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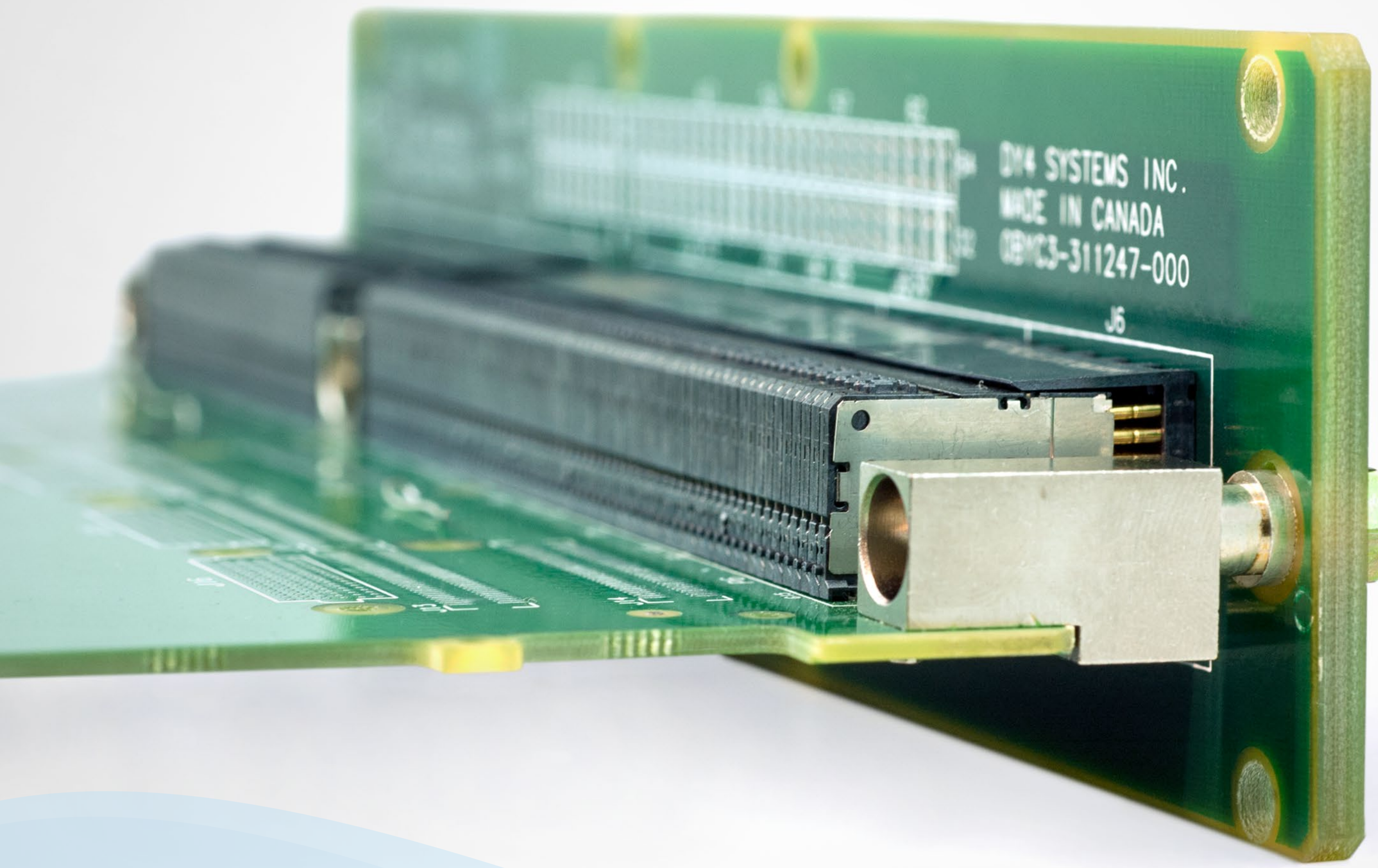
KVPX® CONNECTOR SERIES

HIGH SPEED SIGNAL INTEGRITY REPORT



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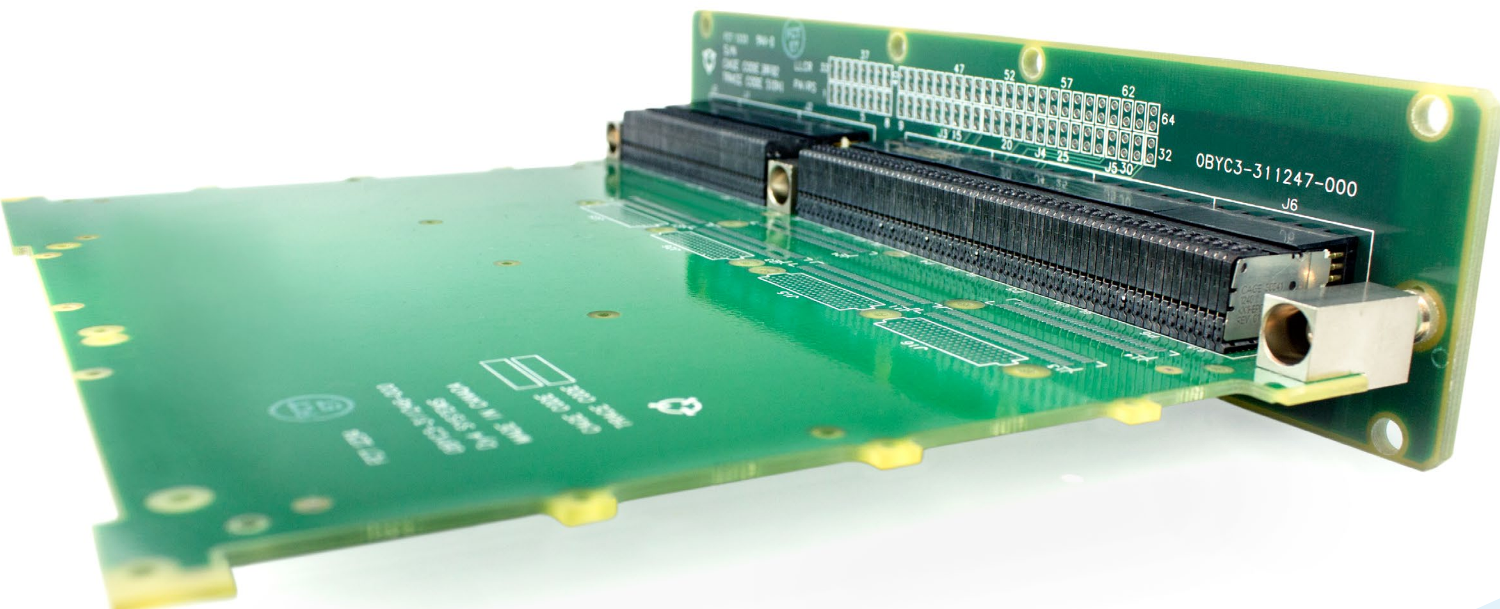


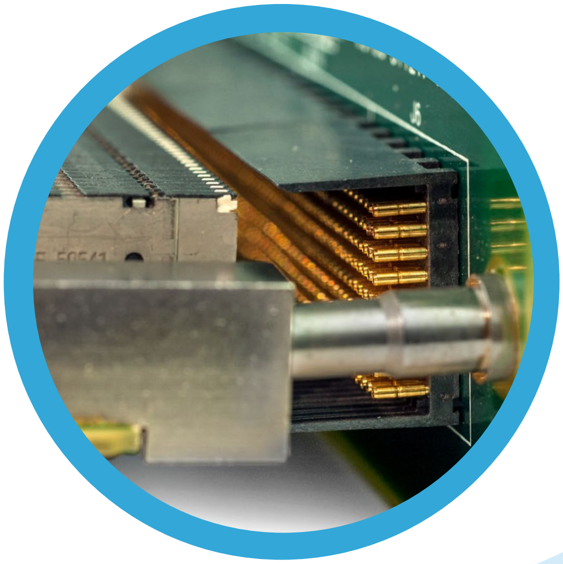
HIGH SPEED DATA TRANSFER

MARKET DRIVERS FOR HIGH SPEED SIGNAL INTEGRITY

The VPX market is an extension of the VME market, since VPX is predominately a high speed replacement and/or upgrade technology. New designs moving forward can be broken into two categories, event driven and data driven. An event driven application – controlling motors and actuators, moving gun turrets and missile launch frames into position are control system applications and do not require high speed or intensive computing power. These event driven applications will continue to utilize existing legacy, lower cost architectures like VME or cPCI. Data driven applications will require the high speed and intensive computing power enabled by the VPX architecture. Data driven applications include (but are not limited to) Radar Processing or Intelligence Surveillance & Reconnaissance and Multi-function Digital Display Processors.

As single board computers and board I/O devices have become faster and more powerful, the need to improve the transmission of signals or data has become an obstacle in the performance advancement of many military and aerospace applications. Currently devices are trying to operate above the 1 Gbps limit of the DIN connectors found in VME64x systems. This is far below commercial and telecommunication standards (6.25+ Gbps) and not fast enough to provide real-time information demanded by military leadership and associated applications. This limitation of the VME architecture is a main driving force that defined the VPX requirements.

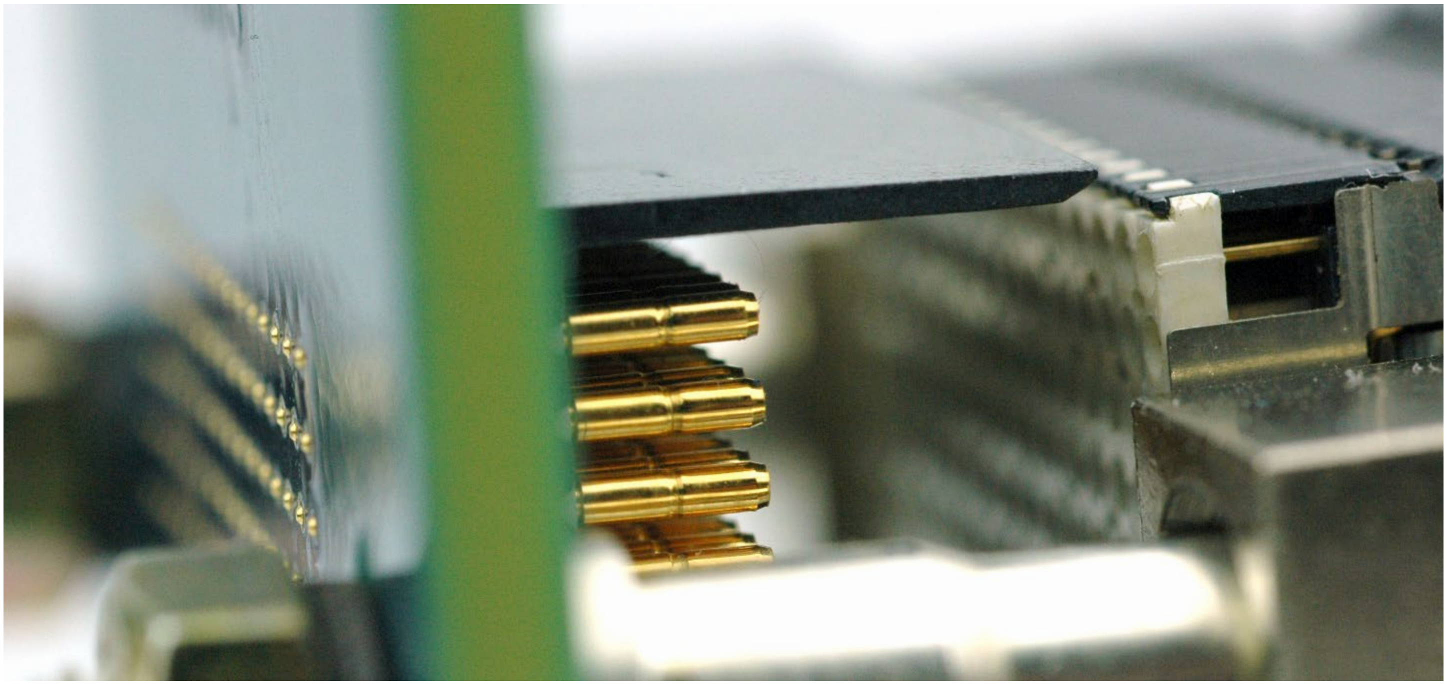
VPX is becoming the standard of choice for high performance military systems; systems that employ high-speed serial fabrics such as Serial Rapid I/O, PCI Express, or Ethernet. The initial VPX standards focused on data rates of 3.125 Gbps and quickly moved to 6.25 Gbps to support Serial RapidIO Gen2 and PCIe 2.0. More recently systems are looking to meet 10 Gbps with the introduction of PCIe 3.0 and 10GBASE-KR. Supporting these evolving performance parameters requires design discipline and analysis.



HIGH SPEED DATA TRANSFER

KEY CHARACTERISTICS

Optimal signal integrity at high speed (>6.25 Gbps) is a critical factor when comparing VPX connector solutions and as technology evolution continues to push the data rate limits. For system solution providers, signal integrity at high speed is a critical element in their ability to address the computation and IO requirements of data driven applications. When evaluating the signal integrity performance of a connector the key factors are impedance, return loss, insertion loss and crosstalk at the desired data rates. These performance metrics have been evaluated across the 4 unique differential pairs for KVPX.



IMPEDANCE MATCHING

The use of impedance controlled connectors is standard practice in radio frequency applications and is now being utilized for high-speed data transmission. In a transmission line, impedance matching is necessary to minimize reflections, to deliver the correct amplitude signal, and to maximize power at the receiving end. To maximize signal performance it is critical to maintain a differential impedance as close to 100 Ω as possible.

RETURN LOSS

Return loss is a measure of the amount of reflection caused by a discontinuity in a transmission line. It is expressed as a ratio in decibels (dB). When a high data rate signal travels through a set of transmission lines, some portion of the signal returns to the source due to impedance mismatches along the line. The returning signal is undesired since it interferes with the primary signal. Return loss is a measure of how well devices or lines are matched and it is desired to be as low as possible, ultimately below -10 dB up to the first harmonic frequency.

INSERTION LOSS

When a high data rate signal travels through a set of transmission lines, only some portion of this signal is transferred to the receiving end. Because of the reflections and material related losses, the power level of the signal decreases along the transmission line. Insertion loss is used to characterize the relative amount of power lost in the transmission line. Lower insertion loss is more desired to maximize transmitted power from the excitation to the receiver end. In general, board designers would need the connector to achieve better than -3dB insertion loss across the applications frequency requirements, since -3 dB corresponds to half of the input power.

CROSSTALK

Crosstalk is the undesired distortion of a signal created by interference from a separate transmission line in close proximity to the signal source. There are 2 types of metrics for crosstalk, NEXT and FEXT (near end cross talk and far end cross talk). The design goal is to minimize both types of crosstalk. The KVPX product minimizes interactions between the signal pairs by optimizing the design, including a ground shield between the wafers, resulting in very minimal NEXT and FEXT crosstalk.

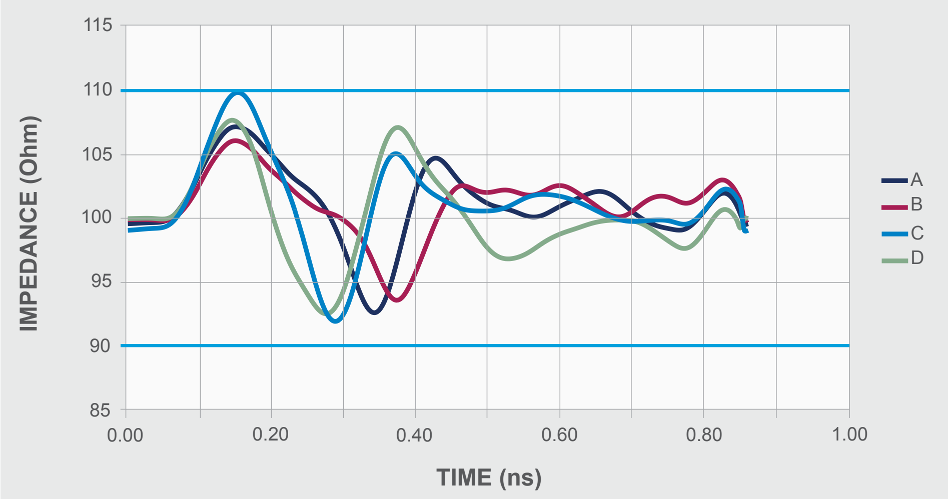
TEST RESULTS

IMPEDANCE MATCHING

The use of impedance-controlled connectors is standard practice in radio frequency applications and is now being utilized for high-speed data transmission. In a transmission line, impedance matching is necessary to minimize reflections, to deliver the correct amplitude signal, and to maximize power at the receiving end. To maximize signal performance it is critical to maintain a differential impedance as close to 100 Ω as possible. The KVPX connector has an impedance variation <10% of the target 100 Ω with a 50 ps rise time (0%, no signal, to 100%, full signal) which is representative of the rise time of a 6 Gbps signal.

The connector needs to maintain uniform impedance along the signal path in order to not degrade the quality of the signal integrity at higher data rates. KVPX's impedance remaining within 10% of the target meets and exceeds this requirement.

TDR MEASUREMENT



MEASURED IMPEDANCES FOR EACH CONNECTOR

50 ps Rise Time

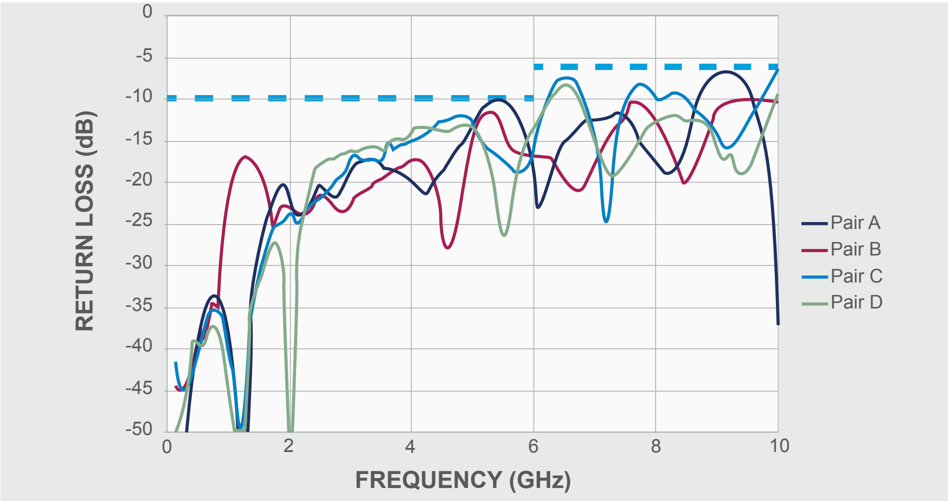
	A	B	C	D
Z_{MIN}	92.7 Ω	93.6 Ω	92.6 Ω	92 Ω
Z_{MAX}	107.2 Ω	106.1 Ω	107.7 Ω	109.8 Ω

RETURN LOSS

The return loss profile of a KVPX mated pair is shown. Due to the matched impedance profile and low loss performance of KVPX, signals travel with minimal disruption. In correlation with the impedance profile there is minimal disruption. Up to 10 GHz there is less than -6.5 dB of return loss and remains below -10 dB up to 6 GHz.

It is extremely critical that the connector is designed to minimize the return loss which in turn minimizes the noise caused by reflections along the signal path. KVPX's return loss below -10 dB through 6 Ghz enables data rates up to 10 Gbps.

MEASURED DIFFERENTIAL RETURN LOSS



WORST CASE MEASURED RETURN LOSS UP TO GIVEN FREQUENCY

Frequency (GHz)	KVPX
1 GHz	-18.6 dB
3 GHz	-16.2 dB
6 GHz	-10.1 dB
10 GHz	-6.5 dB

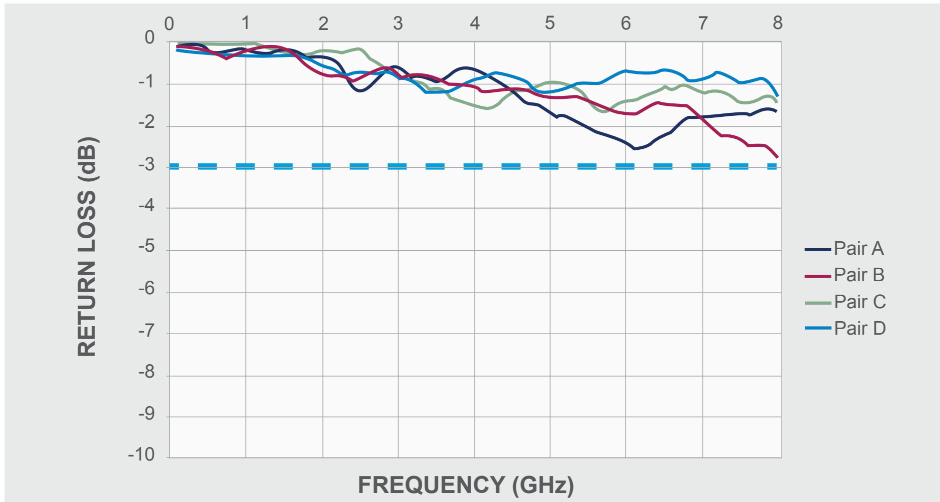
TEST RESULTS

INSERTION LOSS

Lower insertion loss is desired to maximize transmitted power. In general, board designers need the connector to achieve better than -3dB insertion loss for the applications frequency requirement since -3 dB corresponds to half of the input power. The KVPX design and material selection enables the low loss profile shown to the right.

It is important that the insertion loss does not drop below -3 dB up to the corresponding frequency for the applications data rate requirement. KVPX maintains this requirement well over 8 Ghz, enabling data rates up to 10 Gbps.

MEASURED DIFFERENTIAL INSERTION LOSS



INSERTION LOSS (dB)

Frequency	A	B	C	D
3 GHz	-0.64 dB	-0.76 dB	-0.83 dB	-0.84 dB
6 GHz	-2.44 dB	-1.71 dB	-1.41 dB	-0.72 dB

TEST RESULTS

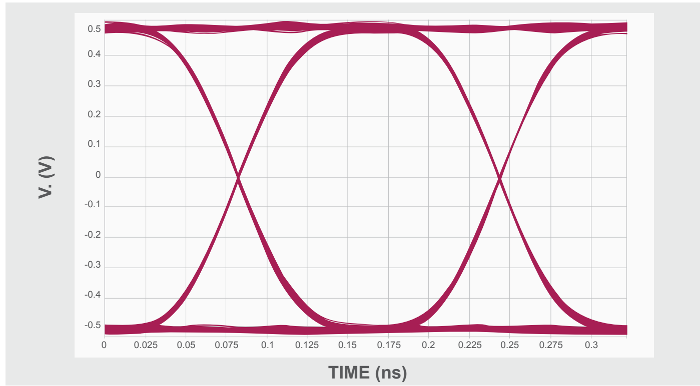
EYE DIAGRAM ANALYSIS

With Crosstalk

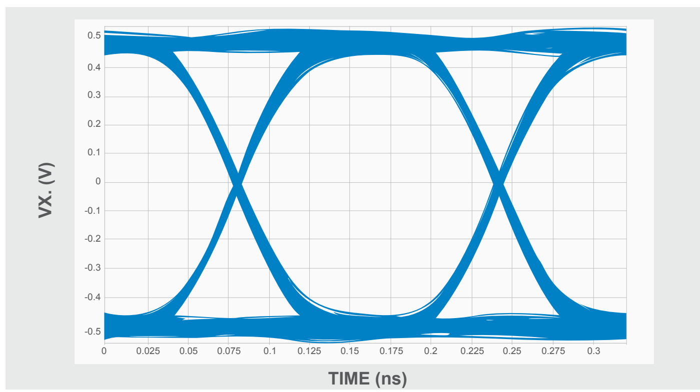
The eye diagram of the KVPX connector shows a low amount of jitter and a wide eye opening which indicates that the KVPX connector is more than capable of providing an optimal signal at 10 Gbps data rates. The eye diagram shown to the right, combines the impacts of impedance matching, return loss, insertion loss and crosstalk talk performance to ultimately determine the signal integrity at the respective speeds of 6.25 Gbps and 10 Gbps.

Crosstalk is minimal in the KVPX enabling, when combined with the impacts of matched impedance, low insertion and return loss, an eye diagram for the KVPX connector up to 10 Gbps with very little noise or jitter.

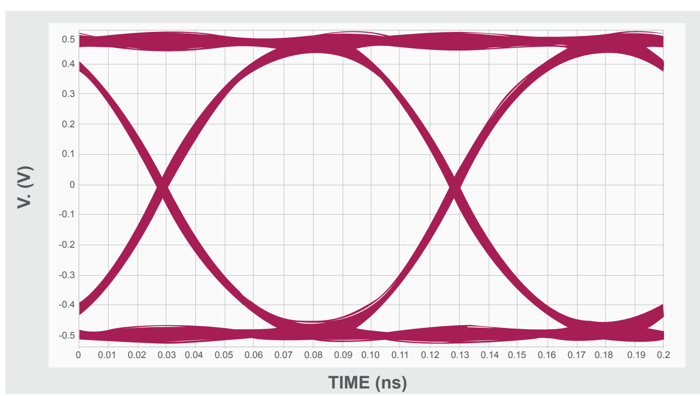
EYE DIAGRAM @ 6.25 Gbps *without Crosstalk*



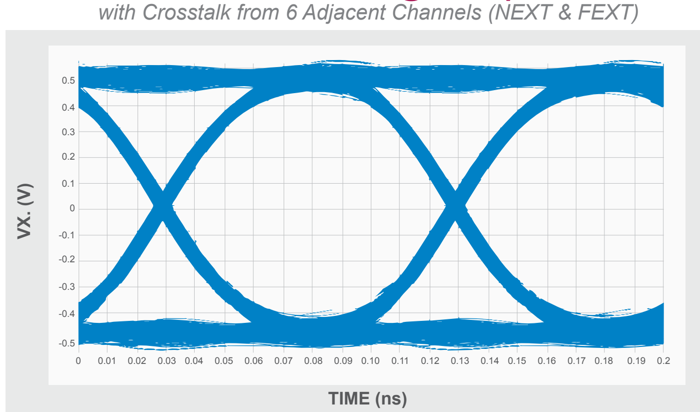
EYE DIAGRAM @ 6.25 Gbps
with Crosstalk from 6 Adjacent Channels (NEXT & FEXT)



EYE DIAGRAM @ 10 Gbps *without Crosstalk*



EYE DIAGRAM @ 10 Gbps
with Crosstalk from 6 Adjacent Channels (NEXT & FEXT)



SUMMARY

Based on the aforementioned data the Hypertac KVPX connector is meeting the requirements for a high data rate system. It is a common practice in the industry to rate connectors based on insertion loss; the frequency where the connector's insertion loss reaches -3dB is accepted as a threshold, since at -3dB half of the power is lost in the connector. This frequency is referred to as the first harmonic frequency of the maximum data rate and is multiplied by two to find the data rate it would support. Based on this methodology the KVPX connector, which does not reach -3 dB until after 8 GHz, is able to support high speed signals of data rates up to 10 Gbps.

KVPX is best suited and positioned for data intensive applications where high throughput and high computes are the critical factors. Intelligence, Surveillance & Reconnaissance (ISR), Signals Intelligence (SIGINT), radar applications and Electronic Counter Measures (ECM).

The ruggedization and durability benefits of the Hypertac hyperboloid based design keeps these platforms in the theatre and operational where they are most critical and impactful.

Benefits of Hyperboloid and KVPX

- High speed data rate, KVPX is capable of supporting up to 10 Gbps
- Immunity to shock and vibration
- Extremely low fretting corrosion
- Low contact resistance
- High number of mating cycles
- Low insertion and extraction force
- Daughtercard faceplate protects the male pins

SMITHS CONNECTORS

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