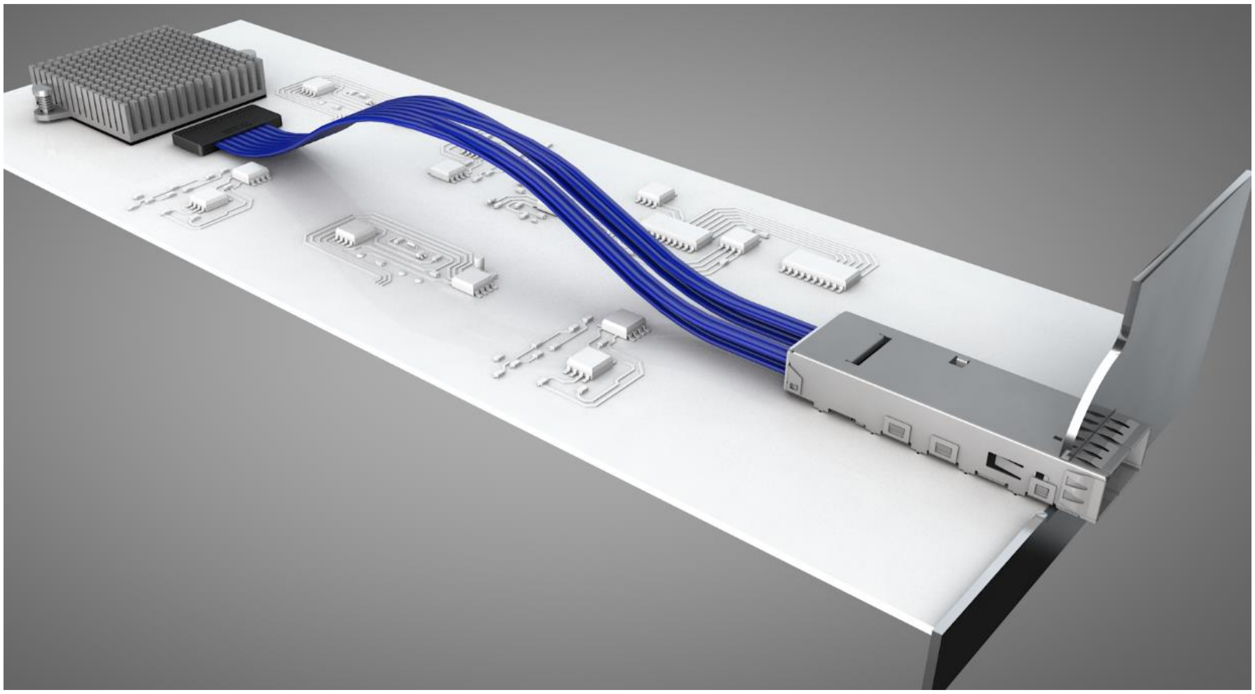
Samtec Flyover®- QSFP (FQSFP)

FLY CRITICAL HIGH SPEED SIGNALS OVER THE PCB



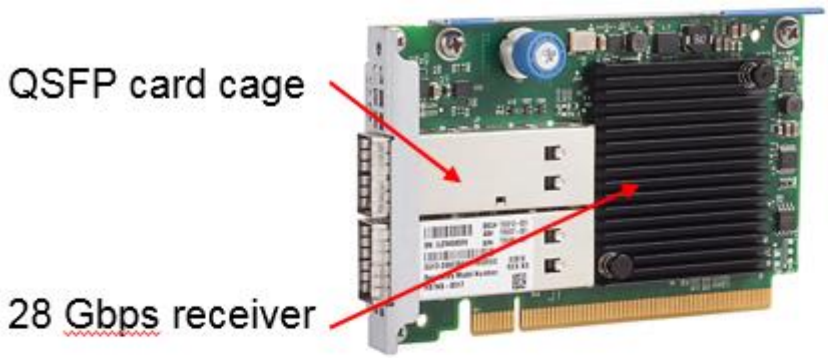
Background: The **Quad Small Form-factor Pluggable** (**QSFP**) is a compact, hot-pluggable cable and/or transceiver used for data communications applications. It is an industry formfactor jointly developed and supported by many network component vendors. The QSFP specification accommodates multiple standard protocols including Ethernet, Fibre Channel, and InfiniBand. QSFP modules increase the port-density by 3x-4x compared to SFP+ modules.

Multiple vendors today support data rates up to 4x14 Gbps. A much smaller population (handful) of interconnect cage/connector + cable vendors support 4x28 Gbps applications.

This tech note further focuses on 4x28Gbps applications (also marketed as "zQSFP") and challenges created by their implementation.

Existing 4x28Gbps QSFP Problem Statement:

- All presently available 28 Gbps QSFP ports are surface mount to PCB pads & traces; essentially a revision of the available 10-14Gbps QSFP+ designs.
- The major problem for the 28 Gbps QSFP is the large loss associated with the circuit card PCB traces.
- PCB loss issues further constrain system design decisions forcing the 28Gbps receiver close to the QSFP port cage.
- Card routing options and component placement is stymied by the reality of 28G PCB trace loss.
- Component stack-up creates aggregate thermal disadvantages.



The Solution:

Samtec Direct Attach Twin-ax Flyover QSFP Approach allows the receiver to be remotely located allowing for more flexibility in system architecture.

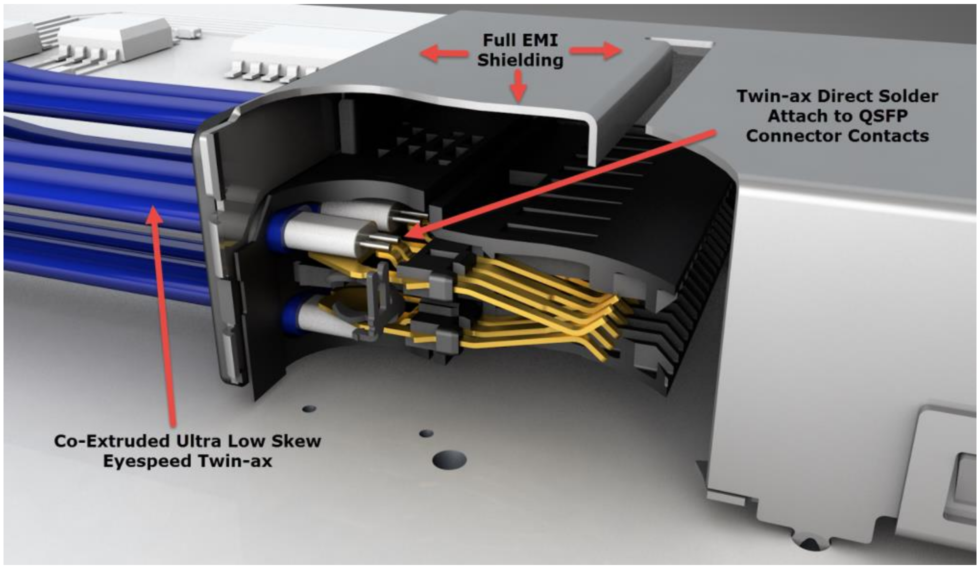


Figure 1.1 Mechanical Anatomy of Samtec FQSFP

Advantages:

- Inherently lower attenuation using ultra low loss Samtec Eyespeed® Twinax Cable.
- Consistent SI performance in dual stack configuration
- Backwards-compatible with all industry standard QSFP Copper and Optical cable and transceivers.
- No re-timers are needed resulting in reduced costs and lower power
- Reduced power and thermal dissipation
- Reduced PCB material costs and loss due to lower layer count required
- QSFP sidebands carried through press fit contacts.
- Airflow is improved by placing device on PCB where customer can control/achieve the best thermal cooling.

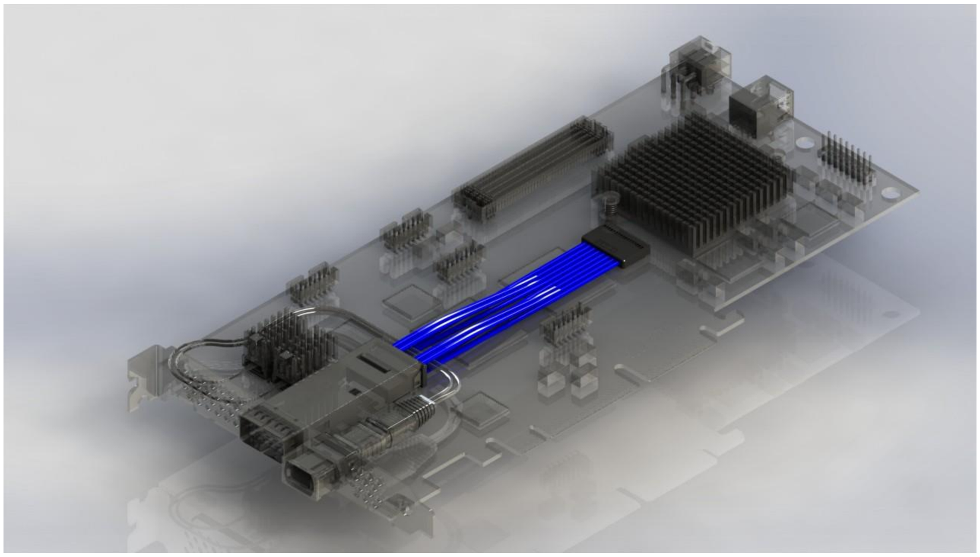


Figure 1.2 Samtec FQSFP Application Example

Signal Integrity Performance

The key performance advantage of FQSFP is the low loss associated with twinax cable in comparison to PCB traces. Figure 2.1 shows a comparison of a 12 inch 30 AWG twinax cable in comparison with a high performance PCB laminate (Megtron 6) with 5 mil copper traces.

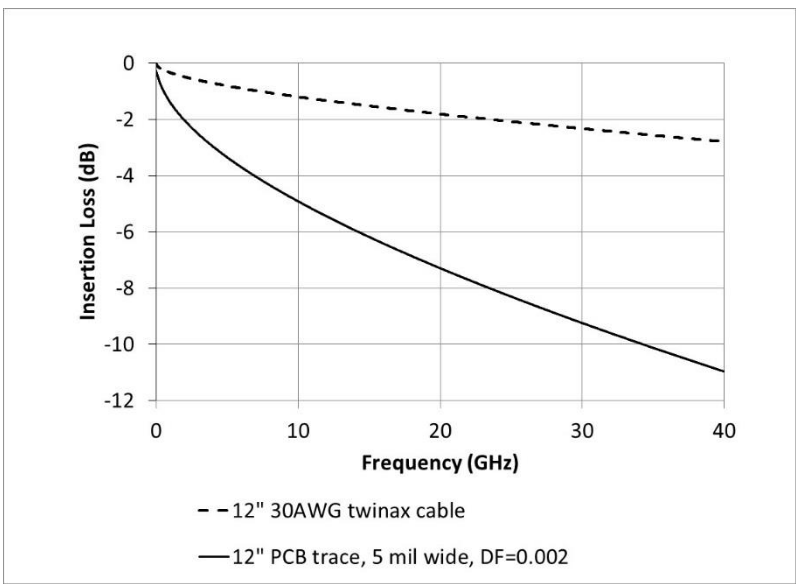


Figure 2.1 Insertion Loss Comparison of Twinax vs Meg6 PCB Traces

While 12” of PCB trace for a QSFP application may seem excessive, it illustrates a key advantage of FQSFP. Because of the high PCB trace loss it is typically required that the SERDES be located as close as possible to the QSFP module. FQSFP changes that, the low loss of the twinax means that the SERDES can be located much further from the front panel opening options for the mechanical architecture of the switch.

The 30 AWG twin-ax cable used in FQSFP is designed and manufactured by Samtec. The cable construction and pitch can be tuned as part of the design optimization process resulting in a low discontinuity transition from the twin-ax cable to the mating connectors. Cable strip lengths and termination details are designed for SI performance with full wave simulation software. These mechanical dimensions are then reviewed and discussed with manufacturing for a balance between performance and yield.

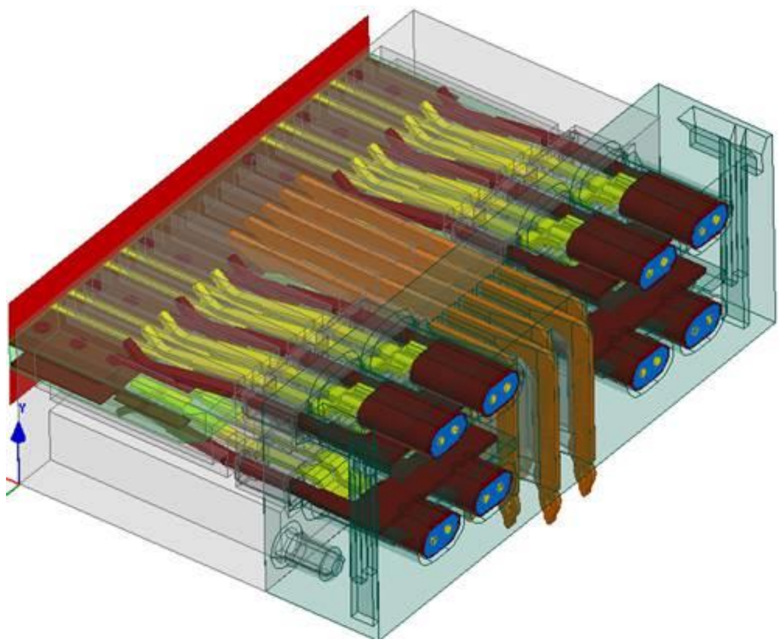


Figure 2.2 Semi-transparent Iso View of cable and contact system.

The result is a resonance free insertion loss profile to 40 GHz for an 18” FQSFP assembly as shown in Figure 2.3. Above 20 GHz connector and PCB termination effects add reflection loss to the cable attenuation profile. Figure 2.3 also shows the multi-aggressor far end crosstalk performance for a fully populated FQSFP assembly. For QSFP interconnect, PSFEXT is typically worst case as the Tx and Rx lines are separated by multiple press fit contacts which support control power and status signals.

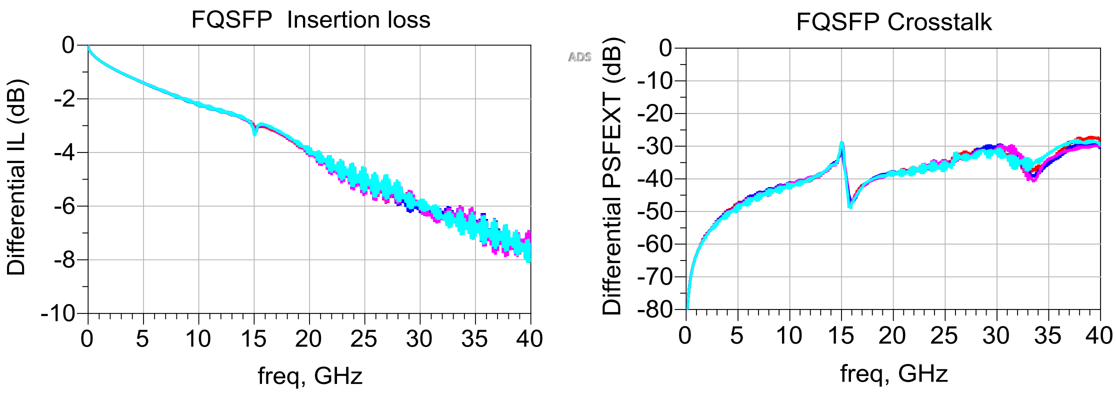
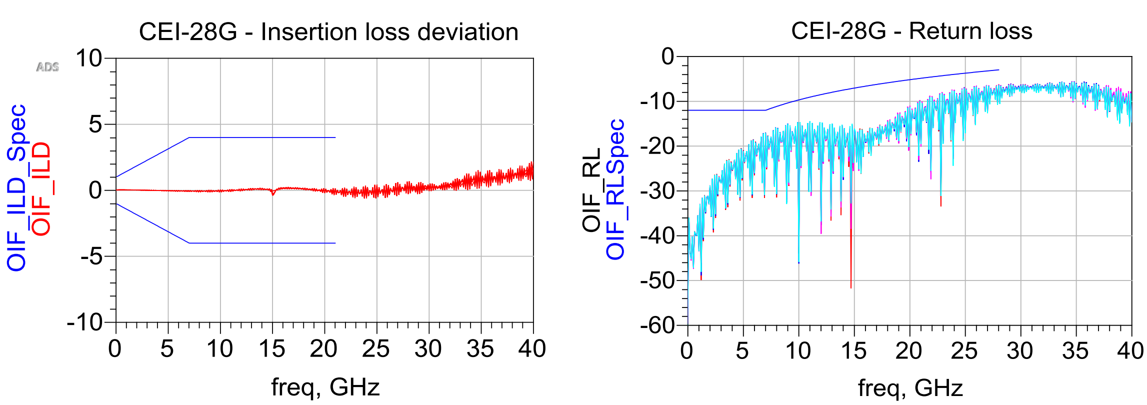


Figure 1.3. 18" FQSFP Cable Assembly Performance

OIF-CEI-03.01 defines channel requirements for 28 Gbps NRZ applications and it is helpful to leverage this work in assessing the SI performance of FQSFP. This standard seeks to achieve a low BER (10^{-12}) by defining typical transmit/receive characteristics and channel requirements. We compare the FQSFP performance with the OIF requirements to assess 28 Gbps feasability.

Figure 2.4 shows the insertion loss deviation, return loss and integrated crosstalk noise for FQSFP in comparsion with the requirements of OIF-CEI-3.1.



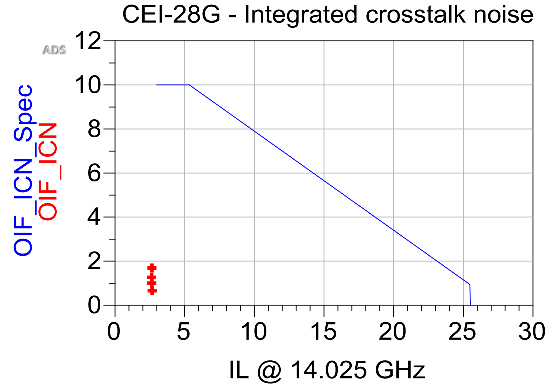


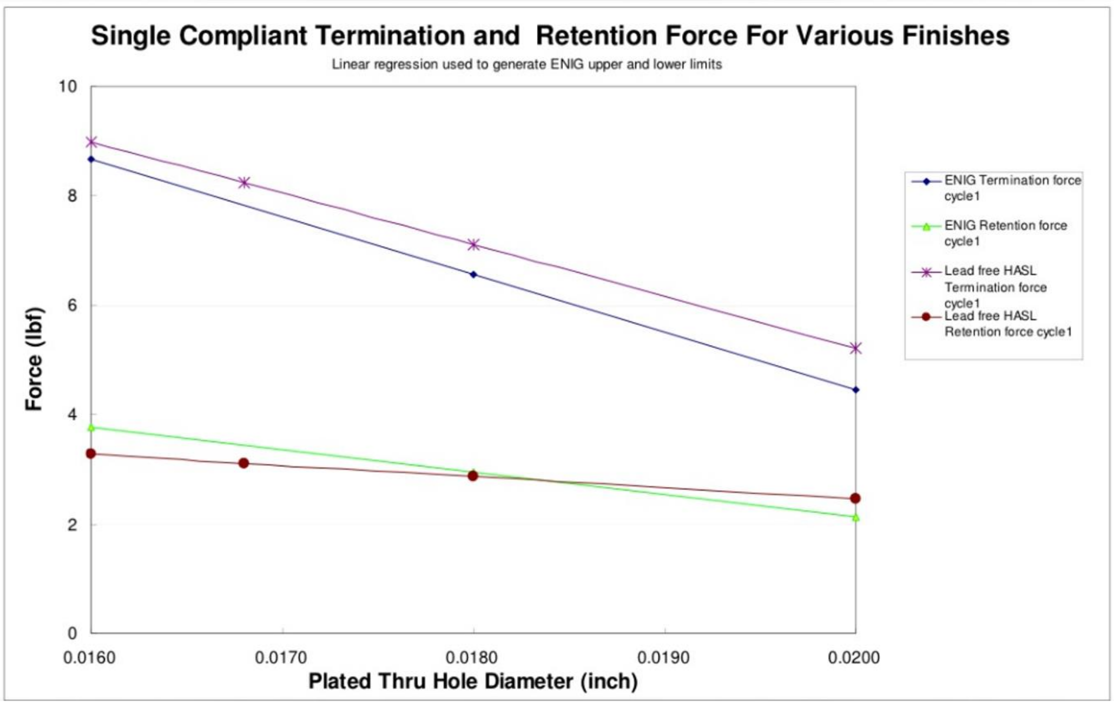
Figure 2.4 FQSFP Performance in Comparison to OIF-CEI-3.1 Requirements

We conclude from this data that the FQSFP has the SI performance required to support 28 Gbps NRZ data streams.

Mechanical Specs (ref: Samtec QSFP8)

http://suddendocs.samtec.com/testreports/132820_report_rev_1_qua.pdf

Insulator Material: LCP
Contact Material: BeCu
Operating Temp Rating: 105°C
CCC for a 30°C Temperature Rise---------1.6 A per contact with 2 adjacent contacts powered
CCC for a 30°C Temperature Rise---------1.3 A per contact with 4 adjacent contacts powered
Compliant pin insertion/retention force:



Qualification criteria:

LLCR per EIA-364-23
Mechanical Shock per EIA 364-27 Half Sine
Vibration per EIA 364-28, Random Vibration
Event detection during Shock / Vibration is 50 nanoseconds minimum per EIA-364-87
Current Carrying Capacity (for sideband signals) per EIA-364-70
Thermal Shock per EIA-364-32
Mating/Unmating per EIA-364-13
Contact normal force per EIA-364-04
Insulation Resistance per EIA-364-21 (500VDC test voltage)
Dielectric Withstanding Voiltage per EIA-364-20