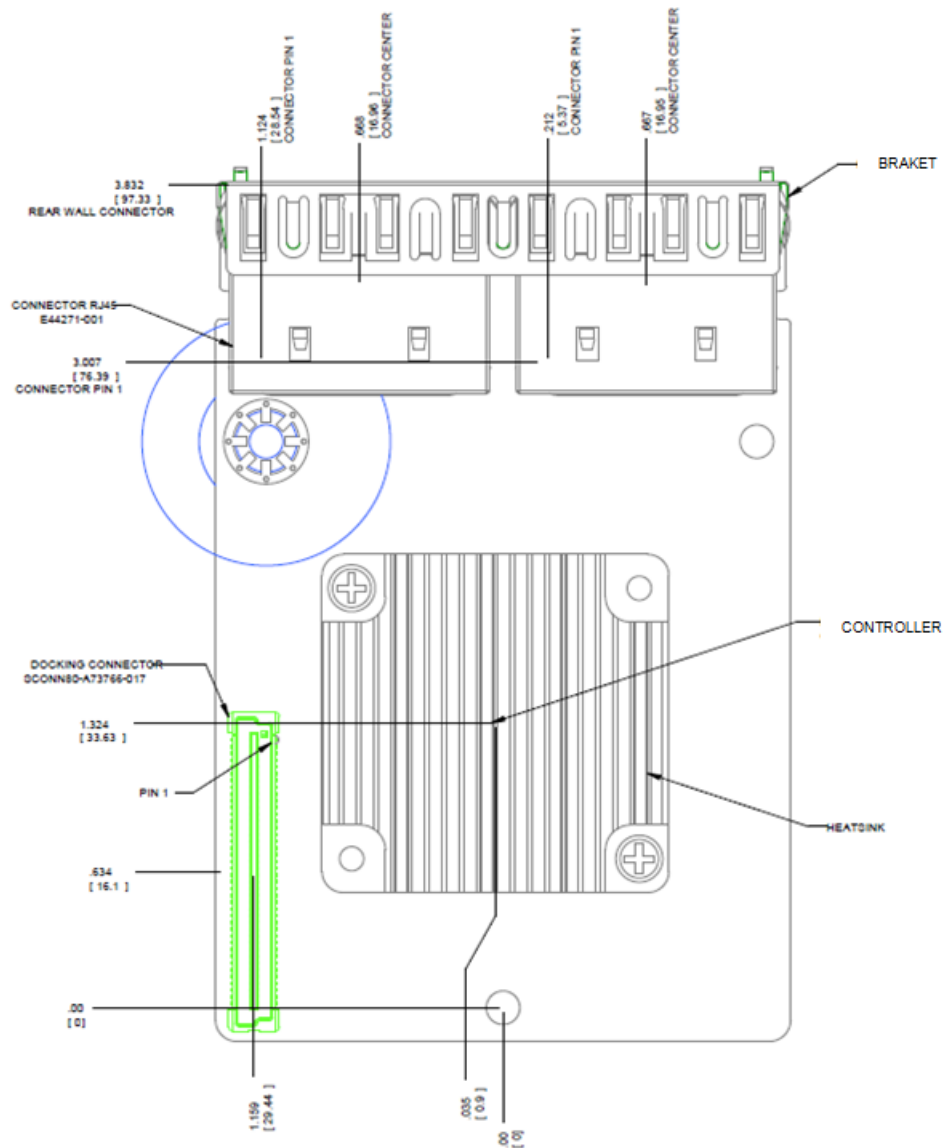


Figure 5. Quad Port Intel® I350 GbE I/O Module Dimensions; Bottom View

## 2.4 Intel® I350 Gb Ethernet Controller

The Intel® Ethernet Controller I350 is a single, compact, low power component that supports quad port and dual port gigabit Ethernet designs. The device offers four fully-integrated gigabit Ethernet media access control (MAC), physical layer (PHY) ports and four SGMII/SerDes ports that can be connected to an external PHY. The I350 supports PCI Express\* (PCIe v2.1 (2.5GT/s and 5GT/s)).

The device enables two-port or four-port 1000BASE-T implementations using integrated PHYs. It can be used for server system configurations such as rack mounted or pedestal servers, in an add-on NIC or LAN on Motherboard (LOM) design. Another possible system configuration is for blade servers. Here, the I350 can support up to four SerDes ports as LOM or mezzanine card. It can also be used in embedded applications such as switch add-on cards and network appliances.

1. External Interfaces provided
  - PCIe v2.1 (2.5GT/s and 5GT/s) x4/x2/x1
  - MDI (Copper) standard IEEE 802.3 Ethernet interface for 1000BASE-T, 100BASE-TX, and 10BASE-T applications (802.3, 802.3u, and 802.3ab)
  - Serializer-Deserializer (SERDES) to support 1000BASE-SX/LX (optical fiber - IEEE802.3)
  - Serializer-Deserializer (SERDES) to support 1000BASE-KX(802.3ap) and 1000BASE-BX (PICMIG 3.1) for Gigabit backplane applications
  - SGMII (Serial-GMII Specification) interface for SFP (SFP MSA INF-8074i)/external PHY connections
  - NC-SI (DMTF NC-SI) or SMBus for Manageability connection to BMC
  - IEEE 1149.6 JTAG
2. Performance Enhancements
  - PCIe v2.1 TLP Process Hints (TPH)
  - UDP, TCP and IP Checksum offload
  - UDP and TCP Transmit Segmentation Offload (TSO)
  - SCTP receive and transmit checksum offload
3. Virtualization ready
  - Next Generation VMDq support (8 VMs)
  - Support of up to 8 VMs per port (1 queue allocated to each VM)
  - PCI-SIG I/O SR-IOV support (Direct assignment)
  - Queues per port: 8 TX and 8 RX queues
4. Power saving features
  - Advanced Configuration and Power Interface (ACPI) power management states and wake-up capability
  - Advanced Power Management (APM) wake-up functionality
  - Low power link-disconnect state
  - PCIe v2.1 LTR
  - DMA Coalescing for improved system power management
  - EEE (IEEE802.3az) for reduced power consumption during low link utilization periods
5. IEEE802.1AS - Timing and Synchronization
  - IEEE 1588 Precision Time Protocol support
  - Per-packet timestamp
6. Total Cost of Ownership (TCO)
  - IPMI BMC pass-thru; multi-drop NC-SI
  - Internal BMC to OS and OS to BMC traffic support
7. Additional product details
  - 17x17 (256 Balls) or 25x25 (576 Balls) PBGA package
  - Estimated power: 2.8W (max) in dual port mode and 4.2W (max) in quad port mode
  - Memories have Parity or ECC protection

See *Intel® Ethernet Controller I350 Datasheet* for more details.

### 3. Dual Port Intel® X540 10GbE I/O Module (AXX10GBTWLIOM and AXX10GBTWLHW)

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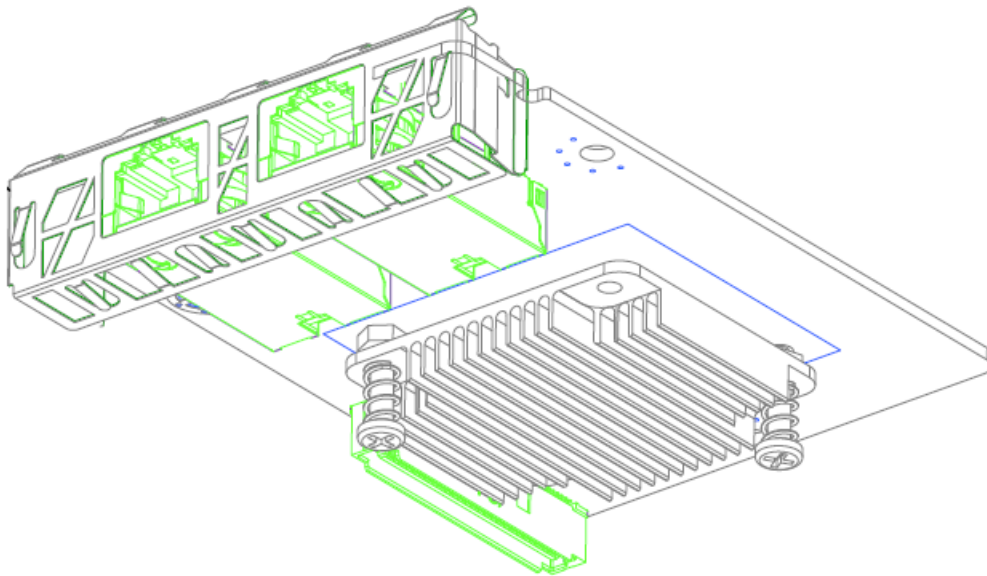


Figure 6. Dual Port Intel® X540 10GbE I/O Module

#### 3.1 Feature Set

Following is the feature set:

- Intel® X540 Controller 25x25mm chip
- Two 10Gb RJ45 Ethernet external connections
- Support PXE and iSCSI
- WOL support of one 1GbE port
- Speed and Link/Act LEDs for each 10Gb RJ45 connection
- 16M bit SPI Flash
- 256Byte FRU EEPROM and TMP75 temp sensor
- Stainless steel EMI shield
- AXX10GBTWLHW is the same with AXX10GBTWLIOM except for the heat sink to fit Intel® Server Board S2600JF, S2600WP, and Intel® Server Chassis H2000 Family.

### 3.2 Functional Block Diagram

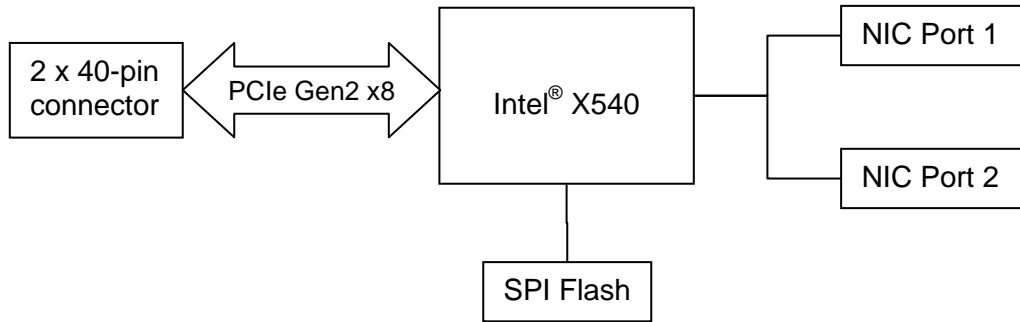


Figure 7. Dual Port Intel® X540 10GbE I/O Module Block Diagram

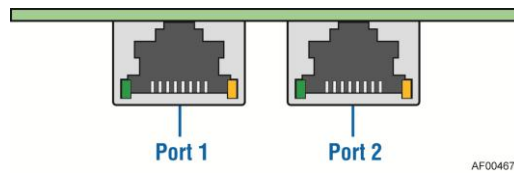


Figure 8. Dual Port Intel® X540 10GbE I/O Module Port Identification





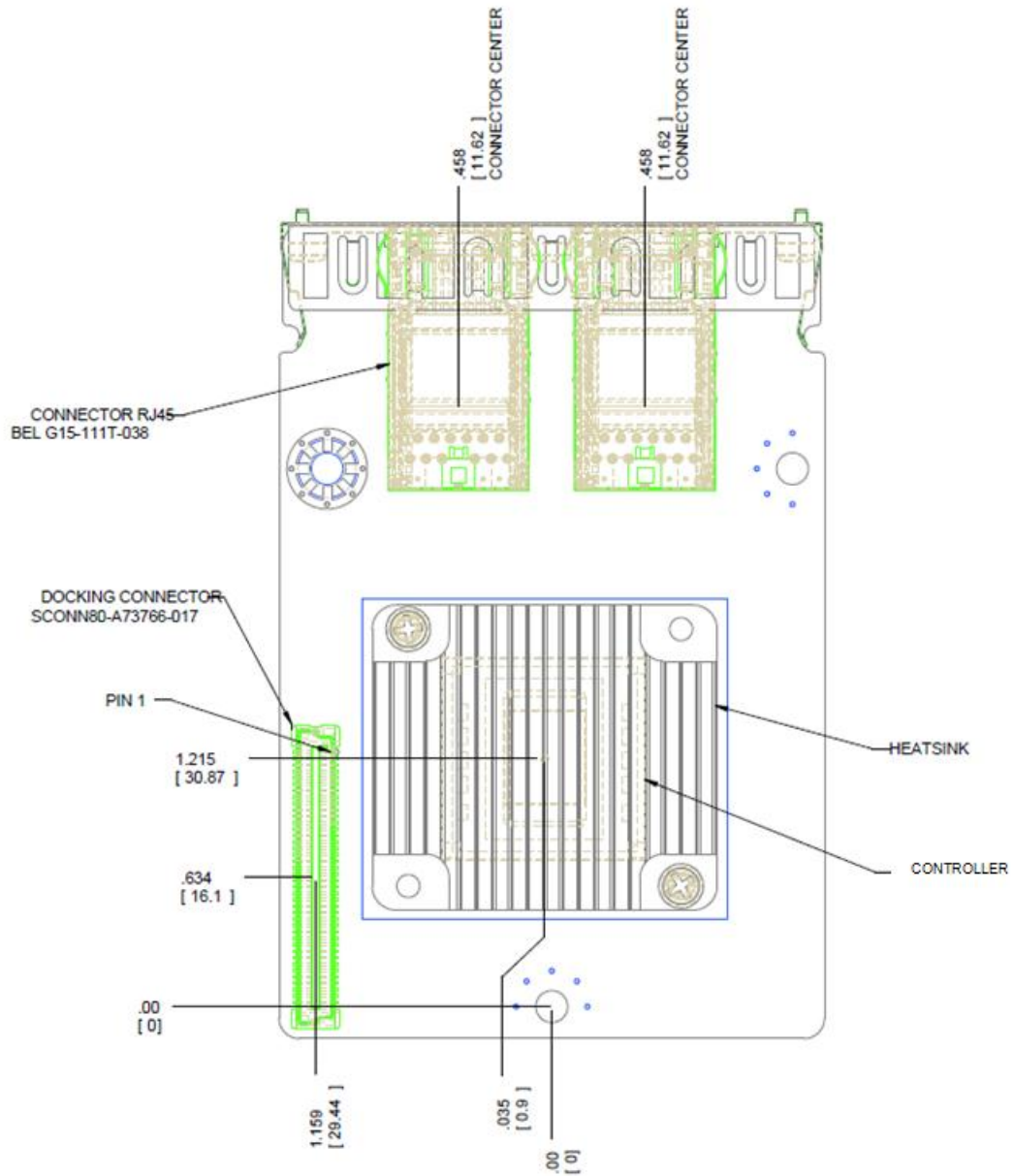


Figure 10. Dual Port Intel® X540 10GbE I/O Module Dimensions; Bottom View

## 3.4 Intel® X540 10Gb Ethernet Controller

### 1. General

- Serial flash interface
- Device disable capability
- Package size - 25 mm x 25 mm

### 2. Networking

- 10 GbE/1 GbE/100 Mb/s copper PHYs integrated on-chip
- Support for jumbo frames of up to 15.5 KB
- Flow control support: send/receive pause frames and receive FIFO thresholds
- Statistics for management and RMON
- 802.1q VLAN support
- TCP segmentation offload: up to 256 KB
- IPv6 support for IP/TCP and IP/UDP receive checksum offload
- Fragmented UDP checksum offload for packet reassembly
- Message Signaled Interrupts (MSI)
- Message Signaled Interrupts (MSI-X)
- Interrupt throttling control to limit maximum interrupt rate and improve CPU usage
- Receive packet split header
- Multiple Receive Queues (RSS) 8x8 and 16x4
- 32 transmit queues
- Receive header replication
- Dynamic interrupt moderation
- DCA support
- TCP timer interrupts
- No snoop
- Relaxed ordering
- Support for 16 Virtual Machines Device Queues (VMDq) per port

### 3. Host Interface

- PCIe base specification 2.1 (2.5GT/s or 5GT/s)
- Bus width — x1, x2, x4, x8
- 64-bit address support for systems using more than 4 GB of physical memory

### 4. MAC Functions

- Descriptor ring management hardware for transmit and receive
- ACPI register set and power down functionality supporting D0 and D3 states
- A mechanism for delaying/reducing transmit interrupts
- Software-controlled global reset bit (resets everything except the configuration registers)
- Four Software-Definable Pins (SDP) per port
- Wake up
- IPv6 wake-up filters
- Configurable flexible filter (through NVM)
- LAN function disable capability
- Programmable memory transmit buffers (160 KB/port)
- Default configuration by NVM for all LEDs for pre-driver functionality

### 5. Manageability

- Eight VLAN L2 filters
- 16 Flex L3 port filters

- Four Flexible TCO filters
- Four L3 address filters (IPv4)
- Advanced pass through-compatible management packet transmit/receive support
- SMBus interface to an external Manageability Controller (MC)
- NC-SI interface to an external MC
- Four L3 address filters (IPv6)
- Four L2 address filters

See *Intel® Ethernet Controller 10G X540 Datasheet* for more details.

## 4. Dual Port Intel® 82599 10GbE I/O Module (AXX10GBNIAIOM)

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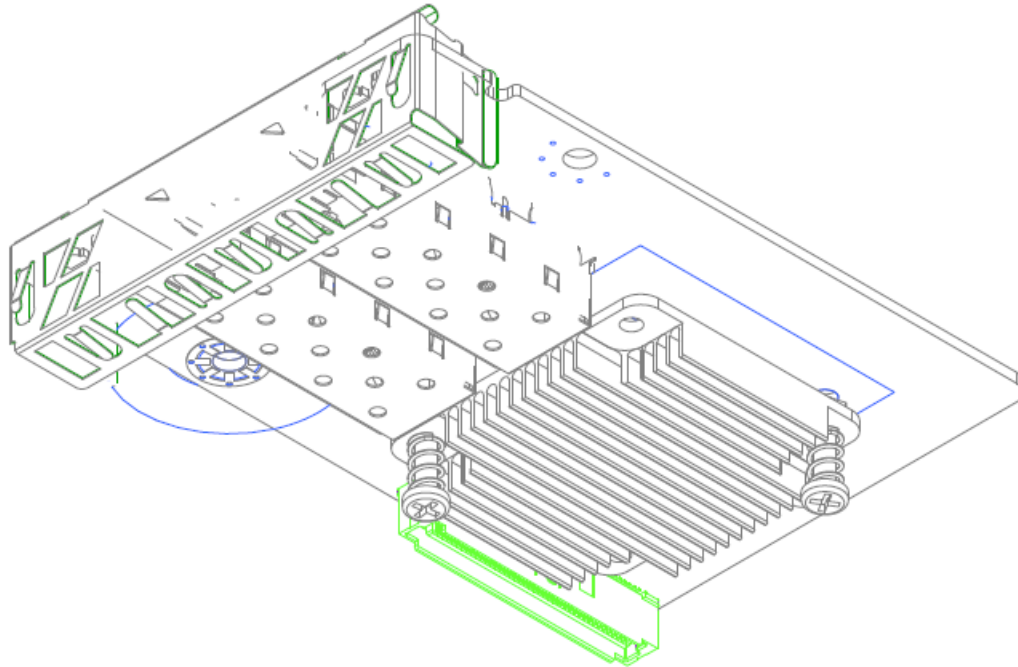


Figure 11. Dual Port Intel® 82599 10GbE I/O Module

### 4.1 Feature Set

Following is the feature set:

- Intel® 82599 10GbE Controller 25x25mm chip
- Two 10Gb SFP+ Ethernet external connections
- Speed and Link/Act LEDs for each 10Gb SFP+ connection
- Support PXE, iSCSI, and FCoE functionalities
- 256k bit LAN EEPROM and 4Mbit SPI Flash
- 256 Byte FRU EEPROM and TMP75 temp sensor
- The following SFP+ modules are supported:
  - Intel® Ethernet SFP+ SR Optics E10GSFPSR
  - Intel® Ethernet SFP+ LR Optics E10GSFPLR

## 4.2 Functional Block Diagram

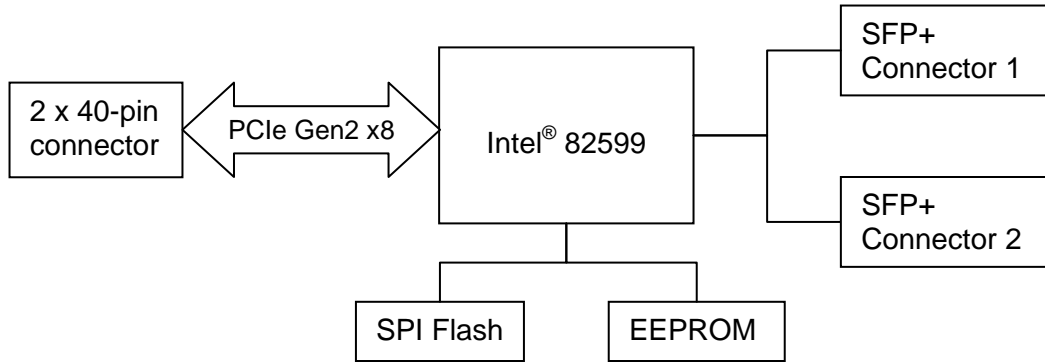


Figure 12. Dual Port Intel® 82599 10GbE I/O Module Block Diagram

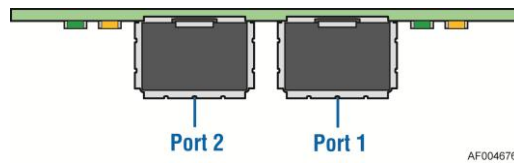


Figure 13. Dual Port Intel® 82599 10GbE I/O Module Port Identification

### 4.3 Mechanical Dimensions

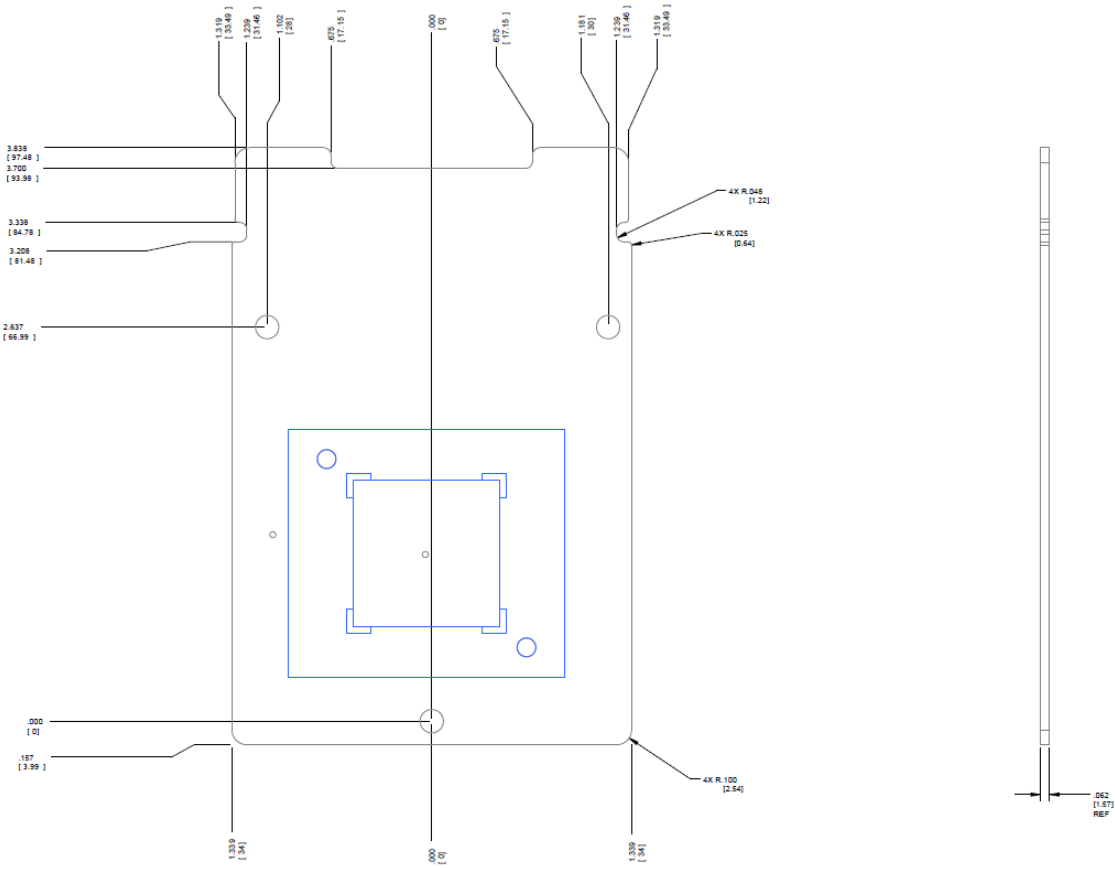


Figure 14. Dual Port Intel® 82599 10GbE I/O Module Dimensions; Top and side View

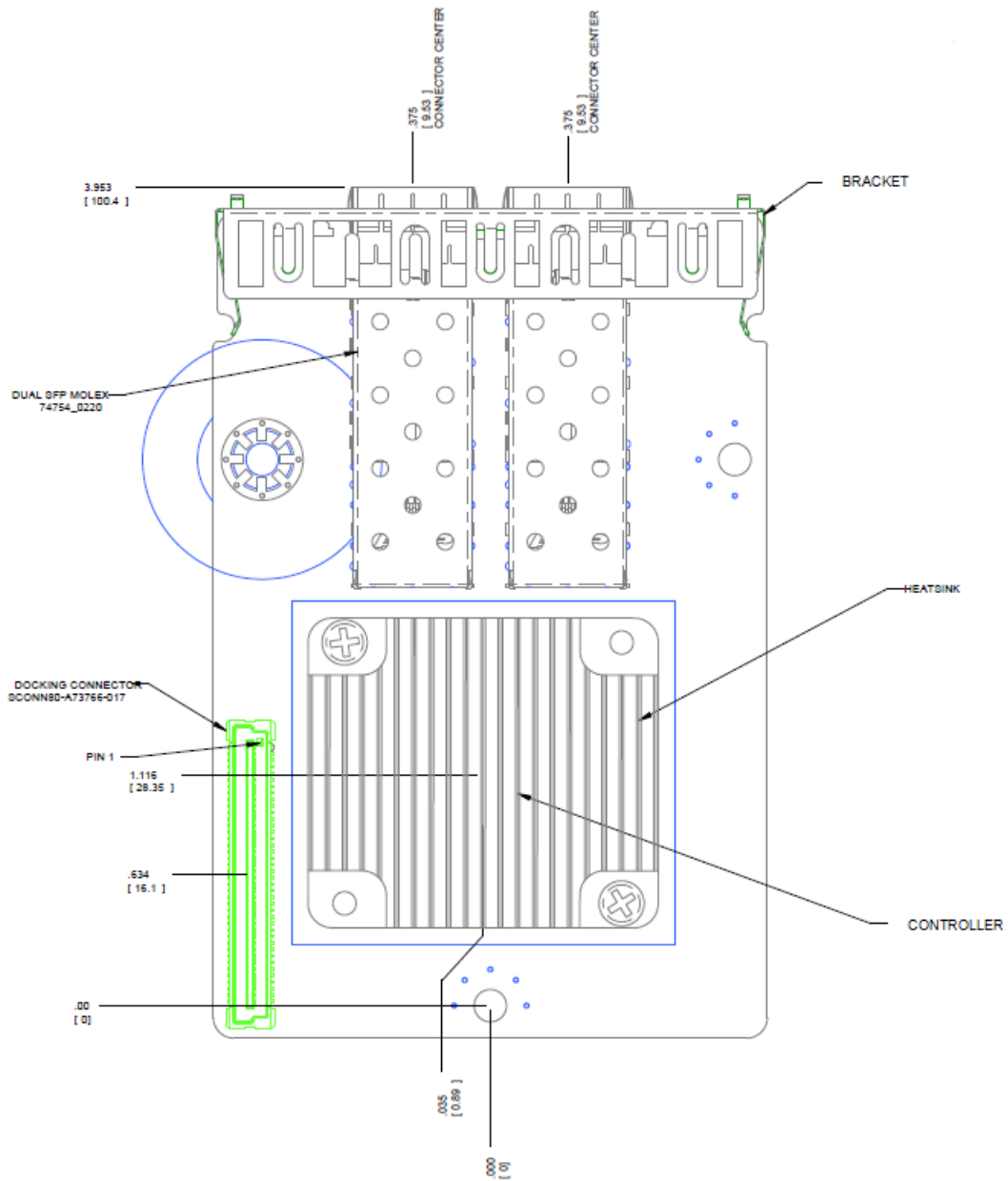


Figure 15. Dual Port Intel® 82599 10GbE I/O Module Dimensions; Bottom View



## 4.4 Intel® 82599 10Gb Ethernet Controller

### 1. General

- Serial Flash Interface
- 4-wire SPI EEPROM Interface
- Protected EEPROM space for private configuration
- Device disable capability
- Package Size - 25 mm x 25 mm

### 2. Networking

- Complies with the 10 Gb/s and 1 Gb/s Ethernet/802.3ap (KX/KX4/KR) specification
- Complies with the 10 Gb/s Ethernet/802.3ae (XAUI) specification
- Complies with the 1000BASE-BX specification
- Complies with the IEEE 802.3x 100BASE-TX specification
- Support for jumbo frames of up to 15.5 KB
- Auto negotiation Clause 73 for supported mode
- CX4 per 802.3ak
- Flow control support: send/receive pause frames and receive FIFO thresholds
- Statistics for management and RMON
- 802.1q VLAN support
- TCP segmentation offload: up to 256 KB
- IPv6 support for IP/TCP and IP/UDP receive checksum offload
- Fragmented UDP checksum offload for packet reassembly
- Message Signaled Interrupts (MSI)
- Message Signaled Interrupts (MSI-X)
- Interrupt throttling control to limit maximum interrupt rate and improve CPU usage
- Receive packet split header
- Multiple receive queues (Flow Director) 16 x 8 and 32 x 4
- 128 transmit queues
- Receive header replication
- Dynamic interrupt moderation
- DCA support
- TCP timer interrupts
- NO snoop
- Relaxed ordering
- Support for 64 virtual machines per port (64 VMs x 2 queues)
- Support for Data Center Bridging (DCB) (802.1Qaz, 802.1Qbb, 802.1p)

### 3. Host Interface

- PCIe Base Specification 2.0 (2.5GT/s) or (5GT/s)
- Bus width — x1, x2, x4, x8
- 64-bit address support for systems using more than 4 GB of physical memory

### 4. MAC Functions

- Descriptor ring management hardware for transmit and receive
- ACPI register set and power down functionality supporting D0 and D3 states
- A mechanism for delaying/reducing transmit interrupts
- Software-controlled global reset bit (resets everything except the configuration registers)
- Eight Software-Definable Pins (SDP) per port
- Four of the SDP pins can be configured as general-purpose interrupts

- Wake up
  - Ipv6 wake-up filters
  - Configurable flexible filter (through EEPROM)
  - LAN function disable capability
  - Programmable memory transmit buffers (160 KB/port)
  - Default configuration by EEPROM for all LEDs for pre-driver functionality
  - Support for SR-IOV
5. Manageability
- Eight VLAN L2 filters
  - 16 flex L3 port filters
  - Four Flexible TCO filters
  - Four L3 address filters (IPv4)
  - Advanced pass through-compatible management packet transmit/receive support
  - SMBus interface to an external manageability controller
  - NC-SI interface to an external manageability controller
  - Four L3 address filters (IPv6)
  - Four L2 address filters

See *Intel® 82599 10 GbE Controller Datasheet* for more details.

## 4.5 LAN LED Functionality

Each of the two SFP+ Ethernet ports on the Dual Port Intel® 82599 10GbE I/O Module will have both a speed LED and a link/activity LED.

Table 3. Dual Port Intel® 82599 10GbE I/O Module LED Functionality

LED Color	LED State	NIC State
Green/Amber (Right)	Off	Not used
	Amber	1 Gbps
	Green	10 Gbps
Green (Left)	On	Active Connection
	Blinking	Transmit / Receive activity

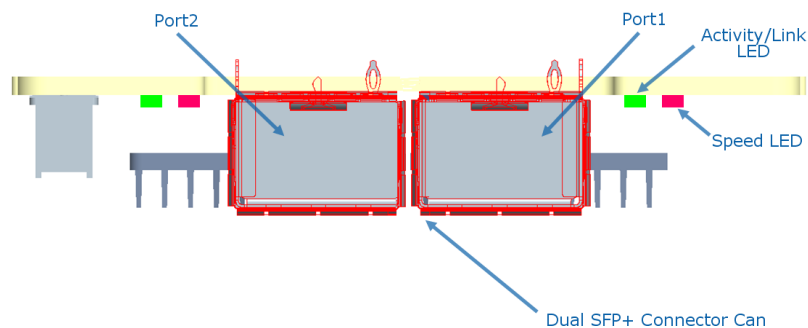


Figure 16. Dual Port Intel® 82599 10GbE I/O Module; Rear View

## 5. Single Port FDR InfiniBand\* ConnectX\*-3 I/O Module (AXX1FDRIBIOM)

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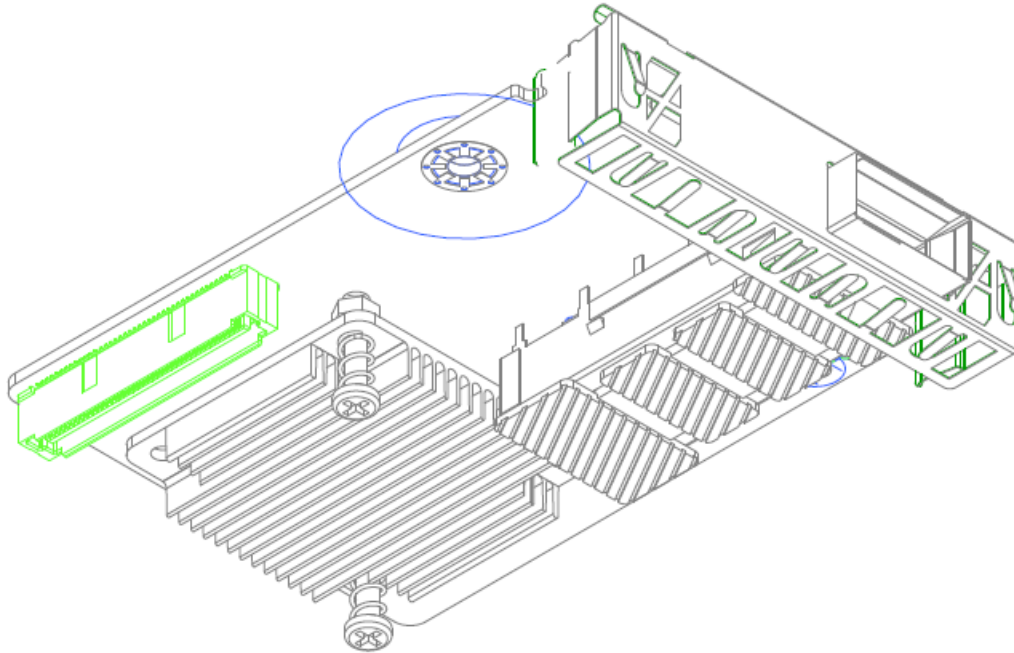


Figure 17. Single Port FDR InfiniBand\* ConnectX\*-3 I/O Module

### 5.1 Feature Set

Following is the feature set:

- Mellanox\* Connect X-3\* FDR/10GbE silicon
- Single QSFP+ external connector, standard style QSFP+ cage (not PCI) with EMI spring fingers and with custom heat sink and retention clip for IOM low profile form factor
- SMB bus isolation and power control to the QSFP+ external connector
- Link (green) and Activity (amber) LEDs for the QSFP+ connection
- 16Mbit SPI Flash
- 256Byte FRU EEPROM and TMP75 temp sensor (stuffed)
- Stainless steel EMI shield

See *Mellanox\* Connect X-3\* Datasheet* for additional silicon and software level features supported.

## 5.2 Functional Block Diagram

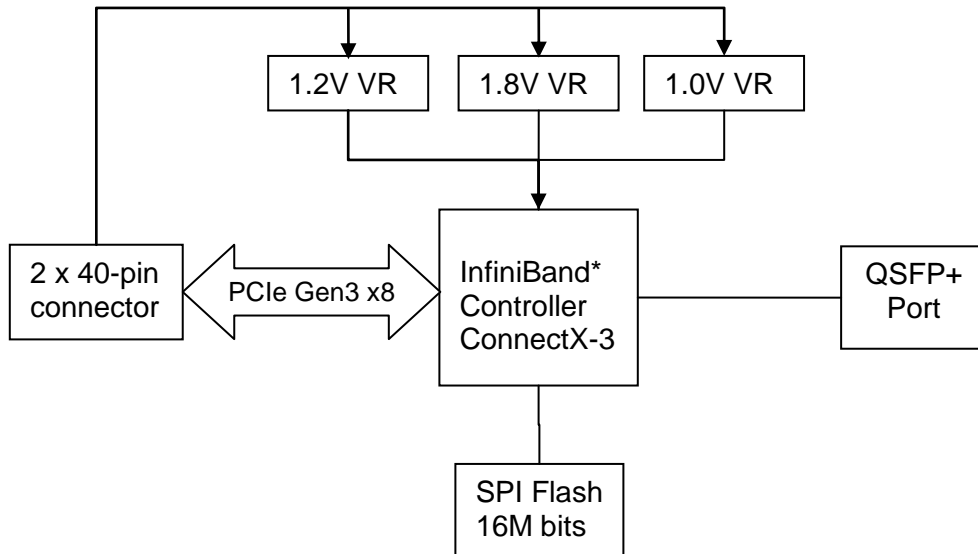


Figure 18. Single Port FDR InfiniBand® ConnectX®-3 I/O Module Block Diagram

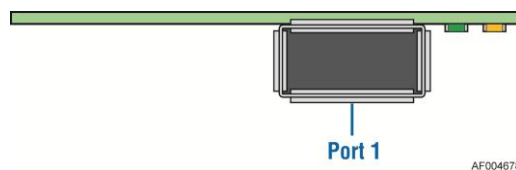


Figure 19. Single Port FDR InfiniBand® ConnectX®-3 I/O Module Port Identification

### 5.3 Mechanical Dimensions

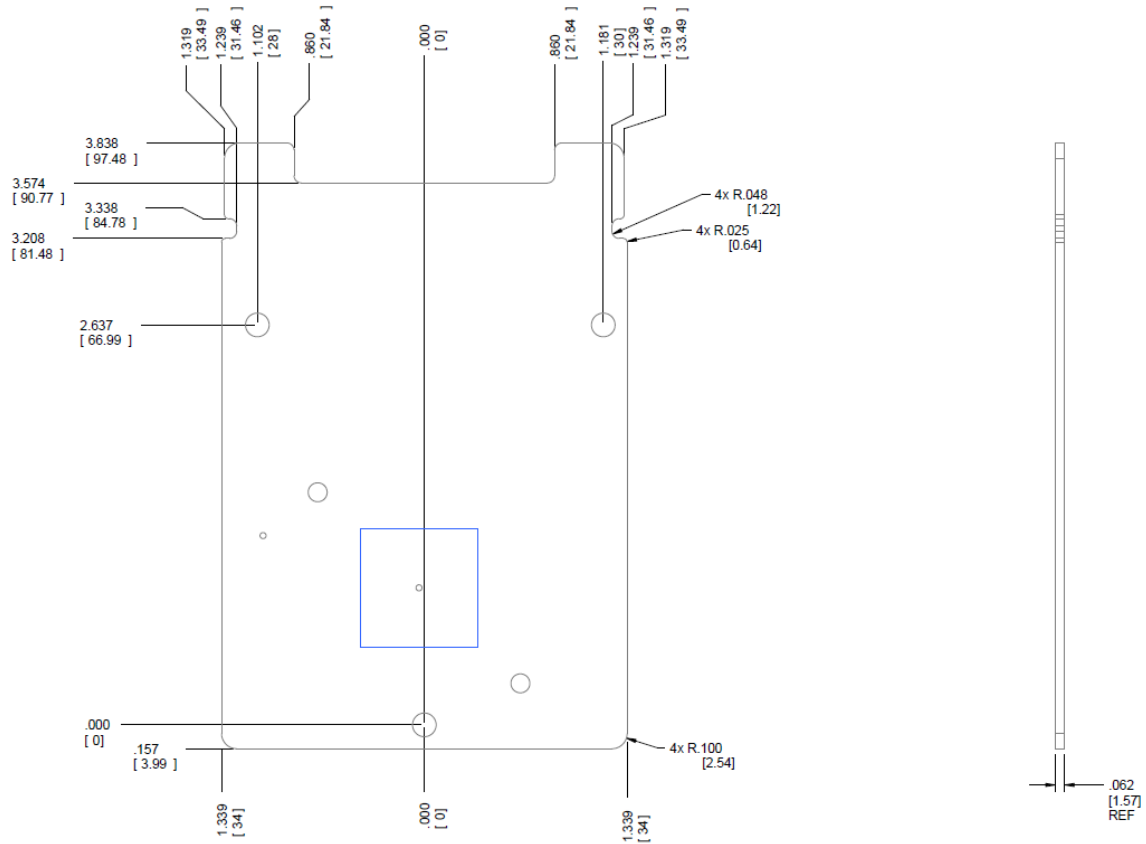


Figure 20. Single Port FDR InfiniBand\* ConnectX\*-3 I/O Module Dimensions; Top and side View

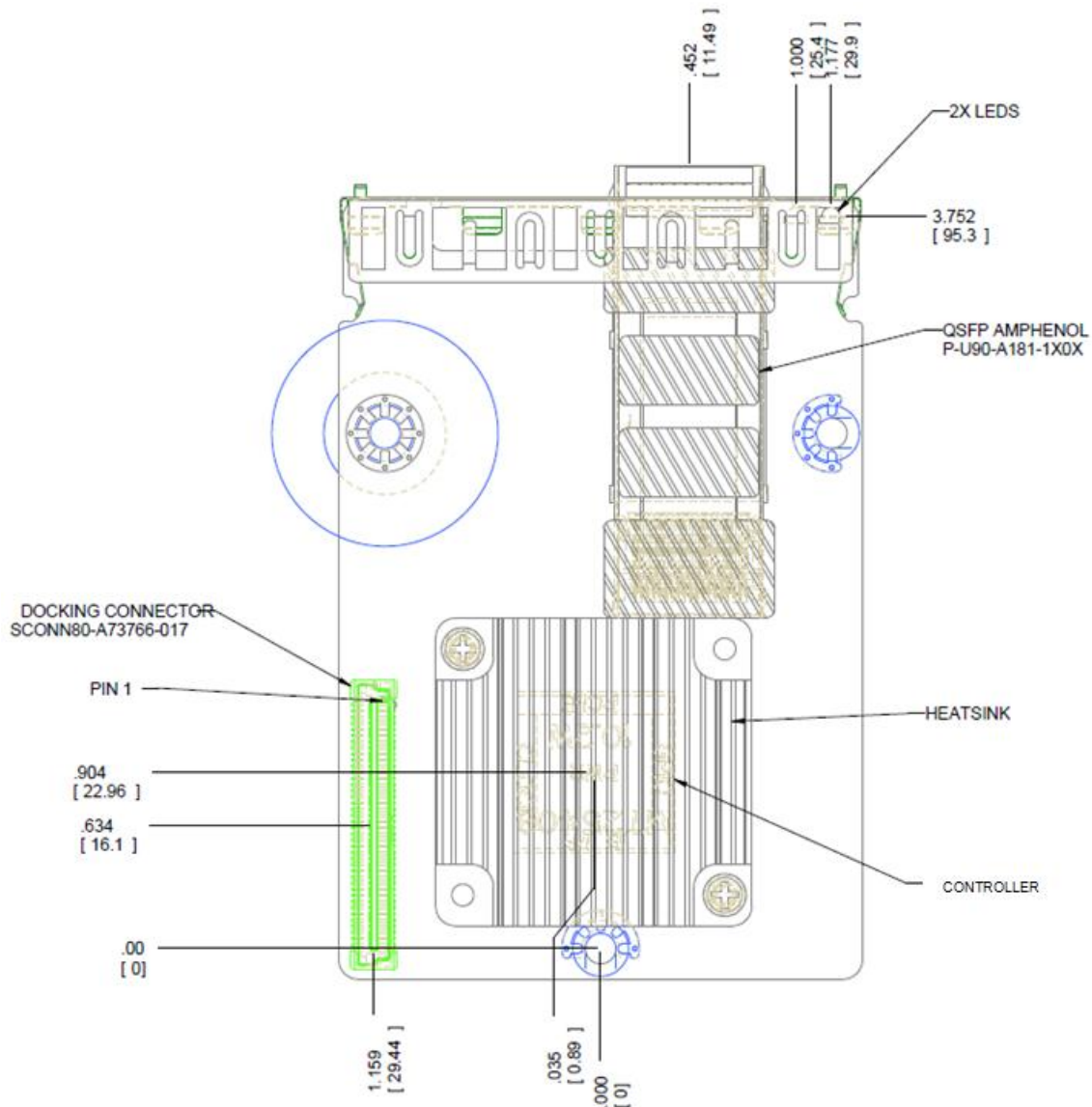


Figure 21. Single Port FDR InfiniBand® ConnectX-3® I/O Module Dimensions; Bottom View

## 5.4 ConnectX-3 Single/Dual-Port Adapter Silicon with VPI

### 5.4.1 Overview

ConnectX-3 adapter devices with Virtual Protocol Interconnect (VPI) supporting InfiniBand® and Ethernet connectivity provide the highest performing and most flexible interconnect solution for PCI Express Gen3 Blade Server and Landed-on-Motherboard designs used in Enterprise Data Centers, High-Performance Computing, and Embedded environments.

Clustered data bases, parallel processing, transactional services and high-performance embedded I/O applications will achieve significant performance improvements resulting in

reduced completion time and lower cost per operation. ConnectX-3 with VPI also simplifies system development by serving multiple fabrics with one hardware design.

### 5.4.2 Key Features

- 1µs MPI ping latency
- Up to 56Gb/s InfiniBand\* or 40 Gigabit Ethernet per port
- PCI Express 3.0 (up to 8GT/s)
- CPU offload of transport operations
- Application offload
- GPU communication acceleration
- Precision Clock Synchronization
- End-to-end QoS and congestion control
- Hardware-based I/O virtualization
- Dynamic power management
- Fibre Channel encapsulation (FCoIB or FCoE)
- Ethernet encapsulation (EoIB)
- 17mm X 17mm RoHS-R6

## 5.5 Network LED Functionality

The QSFP+ port on the Single Port FDR InfiniBand\* ConnectX\*-3 I/O Module will have a green LED and amber LED. The following is a mapping of LED color, function, and physical location with respect to the QSFP+ connector.

Table 4. Single Port FDR InfiniBand\* ConnectX\*-3 I/O Module LED Functionality

LED Color	LED State	NIC State
Amber (Right)	Off	No Activity
	Blinking	Transmit / Receive Activity
Green (Left)	Off	No Active Link Connection
	On	Active Link Connection

## 6. Dual Port FDR InfiniBand® ConnectX®-3 I/O Module (AXX2FDRIBIOM)

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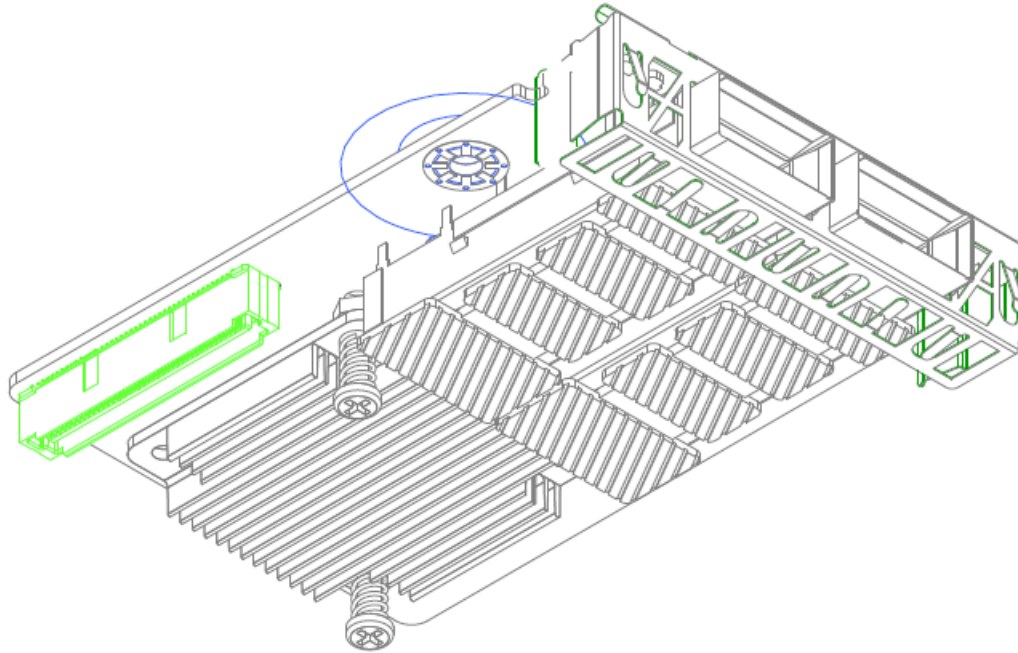


Figure 22. Dual Port FDR InfiniBand® ConnectX®-3 I/O Module

### 6.1 Feature Set

Following is the feature set:

- Mellanox® Connect X-3® FDR/10GbE silicon
- Dual QSFP+ external connectors, standard style QSFP+ cage (not PCI) with EMI spring fingers and with custom heat sink and retention clip for IOM low profile form factor
- SMB bus isolation and power control to the QSFP+ external connector
- Link (green) and Activity (amber) LEDs for the QSFP+ connection
- 16Mbit SPI Flash
- 256Byte FRU EEPROM and TMP75 temp sensor (stuffed)
- Stainless steel EMI shield

See *Mellanox® Connect X-3® Datasheet* for additional silicon and software level features supported.



## 6.2 Functional Block Diagram

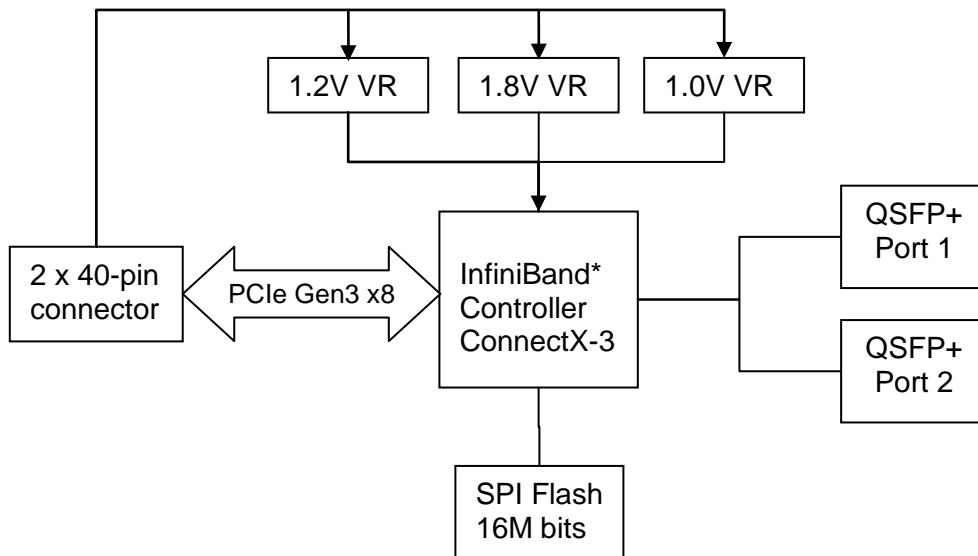


Figure 23. Dual Port FDR InfiniBand\* ConnectX\*-3 I/O Module Block Diagram

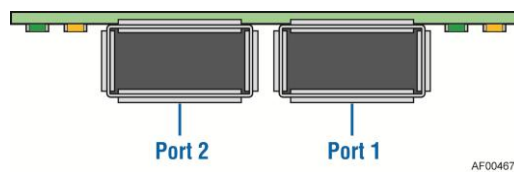


Figure 24. Dual Port FDR InfiniBand\* ConnectX\*-3 I/O Module Port Identification

### 6.3 Mechanical Dimensions

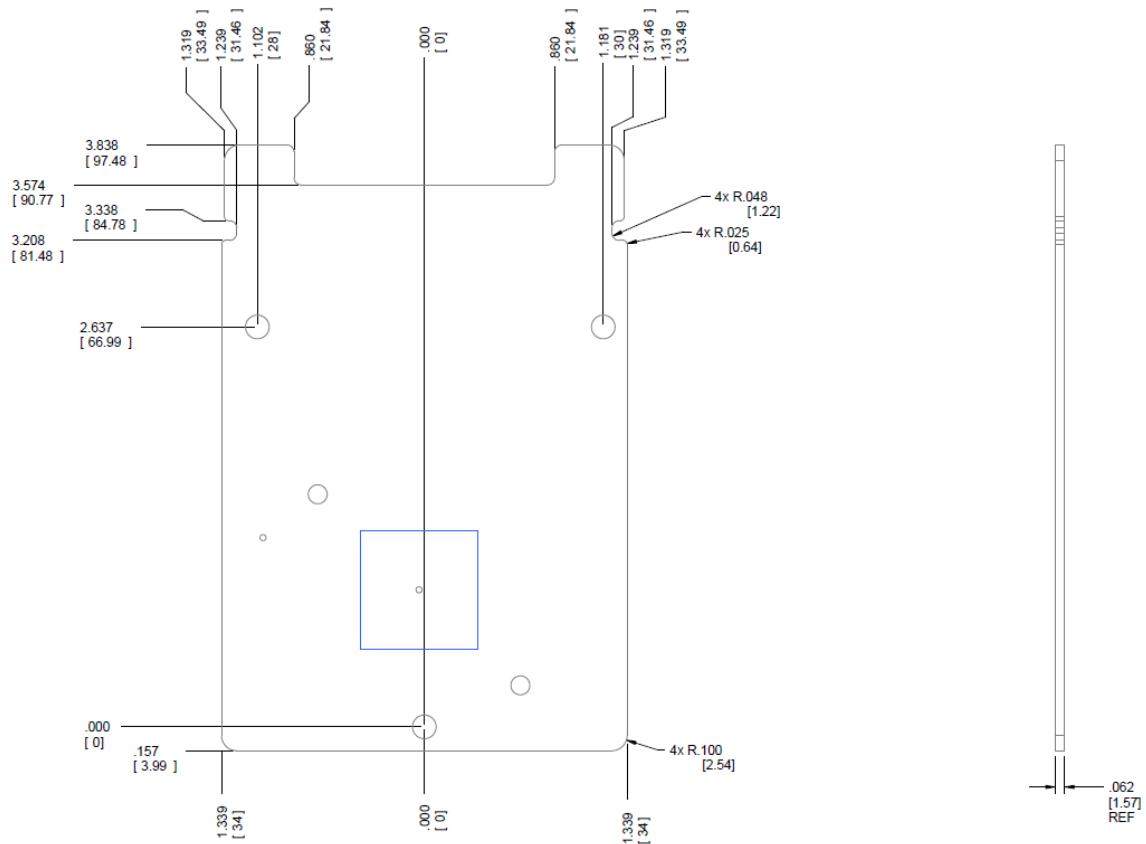


Figure 25. Dual Port FDR InfiniBand® ConnectX®-3 I/O Module Dimensions; Top and side View

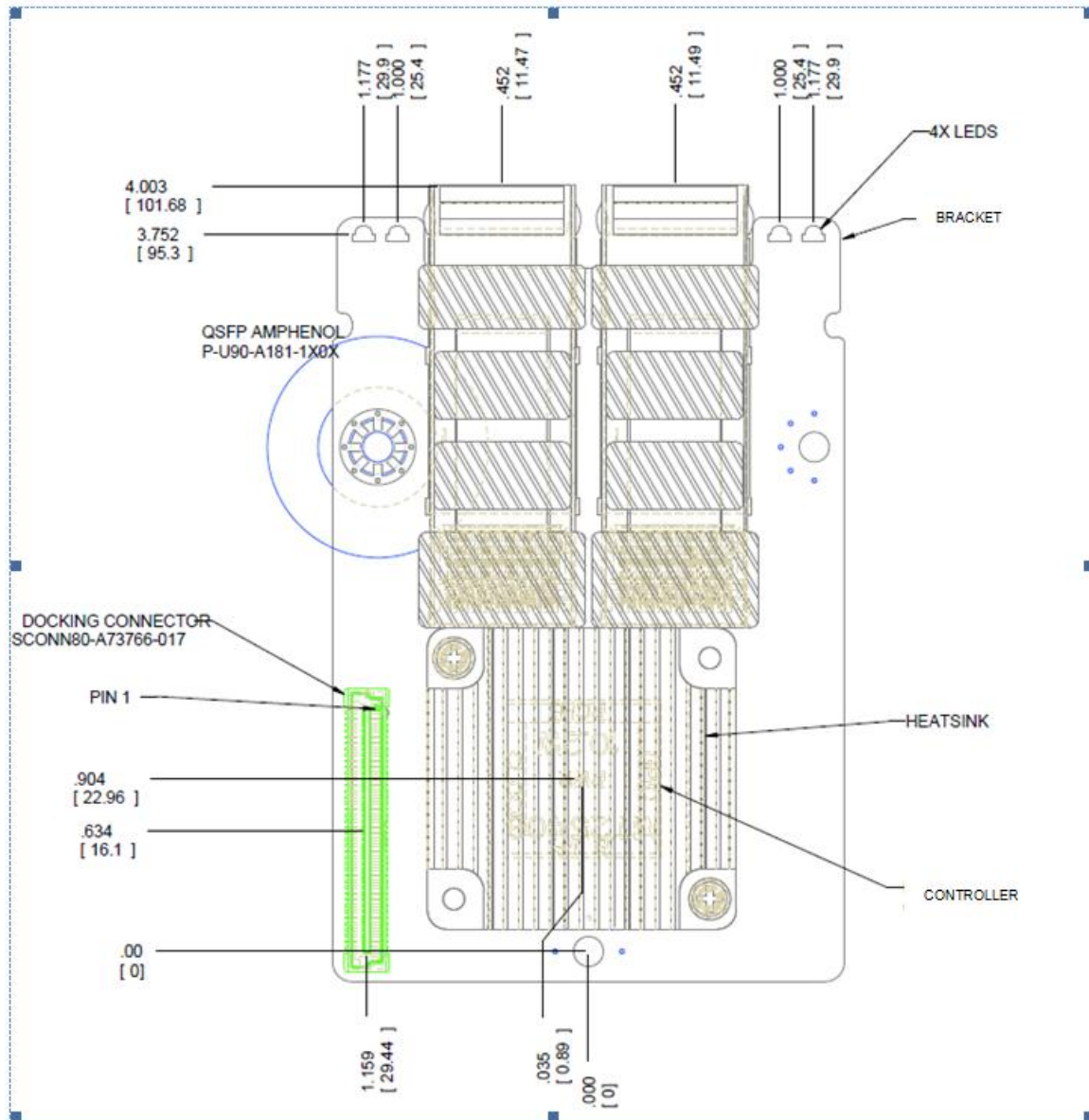


Figure 26. Dual Port FDR InfiniBand® ConnectX®-3 I/O Module Dimensions; Bottom View

## 6.4 ConnectX®-3 Single/Dual-Port Adapter Silicon with VPI

### 6.4.1 Overview

ConnectX-3 adapter devices with Virtual Protocol Interconnect (VPI) supporting InfiniBand® and Ethernet connectivity provide the highest performing and most flexible interconnect solution for PCI Express Gen3 Blade Server and Landed-on-Motherboard designs used in Enterprise Data Centers, High-Performance Computing, and Embedded environments.

Clustered data bases, parallel processing, transactional services and high-performance embedded I/O applications will achieve significant performance improvements resulting in

reduced completion time and lower cost per operation. ConnectX-3 with VPI also simplifies system development by serving multiple fabrics with one hardware design.

### 6.4.2 Key Features

- 1µs MPI ping latency
- Up to 56Gb/s InfiniBand® or 40 Gigabit Ethernet per port
- PCI Express 3.0 (up to 8GT/s)
- CPU offload of transport operations
- Application offload
- GPU communication acceleration
- Precision Clock Synchronization
- End-to-end QoS and congestion control
- Hardware-based I/O virtualization
- Dynamic power management
- Fibre Channel encapsulation (FCoIB or FCoE)
- Ethernet encapsulation (EoIB)
- 17mm X 17mm RoHS-R6

**Note:** Due to PCIe3 x8 bandwidth limitation, both ports cannot run simultaneously at full speed.

## 6.5 Network LED Functionality

The QSFP+ port on the Dual Port FDR InfiniBand® ConnectX®-3 I/O Module will have a green LED and an amber LED. Below is a mapping of LED color, function, and physical location with respect to the QSFP+ connector.

Table 5. Dual Port FDR InfiniBand® ConnectX®-3 I/O Module LED Functionality

LED Color	LED State	NIC State
Amber (Right)	Off	No Activity
	Blinking	Transmit / Receive Activity
Green (Left)	Off	No Active Link Connection
	On	Active Link Connection