FAQ

CoaXPress-over-Fiber

The future of CoaXPress

What is CoaXPress-over-Fiber?

CoaXPress-over-Fiber is a light but significant extension of the existing CoaXPress specification to support transport over fiber optics.

CoaXPress (CXP) is the de-facto standard for high-bandwidth computer vision applications. CoaXPress 2.0, the latest version of the specification, specifies the CXP-12 speed, a 12.5 Gbps (Gigabit per second) link over a coaxial copper cable. As link aggregation is common with CoaXPress, bandwidths of 50 Gbps (12.5 x 4) are easily achievable with four CXP-12 links.

CoaXPress-over-Fiber has been designed as an add-on to the CoaXPress 2.0 specification. It provides a way to run the CoaXPress protocol, as it is, unmodified, over a standard Ethernet connection, including fiber optics. As such, CoaXPress-over-Fiber uses standard electronics, connectors and cables designed for Ethernet, but the protocol is CoaXPress, not Ethernet, not GigE Vision.

Euresys and Sensor to Image have started the development and demonstration of CoaXPress-over-Fiber in 2018. The CoaXPress-over-Fiber specification has now been approved as an add-on to the CoaXPress 2.0 standard, which is hosted by the JIIA (Japan Industrial Imaging Association).

What are the advantages of using Ethernet connectivity?

By using Ethernet connectivity, CoaXPress-over-Fiber benefits from the low-cost standard equipment (such as connectors and cables) designed for Ethernet. Ethernet is defined by IEEE 802.3 standards; by leveraging these standards, CoaXPress-over-Fiber will also benefit from the constant evolution of Ethernet towards higher bandwidths

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What are the pros and cons of using fiber optics?

Pros

- First and foremost, cable length is not an issue anymore as fiber connectivity is basically not limited in length.
- Fiber optics provide more bandwidth, as connectivity at 10, 25 and 50 Gbps per fiber is standard today and widely used in data centers.
- Fiber optics are immune to electrical noise, which is a significant advantage on the production floor in and some medical applications.
- Fiber optics are lighter and smaller in size than the equivalent copper cabling, making it appropriate for applications where this characteristic is essential, like in aircrafts or vehicles.

Cons

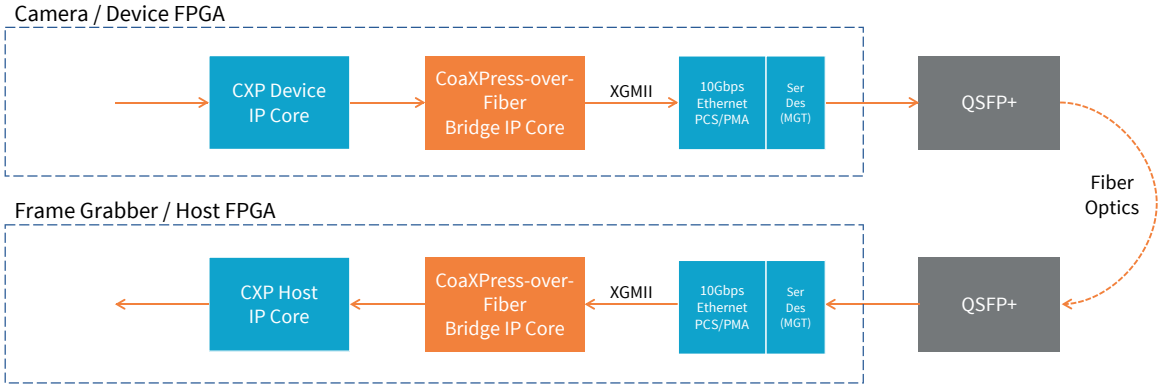
There is no «power over fiber». As signals in fiber optics are transmitted using light, there is no way to transfer power over fiber optics and devices such as cameras must be powered separately.

What does CoaXPress-over-Fiber mean for camera makers?

As CoaXPress-over-Fiber is an add-on to the CoaXPress standard, existing CoaXPress cameras can relatively easily be upgraded to CoaXPress-over-Fiber, without any significant redevelopment or test of a new protocol.

FPGAs already in use in CoaXPress cameras include many features to support the Ethernet standard. The 10 Gbps Media Independent Interface (XGMII), defined in IEEE Std 802.3 Clause 46, is the main access to the 10G Ethernet physical layer. The generic nature of this interface facilitates mapping the CoaXPress signaling into the PCS/PMA Ethernet sublayers. The use of the XGMII also allows CoaXPress to be ready to support higher bandwidths via the 25 Gbps Media Independent Interface (25GMII), defined in IEEE Std 802.3 Clause 106. The 25GMII is a speeded-up version of the XGMII while being logically equivalent to it.

Sensor to Image, a Euresys company, provides CoaXPress-over-Fiber Bridge IP Cores (CXP to XGMII and XGMII to CXP) compliant with the standard



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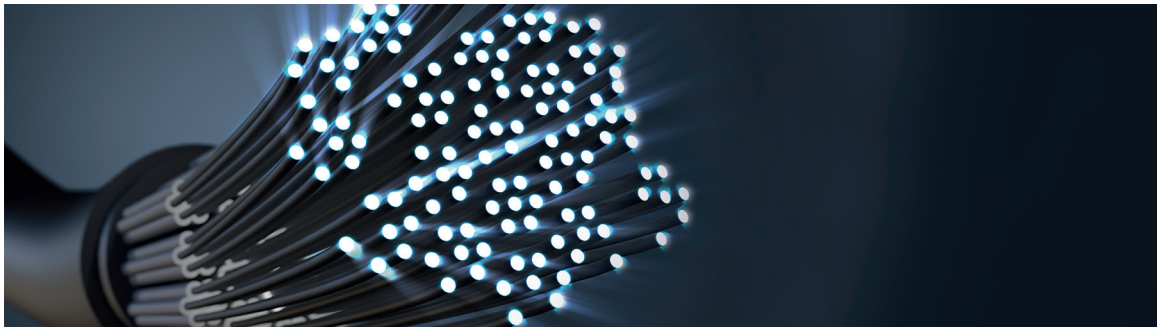
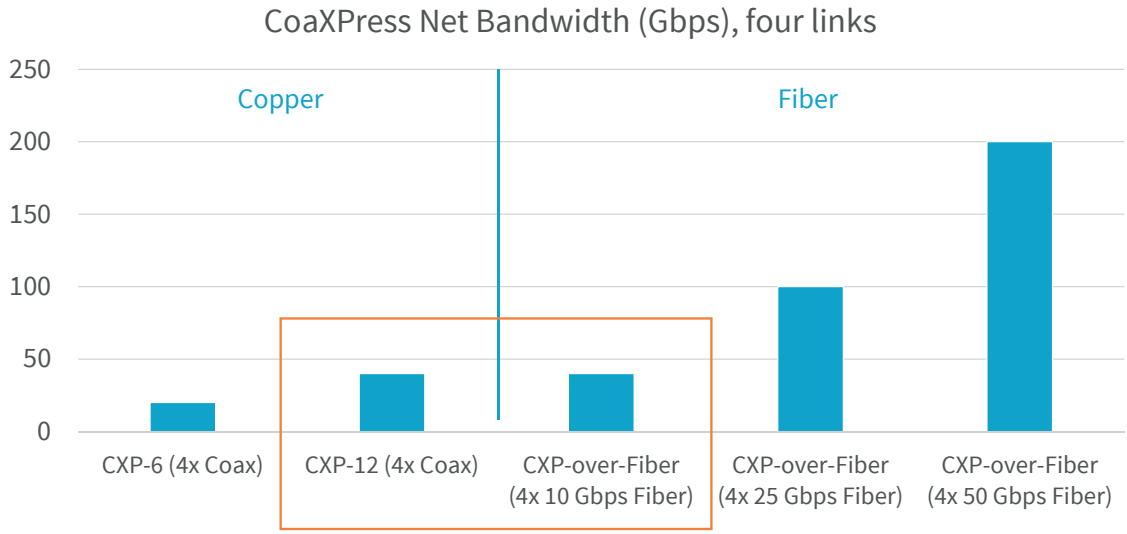


What is the bandwidth of CoaXPress-over-Fiber?

The initial configuration of CoaXPress-over-Fiber is 4 x 10 Gbps on a single QSFP+ module for a total of 40 Gbps per camera. This represents exactly the same net bandwidth as four CXP-12 links over four copper coaxial cables. There is however a clear upgrade path for CoaXPress-over-Fiber towards 4 x 25 Gbps = 100 Gbps with, for example, QSFP28 modules and 4 x 50 Gbps = 200 Gbps with QSFP56 modules;



What does CoaXPress-over-Fiber mean for end-users?

By leveraging Ethernet connectivity, CoaXPress-over-Fiber benefits from the low-cost standard equipment (such as connectors and cables) designed for Ethernet, as well as the constant evolution of Ethernet towards higher bandwidths. End-users can expect products that satisfy the future demand for higher resolution imaging as well as higher inspection speed and reliability.

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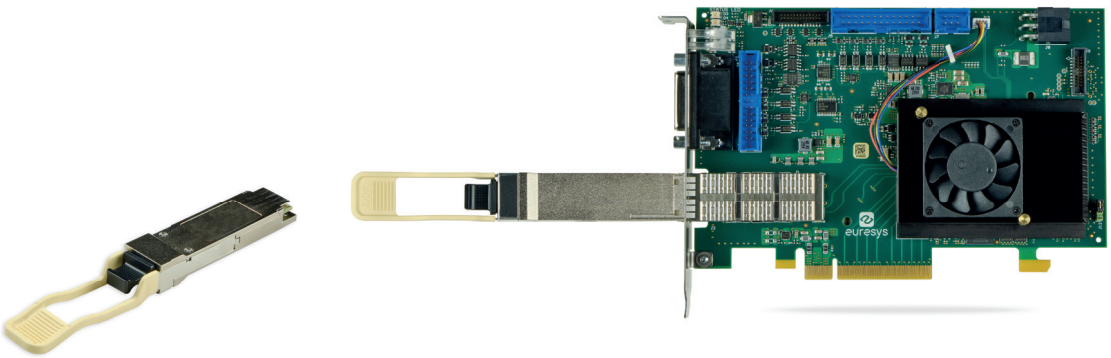
What are the cable options for CoaXPress-over-Fiber and what is the maximum cable length?

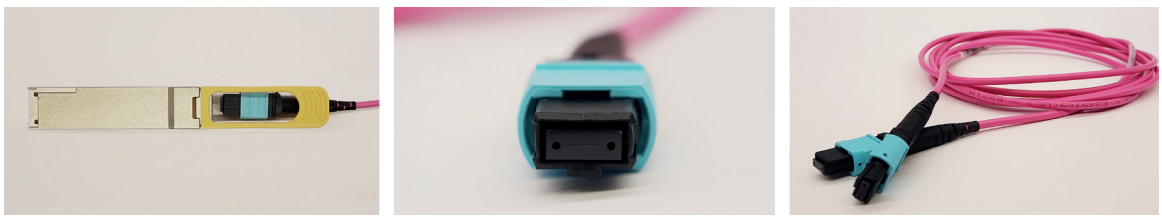
One of the most important benefits of CoaXPress-over-Fiber is the wide variety of connectivity options already available from multiple companies. The initial connectivity options for CoaXPress-over-Fiber at 10 Gbps are SFP+ and QSFP+ (Quad, or four times SFP+) modules.

The advantage of using modules compared to fixed interfaces is that ports can be equipped with any suitable type of transceiver as required by the application. A variety of transmitter and receiver types is available, allowing users to select the appropriate transceiver to provide the required optical reach over multi-mode or single-mode fiber.



Euresys Coaxlink QSFP+ fitted with an AOC (Active Optical Cable) transceiver

The first option is using a 40GBASE-SR4 QSFP+ Optical Transceiver Module for multi-mode fibers. It uses an MTP/MPO fiber connector with a maximum 150-meter fiber optic cable. This solution is suitable for machine vision applications.



40GBASE-SR4 QSFP+ 850nm 150m MTP/MPO Optical Transceiver Module for MMF
MTP/MPO fiber connector, with maximum 150 m fiber optic cable

The second option is using a 40GBASE-ER4 QSFP+ LC DOM Optical Transceiver Module for single-mode fibers. It uses an LC-Duplex fiber connector with a maximum 40-km fiber optic cable. This solution is suitable, for example, for video transmission applications.

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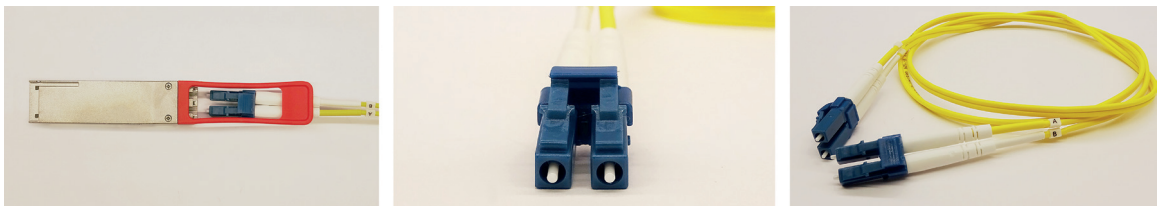

40GBASE-ER4 QSFP+ 1310nm 40km LC DOM Optical Transceiver Module for SMF
LC-Duplex fiber connector, with maximum 40 km fiber optic cable

Breakout active optical cables are also available. They feature a 40G QSFP+ transceiver (for the frame grabber) on one side and four 10G SFP+ transceivers (for four cameras) on the other side.

These solutions are future proof as higher speed options are already available. The SFP28 iteration is designed for speeds of 25 Gbps. The QSFP28 (Quad SFP28) variant allows speeds up to 100 Gbps. Already in 2019, QSFP56 was standardized, doubling the top speeds to 200 Gbps with products already selling from major vendors. There are also inexpensive adapters allowing SFP transceivers to be placed in a QSFP port.

What are the benefits of using CoaXPress-over-Fiber for my application?

- Ultra-high data/frame rates
- Many accessory and cabling options to cover any length requirement
- Low CPU overhead, low latency, low jitter image acquisition
- Highest camera count per PC performance
- Very competitive cost/performance ratio
- Wide industry acceptance due to JIIA and IEEE standardization

What are the jitter and latency of CoaXPress-over-Fiber? How do they compare to «traditional» CoaXPress?

CoaXPress-over-Fiber is based on the CoaXPress protocol and it exhibits the same high performance as CoaXPress in terms of jitter and latency. In addition, as CoaXPress-over-Fiber supports higher transmission speed compared to CoaXPress, the jitter and latency will be further improved in these versions.

How do CoaXPress and CoaXPress-over-Fiber compare with other vision interfaces in general?

CoaXPress is successful because of its unique combination of

- High bandwidth
- Low latency (including trigger latency)
- High stability / reliability

CoaXPress-over-Fiber is CoaXPress, it features and further develops the same advantages.

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How do CoaXPress and CoaXPress-over-Fiber compare with GigE Vision?

In terms of image transfer bandwidth

CoaXPress and CoaXPress-over-Fiber easily support link aggregation and most CoaXPress cameras currently use two or four links. Similarly, CoaXPress frame grabbers offer from one to eight connections per card. The initial configuration of CoaXPress-over-Fiber is 4 x 10 Gbps for a total of 40 Gbps (the same net bandwidth as four CXP-12 links). There is a clear upgrade path towards 8 x 10 Gbps = 80 Gbps, 4 x 25 Gbps = 100 Gbps and 4 x 50 Gbps = 200 Gbps.

On the contrary, link aggregation with GigE Vision is difficult and most GigE Vision cameras use only one link.

In terms of image acquisition stability

The data packet management of the CoaXPress protocol is simpler. It is done by the frame grabber or interface card, using dedicated hardware, ensuring low latency and stable image acquisition without loading the host CPU.

On the contrary, GigE Vision applications use standard Network Interface Cards (NIC) where data packet management is done by the driver, while significantly loading the host CPU.

Overall, CoaXPress provides more stable, reliable image transfer without loading the host CPU. This will be even more true at higher speeds.

What operating systems are supported?

CoaXPress-over-Fiber is independent from any operating system. As of today, CoaXPress frame grabbers support Windows, Linux, macOS and/or specialized embedded Operating Systems; the same will apply to CoaXPress-over-Fiber.

Do CoaXPress-over-Fiber cameras work with GenICam compatible software?

Yes. CoaXPress-over-Fiber is an add-on to CoaXPress, they both include mandatory support for GenICam.

Which CoaXPress-over-Fiber products are available?

- The Coaxlink QSFP+, a CoaXPress-over-Fiber PCIe frame grabber with a QSFP+ cage providing four bidirectional 10 Gbps links is available from Euresys.
- A CoaXPress-over-Fiber Bridge IP Core is available from Sensor to Image.