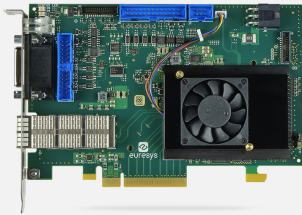**euresys**
Empowering Computer Vision

# Coaxlink QSFP+

Four-connection CoaXPress-over-Fiber frame grabber

## At a Glance

- One QSFP+ port compliant with 40 Gbps optical modules
- 5,000 MB/s camera bandwidth
- PCIe 3.0 (Gen 3) x8 bus: 6,700 MB/s bus bandwidth
- Feature-rich set of 20 digital I/O lines
- Extensive camera control functions
- Memento Event Logging Tool

## Benefits

### 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. CoaXPress2.0, 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. The CoaXPress specification is hosted by the JIIA (Japan Industrial Imaging Association).

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.

Read more about CoaXPress-over-Fiber on our technology page.

### PCIe 3.0 (Gen 3) x8 bus

- 7,800 MB/s peak bus bandwidth
- 6,700 MB/s sustained bus bandwidth

### Acquire images from the fastest and highest resolution cameras

- Highest data acquisition rate in the industry
- Up to 50 Gbit/s (5,000 MB/s) bandwidth from camera to host PC memory

### 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 and 25 Gbps per fiber is standard today and widely used in data centers.
- Fiber optics are immune to electrical noise, which will be 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 are the cable options for CoaXPress-over-Fiber?

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 and the Coaxlink QSFP+ 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.

## 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.

## What is the maximum cable length with multi-mode fibers?

With a standard 40GBASE-SR4 QSFP+ Optical Transceiver Module and an MTP/MPO fiber connector for multi-mode fibers, the maximum fiber optic cable length can reach 150 meters. This solution is suitable for machine vision applications.

## What is the maximum cable length with single-mode fibers?

With a standard 40GBASE-ER4 QSFP+ LC DOM Optical Transceiver Module and an LC-Duplex fiber connector for single-mode fibers, the maximum fiber optic cable length can reach 40 kilometers. This solution is suitable, for example, for video transmission applications.

## What is the status of the CoaXPress-over-Fiber standard?

As of October 2020

Euresys and Sensor to Image have started the development and demonstration of CoaXPress-over-Fiber in 2018. Since early 2020, Euresys and the CoaXPress Workgroup, which includes most major vision manufacturers, are working within the JIIA on the review of the specification as an add-on to the CoaXPress standard.

The publication of the final specification is expected in the coming months.

Meanwhile, an "Optical Interface Guideline for CoaXPress" which details fiber optics connector options for CoaXPress has been published by the JIIA in January 2020.

## Memento Event Logging Tool

- Memento is an advanced development and debugging tool available for Coaxlink cards.
- Memento records an accurate log of all the events related to the camera, the frame grabber and its driver as well as the application.

- It provides the developer with a precise timeline of time-stamped events, along with context information and logic analyzer view.
- It provides valuable assistance during application development and debugging, as well as during machine operation.

## Direct GPU transfer

- Sample programs for AMD DirectGMA and NVIDIA (CUDA) available.
- Direct GPU transfer eliminates unnecessary system memory copies, lowers CPU overhead, and reduces latency, resulting in significant performance improvements in data transfer times for applications.
- Direct capture of image data to GPU memory is available using AMD's DirectGMA. Compatible with AMD FirePro W5x00 and above and all AMD FirePro S series products.

## General purpose I/O lines compatible with a wide range of sensors and motion encoders

## High-performance DMA (Direct Memory Access)

- Direct transfer into user-allocated memory
- Hardware scatter-gather support

## Area-scan triggering capabilities

- A trigger is used to start the acquisition when the part is in position. Hardware triggers come from the Coaxlink's I/O lines. Software triggers come from the application.
- An optional trigger delay is available to postpone the acquisition for a programmable time.
- A trigger decimation function allows to skip some of the triggers.
- Camera exposure control allows the application to control the exposure time of the camera.
- When the acquisition starts, at the appropriate timing, the Coaxlink board generates a signal to control an illumination device connected to one of its output lines.

## Windows, Linux and macOS drivers available

- Including support for Intel 32-bit and 64-bit platforms as well as ARM 64-bit platforms

## Compliant with Genicam

Including support for

- GenApi
- The Standard Feature Naming Convention (SFNC)
- GenTL

## Compatible with eGrabber

- eGrabber Studio: eGrabber's new interactive evaluation and demonstration application
- Genicam Browser: An application giving access to the Genicam features exposed by the GenTL Producer(s)
- GenTL Console: A command-line tool giving access to the functions and commands exposed by the Euresys GenTL Producer

## Specifications

### Mechanical

| Format | Standard profile, half length, 8-lane PCI Express card |
|---|---|
| Cooling method | Air cooling, fan-cooled heatsink |
| Mounting | For insertion in a standard height, 8-lane or higher, PCI Express card slot |

| | |
|---|---|
| Connectors | • 'QSFP+' on bracket:<br>  − Enhanced Quad Small Form-factor Pluggable port<br>  − CoaXPress-over-Fiber host interface<br>• 'EXTERNAL I/O' on bracket:<br>  − 26-pin 3-row high-density female sub-D connector<br>  − I/O lines and power output<br>• 'INTERNAL I/O 1' and 'INTERNAL I/O 2' on PCB:<br>  − 2x 26-pin 2-row 0.1" pitch pin header with shrouding<br>  − I/O lines and power output<br>• 'I/O EXTENSION' on PCB:<br>  − 26-pin 2-row 0.05" pitch pin header with shrouding<br>  − I/O extension lines and power output<br>• 'AUXILIARY POWER INPUT' on module:<br>  − 6-pin PEG power socket<br>  − 12 VDC power input for I/O power<br>• 'C2C-LINK' on module:<br>  − 6-pin 2-row 0.1" header<br>  − Card to card link |
| LED indicators | • 'A', 'B', 'C', 'D' on bracket:<br>  − Bi-color red/green LEDs<br>  − CoaXPress Host connector indicator<br>• 'FPGA STATUS LAMP' on PCB:<br>  − Bi-color red/green LED<br>  − FPGA status indicator<br>• 'BOARD STATUS LAMP' on PCB:<br>  − Bi-color red/green LED<br>  − Board status indicator |
| Switches | 'RECOVERY' on card PCB:<br>• 3-pin 1-row 0.1" header<br>• Firmware emergency recovery |
| Dimensions | L 167.65 mm x H 111.15 mm<br>L 6.6 in x H 4.38 in |
| Weight | 176 g, 6.21 oz (without transceiver) |

## Host bus

| | |
|---|---|
| Standard | PCI Express 3.0 |
| Link width | • 8 lanes<br>• 1 lane, 2 lanes or 4 lanes with reduced performance |
| Link speed | • 8.0 GT/s (PCIe 3.0)<br>• 5.0 GT/s (PCIe 2.0)  with reduced performance |
| Maximum payload size | 512 bytes |
| DMA | 32- and 64-bit |
| Peak delivery bandwidth | 7,800 MB/s |
| Effective (sustained) delivery bandwidth | 6,700 MB/s (Host PC motherboard dependent) |
| Power consumption | Typ. 16.5 W ( 3.0 W @ +3.3V, 12.5 W @ +12V), excluding I/O power output and optical transceiver module |

## Camera / video inputs

| | |
|---|---|
| Interface standard(s) | CoaXPress 1.0, 1.1, 1.1.1 and 2.0, CoaXPress-over-Fiber |
| Connectors | • Enhanced Quad Small Form-factor Pluggable (QSFP+) port<br>• Compliant with SFF-8436 (4 x10 Gbit/s Pluggable Transceiver) specification<br>• Compliant with CoaXPress over Fiber<br>• Available power for the module: 3.5 W (SFF-8436 Power Level 4) |
| Status LEDs | One CoaXPress Host connection status LED per connection |
| Number of cameras | One 1- or 2- or 4-connection camera |
| Maximum aggregated camera data transfer rate | 5,000 MB/s |
| Supported CXP down-connection speeds | 1.25 GT/s (CXP-1), 2.5 GT/s (CXP-2), 3.125 GT/s (CXP-3), 5 GT/s (CXP-5), 6.25 GT/s (CXP-6), 10.0 GT/s (CXP-10), and 12.5 GT/s (CXP-12) |
| Supported CXP up-connection speeds | • Low-speed 20.83... Mbps (CXP-1 to CXP-6)<br>• Low-speed 41.6... Mbps (CXP-10, CXP-12)<br>• High-speed (CXP-1 to CXP-12) |
| Number of CXP data streams (per camera) | 1 data stream per camera |
| Maximum CXP stream packet size | 16,384 bytes |
| Camera types | Area-scan cameras:<br>• Grayscale and color (YCbCr, YUV, RGB and Bayer CFA)<br>• Single-tap (1X-1Y) progressive-scan |
| Camera pixel formats supported | Raw, Monochrome, Bayer, RGB, and RGBA (PFNC names):<br>• Raw<br>• Mono8, Mono10, Mono12, Mono14, Mono16<br>• BayerXX8, BayerXX10, BayerXX12, BayerXX14, BayerXX16 where XX = GR, RG, GB, or BG<br>• RGB8, RGB10, RGB12, RGB14, RGB16<br>• RGBA8, RGBA10, RGBA12, RGBA14, RGBA16<br>• YCbCr601_422_8, YCbCr601_422_10<br>• YCbCr709_422_8, YCbCr709_422_10<br>• YUV422_8, YUV422_10 |

## Area-scan camera control

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|---|---|
| Trigger | • Precise control of asynchronous reset cameras, with exposure control.<br>• Support of camera exposure/readout overlap.<br>• Support of external hardware trigger, with optional delay and trigger decimation. |
| Strobe | • Accurate control of the strobe position for strobed light sources.<br>• Support of early and late strobe pulses. |

## On-board processing

| | |
|---|---|
| On-board memory | 4 GB |
| Image data stream processing | • Unpacking of 10-/12-/14-bit to 16-bit with selectable justification to LSb or MSb<br>• Optional swap of R and B components<br>• Little endian conversion |
| Input LUT (Lookup Table) | Only available for monochrome cameras:<br>• 8 to 8 bits<br>• 10 to 8, 10 or 16 bits<br>• 12 to 8, 12 or 16 bits |

| Data stream statistics | • Measurement of: |
|---|---|
| |    – Frame rate (Area-scan only) |
| |    – Line rate |
| |    – Data rate |
| | • Configurable averaging interval |
| Event signaling and counting | • The application software can be notified of the occurrence of various events: |
| |    – Standard event: the EVENT_NEW_BUFFER event notifies the application of newly filled buffers |
| |    – A large set of custom events |
| | • Custom events sources: |
| |    – I/O Toolbox events |
| |    – Camera and Illumination control events |
| |    – CoaXPress data stream events |
| |    – CoaXPress host interface events |
| | • Each custom event is associated with a 32-bit counter that counts the number of occurrences |
| | • The last three 32-bit context data words of the event context data can be configured with event-specific context data: |
| |    – Event-specific data |
| |    – State of all System I/O lines sampled at the event occurrence time |
| |    – Value of any event counter |

## General Purpose Inputs and Outputs

| Number of lines | 20 I/O lines: |
|---|---|
| | • 4 differential inputs (DIN) |
| | • 4 singled-ended TTL inputs/outputs (TTLIO) |
| | • 8 isolated inputs (IIN) |
| | • 4 isolated outputs (IOUT) |
| | NOTE: The number of I/O lines can be extended using I/O modules attached to the I/O EXTENSION connector. |
| Usage | • Any I/O input lines can be used by any LIN tool of the I/O Toolbox |
| | • Selected pairs of I/O input lines can be used by any QDC tool of the I/O toolbox to decode A/B signals of a motion encoder |
| | • The LIN and QDC tools outputs can be further processed by the other tools (DIV, MDV, DEL) of the I/O toolbox to generate any of the following "trigger" events: |
| |    – The "cycle trigger" of the Camera and Illumination controller |
| |    – The "cycle sequence trigger" of the Camera and Illumination controller |
| |    – The "start-of-scan trigger" of the Acquisition Controller (line-scan only) |
| |    – The "end-of-scan trigger" of the Acquisition Controller (line-scan only) |
| Electrical specifications | • DIN:  High-speed differential inputs compatible with ANSI/EIA/TIA-422/485 differential line drivers and complementary TTL drivers |
| | • TTLIO: High-speed 5V-compliant TTL inputs or LVTTL outputs, compatible with totem-pole LVTTL, TTL, 5V CMOS drivers or LVTTL, TTL, 3V CMOS receivers |
| | • IIN: Isolated current-sense inputs with wide voltage input range up to 30V, compatible with totem-pole 5V CMOS drivers, RS-422 differential line drivers, potential free contacts, solid-state relays and opto-couplers |
| | • IOUT: Isolated contact outputs compatible with 30V / 100mA loads |

| | |
|---|---|
| Filter control | • Glitch removal filter available on all System I/O input lines<br>• Configurable filter time constants:<br>  − for DIN and TTLIO lines: 50 ns, 100 ns, 200 ns, 500 ns, 1 µs<br>  − for IIN lines: 500 ns, 1 µs, 2 µs, 5 µs, 10 µs |
| Polarity control | Yes |
| Power output | Non-isolated, +12V, 1A, with electronic fuse protection |
| I/O Toolbox tools | The I/O Toolbox is a configurable interconnection of tools that generates events (usually triggers) from input lines. The composition of the toolset is product- and firmware-dependent.<br>• Line Input tool (LIN): Edge detector delivering events on rising or falling edges of any selected input line.<br>• Quadrature Decoder tool (QDC): A composite tool including:<br>  − A quadrature edge detector delivering events on selected transitions of selected pairs of input lines.<br>  − An optional backward motion compensator for clean line-scan image acquisition when the motion is unstable.<br>  − A 32-bit up/down counter for delivering a position value.<br>• Divider tool (DIV): to generate an event every nth input events from any I/O toolbox event source.<br>• Multiplier/divider tool (MDV): to generate m events every d input events from any I/O toolbox event source.<br>• Delay tool (DEL): to delay up to 16 events from one or two I/O toolbox event sources, by a programmable time or number of motion encoder ticks (any QDC events).<br>• User Actions Scheduler tool (UAS): to delegate the execution of User Actions at a scheduled time or encoder position. Possible user actions include setting low/high/toggle any bit of the User Output Register or generation of any User Events. |
| I/O Toolbox composition | 8 LIN, 1 QDC, 1 DIV, 1 MDV, 2 DEL, 1 UAS |

## C2C-Link

| | |
|---|---|
| Description | • Accurate synchronization of the trigger and the start-of-exposure of multiple grabber-controlled area-scan cameras.<br>• Accurate synchronization of the start-of-cycle, start-of-scan and end-of-scan of multiple grabber-controlled line-scan cameras. |
| Specification | • C2C-Link synchronizes cameras connected to:<br>  − the same card<br>  − to different cards in the same PC (requires an accessory cable such as the "3303 C2C-Link Ribbon Cable" or a custom-made C2C-Link cable)<br>  − to different cards in different PCs (requires one "1636 InterPC C2C-Link Adapter" for each PC and one RJ 45 CAT 5 STP straight LAN cable for each adapter but the last one)<br>• Maximum distance:<br>  − 60 cm inside a PC<br>  − 1200 m cumulated adapter to adapter cable length<br>• Maximum trigger rate:<br>  − 2.5 MHz for configurations using a single PC, or up to 10 PCs and 100 m total C2C-Link cable length<br>  − 200 kHz for configurations up to 32 PCs and 1200m total C2C-Link cable length<br>• Trigger propagation delay from master to slave devices:<br>  − Less than 10 ns for cameras on the same card or on different cards in the same PC<br>  − Less than 265 ns for cameras on different cards in different PCs (3 PCs and 40m total C2C-Link cable length) |

## Software

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|---|---|
| Host PC Operating System | • Microsoft Windows 10, 8.1, 7 for x86 (32-bit) and x86-64 (64-bit) processor architectures |
| | • Linux  for x86 (32-bit), x86-64 (64-bit) and aarch64 (64-bit) processor architectures |
| | • macOS for x86-64 (64-bit) processor architecture |
| | Refer to release notes for details |
| APIs | EGrabber class, with C++ and .NET APIs: |
| | • .NET assembly designed to be used with development environments compatible with .NET frameworks version 4.0 or higher |
| | GenICam GenTL producer libraries compatible with C/C++ compilers: |
| | • x86 dynamic library designed to be used with ISO-compliant C/C++ compilers for the development of x86 applications |
| | • x86_64 dynamic library designed to be used with ISO-compliant C/C++ compilers for the development of x86_64 applications |
| | • aarch64 dynamic library designed to be used with ISO-compliant C/C++ compilers for the development of aarch64 applications |

## Environmental conditions

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|---|---|
| Operating ambient air temperature | 0 to +55 °C / +32 to +131 °F |
| Operating ambient air humidity | 10 to 90% RH non-condensing |
| Storage ambient air temperature | -20 to +70 °C/ -4 to +158 °F |
| Storage ambient air humidity | 10% to 90% RH non-condensing |

## Certifications

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|---|---|
| Electromagnetic - EMC standards | • European Council EMC Directive 2004/108/EC |
| | • United States FCC rule 47 CFR 15 |
| EMC - Emission | • EN 55022:2010 Class B |
| | • FCC 47 Part 15 Class B |
| EMC - Immunity | • EN 55024:2010 Class B |
| | • EN 61000-4-3 |
| | • EN 61000-4-4 |
| | • EN 61000-4-6 |
| Flammability | PCB compliant with UL 94 V-0 |
| RoHS | European Union Directive 2015/863 (ROHS3) |
| REACH | European Union Regulation 1907/2006 |
| WEEE | Must be disposed of separately from normal household waste and must be recycled according to local regulations |

## Ordering Information

| | |
|---|---|
| Product code - Description | • 3625 - Coaxlink QSFP+ |
| Optional accessories | • 1625 - DB25F I/O Adapter Cable |
| | • 1636 - InterPC C2C-Link Adapter |
| | • 3303 - C2C-Link Ribbon Cable |
| | • 3304 - HD26F I/O Adapter Cable |
| | • 3610 - HD26F I/O Extension Module TTL-RS422 |
| | • 3612 - HD26F I/O Extension Module TTL-CMOS5V-RS422 |

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