

Test Title:	INSTRUMENT REDO - Fiber Optic Cable Handling in A6500/A5500		
Project I/O no.:	114561	Creation Date:	10/11/2021
Product:	A6500/A5500 Fiber Optic	Approval Date:	10/11/2021
Project Name:	Fiber Optic Handling	Start Date:	12/20/2021
Requested By:	Scott Gehring	End Date:	12/23/2021
DVT Lead:	Lucas Zahn	Entry Code:	LCZ-21-042
Tested By:	Lucas Zahn		
File Location:	This document can be retrieved from ELN using the entry code.		

Reason for Testing

- | | |
|--|---|
| <input type="checkbox"/> New Product | <input checked="" type="checkbox"/> Evaluation |
| <input type="checkbox"/> Engineering Change
ECO/Deviation# (if applicable) <u>Click here to enter text.</u> | <input checked="" type="checkbox"/> Design Validation |
| <input type="checkbox"/> SMP | <input type="checkbox"/> Production Validation |
| <input type="checkbox"/> Other <u>Click here to enter text.</u> | <input type="checkbox"/> OPS |

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1. Purpose of Test

Determine if rubber inserts applied to A6500 and A5500 Fiber Optic units meet fiber optic wrapping requirements of the MRD-PRD. As well as if wrapping/flagging with either printer damages fiber optic wires. Primary metric to be analysed will be signal loss inspection.

This test is being performed due to favorable results from LCZ-21-030. For this reason, a laser guided test will not be performed.

Please note that copper wire will not be tested as part of this test. Copper wire testing has been completed in LCZ-21-033

2. Conclusions

This test has PASSED with all fiber optic cables tested having minimal visual markings, none of which remained after one hour after testing.

Power meter testing shows a difference less than 2% between unwrapped and wrapped cabled.

OTDR testing shows that a majority of cables have similar results when comparing the unwrapped and wrapped reports. Please see the attached .zip file attached to the ELN report number listed at the top of this report. The file will have all files generated during testing.

3. Test Design

Multiple cables will be tested: OS2 singlemode, OM1 multimode and OM2 multimode cables. Which will cover the internal core diameters of 9um, 62.5um and 50um respectively. The primary metric to be tested is optical return loss. Testing includes:

- Visual inspection of cable at point where jaws come in contact with the cable

- Tier 2 Optical Time Domain Reflectometer (OTDR) inspection on single mode cables

- Power reading with Multimode Cables

3.1. Test Plan Approval

This test plan has been approved by: Scott Gehring.

4. Test Setup and Equipment Use

4.1. Sample Specifics

Ten, one meter length cables of the following will be needed:

Material	Outer Diameter	Description
OS2 Fiber Cable	0.079" (2mm)	LC to LC Duplex 9/125 SingleMode
OS2 Fiber Cable	0.118" (3mm)	SC to SC Duplex 9/125 SingleMode
OM1 Fiber Cable	0.079" (2mm)	LC to LC Duplex Corning 62.5/125 MultiMode
OM1 Fiber Cable	0.118" (3mm)	SC to SC in/outdoor Duplex 62.5/125 MultiMode
OM2 Fiber Cable	0.079" (2mm)	LC to LC Duplex 50/125 MultiMode
OM2 Fiber Cable	0.118" (3mm)	SC to SC Duplex 50/125 MultiMode

Note: The first set of numbers - 9, 50 and 62.5 refer to the diameter of the fiber cable's core. The second set of numbers - 125 refer to the diameter of the outside of the fiber cable's cladding.

4.2. Equipment Specifics

The following test equipment will be needed:

- 1 x FFL-100 Visual Fault Locator
- 1 x P5000i Fiber Microscope
- 1 x T-BERD/MTS-6000A Optical Test Platform
- 1 x T-BERD/MTS-8000 Optical Test Platform
- 1 x E4146 QUAD MultiMode Power Meter
- 1 x ES2425 (fiber optic cleaning solution)
- 1 x 348X950 (fiber optic cleaning dry wipes)

The equipment to be tested:

- 1 x A6500 Fiber Optic Printers
- 1 x A5500 Printers
- 1 roll of WRAP-1-417
- 1 roll of WRAP-4-417
- 1 roll of A55-4-483
- 1 roll of A55-1-483

4.3. Test Setup

Visual inspection:

Inspect the site where the jaws clamp on the fiber optic cable. Report any visual defects.

Multi-Mode Power Test:

- Power on the Power Meter and verify the battery is charged and the test display is functioning.
- Clean and inspect the ends of all fibers under test, launch cables, connectors, and adapters.
 - Use the "Wet/Dry" method
 - Soak a dry wipe in solution
 - Wipe each end of the cable on the wipe
 - Wipe each end on a second dry wipe
- Carefully connect the launch cable to the output port of the Power Meter at one end and the fiber under test at the meter side.
- Turn on the power meter and record the results.

Optical Time Domain Reflectometer (OTDR) Test:

- Power on the OTDR and verify the battery is charged and the test display is functioning.
- Clean and inspect the ends of all fibers under test, launch cables, connectors, and adapters.
 - Use the "Wet/Dry" method
 - Soak a dry wipe in solution
 - Wipe each end of the cable on the wipe
 - Wipe each end on a second dry wipe
- Carefully connect the launch cable to the output port of the OTDR at one end and the fiber under test at the opposite end.
- Select a pre-programmed Tier 2 OTDR test routine:
 - **Range:** Set appropriate range (distance) based on the overall fiber length
 - **Pulse Width:** Sets the duration of each laser pulse emitted, determined by fiber
 - **Acquisition Time:** Sets the time duration for averaging the measurements of reflected light, approximately 2-5 minutes
 - **Refractive Index:** Matches the index of the cable material being tested
 - Loss threshold settings for the system and individual elements or "events"
- Run the OTDR for the necessary time to acquire the test results and "trace"

- Store and/or upload tier 2 test results as necessary
- Carefully disconnect all cables, connectors, and adapters

4.4. Test Groups

No test groups defined

4.5. Assumptions

The jaw tension for the A6500 has been properly set.

The jaw tension on the A5500 is unmodified.

5. Test Procedure(s)

For each cable listed in the sample specifics section and for both the A5500 and A6500 printer, perform the following steps:

- Perform visual inspection, OTDR, and Multi-Mode Power Meter Tests
- Record results
- Wrap/flag the cable individually with:
 - WRAP-4-417 if using an A6500
 - A55-4-483 if using an A5500
- Perform visual inspection, OTDR, and Multi-Mode Power Meter Tests
- Record Results
- On a second cable Perform visual inspection, OTDR, and Multi-Mode Power Meter Tests
- Record Results
- Insert a second cable pair into the jaws side-by-side as opposed to over-under, Wrap/flag a second cable as a pair with:
 - WRAP-4-417 if using an A6500
 - A55-4-483 if using an A5500
- Perform visual inspection, OTDR, and Multi-Mode Power Meter Test
- Record Results

No fiber optic cable will be wrapped or flagged more than one time. Each wrap/flag operation is to take place on an unwrapped/unflagged cable.

Cross sectional view of proper cable alignment with jaws when wrapping a pair of cables:



5.1. Pass/Fail Criteria

This test will be considered to have PASSED if the following criteria have been met:

No visual markings are present on the jacket from visual inspection.

No laser guided visual fault indicators are present.

Each cable tested must pass Tier 2 Optical Time Domain Reflectometer (OTDR) inspection

Failure to meet any of these criteria will mark the test as a FAIL.

6. Deviations from Test Plan

Add in as needed

7. Observations

Add in as needed

8. Test Results

Visual inspection of fiber optic cables:

Minor indentation noticed on larger diameter cables.

The indentation was not present one hour after testing.

Multi-Mode Power Measurements:

Cables denoted Single2 did not have a label applied and can be considered a control to identify if the difference between unwrapped and wrapped is due to handling of the cable at time of measurement or due to internal damage. Cables denoted with Double had the label applied across both cables at once. The test was conducted at 1300nm

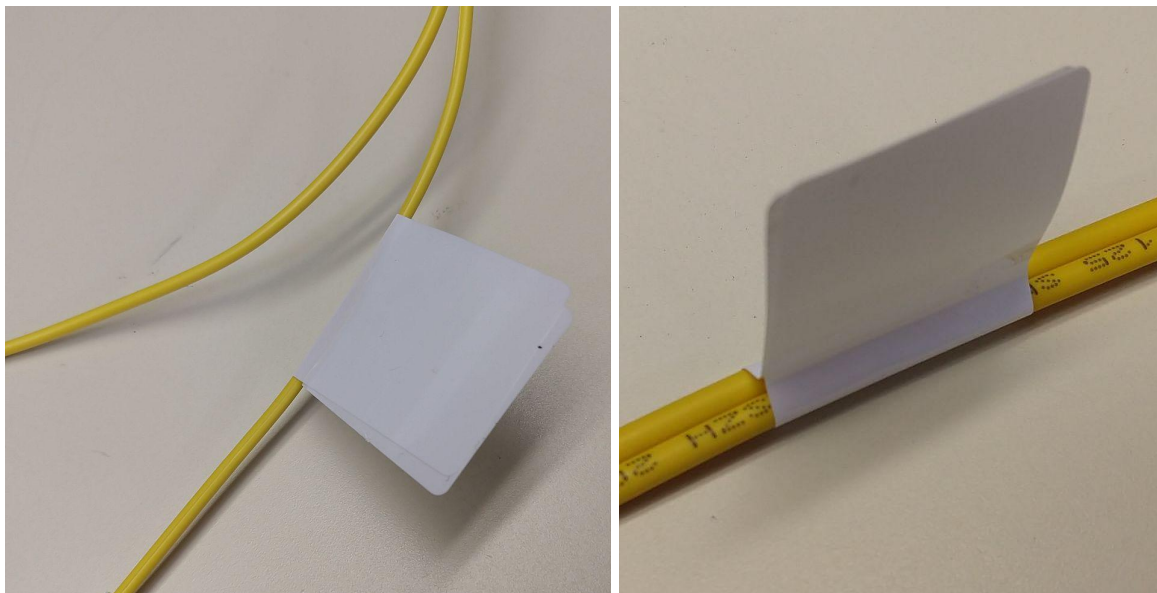
Cable	Printer	Cable Identifier	Unwrapped Value(dB)	Wrapped Value (dB)
OM1LC	A6500	Single1	-18.71	-18.87
OM1LC	A6500	Single2	-18.71	-18.86
OM1LC	A6500	DoubleA	-19.87	-20.07
OM1LC	A6500	DoubleB	-19.53	-19.71

Fiber Optic Cable Handling in A6500 Fiber Optic and A5500 Printer

OM1LC	A5500	Single1	-19.64	-19.82
OM1LC	A5500	Single2	-18.82	-18.92
OM1LC	A5500	DoubleA	-19.16	-19.32
OM1LC	A5500	DoubleB	-20.08	-20.23
OM1SC	A6500	Single1	-6.21	-6.25
OM1SC	A6500	Single2	-6.18	-6.22
OM1SC	A6500	DoubleA	-6.67	-6.71
OM1SC	A6500	DoubleB	-6.18	-6.24
OM1SC	A5500	Single1	-6.19	-6.23
OM1SC	A5500	Single2	-6.18	-6.24
OM1SC	A5500	DoubleA	-6.17	-6.22
OM1SC	A5500	DoubleB	-6.17	-6.21
OM2LC	A6500	Single1	-21.87	-22.05
OM2LC	A6500	Single2	-21.80	-22.00
OM2LC	A6500	DoubleA	-21.43	-21.54
OM2LC	A6500	DoubleB	-20.28	-20.42
OM2LC	A5500	Single1	-21.17	-21.34
OM2LC	A5500	Single2	-20.37	-20.56
OM2LC	A5500	DoubleA	-21.47	-21.68
OM2LC	A5500	DoubleB	-22.8	-22.92
OM2SC	A6500	Single1	-6.30	-6.35
OM2SC	A6500	Single2	-6.23	-6.27
OM2SC	A6500	DoubleA	-6.20	-6.25
OM2SC	A6500	DoubleB	-6.23	-6.28
OM2SC	A5500	Single1	-6.22	-6.27
OM2SC	A5500	Single2	-6.30	-6.36

OM2SC	A5500	DoubleA	-6.26	-6.31
OM2SC	A5500	DoubleB	-6.28	-6.32

For reference, no light received by the power meter reads as -60dB.



Above shows an example of a flagged single cable (LEFT) and a flagged double cable (RIGHT).

Optical Time Domain Reflectometer (OTDR) Test:

Please see the attached .zip file attached to the ELN report number listed at the top of this report. The file will have all files generated during testing.

9. Appendix



Figure 1. P5000i Fiber Microscope with SC connector attached

Fiber Optic Cable Handling in A6500 Fiber Optic and A5500 Printer



Figure 2. Tier 2 Test setup. Cable connects between T-BERD8000 (LEFT) and T-BERD6000A (RIGHT).

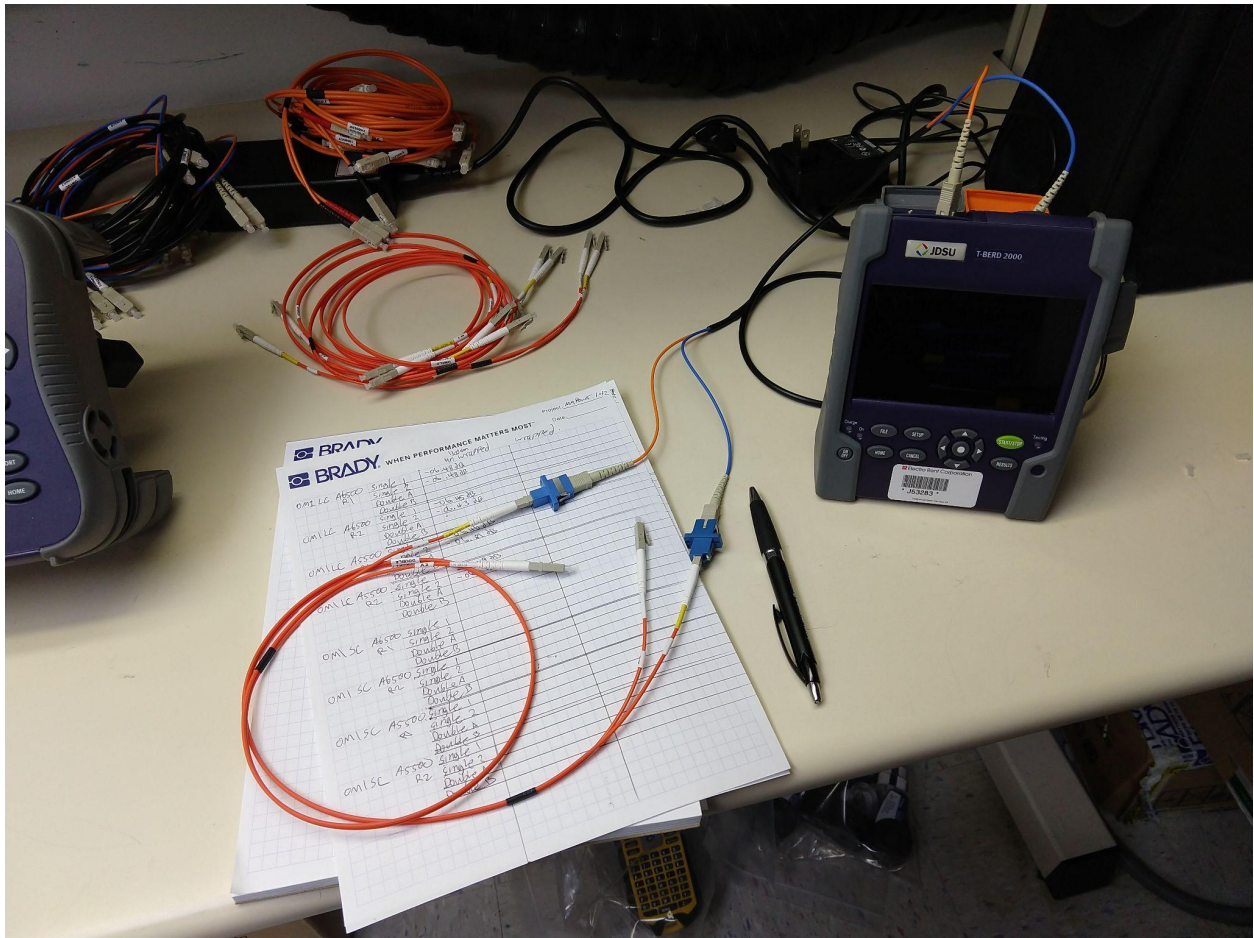


Figure 3. Power meter test setup pictured with LC adapters. SC cables connected directly to the power meter.

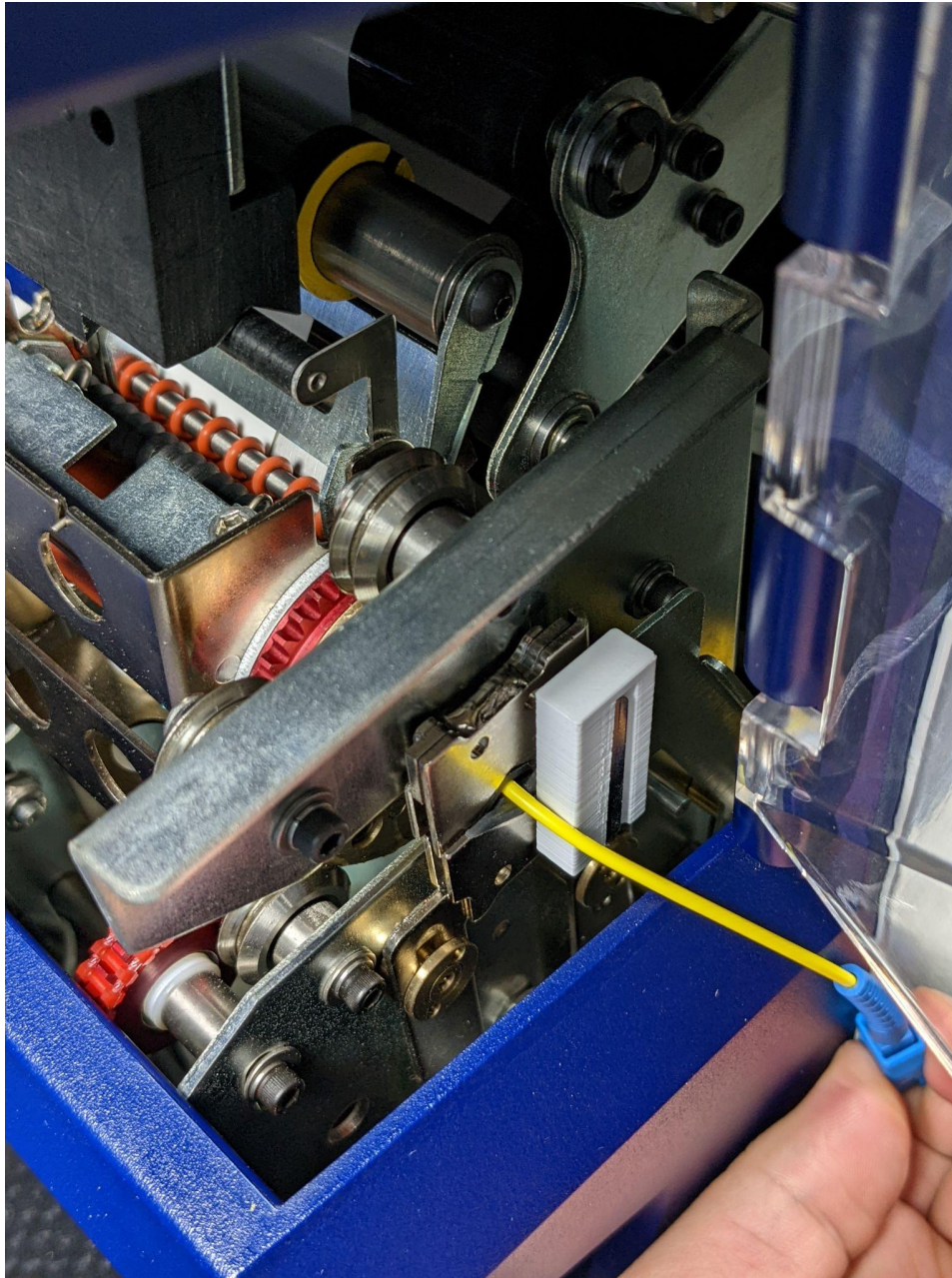


Figure 4. A single cable shown being gripped by the A6500 printer jaws with 3D printed trigger extender



15385 OXNARD ST
VAN NUYS, CA 91411

CALIBRATION CERTIFICATE

Certificate Number: J55726-11/20/21

Calibration Date: 11/20/21

Procedure Method: ER PROCEDURE

Revision Level: MFR

Calibration Facility: ELECTRO RENT CORPORATION (WDC)
15385 OXNARD ST
VAN NUYS, CA 91411

The equipment listed has been calibrated using the method identified above.

Measurements are traceable to the SI as defined by the documentary standards to which compliance is claimed through the calibration equipment identified on the following page, or the supplier's certificate.

Reported results of calibration are based on calibration procedure test limits, test ratios or measurement uncertainty and decision risk rules of the documentary standards to which compliance is claimed. Electro Rent Corp. does not report indeterminate results.

Calibration measurement results with units of measurement and associated measurement uncertainty information calculated using GUM methods, or as provided by the calibration procedure are identified with the asset number in order to ensure that the page(s) is (are) recognized as a part of this calibration certificate.

This certificate and associated report may not be reproduced except in full without approval of Electro Rent Corporation.

Electro Rent West Coast Distribution Center quality management system implements ISO 9001 and is registered. Our calibration system implements ISO/IEC 17025, ANSI Z540-1, and MIL-STD-45662A.

This calibration certificate and any associated report is not intended to demonstrate traceability per ILAC P10.

Manufacturer: Viavi Solutions Inc.
Model Number: E4146QUAD
Serial Number: 36244/33666
Asset Number: J55726
Description: Multimode/Singlemode
850/1300/1310/1550 NM Quad
OTDR

Customer: BRADY CORP
6555 W GOOD HOPE ROAD
MILWAUKEE, WI 53223

Customer PO: CREDIT CARD
Performance upon receipt: WITHIN MFR SPECS
Results of calibration: IN TOL NO ADJ
Ambient Temp: 73.0F
Relative Humidity: 52.00%
Date of issue: 12/17/21
Calib Due Date: 11/20/22
OS Build: NA
Firmware: NA

Laboratory Manager:
Alejandra Salazar

Alejandra Salazar

Technician:
R. GARCIA

R. Garcia

Figure 5. Power Meter E4146QUAD Certificate of Calibration

Fiber Optic Cable Handling in A6500 Fiber Optic and A5500 Printer

Product Analysis

ELECTRO RENT TECHNICAL STANDARDS
DOCUMENT (REPRINT) PA0355

Asset No. J55726 Part Number VV-E4146QUAD/Z6 Market Index: Compl:
Serial Nbr: 36244/33666
Part Desc: Multimode/Singlemode 850/1300/1310/1550 NM OT
Product Segment: WLN Time: 2.0 Doc Std: POST
Calib Interval: 12 BLW
Calib WHS : WDC

Previous Order: Doc. Type: Time: 11:37 Date: 11-20-21
Year 2000 : Y2K Audit : Current WHS: WDC

Operating System:

Accessory Count: 19

Mfr Part Number Accessory Description Qty Price Inc

Mfr Part Number	Accessory Description	Qty	Price	Inc
4146 QUAD	SM/MM OTDR SOURCE MODULE	1		
E20PMMC	SC/PC/APC CLIP ON ADAPTER	2		
8633	12V POWER ADAPTER	1		
2256/90.03	USB A -MINI B CABLE	1		
2256/90.06	UPP ADAPTER FOR 1.25mm	1		
	UPP ADAPTER FOR 2.5mm	1		
	LC-LC SIMPLEX COUPLER	1		
	SC-SC SIMPLEX COUPLER	1		
	SC/APC-SC/PC SM SIMPLEX CABLE 10m	1		
	SC/APC-LC/PC SM SIMPLEX CABLE 10m	1		
	SC/APC-FC/PC SM SIMPLEX CABLE 10m	1		
	SC/APC-LC/APC SM SIMPLEX CABLE 10m	1		
	SC/APC-SC/APC SM SIMPLEX CABLE 10m	1		
	SC/PC-LC/PC MM SIMPLEX CABLE 10m	1		
	STYLUS	1		
OGLOVE	SHOULDER STRAP FOR UNIT	1		
OSCASE1	HAND FREE SOFT CARRY CASE	1		
000002202	LARGE SOFT CARRY CASE	1		
	T-BERD/MTS 2K GETTING STARTED GUIDE	1		

***** DEFAULT SETTINGS *****

***** CALIBRATION STANDARDS *****

***** STANDARD TEST *****

ing Technician Signature: R. C. [Signature] DATE: 11/20/21

RTS Signature: _____ DATE: _____

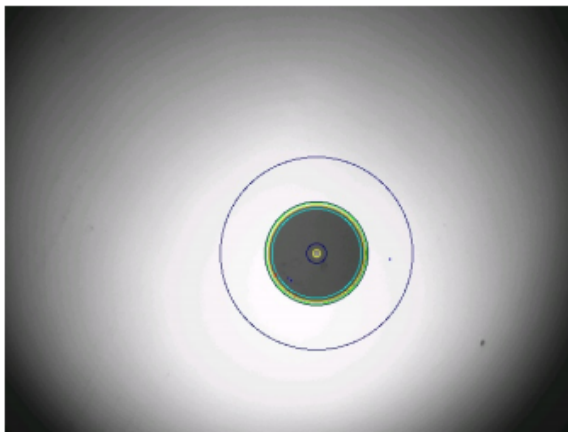
Figure 6. Product Analysis Document

BRADY CORP		
Cable ID	OS2SC	Fail
Fiber ID	FCD US 1	
Direction	O->E	
Location A	tberd8000	
Location B	tberd6000	
Technician Id		
Job ID	A6500/A5500	
Probe	FBP-P5000i S/N 2282479181	
Test date	Fri 09 Apr 2021 10:13:21 AM UTC	
Profile	SM UPC (IEC 61300-3-35 2.0)	
Comment		

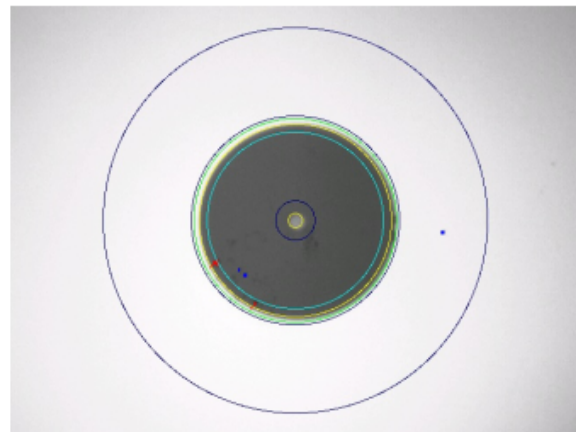
Inspection summary

Zone	Diameter		Defects		Scratches	
	Inner	Outer	Result	Count	Result	Count
Zone A	0.000	25.000	Pass	0	Pass	0
Zone B	25.000	115.000	Fail	3	Pass	0
Zone C	115.000	135.000	Pass	2	Pass	0
Zone D	135.000	250.000	Pass	1	Pass	0

Low magnification



High magnification



VIavi

v2.2 © Viavi Solutions

Figure 7. Report of a failed fiber microscope inspection (cleaning required)

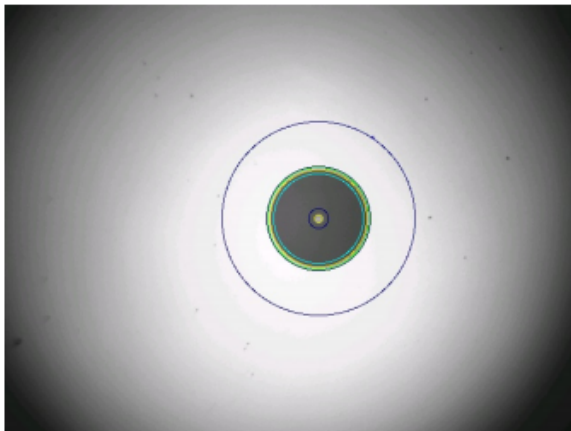
BRADY CORP

Cable ID	OS2SC	Pass
Fiber ID	FCD US 1	
Direction	O->E	
Location A	tberd8000	
Location B	tberd6000	
Technician Id		
Job ID	A6500/A5500	
Probe	FBP-P5000i S/N 2282479181	
Test date	Thu 08 Apr 2021 03:56:36 PM UTC	
Profile	SM UPC (IEC 61300-3-35 2.0)	
Comment		

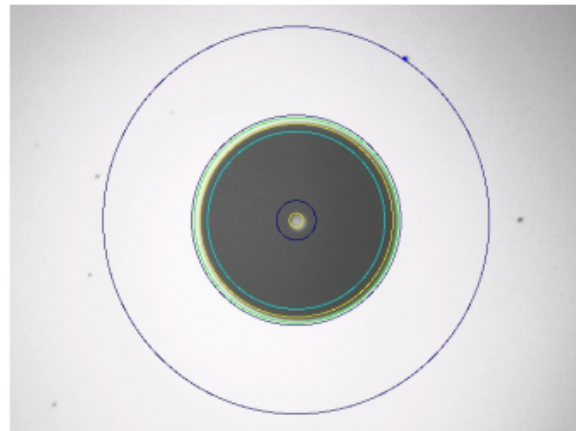
Inspection summary

Zone	Diameter		Defects		Scratches	
	Inner	Outer	Result	Count	Result	Count
Zone A	0.000	25.000	Pass	0	Pass	0
Zone B	25.000	115.000	Pass	0	Pass	0
Zone C	115.000	135.000	Pass	0	Pass	0
Zone D	135.000	250.000	Pass	1	Pass	0

Low magnification



High magnification



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Figure 8. Report of a passed fiber microscope inspection (Cleaning not required)