ConnectX®-5 EN
Ethernet Adapter Card

Intelligent RDMA-enabled network adapter card with advanced application offload capabilities for High-Performance Computing, Web2.0, Cloud and Storage platforms

ConnectX-5 EN supports two ports of 100Gb Ethernet connectivity, while delivering low sub-600ns latency, extremely high message rates, PCIe switch and NVMe over Fabric offloads. ConnectX-5 providing the highest performance and most flexible solution for the most demanding applications and markets: Machine Learning, Data Analytics, and more.

HPC ENVIRONMENTS
ConnectX-5 delivers high bandwidth, low latency, and high computation efficiency for high performance, data intensive and scalable compute and storage platforms. ConnectX-5 offers enhancements to HPC infrastructures by providing MPI and SHMEM/PGAS and Rendezvous Tag Matching offload, hardware support for out-of-order RDMA Write and Read operations, as well as additional Network Atomic and PCIe Atomic operations support.

ConnectX-5 EN utilizes RoCE (RDMA over Converged Ethernet) technology, delivering low-latency and high performance. ConnectX-5 enhances RDMA network capabilities by completing the Switch Adaptive-Routing capabilities and supporting data delivered out-of-order, while maintaining ordered completion semantics, providing multipath reliability and efficient support for all network topologies including DragonFly and DragonFly+.

ConnectX-5 also supports Burst Buffer offload for background checkpointing without interfering in the main CPU operations, and the innovative transport service Dynamic Connected Transport (DCT) to ensure extreme scalability for compute and storage systems.

STORAGE ENVIRONMENTS
NVMe storage devices are gaining popularity, offering very fast storage access. The evolving NVMe over Fabric (NVMe) protocol leverages the RDMA connectivity for remote access. ConnectX-5 offers further enhancements by providing NVMe target offloads, enabling very efficient NVMe storage access with no CPU intervention, and thus improved performance and lower latency.

Moreover, the embedded PCIe switch enables customers to build standalone storage or Machine Learning appliances. As with the earlier generations of ConnectX adapters, standard block and file access protocols can leverage RoCE for high-performance storage access. A consolidated compute and storage network achieves significant cost-performance advantages over multi-fabric networks.
CLOUD AND WEB2.0 ENVIRONMENTS

Cloud and Web2.0 customers that are developing their platforms on Software Defined Network (SDN) environments are leveraging their servers’ Operating System Virtual-Switching capabilities to enable maximum flexibility.

ConnectX-5 enables an innovative storage rack design, Host Chaining, by which different servers can interconnect directly without involving the Top of the Rack (ToR) switch. Alternatively, the Multi-Host technology that was first introduced with ConnectX-4 can be used. Mellanox Multi-Host™ technology, when enabled, allows multiple hosts to be connected into a single adapter by separating the PCIe interface into multiple and independent interfaces. With the various new rack design alternatives, ConnectX-5 lowers the total cost of ownership (TCO) in the data center by reducing CAPEX (cables, NICs, and switch port expenses), and by reducing OPEX by cutting down on switch port management and overall power usage.

Open V-Switch (OVS) is an example of a virtual switch that allows Virtual Machines to communicate with each other and with the outside world. A virtual switch traditionally resides in the hypervisor and switching is based on twelve-tuple matching on flows. The virtual switch or virtual router software-based solution is CPU intensive, affecting system performance and preventing fully utilizing available bandwidth.

Mellanox Accelerated Switching And Packet Processing (ASAP™) Direct technology allows to offload vSwitch/vRouter by handling the data plane in the NIC hardware while maintaining the control plane unmodified. As a result there is significantly higher vSwitch/vRouter performance without the associated CPU load.

With these capabilities data center administrators benefit from better server utilization while reducing cost, power, and cable complexity, allowing more Virtual Appliances, Virtual Machines and more tenants on the same hardware.

COMPATIBILITY

PCI Express Interface
- PCIe Gen 4
- PCIe Gen 3.0, 1.1 and 2.0 compatible
- 2.5, 5.0, 8, 16GT/s link rate
- Auto-negotiates to x16, x8, x4, x2, or x1 lanes
- PCIe Atomic
- TLP (Transaction Layer Packet) Processing Hints (TPH)
- Embedded PCIe Switch: Up to 8 bifurcations
- PCIe switch Downstream Port Containment (DPC) enablement for PCIe hot-plug
- Access Control Service (ACS) for peer-to-peer secure communication
- Advance Error Reporting (AER)
- Process Address Space ID (PASID) Address Translation Services (ATS)
- IBM CAPI v2 support (Coherent Accelerator Processor Interface)
- Support for MSI/MSI-X mechanisms

Operating Systems/Distributions*
- RHEL/CentOS
- Windows
- FreeBSD
- VMware
- OpenFabrics Enterprise Distribution (OFED)
- OpenFabrics Windows Distribution (WinOF-2)

Connectivity
- Interoperability with Ethernet switches (up to 100GbE)
- Passive copper cable with ESD protection
- Powered connectors for optical and active cable support

©2017 Mellanox Technologies. All rights reserved.
**FEATURES**

**Ethernet**
- 100GbE / 50GbE / 40GbE / 25GbE / 10GbE / 1GbE
- IEEE 802.3bj, 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
- Proprietary Ethernet protocols (20/40GBASE-R2, 50/56GBASE-R4)
- IEEE 802.3ad, 802.1AX Link Aggregation
- IEEE 802.1Qbg
- IEEE 802.1Qbb (PFC)
- IEEE 802.1Qaz (ETS)
- IEEE 802.1Q, 802.1P VLAN tags and IEEE 802.3ad, 802.1AX Link aggregation
- IEEE 802.3ap based auto-negotiation and KR startup
- IEEE 802.3ad, 802.1AX Link Aggregation
- IEEE 802.1Qbg
- IEEE 1588v2
- Jumbo frame support (9.6KB)

**Enhanced Features**
- Hardware-based reliable transport
- Collective operations offloads
- Vector collective operations offloads
- PeerDirect™ RDMA (aka GPUDirect®) communication acceleration
- 64/66 encoding
- Extended Reliable Connected transport (XRC)
- Dynamically Connected Transport (DCT)
- Enhanced Atomic operations
- Advanced memory mapping support, allowing user mode registration and remapping of memory (UMR)
- 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/UDP/IP stateless offload
- LSO, LRO, checksum offload
- RSS (also on encapsulated packet), TSS, HOS, 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**
- NVMe over Fabric offloads for target machine
- Erasure Coding offload – offloading Reed Solomon calculations
- T10 DIF – Signature handover operation at wire speed, for ingress and egress traffic
- Storage Protocols:
  - SRP, iSER, NFS RDMA, SMB Direct, NVMe

**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**
- Single Root I/OV
- Address translation and protection
- VMware NetQueue support
- SR-IOV: Up to 1K Virtual Functions
- SR-IOV: Up to 16 Physical Functions per host
- Virtualization hierarchies (e.g., NPAR and Multi-Host, when enabled)
- Virtualizing Physical Functions on a physical port
- SR-IOV on every Physical Function
- Configurable and user-programmable QoS
- Guaranteed QoS for VMs

**HPC Software Libraries**
- Open MPI, IBM PE, OSU MPI (MVAPICH2), Intel MPI
- Platform MPI, UPC, Open SHMEM

**Management and Control**
- NC-SI over MCTP over SMBus and NC-SI over MCTP over PCIe
- PLDM for Monitor and Control DSP0248
- PLDM for FW Update DSP0267
- SDN management interface for managing the eSwitch
- PC 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 Ethernet
- Remote boot over iSCSI
- Unified Extensible Firmware Interface (UEFI)
- Pre-execution Environment (PXE)

* This section describes hardware features and capabilities. Please refer to the driver and firmware release notes for feature availability.

Table 1 - Part Numbers and Descriptions

<table>
<thead>
<tr>
<th>OPN</th>
<th>Description</th>
<th>Dimensions w/o Bracket</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCX512A-ACAT</td>
<td>ConnectX®-5 EN network interface card, 25GbE dual-port SFP28, PCIe3.0 x8, tail bracket, ROHS R6</td>
<td>14.2cm x 6.9cm (Low Profile)</td>
</tr>
<tr>
<td>MCX515A-ACAT</td>
<td>ConnectX®-5 EN network interface card, 50GbE single-port QSFP28, PCIe3.0 x16, tail bracket, ROHS R6</td>
<td></td>
</tr>
<tr>
<td>MCX516A-GCAT</td>
<td>ConnectX®-5 EN network interface card, 50GbE single-port QSFP28, PCIe3.0 x16, tail bracket, ROHS R6</td>
<td></td>
</tr>
<tr>
<td>MCX515A-CCAT</td>
<td>ConnectX®-5 EN network interface card, 100GbE single-port QSFP28, PCIe3.0 x16, tail bracket, ROHS R6</td>
<td></td>
</tr>
<tr>
<td>MCX516A-CCAT</td>
<td>ConnectX®-5 EN network interface card, 100GbE dual-port QSFP28, PCIe4.0 x16, tail bracket, ROHS R6</td>
<td></td>
</tr>
<tr>
<td>MCX516A-CDAT</td>
<td>ConnectX®-5 Ex EN network interface card, 100GbE dual-port QSFP28, PCIe4.0 x16, tail bracket, ROHS R6</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: All tall-bracket adapters are shipped with the tall bracket mounted and a short bracket as an accessory.