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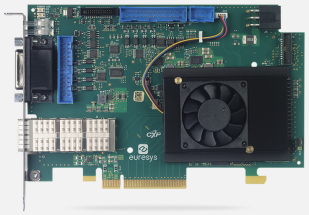
Empowering Computer Vision

Coaxlink QSFP+

四路 CoaXPress-over-Fiber 采集卡



特性一览

- 1 个符合 40 Gbps 光学模块要求的 QSFP+ 端口
- 5,000 MB/s 相机带宽
- PCIe 3.0 (Gen 3) x8 总线：6,700 MB/s 总线带宽
- 特征丰富的 20 条数字 I/O 线
- 丰富的相机控制功能
- Memento 事件日志工具
- 兼容CustomLogic：您自己的FPGA逻辑

优势

CoaXPress-over-Fiber 是什么？

CoaXPress-over-Fiber 是对现有 CoaXPress 规范进行的较少但却很重要的扩展，旨在支持光纤传输。

CoaXPress (CXP)是业界高带宽计算机视觉应用标准。最新版CoaXPress 2.1规范中规定了CXP-12速度，即通过同轴铜缆进行12.5 Gbps（千兆位每秒）连接。由于链路聚合在CoaXPress中很常见，因此四路CXP-12连接可以轻松实现50 Gbps (12.5 x 4)的带宽。CoaXPress-over-Fiber是CoaXPress规范的附加部分。它提供了一种通过标准以太网连接（包括光纤）运行未经修改的CoaXPress协议的方法。因此，CoaXPress-over-Fiber使用为以太网设计的标准电子设备、连接器和电缆，但所采用的协议既不是以太网，也不是GigE Vision，而是CoaXPress。

阅读技术页面上有关CoaXPress-over-Fiber的更多信息。

PCIe 3.0 (Gen 3) x8 总线

- 7,800 MB/s 峰值总线带宽
- 6,700 MB/s 持续总线带宽

连接最快速最高分辨率的相机来采集图像

- 在同行业中最高的数据采集速率
- 相机到主机PC内存的带宽高达5,000 MB/s

使用光纤有何优缺点？

优点

- 首先，由于光纤连接长度基本不受限制，因此电缆长度不再是问题。
- 光纤提供更高的带宽，如今每条光纤的标准连接速度为 10 Gbps 和 25 Gbps，并且在数据中心得到广泛使用。
- 光纤不受电噪声的影响，对于生产车间和某些医疗应用而言，这是一大重要优势。
- 光纤比同等的铜缆更轻便、小巧，很适合于必须具备这一特点的应用，例如飞机或车辆。

缺点

- 不能“通过光纤传送电能”。由于光纤中的信号通过光传输，因此无法通过光纤传送电能，诸如相机等设备必须单独供电。

CoaXPress-over-Fiber 的电缆选择有哪些？

CoaXPress-over-Fiber 最重要的优势之一，就是众多公司已提供多种连接选择。10 Gbps CoaXPress-over-Fiber 和 Coaxlink QSFP+ 的的初始连接选择有 SFP+ 和 QSFP+（Quad 或四倍 SFP+）模块。
相较于固定接口，使用模块的优势在于可以根据应用要求为端口配备任何合适类型的收发器。由于可以使用的发送器和接收器类型多样，因此用户可以选择合适的收发器，通过多模或单模光纤提供所需的光学范围。

使用 CoaXPress-over-Fiber 有何益处？

- 可作为CXP至nGMII（设备）或nGMII至CXP（主机）Bridge IP Core
- 超高数据/帧率
- 提供多种附件和布线方案，能满足任何长度要求
- CPU 开销低，延迟低，图像采集抖动程度低
- 就 PC 性能而言，支持的相机数量最多
- 极具竞争力的性价比
- 由于实现了JIIA标准化，得到了业界的广泛认可
- 适用于 CXP25

CoaXPress-over-Fiber 的抖动和延迟是多少？它们与“传统”CoaXPress 相比如何？

CoaXPress-over-Fiber 基于 CoaXPress 协议，在抖动和延迟方面，其性能与 CoaXPress 一样高。另外，CoaXPress-over-Fiber 比 CoaXPress 支持的传输速度更高，因此这些版本中的抖动和延迟将得到进一步改善。

多模光纤的最大电缆长度是多少？

使用标准的40GBASE-SR4 QSFP+光纤收发器模块和MTP/MPO多模光纤电缆时，电缆最大长度可达150米。这种解决方案适合于机器视觉应用。

单模光纤的最大电缆长度是多少？

使用标准的40GBASE-ER4 QSFP+ LC DOM光纤收发器模块和用于单模光纤的LC双工时，最大电缆长度可达40公里。这种解决方案适合于视频传输应用等。

Memento 事件日志工具

- Memento是供Coaxlink和Grablink卡使用的高级开发和调试工具。
- Memento 记录与相机、图像采集卡及其驱动程序以及应用程序相关的所有事件的准确日志。
- 对于包含时间戳的时间，它为开发人员提供精确的时间表，也提供上下文信息和逻辑分析器视图。
- 它可以在应用程序开发和调试，以及机器操作期间提供宝贵的协作。

CustomLogic：制定您自己的 FPGA 逻辑！

- CustomLogic 是一款 FPGA 设计套件，可以用它进行设计，并将 FPGA 代码上传到 Coaxlink 板上
- 它兼容Coaxlink Octo、Coaxlink Quad CXP-12和Coaxlink QSFP+，AMD Kintex Ultrascale XCKU035 FPGA资源的利用率高达70%。
- 设计阶段使用 Xilinx Vivado 开发工具（不提供）。
- 使用 CustomLogic 时无需任何附加硬件

直接GPU传输

- 可提供用于AMD DirectGMA和NVIDIA (CUDA)的样例程序。
- GPU 直接传输消除了不必要的系统内存副本，降低了 CPU 开销，减少了延迟，从而显著改善了应用程序的数据传输时间。
- 使用AMD的DirectGMA，可直接将图像数据采集到GPU内存。兼容AMD FirePro W5x00和更高版本以及所有AMD FirePro S系列产品。

通用 I/O 线兼容多种传感器和运动编码器

高性能 DMA（直接存储器存取）

- 直接传送到用户分配的内存

- 硬件分散 – 聚集支持

区域扫描触发功能

- 触发器用于在零件就位时启动采集。硬件触发器来自 Coaxlink 的 I/O 线。软件触发器来自于应用程序。
- 可控的延时触发器，用来控制推迟图像采集的时间点。
- 触发抽取功能允许跳过某些触发器。
- 相机曝光控制允许应用来控制相机的曝光时间。
- 当系统开始采集图像时，Coaxlink采集卡会在一个适当的时间点生成信号来控制连接在输出端的照明设备。

线扫描触发能力 1/2

Coaxlink 支持连续滚网扫描（以检查无限、连续移动的表面而不丢失行）和离散的目标扫描（以采集在相机前方移动的目标图像）。

- 触发器用于在零件就位时启动采集。硬件触发器来自主板 I/O 线。软件触发器来自于应用程序。
- 启动以后，采集将：
  - 无限进行下去 (用于滚网式监测应用)
  - 继续进行可编程的行数（以采集已知长度的目标图像）
  - 继续进行直至收到结束触发信号（以采集可变长度的目标图像）
- 可控的延时触发器，用来以可编程的行数推迟开始采集。

线扫描触发能力 2/2

- Coaxlink 图像采集卡根据从运动编码器接收到的信号来控制相机扫描率。如果零件移动速度变快，相机的采集线率将增大。如果零件移动速度变慢，相机的采集线率将减小。
- Coaxlink 板解读来自正交运动编码器的 A/B 信号，了解零件向哪个方向（向前或向后）移动。
- 也可以在对象只向前移动或只向后移动时命令 Coaxlink 卡采集激光线。
- 监测到向后运动时，名为“向后动作取消”的功能即停止采集。当在采集中断位置再次向前运动时，自动恢复行采集。
- 速率转换器能够让相机以任何低于或高于运动编码器分辨率的可编程分辨率来采集行。这就为设计师在应用程序开发过程中提供了惊人的自由度和灵活度。
- 速率分割器允许相机采集的图像分辨率高于或低于运动编码器的分辨率，它实现于利用一个可编程的整数倍来对编码器输入信号进行分割。

Line-scan Metadata insertion

When activated, this feature records metadata beside image data. Line metadata are captured every acquired image line. Buffer metadata are only captured when the first image line of a buffer is acquired.

The metadata are composed with a configurable set of general purpose event counters, quadrature encoder position counters and/or I/O line status.

This feature allows line-scan applications to correlate image data with system events including motion encoder positions.

通过速率转换器实现灵活的线扫相机操作

- 速率转换器是一个智能的、可编程的倍频器/分频器。
- 用于运动编码器和线扫描相机，允许用户选择该图像中的像素纵横比。
- 它提供了一种方法来校准采集链以轻松达到正方形（1:1 纵横比）像素。

C2C-Link相机同步

可精确同步相连的多个面扫或线扫相机

- 同一张卡
- 同一台PC中的不同卡
- 不同PC中的不同卡

Windows、Linux和macOS驱动程序可用

- 支持英特尔64位平台以及ARM 64位平台

符合 Genicam 标准

包括支持

- GenApi
- 标准功能命名约定（SFNC）
- GenTL

兼容eGrabber

- eGrabber Studio：eGrabber新型交互式评估和演示应用程序
- GenICam 浏览器：该应用程序提供对 GenTL Producer 中 GenICam 功能的访问渠道。
- GenTL 控制台：该命令行工具提供对 Euresys GenTL Producer 功能和命令的访问渠道。

规格

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: – Enhanced Quad Small Form-factor Pluggable port – CoaXPress-over-Fiber host interface • 'EXTERNAL I/O' on bracket: – 26-pin 3-row high-density female sub-D connector – I/O lines and power output • 'INTERNAL I/O 1' and 'INTERNAL I/O 2' on PCB: – 2x 26-pin 2-row 0.1" pitch pin header with shrouding – I/O lines and power output • 'I/O EXTENSION' on PCB: – 26-pin 2-row 0.05" pitch pin header with shrouding – I/O extension lines and power output • 'AUXILIARY POWER INPUT' on module: – 6-pin PEG power socket – 12 VDC power input for I/O power • 'C2C-LINK' on module: – 6-pin 2-row 0.1" header – Card to card link
LED indicators	• 'A', 'B', 'C', 'D' on bracket: – Bi-color red/green LEDs – CoaXPress Host connector indicator • 'FPGA STATUS LAMP' on PCB: – Bi-color red/green LED – FPGA status indicator • 'BOARD STATUS LAMP' on PCB: – Bi-color red/green LED – Board status indicator

Switches	'RECOVERY' on PCB: • 3-pin 1-row 0.1" header or 2-way DIP switch • Firmware emergency recovery
Dimensions	PCB L X H: 167.65 mm x 111.15 mm, 6.6 in x 4.38 in
Weight	176 g, 6.21 oz (without transceiver)

Host bus

Standard	PCI Express 3.0
Link width	• 8 lanes • 1 lane, 2 lanes or 4 lanes with reduced performance
Link speed	• 8.0 GT/s (PCIe 3.0) • 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 Bridge Protocol 1.0
Connectors	• Enhanced Quad Small Form-factor Pluggable (QSFP+) port • Compliant with SFF-8436 (4 x10 Gbit/s Pluggable Transceiver) specification • Compliant with CoaXPress over Fiber • 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	• Area-scan cameras: – One 1- or 2- or 4-connection camera • Line-scan 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) • Low-speed 41.66... Mbps (CXP-10, 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: – Grayscale and color (YCbCr, YUV, RGB and Bayer CFA) – Single-tap (1X-1Y) progressive-scan • Line-scan cameras and contact imaging sensors: – Grayscale and color RGB

Camera pixel formats supported	• Mono8, Mono10, Mono12, Mono14, Mono16 • BayerXX8, BayerXX10, BayerXX12, BayerXX14, BayerXX16 where XX = GR, RG, GB, or BG • RGB8, RGB10, RGB12, RGB14, RGB16 • RGBA8, RGBA10, RGBA12, RGBA14, RGBA16 • YCbCr601_422_8, YCbCr601_422_10 • YCbCr709_422_8, YCbCr709_422_10 • YUV422_8, YUV422_10 • Raw

Area-scan camera control

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

Line-scan camera control

Scan/page trigger	• Precise control of start-of-scan and end-of-scan triggers. • Support of external hardware trigger, with optional delay. • Support of infinite acquisition, without missing line, for web inspection applications.
Line trigger	• Support for quadrature motion encoders, with programmable noise filters, selection of acquisition direction and backward motion compensation. • Rate Converter tool for fine control of the pixel aspect ratio: Rate Conversion Ratio in the range 0.001 to 1000 with an accuracy better than 0.1%. • Rate Divider tool
Line strobe	• Accurate control of the strobe position for strobed light sources.

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 • Optional swap of R and B components • Little endian conversion
Input LUT (Lookup Table)	• Monochrome 8-bit to 8-bit transformation • Monochrome 10-bit to 8-, 10- or 16-bit transformations • Monochrome 12-bit to 8-, 12- or 16-bit transformations
Bayer CFA to RGB decoder	'1-camera' firmware variant: • 3x3 linear interpolation method • 3x3 median-based interpolation method
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
Metadata Insertion	Recording of metadata beside image data. • The metadata are composed with a configurable set of general purpose event counters, quadrature encoder position counters and/or I/O line status. • Line metadata are captured every acquired image line. • Buffer metadata are only captured when the first image line of a buffer is acquired. • Allows line-scan applications to correlate image data with system events including motion encoder positions. NOTE: Only available on selected line-scan firmware variants. Refer to release notes.

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
Electrical specifications	• DIN: High-speed differential inputs, up to 5 MHz, 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: 200 kHz isolated current-sense input with wide voltage input range up to 30V, compatible with totem-pole (push-pull) HTL drivers, 5V TTL/RS-422 differential line drivers, 5V CMOS drivers, potential free contacts, solid-state relays and opto-couplers • IOUT: Isolated contact outputs compatible with 30V / 100mA loads NOTE: IIN and IOUT lines provide a functional isolation grade for the circuit technical protection. It does not provide an isolation that can protect a human being from electrical shock!

Filter control	• Glitch removal filter available on all System I/O input lines • Configurable filter time constants: – for DIN and TTLIO lines: 50 ns, 100 ns, 200 ns, 500 ns, 1 µs – 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): • Line Input tool (LIN): edge detector delivering events on rising or falling edges of any selected input line. • Quadrature Decoder tool (QDC): a composite tool including: – A quadrature edge detector delivering events on selected transitions of selected pairs of input lines. – An optional backward motion compensator for clean line-scan image acquisition when the motion is unstable. – A 32-bit up/down counter for delivering a position value. • Device Link Trigger tool (DLT): delivers an event on reception of a valid high-speed CoaXPress 2.0 connection trigger packet message from the remote device. • 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. • 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). • Divider tool (DIV): to generate an event every nth input events from any I/O toolbox event source. • Multiplier/divider tool (MDV): to generate m events every d input events from any I/O toolbox event source. • The 'Input Tools' (LIN, QDC, DLT and UAS) can be further processed by the 'Event Tools' (DEL, DIV and MDV) 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)
I/O Toolbox composition	Determined by the selected firmware variant: • '1-camera': 8 LIN, 1 QDC, 2 DLT,1 UAS, 2 DEL, 1 DIV, 1 MDV, 2 C2C • '1-camera, line-scan': 8 LIN, 1 QDC, 2 DLT, 1 UAS, 2 DEL, 1 DIV, 1 MDV, 3 C2C

C2C-Link

Description	• Accurate synchronization of the trigger and the start-of-exposure of multiple grabber-controlled area-scan cameras. • 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: – the same card – 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) – 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) • Maximum distance: – 60 cm inside a PC – 1200 m cumulated adapter to adapter cable length • Maximum trigger rate: – 2.5 MHz for configurations using a single PC, or up to 10 PCs and 100 m total C2C-Link cable length – 200 kHz for configurations up to 32 PCs and 1200m total C2C-Link cable length • Trigger propagation delay from master to slave devices: – Less than 10 ns for cameras on the same card or on different cards in the same PC – Less than 265 ns for cameras on different cards in different PCs (3 PCs and 40m total C2C-Link cable length)

Software

Host PC Operating System	• Microsoft Windows 11, 10, 8.1, 7 for x86-64 (64-bit) processor architecture • Linux for x86-64 (64-bit) and AArch64 (64-bit) processor architectures • macOS for x86-64 (64-bit) and AArch64 (64-bit) processor architectures
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_64' dynamic library designed to be used with ISO-compliant C/C++ compilers for the development of x86-64 (64-bit) applications – 'aarch64' dynamic library designed to be used with ISO-compliant C/C++ compilers for the development of AArch64 (64-bit) applications

Environmental conditions

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

Certifications

Electromagnetic - EMC standards	• European Council EMC Directive 2014/30/EU • United States FCC rule 47 CFR 15
EMC - Emission	• EN 55032:2015 / CISPR 32:2012 Class B • FCC 47 Part 15 Class B
EMC - Immunity	• EN 55035:2017 / CISPR 35:2016 • EN 61000-6-2:2005 / IEC 61000-6-2:2016 • EN 61000-4-2:2009 • EN 61000-4-3:2006 • EN 61000-4-4:2004 • EN 61000-4-6:2014
KC Certification	Korean Radio Waves Act, Article 58-2, Clause 3
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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