ConnectX®-6 VPI Card
200Gb/s InfiniBand & Ethernet Adapter Card

World’s first 200Gb/s HDR InfiniBand and Ethernet network adapter card, offering industry-leading performance, smart offloads and In-Network Computing, leading to the highest return on investment for High-Performance Computing, Cloud, Web 2.0, Storage and Machine Learning applications

ConnectX-6 Virtual Protocol Interconnect® (VPI) cards are a groundbreaking addition to the Mellanox ConnectX series of industry-leading adapter cards. Providing two ports of 200Gb/s for InfiniBand and Ethernet connectivity, sub-600ns latency and 215 million messages per second, ConnectX-6 VPI cards enable the highest performance and most flexible solution aimed at meeting the continually growing demands of data center applications. In addition to all the existing innovative features of past versions, ConnectX-6 cards offer a number of enhancements to further improve performance and scalability.

ConnectX-6 VPI cards supports HDR, HDR100, EDR, FDR, QDR, DDR and SDR InfiniBand speeds as well as 200, 100, 50, 40, 25, and 10 Gb/s Ethernet speeds.

**HPC Environments**

Over the past decade, Mellanox has consistently driven HPC performance to new record heights. With the introduction of the ConnectX-6 adapter card, Mellanox continues to pave the way with new features and unprecedented performance for the HPC market.

ConnectX-6 VPI delivers the highest throughput and message rate in the industry. As the first adapter to deliver 200Gb/s HDR InfiniBand, 100Gb/s HDR100 InfiniBand and 200Gb/s Ethernet speeds, ConnectX-6 VPI is the perfect product to lead HPC data centers toward Exascale levels of performance and scalability.

ConnectX-6 supports the evolving co-design paradigm, which transforms the network into a distributed processor. With its In-Network Computing and In-Network Memory capabilities, ConnectX-6 offloads computation even further to the network, saving CPU cycles and increasing network efficiency.

ConnectX-6 VPI utilizes both IBTA RDMA (Remote Direct Memory Access) and RoCE (RDMA over Converged Ethernet) technologies, delivering low-latency and high performance. ConnectX-6 enhances RDMA network capabilities even further by delivering end-to-end packet level flow control.

**Machine Learning and Big Data Environments**

Data analytics has become an essential function within many enterprise data centers, clouds and Hyperscale platforms. Machine learning relies on especially high throughput and low latency to train deep neural networks and to improve recognition and classification accuracy. As the first adapter card to deliver 200Gb/s throughput, ConnectX-6 is the perfect solution to provide machine learning applications with the levels of performance and scalability that they require.

ConnectX-6 utilizes the RDMA technology to deliver low-latency and high performance. ConnectX-6 enhances RDMA network capabilities even further by delivering end-to-end packet level flow control.

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**HIGHLIGHTS**

- World’s first 200Gb/s HDR InfiniBand and Ethernet network adapter card
- Industry-leading performance, smart offloads and In-Network Computing
- Leading to the highest return on investment for High-Performance Computing, Cloud, Web 2.0, Storage and Machine Learning applications
- ConnectX-6 VPI delivers the highest throughput and message rate in the industry
- As the first adapter to deliver 200Gb/s HDR InfiniBand, 100Gb/s HDR100 InfiniBand and 200Gb/s Ethernet speeds, ConnectX-6 VPI is the perfect product to lead HPC data centers toward Exascale levels of performance and scalability
- ConnectX-6 supports the evolving co-design paradigm, which transforms the network into a distributed processor
- ConnectX-6 VPI utilizes both IBTA RDMA (Remote Direct Memory Access) and RoCE (RDMA over Converged Ethernet) technologies
- Delivering low-latency and high performance
- ConnectX-6 enhances RDMA network capabilities even further by delivering end-to-end packet level flow control
Security
The ConnectX-6 block-level encryption offers a critical innovation to network security. As data in transit is stored or retrieved, it undergoes encryption and decryption. ConnectX-6 hardware offloads the IEEE AES-XTS encryption/decryption from the CPU, saving latency and CPU utilization. It also guarantees protection for users sharing the same resources through the use of dedicated encryption keys.

By performing block-storage encryption in the adapter, ConnectX-6 excludes the need for self-encrypted disks. This allows customers the freedom to choose their preferred storage device, including byte-addressable and NVDIMM devices that traditionally do not provide encryption. Moreover, ConnectX-6 can support Federal Information Processing Standards (FIPS) compliance.

ConnectX-6 also includes a hardware Root-of-Trust (RoT) that uses HMAC relying on a device-unique key. This provides both secure boot as well as cloning protection. Delivering best-in-class device and firmware protection, ConnectX-6 also provides secured debugging capabilities, without the need for physical access.

Storage Environments
NVMe storage devices are gaining momentum, offering very fast access to storage media. The evolving NVMe over Fabric (NVMe-oF) protocol leverages RDMA connectivity to remotely access NVMe storage devices efficiently, while keeping the end-to-end NVMe model at lowest latency. With its NVMe-oF target and initiator offloads, ConnectX-6 brings further optimization to NVMe-oF, enhancing CPU utilization and scalability.

Cloud and Web 2.0 Environments
Telco, Cloud and Web 2.0 customers developing their platforms on Software Defined Network (SDN) environments are leveraging the Virtual Switching capabilities of the operating systems on their servers to enable maximum flexibility in the management and routing protocols of their networks.

Open vSwitch (OVS) is an example of a virtual switch that allows Virtual Machines to communicate among themselves and with the outside world. Software-based virtual switches, traditionally residing in the hypervisor, are CPU intensive, affecting system performance and preventing full utilization of available CPU resources.

To address such performance issues, ConnectX-6 offers Mellanox ASAP®-Accelerated Switch and Packet Processing® technology. ASAP® offloads the vSwitch/vRouter by handling the data plane in the NIC hardware while maintaining the control plane unmodified. As a result, significantly higher vSwitch/vRouter performance is achieved minus the associated CPU load.

The vSwitch/vRouter offload functions supported by ConnectX-5 and ConnectX-6 include encapsulation and de-capasulation of overlay network headers, as well as stateless offloads of inner packets, packet headers re-write (enabling NAT functionality), hairpin, and more.

In addition, ConnectX-6 offers intelligent flexible pipeline capabilities, including programmable flexible parser and flexible match-action tables, which enable hardware offloads for future protocols.

Wide Selection of Smart Adapters
Providing up to two ports of 200Gb/s InfiniBand or Ethernet connectivity, ConnectX-6 VPI Smart Adapters are available in two form factors: low-profile stand-up PCIe and OCP3.0 cards with QSFP connectors. The ConnectX-6 VPI portfolio also provides options for Mellanox Socket Direct® configurations.

Mellanox Socket Direct® technology improves the performance of multi-socket servers, by enabling each of their CPUs to access the network through its dedicated PCIe interface. This enables data to bypass the QPI (UPI) and the other CPU, improving latency, performance and CPU utilization.

Mellanox Socket Direct also enables GPU Direct® RDMA for all CPU/GPU pairs by ensuring that GPUs are linked to the CPUs closest to the adapter card. Mellanox Socket Direct enables Intel® DDIO optimization on both sockets by creating a direct connection between the sockets and the adapter card.

Mellanox Socket Direct technology is enabled by a main card housing the ConnectX-6 and an auxiliary PCIe card bringing in the remaining PCIe lanes. The ConnectX-6 Socket Direct card is installed into two PCIe x16 slots and connected using a 350mm long harness. The two PCIe x16 slots may also be connected to the same CPU. In this case, the main advantage of the technology lies in delivering 200Gb/s to servers with PCIe Gen3-only support.

Host Management includes NC-SI over MCTP over SMBus, and MCTP over PCIe - Baseboard Management Controller (BMC) interface, as well as PLDM for Monitor and Control DSP0248 and PLDM for Firmware Update DSP0267.

Compatibility

**PCI Express Interface**
- PCIe Gen 4.0, 3.0, 2.0, 1.1 compatible
- 2.5, 5.0, 8, 16 GT/s link rate
- 32 lanes as 2x 16-lanes of PCIe
- Support for PCIe x1, x2, x4, x8, and x16 configurations
- PCIe Atomic
- TLP (Transaction Layer Packet) Processing Hints (TFH)
- PCIe switch Downstream Port Containment (DPC) enablement for PCIe hot-plug
- Advanced Error Reporting (AER)
- Access Control Service (ACS) for peer-to-peer secure communication
- Process Address Space ID (PASID)
- Address Translation Services (ATS)
- IBM CAPv2 (Coherent Accelerator Processor Interface)
- Support for MSI/MSI-X mechanisms

**Operating Systems/Distributions**
- RHEL, SLES, Ubuntu and other major Linux distributions
- Windows
- FreeBSD
- VMware
- OpenFabrics Enterprise Distribution (OFED)
- OpenFabrics Windows Distribution (WinOF-2)

**Connectivity**
- Interoperability with InfiniBand switches (up to HDR, as 4 lanes of 50Gb/s data rate)
- Interoperability with Ethernet switches (up to 200GbE, as 4 lanes of 50Gb/s data rate)
- Passive copper cable with ESD protection
- Powered connectors for optical and active cable support
**Features**

- InfiniBand
  - HDR / HDR100 / EDR / DDR / DDR / DDR
  - IBTA Specification 1.3 compliant
  - RDMA, Send/Receive semantics
  - Hardware-based congestion control
  - Atomic operations
  - 16 million I/O channels
  - 256 to 4Kbyte MTU, 2Gbyte messages
  - 8 virtual lanes + VL15

- Ethernet
  - 200GbE / 100GbE / 50GbE / 40GbE / 25GbE / 10GbE / 1GbE
  - IEEE 802.3q, 802.3bm 100 Gigabit Ethernet
  - IEEE 802.3by, Ethernet Consortium 25, 50 Gigabit Ethernet, supporting all FEC modes
  - IEEE 802.3ba 40 Gigabit Ethernet
  - IEEE 802.3ae 10 Gigabit Ethernet
  - IEEE 802.3az Energy Efficient Ethernet
  - IEEE 802.3ap based auto-negotiation and KR startup
  - IEEE 802.3ad, 802.1AX Link Aggregation
  - IEEE 802.1q, 802.1vP VLAN tags and priority
  - IEEE 802.1Qau (QCN) – Congestion Notification
  - IEEE 802.1Qaz (ETS)
  - IEEE 802.1Qbb (PFC)
  - IEEE 802.1Qbg
  - IEEE 1588v2
  - Jumbo frame support (9.6KB)

Enhanced Features
- Hardware-based reliable transport
- Collective operations offloads
- Mellanox PeerDirect® RDMA (aka GPUDirect®) communication acceleration
- 64/66 encoding
- Advanced Atomic operations
- Advanced memory mapping support, allowing user mode registration and remapping of memory (UMR)
- Extended Reliable Connected transport (XRC)
- Dynamically Connected Transport (DCT)
- On demand paging (ODP)
- MPI Tag Matching
- Rendezvous protocol offload
- Out-of-order RDMA supporting Adaptive Routing
- Burst buffer offload
- In-Network Memory registration-free RDMA memory access

CPU Offloads
- RDMA over Converged Ethernet (RoCE)
- TCP/IP offload stateless fallback
- LSO, LRO, checksum offload
- RSS (also on encapsulated packet), TSS, HDS, VLAN and MPLS tag insertion/ stripping, Receive flow steering
- Data Plane Development Kit (DPDK) for kernel bypass applications

Open vSwitch (OVS) offload using ASAP®
- Flexible match-action flow tables
- Tunneling encapsulation / de-encapsulation
- Intelligent interrupt coalescence
- Header rewrite supporting hardware offload of NAT router

Storage Offloads
- Block-level encryption: XTS-AES 256/512 bit key
- NVMe over Fabric offloads for target machine
- T10 DIF - signature handover operation at wire speed, for ingress and egress traffic
- Storage protocols: SRP, iSER, NFS
- RDMA, SMB Direct, NVMe-oF

Overlay Networks
- RoCE over overlay networks
- Stateless offloads for overlay network tunneling protocols
- Hardware offload of encapsulation and decapsulation of VXLAN, NVGRE, and GENEVE overlay networks

Hardware-Based I/O Virtualization - Mellanox ASAP®
- Single Root IOV
- Address translation and protection
- VMware NetQueue support
- SR-IOV. Up to 1K Virtual Functions
- SR-IOV. Up to 8 Physical Functions per host

Virtualization hierarchies (e.g., NPAR)
- Virtualizing Functions on a physical port
- SR-IOV on every Physical Function
- Configurable and user-programmable QoS
- Guaranteed QoS for VMs

**HPC Software Libraries**
- HPC-X, OpenMPI, MPICH, MPICH
- OpenSHMEM, PGAS and varied commercial packages

**Management and Control**
- NIC-SI, MCTP over SMIbus and MCTP over PCIe - Baseboard Management Controller interface
- PLDM for Monitor and Control
- PLDM for Firmware Update
- SDN management interface for managing the eSwitch
- PCI interface for device control and configuration
- General Purpose I/O pins
- SPI interface to flash
- JTAG IEEE 1149.1 and IEEE 1149.6

**Remote Boot**
- Remote boot over InfiniBand
- Remote boot over Ethernet
- Remote boot over iSCSI
- Unified Extensible Firmware Interface (UEFI)
- Pre-execution Environment (PXE)

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**Table 1 - Part Numbers and Descriptions**

<table>
<thead>
<tr>
<th>OPN</th>
<th>InfiniBand Supported Speeds (Gb/s)</th>
<th>Ethernet Supported Speeds (Gb/s)</th>
<th>Network Ports</th>
<th>Cages</th>
<th>PCI Express Configuration</th>
<th>Form Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCX653105A-ECAT</td>
<td>HDR100, EDR, DDR, DDR, DDR, DDR</td>
<td>100,50,40,25,10</td>
<td>1 QSP56</td>
<td>PCIe 3.0/4.0 x16</td>
<td>PCIe Standup</td>
<td></td>
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<tr>
<td>MCX651105A-ECAT</td>
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<td>PCIe 4.0 x8</td>
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<tr>
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<td>100,50,40,25,10</td>
<td>2 QSP56</td>
<td>PCIe 3.0/4.0 x16</td>
<td>PCIe Standup</td>
<td></td>
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<tr>
<td>MCX653106A-HDAT</td>
<td>HDR, HDR100, EDR, DDR, DDR, DDR</td>
<td>200,100,50,40,25,10</td>
<td>1 QSP56</td>
<td>PCIe 3.0/4.0 x16</td>
<td>PCIe Standup</td>
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</tr>
<tr>
<td>MCX653106A-HDAT</td>
<td>HDR, HDR100, EDR, DDR, DDR, DDR</td>
<td>200,100,50,40,25,10</td>
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<td>PCIe 3.0/4.0 x16</td>
<td>PCIe Standup</td>
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<td>PCIe Standup</td>
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<tr>
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<td>100,50,40,25,10</td>
<td>2 QSP56</td>
<td>PCIe 3.0/4.0 x16</td>
<td>PCIe Standup</td>
<td></td>
</tr>
<tr>
<td>MCX654105A-HCAT</td>
<td>HDR, HDR100, EDR, DDR, DDR, DDR</td>
<td>200,100,50,40,25,10</td>
<td>1 QSP56</td>
<td>PCIe 3.0/4.0 x16</td>
<td>PCIe Standup</td>
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</tr>
<tr>
<td>MCX654106A-HCAT</td>
<td>HDR, HDR100, EDR, DDR, DDR, DDR</td>
<td>200,100,50,40,25,10</td>
<td>2 QSP56</td>
<td>PCIe 3.0/4.0 x16</td>
<td>PCIe Standup</td>
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<tr>
<td>MCX654106A-EFAT</td>
<td>HDR100, EDR, DDR, DDR, DDR, DDR</td>
<td>100,50,40,25,10</td>
<td>1 QSP56</td>
<td>PCIe 3.0/4.0 x16</td>
<td>PCIe Standup</td>
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<tr>
<td>MCX654105A-ECAT</td>
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<td>MCX653405A-HDIA</td>
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<td>MCX653406A-HDIA</td>
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<td>2 QSP56</td>
<td>PCIe 3.0/4.0 x16</td>
<td>PCIe Standup</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Dimensions without brackets are 167.65mm x 89.9mm. All tail-bracket adapters are shipped with the tail bracket mounted and a short bracket as an accessory.

The last digit of the DCP3.0 OPN-suffix displays the OPN’s default bracket option: I = Internal Lock; E = Ejector Latch. For other bracket types, contact Mellanox.

Note [1]: Includes a cold plate for insertion into a liquid cooled Intel® Server System D50TN.