14 September 2020
Company confidential:
*This letter must **not** be forwarded to persons outside JAI's official distribution network.*

See the possibilities

To JAI's sales organization:

Launch of SW-8000T-10GE and SW-8000T-SFP (Sweep+ Series)

Following up on the launch of the industry's first 8K prism line scan cameras at the end of August, JAI is now completing the rollout by adding two new 8K 3-CMOS R/G/B models.

The SW-8000T-10GE and SW-8000T-SFP are equipped with three prism-mounted 8192-pixel CMOS line sensors to provide 8K color (R/G/B) image capture with a level of color and spatial precision not available from competitive 8K trilinear models.

Unlike trilinear cameras which must use compensation algorithms to account for the spacing between the lines in their multi-line sensors, the three prism-mounted sensors are precisely aligned to a common optical path. Because of this, the prism cameras are not affected by vibrations and speed variations typical of loose objects on conveyor belts or in free-fall sorting, which can cause color fringes or "halos" in images from non-prism cameras due to constantly changing parallax and keystone effects.

GIGE VISION

GENICAM

Both new cameras provide GigE Vision output at 10 GigE speeds. The difference is in the physical transport medium.

SW-8000T-10GE
SW-8000T-SFP
Highlights:

- New 3-CMOS prism-based RGB line scan cameras with 8K pixel resolution.
- 10GBASE-T copper interface (SW-8000T-10GE) and 10GBASE-R fiber interface (SW-8000T-SFP) provide high-speed, GenICam-compliant GigE Vision output.
- 8192 pixels (8K) per line.
- Up to 49.0 kHz at full 8-bit resolution (49,000 lines/s).
- 3.75 x 5.78 µm pixel size.
- Vertical dual-line binning, 2x horizontal binning, or both.
- Built-in color space conversions.
- Direct encoder connection to the camera.
- Precision time protocol support (IEEE 1588)

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See the possibilities

The SW-8000T-10GE model features a copper-based 10 GigE interface that also supports backward compatibility to 5 Gbps, 2.5 Gbps, and 1 Gbps Ethernet standards. The interface can automatically detect the capability of its PC or network connection and adjust accordingly for customers running vision applications on these lower-speed Ethernet standards.

The SW-8000T-SFP model features an "Enhanced Small Form-factor Pluggable" (SFP+) interface which delivers GigE Vision output via optical fiber cables. The SFP+ interface supports very long cables with low latency (low data transmission delay), low data transmission noise, as well as immunity to electromagnetic interference and system crosstalk.

Most of the basic specifications for the two models are identical and are shown in the table below:

	SW-8000T-10GE (NEW)	**SW-8000T-SFP (NEW)**	**SW-4000T-10GE (For comparison)**
No of channels:	3 x CMOS (R-G-B)	3 x CMOS (R-G-B)	3 x CMOS (R-G-B)
Pixel size:	3.75 µm x 5.78 µm	3.75 µm x 5.78 µm	7.5 µm x 7.5 µm or 7.5 µm x 10.5 µm
Pixels per line:	8192	8192	4096
Lines per sensor:	2 (for binning)	2 (for binning)	2 (for binning each pixel size – 4 total)
Max line rate: RGB8 RGB10 YUV8	 49 kHz 37 kHz 73 kHz	 49 kHz 37 kHz 73 kHz	 97 kHz 73 kHz 145 kHz
Interface	10GBASE-T (copper) with auto-negotiation to lower speeds	10GBASE-R (fiber) Power level 1	10GBASE-T (copper) with auto-negotiation to lower speeds (Also available with SFP+ interface)

The competition

Customers looking for 8K color line scan capability can choose between trilinear cameras, prism cameras, and a few bilinear (interpolated) cameras. Prism cameras are more expensive than the trilinear and bilinear models – 50% or more in some cases. To be successful, the customer must be convinced that they need a prism-based solution due to the issues described in the application section below and in Appendix A of this launch letter.

Teledyne Dalsa

The giant here is, of course, Teledyne Dalsa. You will likely encounter them in one way or another on any color line scan opportunity.

Piranha 4 (their classic series) has both bilinear and trilinear 8K models with Camera Link interfaces. The bilinear model runs at 50 kHz – roughly the same as the new SW-8000T models - while the trilinear runs at 33 kHz. This gives a slight edge to the new JAI models and some customers may also prefer the flexibility of the 10GigE or SFP+ interfaces. However, the Piranha 4 models have larger pixels, 7 µm and 7.5 µm, respectively, which may make them more attractive to some customers from a light gathering or a lensing standpoint.

Eliixa from the e2v side of Teledyne, also offers some 8K color models. These feature multi-line sensors with a filter pattern to provide interpolated color output. The custom sensor has 5 micron pixels and can produce RGB output at 50 kHz via a Camera Link interface. Again, some may prefer JAI's 10GigE or SFP+ interfaces, but the real issue is whether they need the advantages of the prism camera's single optical path as documented in the next section.

Linea ML is Dalsa's newest family of line scan cameras, offering 8K and 16K models in trilinear and quadlinear configurations. The original Linea cameras only had bilinear color models in Camera Link and GigE configurations. The GigE output was given a performance boost using Dalsa proprietary TurboDrive lossless compression technology so that both models could deliver 24-bit interpolated RGB output at up to 80 kHz. The Linea ML 8K trilinear camera features the same 5-micron pixel size but can run at up to *280* kHz (yowza!) over a Camera Link HS interface. So, if an extreme line rate is the key factor, and the cost and complexity of adopting a new CLHS interface standard is not a problem, this is tough to beat. But once again, it depends on whether the customer's application needs this (often they do not) and can accept the spatial compensation issues and angular magnification challenges of trilinear technology vs. prism technology.

Dalsa custom designs – As we noted in our SW-8000Q launch letter, one of Dalsa's biggest competitive threats is the fact that they control the sensor manufacturing process, making it relatively easy for them to offer custom solutions without ever appearing in their public product offering. Again, the most important things to focus on are the advantages of prism technology, which is one thing Dalsa can't provide.

Chromasens
Also, as we noted in the previous launch letter, Chromasens may offer some competition here based on their line of cameras built around custom sensors from Awaiba (AMS). They have 10240 pixels per line - 25% more resolution that the SW-8000T models – and are available in trilinear and quadlinear models. The trilinear specs are:

allPIXA evo
3 x 10240 CMOS
Up to 32 kHz in single 10GigE or 52 kHz in Dual 10GigE
10GigE Vision to SFP+ interface

allPIXA wave
3 x 10240 CMOS
Up to 25 kHz
Camera Link

These are attractively priced at around €5,000. But they are still quite new and unproven.

Others
There are a few other choices for 8K color line scan applications, but none that really stands out. For example, Vieworks offers one 8K line scan camera with bilinear color capabilities. It has 7-micron pixels, a Camera Link interface, and can run at up to 77 kHz. But most customers turn to Vieworks for their TDI cameras as a competitive alternative to Dalsa, not for a little-known bilinear model.

Application targets

As noted at the start of this letter, the new SW-8000T-10GE and SW-8000T-SFP leverage the precise alignment of their 3 sensors to a common optical path. This gives them a particular advantage over trilinear cameras in applications where the speed or position of objects is constantly varying. Examples include objects that roll or wobble on conveyor belts, free-falling objects, and even vibrations or undulations in web-based rolls. Random variations such as these are difficult or impossible for the spatial

compensation algorithms in trilinear cameras to adjust for, leading to color fringes or "halos" due to parallax (optical plane) or keystone (angular magnification) issues.

For these reasons, the best target applications for the new 8K prism cameras are:

- Belt/bulk (not lane) sorting and inspection of fruits, vegetables, or other loose items.
- Free-fall inspection of grains, nuts, or other similar items.
- Recycling applications using belts to sort various loose items.
- Textile, steel, paper, or foil inspection where vibrations or undulations in the web are common.
- Any other continuous motion applications where color imaging is needed and where there are frequent variations in the speed or position of items. These might include PCB inspection, pharmaceutical inspection, and others.

For more discussion about the advantages of prism vs. trilinear methods, see Appendix A at the end of this letter.

The features described below are the same as those described for JAI's 8K 4-CMOS 10GigE and SFP+ models launched two weeks ago.

Top features in these new color line scan cameras include:

- Multi-line sensor technology.
- Vertical/horizontal binning.
- Built-in color space conversion.
- Precision Time Protocol (PTP).
- Direct encoder control.

Let’s take a look at these features in more detail:

Multi-Line sensor technology:

As the SW-8000T-10GE and SW-8000T-SFP are prism-based RGB cameras they incorporate 3xCMOS sensors. Each custom designed “state-of-the-art” CMOS sensor features 2 lines of pixels with a size of 3.75 µm x 5.78 µm.

Vertical/horizontal binning:

In normal mode, the cameras read out a single line from each sensor. But if

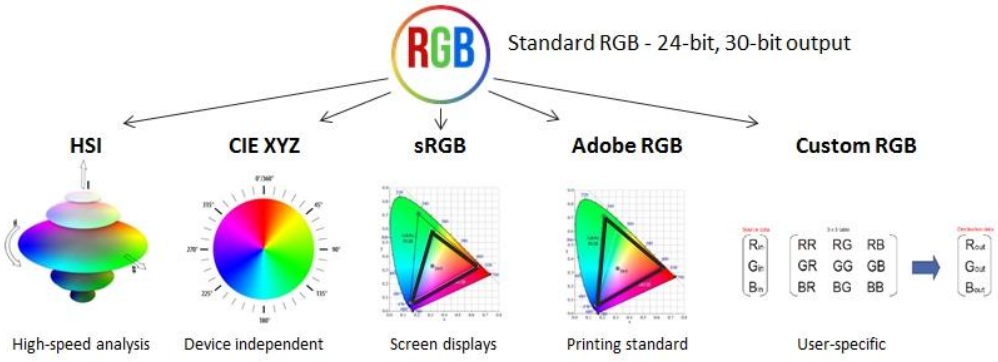
more sensitivity is needed, the cameras can combine pixel information from both sensor lines for vertical binning using a dual-line readout mode. Each pixel will then have a size of 3.75 µm x 11.56 µm.

The cameras also offer horizontal binning. Using a combination of vertical and horizontal binning the sensitivity of the sensors can be increased even further, to ensure the sensors are gathering enough light in "low light situations". (Using horizontal binning will cut the maximum resolution to 4096 pixels). The custom designed sensor uses floating diffusion nodes to read two pixel charges through a single node during the binning process. This produces 2X signal while maintaining only 1X of readout noise, dramatically increasing the sensitivity of the camera when needed for certain applications.

Built-in color space conversion:

Advanced color imaging systems often require a specific type of color representation to efficiently perform their intended function. RGB values must be converted to these different representations – also called color spaces – as part of the application.

But if the data coming from the camera was already in the proper color space, application development could be simplified, host processing could be reduced, and product development schedules could be shortened – and this is what the SW-8000T-10GE and SW-8000T-SFP can do.



The new cameras feature a programmable color matrix circuit with built-in conversions from standard RGB output. These include:

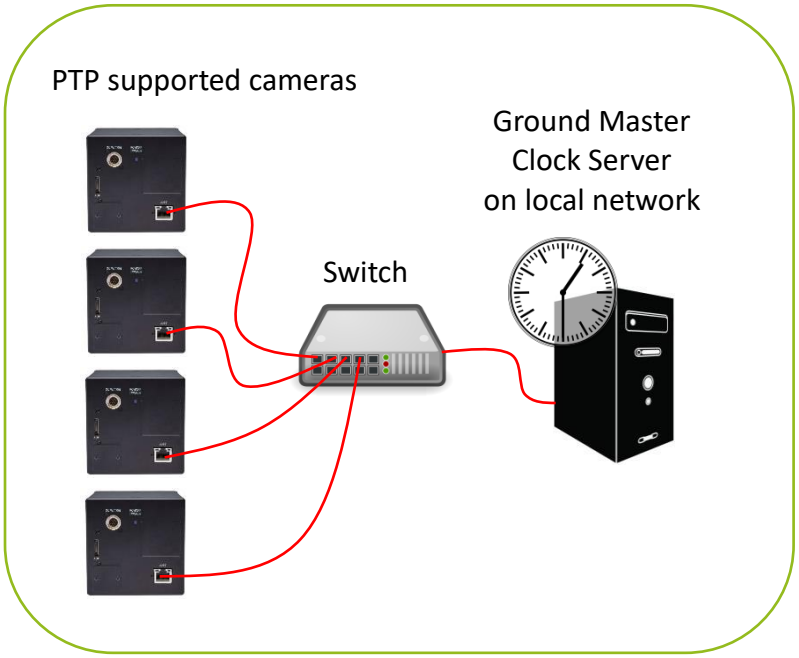
- **sRGB** color space for screens and online types of applications (for example, an online aerial imaging company, or remote viewing of medical diagnostics).

- **Adobe RGB** space for print-related applications.
- **HSI** color space favored by virtual reality companies, artists, broadcasters, and others.
- **CIE XYZ** color space, the first step towards converting to any of the device independent CIE color spaces used to measure human visual perception for a wide range of applications.

Customers can also program their own custom RGB conversions using the color matrix circuit. This broad range of color space options is not available in any other 8K line scan cameras on the market.

Precision Time Protocol (PTP):

The Precision Time Protocol (PTP) is a protocol used to synchronize clocks throughout a computer network. (PHY chip and FPGA/Firmware have to have specific architectures to support PTP processing). With the PTP feature, image capture can take place at the same time for all linked cameras. All synchronous images have the shared timestamp, making image analysis easier.

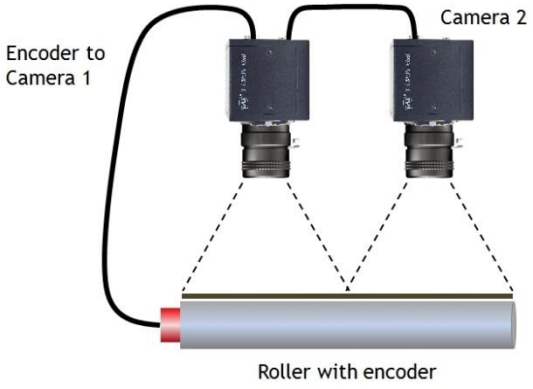


Direct connection to encoders from the camera:

The operation of a line scan camera must be synchronized to the speed of the target web or other motion control system. This is generally accomplished by having an encoder, which is integrated into the conveyance system, emit a number of pulses per rotation equal to the number of lines that need to be captured for the corresponding distance that the web has moved.

Typical Ethernet interface cards or SFP+ interface modules do not have the functionality to handle these encoder signals the way that Camera Link or CoaXPress frame grabbers do. That is why the SW-8000T-10GE and SW-8000T-SFP provide four separate input lines plus built-in algorithms to support a direct connection from up to two separate rotary encoders.

Functions are provided in the software control tool to let users easily define the inputs and the synchronization relationship between the encoder and the camera. Signals can also be daisy-chained from one camera to the next in multi-camera setups. This capability enables the camera and web to be closely integrated as a single subsystem, and lowers the complexity of the total setup.



Direct connection to encoder

Additional features:

Apart from the features described above, the SW-8000T-10GE and SW-8000T-SFP cameras come with a wide range of additional features in keeping with the high reliability and high image quality typical of JAI cameras. These include:

- Digital gain adjustment

- Black level adjustment
- Manual, one-push, and automatic white balancing
- Multiple color temperature presets
- PRNU/DSNU correction
- Color shading correction
- Chromatic aberration correction
- Line counter/Timestamp information
- Horizontal image mirroring
- Large variety of trigger options.
- High shock & vibration rating (50 G, 3 G respectively)

You can read more about these features in the SW-8000T-10GE-SFP user manual if you find yourself in a competitive situation where more details are needed.

Pricing and ordering information:

Consult your latest price list for the pricing on the SW-8000T-10GE and SW-8000T-SFP. If it is not shown in the price list you have, please contact JAI for an update.

Ordering information:

31016645	**SW-8000T-10GE-F**	**8K RGB prism line scan camera with F mount.**
31016646	**SW-8000T-10GE-M52**	**8K RGB prism line scan camera with M52 mount.**
31016647	**SW-8000T-SFP-F**	**8K RGB prism line scan camera with F mount.**
31016648	**SW-8000T-SFP-M52**	**8K RGB prism line scan camera with M52 mount.**

Sales and marketing launch package:

A complete product launch package for the SW-8000T-10GE and SW-8000T-SFP is available on JAI´s Partner Site. Elements include:

- Launch letter to JAI's sales organization (**This letter you are reading**).
- PowerPoint product presentation **(On JAI partner site).**
- Datasheet for the SW-8000T-10GE (**on jai.com**).
- Datasheet for the SW-8000T-SFP (**on jai.com**).
- Combined manual for the SW-8000T-10GE & SW-8000T-SFP (**on jai.com**).
- SW-8000T-10GE product page (**on jai.com**).
- SW-8000T-SFP product page (on jai.com).
- News article (**on jai.com**).
- SDK and Control Tool software (**on jai.com**).
- Press release introducing the camera (**on JAI partner site**).
- Product image in hi-res format (**on JAI partner site**).

Launch package items are available for download on JAI's Partner Site (please refer to the section "Marketing & sales support > Product launch packages". Public materials, such as the final datasheets, manuals, and software, can be found on the jai.com public website from 16 September 2020.

Local promotion activities:

Soon, we will issue the press release to various trade publications and industry websites around the globe. We also ask that you help us to make this product launch successful by promoting these new Sweep+ 8K multispectral line scan cameras on your web site, social media and if you have one, in your e-mail newsletters.

If you have any additional questions, please let us know. We are looking forward to supporting you in the ongoing sales of these cameras.

Best regards,
JAI Marketing Department

APPENDIX A:

Prism technology vs. trilinear/quadlinear technology:

As always, the main competition for JAI's 3-sensor and 4-sensor prism line scan cameras will be trilinear and quadlinear cameras which use a side-by-side arrangement for the R, G, B and/or NIR sensors.

JAI now has excellent options for both types with our SW-4000TL (trilinear) models and a range of prism based cameras including our latest SW-8000T-10GE and SW-8000T-SFP models. But, of course, competition will surely come from 8K trilinear cameras built by several other vendors.

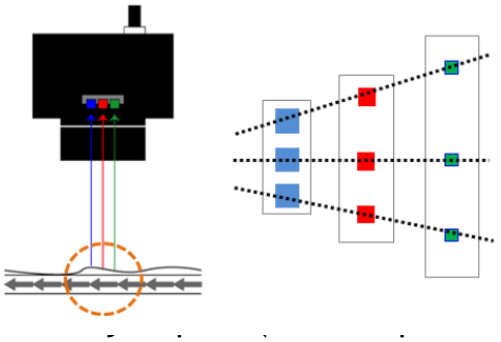
From a pure cost standpoint, customers will usually gravitate towards trilinear/quadlinear solutions for their color line scan applications. But with the powerful combination of 10GE or SFP+ interfaces, high speed, backwards compatibility, advanced features, and greater affordability, more customers will see the benefits of prism-based technology when the characteristics of their application demand better multispectral precision.

The following examples focus on trilinear issues. The same issues also apply to quadlinear cameras. The application characteristics that will drive users to JAI prism cameras include:

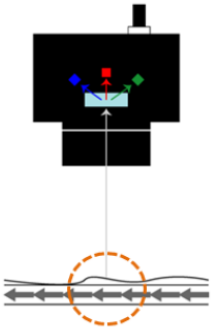
Wavy or uneven surfaces (better for prism cameras)

Even with spatial compensation algorithms, uneven surfaces can be difficult to adjust for in a multi-line setup. If customers need crisp edges and printing in these situations, with no fringes or halos, the single optical plane of the prism camera will be worth the additional cost.

Tri-linear cameras

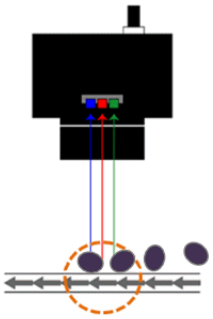


Prism cameras

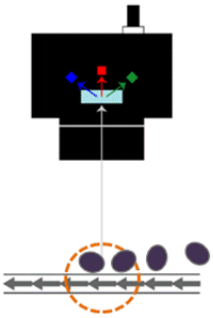


While a good encoder connection can maintain reasonable synchronization with gradual changes in web speed, sudden changes may cause problems for the spatial compensation routines in a trilinear/quadlinear camera. Even more problematic are situations where the objects themselves might be moving on the web. Food, recyclables, and other items often wobble or roll as they move along a conveyor. This is not tracked by the encoder and therefore can't be compensated for by a trilinear camera. Again in these cases, the single optical plane of the prism technology may provide better results.

Tri-linear cameras



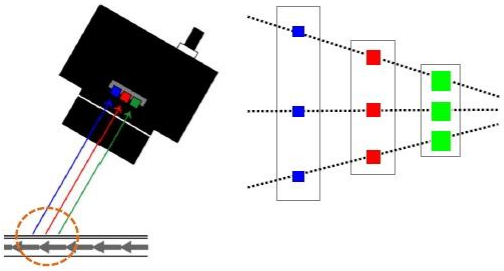
Prism cameras



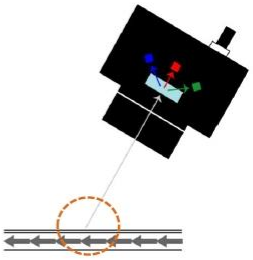
Off-angle viewing (better for prism cameras)

Tilted-view corrections in a trilinear camera are limited to ± 4 pixels, due to both geometry and optical limitations. They also require careful adjustment of both width (keystone) and subtle chromatic aberrations. Prism cameras require no compensation for off-angle viewing and are able to deal with virtually any angle and any dynamism with respect to the camera-object orientation.

Tri-linear cameras



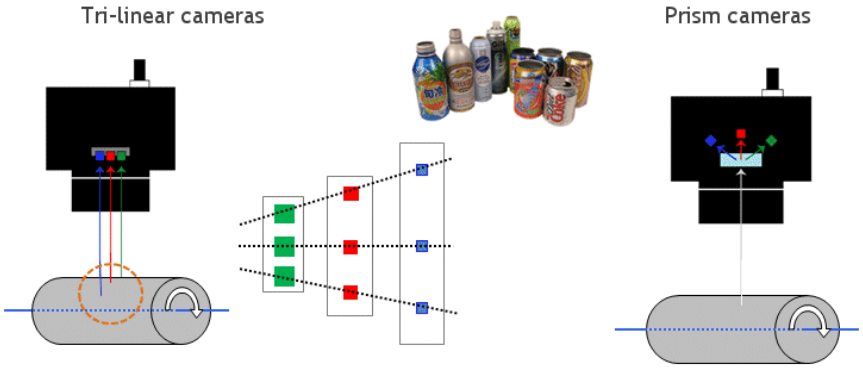
Prism cameras



Cylindrical objects (better for prism cameras)

Curved surfaces create different focal distances for each of the sensors in a trilinear camera. This affects image quality when using trilinear or quadlinear cameras to optically "unwrap" the labels on bottles and cans or perform

inspections of other cylindrical objects. The single optical plane of prism cameras gives each sensor the same focal point to avoid any degradation of image quality.



APPENDIX B:

About 10GBASE-T

10 Gigabit Ethernet (GigE) is a group of computer networking technologies for transmitting Ethernet frames at a rate of 10 gigabits per second. It was first defined by the IEEE 802.3ae-2002 standard.

The 10 Gigabit Ethernet standard encompasses a number of different physical layer (PHY) standards. A networking device, such as a switch or a network interface controller may have different PHY types through pluggable PHY modules. 10GigE can use either copper or fibre cabling just like previous versions of Ethernet. Maximum distance over copper cable is 100 meters but because of its bandwidth requirements, higher-grade cables are required.

About NBASE-T:

The NBASE-T Alliance is an industry-wide cooperative effort focused on enabling the development and deployment of products that support 2.5GBASE-T and 5GBASE-T Ethernet. The alliance was founded in 2014 to build consensus and help streamline the development of a new standard. That standard, IEEE 802.3bz, is compatible with specifications published by the NBASE-T Alliance. In addition, the specification includes additional features that further optimize networks based on the standard.

The specifications enabled member companies to quickly develop and deploy 2.5G and 5GBASE-T products, making use of the large, installed base of copper cabling, such as Cat5e and Cat6, found in many places including enterprise and service provider networks.

More than 45 companies have joined the alliance, representing all major facets of networking infrastructure such as access points, Ethernet switching, and computing, as well as the necessary technologies required to deliver these applications including physical layer ICs (PHYs), processors, connectors, controllers, switches, FPGAs, Power-over-Ethernet ICs, cables and test equipment.

About auto-negotiation:

Auto-negotiation is a signaling mechanism and procedure used by Ethernet over twisted pair by which two connected devices choose common transmission parameters, such as speed, duplex mode, and flow control. In this process, the connected devices first share their capabilities regarding these parameters and then choose the highest performance transmission mode they both support.

APPENDIX C:

About SFP+

The "Enhanced Small Form-factor Pluggable" interface (SFP) is a compact, hot-pluggable network interface using transceiver modules to transmit and receive digital data via optical fiber cables. The standard SFP optical interface supports up to 4.25 Gbps.

It is a popular industry format jointly developed and supported by many network component vendors and supports the Gigabit Ethernet standard among other network standards.

In 2006, the **Enhanced** small form-factor pluggable transceiver (SFP+) specification was released bringing speeds up 10 Gbit/s and is compliant with the 10GBASE-T GigE Vision standard. JAI has chosen this enhanced SFP+ standard for its camera interfaces.

The advantages of the SFP+ technology can be summarized as:

- It's possible to use longer cables – up to 10 km, and at the same time have extremely low latency (low data transmission delay).
  (In longer distances, latency in the fiber optical cable system is much lower because of less need for processing and repeating of the signals).

- Negligible data loss at very high data rates.
  (Signals in copper cables are easy to be interrupted by electromagnetic interference from surrounding environments, especially in long distance transmission. The signals will attenuate as distance increases, which can lead to data transmission error and make users feel slow transmission speeds. Besides, alien crosstalk also would cause transmission errors and latency in long copper cables. So, crosstalk and data transmission errors over long distance fiber optical connections is not a problem).

- Fiber optical cables have low data transmission noise.

- Very wide variety of SFP+ modules available at different price range.

- Optical fiber cables have gone down in price.

What are the drawback to be aware about?

- Requires 10GigE network configuration. (No backwards compatibility to NBASE-T and 1000BASE-T).
- The cost can be high, depending on the choice of transceivers and patch panels.
- Functions such as triggering, encoder control etc. should be managed with additional cables.

Why choose color line scan models with SFP+ optical interface instead of 10GigE Ethernet copper cable interface:

- If customers looking for color line scan cameras already have a network configuration with 10GBASE-T and optical fiber cabling, then these new SFP+ interface models are ideal for the purpose.
- If customers are looking for high-speed megapixel color line scan cameras that supports extra-long cabling possibilities, that at the same time keeps transmission noise and latency at a minimum level.

Supported SFP+ modules (camera-side):

INTEL: FTLX8571D3BCV-IT
CISCO SFP-10G SR-SA
PROFITAP: PT-10G-SR-85
FINISAR: FTLX8574D3BCL
10GTEK: ASX85-192-M3

See the possibilities

Supported SFP+ port types and optical cable types:

The JAI color line cameras with SFP+ interface support different SFP+ standards. These are: 10GBASE-SR (Short Range), 10GBASE-LR (Long Reach), 10GBASE-ER (Extended Reach) and 10GBASE-CR (Direct attached copper). The table below summarizes some of the most important specifications to be aware of.

	10GBASE-SR (Short Range) Port type for Multi-mode (OM) fiber cables.	10GBASE-LR (Long Reach) Port type for Single-mode (OS) fiber cables.	10GBASE-ER (Extended Reach) Port type for Single-mode (OS) fiber cables.	10GBASE-CR (Copper cable) Twinaxial balanced copper cables.
Standard	IEEE802.3ae	IEEE802.3ae	IEEE802.3ae	SFF-8431
Speed	10Gbps	10Gbps	10Gbps	10Gbps
Module Type	SFP+	SFP+	SFP+	SFP+
Media	Multi-Mode Fiber	Single Mode Fiber	Single Mode Fiber	Direct attached copper cable
Laser wave length in transceiver	850 nm	1310 nm	1550 nm	N/A
Maximum Cable length	OM3: 300 m OM4: 400 m	OS2:10 km	OS2:40 km	7 m
Support	YES	YES	YES *)	YES
Transceiver module power level	Max Power: ”Power Level 1”	Max Power: ”Power Level 1”	Max Power: ”Power Level 1” *) ER transceivers used must be with “Power Level 1”).	Max Power: ”Power Level 1”