



**VIAVI**

VIAVI Solutions



# A Quick Start Guide to Fiber-to-the- Antenna (FTTA) Installation and Maintenance Testing

Vol. 1 — Certifying Simplex Fiber  
Cabling and Components

# A Quick Start Guide to Fiber-to-the-Antenna (FTTA) Installation and Maintenance Testing

## Vol. 1 — Certifying Simplex Fiber Cabling and Components

### **Notice**

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### **FCC Information**

Electronic test equipment is exempt from Part 15 compliance (FCC) in the United States..

### **European Union**

Electronic test equipment is subject to the EMC Directive in the European Union. The EN61326 standard prescribes both emission and immunity requirements for laboratory, measurement, and control equipment. This unit has been tested and found to comply with the limits for a Class A digital device.

### **Independent Laboratory Testing**

This unit has undergone extensive testing according to the European Union Directive and Standards

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## FTTA

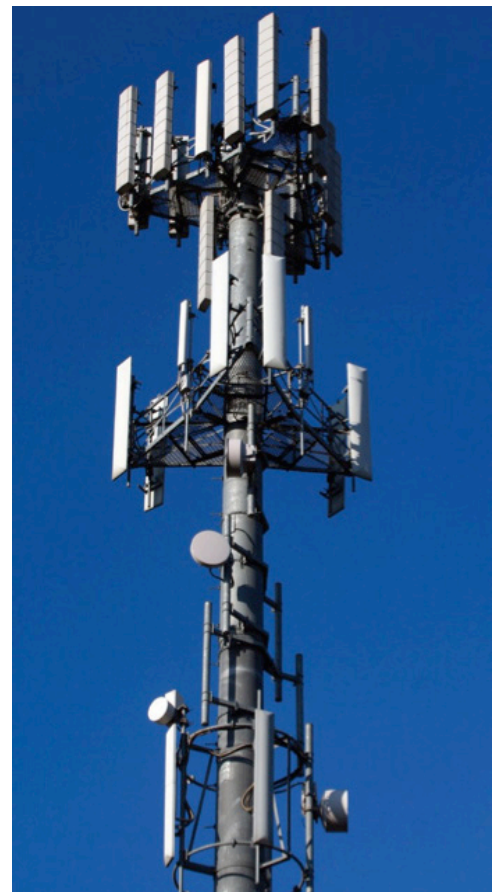
Staggering increases in bandwidth demand are forcing network operators to new models of mobile infrastructure like fiber-to-the-antenna (FTTA) to improve user experience and reduce costs. The performance of the cabling and components between the RRU (Radio remote Unit) and BBU (Base Band Unit) is key to delivering optimized system performance between the backhaul network and the end user.

Network professionals must ensure network uptime and reliability while maximizing customer experience. The comprehensive VIAVI suite of fiber optic handhelds, portables and inspection test solutions for FTTA help support that goal.

### Benefits of VIAVI Acceptance Test Tools

- Finish jobs faster, correctly, and on time — the first time
- Optimize technician workflow with easy and intuitive operation
- Eliminate subjective guesswork with automated pass/fail test results
- Pre-load job-specific acceptance criteria directly onto the device
- Prove the quality of your work by generating certification reports

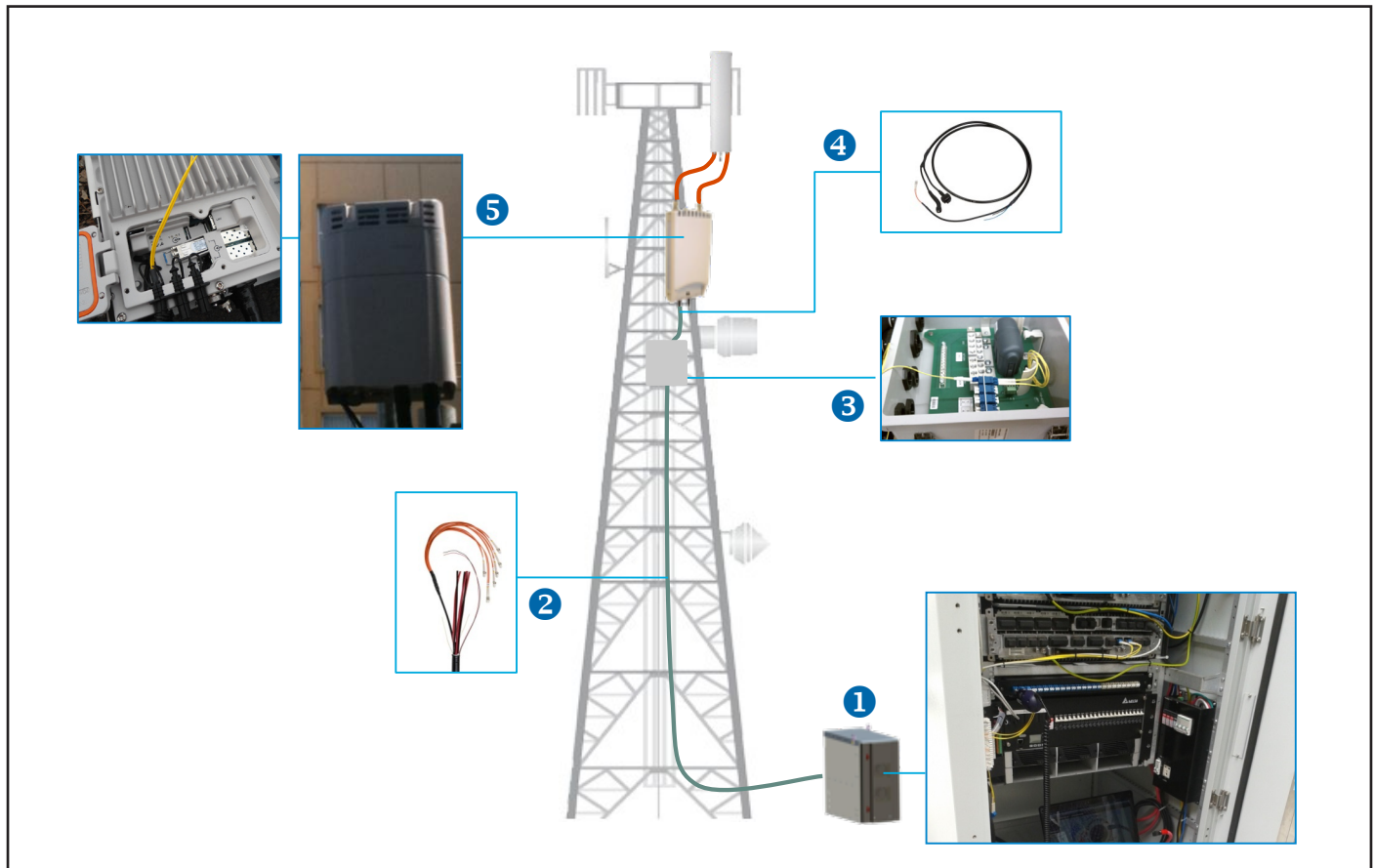
This guide addresses FTTA Tier 1 installation and maintenance testing topics only.





## Macrocell and Fiber Components

This guide will focus on macrocell fiber installation and maintenance tests. This type of network architecture generally involves RRU and BBU functions that are physically separated. The radio equipment is relocated next to their respective antennas in the RRU enclosures. Fiber is deployed using a remote fiber feeder cable (RFF) that interconnects the BBU located at ground level to a breakout box at the top. The fiber is then patched using a jumper into the RRU.

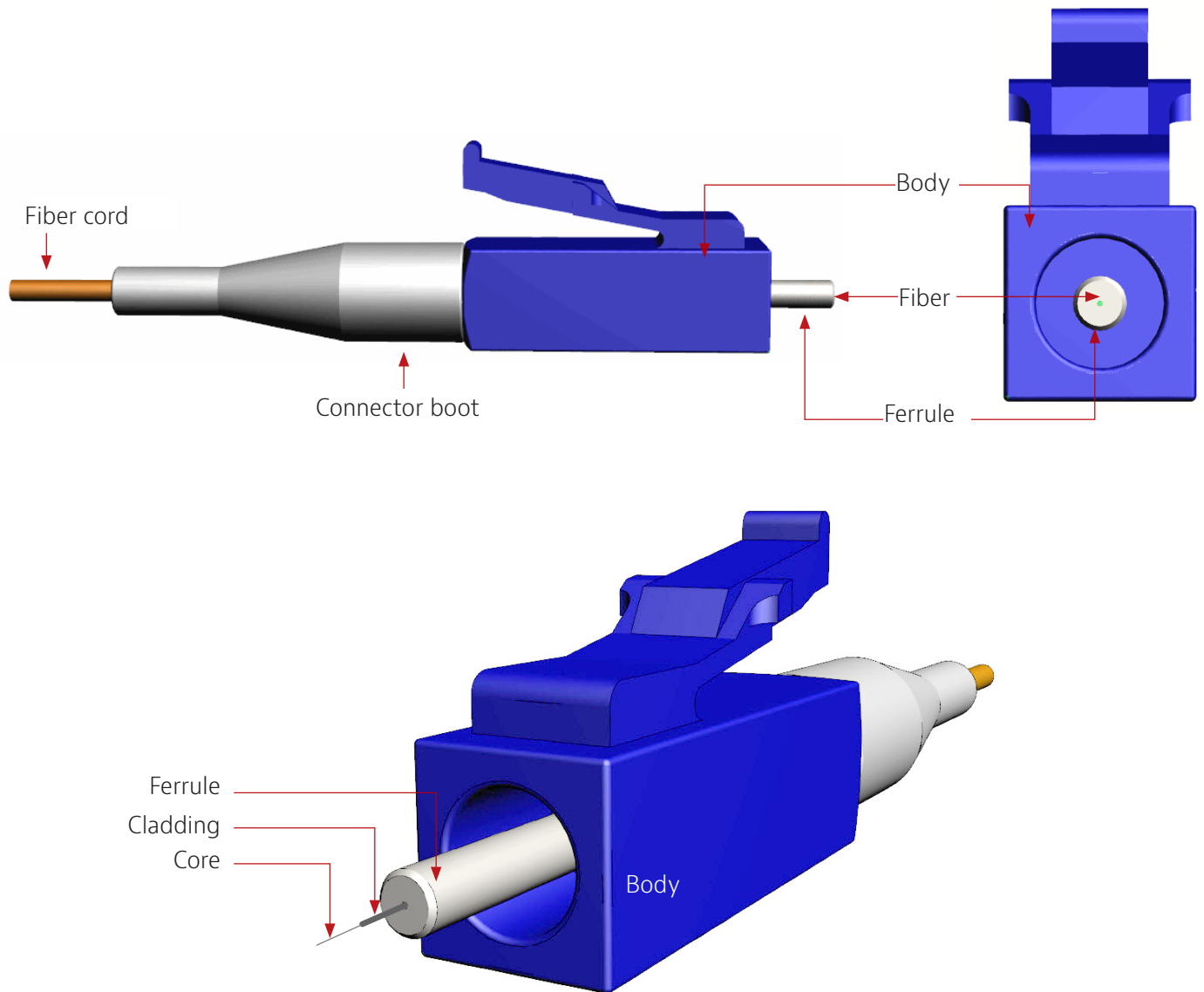


Macrocell tower and network elements

- 1.BBU
- 2.Remote fiber feeder cable or trunk
- 3.Junction box or breakout box
- 4.Jumper cables
- 5.RRU (also termed remote radio head or RRH)

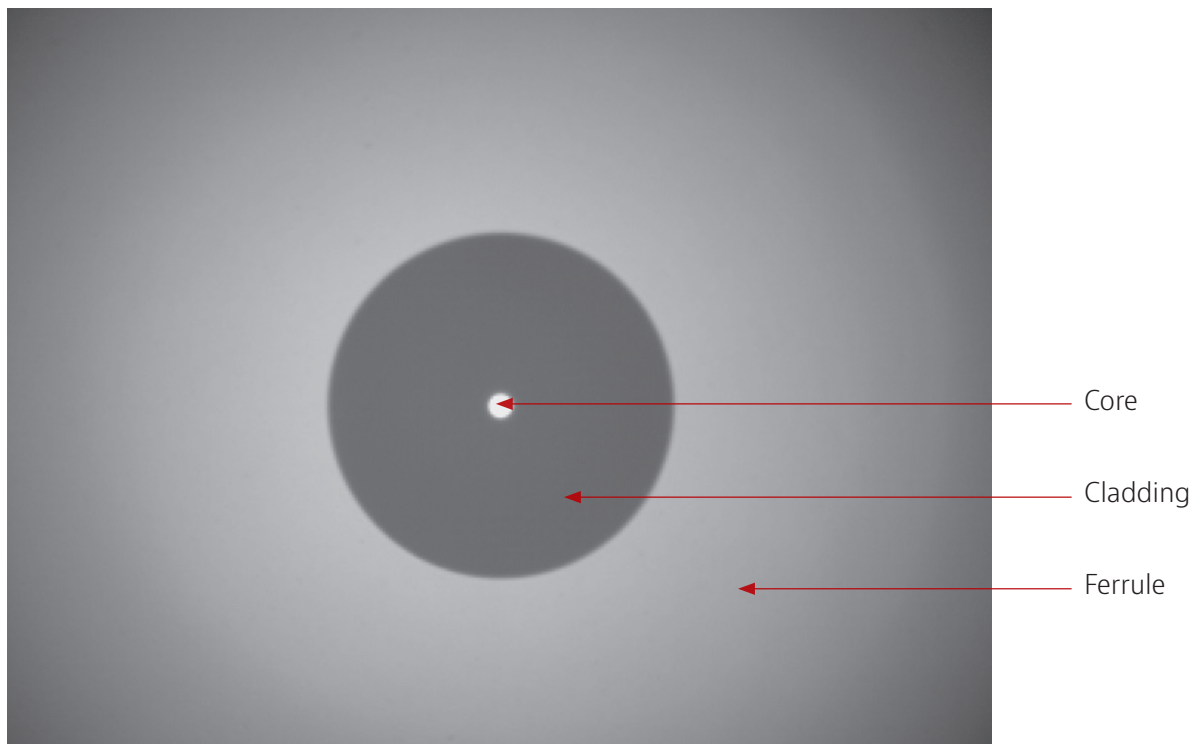
## Connectors

Fiber connectors enable fiber-to-fiber mating by aligning the two optical fibers. Fiber connectors come in various types and have different characteristics for use in different applications. The main components of a fiber connector are detailed in the following figures:



Fiber optic connector components and endface (LCPC example)

## Simplex Fiber



Fiber endface view

**Body:** Houses the ferrule that secures the fiber in place; utilizes a latch and key mechanism that aligns the fiber and prevents the rotation of ferrules of two mated connectors.

**Ferrule:** Thin cylinder where the fiber is mounted and acts as the fiber alignment mechanism; the end of the fiber is located at the end of the ferrule which is referred to as the endface. The overall diameter of the ferrule depends on the relevant connector type. There are typically two ferrule diameters used: 2.5 mm diameter, such as in SC-APC type connectors, and the smaller, 1.25 mm diameter such as in LCPC type connectors.

**Cladding:** Glass layer surrounding the fiber core that prevents the signal in the core from escaping (125  $\mu\text{m}$  diameter for single connectors).

**Core:** The critical center layer of the fiber; the conduit that light passes through (8 – 10  $\mu\text{m}$  diameter for single-mode connectors).

## Inspect Before You Connect

### Contamination is the #1 source of troubleshooting in optical networks!

A single particle mated into the core of a fiber can cause significant back reflection (return loss), insertion loss, and equipment damage. Visual inspection is the only way to determine if fiber connectors are truly clean before mating them.

Fiber inspection and cleaning are critical components in a comprehensive fiber deployment and operation strategy. From new Fiber-to-the-Antenna installation certification to troubleshooting, VIAVI probe microscopes help technicians eliminate subjectivity and guesswork with intuitive and reliable inspection solutions.

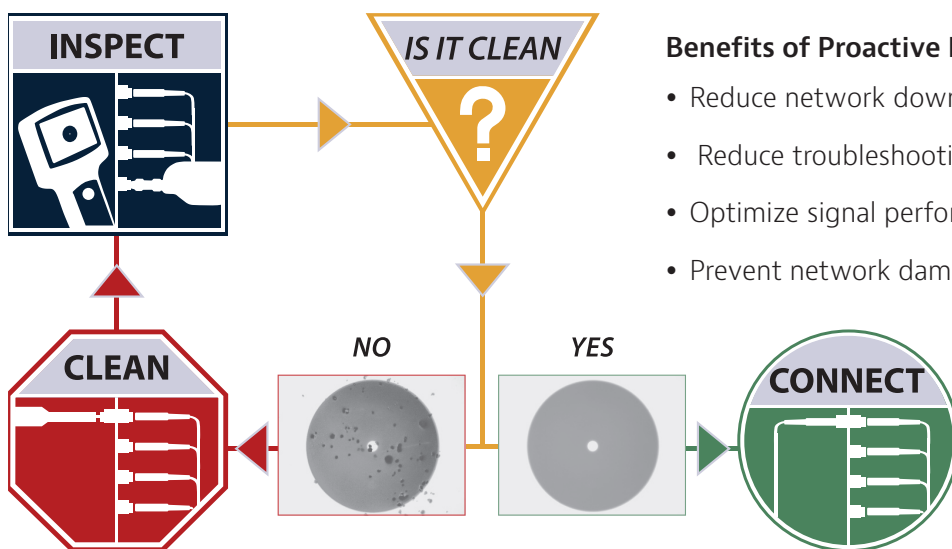
- Automated pass/fail analysis
- Test to IEC-61300-3-35 standards or customer-specific requirements
- Dual-magnification (200/400x) inspection functionality
- Generate detailed certification reports



The FiberChek probe provides a fully automated handheld solution that makes inspection at the top of a cell tower fast and easy.

### Simple Solution

By implementing a simple yet important process of proactive visual inspection and cleaning, poor optical signal performance and potential equipment damage can be avoided. Network failures can be significantly minimized by up to 80%.



#### Benefits of Proactive Inspection

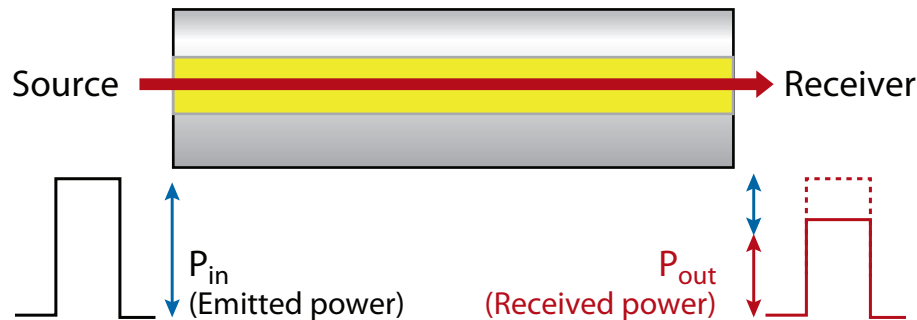
- Reduce network downtime
- Reduce troubleshooting
- Optimize signal performance
- Prevent network damage

Inspect before you connect diagram



## Fiber Attenuation Overview

For any optical fiber link, we need to know the loss or attenuation of the cable or link to ensure it meets system requirements and is ready to survive network aging and environmental effects. As the light signal traverses a fiber, it decreases in power level. The decrease in power level is expressed in (dB) or as a rate of loss per unit distance (dB/Km).



Attenuation is caused by:

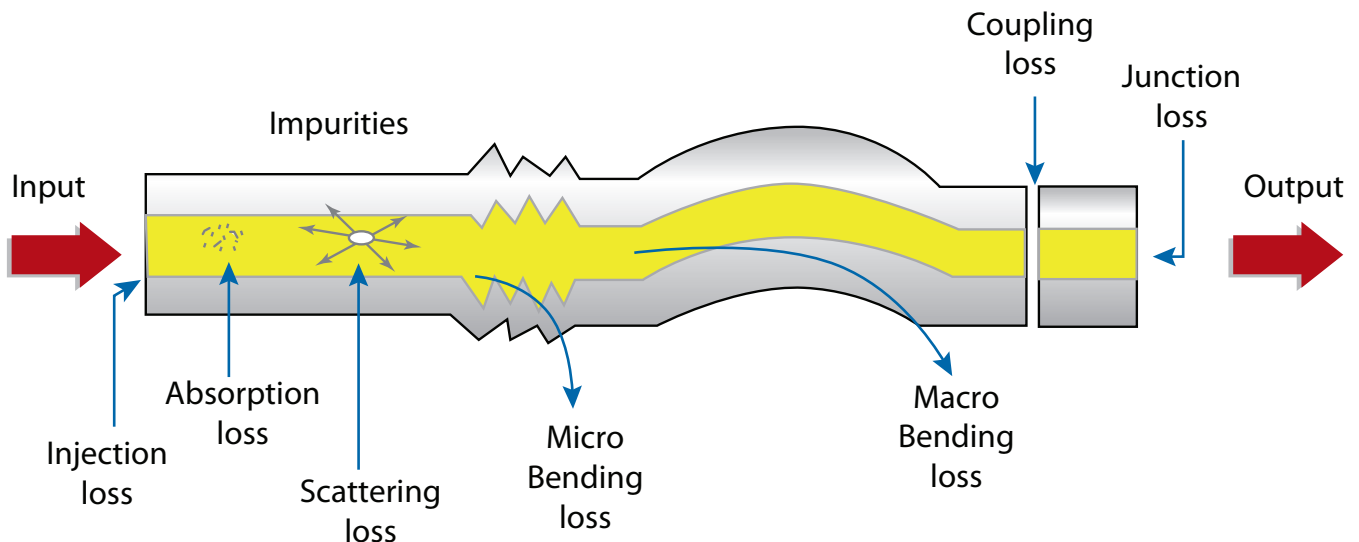
- Absorption of light by impurities within the fiber
- Scattering losses from variations in the silica structure within the fiber
- Bending losses due to over tightening of clamps or cable ties
- Contaminated or damaged connectors of the equipment and patch panels

Attenuation is the most critical parameter to look at in fiber optic networks.

Fiber loss is not a deterministic process that always behaves in the same way. There are many different factors that can produce signal loss in the fiber link, including fiber impurities and poor installations. During transmission, losses also occur when light is injected and by the different couplings and junctions made by connectors and splices.

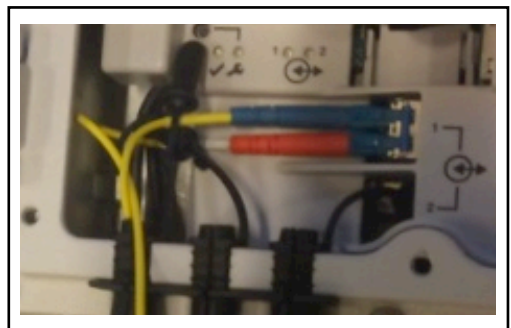
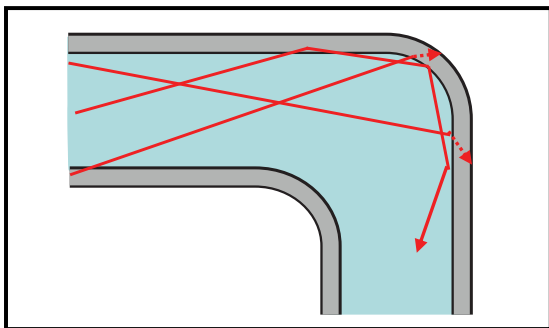
For a fiber optic span, the effects of passive components and connector losses must be added to the inherent attenuation of the fiber in order to obtain the total signal loss.

## Fiber Attenuation Overview



**Microbending** occurs when the fiber core deviates from the axis. It can be caused by manufacturing defects, mechanical constraints during the fiber laying process, and environmental variations (temperature, humidity or pressure) during the fiber's lifetime. Typical causes include freezing water causing external pressure or sharp objects impeding the fiber.

**Macrobending** is caused by physical bends in the fiber that exceed fiber bend-radius limitations (more than a 2 mm radius). Typical causes are poor installation or loading of fiber into BBU/RRU enclosures, fiber trays or junction boxes, and tampering. Optical signal level attenuation due to macrobending increases with wavelength. For example, a signal travelling at 1550 nm will attenuate more than a signal travelling at 1310 nm in the presence of a bend.



Macrobends, typically found in RRU enclosures, junction boxes, and fiber trays.

## Inspect

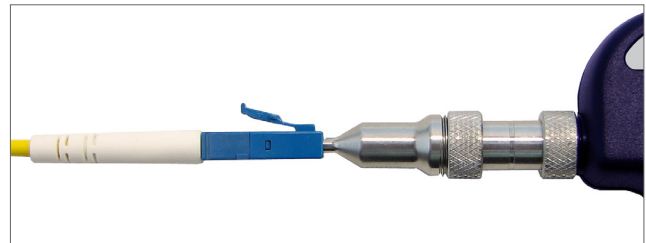


### Inspect Bulkhead

1. Select the appropriate bulkhead inspection tip that corresponds to the connector type and install on a probe.
  2. Insert the probe into the bulkhead to inspect.
  3. Determine whether the bulkhead is clean or dirty.
- If clean, do not touch it and CONNECT
  - If dirty, CLEAN

### Inspect Patch Cord

1. Select the appropriate patch cord inspection tip that corresponds to the connector type and install on probe.
  2. Attach the patch cord to the probe.
- Determine whether clean or dirty.
- If clean, do not touch it and CONNECT
  - If dirty, CLEAN



OLTS-85 with P5000i probe microscope



## Inspect: Is It Clean?

### Inspection Criteria

Dirt is everywhere, and a typical dust particle (2 – 15  $\mu\text{m}$  in diameter) can significantly affect signal performance and cause permanent damage to the fiber endface. Most field test failures can be attributed to dirty connectors, and most connectors are not inspected until the problem is detected, after permanent damage has already occurred.

### Zones and Acceptance Criteria

Zones are a series of concentric circles that identify areas of interest on the connector endface. The innermost zones are more sensitive to contamination than the outer zones. Acceptance criteria are a series of failure thresholds that define contamination limits for each zone.

### The Grading Process

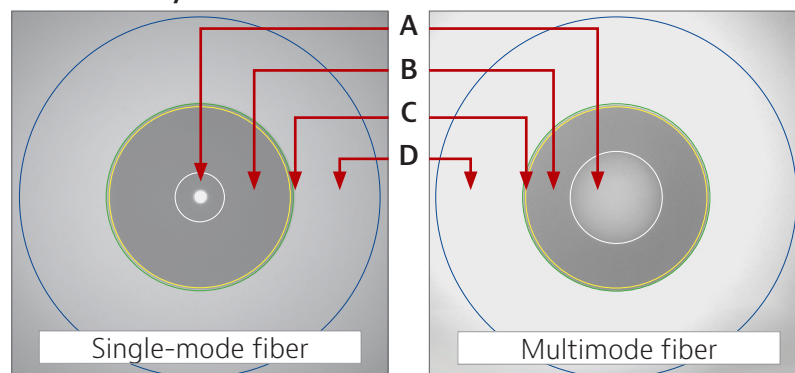
1. Count/measure the particles/contamination that are on the fiber surface.
2. Estimate or use a grading overlay to grade the fiber by determining the number and size of each particle present in each of the four fiber zones. Note: The VIAVI P5000i and FiberChek probe microscopes provide automated analysis and show the grading overlay on the viewing screen.

In most cases, there are no limits to the number/size of contaminations present on zone C (adhesive/epoxy).

- If acceptable, do not touch it and CONNECT

#### Zone Overlays

- A. Core zone
- B. Cladding zone
- C. Adhesive/epoxy zone
- D. Contact/ferrule Zone





## Inspect: Acceptance Criteria

The tables below list the acceptance criteria standardized by the International Electrotechnical Commission (IEC) for single-mode and multimode connectors as documented in IEC 61300-3-35 Ed. 1.0.

Single-Mode PC Connectors, RL  $\geq 26$  dB (Ref: Table 5)

Zone Name	Diameter	Defects	Scratches
<b>A. Core</b>	0 – 25 $\mu\text{m}$	2 $\leq 3 \mu\text{m}$ none $> 3 \mu\text{m}$ none	2 $\leq 3 \mu\text{m}$ none $> 3 \mu\text{m}$ none
<b>B. Cladding</b>	25 – 120 $\mu\text{m}$	no limit $< 2 \mu\text{m}$ 5 from 2 – 5 $\mu\text{m}$ none $> 5 \mu\text{m}$	no limit $\leq 3 \mu\text{m}$ none $> 3 \mu\text{m}$
<b>C. Adhesive</b>	120 – 130 $\mu\text{m}$	no limit	no limit
<b>D. Contact</b>	130 – 250 $\mu\text{m}$	none $\geq 10 \mu\text{m}$	no limit

Multimode Connectors (Ref: Table 6)

Zone Name	Diameter	Defects	Scratches
<b>A. Core</b>	0 – 65 $\mu\text{m}$	4 $\leq 5 \mu\text{m}$ none $> 5 \mu\text{m}$	no limit $\leq 5 \mu\text{m}$ 0 $> 5 \mu\text{m}$
<b>B. Cladding</b>	65 – 120 $\mu\text{m}$	no limit $< 2 \mu\text{m}$ 5 from 2 – 5 $\mu\text{m}$ none $> 5 \mu\text{m}$	no limit $\leq 5 \mu\text{m}$ 0 $> 5 \mu\text{m}$
<b>C. Adhesive</b>	120 – 130 $\mu\text{m}$	no limit	no limit
<b>D. Contact</b>	130 – 250 $\mu\text{m}$	none $\geq 10 \mu\text{m}$	no limit





## Clean

### Clean Bulkhead with the IBC™

Guide cap cover



1. Select the appropriate cleaning tool for the connector type.
2. Pull off the guide cap cover.

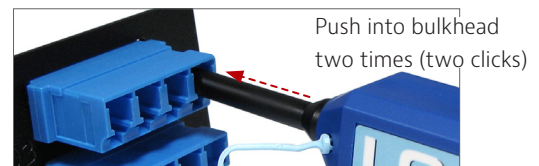


### Dry Clean

3. Insert the cleaning tool into the bulkhead adapter and push the cleaner into the bulkhead two times (two clicks).

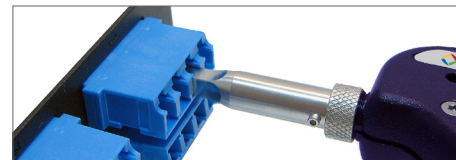
For hard-to-reach places, push the nozzle extender lock and pull the nozzle out.

4. Determine whether clean or dirty.



### Impact

- If clean, do not touch it and CONNECT
- If dirty, either repeat step 3 or go to step 5



### Wet → Dry Clean

5. Apply a fiber optic cleaning solution onto a clean fiber wipe.
6. Dab the cleaning tool onto the wet area of the wipe to moisten the cleaning tip, then go to step 3.



Repeat steps 3, 4, and 5 if necessary.



## Clean

### Clean Patch Cord with the IBC™ Cleaner

Guide cap cover

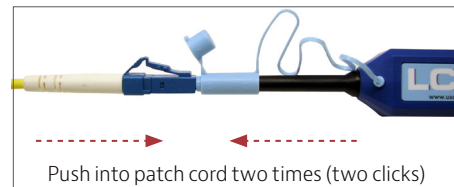


1. Select the appropriate cleaning tool for the connector type.
2. Pull off the guide cap cover.



### Dry Clean

3. Attach the cleaning tool to the connector and push the cleaner into the patch cord two times (two clicks).



### Impact

4. Determine whether clean or dirty.
  - If clean, do not touch it and CONNECT
  - If dirty, either repeat step 3 or go to step 5

Repeat steps 3, 4, and 5 if necessary.

### Wet → Dry Clean

5. Apply a fiber optic cleaning solution onto a clean fiber wipe.
6. Wipe the end of the fiber connector on the wet area of the wipe, then go to step 3.





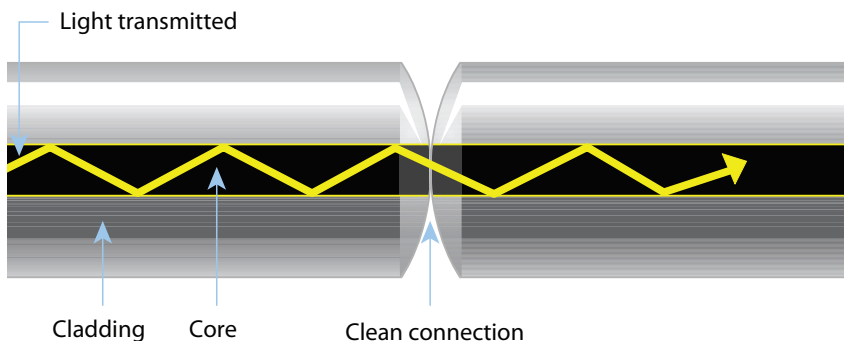
## Connect

There are three basic principles that are critical to achieving an efficient fiber optic connection:

- Perfect core alignment
- Physical contact
- Pristine connector interface

Today's connector design and production techniques have eliminated most of the challenges to achieving core alignment and physical contact.

What remains challenging is maintaining a pristine endface. As a result, contamination is the #1 reason for troubleshooting optical networks.



## Fiber Connections

### Optical connections are made for one of two reasons:

1. Completing a System Light Path (TX to RX) Connectors are used extensively throughout optical networks. They give us the ability to re-configure the network and provision services. If contamination is present in the light path, system performance will be degraded.

NOTE: Always inspect and, if necessary, clean the contamination from the optical port and optical cable before connecting.

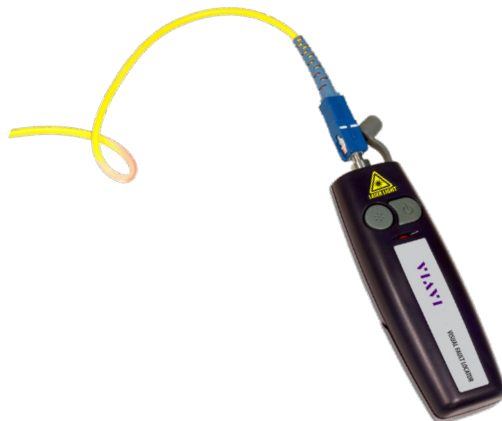
2. Connecting a Test Device to Part of the System Test devices are frequently connected and disconnected to elements of the network. Often, test leads are systematically connected to each port in a network element in sequence. This duty cycle makes test leads especially prone to contamination and damage. If a test lead is contaminated, it can quickly spread that contamination through a large portion of the network.

NOTE: Always inspect and, if necessary, clean the contamination from the network port and test lead before connecting.



## Test Fiber Continuity

A visual fault locator (VFL) emits visible light to let technicians easily see light escaping from bends or breaks in the fiber. This is ideal for continuity checking and also to provide a means to identify the correct RFF fiber is routed to the correct RRU port.



A VIAVI FFL-050 VFL detects bends, breaks, and fiber continuity.



## Test: Attenuation Insertion Loss Measurement

An insertion loss measurement for fiber acceptance test during onsite build is a non-destructive method and is used to measure the attenuation across a fiber, a passive element, or the entire optical link. This is often required where install phases do not have active equipment provisioning onsite or where cable infrastructure and equipment installs are performed by separate teams. Measure the output from the source fiber and a reference fiber directly. Then, obtain a measurement with the fiber under test added to the system. The difference between the two results provides the attenuation of the fiber.

**Attenuation Measurement (*optical link loss*)** on optical components or fiber optic links (for example, fiber connectors, cable assemblies, and installed fiber optic links) are acquired by measuring the relative power level (dB) at the far end of the link or device under test.

**Relative Power Level (*attenuation measurement*)** is the amount of power lost (attenuated) by the optical link being tested, measured in dB. The source of this power is typically a handheld optical light source. This test determines whether the optical link is constructed properly, either as a qualification test or when troubleshooting the fiber cabling.

NOTE: It is common practice to make a simple insertion loss measurement using an optical light source (OLS) at the BBU and an OPM at the RRU to check the link loss. However, in order to minimize the operations and tools required at the remote end, a loopback device is often used to enable measuring the loss of the entire channel. Both methods are described below.

### To measure attenuation, you must:

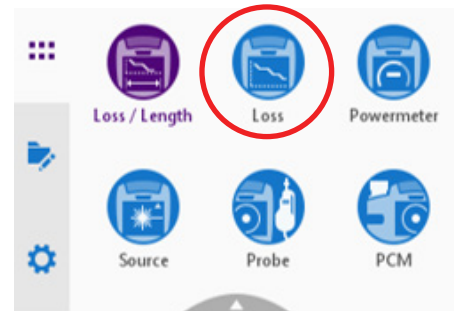
1. Get a reference measurement.
2. Get an attenuation measurement.

NOTE: Loss testing of single-mode fiber links is specified in ANSI/TIA/EIA-526-7 and ISO/IEC-TR-14763-3.  
Loss testing of multimode fiber links is specified in ANSI/TIA/EIA-526-14A and ISO/IEC-TR-14763-3.






## Creating a Project on the OLTS-85

1. Connect the OLTS-85 to a PC via USB.
2. Download and install the most recent version of FiberChekPRO software at: <http://fcpro.updatemyunit.net>.
3. Ensure the OLTS-85 is powered on and open the FiberChekPRO software.
4. Navigate to Setup/OLTS-85.
5. Select the desired categories from the table on the left side and populate the fields accordingly with information about the project.



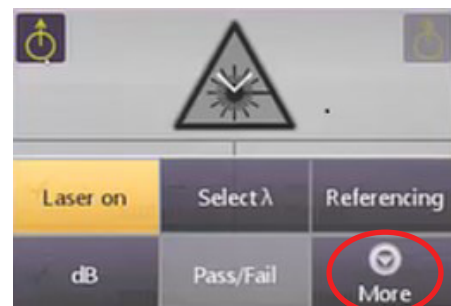
OLTS-85: Home Screen

## Setting Loss Limits on the OLTS-85

1. Open the Loss application on the OLTS-85 by tapping the Loss icon.
2. Activate the desired source port by selecting the  icon (SM = top left / MM = top right) and select the wavelengths you want to test by checking the boxes for the wavelengths to test.
3. Open the Application Menu by tapping the semi-circle icon at the bottom of the screen or the menu button  on the keypad.
4. Tap the MORE icon on and select "Edit Ref & Limit."
5. Tap on a desired row to and select "Edit Limit."
6. Enter desired limit values for each respective wavelength as required and press OK.
7. Press the BACK  button on the keypad to return to the Loss Application.



OLTS-85: Loss Application





OLTS-85: Loss Application Menu



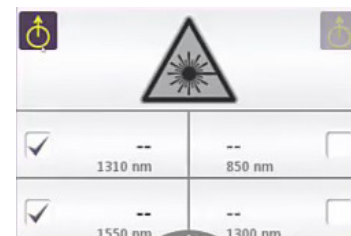
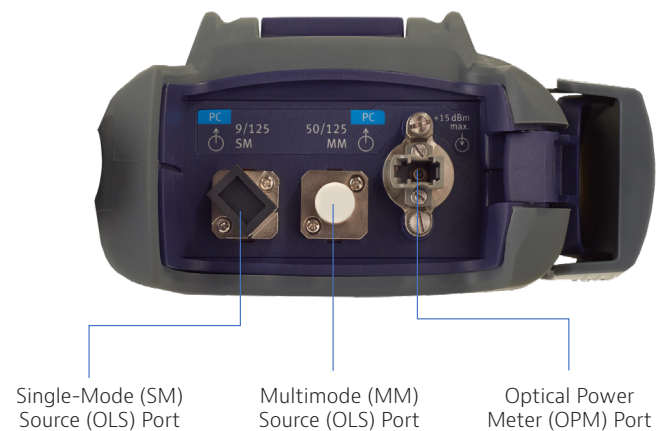
OLTS-85: Edit Limit

## Obtaining Reference Power Measurement on the OLTS-85

1. Inspect and, if necessary, clean end A of the reference fiber jumper [J1].
2. Inspect and, if necessary, clean the OLS port.
3. Connect end A to the OLS\* port.
4. Inspect and, if necessary, clean end B of the reference fiber jumper [J1].
5. Connect end B to the OPM port.
6. Activate the OLS by tapping the Laser icon in the Loss Application. (The icon will turn yellow when active)
7. Open the Application Menu by tapping the semi-circle icon at the bottom  of the screen or the menu button on the keypad.
8. Tap the REFERENCING icon to begin referencing.
9. Press the BACK  button on the keypad to return to the Loss Application.



-  Patch Cord Inspection
-  Bulkhead Inspection



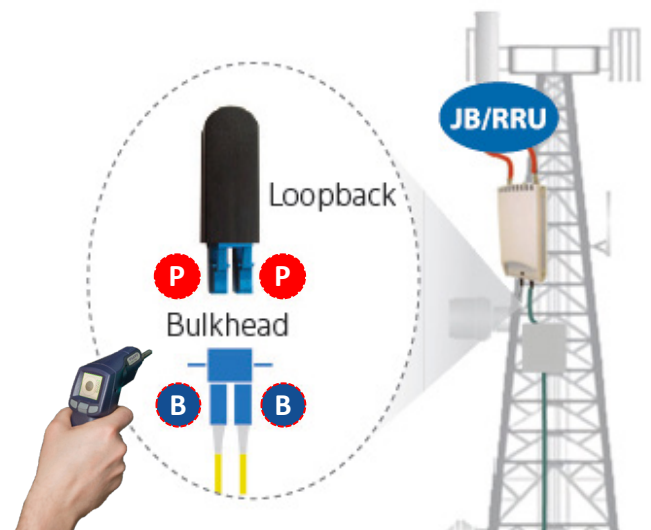
OLTS-85: Loss Application

\*Example is demonstrating a Singlemode (SM) power measurement

## Obtaining Reference Power Measurement on the OLTS-85

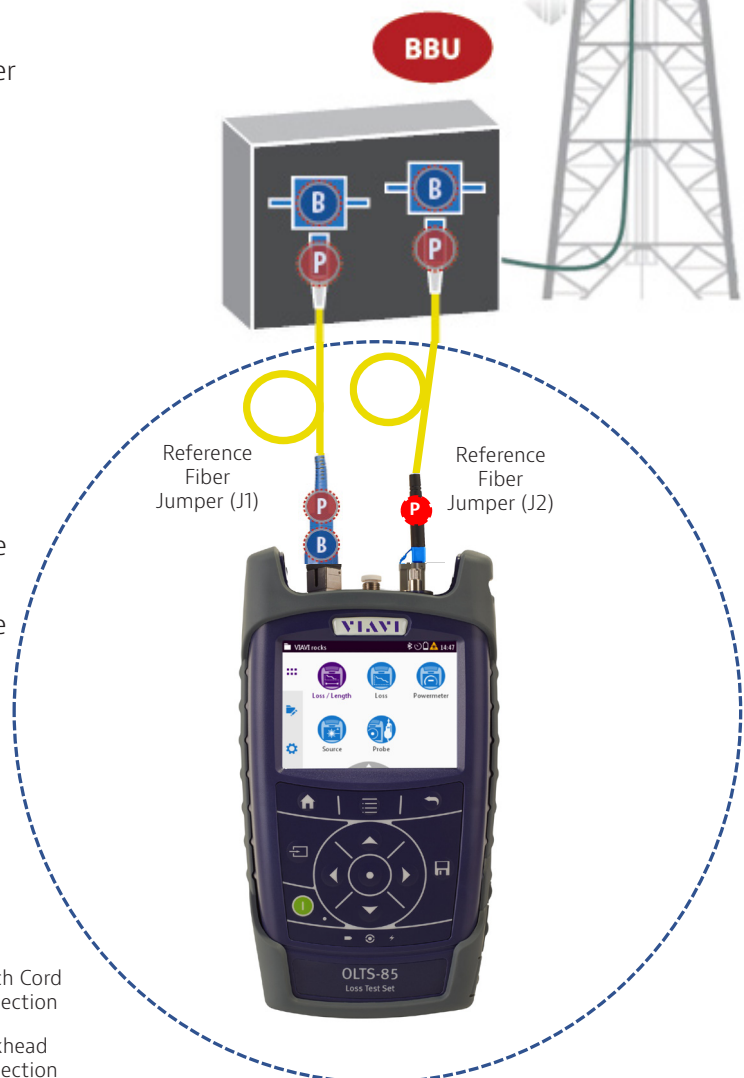
### REMOTE END (at Junction Box [JB] or RRU)

1. Inspect and, if necessary, clean both ends of the Loopback device using the FiberChek probe microscope.
2. Inspect and, if necessary, clean the male end of fiber pair under test on the RFF or Jumper cable. Save images for report generation.
3. Connect the loopback device on the fiber pair under test using a bulkhead adapter.
4. After attenuation, measurement is complete.
5. Inspect and, if necessary, clean the female end of fiber pair under test and make a connection.



### LOCAL END (at BBU)\*

1. Inspect and, if necessary, clean both ports of the fiber pair under test. Save images for report generation.
2. Disconnect End B of J1 from the OPM port, Inspect and, if necessary, clean.
3. Connect the End B of J1 to the Bulkhead port of the fiber pair under test.
4. Inspect and, if necessary, clean both ends of the Receive Jumper [J2].
5. Connect End B of J2 to the other Bulkhead port of the fiber pair under test and End A to the OPM Port on the OLTS-85.
6. From the LOSS application screen.
7. Save channel loss by clicking the SAVE button on the OLP at 1310 and 1550 nm.
8. Inspect and, if necessary, clean the female end of the fiber pair under test and make a connection.



- P** Patch Cord Inspection
- B** Bulkhead Inspection

## Certification Report

Qualification testing of the link throughout deployment and maintenance ensures problems are identified and resolved quickly. Proactive testing during key installation phases will help avoid turn-up delays and can significantly reduce the cost of deployment and maintenance.

A certification report provides documented authentic proof (birth certificate) on the quality of installation, ensures that installation meets industry standards and equipment specification requirements and is ready to survive network aging and environmental effects.

1. Connect the OLTS-85 to a PC via USB.
2. Ensure the OLTS-85 is powered on and open the FiberChekPRO software.
3. Follow the on-screen instructions to import reports from the OLTS-85.

File Name	LOSS.pdf							
Project Name	VIAVI rocks							
Report Date	2020-09-10 16:01:07							
Device Name	OLTS-85P							
Serial Number	C-0048							
Calibration Date	2015-10-14							
Project Information								
Customer	Joe's Garage							
Operator	Neven							
Operator ID								
Connector ID								
Company Name								
Location	Zapa 123							
Cable ID								
Address								
Comments								
Test Summary								
Fiber ID	λ	Measurement Mode	dBm	Watts	dB	Reference	Result	Timestamp
FiberID4	1550	Relative	-.59	872.9uW	.56	-.03	PASS	2020-06-11 13:32:42
FiberID4	1310	Relative	-.63	865.5uW	.70	.07	PASS	2020-06-11 13:32:42
FiberID3	1550	Relative	-.59	873.4uW	.56	-.03	PASS	2020-06-11 13:32:19
FiberID3	1310	Relative	-.62	866.5uW	.69	.07	PASS	2020-06-11 13:32:19
FiberID2	1550	Relative	-.58	875.4uW	.55	-.03	PASS	2020-06-11 13:31:25
FiberID2	1310	Relative	-.61	868.5uW	.68	.07	PASS	2020-06-11 13:31:25
FiberID1	1550	Relative	-.16	964.5uW	.20	.04	PASS	2020-05-13 14:57:01
FiberID1	1310	Relative	-.10	976.7uW	.20	.10	PASS	2020-05-13 14:57:01

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Page #1

Typical VIAVI certification report

## Fiber Installer Kit for Wireless Contractors



### OLTS-85 Optical Loss Set

Quad, single-ended loss testing  
& reporting



### P5000i Digital Probe

Fiber end-face quality  
inspection and certification  
at bottom of tower



### Visual Fault Locator

Localization of fiber bends,  
breaks, and damages. End-to-  
end continuity check



### FiberChek Probe

Fiber end-face quality  
inspection and certification.  
Built-in touch screen for ease  
of use on top of the tower  
(sold separately)

\*Other accessories included. Request brochure for complete list.



## Additional Test & Measurement Tools for Wireless Contractors



### 3Z RF Vision

Accurate antenna alignment  
and line-of-sight reports



### OneAdvisor-800

All-in-one test set for  
fiber, coax, and RF



### SmartOTDR

Single mode test set  
for fiber installation,  
turn-up and  
maintenance



### T-BERD 2000

Quad test set for fiber  
installation, turn-up  
and maintenance

## Additional Test & Measurement Tools for Wireless Contractors



### OMK-36 SmartPocket

SmartPocket Optical test kit includes a light source, a power meter, and accessories



### MP-60 USB Power Meter

Measure general power and loss, as well as high power applications



Contact Us **+1 844 GO VIAVI**  
(+1 844 468 4284)

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