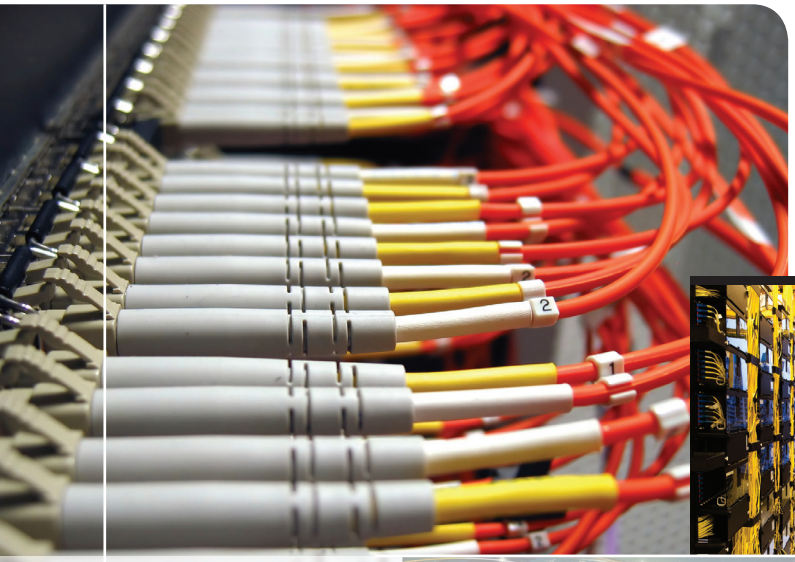
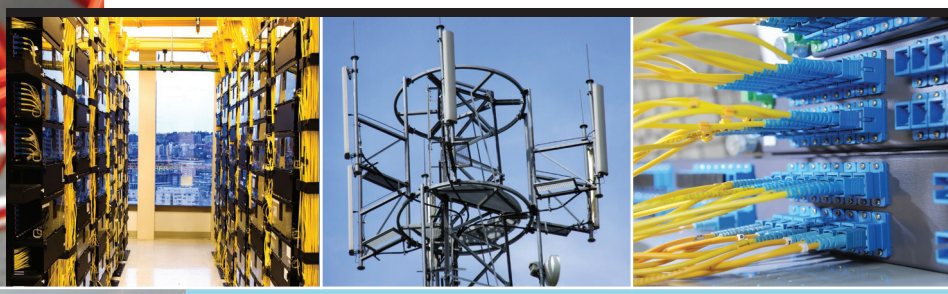
Fiber Optic Cable Assemblies

Cablcon Technical Paper

CABLCON





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TL9000

MADE IN USA

QuEST FORUM

Introduction

Cablcon is an ISO & TL 9000 certified manufacturer of custom broadband solutions. Formed in 1986, the company has evolved to manufacture fiber optic management solutions, passive fiber optic equipment and high quality copper and fiber assemblies. Our exceptional service and delivery assist in alleviating challenges associated with upgrading and building out networks to support today's intense bandwidth requirements. Our solutions focus on consistent, reliable, high-quality products manufactured in one of our responsive production facilities based in the United States.

As broadband providers continue upgrading their networks to support high-bandwidth services, increased fiber utilization is essential to meet both bandwidth and cost requirements. Proper fiber deployment has a direct impact on a network's reliability, performance and cost. It affects network maintenance, operations, expansion, restoration and the ability to rapidly implement new services. Cablcon solutions meet the needs of service providers to achieve faster time to market, future-proof their networks, streamline service delivery, and lower network up-front and operational costs.

Cablcon Commitment to Quality

Cablcon differentiates itself from low quality competitors by constantly monitoring our manufacturing process and ensuring all steps of our quality procedures are followed. Our high quality fiber optic assemblies are manufactured to clearly defined standards, and are built in one of our state of the art, ISO & TL 9000 certified manufacturing facilities. All of our assemblies meet or exceed Telcordia standards. We adhere to a strict maintenance program for all manufacturing equipment, which includes routine inspection & calibration.

Our inspection procedures, which ensure we operate within specifications, encompass all of the following:

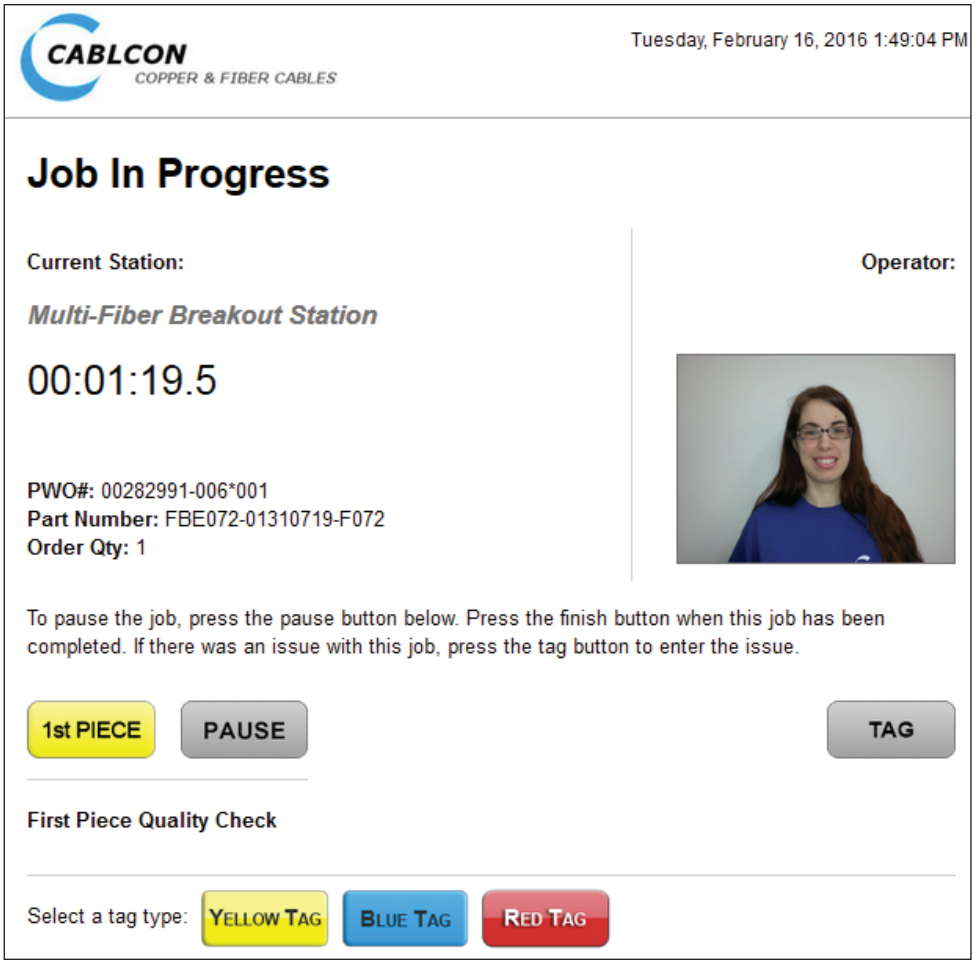
- Termination & Tool Audits
- Termination cross-section audits
- Ferrule tip integrity
- Visual inspection of the ferrule surface after polishing
- Surface symmetry Interferometric test/audit
- Insertion loss measurement
- Reflectance testing
- Repeated ferrule surface inspection prior to packing
- Out-of-Box audits
- Pull test audit

Our manufacturing process is monitored by collecting data and capturing it in our Internal Nonconformance Database (IND). The IND allows us to drive cost reduction and promote continual improvement through trend analysis. Utilizing a centralized custom software for our fiber optic assembly manufacturing process, the following data is collected, analyzed and archived:

- Equipment maintenance reports
- Pull test results
- Insertion loss and reflectance testing results
- End Face Geometry results (Cablcon fiber assemblies are built to meet or exceed GR-326 Issue 4 standards for End Face Geometry and IEC-61300-3-35 for End Face Cleanliness)
- Rework data
- Operations Log (each operation is traceable back to the assembler performing the operation, and is logged in our Time & Traceability database)

Cablcon Commitment to Quality cont.

Cablcon's Time & Traceability manufacturing O/S database collects data via bar code scans throughout the production process, allowing for report generation and analysis based on assembly technician, material component and/or assembly processing time. Every assembly manufactured can be traced back through the production process to which assembly technician performed what step in the build process, where the components came from by manufacturer and lot code, and how much time each step in the build process took.



Fiber Cables

Whether your application requires simple patch cables, complex multi-fiber pre-terminated trunk cables or something in-between, Cablcon has the experience, expertise and capabilities to meet nearly any fiber optic cable requirement. We are pleased to offer leading GR-certified components from industry leading manufacturers. We support a variety of cable types and constructions:

Interconnect Cables

- Single Fiber
- Duplex Zipcord
- Ribbon

Indoor Premise Cables

- Distribution (MIC) 2-144f
- Distribution Unitized
- Distribution (MIC) Interlocking Armored
- Micro Armored Corr2Flex® Plenum
- Fanout 2-24f
- Ribbon
- Ribbon Interlocking Armored
- Micro Distribution

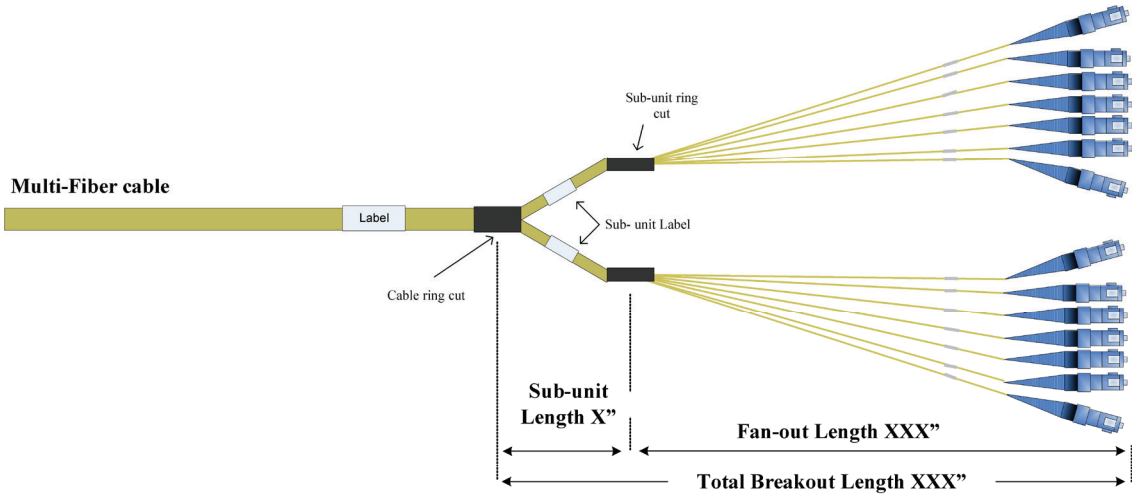
Indoor/Outdoor Cables

- Loose Tube
- Loose Tube Interlocking
- Armored Ribbon

Outdoor Cables

- All Dielectric
- Loose Tube
- Loose Tube Armored
- Micro Armored Corr2Flex®

Cablcon custom manufactures each assembly so you can specify the cable and fiber type, connector type, and breakout length that meets your needs.



Furcation is available with 900um, 1.6mm, 2.0mm and 3.0mm Fan-out tubing

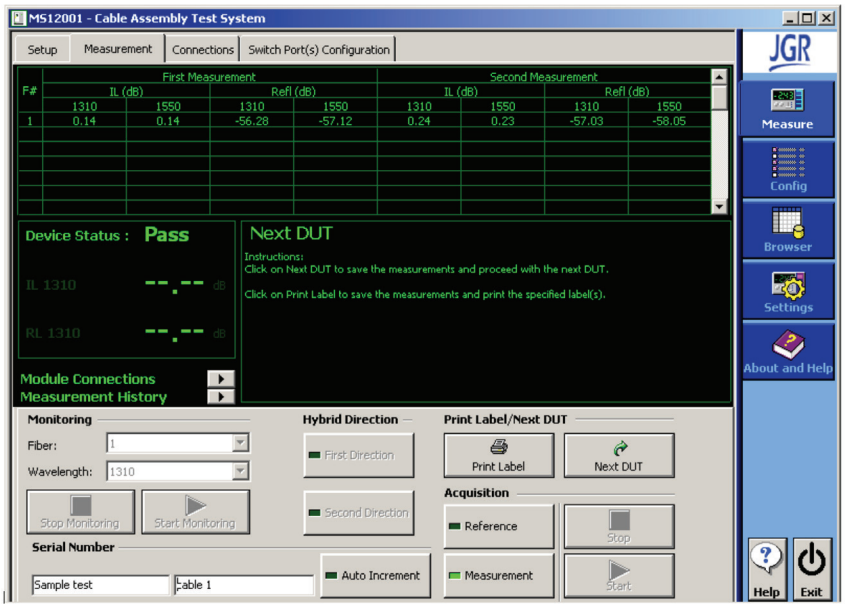
Optical Performance: Insertion Loss & Reflectance Testing

Cablcon fiber optic testing capabilities are accurate and repeatable. We test all of our fiber cable assemblies with an advanced, fully integrated testing system. Our state of the art testing equipment collects data on every termination tested using a non-mandrel reflectance test. Electronic test results are available online at *fibertest.cablcon.com* for each order and are archived at Cablcon for warranty purposes. Custom test reports are available. Our equipment offers real-time monitoring of system and reference cables to assure reliable testing data.

Our insertion loss measurement utilizes a test laboratory quality light-source and power meter employing the use of an internal power monitor for high stability and repeatability.

Our reflectance measurement uses a mandrel-free method with referenced reflections based on an Optical Time Domain Reflectometer (OTDR) type methodology.

Available measurements include both unidirectional and bidirectional (end to end). All data is recorded with a unique serial number identifiable to each assembly.

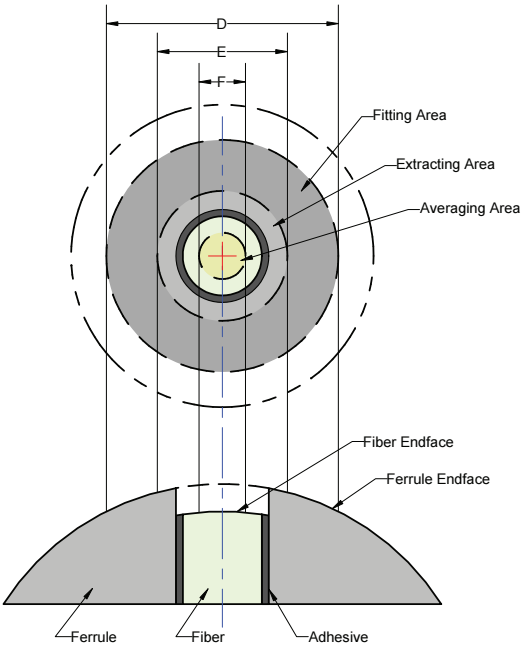


Cablcon manufactures all assemblies to meet or exceed industry Telcordia standards.

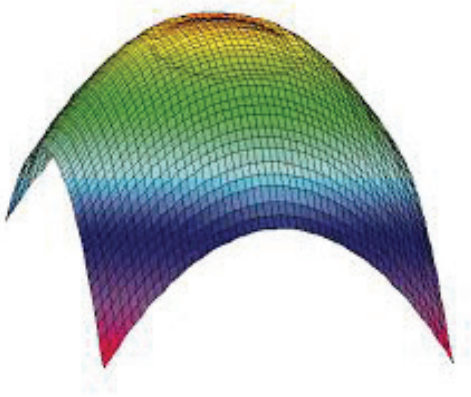
Connector Type	Core	Wavelength nm	Bi-directional IL (dB) per connector	Unidirectional IL (dB) per fiber
Single mode single fiber	8.3 um UPC	1310/1550	0.3	0.6
	8.3 um APC	1310/1550	0.3	0.6
Multimode single fiber	50 um	850/1300	0.3	0.6
	62.5 um	850/1300	0.3	0.6
Single mode MT/APC	8.3 um	1310	0.5	1
		1550	0.5	1
Multimode MT	50 um	850	0.5	1
		1300	0.5	1
Multimode MT	62.5 um	850	0.5	1
		1300	0.5	1

End Face Geometry (EFG)

The end face geometry of a connector directly impacts the connector's optical performance. Cablcon constantly monitors the most critical end face parameters utilizing Norland Advantage Multifiber Interferometers. Our critical measurements include Radius of Curvature (ROC), Fiber Height, Linear (Apex) Offset and Angular Offset. Other consistently monitored parameters include Curvature Radius Low/High, Fiber Roughness Avg/Max and Ferrule Roughness Avg/Max. Interferometry measurements are used for quality control and quality assurance, and guarantee long-term performance.



Measurement Areas are Not to Scale

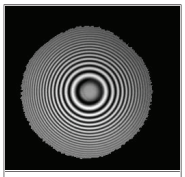


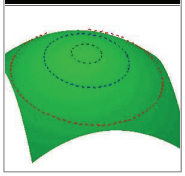
3D Mesh Display

Endface QC Report — **PASS**

Product ID:	Cable1
Connector ID:	SC UPC
Scan Date:	2/11/2016
Scan Time:	9:45:12 AM
System:	Advantage_SF

Scan Input Parameter	Value
FiberCount	1
FiberDiameter	126.00
FerruleType	Ceramic
FerruleCount	1
Nominal Y-Angle	0.00
SampleType	PC_Connector
FittingAreaDiameter(um)	250.00
ExtractingAreaDiameter(um)	140.00
AveragingAreaDiameter(um)	50.00





Test Parameter	Value	Test Min	Test Max
MeasurementConfig	Telcordia_PC		
CurvRadius(mm)	13.72	7.00	25.00
CurvRadius Low(mm)	13.64		
CurvRadius High(mm)	13.81		
FiberHeight(nm)	11.08	-92.70	50.00
LinearOffset(um)	6.85	0.00	50.00
LinearOffset X(um)	-6.84		
LinearOffset Y(um)	-0.32		
AngularOffset(deg)	0.03	0.00	20.00
Ra_Fiber(nm)	1.12		
Ra_Ferrule(nm)	1.74		
Rq_Fiber(nm)	1.42		
Rq_Ferrule(nm)	2.13		

Product ID:	Cable1	Connector ID:	SC UPC		
Scan Date:	2/11/2016	Scan Time:	9:45:12 AM	System:	Advantage_SF

Notes _____ Signature _____

Endface QC Report — **PASS**

Product ID:	P00280952-030002		
Connector ID:	MPO-A2		
Scan Date:	6/1/2015		
Scan Time:	9:25:54 AM		
System:	Advantage_MF		
ROC_X(mm)	3837.53	PASS	
ROC_Y(mm)	116.83	PASS	
FiberHeight(um)	1.370/1.679	PASS	

Test Parameter	Value	Test Spec. Min	Test Spec. Max
MaxFibDiffH(um)	0.31	0.00	0.50
MaxCoreDip(um)	0.26	-1.00	1.00
ROC_X(mm)	3837.53	2000.00	9999999.00
ROC_Y(mm)	116.83	5.00	9999999.00
XEndFaceAngle(deg)	0.17	-0.25	0.25
YEndFaceAngle(deg)	-0.02	-0.25	0.25
FlatnessDeviation(um)	0.27	-0.50	0.50
Fiber Array X Angle(deg)	0.17	-0.20	0.20
Fiber Array Y Angle(deg)	-0.02	-0.20	0.20
Coplanarity(um)	0.25		1.00

Company Information

Ph:

Fax:

Scan Input Parameter	Value	Scan Input Parameter	Value
FiberCount	12	Nominal Y-Angle	0.00
FiberPitch	250.00	ConnectorType	Large MT (12 fibers)
FibersPerRow	12	ScanSegmentsNmb	4
FiberRowPitch	0.00	ROI_width(um)	2900.00
RowsVerticalOffset	0.00	ROI_height(um)	675.00
FiberCaptureShape	Hole	AvgDiameter(um)	100.00
Shape	Block	ExtractingDiameter(um)	140.00
FiberDiameter	126.00	Minimum Modulation(%)	20
FerruleType	Glass	TopPixRemove(%)	3
FerruleCount	1	TopPixLeft(%)	20
GuideStructureType	Hole	SampleType	MT_12_MM
GuideStructurePitch	4600.00		

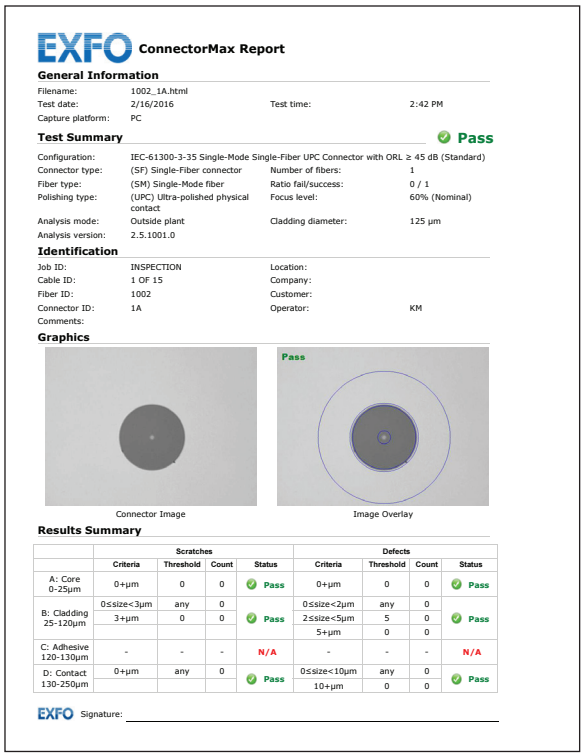
End Face Cleanliness (EFC)

A clean connection is a requirement for maintaining an error-free fiber optic network. Dust, lint, oil or other foreign particles may contaminate an end face, compromising the integrity of the optical signal. Therefore, it is essential that fiber optic users develop the necessary disciplines and habits to ensure clean connections during the manufacturing, testing, installation and maintenance of fiber optic connections.

Cablcon fiber assemblies are built to meet or exceed GR-326 Issue 4 standards for End Face Geometry and IEC-61300-3-35 End Face Cleanliness.

	Scratches				Defects			
	Criteria	**Threshold**	**Count**	**Status**	**Criteria**	**Threshold**	**Count**	**Status**
A: Core 0-25µm	0 + µm	0	0	**Pass**	0 + µm	0	0	**Pass**
B: Cladding 25-120 µm	0≤size<3µm	any	1	**Pass**	0≤size<2µm	any	1	**Pass**
	3+µm	0	0	**Pass**	2≤size<5µm	5	4	
					5+µm	0	0	
C: Adhesive 120-130µm	-	-	-	**N/A**	-	-	-	**N/A**
D: Contact 130-250µm	0+µm	any	0	**Pass**	0≤size<10µm	any	0	**Pass**
					10 + µm	0	0	

As part of our manufacturing process, every end face is digitally mapped to ensure all assemblies leaving our facility meet these stringent standards and are constructed to perform optimally in your network.



EXFO ConnectorMax Report

General Information

Filename:	1002_1A.html		
Test date:	2/16/2016	Test time:	2:42 PM
Capture platform:	PC		

Test Summary — Pass

Configuration:	IEC-61300-3-35 Single-Mode Single-Fiber UPC Connector with ORL ≥ 45 dB (Standard)		
Connector type:	(SF) Single-Fiber connector	Number of fibers:	1
Fiber type:	(SM) Single-Mode fiber	Ratio fail/success:	0 / 1
Polishing type:	(UPC) Ultra-polished physical contact	Focus level:	60% (Nominal)
Analysis mode:	Outside plant	Cladding diameter:	125 µm
Analysis version:	2.5.1001.0		

Identification

Job ID:	INSPECTION	Location:	
Cable ID:	1 OF 15	Company:	
Fiber ID:	1002	Customer:	
Connector ID:	1A	Operator:	KM
Comments:			

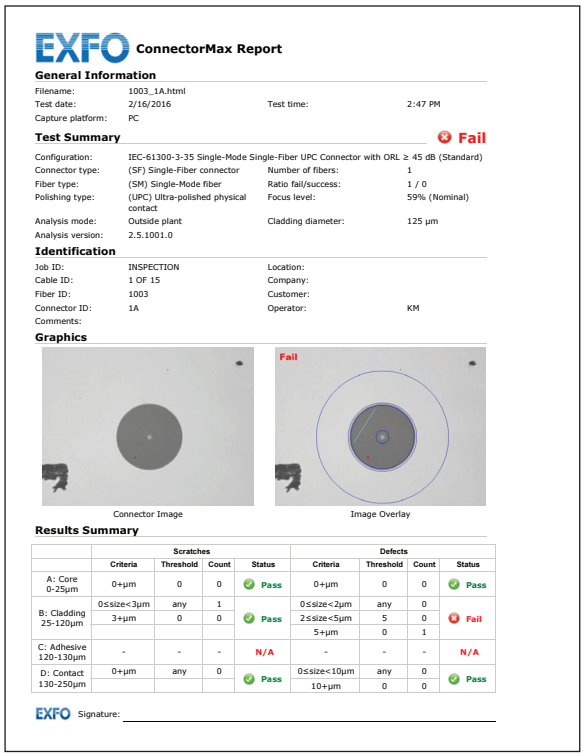
Graphics

Connector Image — Image Overlay

Results Summary

	Scratches				Defects			
	Criteria	Threshold	Count	Status	Criteria	Threshold	Count	Status
A: Core 0-25µm	0+µm	0	0	Pass	0+µm	0	0	Pass
B: Cladding 25-120µm	0≤size<3µm	any	0	Pass	0≤size<2µm	any	0	Pass
	3+µm	0	0		2≤size<5µm	5	0	
					5+µm	0	0	
C: Adhesive 120-130µm	-	-	-	N/A	-	-	-	N/A
D: Contact 130-250µm	0+µm	any	0	Pass	0≤size<10µm	any	0	Pass
					10+µm	0	0	

EXFO Signature: _____



EXFO ConnectorMax Report

General Information

Filename:	1003_1A.html		
Test date:	2/16/2016	Test time:	2:47 PM
Capture platform:	PC		

Test Summary — Fail

Configuration:	IEC-61300-3-35 Single-Mode Single-Fiber UPC Connector with ORL ≥ 45 dB (Standard)		
Connector type:	(SF) Single-Fiber connector	Number of fibers:	1
Fiber type:	(SM) Single-Mode fiber	Ratio fail/success:	1 / 0
Polishing type:	(UPC) Ultra-polished physical contact	Focus level:	59% (Nominal)
Analysis mode:	Outside plant	Cladding diameter:	125 µm
Analysis version:	2.5.1001.0		

Identification

Job ID:	INSPECTION	Location:	
Cable ID:	1 OF 15	Company:	
Fiber ID:	1003	Customer:	
Connector ID:	1A	Operator:	KM
Comments:			

Graphics

Connector Image — Image Overlay

Results Summary

	Scratches				Defects			
	Criteria	Threshold	Count	Status	Criteria	Threshold	Count	Status
A: Core 0-25µm	0+µm	0	0	Pass	0+µm	0	0	Pass
B: Cladding 25-120µm	0≤size<3µm	any	1	Pass	0≤size<2µm	any	0	Fail
	3+µm	0	0		2≤size<5µm	5	0	
					5+µm	0	1	
C: Adhesive 120-130µm	-	-	-	N/A	-	-	-	N/A
D: Contact 130-250µm	0+µm	any	0	Pass	0≤size<10µm	any	0	Pass
					10+µm	0	0	

EXFO Signature: _____

Durability & Reliability Requirements (GR-326-CORE ISSUE 4)

Cablcon high quality fiber assemblies have been tested at an Independent Test Lab (ITL) to ensure compliance with the requirements described in the following industry standards:

GR-326 Issue 4 "Generic Requirements for Single mode Optical connectors and Jumper Assemblies"

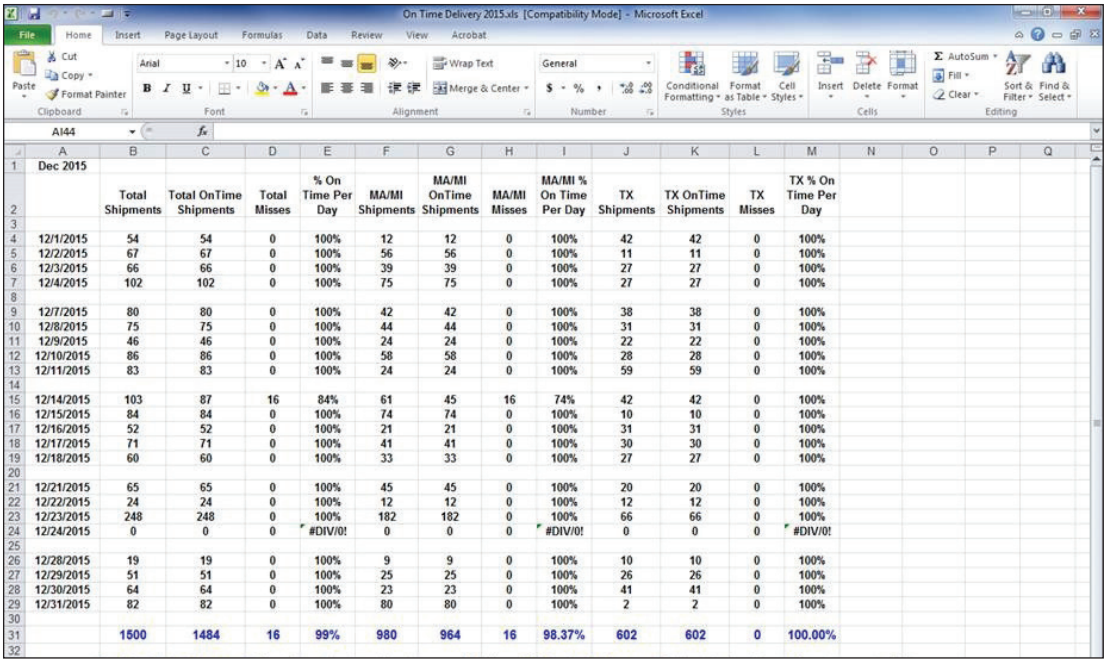
Components are selected to comply with the necessary requirements to meet Industry Standards:

GR-1209 "Generic Requirements for Passive Optical Components"
GR-20 "Generic Requirements for Optical Fiber and Optical Fiber Cable"
GR-2866 "Generic Requirements for Optical Fiber Fanouts"
GR-2923 "Generic Requirements for Optical Fiber Connector Cleaning"
GR-409 Products" "Generic Requirements for Premises Fiber Optic Cable"

Delivery & Lead Time

Cablcon has serviced the telecommunications industry for 30 years. Over the years we have found our niche as a custom, quick-turn manufacturer of high quality copper and fiber optic assemblies.

Cablcon is committed to 100% On-Time Delivery, while averaging a best in class 98%+. In 2002, the company became a member of the QuEST Forum (the governing body of TL 9000), and became TL 9000 certified in 2003. One of the Key Performance Indicators (KPI) we report to the QuEST Forum is our On-Time Delivery Performance. Our delivery performance is tracked daily and measured against our committed on-site date. If we do not reach 100%, the area of failure is documented and a Root Cause Analysis performed. Upon our analysis, Corrective Action Requests (CAR's) and Supplier Corrective Action Requests (SCAR's) are issued so our level of performance is continually improved.



Dec 2015	Total Shipments	Total OnTime Shipments	Total Misses	% On Time Per Day	MA/MI Shipments	MA/MI OnTime Shipments	MA/MI Misses	MA/MI % On Time Per Day	TX Shipments	TX OnTime Shipments	TX Misses	TX % On Time Per Day
12/1/2015	54	54	0	100%	12	12	0	100%	42	42	0	100%
12/2/2015	67	67	0	100%	56	56	0	100%	11	11	0	100%
12/3/2015	66	66	0	100%	39	39	0	100%	27	27	0	100%
12/4/2015	102	102	0	100%	75	75	0	100%	27	27	0	100%
12/7/2015	80	80	0	100%	42	42	0	100%	38	38	0	100%
12/8/2015	75	75	0	100%	44	44	0	100%	31	31	0	100%
12/9/2015	46	46	0	100%	24	24	0	100%	22	22	0	100%
12/10/2015	86	86	0	100%	58	58	0	100%	28	28	0	100%
12/11/2015	83	83	0	100%	24	24	0	100%	59	59	0	100%
12/14/2015	103	87	16	84%	61	45	16	74%	42	42	0	100%
12/15/2015	84	84	0	100%	74	74	0	100%	10	10	0	100%
12/16/2015	52	52	0	100%	21	21	0	100%	31	31	0	100%
12/17/2015	71	71	0	100%	41	41	0	100%	30	30	0	100%
12/18/2015	60	60	0	100%	33	33	0	100%	27	27	0	100%
12/21/2015	65	65	0	100%	45	45	0	100%	20	20	0	100%
12/22/2015	24	24	0	100%	12	12	0	100%	12	12	0	100%
12/23/2015	248	248	0	100%	182	182	0	100%	66	66	0	100%
12/24/2015	0	0	0	#DIV/0!	0	0	0	#DIV/0!	0	0	0	#DIV/0!
12/28/2015	19	19	0	100%	9	9	0	100%	10	10	0	100%
12/29/2015	51	51	0	100%	25	25	0	100%	26	26	0	100%
12/30/2015	64	64	0	100%	23	23	0	100%	41	41	0	100%
12/31/2015	82	82	0	100%	80	80	0	100%	2	2	0	100%
	1500	1484	16	99%	980	964	16	98.37%	602	602	0	100.00%

Conclusion

Our Mission Statement is “to be the most reliable supplier of cabling products to the broadband communications industry, providing valued solutions that develop long term relationships.”

Our Commitment: Customer service is key! We base everything we do on exceeding our internal and external customers’ expectations. We create value for our customers by working with their requirements, understanding their needs and delivering exceptional quality. Our goal is to become the first company that comes to mind for fiber optic cable assemblies.

At Cablcon, we seek to maximize customer confidence and satisfaction by consistently exceeding expectations, in a culture of continual improvement that focuses on *People, Process, and Product*.

CABLCON

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Specifications published here are current as of the date of publication of this document.
Cablcon reserves the right to change specifications without prior notice.
At any time, you may verify product specifications by contacting our headquarters office in Troy, MI.

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TL9000

MADE IN USA