Enhancing Industrial Connectivity with MaxLinear's USB Ethernet Bridges



WHITE PAPER

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Introduction

In today's rapidly evolving digital landscape, reliable and flexible connectivity is essential across a wide range of embedded and industrial applications. MaxLinear's USB Ethernet bridges offer a compact, high-performance solution for adding Ethernet connectivity to any system equipped with a USB port. These bridges are engineered to meet the demands of space-constrained environments while providing robust functionality and seamless integration.

Product Overview

MaxLinear's USB Ethernet bridges are designed to simplify development and accelerate time to market (TTM) for system designers.

MaxLinear's USB Ethernet bridges add Ethernet connectivity to any system with an available USB port. Designed for embedded and industrial applications where space is at a premium, MaxLinear's USB Ethernet bridges offer maximum functionality in the smallest package on the market. The XR22800 and XR22801 USB Ethernet devices, which integrate an I^2C master and multiple general-purpose inputs/outputs (GPIOs), come in a 5mm × 5mm QFN package. Even the XR22804, which bridges USB to Ethernet and integrates four universal asynchronous receivers/transmitters (UARTs), an I^2C master, and 32 GPIOs, comes in a compact 8mm × 8mm footprint. Other devices in similar package sizes only offer USB to Ethernet. All MaxLinear's USB Ethernet products are designed for reliability in consumer and industrial environments and provide the industry's highest level of ESD protection at ±15kV human body model (HBM).

Development is simple with MaxLinear's USB bridging products. The devices work with standard software drivers in Windows, Linux, Android, and macOS. For designers who need to get to market quickly, enhanced features such as RS-485 half-duplex control and 9-bit or multidrop mode can be enabled in MaxLinear's USB bridges to simplify software and hardware development.

Custom software drivers and applications are also available for cases where a standard driver is not available, or where unique functionality is required. For example, the UART ports are easily configured for any non-standard baud rate over 300bps and the GPIOs are readily tailored for enhanced functionality. All MaxLinear's custom Windows drivers are certified to the Microsoft WHQL standard to ensure compatibility and reliable performance.

Key features of MaxLinear's USB Ethernet bridges include:

- Plug and Play, fully compatible with standard drivers across major operating systems (OSs), including Windows, Linux, Android, and macOS.
- Compact design, ideal for embedded, consumer, and industrial applications where board space is limited.
- Advanced features such as RS-485 half-duplex control, 9-bit or multidrop mode, and customizable UART configurations.
- Support for custom Windows drivers certified to the Microsoft WHQL/HCK standards, which ensures reliable performance and compatibility.
- Flexible, easily configurable GPIOs for enhanced system control and integration.

Technical Specifications

MaxLinear's USB Ethernet bridges are engineered for high performance and flexibility. Key technical specifications include:

- USB interface with backward-compatible USB 2.0
- Ethernet support for 10/100Mbps (Fast Ethernet) speed mode
- Native support for Windows, Linux, Android, and macOS OSs
- Driver support:
  - Standard CDC-ECM/NCM and RNDIS drivers
  - Custom, WHQL-certified Windows drivers available
- UART features:
  - Configurable baud rates (300bps and above)
  - Support for 9-bit and multidrop mode
- RS-485 support:
  - Half-duplex control
  - Automatic direction control
- GPIOs:
  - Multiple configurable GPIOs
  - Customizable for application-specific functions
- USB bus power supply
- Compact, space-efficient design for embedded systems

Industrial Use Case Scenarios

MaxLinear's USB Ethernet bridges are ideal for a wide range of applications:

- **Industrial Automation**—Enabling Ethernet connectivity in programmable logic controllers (PLCs), human-machine interfaces (HMIs), and industrial controllers where native Ethernet is unavailable.
- **Legacy System Upgrades**—Adding modern networking capabilities, such as remote monitoring, data logging, and integration with modern Supervisory Control and Data Acquisition (SCADA) or cloud systems to older systems using only a USB port.
- **Internet of Things (IoT) Gateways**—Providing a reliable Ethernet backhaul for IoT gateways is crucial for ensuring stable, high-bandwidth, and low-latency communication in smart environments such as buildings, factories, and cities.
- **Embedded Systems**—Integrating MaxLinear's USB Ethernet bridges into compact embedded platforms such as single-board computers (SBCs) and development kits is a powerful way to deploy smart, connected, and efficient systems in industrial and consumer applications.
- **Networking Equipment**—Using USB-based Ethernet expansion or redundancy in networking equipment such as routers, switches, and access points is a smart way to enhance connectivity, especially in constrained or legacy environments.

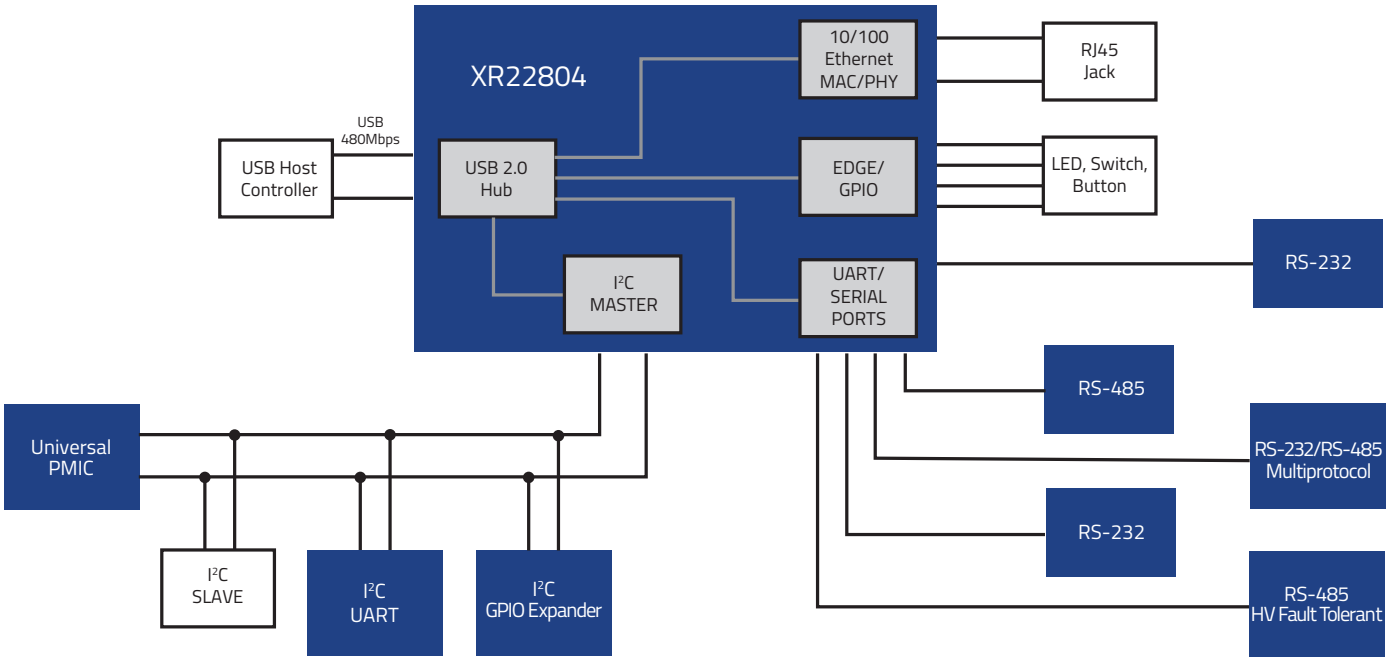


Figure 1: Connectivity Bridges the I/O Gaps in the IoT Landscape

Performance Metrics

While performance can vary based on system configuration and use case, typical benchmarks include:

- **Throughput**—Up to 940Mbps in Fast Ethernet mode over USB 2.0.
- **Latency**—Low-latency performance suitable for real-time industrial applications**.**
- **Driver Load Time**—Near-instantaneous recognition and driver loading on supported OS platforms.
- **Power Consumption**—Optimized for low power consumption, ideal for battery-powered and energy-sensitive applications.

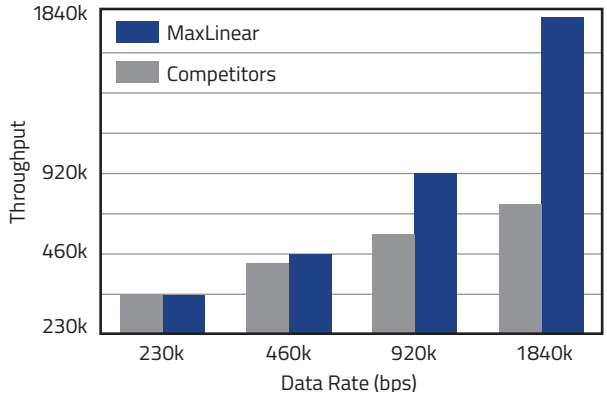


Figure 2: MaxLinear's USB UART Data Throughput vs. Competitors

The applications of MaxLinear's USB Ethernet bridges with I²C master, UARTs, GPIOs are:

- Point-of-sale (POS) systems
- Docking stations
- USB Ethernet dongles
- Serial port expanders
- Embedded connectivity
- Network interface card (NIC)

Table 1: Maxlinear's USB Ethernet Bridges Product

Part Number	CPU Interface	Ethernet MAC/ PHY (Mbps)	UARTs	Max UART Data Rate (Mbps)	UART Tx/Rx FIFO (Bytes)	Max GPIOs	I²C Master	Auto RS-485 Half-Duplex Control	Multidrop (9-bit) Mode	ESD (USB)	Supply Voltage Range V_{CC} (V)	Max UART/ GPIO Input Voltage (V)	Max UART/ GPIO Output Voltage (V)	Temp Range (°C)	Packages
XR22800	USB 2.0 HS	10/100	0	15	N/A	8	Yes	No	No	±15kV HBM	4.4 to 5.25	3.6	3.6	–40 to 85	QFN-32
XR22801	USB 2.0 HS	10/100	1	15	1024/1024	8	Yes	Yes	Yes	±15kV HBM	4.4 to 5.25	3.6	3.6	–40 to 85	QFN-32
XR22802	USB 2.0 HS	10/100	2	15	1024/1024	32	Yes	Yes	Yes	±15kV HBM	4.4 to 5.25	3.6	3.6	–40 to 85	QFN-56
XR22804	USB 2.0 HS	10/100	4	15	1024/1024	32	Yes	Yes	Yes	±15kV HBM	4.4 to 5.25	3.6	3.6	–40 to 85	QFN-56

Conclusion

MaxLinear's USB Ethernet bridges offer a powerful combination of compact design, robust performance, and flexible integration options, making them an ideal solution for a wide range of embedded and industrial applications. With support for standard operating systems, advanced UART and GPIO configurations, and industry-leading ESD protection, these bridges simplify development while ensuring reliable connectivity.

Whether upgrading legacy systems, enabling Ethernet in space-constrained environments, or building next-generation IoT and industrial solutions, MaxLinear's USB Ethernet bridges provide the performance and versatility needed to meet today's connectivity challenges.

References

- *XR22804 Data Sheet*.
- *XR22804IL56-0A-EB Evaluation Board User's Manual*.
- *USB UART Board Design Recommendations for USB Compliance Application Note AN202* (202AN).

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