The FastLinQ® 41000 Series Intelligent Ethernet Adapter with Universal Remote Direct Memory Access (RDMA)—available in 10GBASE-T (RJ45), 10-Gigabit Ethernet (GbE) SFP, and 25GbE SFP28—supports LAN (TCP/IP) traffic at 10/25GbE line-rate speeds. The 41000 Series provides extremely low host CPU usage by enabling full stateless offloads to meet the performance requirements of the most demanding enterprise applications.

The evolution of data centers—triggered by high-density server virtualization, software-defined networking (SDN), and multitenant cloud computing platforms—demands a high-performance 10/25GbE solution that boosts CPU efficiency and reduces capital expenditures (CAPEX) and operational expenditures (OPEX) of the migration to 10/25GbE. The FastLinQ 41000 Series Adapters are the best choice for workload-intensive computing environments, providing reliable, high-performance 10/25GbE connectivity solutions.
FEATURES

- PCI Express® (PCIe®) Gen 3 x8 (8GT/s) support
- Full line-rate performance across single and dual ports
- Broad operating system (OS) and hypervisor support
- Network boot support
  - iSCSI remote boot
  - FCoE remote boot from LUN
  - Preboot Execution Environment (PXE) 2.0
  - Unified Extensible Firmware Interface (UEFI) support
- Simplifies deployment and troubleshooting using QConvergeConsole® (QCC) GUI, QLogic® Control Suite (QCS) CLI, QCC PowerKit, UEFI human interface infrastructure (HII), in-OS utilities, QCC vCenter GUI and ESXCLI Plug-ins, and OpenStack® integration
- Switch-independent NPAR with up to 16 partition assignments per adapter
- Marvell Data Plane Development Kit (DPDK) high-speed packet processing engine delivers up to 38 million packets per second at 64B frame sizes
- Marvell Flow Filtering is supported on Linux® using the ethtool -u/-U commands. See the n-tuple Flow Filtering and Steering FastLinQ 41000/45000 Series Adapters Deployment Guide for more information.
- Universal RDMA technologies—RDMA over Converged Ethernet (RoCE), RoCEv2, and Internet wide area RDMA protocol (iWARP)
- Energy Efficient Ethernet (EEE) support for reduced idle power consumption in RJ-45-based networks (10GBase-T variants only)
- MSI and MSI-X support
- IPv4 and IPv6 stateless offloads
- PCI-SIG® single root input/output virtualization (SR-IOV) with up to 192 virtual functions
- Comprehensive stateless offloads
- Auto negotiation: 1G/10G/25G (10GBase-T variants only)
- FastLinQ SmartANI™ for simplified connectivity with 10G SFP+/25G SFP28 interfaced switches. (SFP+ interfaces can accept direct attach cable (DAC) or optical (discrete or active optic cable (AOC)) connections).
- RX/TX multiqueue
  - VMware® NetQueue
  - RX/TX multiqueue (continued)
    - Windows® Hyper-V® Virtual Machine Queue
    - Linux Multiqueue
  - Tunneling offloads
    - Windows Network Virtualization using Generic Routing Encapsulation (NVGRE)
    - Linux Generic Routing Encapsulation (GRE)
    - VMware, Windows, and Linux Virtual Extensible LAN (VXLAN)
    - Linux and VMware Generic Network Virtualization Encapsulation (GENEVE)
  - Receive side scaling (RSS)
  - Transmit side scaling (TSS)
  - Support for virtual LAN (vLAN) tagging
  - Support for jumbo frames larger than 1,500 bytes (up to 9,600 bytes)
  - Network teaming, failover, and load balancing
    - Switch independent NIC teaming/bonding
    - Switch dependent NIC teaming/bonding such as link aggregation control protocol (LACP) and generic trunking
  - Data center bridging (DCB)
    - Data center bridging capability exchange protocol (DCBX) link layer discovery protocol (LLDP)
    - Priority-based flow control (PFC)
    - Traffic Class over VLAN’s 3-bit priority code point (PCP) field or Traffic Class over the IP header’s 3-bit differentiated services code point (DSCP) field
    - Enhanced Transmission Selection (ETS)
    - Explicit Congestion Notification (ECN or CN)
    - Data Center Quantized Congestion Notification (DCQCN)
  - Non-offloaded Storage over Ethernet
    - iSCSI using OS-based software initiators
  - Offloaded storage over Ethernet
    - decreases server performance with full hardware offload for storage traffic
    - Industry-leading FCoE-Offload performance of up to 3.6 million IOPS, suitable for high-density server virtualization and large databases
    - Industry-leading iSCSI-Offload performance of up to 2.9 million IOPS, suitable for a diverse set of applications leveraging the flexibility of iSCSI
**BENEFITS**

**Simplified Migration to 10/25GbE**

FastLinQ 41000 Series Adapters feature a high-speed, flexible architecture and switch-independent NPAR technology. Designed for both physical and virtual environments, this switch-agnostic approach enables administrators to split up the 10/25GbE network pipe to divide and reallocate bandwidth and resources, as needed, at the adapter level.

- Customers deploying rack and tower servers with multiple GbE adapters can greatly benefit from consolidating multiple network adapters and freeing up PCI slots for other add-in card upgrades.
- With NPAR, 41000 Series Adapters can further partition their network bandwidth into multiple virtual connections, making 1 adapter appear as 16 adapters to the OS for use by the applications.
- NPAR greatly simplifies the physical connectivity to the server, reduces implementation time, and lowers the acquisition cost of 10/25GbE migration.
- Available in 10GBASE-T, SR and LR optics, and direct-attach copper (DAC), 41000 Series Adapters are the ideal choice for migrating multiple 1GbE network connections to consolidated 10/25GbE.
- FastLinQ 41000 Series Adapters can converge storage and networking I/O by deploying OS-based software iSCSI initiators over their 10GBASE-T and optical or DAC connections.
- Marvell 41000 Series Converged Network Adapters (CNAs) deliver a fully offloaded iSCSI and Fibre Channel over Ethernet (FCoE) solution that conserves CPU resources and delivers maximum performance.

**Designed for Next-gen Server Virtualization**

The FastLinQ 41000 Series Adapters support today's most compelling set of powerful networking virtualization features: SR-IOV, NPAR, tunneling offloads (VXLAN, GRE, GENEVE, and NVGRE), and industry-leading performance, thus enhancing the underlying server virtualization features.

- SR-IOV delivers higher performance and lower CPU use with increased virtual machine (VM) scalability.
- Marvell NPAR enables up to 16 physical, switch-agnostic, switch-independent NIC partitions per adapter. Dynamic and fine-grained bandwidth provisioning enables control of network traffic from VMs and hypervisor services.
- Concurrent support for SR-IOV and NPAR enables virtual environments with the choice and flexibility to create an agile virtual server platform.
- Availability of both RSS and TSS allows for more efficient load balancing across multiple CPU cores.

**High-Performance Multitenancy Delivered**

As large-scale private and public cloud deployment requirements for isolation and security stretch the boundaries of traditional vLANs, the FastLinQ 41000 Series Adapters deliver network virtualization features for high-performance overlay networks.

- Designed to meet the demands of large, public cloud deployments, the 41000 Series Adapters feature tunneling offloads for multitenancy with VXLAN, GRE, GENEVE, and NVGRE support.
- Line-rate 10/25GbE performance across individual ports in multitenant deployments maximizes server-processing performance by delivering an offloaded Ethernet adapter for enterprise, telco, and cloud deployments on Microsoft® Windows Server®, VMware vSphere®, and various Linux distributions.
Simplified Management
Marvell’s QConvergeConsole (QCC) GUI delivers a broad set of powerful Ethernet and Fibre Channel (FC) adapter management features for administrators to maximize application performance and availability. QCC GUI offers application-based wizards to enable the environment to be quickly and easily provisioned based on published best practices. vCenter GUI and ESXCLI Plug-ins and OpenStack integration are also available.

QCS CLI is available for locally and remotely managing Linux and Windows servers. QCC PowerKit is available for remotely managing Linux, VMware (PowerCLI), and Windows servers. Additionally, pre-boot UEFI HII system BIOS device configuration is available on servers that support UEFI HII.

ACCELERATE ANY NETWORK WITH UNIVERSAL RDMA OFFLOAD
The FastLinQ 41000 Series Adapters support RoCE and iWARP acceleration to deliver low latency, low CPU utilization and high performance on Windows, VMware, and Linux operating systems. 41000 Series Adapters have the unique capability to deliver Universal RDMA that enables RoCE, RoCEv2, and iWARP. Marvell Universal RDMA provides the ultimate flexibility in accelerating use cases like Microsoft Storage Spaces Direct (S2D), Windows Live Migration, Windows SMB Direct, Linux/Windows VF RDMA, VMware PVRDMA and vSAN, NVMe™ over Fabrics (NVMe-oF), CEPHS and NFS over RDMA, and so on. Marvell’s cutting-edge offloading technology increases cluster efficiency and scalability to many thousands of nodes for HyperConverged infrastructure deployments. Customers looking to scale out NVMe-oF can leverage the 41000 Series capabilities of supporting NVMe-oF over TCP (NVMe/TCP) in addition to RDMA transports.

ACCELERATE TELCO NETWORK FUNCTION VIRTUALIZATION (NFV) WORKLOADS
In addition to OpenStack, the FastLinQ 41000 Series Adapters support NFV, which allows decoupling network functions and services from dedicated hardware (such as routers, firewalls, and load balancers) into hosted VMs. NFV enables network administrators to flexibly create network functions and services as they need them, reducing capital expenditure and operating expenses, and enhancing business and network services agility. Marvell technology is integrated into the DPDK and can deliver up to 38 million packets per second to host the most demanding NFV workloads.

TRUSTED, SECURE, RELIABLE, AND INTEROPERABLE
The FastLinQ 41000 Series 10/25GbE Adapters adhere to standards that ensure interoperability with a wide range of network solutions. Marvell adapters are secure by design. Through public and private key encryption technology, the adapters enforce a process for secure firmware updates that prevent hackers from altering the code running on the adapters.
### Host Bus Interface

**Bus Interface**
- PCI Express (PCIe) Gen 3 x8 (x8 physical connector)

**Host Interrupts**
- MSI-X supports independent queues

### I/O Virtualization and Multitenancy

- SR-IOV (up to 192 virtual functions)
- Switch-independent NPAR (up to 16 physical functions)
- GRE and NVGRE packet task offloads
- VXLAN packet task offloads
- GENEVE packet task offloads

### Compliance

- PCI Base Specification, rev. 3.1
- PCI Express Card Electromechanical Specification, rev. 3.0
- PCI Bus Power Management Interface Specification, rev. 1.2
- Advanced configuration and power interface (ACPI) v2.0
- OCP Mezzanine Card 2.0 Design Specification, v1.00
- OCP NIC 3.0 Design Specification (draft) v0.90

### Ethernet Throughput

- 10/25Gbps line rate for single and dual port
- 1G/10G/25G Auto Negotiation (10GBASE-T variants only)

### Ethernet Frame

- 1.500 bytes and larger (jumbo frame)

### Stateless Offload (continued)

- DPDK
- Universal RDMA

### Compliance

- IEEE Specifications
  - 802.1AS (Precise Synchronization)
  - 802.lax-2008 (Link Aggregation)
  - 802.1p (Priority Encoding)
  - 802.1q (VLAN)
  - 802.1Qau (CN)
  - 802.1Qaz (DCBX and ETS)
  - 802.3-2018 Annex 3IB (Ethernet Pause Flow Control)
  - (RJ45) 802.3-2018 Clause 78 EEE (Energy Efficient Ethernet)
  - (25GbE) 802.3-2018 Clause 110 (Direct Attach Copper), Clause 112 (SR optical), and Clause 114 (LR optical) (25G Ethernet)
  - (10GbE SFP+) 802.3-2018 Clause 52 (10Gb Ethernet Optical)
  - (RJ45) 802.3-2018 Clauses 55 and 40 (10GBASE-T and 1000BASE-T)
  - I588-2002 PTPv1 (Precision Time Protocol)
  - I588-2008 PTPv2
  - (10GbE SFP+) SFF8431 Annex E (10Gb Direct Attach Copper)
- RFCs
  - IPv4 (RFC 791)
  - IPv6 (RFC 2460)

### Board Firmware Features

- Secure Firmware Update process
- Smart Auto Negotiation (FastLinQ SmartAN)

### RDMA

**Universal RDMA**
- RoCE
- RoCEv2
- iWARP
- Storage over RDMA: iSER, SMB Direct, S2D, and NVMe-oF
- NFSoRDMA

**RDMA Use Cases**
- S2D
- PVRDMA
- VF RDMA
- Live Migration
- SMB Direct
- NVMe-oF

### RDMA Use Cases (continued)

- NFS
- RDMA
- CEPHS over RDMA

### FCoE-Offload

- Performance
  - 3.6 million FCoE IOPS

### iSCSI-Offload

- Performance
  - 2.9 million iSCSI IOPS

### Forward Error Correction (FEC)

- FC-FEC
- RS-FEC

### Tools and Utilities

#### Management Tools and Device Utilities

- QCS Command Line Interface (CLI) for Linux and Windows
- QCC integrated network management utility (GUI) for Linux and Windows
- QCC Plug-in for vSphere (GUI), and ESXCLI plug-in for VMware
- QCC PowerKit (Windows PowerShell) cmdlets and RESTful APIs for Linux, VMware, and Windows
- Pre-boot UEFI HII system BIOS device configuration pages
- Native OS management tools for networking

#### Boot Support

- PXE 2.0
- UEFI
- iSCSI remote boot
- FCoE boot from SAN

#### Operating System Support

- For the latest applicable operating system information, see [www.marvell.com](http://www.marvell.com)

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**Note:** All advertised features are enabled in the hardware. Actual feature availability is dependent on software driver releases. See the release notes.
Packaging

Ports
- Single, dual, and quad port variants available. See the list of adapters and their features on page 7.

Form Factor
- MD2: PCI Express short, low-profile card: 167.65mm × 68.90mm (6.60in. × 2.71in.)
- OCP 2.0: Type 1 with no bracket
- OCP 3.0: SFF with Pull Tab (Thumbscrew) bracket

Environment and Equipment Specifications

Temperature
- Operating: 32°F to 131°F (0°C to 55°C)
- Storage: –40°F to 149°F (–40°C to 65°C)

Airflow
- See the table on page 7.

Humidity (Relative, Non-condensing)
- Operating and non-operating: 10% to 90%

Agency Approvals—EMI and EMC

**US and Canada**
- FCC Rules, CFR Title 47, Part 15, Subpart Class A
- Industry Canada, ICES-003: Class A

**Europe**
- EN55032
- EN55024
- EN61000-3-2
- EN61000-3-3

**Japan**
- VCCI: Class A

**New Zealand and Australia**
- AS/NZS: Class A

**Korea**
- KC-RRA Class A

**Taiwan**
- BSMI CNS 13438

Cable Distance (Maximum)

**Table 1. Cable Distance**

<table>
<thead>
<tr>
<th>Rate</th>
<th>DAC</th>
<th>SR FOC</th>
<th>AOC</th>
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</table>

DAC = Direct attach cable
SR FOC = SR fiber optic cable
AOC = Active optic cable
RJ-45 = 10BASE-T variants only

Compliance
- RoHS compliant

Approvals—Safety

**US and Canada**
- UL 60950-1
- CSA C22.2

**Europe**
- TUV EN60950-1
- TUV IEC 60950-1
- CB Certified

Table 1. Cable Distance

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<tr>
<th>Rate</th>
<th>Cable and Maximum Distance (m)</th>
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</table>

DAC = Direct attach cable
SR FOC = SR fiber optic cable
AOC = Active optic cable
RJ-45 = 10BASE-T variants only
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<th>Adapter Name</th>
<th>QL41112 HLRJ</th>
<th>QL41162 HLRJ</th>
<th>QL41134 HLRJ</th>
<th>QL41132 HQRJ</th>
<th>QL41132 HLCU</th>
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<th>QL41254 HLCU</th>
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</table>

2. BASE-T (RJ-45) interfaces support Auto-Negotiation, 1GbE full duplex, and 10GbE full duplex.

Marvell FastLinQ 41000 Series 10/25GbE
### Table 3. Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Form Factor</th>
<th>Platform</th>
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<tbody>
<tr>
<td>QL41112HLRJ-11-BK/SP/CK</td>
<td>Dual Port 10GbE RJ-45 Adapter</td>
<td>PCIe MD2</td>
<td>L2, RoCE/RocEv2, iWARP</td>
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<td>Dual Port 10GbE SFP+ Adapter</td>
<td>PCIe MD2</td>
<td>L2, RoCE/RocEv2, iWARP</td>
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<td>QL41132HOCU-BK/SP/CK</td>
<td>Dual Port 10GbE SFP+ Adapter</td>
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<td>L2, RoCE/RocEv2, iWARP</td>
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<td>QL41132HOR1-BK/SP</td>
<td>Dual Port 10G RJ-45 Adapter</td>
<td>OCP 2.0</td>
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<td>QL41132HQCU-BK/SP/CK</td>
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<td>L2, RoCE/RocEv2, iWARP</td>
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<td>QL41162HLRJ-11-BK/SP/CK</td>
<td>Dual Port 10GbE RJ-45 Adapter</td>
<td>PCIe MD2</td>
<td>L2, RoCE/RocEv2, iWARP, iSCSI, FCoE</td>
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<tr>
<td>QL41212HLCU-11-BK/SP/CK</td>
<td>Dual Port 25/10GbE SFP28 Adapter</td>
<td>PCIe MD2</td>
<td>L2, RoCE/RocEv2, iWARP</td>
</tr>
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<td>QL41231HOCU-BK/SP/CK</td>
<td>Single Port 25/10GbE SFP28 Adapter</td>
<td>OCP 2.0</td>
<td>L2, RoCE/RocEv2, iWARP</td>
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<tr>
<td>QL41232HOCU-BK/SP/CK</td>
<td>Dual Port 25/10GbE SFP28 Adapter</td>
<td>OCP 2.0</td>
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</tr>
<tr>
<td>QL41232HQCU-BK/SP/CK</td>
<td>Dual Port 25/10GbE SFP28 Adapter</td>
<td>OCP 3.0</td>
<td>L2, RoCE/RocEv2, iWARP</td>
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<td>QL41234HLCU-BK/SP/CK</td>
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<td>PCIe MD2</td>
<td>L2, RoCE/RocEv2, iWARP</td>
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<td>QL41254HLCU-BK/SP/CK</td>
<td>Quad Port 25/10GbE SFP28 Adapter</td>
<td>PCIe MD2</td>
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</tr>
<tr>
<td>QL41262HLCU-11-BK/SP/CK</td>
<td>Dual Port 25/10GbE SFP28 Adapter</td>
<td>PCIe MD2</td>
<td>L2, RoCE/RocEv2, iWARP, iSCSI, FCoE</td>
</tr>
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All adapters support adaptive voltage scaling (AVS).

To order a bulk kit, add **-BK** to the end of the part number; for example, QL41262HLCU-11-BK.

To order a single pack, add **-SP** to the end of the part number; for example, QL41262HLCU-11-SP.

All HL (MD2 PCIe stand-up) adapters come with both full height and low profile brackets.

Twisted pair cabling, DAC cables, SR/LR optics are not included. See [https://www.marvell.com/documents/xalflardzafh32cfvi0z/](https://www.marvell.com/documents/xalflardzafh32cfvi0z/) for a list of cables and optics that have been tested by Marvell and its partners.

10GbASE-T variants ship with RJ45 connectors. Intended for use with twisted pair copper cabling (not included).
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