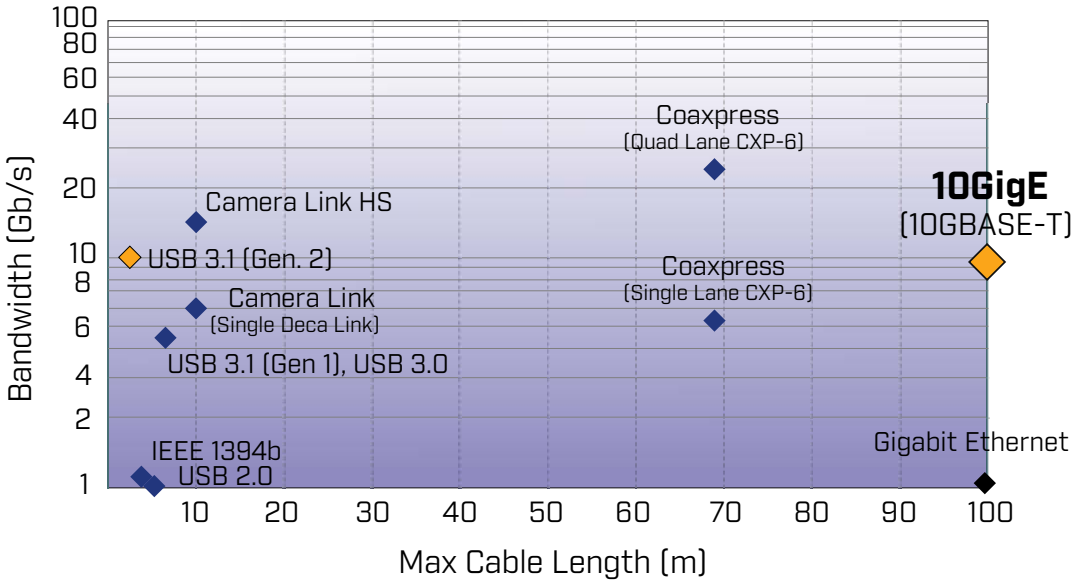
10 Gb/s with 10 GigE & USB 3.1:

Meeting Machine Vision Demand for Higher Resolution

What's inside:



The next generation of high-performance CMOS sensors will open the door to exciting new vision applications, but taking advantage of them will depend on whether your interface can keep up. Ethernet and USB interfaces are increasing their transfer rates to 10Gb/s, adding to the strengths that make them dominant camera interfaces. What are these new technologies and are they ready for machine vision use?

10 Gigabit Ethernet

There are several implementations of 10 Gigabit Ethernet. The 10GBASE-T implementation deploys most easily, using familiar RJ45 connectors and inexpensive Cat6A copper cables. It has the largest install base, the highest growth rate, and is best-suited for machine vision applications. The FLIR Oryx (formerly the Point Grey Oryx) is based on 10GBASE-T and operates at 10 Gb/s over Cat6A cables up to 100 meters long.

Industry-Ready Ecosystem

The full compatibility of 10 Gigabit Ethernet with the GigE Vision standard ensures that 10 GigE cameras like the FLIR Oryx work seamlessly with third-party libraries. Backward compatibility with existing GigE hardware means that 10 Gigabit Ethernet cameras work

at 1 Gb/s on standard laptops and network switches. GigE cameras on 10 Gigabit Ethernet infrastructure run at their normal 1 Gb/s.

Cables that meet the needs of industrial users come in a wide range, including extended temperature, high-flex, and locking Cat 6A and Cat5e models. The Cat6A cables required to operate at 10 Gb/s are offered in cable lengths up to 100 meters, can be field terminated, and cost less than 1€ per meter. Cat5e cables are compatible with cable lengths of less than 40 meters.

Oryx 10 GigE cameras use the IEEE-1588 Precision Time Protocol (PTP) to synchronize with other Ethernet devices and provide precise, time-stamped inputs to industrial vision systems. As more devices connect to the Industrial Internet of Things (IIOT), IEEE-1588 PTP support becomes a key specification.

New Technology Overcomes Previous Limitations

Power

The first 10GBASE-T physical layers (PHYs) dissipated a lot of power. A decade of research and development yielded increased PHY efficiency and a corresponding decrease in power dissipation from 10W per port to 3W. These new PHYs were used to design the FLIR Oryx to operate continuously in still air at an ambient temperature of 50°C. It does not require heat sinking or active cooling.

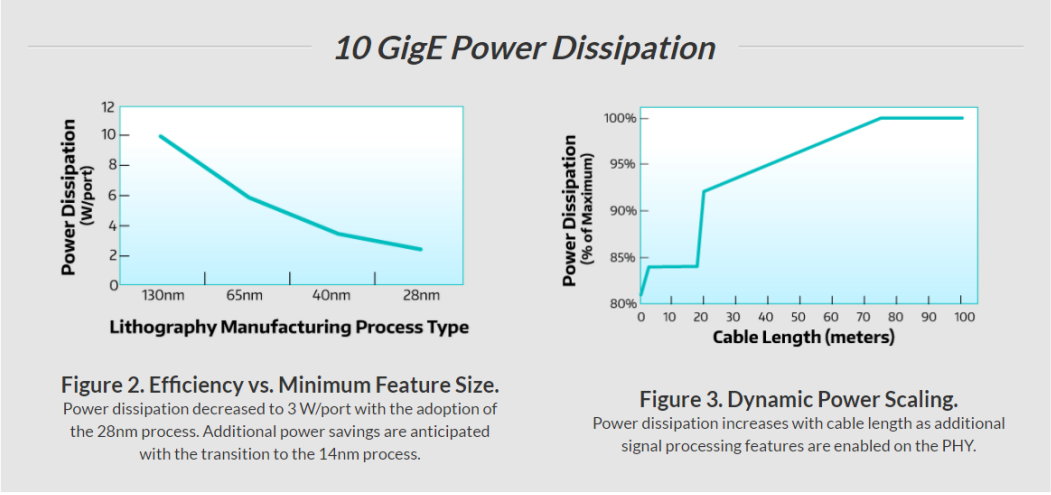


Figure 2. Efficiency vs. Minimum Feature Size.
Power dissipation decreased to 3 W/port with the adoption of the 28nm process. Additional power savings are anticipated with the transition to the 14nm process.

Figure 3. Dynamic Power Scaling.
Power dissipation increases with cable length as additional signal processing features are enabled on the PHY.

CPU

At the time of the GigE Vision standard's introduction in 2006, packet reassembly required significant host-side resources. The processing power of PCs and embedded systems has grown so quickly since then that today, the host-side resources required for packet reassembly are negligible. FLIR's tests have shown that a simple application grabbing 4K resolution images at 60FPS uses less than 1% of an Intel i7 CPU's available power.

Employing the mature, well-established 10GBASE-T ecosystem makes the 10 Gigabit Ethernet interface ready for use in industrial vision systems.

Learn more about 10GigE with FLIR (formerly Point Grey).

USB 3.1 Generation 2

The introduction of two distinct generations resulted from USB 3.1 superseding USB 3.0. USB 3.1 Generation 1 (Gen 1) is functionally equivalent to USB 3.0, and vendors like FLIR are already labelling their products "USB 3.1 (Gen 1) compliant". Generation 2 (Gen 2), or SuperSpeed USB 10 Gbps, increases the USB interface's maximum transfer rate to 10 Gb/s.

Interface	USB 3.1 Gen 2	USB 3.1 Gen 1		USB 3.0
Bandwidth	900 MB/s	400 MB/s	←	400 MB/s
Max cable length	1 m	5 m		5 m
Power delivery	100 W	4.5 W		4.5 W
Data + power over one cable	Yes	Yes		Yes
Multiple cameras	Excellent	Excellent		Excellent
Vision standard	USB3 Vision	USB3 Vision		USB3 Vision

While USB 3.1 Gen 2 offers many exciting possibilities for machine vision applications, there are challenges which must be overcome before this interface is ready for widespread adoption in the industry. For example, USB 3.1 Gen 2 is limited to a

maximum cable length of 1 meter, and a standard Gen 2 connector has not been identified yet. It is likely that the USB Type-C connector will become the standard for Gen 2 products, though it is separate from the USB 3.1 specification. As the USB 3.1 Gen 2 specification evolves, so will its uses in machine vision. FLIR will closely monitor specification's progress to determine when it can be incorporated into our product offerings.

Learn more about USB 3.1 with FLIR (formerly Point Grey).

Conclusion

With the already familiar, mature Gigabit Ethernet ecosystem producing technologies like 10 Gigabit Ethernet, it will be easier than ever for machine vision developers to start truly taking advantage of high-performance CMOS sensors.