USER MANUAL

MTTplus-420

GPON Test Module for MTTplus Modular Platform

Please direct all questions to your local VeEX Sales Office, Representative, or Distributor. Or, contact VeEX technical support at www.veexinc.com.

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1.0 About this User Manual

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2.0 Introduction

2.1 MTTplus-420 Overview

The MTTplus-420 GPON test module for the VeEX® MTTplus platform is designed for ONT/ONU service activation and troubleshooting. It is only intended to be used at the customer site between the splitter and Optical Network Unit/Optical Network Terminal (ONU/ONT). The unit passively monitors downstream and upstream GPON traffic and tests optical power levels for compliance to standards. Advanced testing mode reports system errors/alarms statuses and captures and decode OMCI and PLOAM messages exchanged between the Optical Line Terminal (OLT) and ONT, allowing technicians to perform advanced troubleshooting beyond basic signal level.

The operator is assumed to have received basic training in fiber optics and related testing and measurement practices.

2.2 What is GPON?

The International Telecommunications Union standard (ITU-T G.984) describes attributes of gigabit-capable passive optical network (GPON) systems. GPON utilizes optical wavelength division multiplexing (WDM) so a single fiber from a provider's central office can be split to serve multiple homes and businesses for both downstream and upstream data transmission.

The Optical Line Terminal (OLT) sends 1490nm signal downstream at a rate of 2.488 Gbits/s. Every Optical Network Unit/Optical Network Terminal (ONU/ONT) receives the same data but is able to recognize data targeted to a specific ONU/ONT. Each ONU/ONT upstream 1310nm signal transmits at a rate of 1.244 Gbits/s using a time division multiplex (TDM) format as each ONU/ONT is assigned a timeslot in which it can transmit to the OLT. The total available bandwidth is divided between all ONUs so each user only gets a fraction of available bandwidth, such as 100 Mbits/s, depending on how the OLT allocates it. The upstream transmissions, called burst-mode operation, is allocated on an as need basis by the OLT for each ONU/ONT that needs to send data. Because the TDM method involves multiple users on a single transmission, the upstream data rate is always less than the maximum available bandwidth to support sharing of bandwidth.

The OLT determines the distance and time delay for each subscriber. The software provides a way to allot timeslots to upstream data for each ONU. The typical split of a single fiber is 1:32 or 1:64. That means each fiber can serve up to 32 or 64 subscribers. However, split ratios up to 1:128 are possible on some systems.

As for data format, the original GPON packets could handle ATM packets directly. Recall that ATM packages everything in 53-byte packets with 48 bytes for data and 5 bytes for overhead. In 2008, the GPON standard removed direct ATM and only called for the use of a generic encapsulation method (GEM) frame to carry protocols. GEM can encapsulate Ethernet, IP, TCP, UDP, T1/E1, video, VoIP, or other protocols as called for by the data transmission. Minimum packet size is 53 bytes, and the maximum is 1518 bytes. AES encryption is used downstream only.

2.3 Key Features

Basic Mode

- Two Port pass through mode for measuring ONT upstream and downstream level measurements for 1310and 1490
- Simultaneous display and measurement of calibrated PON signals
- Automatic ODN class detection and power-level pass/fail analysis
- Display OLT TX, PON Type, and Budget
- Filtered, in-service loss measurements for each PON signal
- Low insertion loss: ≤ 1.5 dB type
- User defined Pass/Fail thresholds
- Automated pass/fail fiber inspection analysis with optional fiberscope
- Easy Report generation and data transfer
- Upstream/Downstream LED status indicators for signal, Frame, Err/Alarm, and TC Sync

Advanced Mode

- System Errors and Alarms status with details of type and frequency of occurrence
- FEC detection
- List all active ONT IDs and serial numbers
- PLOAM decoder and display PLOAM Control messages
- OMCI decoder and display OMCI messages

2.4 Specifications

Optical – GPON (designed to meet levels as defined by ITU standard when testing at ONT site)

Optical Measurement	
Downstream 1490 nm OLT Signal[1]	-30 to -8 dBm
	Spectral passband 1480 to 1500 nm
Upstream ONU/ONT 1310 nm Signal[1,2]	-15 to +5 dBm
	Spectral passband 1290 to 1330 nm
Fiber Inspection	Optional Fiberscope via OTG cable

Data Analysis	
ONT serial numbers identification	Standard offering. Extracted from ONT transmission.
In-service signal levels with Pass/Fail analysis	Standard offering. User defined P/F thresholds
PON identification	Standard offering. Extracted from OLT transmission.
System errors/alarms status	Standard offering.
OMCI Capture/Decode	Standard offering.
PLOAM Capture/Decode	Standard offering.

General	
Display size	7” LCD, 800 x 480
Display resolution	0.1 dBm/1 µW
ORL	> 60 dB
Threshold settings	ITU-T G.984.3 or user specified
Pass-through insertion loss[3]	≤ 1.5 dB typ.
Power uncertainty[3]	± 0.5 dB
Calibrated wavelengths	1310nm and 1490nm

Notes:

1. For G-PON (ITU-T G984.x) signals.

2. Burst mode -15 to +5 dBm.

3. At 23°C, at 1310/1490 nm, using CW - 7 dBm source.

3.0 Safety Information

Safety precautions should be observed during all phases of operation of this instrument. The instrument has been designed to ensure safe operation however please observe all safety markings and instructions. Do not operate the instrument in the presence of flammable gases or fumes or any other combustible environment. VeEX Inc. assumes no liability for the customer's failure to comply with safety precautions and requirements.

Laser Safety

- Never look directly into the beam of an active optical source as this may result in harmful eye damage from radiation exposure. Make sure that optical sources are inactive before connecting fiber to the test set to avoid skin or eye damage, or damage to the unit.
- Never look directly into a fiber microscope to check the optical connectors when the laser source is active.

4.0 Basic Operations

The MTTplus-420 uses the MTTplus chassis.

For information on Basic Operations, Home menu, Launching Test Applications, Inserting/Removing Test Modules and other features specific to the MTTplus host chassis, refer to the **MTTplus Platform manual**.

4.1 Connector Panels

The MTTplus-420 module connector panel features an ONU port (**To ONU**) and an OLT port (**To OLT**).

Figure 1: MTTplus-420 connector panel with ONU and OLT ports

5.0 Preparing for Operation

5.1 Equipment Check List

The following tools are required to operate the MTTplus-420 unit for GPON testing:

- MTTplus platform unit with MTTplus-420 GPON module installed. SC/APC is the recommended connector.
- Cleaning supplies to clean patch cord connectors and equipment optical connectors.
- Fiberscope with Universal 2.5mm UPC and APC male tip, SC/APC bulkhead and SC/UPC bulkhead tips to inspect optical connectors.
- Patch cord – one to two patch cords depending on what is required to insert the MTTplus-420 module between the splitter and ONT. Warning: Mating blue (UPC) with green (APC) connectors will result in excessive insertion loss, reflectance, and possible damage to the optical connector.

5.2 GPON ITU-T G.984 Test Standards

The three primary classifications for GPON are Class A, B, and C. According to ITU-T G.984 Test Standards, for a GPON network to operate properly:

- Span length must be ≤ 20 km (Class C+ ≤ 60km) and span loss budget must be met.

GPON 2.48 Gbps Downstream /1.244 Gbps Upstream Span Budget (km)					
	Class A	**Class B**	**Class B+**	**Class C**	**Class C+**
Min. Span Loss Budget G.984.2	5	13		15	
Max Span Loss Budget G.984.2	20	28		30	
Min. Span Loss Budget G.984.2/Amd 2 Digital Only	5	13	10	15	
Max Span Loss Budget G.984.2/Amd 2 Digital Only	20	28	28	30	
Min. 1490nm Loss Budget G.984.2/Amd 2 Vid Overlay	5	10	9	15	17
Max 1490nm Loss Budget G.984.2/Amd 2 Vid Overlay	20	28	27	30	32
Min. 1310nm Loss Budget G.984.2/Amd 2 Vid Overlay	5	10	13	15	17
Max 1310nm Loss Budget G.984.2/Amd 2 Vid Overlay	20	28	29	30	32

Table 1: ITU-T G.984 Test Standards

- A fiberscope must be used to inspect the connectors and ensure that they are free of contaminants, dents, or scratches. Use cleaning supplies to clean off contaminants. Refer to **Optical Fiber Patch Cord Preparation** for contamination, inspection, and cleaning information. Dents or scratches can create insertion loss and reflectance.
- Downstream and upstream launch power must meet signal level specifications (see ***Table 2***). A PON meter must be used to confirm that the signal levels are acceptable per standards.
- Since the MTTplus-420 is only designed to be used between the splitter and ONT (Customer Site), we are only concerned about the ONT received power for the 1490nm signal and ONT launch power at 1310nm. 1490nm received power and 1310 launch power are both shown in ***Table 2***.

	2.48 Gbps Downstream Direction									
	1490nm OLT Launch Power (dBm)					**1490nm ONT/ONU Receive Power (dBm)**				
	Class A	Class B	Class B+	Class C	Class C+	**Class A**	**Class B**	**Class B+**	**Class C**	**Class C+**
Min Avg Power	0	5	1.5	3	-10	**-21**	**-21**	**-28**	**-28**	**-32**
Max Avg Power	4	9	5	7	9	**-1**	**-1**	**-8**	**-8**	**-8**

	1.244 Gbps Upstream Direction									
	1310nm ONT/ONU Launch Power (dBm)					**1310 OLT Receive Power (dBm)**				
	Class A	**Class B**	**Class B+**	**Class C**	**Class C+**	Class A	Class B	Class B+	Class C	Class C+
Min Avg Power	**-3**	**-2**	**1.5**	**2**	**-10**	-24	-28	-28	-29	-34
Max Avg Power	**2**	**3**	**5**	**7**	**8**	-3	-7	-8	-8	-8

Table 2: Launch power specifications for downstream and upstream Signal Levels

The communication ladder is defined within the ITU G.984.3 standards document and provides full details of OLT and ONU communication that occurs during the activation process. For an overview of the GPON activation process, refer to **Appendix C**.

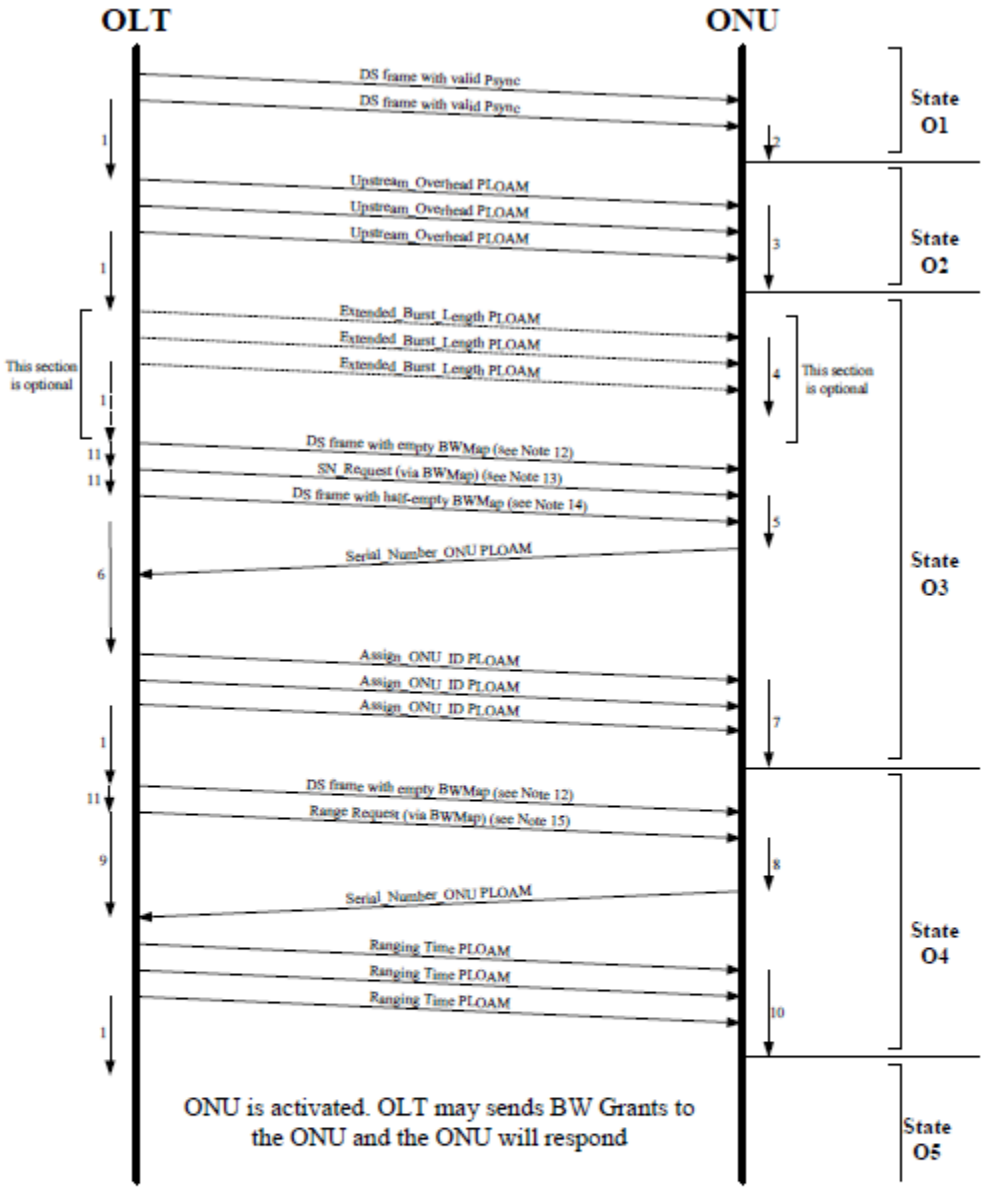


Figure A.6-1 – Activation process flow

Note 1 – OLT waits at least 750 µs for the ONU to process the message.
Note 2 – ONU clears LOS/LOF error.
Note 3 – ONU constructs the preamble and delimiter and sets pre-assigned delay.
Note 4 – ONU constructs extended preamble.
Note 5 – ONU randomizes a response time and constructs Serial_Number_ONU PLOAM message.

108 Rec. ITU-T G.984.3 (03/2008)

Figure 2: OLT and ONU communication defined in ITU G.984.3 standard

6.0 Optical Fiber Patch Cord Preparation

Dirt, dust, and other contaminants severely impact high-speed data transmission in optical fibers and dirty connector end-faces are often the number one cause of link failures. High insertion loss and/or high back reflection can result in transmission loss or high bit errors and poor BER.

Furthermore, most measurement variations and test repeatability conditions in fiber-optic systems can be traced back to the cleanliness of optical connections. Contamination of fiber end faces not only affects optical power levels but also impacts back reflectance performance and levels which is harmful to sensitive optical components.

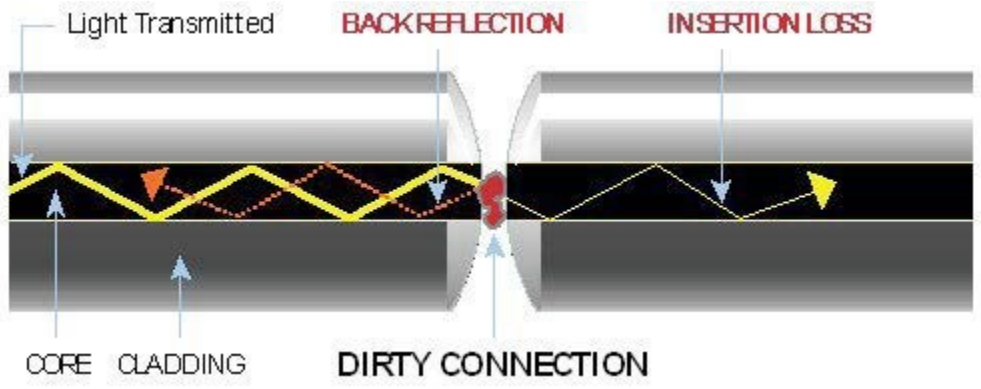


Figure 3: Dirty fiber end faces can cause back reflectance and insertion loss

6.1 Contamination

Optical connectors are susceptible to contamination from air borne particles and human body oils when exposed. Left over liquid residue from improper cleaning can also leave the fiber end face contaminated. The smaller the fiber core, the more severe the problem is likely to be, especially when considering that fiber core diameters can range from 62.5 microns all the way down to 8 microns in size.

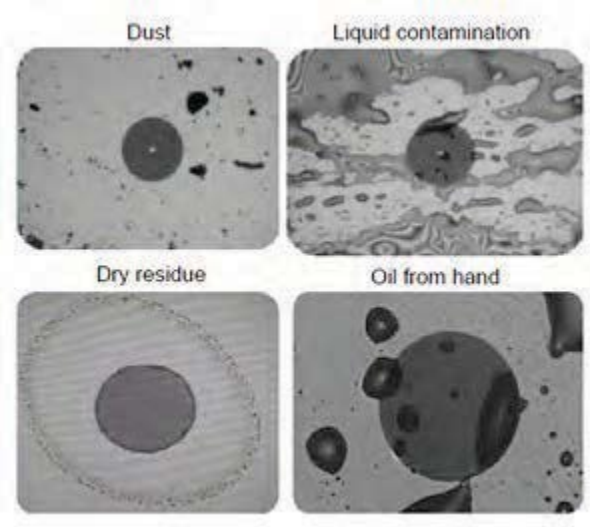


Figure 4: Types of contaminants viewed from a 400x Fiber microscope

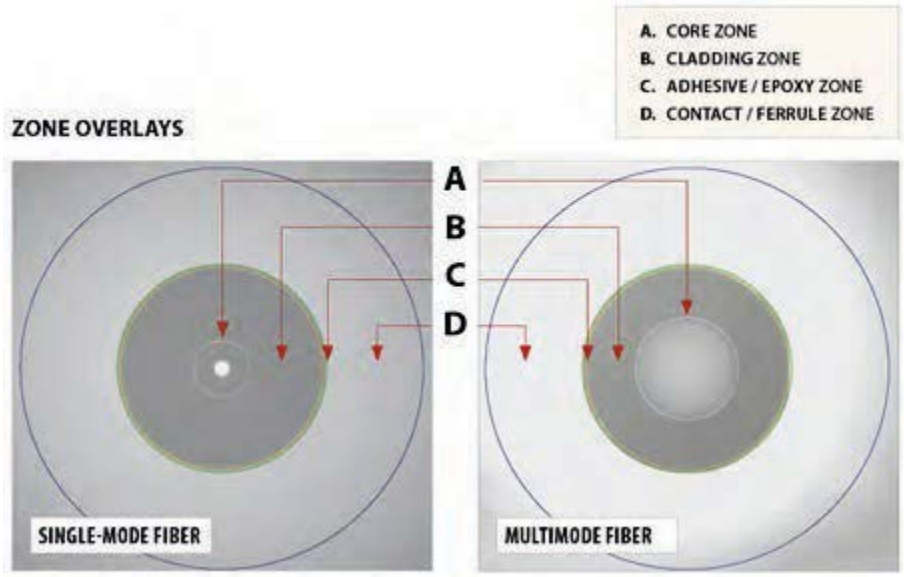


Figure 5: Cross-section of single-mode and multi-mode fiber zones

6.2 Inspection

Whenever possible, inspect the fiber-optic connection (connectors, bulkheads, and test interfaces) with a fiber microscope. It is recommended to wear laser safety glasses when working with fiber-optic connections. Always check that the laser or transmitter is disconnected before cleaning the connector end faces.

6.3 Cleaning Procedure

To ensure proper and effective cleaning of optical fiber connectors and interfaces, use the following cleaning materials:

- Isopropyl alcohol
- Lint free soft tissues
- Ferrule cleaners (1.25mm and 2.5mm versions)
- Connector reel cleaners (CleTop or similar)

Figure 6: Optical fiber cleaning materials clockwise from left--isopropyl alcohol, lint free soft tissues, connector reel cleaners, and a ferrule cleaner

Figure 7: Clean the connector end-face by rubbing it onto a lint-free wipe dampened with isopropyl alcohol

Procedure

1. Dab the contaminated connector end-face with a wipe that has been dampened with isopropyl alcohol - the solvent will dissolve and remove contaminants that have dried and attached to the connector or fiber end-face.
2. Rub the fiber end-face perpendicularly against a dry lint free wipe several times.
3. Alternatively, use compressed air to dry the surface quickly. Do not blow or allow the connector end face to air dry as this may leave a residue behind which is often more difficult to clean and which can attract even more dirt.
4. Re-inspect the fiber end-face with an optical microscope to check that all the contaminants have been removed properly - if not, repeat the process.

Note: Using Compressed Air

In some clean air situations, filtered air is acceptable for use, which is free of oil and moisture to remove debris and clean a fiber optic connection. However, unless very strict cleaning procedures are followed, air-driven contaminants can cause more problems.

To use compressed air, hold the can upright. If the can is held at a slant, propellant could escape and dirty the optical device. First spray into the air, as the initial stream of compressed air could contain some condensation or propellant. Such condensation leaves behind a filmy deposit.

6.4 Best Practices

- Never touch the end face of an optical fiber connector with any hands or fingers.
- Always install dust caps on unplugged fiber connectors.
- Store unused dust caps in a re-sealable plastic bag to prevent dust accumulating.
- Never re-use optic cleaning swabs or lint free wipes. Always discard materials that have been used.
- Ensure all alcohol or solvent residues are removed after using wet cleaning techniques
- It is recommended to re-inspect the bulkhead receptacles and connector end face using a fiber microscope following the cleaning and prior to use.

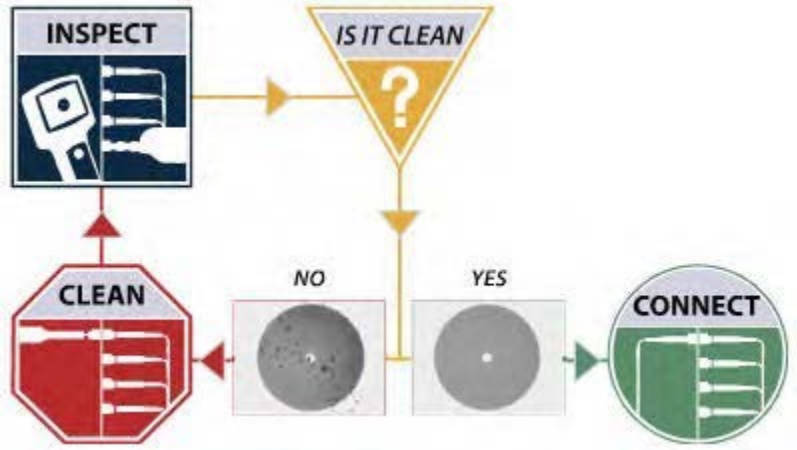


Figure 8: Flow chart describing best practices for inspection and cleaning prior to connecting an optical fiber

6.5 Connectors

6.5.1 Connector Types

GPON networks typically use SC type connectors. The preferred connector polish is the angled polish, SC/APC (Green), but the ultra-polished SC/UPC (Blue) can also be used.

SC Connector

SC officially stands for Subscriber Connector; however, some people believe that “Square Connector,” is the correct name. It is a general purpose push/pull style connector. It was developed by NTT, which has an advantage in LAN/enterprise networks where duplex cabling to support TX/RX channels are commonly used.

Figure 9: SC connector end face

SC Connectors are frequently used in network applications. The connector is square and keyed with push-pull mating, 2.5mm ferrule, and molded housing for protection. The SC is a snap-in connector that is widely used in single mode systems due in part for its performance; it latches with a simple push-pull motion.

6.5.2 Connector Performance and Polishing

Polishing of fiber optic connectors is the process of polishing the end-face of the ceramic ferrule within the fiber optic connector. The purpose is to improve the light transfer between the mating of connectors, in order to minimize optical losses and reducing reflections. This is an important aspect of fiber optic communications as losses affect the quality of the light signals.

There are two main types of losses that are affected by the style and quality of polishing, which dictate the optical performance level of terminated fiber optic connectors:

- **Insertion Loss (IL)** - The most important performance indicator of a fiber optic connection. This is the loss of light signal, measured in decibels (dB), during the insertion of a fiber optic connector.
- **Return Loss (RL)** - Also known as back reflection, is the portion of the light signal that is reflected back to the original light source. This occurs as the light is reflected off the connector and travels back along the fiber to the light source. This indicator is measured in negative decibels (dB). When reading return loss figures, the higher the absolute value of the decibel unit means the better the performance of the interconnection.

The amount of insertion loss is affected by fiber alignment, and/or the quality of the finishing on the end of ferrule, while reflectance is affected by the style of polishing on the ceramic ferrule in a connector. There are two different styles of polishing, reflected by the shape of their finish:

- **Ultra Physical Contact (UPC)** - The UPC style ferrule has the shape of the PC style, except they are polished with several grades of polishing film that allows for an ultra-smooth surface. The main difference between UPC and PC is that the former have lower return loss.
- **Angled Physical Contact (APC)** - The APC style produces the lowest return loss when compared to other styles. The ferrule is polished to an angle of 8 degrees. The angle is calculated so that it is less than the critical angle, which ensures light is not propagated back along the fiber.

Connector Polish and Performance

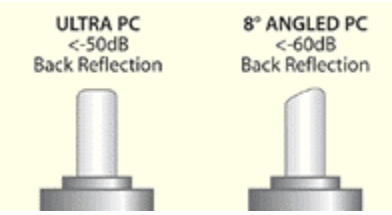


Figure 10: UPC and APC back reflection

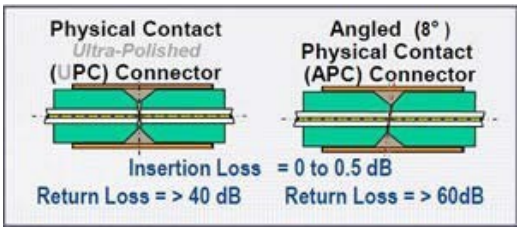


Figure 11: UPC and APC return loss

Typical Return loss values are:

- Polished Connector ~ -45dB
- Ultra-Polished Connector ~ -55dB
- Angled Polished Connector up to ~ -65dB

6.6 Fiber Patch Cords

900µm

- Patchcords
- Simplex (single fiber) or Duplex (two fibers) construction
- Singlemode or Multimode
- Pig tails
- Outer Diameter is usually 1.6mm, 2.0mm, and 3.0mm
- Duplex versions - Zip cord with outer diameters of 1.6mm, 2.0mm, 3.0mm

Ribbon

- Commonly used in LAN and PON applications with MTP/MPO connectors

6.6.1 Fiber Patch Cord

In a typical GPON network, a fiber is connected directly to the customer ONT/ONU. To test the GPON network, the fiber must be temporarily disconnected from the ONT/ONU and inserted into the MTTplus-420 OLT port. An additional fiber patch cord is then used to connect the MTTplus-420 ONU port to the ONT/ONU modem.

The patch cord and optical connectors play a critical role in fiber measurements. Ensure that a high quality patch cord is always used, as this can and will have profound performance on test results and traces.

Color Coding

The buffer or jacket on patch cords is often color-coded to indicate the type of fiber used.

Connector boot

The strain relief “boot” that protects the fiber from bending at a connector is color-coded to indicate the type of connection.

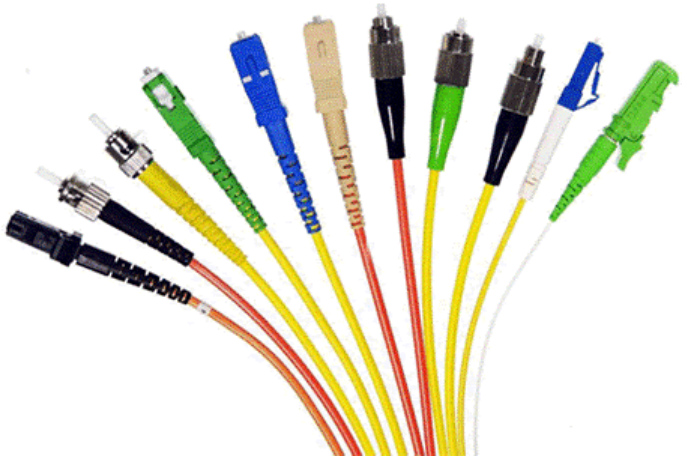
Connectors with a plastic shell (such as SC or E2000) typically use a color-coded shell.

Color Code of Jacket	Definition or Meaning
Yellow	Single mode fiber
Orange	Multimode fiber
Aqua	10G laser-optimized 50/125um multimode optical fiber
Grey	Obsolete color code for multimode fiber
Blue	Sometimes used to designate polarization maintaining fiber

Color Code of Connector Boot	Definition or Meaning

Blue	Physical Contact (PC), 0° Mostly used for single mode fibers; some manufacturers use this for polarization-maintaining optical fiber.
Green	Angle Polished (APC), 8° Single mode only, not available for multimode fibers
Black	Physical Contact (PC), 0°
White	Physical Contact (PC), 0°
Red	High optical power. Sometimes used to connect external pump lasers or Raman pumps

Figure 12: Standard color coding for jackets and boots (or connector shells)



6.7 Inserting the Fiber

Carefully align the optical fiber connector to the port to avoid rubbing the fiber against the external part of the port or any other surface. If the interface of the connector has an alignment key, make sure to insert it correctly into the corresponding groove.

Push the connector in and make sure the optical cables are inserted to guarantee sufficient contact. If the connector has screw bushing, screw down the connector to fix in the optical fiber. Do not over-screw the connector or it will damage the optical fiber and the port.

6.7.1 Preventing Inaccurate Readings

To achieve maximum power and prevent false readings, clean the optical fiber connector interfaces before inserting them into the test port.

Please ensure the correct fiber connector type is used before inserting it into the test port or connector. Mismatched connector types will damage the optical end faces and the test set.

***Note**: If the optical fiber is not aligned properly and/or completely connected, it will cause serious loss and reflection.*

6.8 Fiberscope Utility

6.8.1 Connecting the Fiberscope

Note: *VS500 and DI-1000 Fiber Inspection Scopes require the FiberScope Expert software option to be installed or activated.*

1. Connect the Fiberscope to the test set, using any available USB port (older analog fiberscopes require a USB adapter).
2. Select the **Utilities** or  button on the top-left corner of the screen.
3. Tap the **Tools** menu item, and then tap **Advanced**.
4. Select the **Fiberscope** option.

Note: *The OTDR Viewer app is for the portable USB/Bluetooth OPX BOX micro OTDR option. The Optical Power Meter app is for the UPM-100 USB dongle option or FX40/45 Optical Power Meter.*

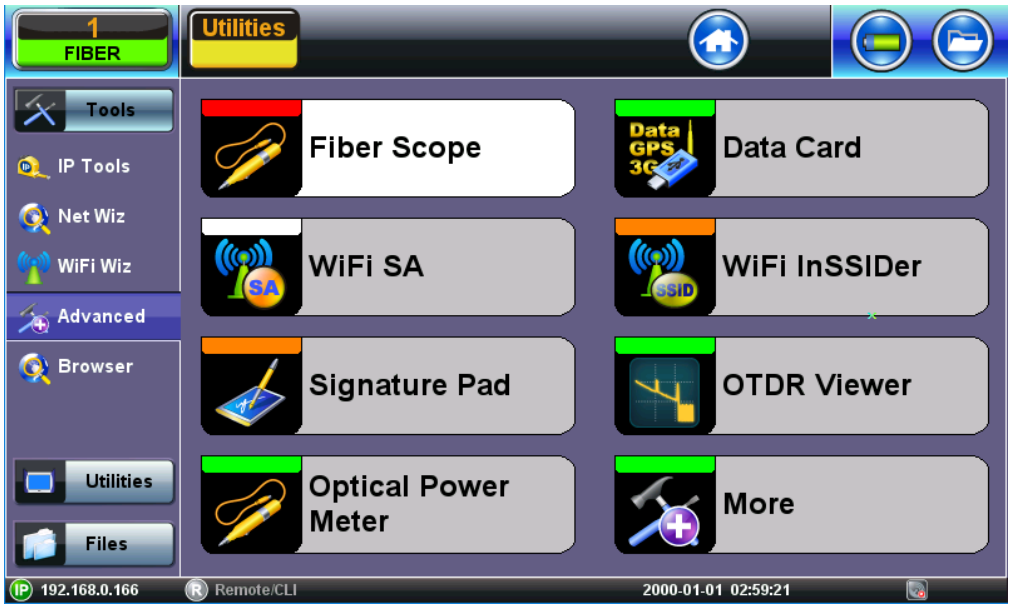


Figure 13: Fiberscope, located in Tools > Advanced menu

6.8.2 FiberScope Setup

Figure 14: Fiberscope Setup menu

Captured patch cord image files are saved within a folder directory. In the Setup tab, name each folder and file in the directory and select a save increment.

- **Scope mode:** Select Local or Remote operation.
- **Auto Save:** Disable, Autosave on Tap, or Autosave after freeze. If either Autosave option is enabled, the unit automatically saves and names the image. The file location and name will display. Selecting **Ask Before Save** brings up the Save menu with naming and comment options.
    - Autosave on Tap: In the capture tab, tap on the screen to automatically save the captured image. “Tap screen to save” will appear to indicate that the feature is enabled.
    - Autosave after freeze: Automatically saves the captured image upon freezing the image.
- Tap on Job ID, Cable ID, Fiber ID, and Trace ID to edit the names.
- **Increment:** Increments the selected ID name if an Auto Save option is selected.

Saved image files can be retrieved from File Manager (see **Managing Fiberscope Results with File Manager** for details) or managed from the **Results** tab. Folders and files are nested in the following order: Job > Cable > Fiber > Trace.

6.8.3 FiberScope Analyzer

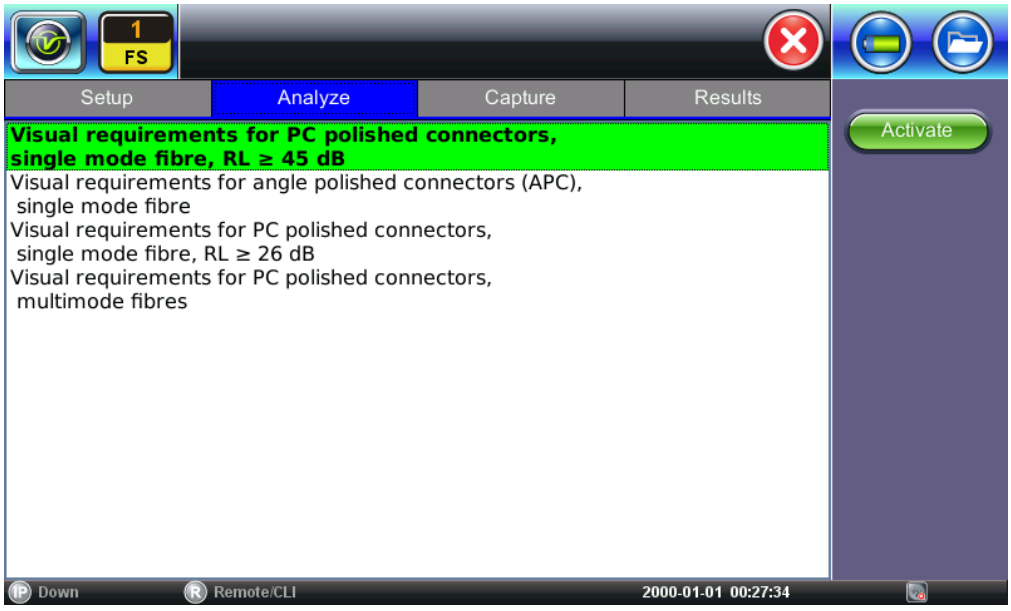


Figure 15: Analyze tab with connector profile selections

To begin analyzing fiber connectors, select the connector profile and press the green **Activate** button which will turn the green highlight to blue.

Note: Currently, no IEC Analysis is available for MTP/MPO connectors.

Fiberscope Connection Instructions

When the DI-1000 or VS-500 fiberscopes are plugged into a USB, they will emit a blue LED. Turn right or left the round focus knob to bring the image into focus. The VS-500 also includes the following buttons located on the top side of the probe:

- **Arrows**: Control contrast
- **File**: Saves results
- **PWR**: Turns the spot LED light on/off

The DI-1000 also includes a freeze/unfreeze button located on the lower side of the probe.

6.8.4 FiberScope Capture Screen

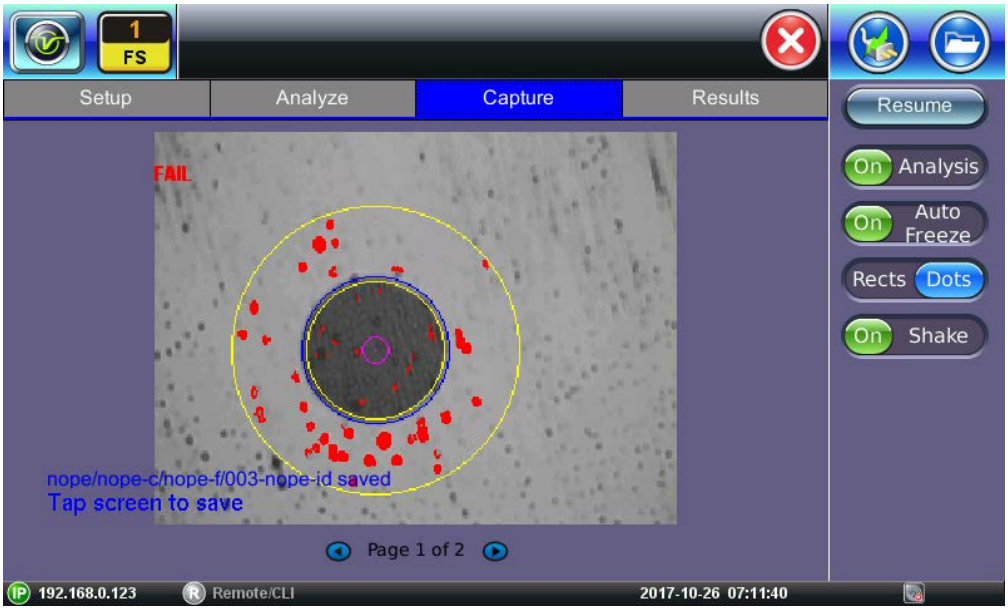


Figure 16: Real time video of the connector face. Red contours indicate scratches and defects.

Page 1 of the capture screen displays a live image of the connector face and features analysis and freeze tools.

- **Freeze / Resume:** Stops the real time video to produce a viewable static image.
- **Analysis On / OFF:** Turn the Auto Analysis ON and OFF (software option).
- **Auto Freeze:** Turn On and OFF the ability to automatically freeze the image when the image comes into focus.
- **Rectangles / Dots:** Dots draw a red contour around scratches and defects. Rectangles highlight scratches and defects without obstructing the view.
- **Shake:** Turn On or OFF the ability to Auto Freeze and Analyze when probe image is unsteady.

Page 2 displays all numeric results from defect and scratch events found for all four zones.

Scratch requirements refer to width.

Note: *This table will also be included in the reports.*

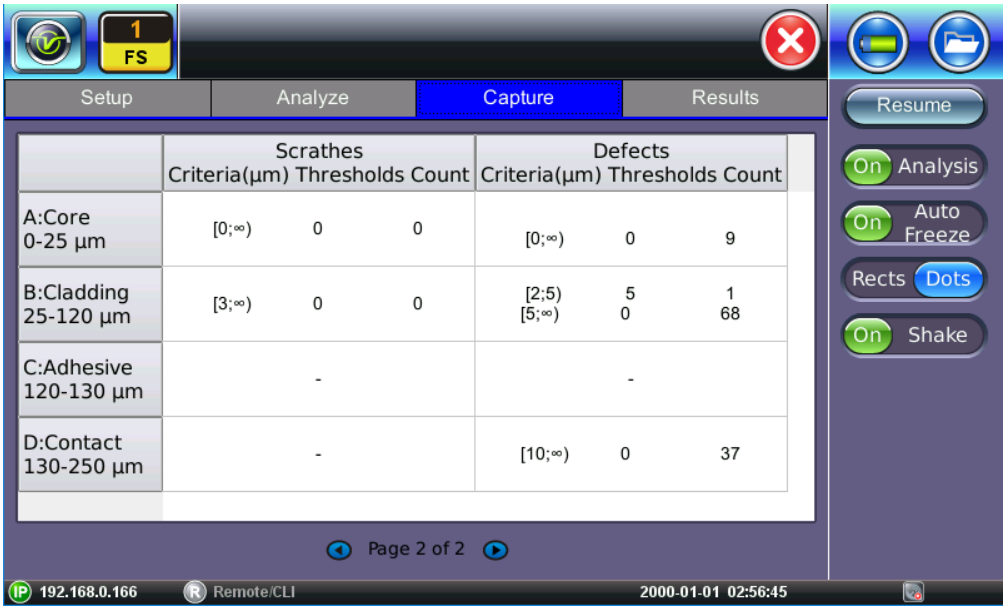


Figure 17: Measured scratches and defects compared with threshold criteria for each fiber layer

6.8.5 Results

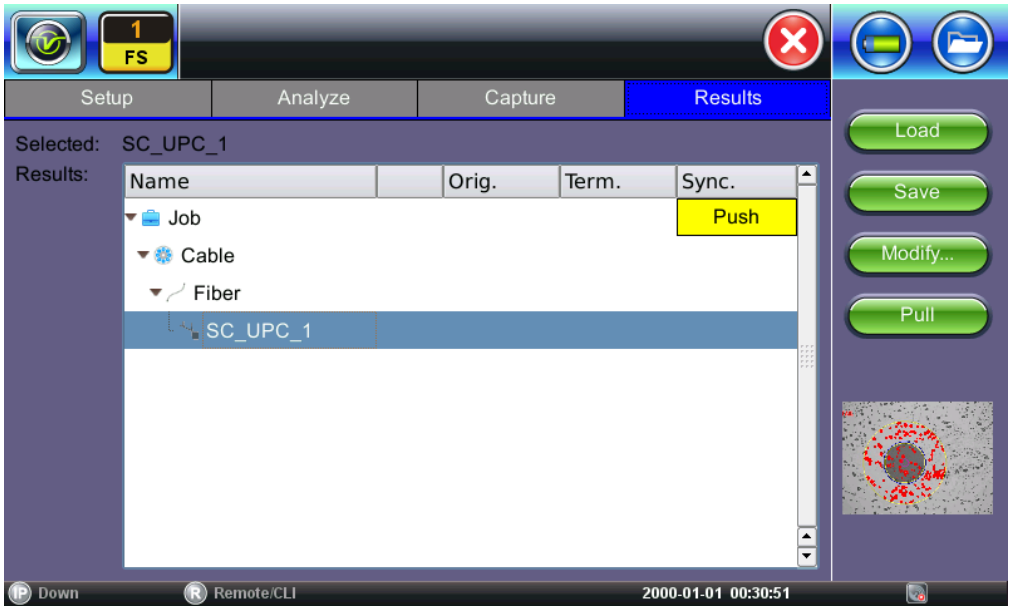


Figure 18: Saved files from Capture screen

The results screen displays management options for saved results including uploading/downloading files from VeEX's Fiberizer Cloud. The directory displays the location of stored files.

- **Load**: Select an image file and tap Load to load the image onto the Capture tab.
- **Save**: Manually saves and names the image displayed in Capture.
- **Modify**: Select a file or folder in the directory to modify. Options to Rename, Remove, and upload the selection to Fiberizer Cloud are available.

Connecting to Fiberizer Cloud

To connect the test set to Fiberizer Cloud, you must be a registered user. For new users, go to the fiberizer.com website from a PC Internet browser to register before proceeding with these directions.

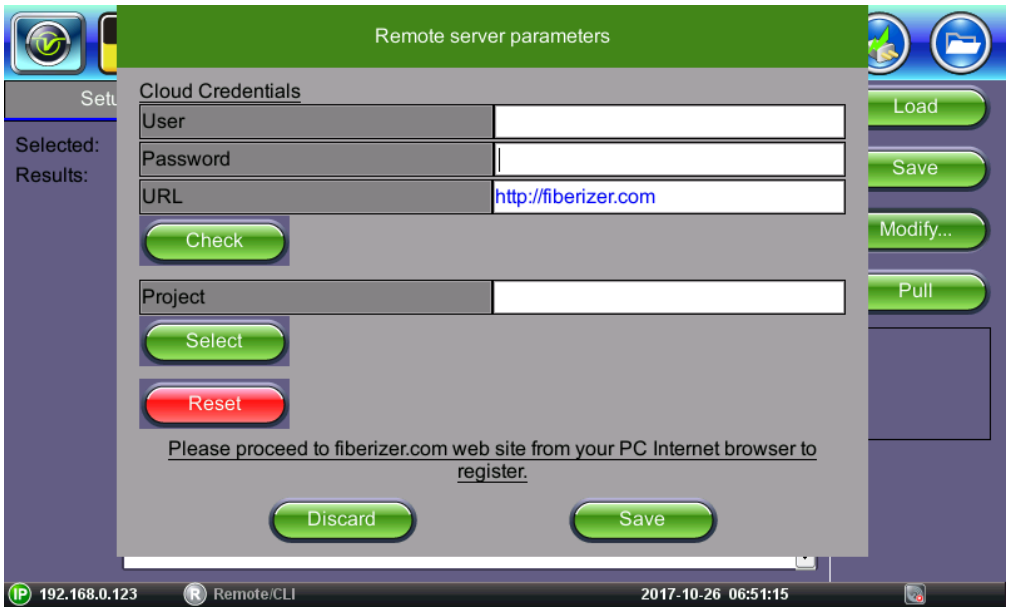


Figure 19: Fiberizer Cloud Log-in

1. Tap on Modify > Settings.
2. Enter the username and password, then tap Check. If the message “Connection has been successfully verified…” does not display, recheck the username and password.
3. Tap Select to choose a project folder to upload files to and tap OK.
4. Save or Discard the cloud login details.

Uploading/Downloading Files with Fiberizer Cloud

Before attempting to upload or download, ensure that the test set is successfully connected to Fiberizer Cloud. Tap on **Push** next to a directory item to upload it into Fiberizer Cloud. **Pulling** downloads the directory collection from Fiberizer Cloud.

- **Clear All:** Deletes all files saved in memory.
- **Delete:** Deletes all selected files.
- **Compare:** If two files are selected, they can be compared. For example, pictures of the same connector before and after cleaning.
- **Analyze:** Open the connector face analysis feature.

6.8.5.1 HTML Report

The FiberScope test report can be viewed in HTML format.

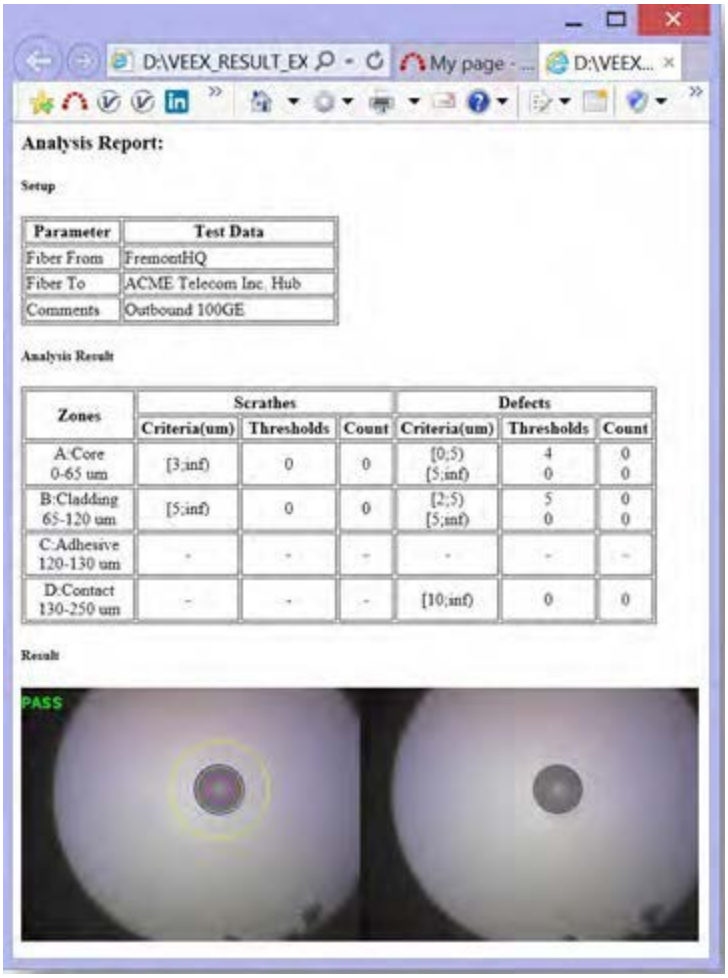


Figure 20: Fiberscope test viewed in an HTML browser

6.8.5.2 PDF Report

The FiberScope test report can be viewed in PDF format.

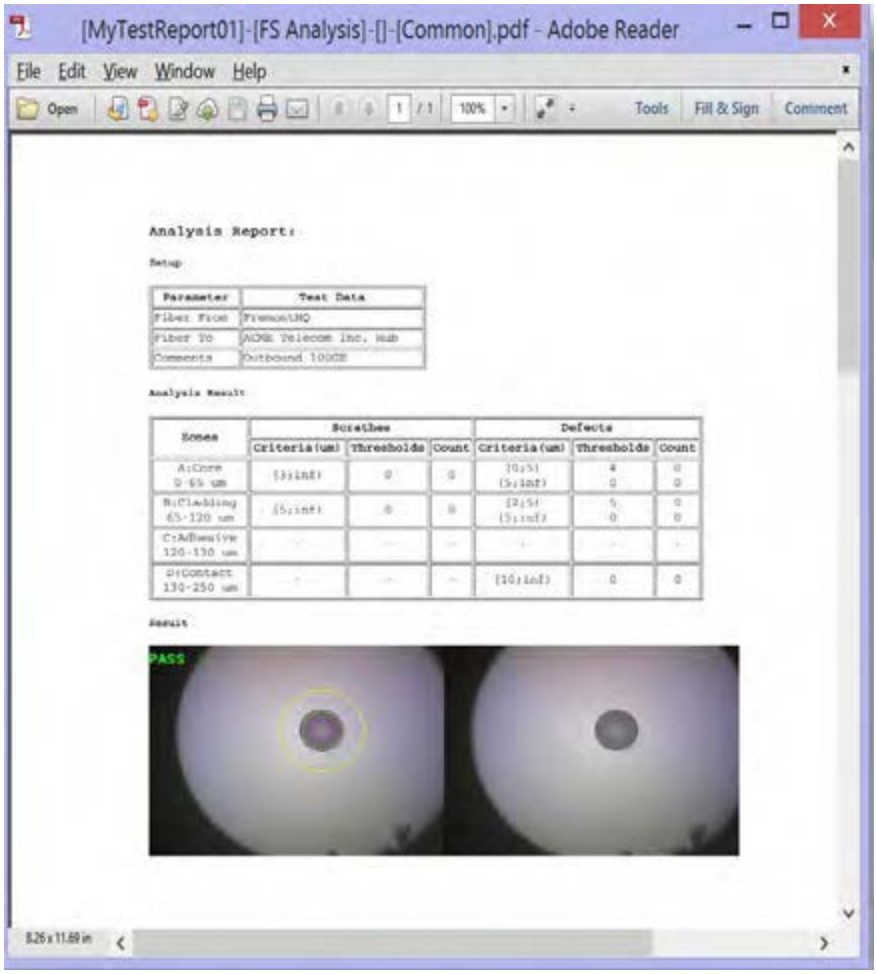


Figure 21: Fiberscope test report in PDF format

6.8.6 Managing Fiberscope Results with File Manager

All results stored in the test set are displayed in the **File Manager**, located in **Utilities > Files > Saved**. When managing files, use the check box ☑ to select the desired file(s).

Figure 22: File Manager menu

The following file management options are available:

- **View:** View file
- **Del:** Delete
- **Rename**
- **U/L**: Unlock or locks files to prevent accidental deletion
- **PDF**: Converts all selected files: Requires FAT32 USB Memory stick

To backup and restore files from a USB Memory stick.

- **To USB**: Copies all selected files to the stick
- **From USB**: Restores all files from the stick
- **BT**: (Bluetooth) File Transfer requires compatible USB dongle

6.8.6.1 File Manager Filters

File Filters make it easier to isolate desired types of results from all other test results stored in the test set. It also reduces the number of pages displayed.

Figure 23: Filtering for specific test types by tapping on the Test header filter+ icon

Fiber inspection test results belong to Common Mode and Fiberscope Tests. Filter parameters can be combined.

Filter Options

- To filter by header type, use the stylus to tap on the filter+  icon.
- To reset filters, press the **Show All** button.
- To select columns to hide/show, tap on **Column** to access the column visibility menu.
- To search for files by specific criteria such as Job ID, Account, and Name, tap on the **Advanced** menu.To sort results in ascending or descending order by header type, tap on the header. An arrow next to the header indicates the file sorting order.

6.8.6.2 Backing up and Restoring Test Profiles and Results From USB

The MTTplus Platform File Management system offers backup **To USB** and restore **From USB** functions to preserve user data.

Enabling To USB and From USB Functions

1. To enable the **To USB** and **From USB** functions, insert a USB Memory stick (FAT32 file format) into a USB port on the side of the unit.
2. Wait for the USB memory to be detected (the folder icon will change appearance with a green USB memory icon).

After the unit detects the USB memory stick, it's now possible to download files to USB or restore files from USB.

Downloading Files To USB

1. Select the desired test results, test profiles, screen capture and protocol capture files to be saved, using the individual ☑ check boxes. For a full backup, check the master check box on the header and all files will be marked.
2. Tap the **To USB** button to initiate the file transfer procedure and wait for the progress bar to finish. Original files won't be deleted from the test set.
3. When all files have been copied to the USB, tap the folder icon (top-right corner) and select **Remove USB Drive** to make sure all cached data is transferred to the USB drive, especially when transferring small files.

6.8.7 Fiberizer Scope Image Management Software (VS-500 and DI-1000 only)

Detailed Windows PC-based Fiber Inspection Monitor & Analysis: Compatible with VS-500 and DI-1000 FiberScope.

- IEC 61300-3-35 Profiles

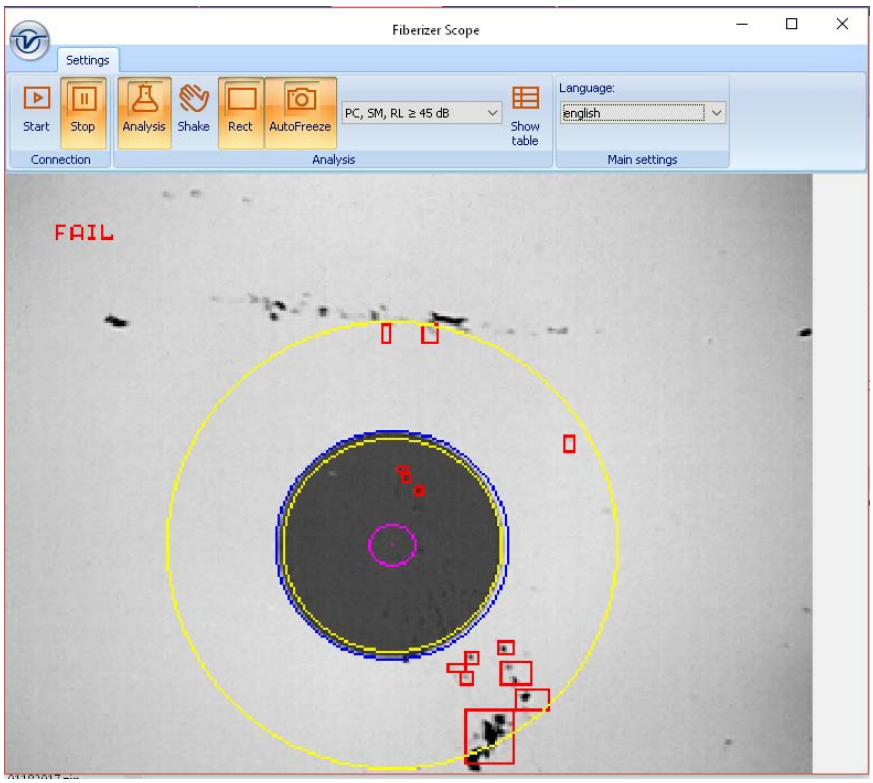


Figure 24: Connector face image as viewed from Fiberizer Scope Image Management software

Analysis Profile Parameters:

- AnalysisParam1: SMF UPC >45 dB
- AnalysisParam2: SMF APC
- AnalysisParam3: SMF PC RL>26 dB
- AnalysisParam4: MMF PC

Video Mode:

- **Start:** Activate Real Time Viewing mode
- **Stop:** Halt Real Time Viewing mode and display last image
- **Analysis:** Turn ON/OFF Auto IEC Analysis when image is in Focus
- **Shake:** Turn ON/OFF Shake function to facilitate auto-freeze and analysis when image is unsteady
- **Rect:** Toggle between dot or rectangular marking of events
- **AutoFreeze:** Turn ON/OFF Auto Freeze when FiberScope image is in Focus
- **UnFocus before Freeze:** Select to unFocus Image prior to freezing it
- **Show Table:** Select to switch from connector image to table view

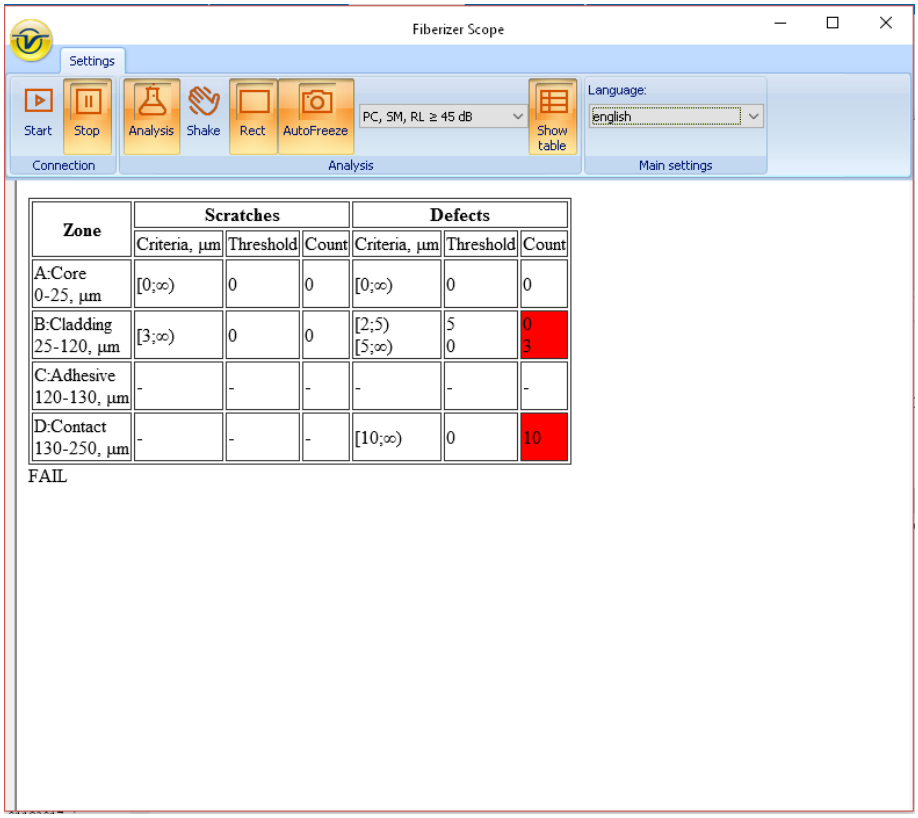
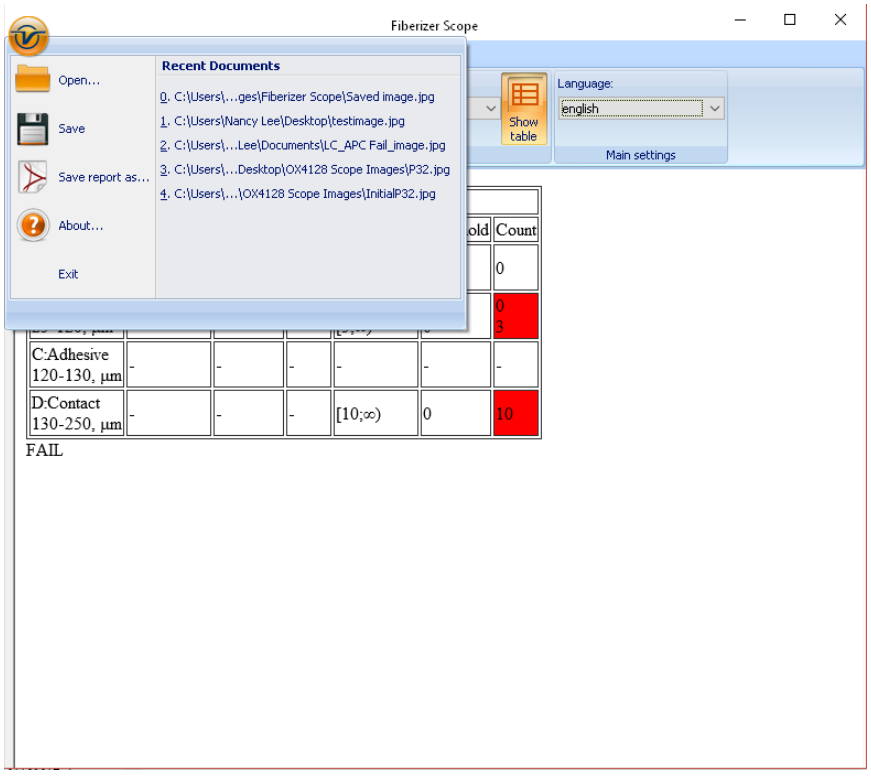


Figure 25: Table view of fiberscope information

Click the  to bring up the File Management Window.



- **OpenFile:** To view saved files

- **SaveFile:** To save FiberScope results
- **Generate Pdf Report:** To save FiberScope results in pdf file format
- **About**: To check the Fiberizer Scope software revision for the FiberScope
- **Exit**: To quit the Fiberizer Scope program

7.0 Optical Power Meter (OPM) Test Mode

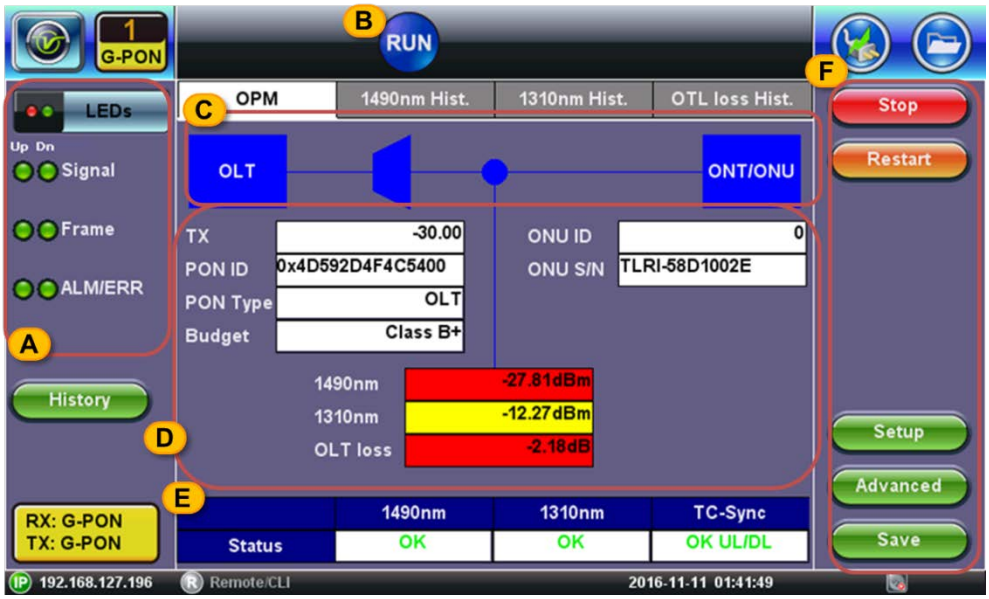


Figure 26: OPM Summary screen

The MTTplus-420 starts up on the OPM Home menu. Refer to the **MTTplus Platform manual** for information on home screen test icons and menus common to all MTTplus modules. The OPM Home menu is described below.

A. LED Indicators

On screen LEDs indicate the status of upstream (**Up**) and downstream (**Dn**) signal and alarm/error traffic detection. Refer to **LED Status** for more information.

B. Status Icon

The RUN icon indicates a test is running.

C. GPON Diagram

Network diagram of the GPON network. Connect the MTTplus-420 between the splitter and ONT/ONU. ***Note: Do NOT** connect the MTTplus-420 between the OLT and splitter.*

Figure 27: The MTTplus-420 should be connected between the splitter and ONT.

D. OLT and ONT/ONU Messages and Measurements

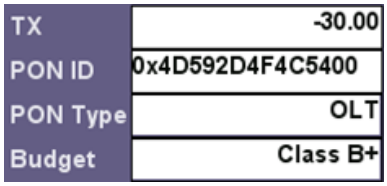


Figure 28 OLT information table

Below the OLT and splitter diagram block, a table displays the transmitting signal level (TX), PON ID, PON Type, and PON Budget Classification (Budget). This is decoded from downstream PLOAM messages from the OLT. This information is only available when sent by the OLT and may need to be enabled.

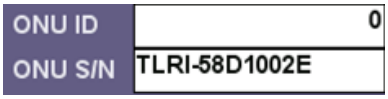


Figure 29 ONU information table

ONU ID and ONU S/N information is decoded from upstream PLOAM messages from the ONT/ONU. If the information is not displayed, it may have been missed. Power cycle the ONU to initiate the ranging process again.

Figure 30 Signal measurement table

Displays 1490nm and 1310nm signal level values as measured at the MTTplus-420's location. OLT Loss is the difference between the transmitting signal from the OLT (**TX**) and the DS 1490nm signal level measured at the MTTplus-420 location.

***Note:** If the OLT is not broadcasting its output power, the span loss value cannot be calculated.*

Green, yellow, and red table colors indicate whether signal levels pass or fail against ITU-T G.984 standard threshold values configured in Setup. Refer to **Test and Profile Settings** for information on test profile setup.

Green: The measured signal is above the critical threshold.

Yellow: The measured signal is below marginal and above critical.

Red: The measured signal level is below the critical threshold and does not meet the specification.

E. Upstream/Downstream/TC-Sync Signal Status

For more information, refer to **Signal and Synchronization Status.**

F. Test and Profile Settings

- **Setup:** Setup Test profile

- **Advanced:** Leads to the Advanced Setup, Results, PLOAM and OMCI Decoder, and Active ONU list.
- **Save:** Saves test results onto the test set. Results can be retrieved via USB. See **Managing Fiberscope Results with File Manager** for USB retrieval instructions.

Signal and Synchronization Status

The Status table displays detected 1490nm downstream, 1310nm upstream, and TC-Sync status.

	1490nm	1310nm	TC-Sync
Status	OK	OK	OK UL/DL

Figure 31: Signal and synchronization status table

Status Table

- **1490nm/1310nm:** If OK is displayed, light in the downstream 1490nm or upstream 1310nm direction is detected. If errors/alarms are detected, they are displayed.
- **Transmission Connectivity Sync (TC-Sync):** OK UL/DL indicates that the MTTplus-420 is properly synchronized with the OLT and ONU/ONT traffic. No UL/DL indicates the OLT and ONU/ONT are not synchronized properly. Consult VeEX technical support if unable to achieve TC-Sync.

Note: *OK indicates US or DS light is detected, but does not indicate whether ITU-T G.984 Threshold values are met or if the OLT and ONU/ONT are properly synchronized.*

LED Status

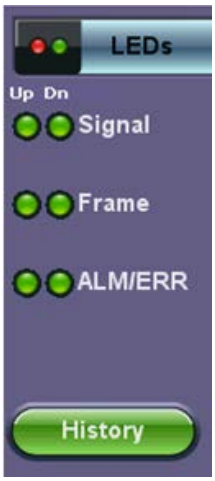


Figure 32: Upstream/Downstream LED status

On screen LED colors indicate the status of upstream (**Up**) and downstream (**Dn**) signals:

- **Green**: Signal level detected. No errors or alarms are present. No further action required.
- **Red**: An error or alarm condition is detected and is currently present. Flashing red indicates a history condition—an error or alarm was detected during the measurement interval but it is no longer present or active. Tap Advanced to view Alarms/Errors, PLOAM, and OMCI.

The **History** button resets the LEDs of past statuses.

Note: *If any LED remains red, clean the patch cord connectors that will connect the MTTplus-420 to the ONU/ONT, the MTTplus-420 test ports (To ONU, To OLT), and the ONU/ONT ports. Refer to* ***Inspection*** *for information on inspecting and cleaning fiber connectors.*

7.1 Optical Power Meter (OPM) Test Procedure

The MTTplus-420 is designed for use at the customer premises to aid with ONT/ONU activation and troubleshooting.

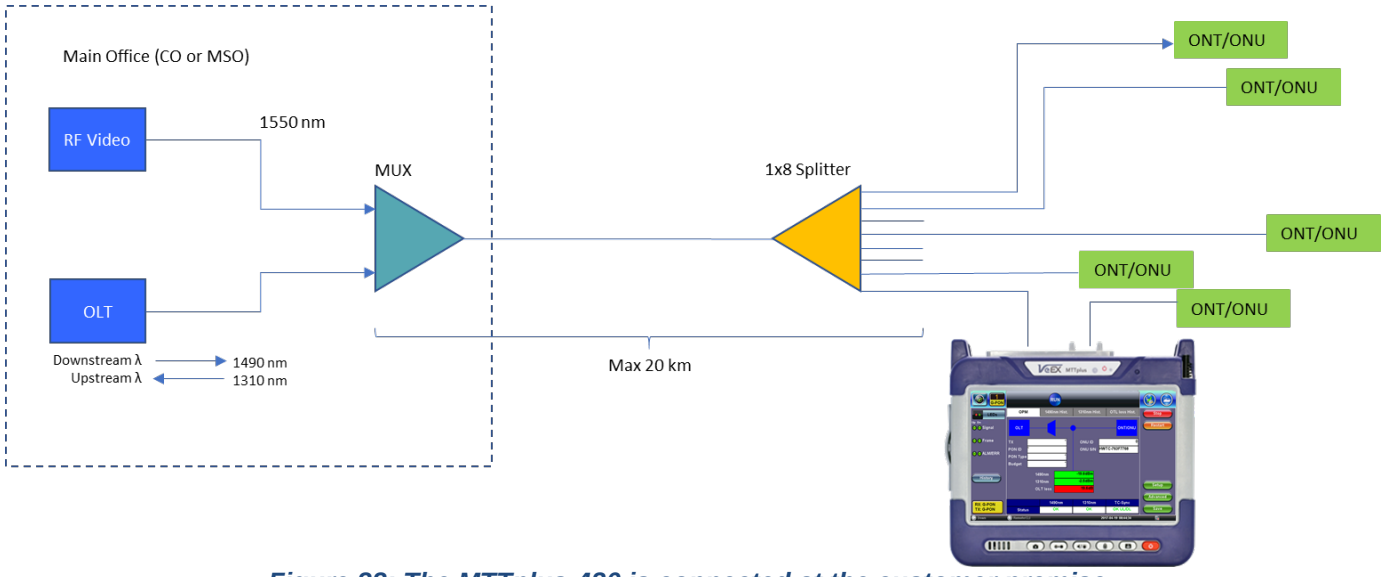


Figure 33: The MTTplus-420 is connected at the customer premise

1. Power up the MTTplus-420 test set. Testing should start automatically. Starting/stopping/restarting measurements from the OPM menu (see **Figure 28 OLT information table**) starts/stops/resets items in the OPM Summary screen - the power level graphs and the Active ONU list in **Advanced Mode**. To clear the PLOAM or OMCI list, go to the respective PLOAM and OMCI decoder menus and press the clear button.

2. Tap on **Setup** and configure the test profile settings according to the GPON class and ITU-T G.984 Test standard. Refer to GPON ITU-T G.984 Test Standards.

Profile	Class A	Class B	Class B+	Class C	Class C+
Downstream Threshold (Marginal)	-19	-19	-25	-28	-32
Downstream Threshold (Critical)	-21	-21	-27	-30	-34
PON Span Loss (Marginal)	18	26	27	28	30
PON Span Loss (Critical)	20	28	29	30	32
Upstream Threshold (Marginal)	-1	0	-0.5	0	1
Upstream Threshold (Critical)	-3	-2	1.5	2	3
Max Physical Length	20 km				60 km

Table 3: ITU-T G.984 Test Standards

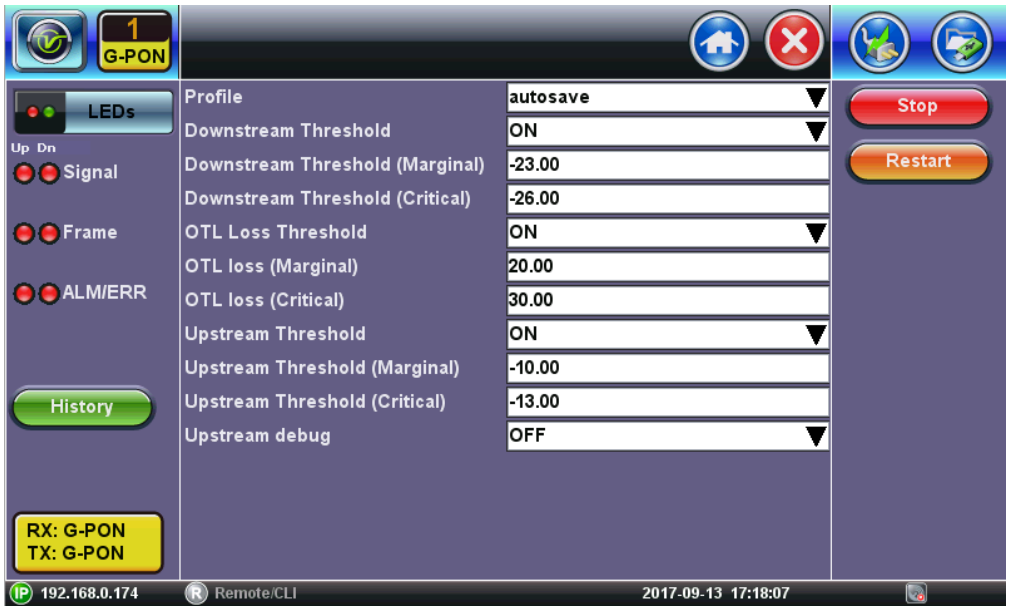


Figure 34: OPM Setup menu

3. Inspect and clean the MTTplus-420 test ports. Inspect and clean the fiber patch cord from the OLT and insert it into the MTT420-plus OLT test port.

   ⚠ ***Warning:*** *Never look directly into the beam of an active optical source as this may result in harmful eye damage from radiation exposure.*

4. If 1490nm light is detected, the **Status** will display **OK.** Verify that the measured 1490nm signal level is green (see **Signal and Synchronization Status**). Confirm TC-Sync DS displays **OK UL/DL**. Consult VeEX technical support if you are not able to achieve TC-Sync.

5. All DS LEDs should turn from red to Green. If any LED remains red, clean and inspect the connectors again as specified in Step 4.

6. Inspect and clean the patch cord connectors that will connect MTTplus-420 to ONU/ONT and the ONU/ONT test port.

7. Connect the MTTplus-420 to the ONU/ONT test port. If 1310nm light is detected, the Status will display **OK.** Verify that the measured 1310nm signal level is green (see **Signal and Synchronization Status**).

8. Confirm TC-Sync DS displays **OK UL/DL**. Consult VeEX technical support if you are not able to achieve TC-Sync.

9. All US LEDs should turn from red to green. If any LED remains red, clean the ONU connections again as outlined in Step 6.

Synchronizing the MTTplus-420 with the ONU Activation Process

The MTTplus-420 will synchronize to the downstream frame (from the OLT) provided the OLT is operational and 1490nm signal level is good. The downstream frame synchronization indicator should occur almost immediately.

In order to synchronize with the ONU, the MTTplus-420 needs to see the ONU registration process. Therefore, only connect the ONU **AFTER** the MTTplus-420 application is already running. Otherwise, power cycle the ONU after the MTTplus-420 application is running if the ONU is already connected to the MTTplus-420.

The reason for this is two-fold. First, the upstream Serial_Number_ONU PLOAM message is **only** transmitted by the ONU during its activation and the MTTplus-420 must see this message in order to populate the ONU ID and ONU S/N fields of the OPM results page. Second, the MTTplus-420 needs to determine its distance from the OLT and the ONU (i.e. needs to know the time difference between when a downstream frame arrives and when the corresponding upstream frame is returned). This is determined during the ranging process.

Once the ONU registration is complete, the MTTplus-420 then uses the bandwidth allocation information contained in the downstream frames in order to determine when the upstream burst from the ONU will occur and what data it will contain. Should the downstream frame become corrupted at this point, the upstream frame reception will also therefore be affected.

Note: *If the OLT and an active ONU are connected to the MTTplus-420 before starting the test application, the MTTplus-420 will not see the ONU activation and the above process will not be completed. In this instance, LOF will be reported for the upstream side; no ONU ID or ONU S/N information on the OPM results page will be displayed.*

7.2 Histogram and OLT Loss History

Tap on 1490nm Histogram, 1310nm Histogram, and OLT Loss (Span Loss) Histogram tabs to Monitor Downstream and Upstream signals. Tap on the upper left and right arrows to scroll through the measurement period. The + and – keys zoom in/out of the time axis.

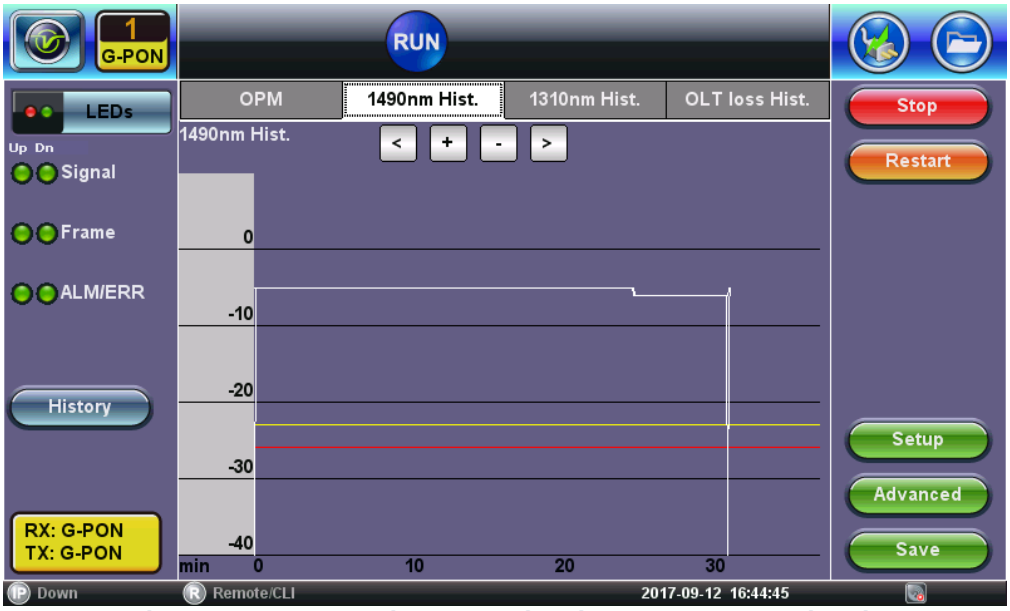


Figure 35: 1490nm Histogram showing Downstream signals

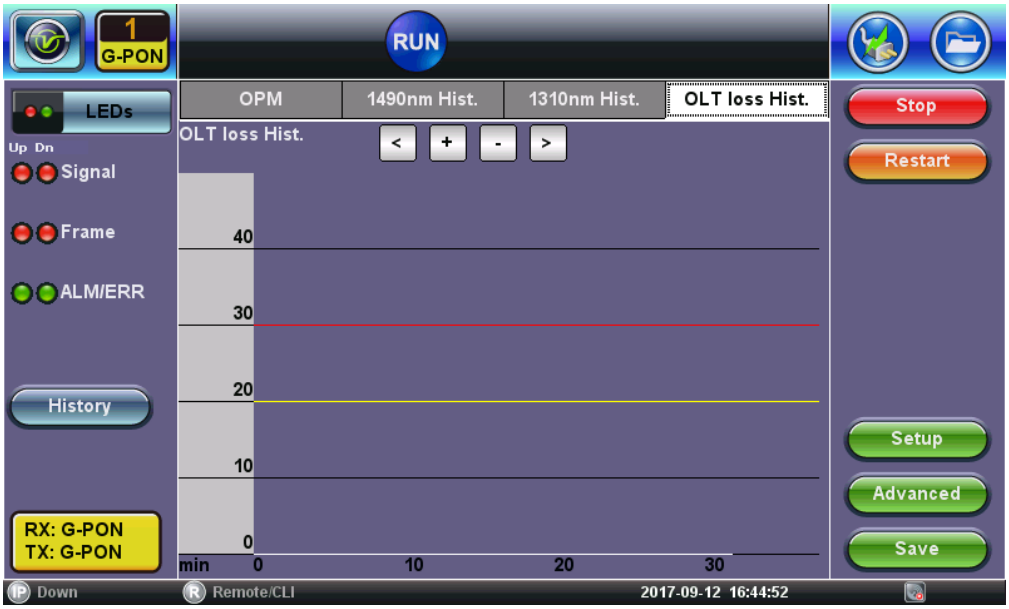


Figure 36: OLT Loss Histogram showing Downstream and Upstream signals

8.0 Advanced Mode

Advanced Mode features advanced troubleshooting tests beyond basic signal level measurements. Further investigation may be required when the OPM test mode indicates good signal level and TCSync is good but network is generating alarm or errors.

- **Advanced Results** provides a summary screen of network status and reports system errors/alarms status.
- **PLOAM and OMCI Decoder** captures and decodes PLOAM and OMCI messages exchanged between the Optical Line Terminal (OLT) and ONT.
- **Active ONU** lists all active ONUs currently on the network as determined by the OLT.

Starting/stopping/restarting measurements from **Advanced Results** starts/stops/resets items in Advanced Mode, namely the power level graphs. Start/stop from Advanced Setup relates to error/alarms on this page. If the ONU is restarted, the power measurement will continue recording the signal levels. The decoded fields will be reset when the ONU is reconnected. Decoded messages continue to persist until the new sync is achieved, when they get updated.

Pressing restart at any time clears the results, filling in the downstream decode after receiving the first PON-ID downstream message. The upstream decode will be filled in when the ONU initializes.

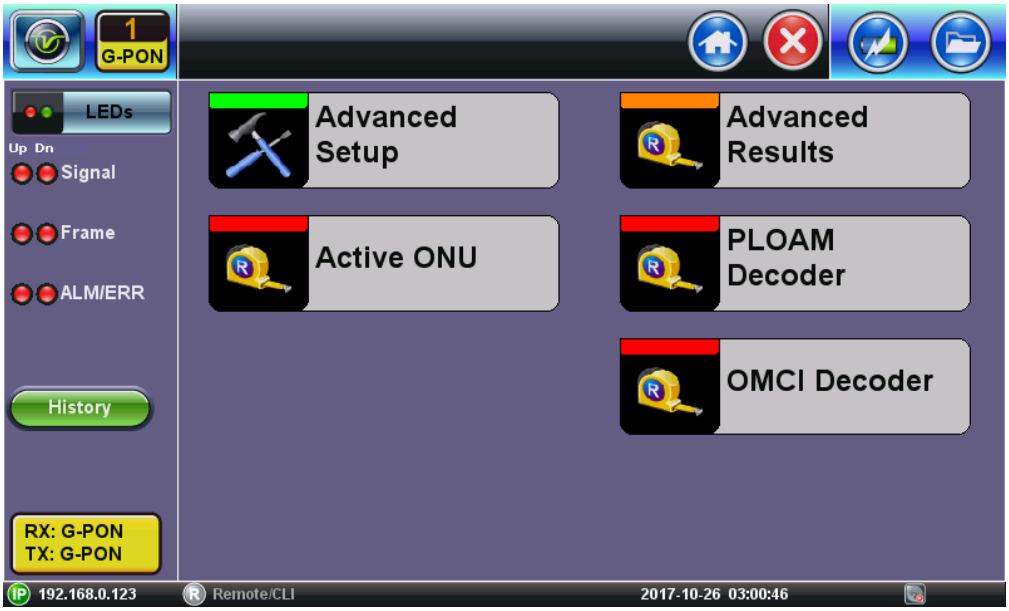


Figure 37: Advanced home menu

8.1 Advanced Setup

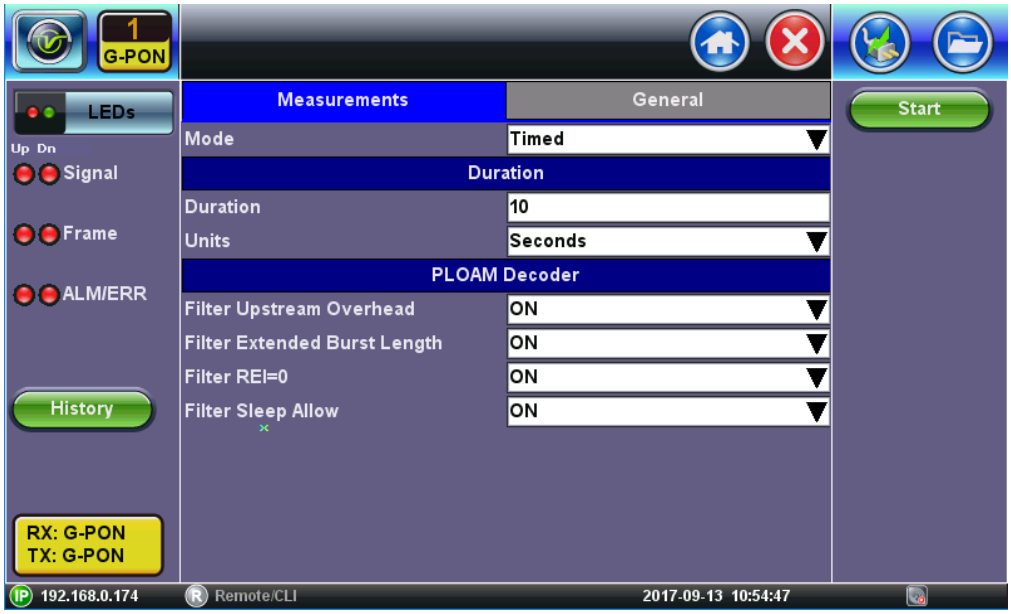


Figure 38: Advanced Setup - Measurements tab

Advanced Setup options include programming test duration/start time, PLOAM Decoder Filter options, and additional test management options.

Measurements

Select a Mode option to enable a test to run for a fixed duration and/or a delayed start.

Mode: Manual, Timed, and Auto selections are available.

- **Manual:** This is directly linked to the Start/Stop function. The test starts as soon as the **Start** button is pressed.
- **Timed:** The test duration can be set in seconds, minutes, hours or days. The test is activated by the Start/Stop function on the drop-down menu and stops automatically when the defined time has elapsed.

  Auto: A predetermined start time can be set. The test duration can be set in seconds, minutes, hours or days. After programming the start time and duration, press the **Start** button and the test will be activated automatically when the programmed start time is reached.
- **Filter Upstream Overhead:** When active, prevents capture in the PLOAM Decoder log of Upstream_Overhead PLOAM messages from the OLT.
- **Filter Extended Burst Length:** When active, prevents capture in the PLOAM Decoder log of Extended_Burst Length PLOAM messages from the OLT.
- **Filter REI=0:** When active, prevents capture in the PLOAM Decoder log of Remote Error Indication (REI) PLOAM messages with zero bit error count from the ONU.
- **Filter Sleep Allow:** When active, prevents capture in the PLOAM Decoder log of Sleep_Allow PLOAM messages from the OLT.

General

The General setup tab features the following test management options:

- **Audible Alarm**: The unit beeps every time an alarm is detected. This feature is not available on all test sets.
- **Results on start**: Provides an automatic move to Result screen when it the test is started.
- **Auto Save**: Automatically saves the results file.
- **Measurement Clock Source**: Select the Measurement clock source used for Frequency measurement.

8.2 Advanced Results

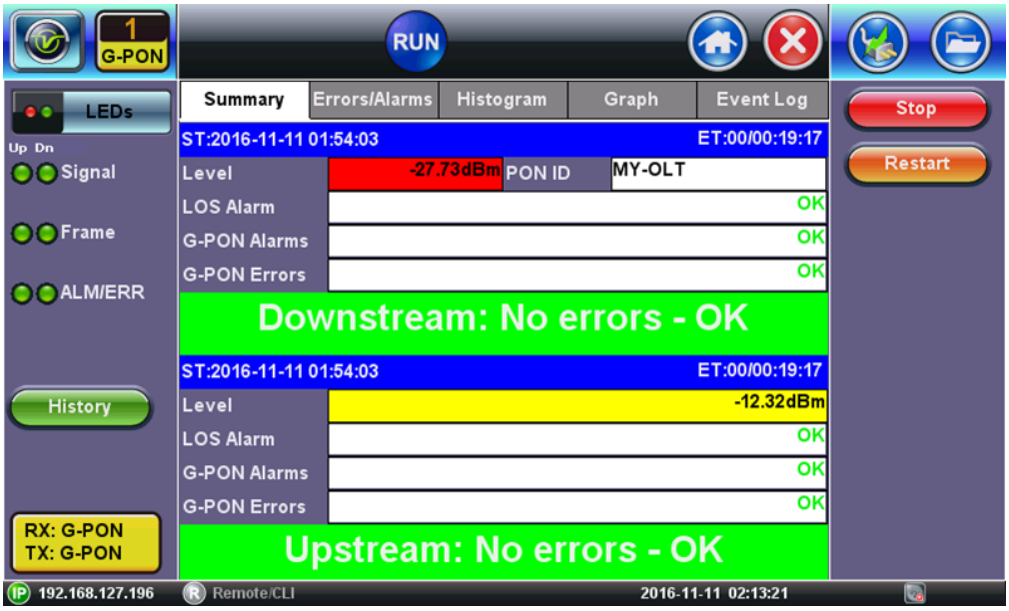


Figure 39: Advanced Results - Summary tab

The Advanced Results menu displays additional Errors/Alarms and Event details.

Summary

The summary tab displays a summary of test results including DS/US signal levels, PON ID, and alarm statuses all on one screen.

8.2.1 Errors/Alarms

Figure 40: Errors/Alarms tab showing summary of US/DS errors/alarms statuses

The Errors/Alarms tab brings up several pages showing error and alarm statuses.

Page 1 provides an overview of all the Errors and Alarms applicable to the signal and network under test. The color of the page tab is normally blue; however, it will turn red when an alarm error condition has been detected or recorded.

The soft LEDs have a tricolor function:

- **Green:** No error or alarm is present.
- **Red:** An error or alarm condition is detected and is currently present.
- **Yellow:** Indicates a history condition. An error or alarm was detected during the measurement interval but it is no longer present or active.
- **White:** Not available
- **Gray:** Not activated

Note: *Tapping the individual soft LED will automatically link directly to the applicable result screen which provides detailed information. Depending on the settings chosen in* ***Setup*** *>* ***Signal****, the Alarms/Errors displayed and page length will vary, but the order in which they are presented remain the same.*

Refer to **Downstream Alarms/Errors** and **Upstream Alarms/Errors** for a description of alarms/errors and troubleshooting guidelines.

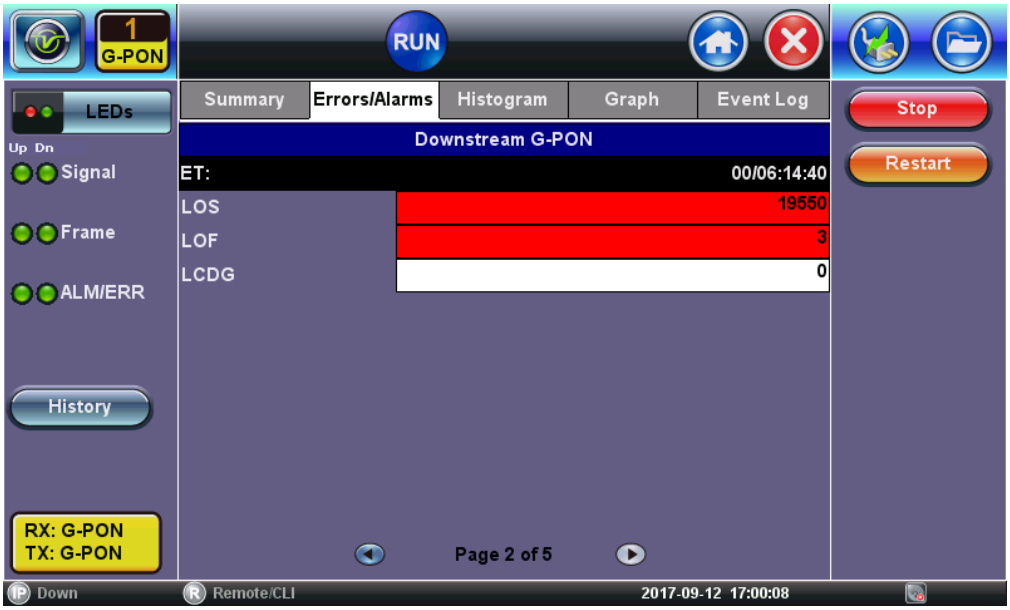


Figure 41 Errors/Alarms tab displaying Downstream G-PON errors/alarms

Histogram

Figure 42: G-PON Histogram showing start and stop time of alarms/errors

The Histogram tab displays a historical record of the Alarms and Errors recorded during the measurement interval. A separate page is available for downstream and upstream results.

A graphical timeline on the horizontal axis indicates when the event occurred in seconds. Tap on the upper left and right arrows to scroll through the measurement period. The + and – keys zoom in/out of the time axis.

Graph

The Graph tab brings up a page displaying a log of the Errors recorded during the measurement interval for each alarm/error.

Figure 43: Graph tab displaying DS BIP error screen

Event Log

Figure 44: Event Log showing start, stop, and error/alarm events

The Event Log tab brings up a screen listing the Error and Alarm events recorded during a test. The events are presented in chronological sequence - number, type of event, start time, duration (alarms), and ratio/count (errors) are displayed.

8.3 Active ONU

Active ONU lists all of the ONUs that have been activated by the OLT since the measurement was started/restarted from the OPM summary screen. Tap **Clear** to clear the list.

Figure 45: Active ONU screen

8.4 PLOAM Decoder

Figure 46: PLOAM Decoder screen

Physical Layer Operations, Administrations and Maintenance (PLOAM).**Decoder** displays upstream/downstream decoded PLOAM messages between the ONUs/ONTs and the OLT. Tap **Clear** to clear the list or tap on the screen to see additional message details. Refer to **Appendix C** for the activation process overview and a description of each PLOAM message.

8.5 OMCI Decoder

Figure 47: OMCI Decoder screen

OMCI messages are used by GPON network to manage PON services and ONU equipment. The Optical Network Unit Management and Control Interface (OMCI) specifies the managed entities of a protocol-independent management information base (MIB) that models the exchange of information between the OLT and an ONU. In addition, it also covers the ONU management and control channel, protocol and detailed messages.

The **OMCI Decoder** displays upstream/downstream decoded OMCI messages between the ONUs/ONTs and the OLT.

Tap **Clear** to clear the list.

9.0 Troubleshooting GPON Alarms/Errors

Alarms and performance monitoring encompasses mechanisms to detect link failure and monitor the health and performance of links. This clause does not cover such functions as station management, bandwidth allocation or provisioning functions.

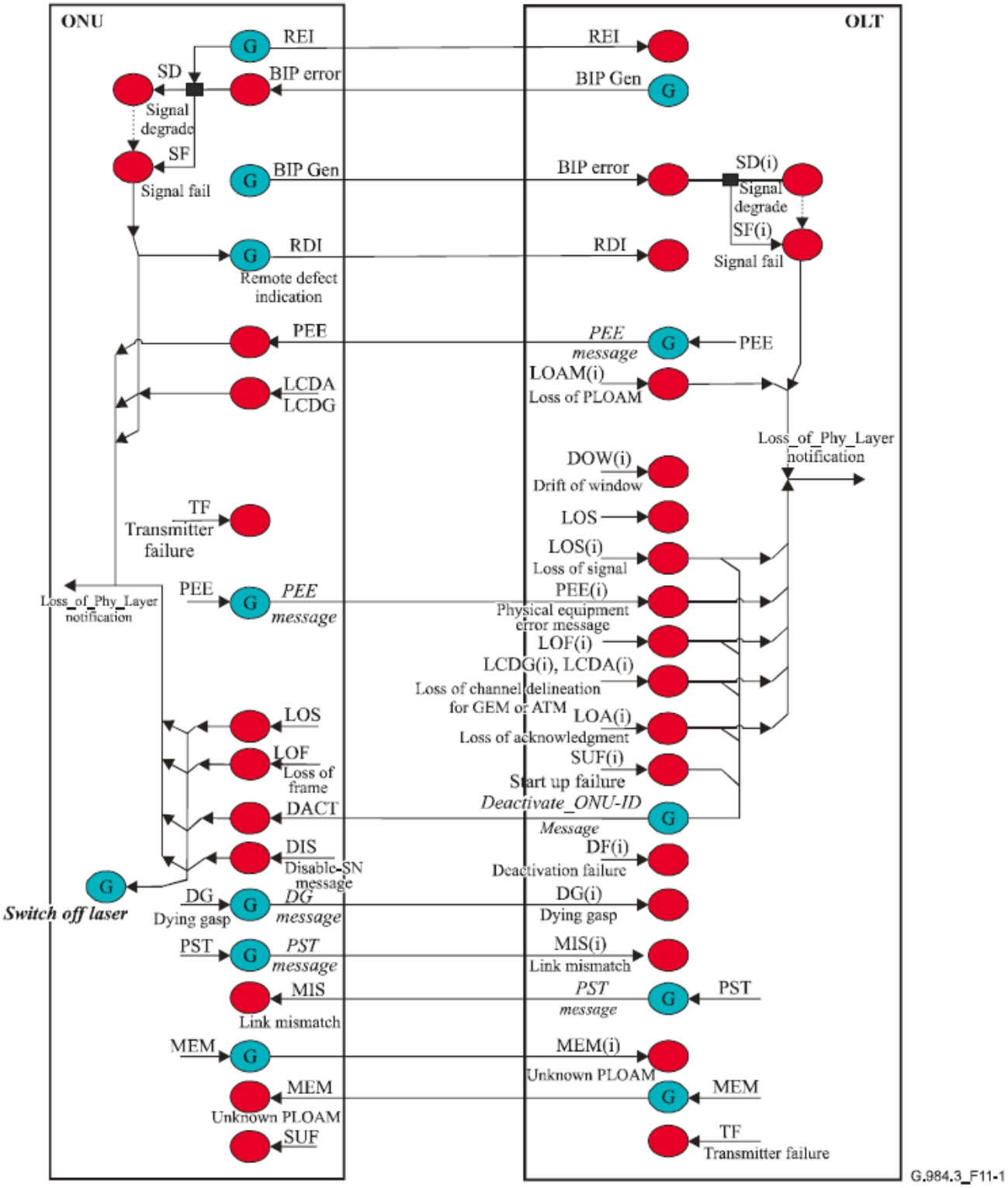


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Figure 48: The flow chart illustrates OAM functions installed in the ONU and OLT. It also shows the Alarm notification signals between OLT and ONU.

9.1 Downstream Alarms/Errors

9.1.1 LOS

LOS means 1490nm Loss of Signal is detected. In an active GPON network, the 1490nm DS is always transmitting.

LOS Troubleshooting

1. Verify GPON fiber is inserted in the To OLT test port.
2. Check the optical fiber.
   - If the optical fiber is not connected properly, clean/inspect/reconnect the optical fiber again and make sure the fiber is connected correctly and securely. You should not be able to pull the connector out of the coupler with a gentle pull on the cable itself.
   - Make sure the mated connector types match. Do not mate a blue color connector with a green connector.
   - If the optical fiber is aged, bent, or damaged: replace the optical fiber.
   - If the connector of the optical fiber is not clean, clean the optical fiber.
   - If the connector of the optical fiber is scratched or pitted, replace connector.

9.1.2 LOF

LOF means 1490nm DS Loss of Frame occurred.

9.1.3 LCDG

LCDG means Loss of Channel Delineation for GEM detected previously but not anymore. The System generates this alarm when delimitation of the GEM frame header is incorrect. The OLT detects HEC check errors of the GEM header in consecutive frames.

LCDG IMPACT: Loss of frame (LOF) in the system, and the ONT goes offline.

Possible LCDG Causes: Optical fiber is faulty or ONT is faulty.

LCDG Troubleshooting:

1. Check the optical fiber.
   - If the optical fiber is not connected properly, clean/inspect/reconnect the optical fiber again and make sure the fiber is connected correctly and securely. You should not be able to pull connector out of the coupler with gentle pull on cable itself.
   - If the optical fiber is aged, bent, or damaged: replace the optical fiber.
   - If the connector of the optical fiber is not clean, clean the optical fiber.
   - If the connector of the optical fiber is scratched or pitted, replace connector.
2. If the ONT is abnormal, reset or replace the ONT.

9.1.4 BIP - Bit Interleaved Parity

Each GPON Transmission Convergence (GTC) frame contains Physical Control Block downstream (PCBd) and payload:

- PCBd contains sync, OAM, DBA info, etc.
- Payload has GEM partitions (ATM partitions removed from standard) but some vendors continue to include either one or both types of partitions.

Downlink frame fixed 125µs frequency is 8000Hz and size is 38,880 bytes at 2.488Gbps rate. GTC payload can have 2 sections:

- GEM partition (current standard)
- ATM partition

Looking at the Downstream and Up Stream Frame Structures below, BIP - SONET/SDH-style Bit Interleaved Parity of all bytes since last BIP (1 Byte) is visible.

BIP Impact: BIP provides an approximate method for monitoring link quality at the bit error level**.**

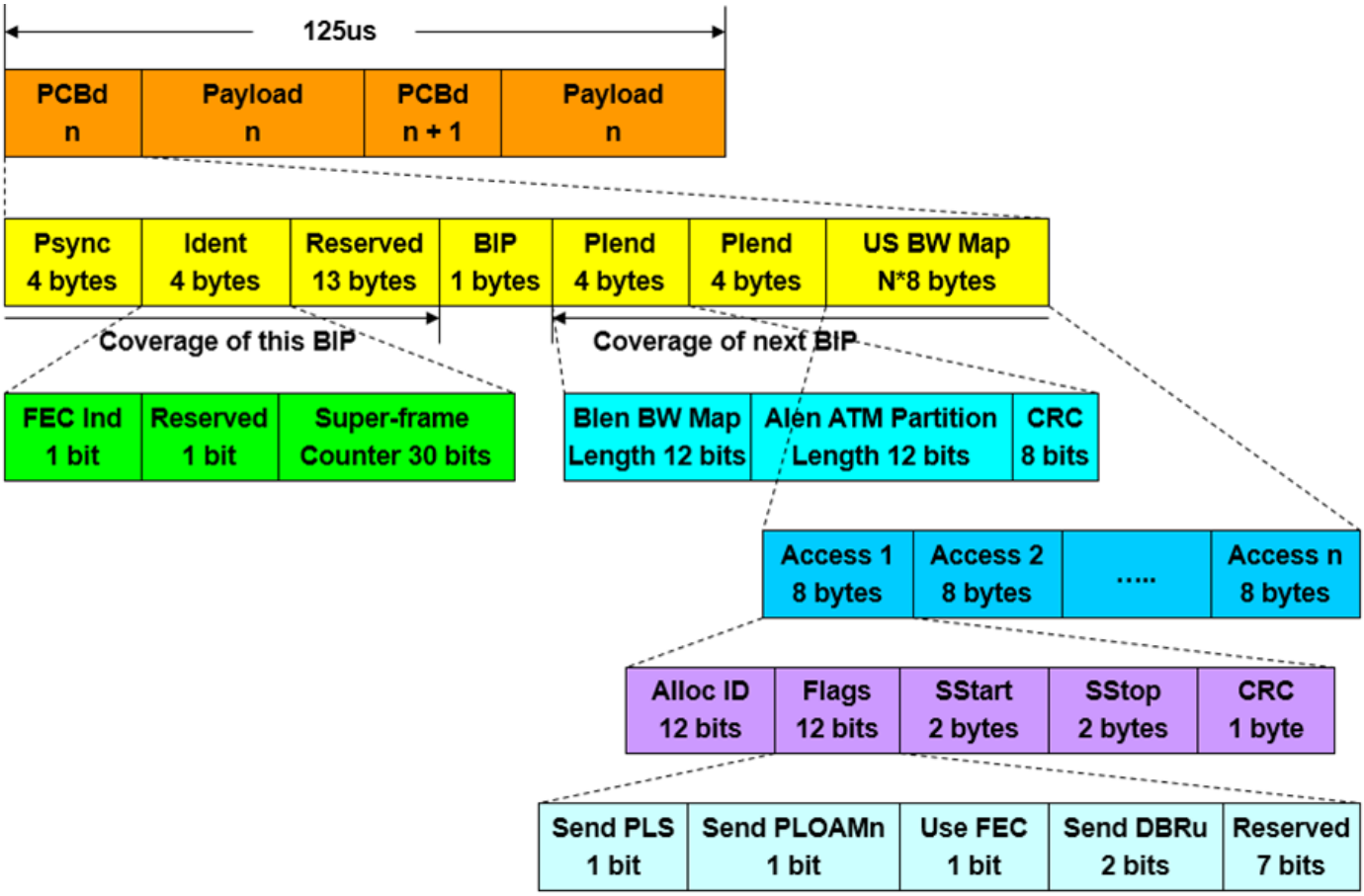


Figure 49: GPON downstream frame structure

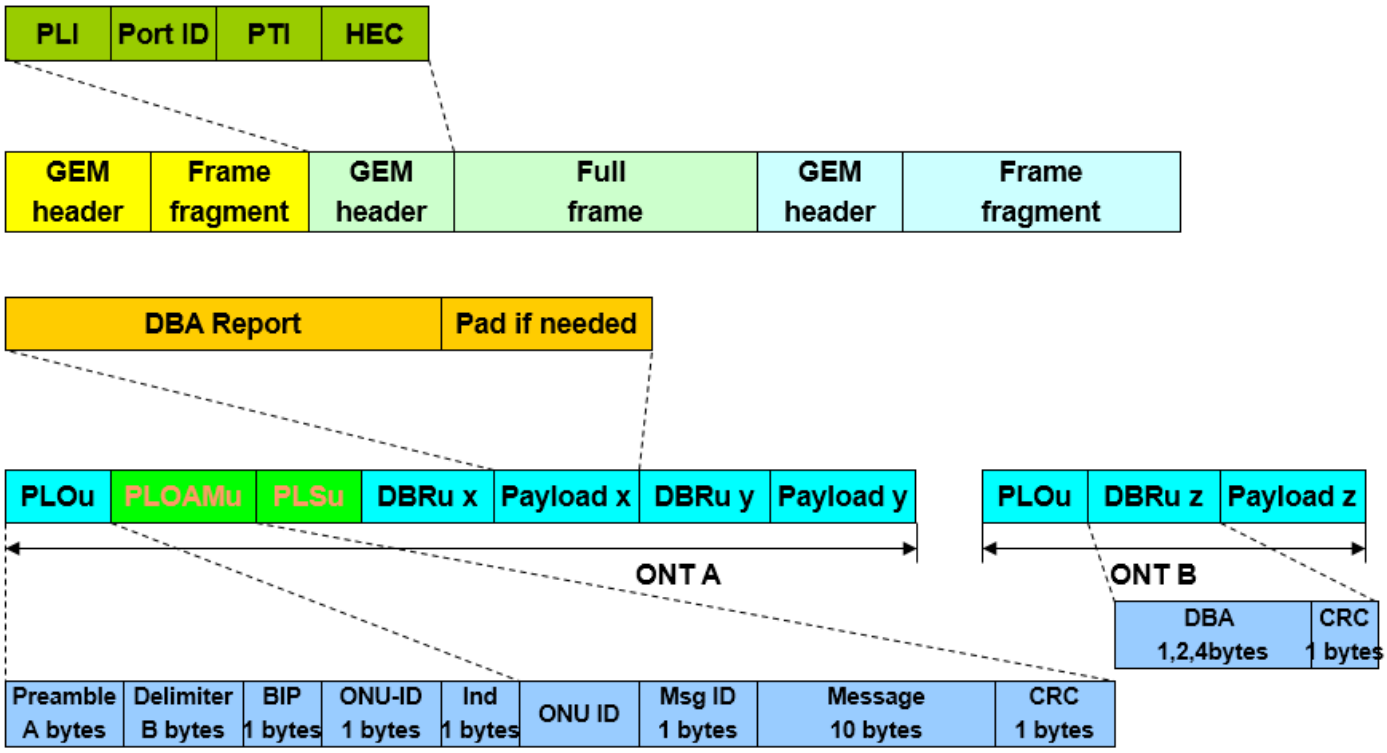


Figure 50: GPON upstream frame structure

9.1.5 Corr FEC

FEC is usually disabled for 20km SFP networks but enabled for Class C+ 60km SFP networks. When FEC is enabled, the unit reports each correctable FEC error detected in the downstream frame.

Possible Downstream Corr FEC Causes:

- The quality of the optical path is deteriorated.
- The port of the OLT is faulty.

Troubleshooting Corr FEC Errors:

1. Confirm that the optical fiber is connected properly by gently pulling on cable. Then, check if the alarm is cleared.
2. Inspect the optical connectors for contamination or damage by using a FiberScope. Clean connector if dirty and if scratches/dents/pits detected, replace connector. Then, check if the alarm is cleared.
3. Check if optical fiber coming into the ONU is worn, bent or broken. Replace the optical fiber if needed. Then, check if the alarm is cleared.
4. On the GPON system, run the ***display port state*** command to check whether the ports are normal. If not, reset or replace the PON board. Then, check whether the clear alarm is generated.

9.1.6 Uncor FEC

When FEC is enabled, the unit reports each uncorrectable FEC error detected in the downstream frame.

9.1.7 Corr HEC

Correctable Header Error Checksum are encoded polynomial multiplication sent with transmission and decoded on the other end with polynomial division. The value corresponds to the number of correctable transmission errors.

9.1.8 Uncor HEC

Uncorrectable Header Error Checksum. The value corresponds to the number of corrupted frame errors that were dropped by the receiver and resent by the OLT.

9.2 Upstream Alarms/Errors

9.2.1 LOS

LOS means 1310nm Loss of Signal is detected. In an active GPON network, the 1310nm US signal is bursty in transmission.

LOS Troubleshooting

1. Verify the patchcord from ONU/ONT is connected to the MTTplus-420 ONT test port.
2. Check the patch cord.
   - If the optical fiber is not connected properly, clean/inspect/reconnect the optical fiber again and make sure the fiber is connected correctly and securely. You should not be able to pull the connector out of the coupler with a gentle pull on the cable itself.
   - Make sure the mated connector types match. Do not mate a blue color connector with a green connector.
   - If the optical fiber is aged, bent, or damaged, replace the optical fiber.
   - If the connector of the optical fiber is not clean, clean the optical fiber.
   - If the connector of the optical fiber is scratched or pitted, replace the connector.

9.2.2 LOF

LOF means 1310nm US Loss of Frame occurred.

9.2.3 LCDG

LCDG means Loss of Channel Delineation for GEM detected previously but not anymore. The System generates this alarm when delimitation of the GEM frame header is incorrect. The OLT detects HEC check errors of the GEM header in consecutive frames.

LCDG IMPACT: Loss of frame (LOF) in the system and the ONT goes offline.

Possible LCDG Causes: Optical fiber is faulty or ONT is faulty.

9.2.4 BIP

Each GPON Transmission Convergence (GTC) upstream frame must contain physical layer overhead data (PLOu) which includes the physical layer overhead and three fields of data: Preamble and delimiter, BIP, ONU ID and real time ONU status report to OLT.
Looking at the Upstream Frame Structures above (see **Figure 51: GPON upstream frame structure**), BIP - SONET/SDH-style Bit Interleaved Parity of all bytes since last BIP (1 Byte) is visible.

BIP Impact: BIP provides an approximate method for monitoring link quality at the bit error level.

9.2.5 RDI

Each ONU upstream frame includes Remote defect status indication (RDI) (1 = Defect, 0 = OK).

9.2.6 REI

Remote error indication.

9.2.7 Corr FEC

FEC is usually disabled for 20km SFP networks but enabled for Class C+ 60km SFP networks. When FEC is enabled, the unit reports each correctable FEC error detected in the upstream burst.

Possible Corr FEC Causes:

The quality of the optical path is deteriorated.

The port of the ONT/ONU is faulty.

Troubleshooting Corr FEC Error:

1. Confirm that the optical fiber is connected properly by gently pulling on cable. Then, check if the alarm is cleared
2. Inspect the optical connectors for contamination or damage by using a FiberScope. Clean connector if dirty and if scratches/dents/pits detected, replace connector. Then, check if the alarm is cleared.
3. Check if optical fiber is work, bent or broken. Replace the optical fiber if needed. Then, check if the alarm is cleared.
4. Run the ***display port state*** command to check whether the ports are normal. If not, reset or replace the ONT/ONU, then check whether the clear alarm is generated.

9.2.8 Uncor FEC

Uncorrectable Forward Error Correction. When FEC is enabled, the unit reports each uncorrectable FEC error detected in the upstream burst.

10.0 GPON Rogue ONU Detection

A GPON network comprises of an optical line terminal (OLT) that may typically interact with 32 optical network units (ONU) with a maximum of 128 ONUs. The OLT manages upstream communication by assigning a time slot for each active ONU in order to prevent transmission collision between active ONUs. In addition to unique ONU timeslots for transmission, each GEM frame also contains a blank BWmap interval which can be used during the ONU activation process to allow the ONU S/N to be broadcast without issue.

The two most common failure modes in any PON network are:

1. Optical Power related issues which are easily identified, or
2. Time-related malfunctions or issues which are harder to detect and isolate.

GPON network data is transmitted using a scrambler without any redundancy. CRC only exists in the last frame field of any packet, and packets can be spread over several grants (US transmission from a ONU). The ITU-T G.984 GPON standard does not provide any specific method to detect a rogue ONU in the network. A rogue ONU is an ONU that goes out of control and works in the continuous or irregular mode. Time related issues can include the following:

1. ONU failed to stop transmission at its expected BWmap stop time.
2. ONU begins transmission pre-maturely.

The MTTplus-420 module does not currently provide an automated ROGUE detection mode. However, in its current form, we can make use of available data already provided to help with isolating the culprit. The following techniques can be used to help identify which ONU may be the culprit.

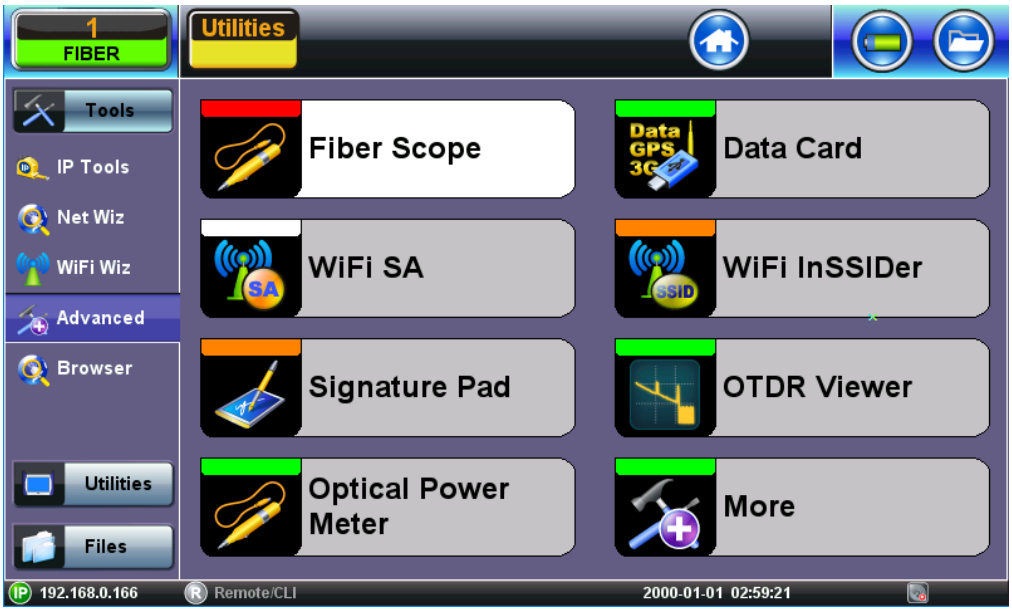
Trouble-shooting Methods

- **Method 1**: View the list of active ONUs (**Advanced** > **Active ONU**) provided by the OLT and see if all active units are listed. The rogue ONU may be missing from the OLT provided list of active ONUs. Before replacing any ONU, connect the MTTplus-420 to the suspect ONU and monitor the US PLOAM messages to confirm when the ONU is actually transmitting data. It is possible for the Rogue ONU to interfere with a good ONU transmission, making the OLT think it is rogue.

- **Method 2**: Another technique is to remove the suspected ONU and check if system errors continue after deactivation.

- **Method 3**: Connect the MTTplus-420 at the FDP on the ONT side and check each optical line one by one. The rogue ONU will often be transmitting in continuous mode not burst mode as expected. Monitor Upstream PLOAM message activity for abnormal/excessive transmissions as the ONU should only transmit when authorized by the OLT. By viewing Downstream PLOAM, we can also determine OLT grant start for the ONU.

11.0 Common Functions



Refer to the **MTTplus Platform manual** for information on the following functions common to all MTTplus-series units:

- Tools:
  - IP Tools
  - Net Wiz
  - WiFi Wiz
  - Advanced
  - Browser

- Utilities
  - Settings
  - Help
  - Backlight
  - VeEXpress
  - R-Server

- Files:
  - Saved
  - USB
  - Manage

12.0 Warranty and Software

Warranty Period: The warranty period for hardware, software and firmware is one (1) year from the date of shipment to the customer. The warranty period for battery pack, LCD, LCD touch panel, LCD protective cover, and accessories (including, but not limited to patch cords, AC adaptor, SFP, USB adaptors, carrying case, carrying pouch) is limited to one (1) year.

Hardware Coverage: VeEX Inc. warrants hardware products against defects in materials and workmanship. During the warranty period, VeEX Inc. will, at its sole discretion, either

- Repair the products
- Replace hardware which prove to be defective

provided that the products that the customer elects to replace are returned to VeEX Inc. by the customer, along with Proof of Purchase, within thirty (30) days of the request by the customer, freight prepaid.

Software Coverage: VeEX Inc. warrants software and firmware materials against defects in materials and workmanship. During the warranty period, VeEX Inc. will, at its sole discretion, either

- Repair the products
- Replace software and/or firmware which prove to be defective

provided that the products that the customer elects to replace are returned to VeEX Inc. by the customer, along with proof of purchase, within thirty (30) days of the request by the customer, freight prepaid.

Additionally, during the warranty period, VeEX Inc. will provide, without charge to the customer, all fixes, patches and enhancements to the purchased software, firmware and software options. VeEX Inc. does not warrant that all software or firmware defects will be corrected. New enhancements attached to a software option require the option to be purchased (at the time of order or the time of upgrade) in order to benefit from such enhancements.

Limitations: The warranty is only for the benefit of the customer and not for the benefit of any subsequent purchaser or licensee of any merchandise (hardware, software, firmware and/or accessories).

Revoking the warranty: VeEX Inc. does not guarantee or warrant that the operation of the hardware, software or firmware will be uninterrupted or error-free. The warranty will not apply in any of the following cases:

- Improper or inadequate maintenance by the customer
- Damage due to software installed by the customer on the unit without prior authorization (written) from VeEX Inc.
- Unauthorized alteration or misuse
- Damage occurred from operating the unit outside of the environmental specifications for the product

- Improper installation by the customer

13.0 Product Specifications

The most recent product specifications can be found on the VeEX web site at www.veexinc.com.

14.0 Certifications and Declarations

Declaration of Conformity

What is CE?

The CE marking is a mandatory European marking for certain product groups to indicate conformity with the essential health and safety requirements set out in European Directives. To permit the use of a CE mark on a product, proof that the item meets the relevant requirements must be documented.

Use of this logo implies that the the unit conforms to requirements of European Union and European Free Trade Association (EFTA). EN61010-1

For a copy of the CE Declaration of Conformity relating to VeEX products, please contact VeEX customer service.

ROHS Statement

What is RoHS?

RoHS is the acronym for Restriction of Hazardous Substances. Also known as Directive 2002/95/EC, it originated in the European Union and restricts the use of specific hazardous materials found in electrical and electronic products. All applicable products imported into the EU market after July 1, 2006 must pass RoHS compliance.

For more information about RoHS as it relates to VeEX Inc, go to the VeEX web site at www.veexinc.com.

15.0 About VeEX

VeEX Inc., the Verification EXperts, is an innovative designer and manufacturer of test and measurement solutions addressing numerous technologies. Global presence through a worldwide distribution channel provides uncompromised product support.
Visit us online at www.veexinc.com for the latest updates and additional documentation.

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Appendix A GPON Definitions

Activation: A set of distributed procedures executed by the OLT and the ONUs that allows an inactive ONU to join or resume operations on the PON. The activation process includes three phases: parameter learning, serial number acquisition, and ranging.

Bandwidth allocation: An upstream transmission opportunity granted by the OLT for the duration of the specified time interval to the specified traffic-bearing entity within an ONU.

C/M-plane: A plane of the G-PON protocol suite that handles control and management information in a G-PON system. Data on OMCI is transferred through this plane.

Dynamic bandwidth assignment (**DBA)**: A process by which the optical line terminal (OLT) distributes the upstream PON capacity between the traffic-bearing entities within optical network units (ONUs), based on the dynamic indication of their activity status and their configured traffic contracts.

Embedded OAM: An operation and management channel between the OLT and the ONUs that utilize the structured overhead fields of the downstream GTC frame and upstream GTC burst, and supports the time sensitive functions, including bandwidth allocation, key synchronization, and DBA reporting.

Equalization delay (EqD): The requisite delay assigned by the OLT to an individual ONU as a result of ranging.

G-PON encapsulation method (GEM): A data frame transport scheme used in G-PON systems that is connection-oriented and that supports fragmentation of the user data frames into variable-sized transmission fragments.

G-PON transmission convergence (GTC) layer: A protocol layer of the G-PON protocol suite that is positioned between the physical media dependent (PMD) layer and the G-PON clients. The GTC layer is composed of GTC framing sublayer and GTC adaptation sublayer.

GEM port: An abstraction on the GTC adaptation sublayer representing a logical connection associated with a specific client packet flow.

Gigabit-capable passive optical network (G-PON): A variant of the passive optical network (PON) access technology supporting transmission rates in excess of 1 Gbit/s and based on the G.984-series of ITU-T Recommendations.

GTC adaptation sublayer: A sublayer of the G-PON transmission convergence layer that supports the functions of user data fragmentation and de-fragmentation, GEM encapsulation, GEM frame delineation and GEM Port-ID filtering.

GTC framing sublayer: A sublayer of the G-PON transmission convergence layer that supports the functions of GTC frame/burst encapsulation and delineation, embedded OAM processing and Alloc-ID filtering.

Optical access network (OAN): A set of access links sharing the same network-side interfaces and supported by optical access transmission systems. The OAN may include a number of ODNs connected to the same OLT.

Optical distribution network (ODN): In the PON context, a tree of optical fibers in the access network, supplemented with power or wavelength splitters, filters or other passive optical devices.

Optical line termination (OLT): A device that terminates the common (root) endpoint of an ODN, implements a PON protocol, such as that defined by [ITU-T G.984.1] and adapts PON PDUs for uplink communications over the provider service interface. The OLT provides management and maintenance functions for the subtended ODN and ONUs.

Optical network termination (ONT): A single-subscriber device that terminates any one of the distributed (leaf) endpoints of an ODN, implements a PON protocol and adapts PON PDUs to subscriber service interfaces. An ONT is a special case of an ONU.

Optical network unit (ONU): A generic term denoting a device that terminates any one of the distributed (leaf) endpoints of an ODN, implements a PON protocol and adapts PON PDUs to subscriber service interfaces. In some contexts, an ONU implies a multiple subscriber device.

Physical layer OAM (PLOAM): A message-based operation and management channel between the OLT and the ONUs that supports the PON TC-layer management functions, including ONU activation, OMCC establishment, encryption configuration, key management and alarm signaling.

Pre-assigned delay (PrD): The requisite delay that all the ONUs on the PON are required to use prior to completion of the ranging phase of the activation process.

Quiet window: A time interval during which the OLT suppresses all the bandwidth allocations to the in-service ONUs in order to avoid collisions between their upstream transmissions and the transmission bursts from the ONUs that have just joined the PON and are undergoing the activation process.

Ranging: A procedure of measuring the logical distance between the OLT and each of its subtending ONUs with the objective to accurately time the individual ONU upstream transmission bursts so that these bursts arrive at the OLT in a collision-free sequential fashion and the upstream overhead, which is required to ensure burst detection and delineation, is minimal. Ranging is performed during the ONU activation and may be performed while the ONU is in service.

Requisite delay: A general term denoting the total extra delay the OLT may require an ONU to apply to the upstream transmission beyond the ONU's regular response time. The purpose of the requisite delay is to compensate for variation of propagation and processing delays of individual ONUs, and to avoid or reduce the probability of collisions between upstream transmissions.

Status reporting DBA (SR-DBA): A method of dynamic bandwidth assignment that infers the dynamic activity status of the traffic-bearing entities within optical network units (ONUs) based on the explicit buffer occupancy reports communicated over the embedded OAM channel.

Traffic-monitoring DBA (TM-DBA): A method of dynamic bandwidth assignment that infers the dynamic activity status of the traffic-bearing entities within optical network units (ONUs) based on the observation of the idle GEM frame transmissions in place of granted upstream bandwidth allocations.

Transmission container (**T-CONT)**: A traffic-bearing object within an ONU that represents a group of logical connections, is managed via the ONU management and control channel (OMCC), and is treated as a single entity for the purpose of upstream bandwidth assignment on the PON.

U-plane: A plane of the G-PON protocol suite that handles user data in a G-PON system. U-Plane provides communication between GEM clients.

Appendix B GPON Abbreviations and Acronyms

AES - Advanced Encryption Standard
Alloc-ID -Allocation Identifier
ANI - Access Node Interface
APS - Automatic Protection Switching
BCH - Bose-Chaudhuri-Hocquengham
BER - Bit Error Ratio
BIP - Bit Interleaved Parity
B-ISDN - Broadband Integrated Services Digital Network
Blen - BWmap Length
B-PON - Broadband Passive Optical Network
BW - Bandwidth
BWmap - Bandwidth Map
CBS - Committed Burst Size
CES - Circuit Emulation Service
CID - Consecutive Identical Digit
CIR - Committed Information Rate
CPL - Change Power Level
CRC - Cyclic Redundancy Check
DACT - Deactivate (ONU-ID)
DBA - Dynamic Bandwidth Assignment
DBRu - Dynamic Bandwidth Report upstream
DEMUX - Demultiplexer
DF - Deactivate Failure
DG - Dying Gasp
DIS - Disable (ONU serial number)
DOW - Drift of Window
DS - Downstream
DSL - Digital Subscriber Line
E/O - Electrical/Optical
EBS - Excess Burst Size
EIR - Excess Information Rate
EMS - Element Management System
EqD - Equalization Delay
FEC - Forward Error Correction
FTTB - Fiber to the Building
FTTC - Fiber to the Curb
FTTH - Fiber to the Home
GEM - Gigabit-capable passive optical network Encapsulation Method
G-PON - Gigabit-capable Passive Optical Network
GTC - Gigabit-capable passive optical network Transmission Convergence
HEC - Header Error Control
IP - Internet Protocol
ISDN - Integrated Services Digital Network
LAN - Local Area Network
LCDG - Loss of Channel Delineation for GEM
LCF - Laser Control Field
LIM - Line Interface Module
LOA - Loss of Acknowledgement
LOAM - Loss of Operations, Administrations and Maintenance

LOF - Loss of Frame
LOK - Loss of Key
LOS - Loss of Signal
LSB - Least Significant Bit
MAC - Media Access Control
ME - Managed Entity
MEM - Message Error Message
MIB - Management Information Base
MIS - (link) Mismatch
MSB - Most Significant Bit
MUX - Multiplexer
NMS - Network Management System
NRZ - Non Return to Zero
NSR - Non-Status-Reporting
O/E - Optical/Electrical
OAM - Operations, Administration and Maintenance
OAN - Optical Access Network
ODF - Optical Distribution Frame
ODN - Optical Distribution Network
OLT - Optical Line Termination
OMCC - Optical Network Unit Management and Control Channel
OMCI - Optical Network Unit Management and Control Interface
ONT - Optical Network Termination
ONU - Optical Network Unit
ONU-ID - Optical Network Unit Identifier
OpS - Operations System
PCBd - Physical Control Block downstream
PDH - Plesiochronous Digital Hierarchy
PDU - Protocol Data Unit
PEE - Physical Equipment Error
PHY - Physical Interface
PIR - Peak Information Rate
PLend - Payload Length downstream
PLI - Payload Length Indicator
PLOAM - Physical Layer OAM Operations, Administrations and Maintenance
PLOAMd - Physical Layer OAM Operations, Administrations and Maintenance downstream
PLOAMu - Physical Layer OAM Operations, Administrations and Maintenance upstream
PLOu - Physical Layer Overhead upstream
PLSu - Power Levelling Sequence upstream
PMD - Physical Media Dependent
PON - Passive Optical Network
Port-ID - Port Identifier
POTS - Plain Old Telephone Service
PrD - Pre-assigned Delay
PST - Passive optical network Section Trace
PSTN - Public Switched Telephone Network
PSync - Physical Synchronization
PTI - Payload Type Indicator
QoS - Quality of Service
RDI - Remote Defect Indication
REI - Remote Error Indication

RMS - Root-Mean-Square
RS - Reed Solomon
RTD - Round-Trip Delay
SD - Signal Degrade
SDH - Synchronous Digital Hierarchy
SDU - Service Data Unit
SF - Signal Fail
SIR - Sustained Information Rate
SN - Serial Number
SNI - Service Node Interface
SR - Status Reporting
SUF - Start Up Failure
TC - Transmission Convergence
T-CONT - Transmission Container
TDMA - Time Division Multiple Access
TE - Terminal Equipment
TF - Transmitter Failure
TM - Traffic Monitoring
UNI - User-Network Interface
US - Upstream
WDM - Wavelength Division Multiplexing

Appendix C PLOAM Messages In G.984 G-PON

C.1 Activation Process Overview

The OLT controls the activation process that allows an inactive ONU to join or resume operations on the PON by exchanging PLOAM messages with the ONT/ONU. It sends instructions downstream and receives data upstream from the ONT/ONU. The activation process is as follows:

- An ONU entering the activation process listens to the downstream transmission and receives PSync and superframe synchronization.
- The ONU waits for the Upstream_Overhead PLOAM message, optionally followed by Extended_Burst_Length PLOAM messages periodically sent by the OLT.
- The ONU receives PON operating parameters through the Upstream_Overhead and Extended_Burst_Length messages.
- The ONU announces its existence on the PON by sending a Serial_Number_ONU message. This is in response to a broadcast serial number request periodically sent by the OLT.
- If the ONT is accepted, the OLT will assign an ONU ID with an Assign_ONU-ID message.
- The OLT will determine the ranging time (depends on span length), configure (Configure_port-ID) and encrypt the Port ID (Encrypted_port-ID) and BER interval.
- Once the ONU is activated, the OLT assigns the ONU Allocation ID (AllocID) and may start sending bandwidth grants to the ONU Allocation ID.
- The ONU adjusts its transmission optical power level using the absence of directed messages from the OLT as a negative acknowledgment.
- The OLT discovers the serial number of a newly connected ONU and sends an Assign_ONU-ID message to assign an ONU-ID to it.
- The OLT issues a serial number request to a newly discovered ONU and times the ONU's response.
- The OLT computes the individual equalization delay and assigns it to the ONU using the Ranging_Time message.
- The ONU adjusts the start of its upstream GTC frame clock based on the equalization delay.
- The ONU completes activation and starts normal operation.

During normal operation, the OLT monitors the phase and BER of upstream ONU transmissions. The OLT may recalculate and dynamically adjust an ONU's equalization delay based on the monitored phase information. Depending on monitored BER information, the OLT might instruct an ONU to change its optical power level.

C.2 PLOAM Messages

According to ITU-T G.984, many PLOAM messages are sent three times for extra assurance in the activation process. Some messages require acknowledgement of receipt (ACK) or another type of response from the ONU/ONT and others are one-way messages.

Direction	Message name	Unicast	Broadcast	ACK	3x
Down	Upstream_overhead		●		●
Down	Extended_burst_length		●		●
Up	Serial_number_ONU				
Down	Assign_ONU-ID		●		●
Down	Ranging_time	●			●
Down	Request_password	●			
Up	Password				●
Down	Assign_alloc-ID	●		●	●
Up	Acknowledge				
Down	Configure_port-ID	●		●	●
Down	Encrypted_port-ID	●		●	●
Down	BER Interval	●	●	●	●
Up	REI (Remote Error Indication)				
Down	Request_key	●			
Up	Encryption_key				●
Down	Key_switching_time	●	●	●	●
Up/Down	No_message		●		
Down	Popup	●	●		●
Down	Deactivate_ONU-ID	●	●		●
Down	Disable_serial_number		●		●
Up	Dying_gasp				●
Up/Down	Physical_equipment_error (PEE)		●		
Up/Down	PST (Protection Switch)	●	●		
Up/Down	Change_power_level	●	●		

Down	PON-ID (optional)		●		
Down	Swift_POPUP (optional)		●		
Down	Ranging_adjustment (optional)	●	●		

Table: PLOAM messages listed in the table are presented in the general order they occur in the activation process. Click on message name for more information.

C.2.1 Upstream_overhead Message: Downstream

An upstream overhead message is sent at the beginning of the G-PON activation process. The ONU will not transmit unless it receives an upstream overhead message.

C.2.2 Extended_burst_length Message: Downstream

The ONU specifies the number of type 3 preamble bytes to use in the upstream direction during and after ONU discovery.

C.2.3 Serial_number_ONU Message: Upstream

While in Serial_Number state, the ONU transmits an unassigned message, in response to a serial number request. The ONU also responds in the ranging state, but with an ONU-ID assigned to it.

When the OLT periodically sends a broadcast serial number request on the PON, the ONU announces its presence by sending the OLT a Serial_number_ONU message. An ONU also sends this message in the ranging state in response to an OLT ranging request.

C.2.4 Assign_ONU-ID Message: Downstream

The OLT assigns an ONU-ID with the Assign_ONU-ID message after discovering the serial number of a newly joined ONU. Receiving an ONU-ID moves the ONU from serial_number state to ranging state. An ONU-ID cannot be changed after the ONU leaves serial_number state unless it is deactivated.

C.2.5 Ranging_time Message: Downstream

The OLT calculates and sets the equalization delay of the ONU, sending the equalization delay to the ONU using the Ranging_time Message. This message is sent during initial activation and during normal operation as needed to correct for drift.

C.2.6 Request_password Message (Downstream) and Password Message (Upstream)

The OLT sends a Request_password message to an ONU to verify its identity. The ONU responds with its password message, which the OLT compares with a table of passwords for all connected ONUs.

C.2.7 Assign_alloc-ID Message: Downstream

The Assign_alloc-ID message instructs an ONU that a specified allocation ID is assigned to it.

C.2.8 Acknowledge Message: Upstream

An ONU sends an Acknowledge (ACK) message to the OLT to indicate that it successfully received a downstream message from it. An ONU that doesn't send back an ACK message can be experiencing problems or might be too busy to immediately respond to the request.

C.2.9 Configure_port-ID Message: Downstream

This message assigns a GEM port-ID to the ONU's OMCC.

C.2.10 Encrypted_port-ID Message: Downstream

This message can be issue at any time. It indicates to ONUs which channels are encrypted or not.

C.2.11 BER Interval Message: Downstream

This message defines the time interval for the ONU(s) to accumulate downstream bit errors. After receiving the message, the ONU starts a timer and accumulates downstream errors until the interval time is met.

C.2.12 REI (Remote Error Indication) Message: Upstream

The ONU sends an upstream REI message with the number of recorded bit errors after each BER interval.

C.2.13 Request_key Message (Downstream) and Encryption_key Message (Upstream)

The OLT requests the ONU to generate a new encryption key and send it in an encryption_key message. This encryption_key message is sent three times.

C.2.14 Key_switching_time Message: Downstream

After requesting a new key from one or all ONUs, the OLT sends the key_switching_time message. This instructs the ONU when to switch keys. The OLT sends three key requests. For each key switching message received, the ONU responds with an acknowledge message.

C.2.15 No_message Message: Both Directions

As defined in the G-PON frame structure, the OLT sends a PLOAM message downstream unconditionally in every frame. If the message queue is empty, the OLT sends a No_message message.
The same is true in the upstream direction. An ONU will send a No_Message message if its message queue is empty and the OLT grants a PLOAM slot to it.

C.2.16 Popup Messages

Downstream, Unicast

A loss of downstream signal or loss of synchronization will cause a G.984 G-PON ONU to enter popup state.

If it recovers the downstream signal before a timer expires (recommended value 100 ms), and if the OLT is quick enough to recognize the loss and respond to it, the popup message may bring the ONU back into operation state without taking it through the reranging process.

Downstream, Broadcast

The broadcast form of this message causes all ONUs in popup state to move into ranging state. ONUs not in popup state ignore the message.

C.2.17 Deactivate_ONU-ID Message: Downstream

ONUs that receive this message stop transmitting upstream and move to standby state. In standby state, the ONU responds to serial number grants, is recognized by the OLT, and is reactivated into the PON.

C.2.18 Disable_serial_number Message: Downstream

An OLT will send this message with the disable option to attempt to deactivate a potential rogue ONU. The disable option moves the ONU to the Emergency Stop state and turns off its laser. In emergency state, the ONU is banned from sending data upstream. Once the deactivated ONU's malfunction is fixed, the OLT may reactivate the ONU, sending a Disable_Serial_Number message with the enable option. This moves the ONU to Standby state.

C.2.19 Dying_gasp Message: Upstream

Dying_gasp informs the OLT that the ONU will be turning off in normal operation and that it is not from any defect in the optical distribution network. This prevents the OLT from issuing unnecessary alarm reports.

C.2.20 Physical_equipment_error (PEE) Message: Both Directions

An OLT will send this PLOAM message once per second when it is unable to transmit GEM frames or OMCI messages.

C.2.21 PST (Protection Switch) Message: Both Directions

If protection switching is available, the OLT can switch all ONUs to the protection fibres. In this event, the OLT sends a broadcast POPUP message to the ONUs instructing them to move to the Ranging state.

If there is no protection switching, or if the ONU has internal protection capabilities, the OLT can send a directed POPUP message to the ONU to move it to the Operation state. While in Operation state, the OLT can test the ONU before returning it to full service.

If the ONU does not recover from the LOS or LOF alarms, it will not receive the broadcast or directed POPUP message and will move to the Initial state following time-out.

C.2.22 Change_power_level Message: Downstream - Unicast or Broadcast

ONUs transmit at their full rated power at all times and this function is rarely if ever used.

C.2.23 PON-ID: Downstream (optional)

Identifies an OLT PON interface and indicates launch power in the message. This enables operators to compare locally measured optical power with the source launch power in the message to distinguish between fiber plant loss from launch power variations.

C.2.24 Swift_POPUP: Downstream (optional)

The OLT forces all ONUs in the POPUP state that have cleared LOS/LOF alarms to enter Operation state.

C.2.25 Ranging_adjustment: Downstream (optional)

Incrementally adjusts the equalization delay to individual ONUs or all active ONUs simultaneously.