UniCam® Connector Performance for High Data Rate and Analog Systems

By Doug Coleman

Introduction

Field termination of optical fiber cables continues to be a dominant termination method in the local area network (LAN). Questions have arisen recently on the ability of field-terminated UniCam® Connectors to support high-data-rate digital systems and analog video systems. These questions have resulted in a number of businesses and campuses installing factory-terminated fibers instead of field-terminated fibers.

This white paper discusses system testing that demonstrates the ability of field-terminated single-mode UniCam Connectors to reliably support high-data-rate digital (10G, 40G) and analog video systems in a manner equivalent to spliced factory-manufactured connectorized pigtails.

The UniCam Connector

The UniCam Connector incorporates a factory-installed fiber stub that is bonded to the ferrule. The ferrule end-face is factory polished and inspected to provide consistent low loss and reflectance performance. The connector is easily installed by inserting a stripped and cleaved field fiber into the back of the connector until the fiber is seated against the factory-stubbed fiber. Then the mechanical splice is engaged using a rotational camming action (See Figure 1).

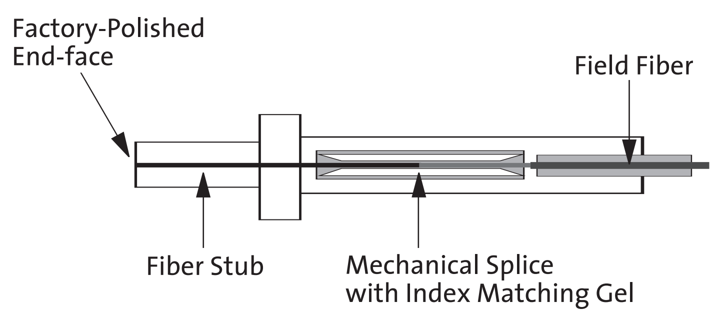

Figure 1 – UniCam Connector

Experiment - Test Scenarios

Four backbone architecture scenarios were evaluated to compare the high-data-rate digital (10G and 40G) and analog video performances of the single-mode UniCam SC Connector to a spliced single-mode SC connector pigtail.

- *Scenario One*
  Simulated a point-to-point campus and building backbone architecture with a 300 m distance from the main cross-connect (MC) to the intermediate cross-connect (IC) or telecommunications room (TR) (See Figure 2).

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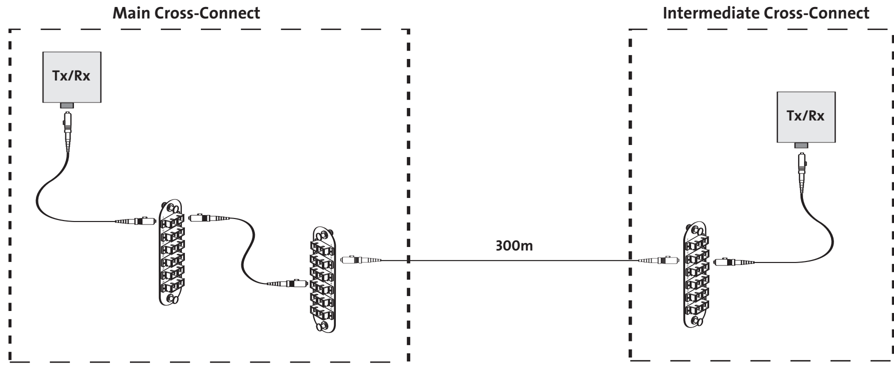

Figure 2 – Point to Point Architecture

- *Scenario Two*
  Simulated a point-to-point campus backbone architecture with a 3 km distance from the MC to the IC (See Figure 3).

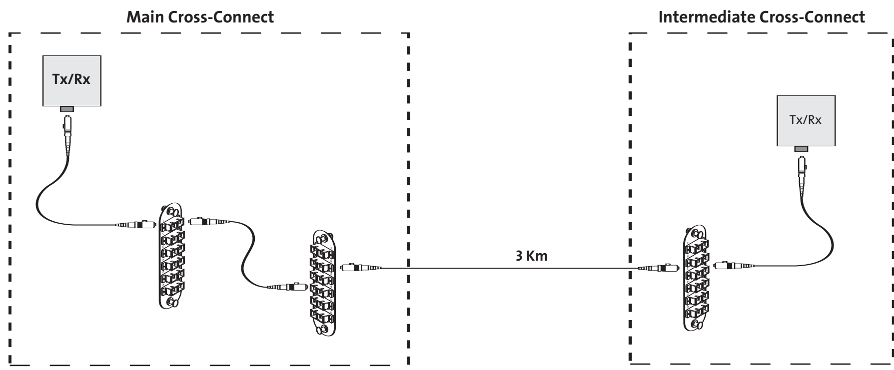

Figure 3 – Point to Point Architecture

- *Scenario Three*
  Simulated a mesh campus backbone architecture with a 6 km distance from an IC to the MC to a second IC (See Figure 4).

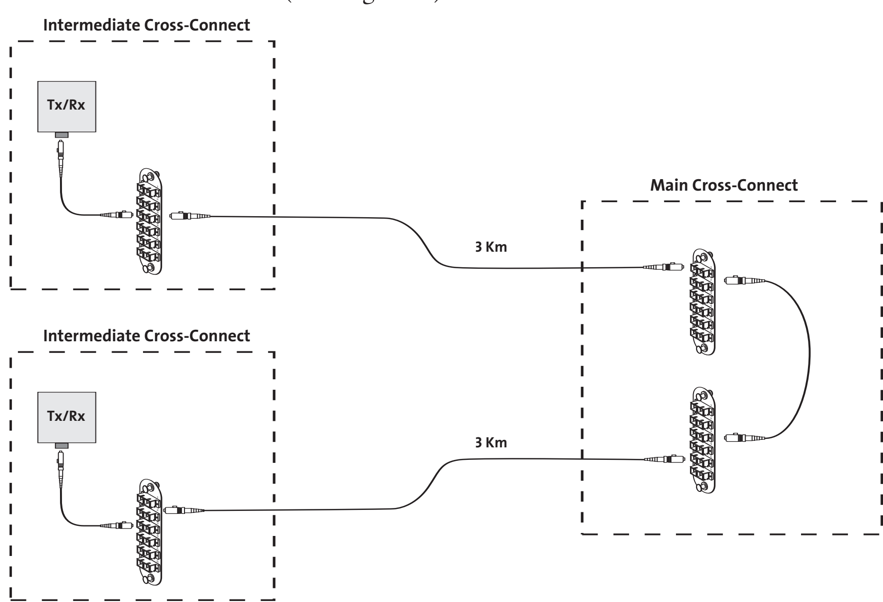

Figure 4 – Mesh Architecture

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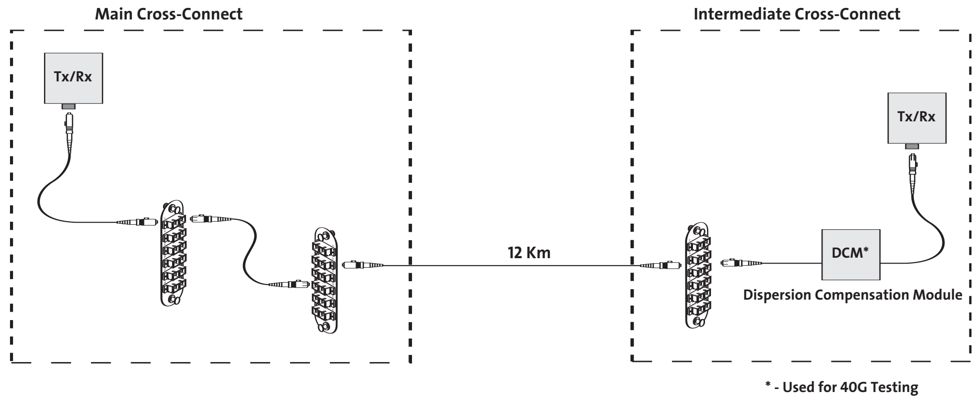

Figure 5 – Point to Point Architecture

- *Scenario Four*
  Simulated a point-to-point campus backbone architecture with a 12 km distance from the MC to the IC (See Figure 5).

For each scenario, the single-mode UniCam® SC Connectors had a -40 dB reflectance and the single-mode SC pigtails had a -55 dB reflectance. In addition, single-mode UniCam SC Connectors with a -55 dB reflectance were also included for the analog video system evaluation. Each connector utilized a flat polished ferrule end-face. UniCam SC Connectors as well as the spliced pigtails were installed on each backbone cable while factory-manufactured SC jumpers with a -55 dB reflectance were used for patch panel cross-connects and interconnects. The UniCam Connectors were installed using the FBC-001 score and snap cleaver (See Figure 6) while the factory pigtails were installed using a FBC-012 precision cleaver and a fusion splicer. Each connector and pigtail was installed by a Corning Cable Systems Extended Warranty℠ Program (EWP) certified contractor to represent actual field deployable conditions.

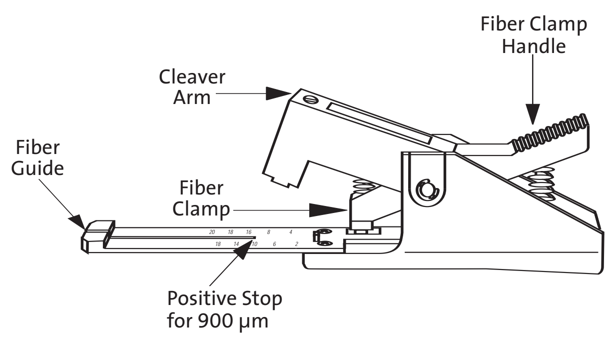

Figure 6 – FBC-001 Cleaver

Electronics Configuration

Digital Test Set-Ups

10 Gb/s testing was performed at the 1310 nm wavelength in accordance with the IEEE-802.3 10GBASE-LR physical media dependent using a standards compliant JDS Uniphase XFP transceiver. A minimum average receiver power level of -14.4 dBm is specified for a bit error rate (BER) of 10^-12. A stringent pseudorandom binary (bit) sequence (PRBS) of 2^31-1 was used to generate receiver BER waterfall curves for the comparative analysis. Figure 7 provides block diagram of the 10 GbE set-up.

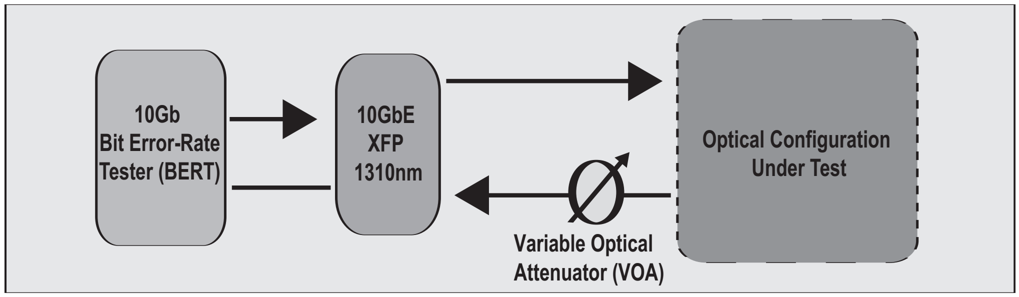

Figure 7 – 10 GbE Testing Setup

40 Gb/s testing was performed at 1550 nm using four time division multiplex (ETDM) 10 Gb/s electrical data signals with a PRBS of 2^31-1 to generate receiver BER waterfall curves for the comparative analysis. Scenarios three and four included 100 ps and 200 ps of dispersion compensation fiber (DCF), respectively, at the receiver to correct for accumulated chromatic dispersion penalties. To date, no standard system guidance exists for 40 Gb/s. A minimum receiver power level of -8 dBm is expected at a BER of 10^-12. Figure 8 provides a block diagram of the 40 Gb/s set-up.

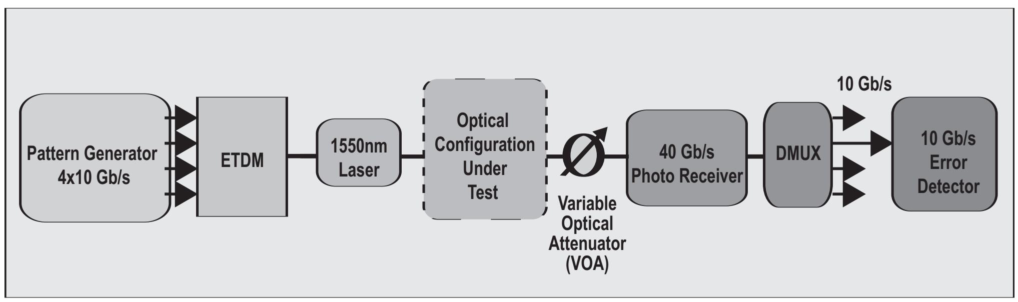

Figure 8 – 40 Gb/s Testing Setup

Analog Video Test Set-Up

Analog testing was performed across the 55 to 550 MHz frequency range using 77 multiplexed RF channels with transmission at the 1550 nm wavelength. A 6 MHz bandpass filter (BPF) was used to isolate channels 2, 9 and 78 to perform the carrier to noise ratio (CNR) comparative analysis using the electronic spectrum analyzer. The VOA was used to set the received optical power at -7.0 dBm for all measurements. Figure 9 provides a block diagram of the analog CATV set-up.

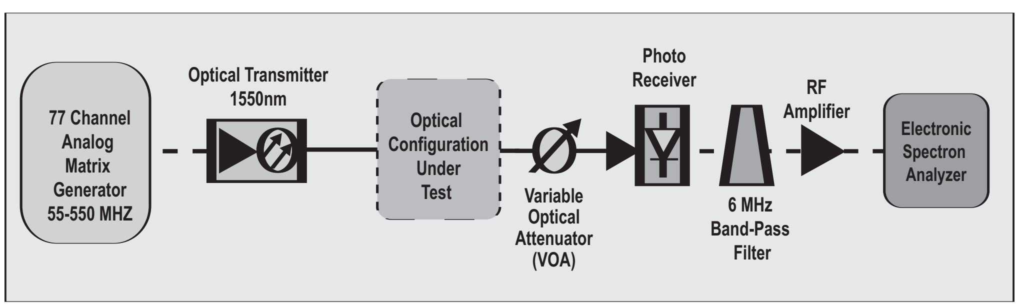

Figure 9 – Analog CATV Setup

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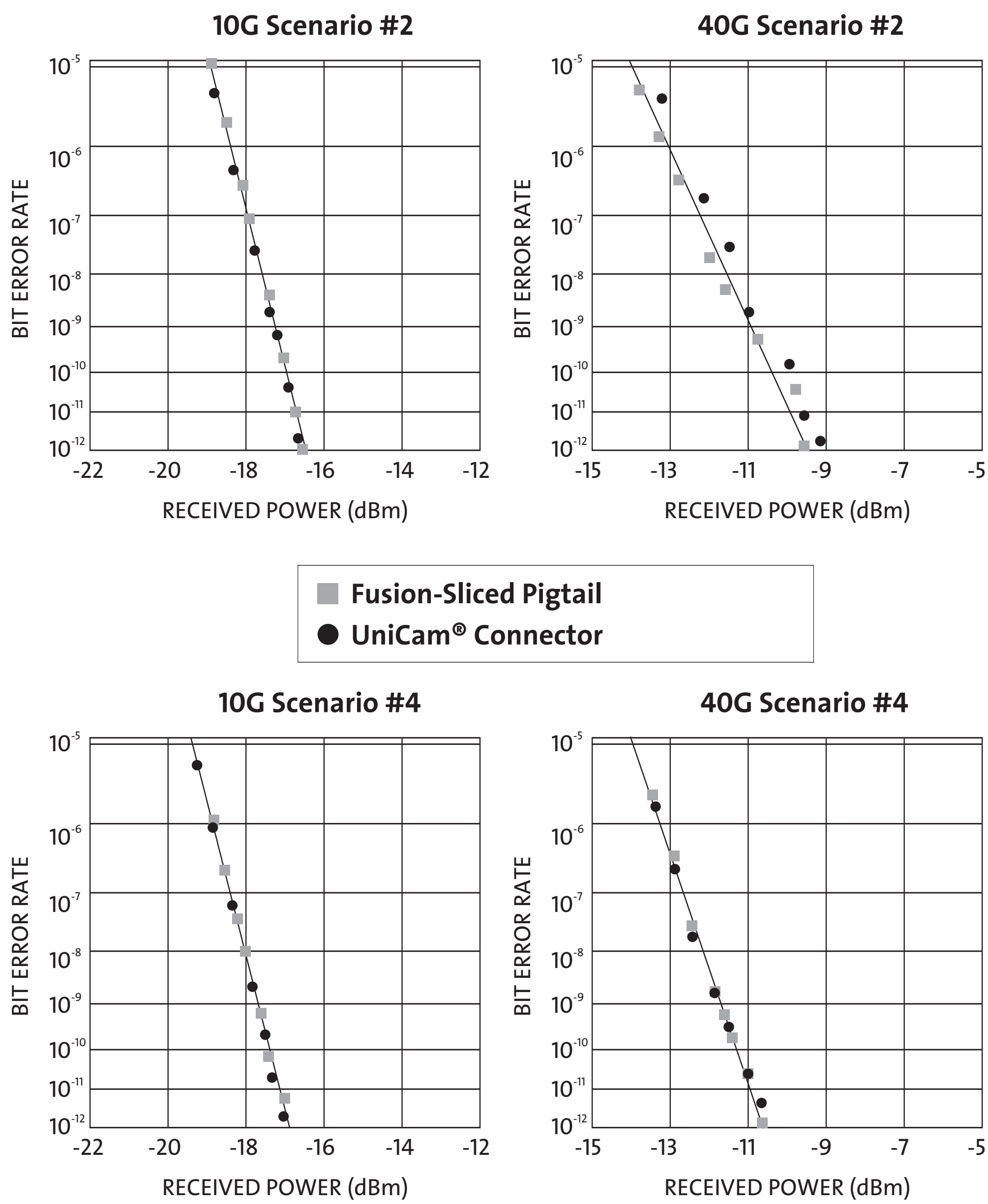
Test Results

Digital Transmission

BER waterfall curves are a standard method for comparing optical transmission capability and quality of digital signals. Waterfall curves express the BER response to decreasing received power. For each test scenario, a variable optical attenuator (VOA) was used to attenuate the receive power to derive the BER waterfall curve. l0G and 40G BER tests results showed that the UniCam® Connector performance was equivalent to that obtained with spliced factory-terminated pigtails. Each test scenario easily conformed to a BER of 10^-12 at the minimum average receiver power level for 10G and 40G. The equivalence in performance is demonstrated in the following typical BER waterfall curve results.

Table 1



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Analog Video Transmission

RF carrier to noise ratio (CNR) analysis is the common metric for evaluating analog video system performance. CATV standards define a minimum 43 dB for video transmission. Three discrete channels were monitored to compare the CNR performance for each scenario. Reference CNR measurements were made for a back-to-back setup with transmission through a short fiber jumper and compared to each tested scenario to derive a delta CNR. As with the 10G and 40G tests results, the analog video test results for each scenario showed that the UniCam® Connectors gave equivalent performance to the spliced factory-terminated pigtails, as shown in the following typical CNR results.

Table 2

CH#	CNR	ΔCNR
Scenario #2	**Reference**	**Spliced Pigtails**
2	47.39	1.45
9	47.56	0.17
78	49.18	-0.35
Scenario #2	**Reference**	**UniCam® Connector (-40 dB)**
2	47.22	1.62
9	47.78	-0.05
78	49.22	-0.39
Scenario #2:	**Reference**	**UniCam Connector (-55 dB)**
2	47.70	1.14
9	47.55	0.18
78	49.05	-0.22
Scenario #3	**Reference**	**Spliced Pigtails**
2	48.86	-0.02
9	48.20	-0.47
78	49.09	-0.26
Scenario #3	**Reference**	**UniCam Connector (-40 dB)**
2	47.40	1.44
9	47.41	0.32
78	49.36	-0.53
Scenario #3	**Reference**	**UniCam Connector (-55 dB)**
2	47.43	1.41
9	47.37	0.36
78	49.39	-0.56

Analog CNR Test Results

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Summary

High data rate digital and analog video testing was performed to evaluate the system performance difference between backbone single-mode fiber cables terminated with UniCam® SC Connectors and spliced factory-polished SC connector pigtails. Test lengths simulated typical distances and architecture topologies used in LANs. Test results showed the UniCam SC Connector to have equivalent performance to a spliced SC connector pigtail for 10G and 40G digital signals and analog CATV signals.

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