

Proudly Presents March 16, 2022
Inside Plant Technical Training

The Connected Home - Ingress Test Equipment Training

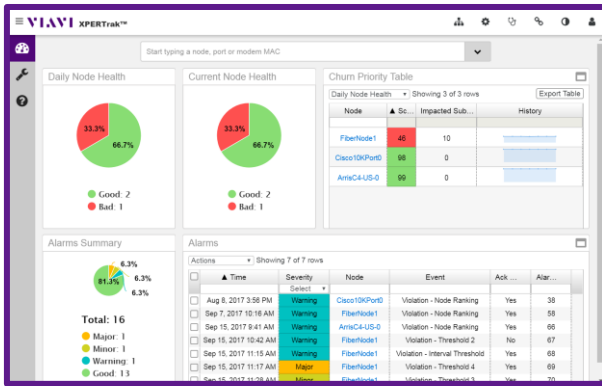
Presenter: Tim Miller
Viavi Solutions, Inc., Solutions Engineer

ENVISIONING THE FUTURE OF CONNECTIVITY, TODAY.

SCTE
a subsidiary of CableLabs®

Tools for Resolving Issues

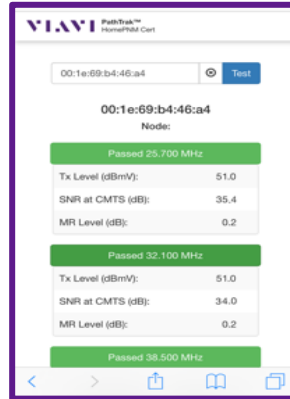
QoE Dashboards



Spectrum



Home Check



Signal Level Meter



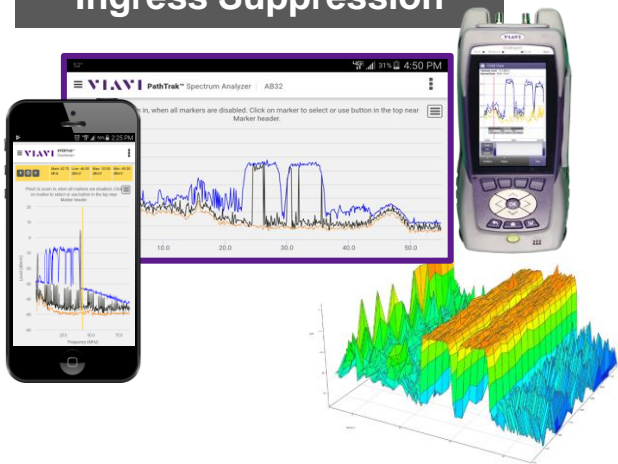
Downstream Localization



Upstream Localization



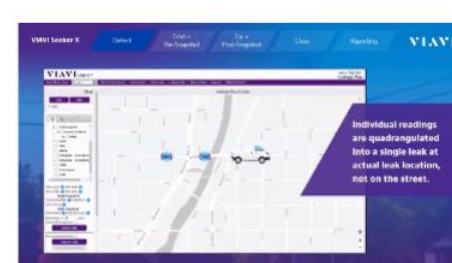
Ingress Suppression



DOCSIS



Leakage



What Noise Does to Our Work

- **Objectives:**
 - What is Noise?
 - What kind of noise is a in CATV Network?
 - What's in those QAM, OFDM, and OFDMA Signals
 - Why Noise Matters is a CATV network
 - Forward Path Noise
 - Return Path Noise
 - How to minimize the noise? Tools for the Job.
 - Live Cable Pressure Test

What is Noise? And why it matters?

Irregular fluctuations that accompany a transmitted electrical signal but are not part of it and tend to obscure it.

- Analogy
- I am talking across the room to another person, and he hears me just fine until a firetruck passes by the window. He says, “I did not hear everything you said when the truck went by”.
- Loss Of Information

Loudness Graph

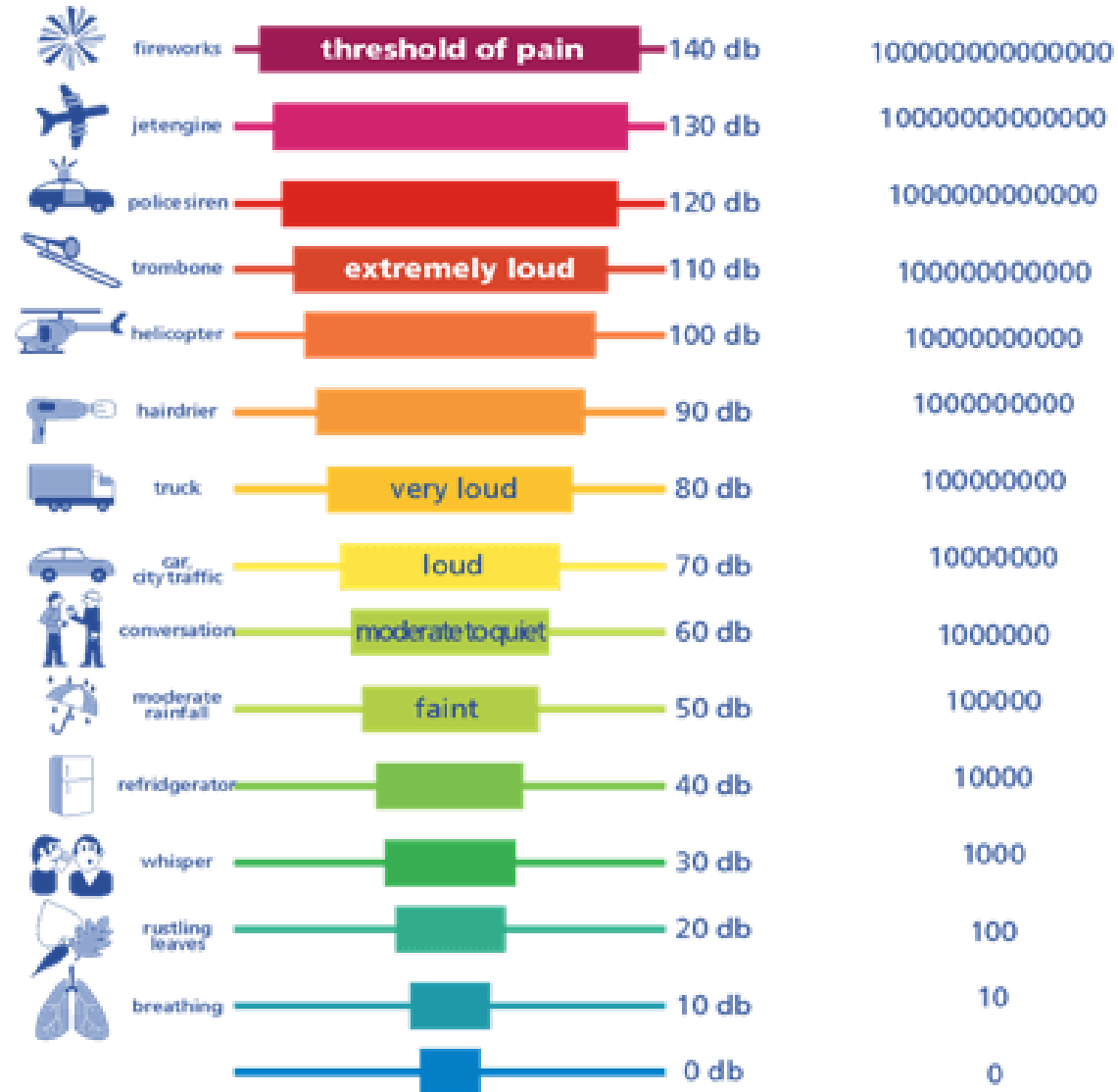
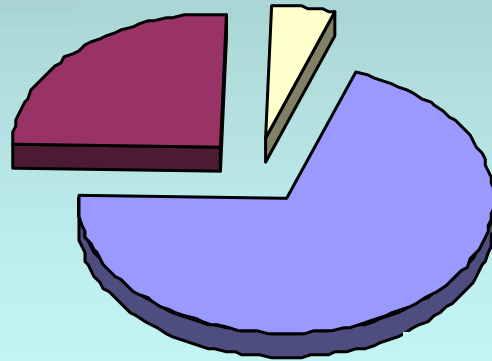


Image
<https://www.commodious.co.uk/knowledge-bank/noise/measuring-levels>

Where is the noise in CATV Network?

Where does ingress come from?

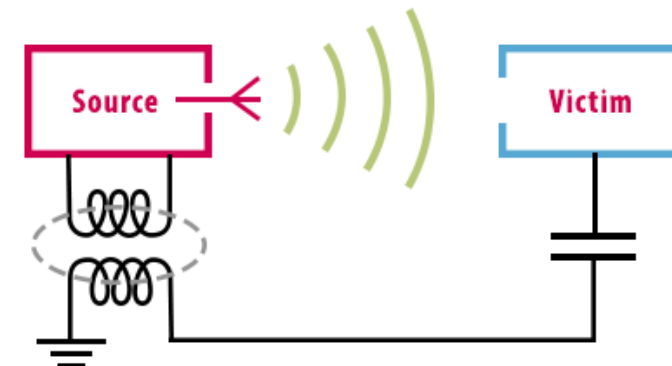
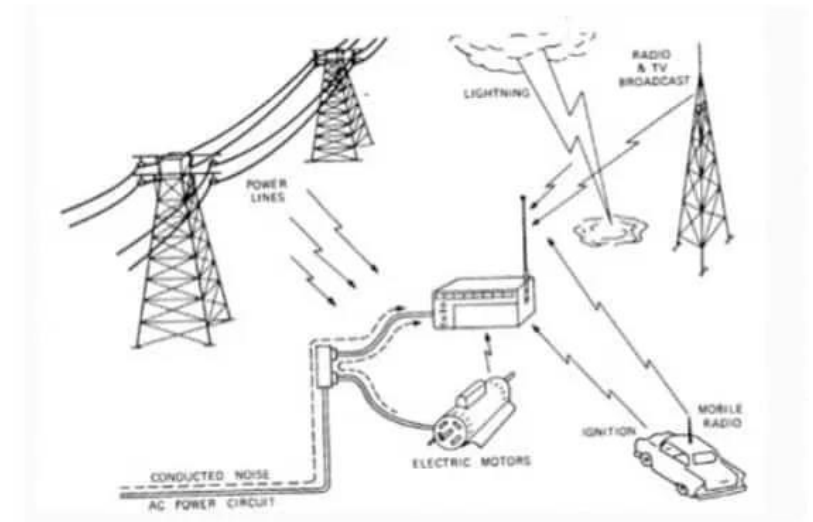


What is noise in a CATV System

- **Electromagnetic interference (EMI)**, also called **radio-frequency interference (RFI)** *“the effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radiocommunication system, manifested by any performance degradation, misinterpretation or loss of information which could be extracted in the absence of such unwanted energy”*.
No. **1.166** of the ITU Radio Regulation

- The interference is created by some electrical source and is detected by radio receiver
 - ✓ Radiation – electromagnetic field
 - ✓ Inductive – magnetic field
 - ✓ Capacitance – electric field
 - ✓ Conductance – conductive

Electromagnetic interference (EMI)

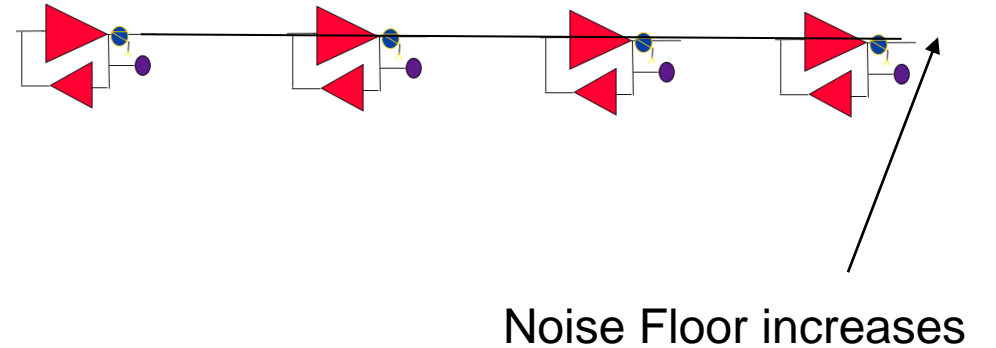


Types of Noise

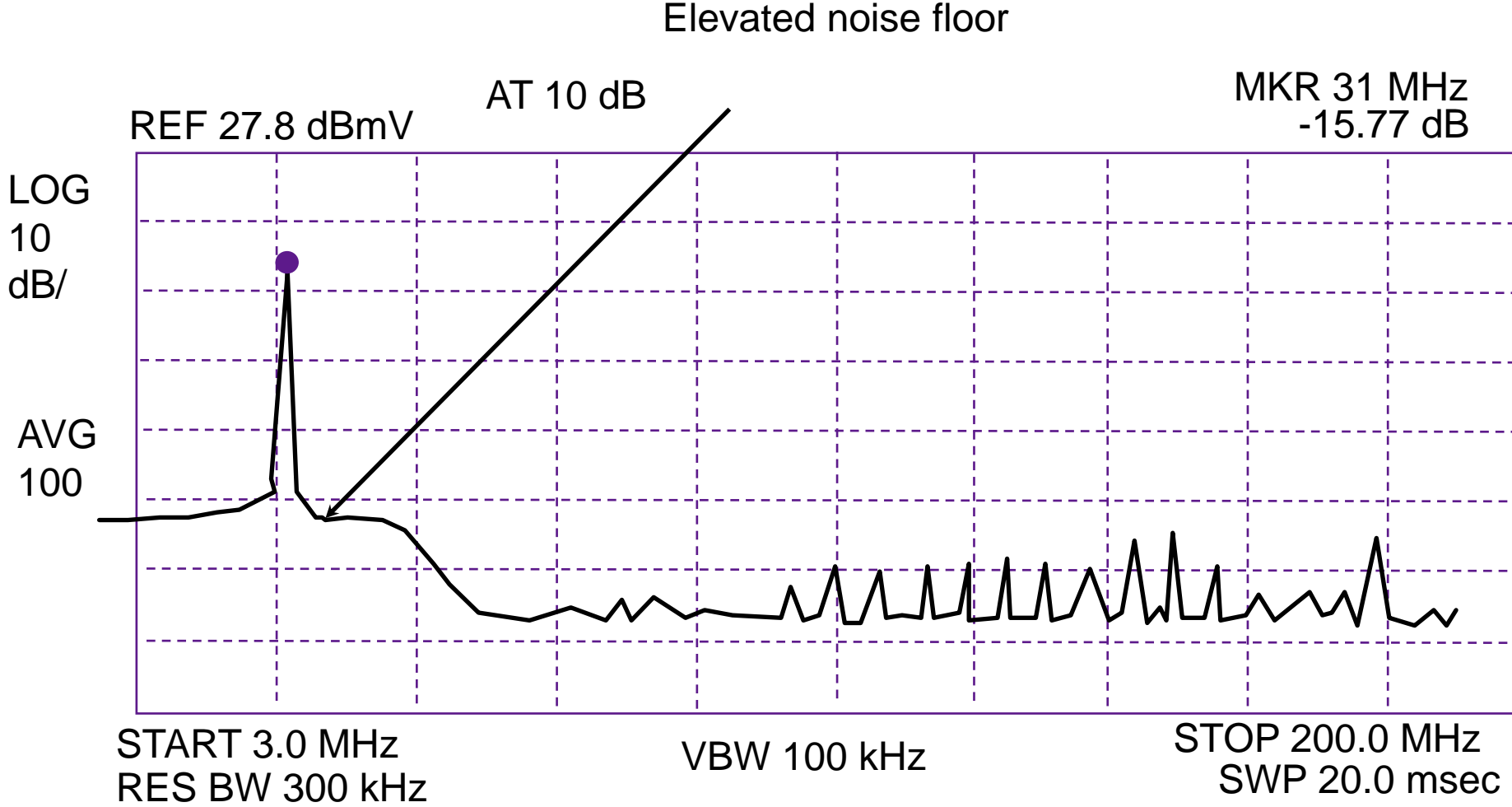
- Additive
 - Intrinsic/Stationery
 - Thermal noise
 - Composite Intermodulation noise (CIN)
 - Common path distortions (CPD)
 - Arcing impulse noise from connectors
 - Extrinsic
- Multiplicative

Thermal Noise Floor

- The noise floor in a 4 MHz BW =
 - -59.4 dBmV
- Noise floor in a different BW =
 - $10 \cdot \log(\text{Data}_{\text{BW}} / 4) - 59$
- The noise contribution (NC) from the actives =
 - $10 \cdot \log(\# \text{ of amps w/similar (NFs)}) + \text{NF}$
- Factor in dissimilar NFs to get the overall noise floor
 - $10 \cdot \log(10^{\text{NC1}/10} + 10^{\text{NC2}/10} + \dots)$
- Or use; $10 \cdot \log(A_1 \cdot 10^{\text{NF1}/10} + A_2 \cdot 10^{\text{NF2}/10} + \dots)$
 - A_x = the number of actives with a certain NF
- Add the noise floor to the noise contribution



Thermal Noise

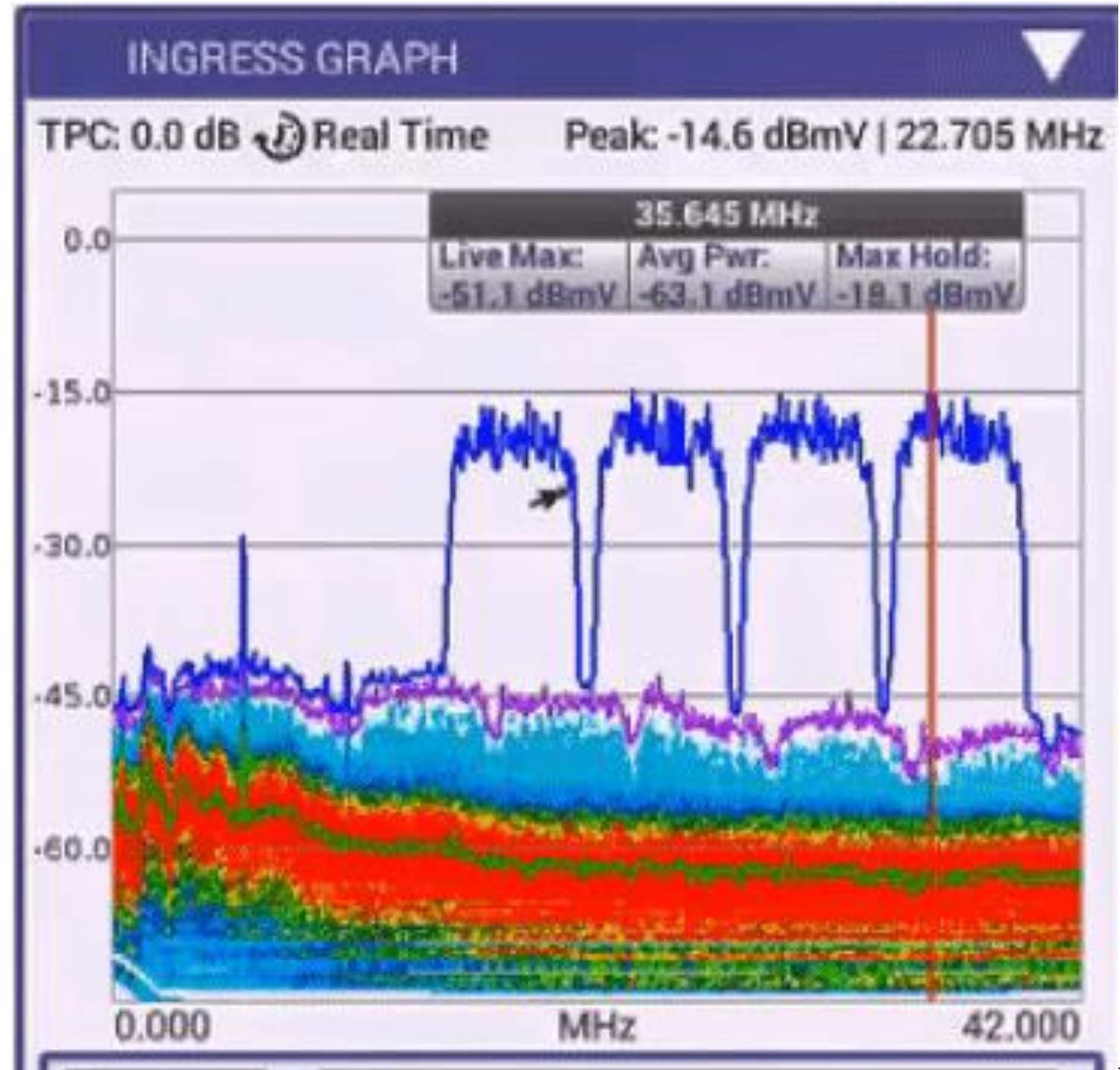


Common Path Distortions (CPD)

- Non-linear mixing from a diode junction
 - Corrosion
 - Dissimilar metal contacts
 - 4 main groups of metals
 - Magnesium and its alloys
 - Cadmium, Zinc, Aluminum and its alloys
 - Iron, Lead, Tin, & alloys (except stainless steel)
 - Copper, Chromium, Nickel, Silver, Gold, Platinum, Titanium, Cobalt, Stainless Steel, and Graphite
- Second and third order distortions
- CPD will make MER worse for forward performance

Common Path Distortions

Over driving an amp can have a similar effect

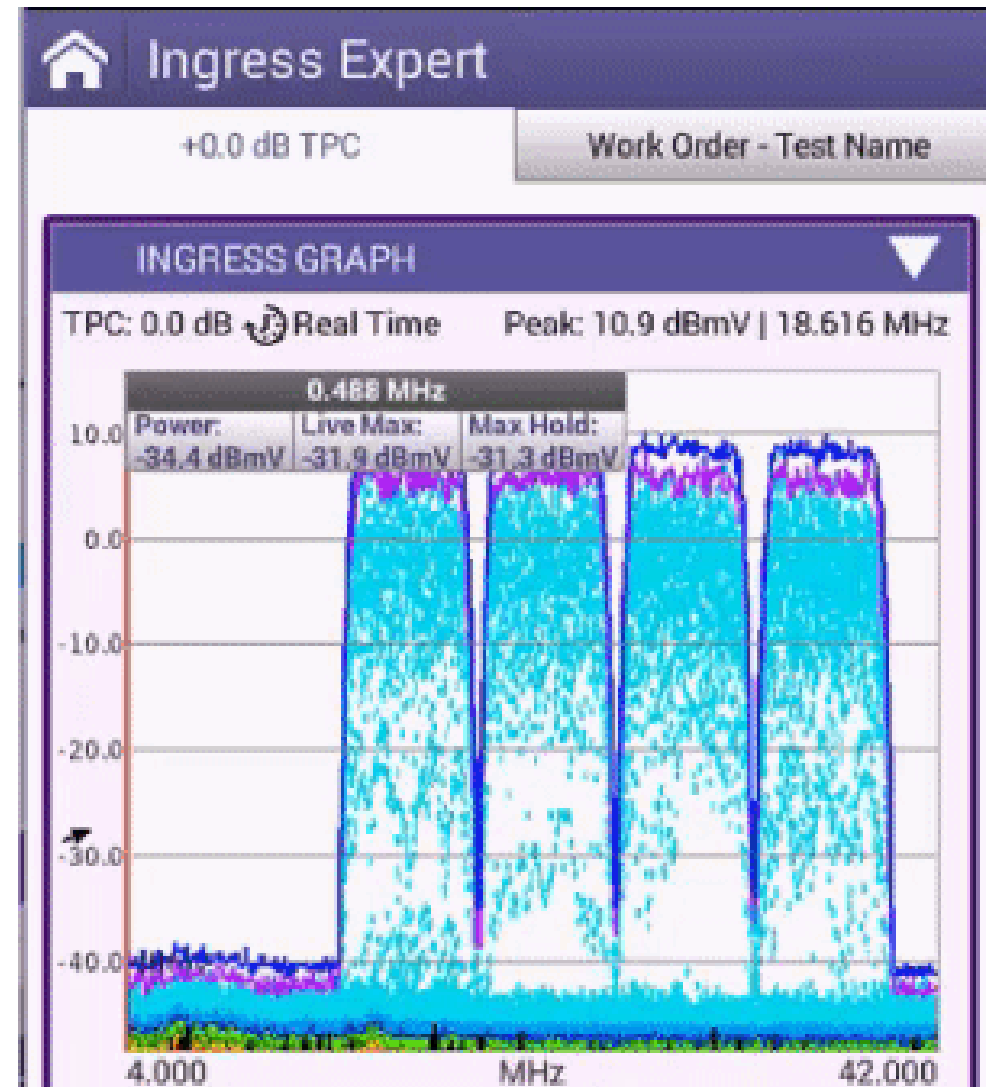


Additive Impairments

- Intrinsic
- Extrinsic
 - Impulse/burst noise
 - Ingress
 - Compression and laser clipping

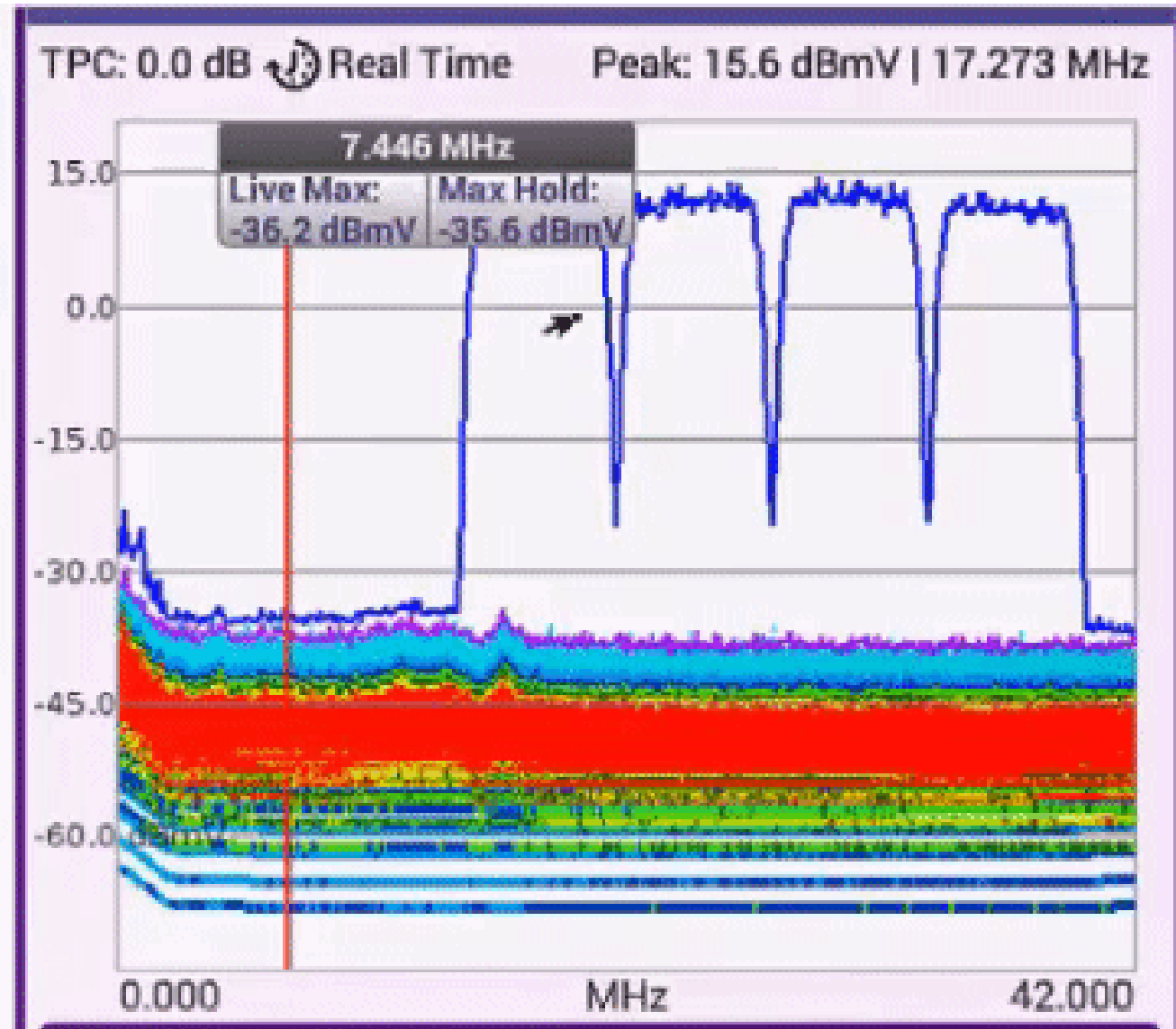
Impulse Noise

- Fast rise time, short duration
 - < 10 microseconds
- Significant energy contribution
- Sources include most household appliances



Impulse Noise Sources

- Electronic motors and switches
- Electric blankets
- Power lines and static from lightning
- Bug zappers
- Neon lights
- Vehicle ignitions
- Arc welders and industrial machinery
- Computers and games



Ingress Sources

- Common IF of most FM Rxs @ 10.7 MHz
- Poorly shielded TVs
- Computer CPUs with video cards installed
 - 25 or 33 MHz
- Short-wave radio / Voice-of-America
- Ham radio operators @ 7 - 30 MHz
 - 7-7.3 MHz, 10.1-10.15, 14-14.35, ~18, 21-21.45
 - 24.89-24.99, and 28-29.7 MHz

Wireless Ingress

- CB @ 27 MHz
- Garage door openers ~300 MHz
- Electronic car door locks? ~ 300 - 315 MHz
- Radio controlled cars 27 & 49.86 MHz
- Land mobile “Walkie Talkies”
- Meter reading equipment? ~ 900 MHz
- Pagers / Intercoms / Cordless phones

More Ingress Contributors

- Passives with poor isolation (FM radio)
- Do-it-yourselfers
- “Finger tight, ain’t good enough”
- “Good buddy, CB’er with a linear amp”
- Faulty grounds & grounding systems

Laser Performance - Distortion and Clipping

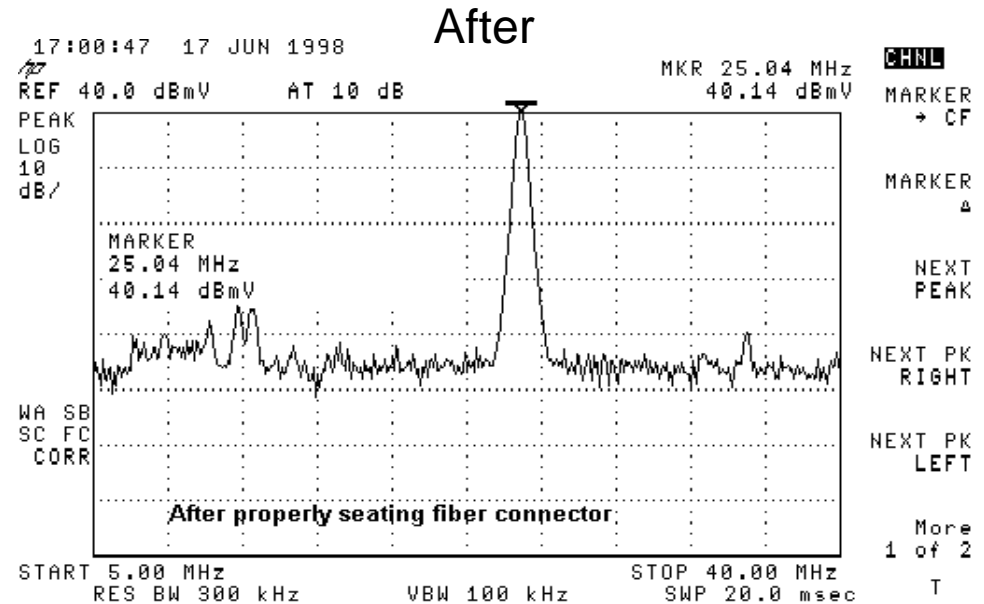
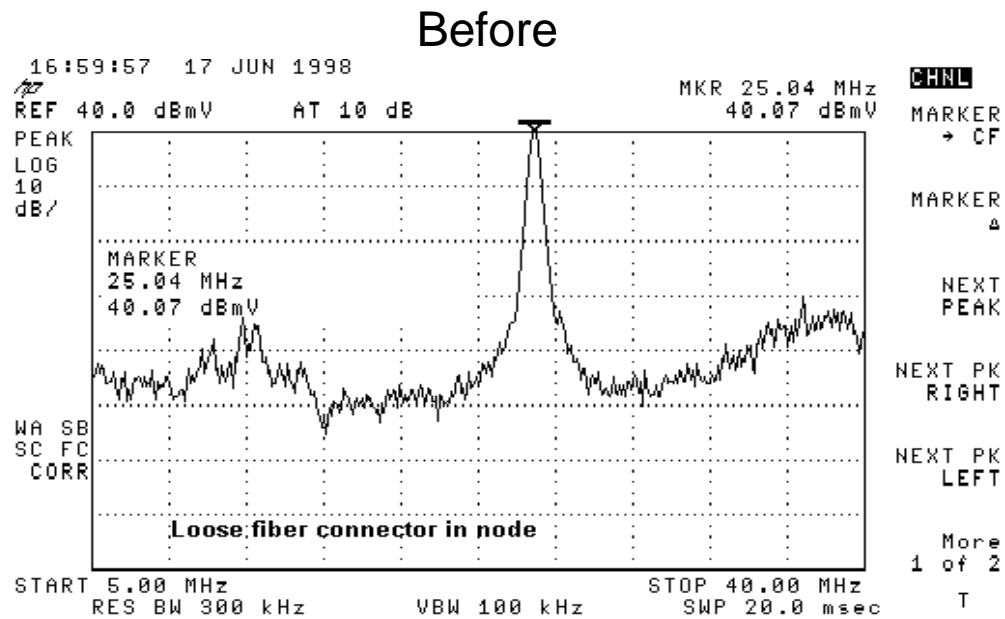
- Overdriving a laser with excessive signal causes clipping in the laser
 - This produces Intermodulation distortions that appear as noise called **Composite Intermodulation Noise (CIN)**
 - CIN adds on a 20log basis when levels are changed
 - CIN cascades on a 20log basis
- Thermal noise and CIN add on a 10Log basis
 - **Carrier-to-Composite Noise Ratio (CCNR)**
- At lower levels, CNR is dominant
- At higher levels, CCNR is dominant

Laser Clipping



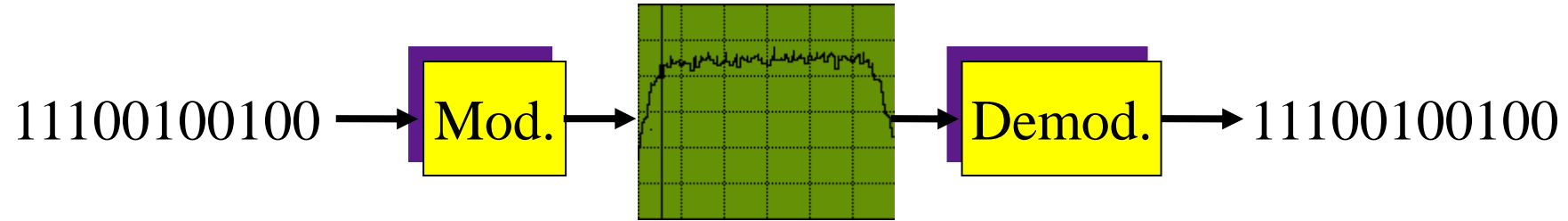
Loose Fiber Connector

- SC connector not pushed in all the way



Analog to Digital and Forward Path Noise

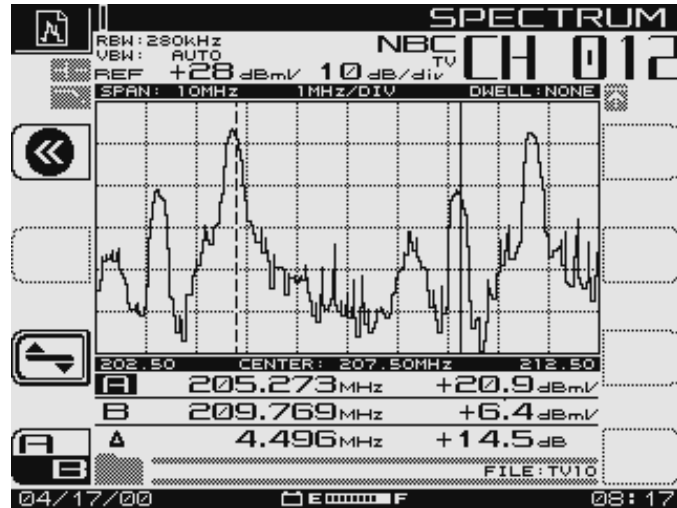
Digital Signals



- Amplitude Shift Keying “ASK”
- Frequency Shift Keying “FSK”
- Phase Shift Keying “PSK”
- Bi-Phase Shift Keying “BPSK”
- Quadrature Phase Shift Keying “QPSK”
- Quadrature Amplitude Modulation “QAM”

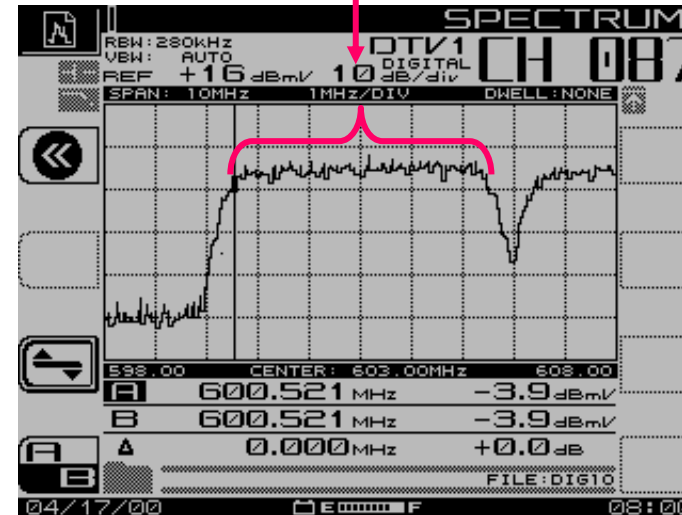
Why go Digital?

Analog Video Spectrum



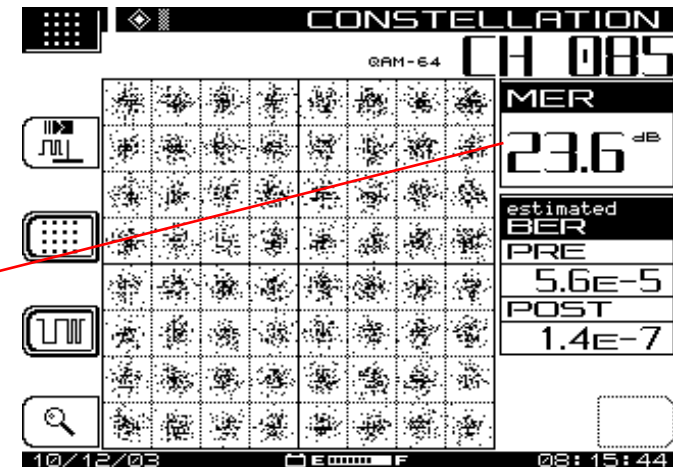
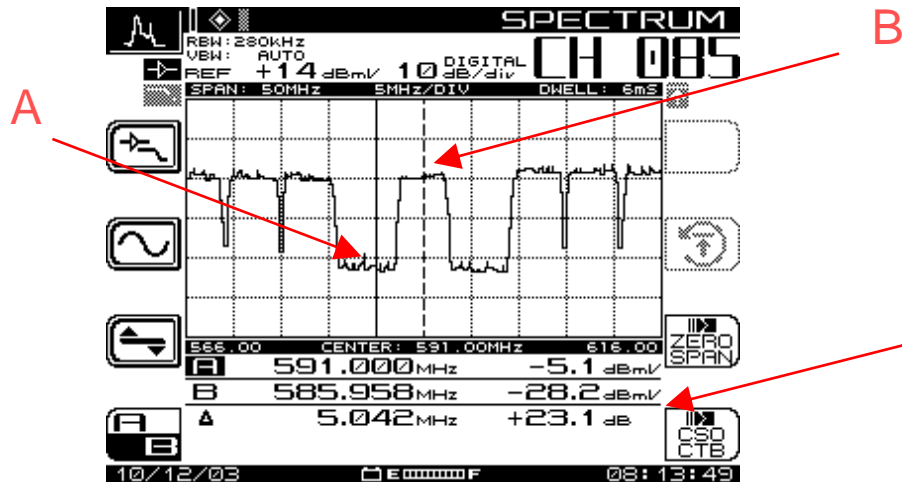
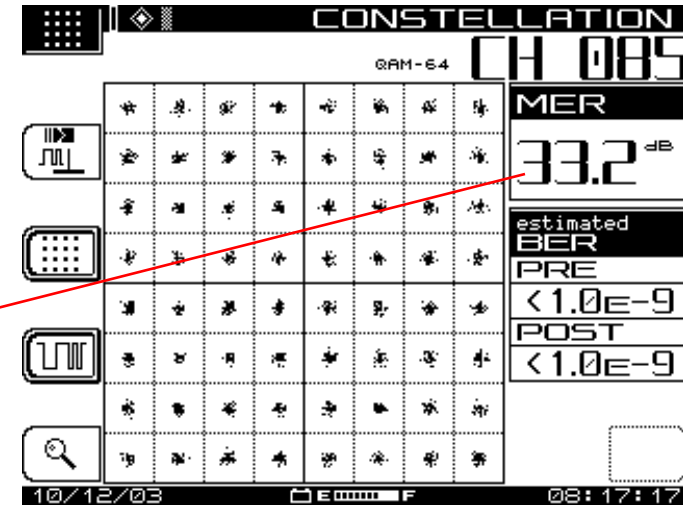
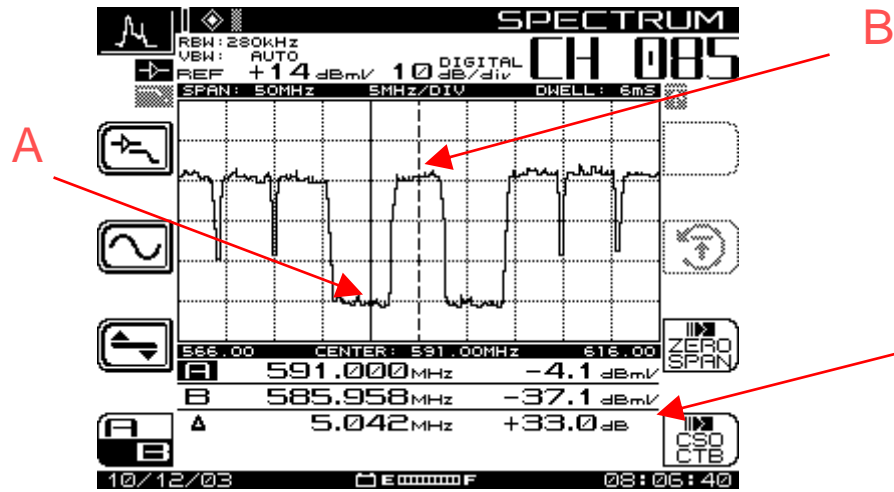
- 6 MHz Analog = 2 programs
- 1 video and audio

Digital QAM Spectrum



- 6 MHz Digital = 6 - 12 programs depending on compression factors
- Looks like a haystack

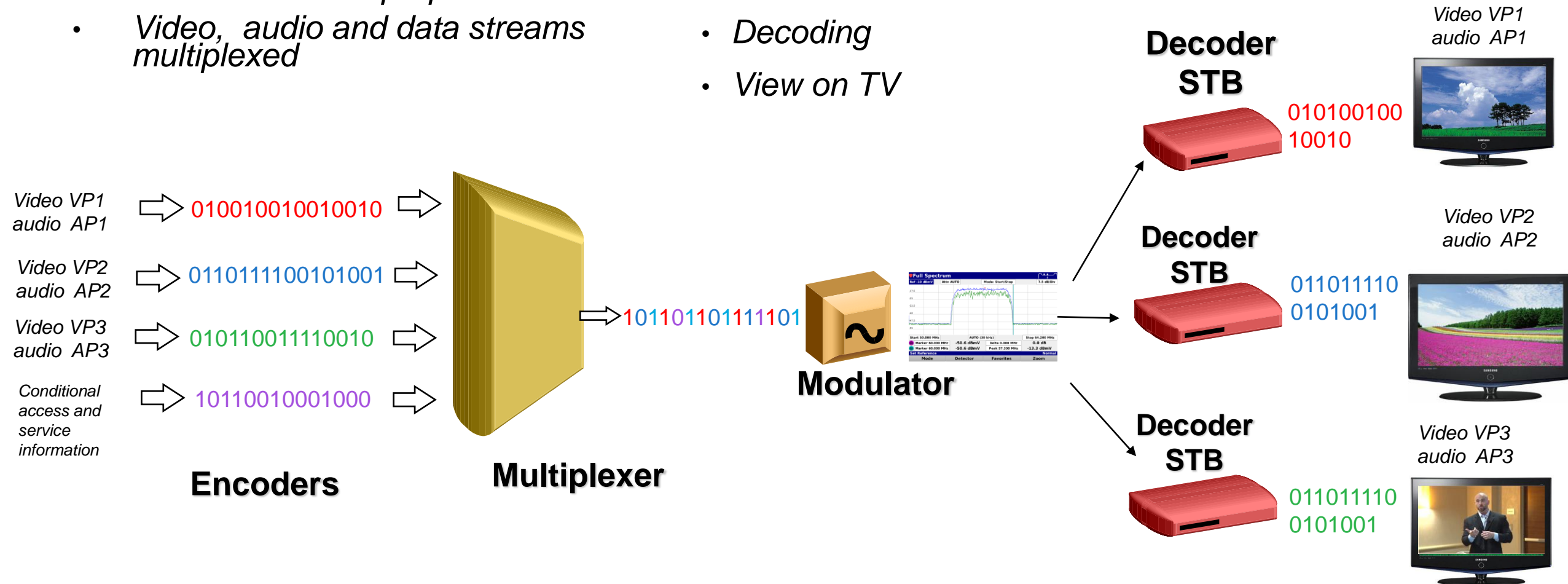
What Causes MER and BER to degrade?



The Digital TV System

- Video and audio source compressed
- Conditional access and service information added
- Data information prepared
- Video, audio and data streams multiplexed

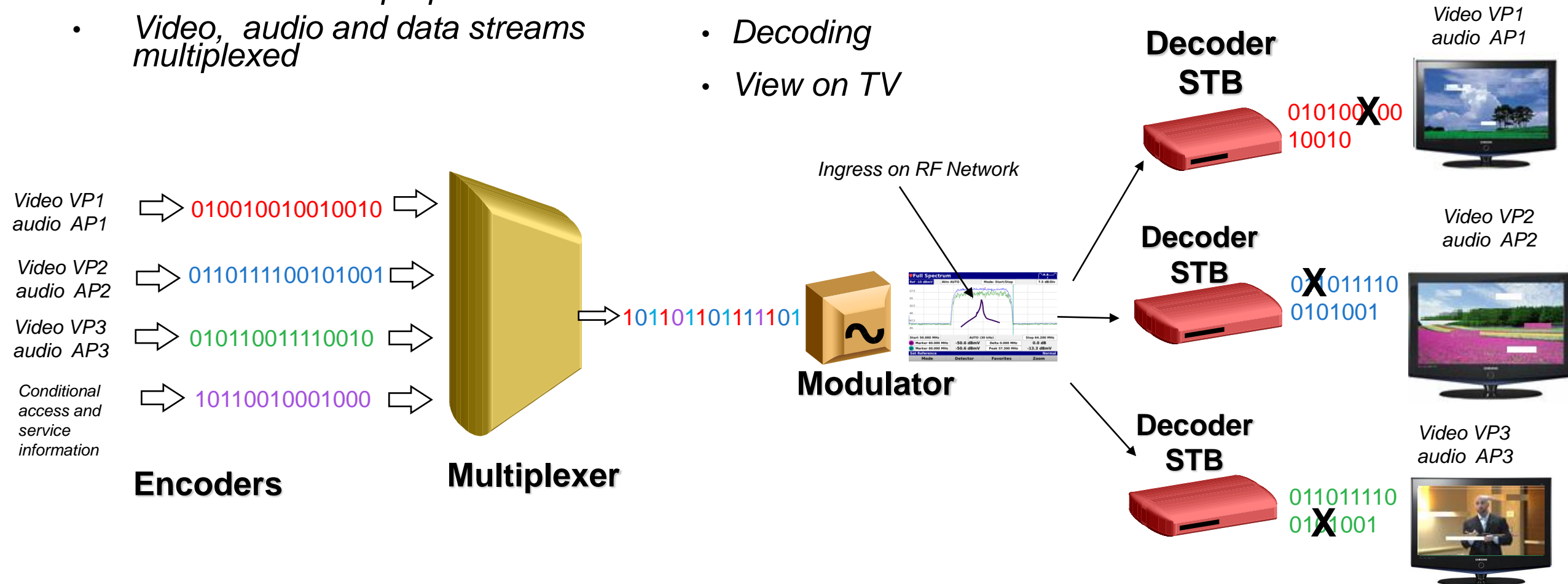
- Transmission by cable/satellite/MMDS/terrestrial
- Demultiplexing
- Decoding
- View on TV



The Digital TV System

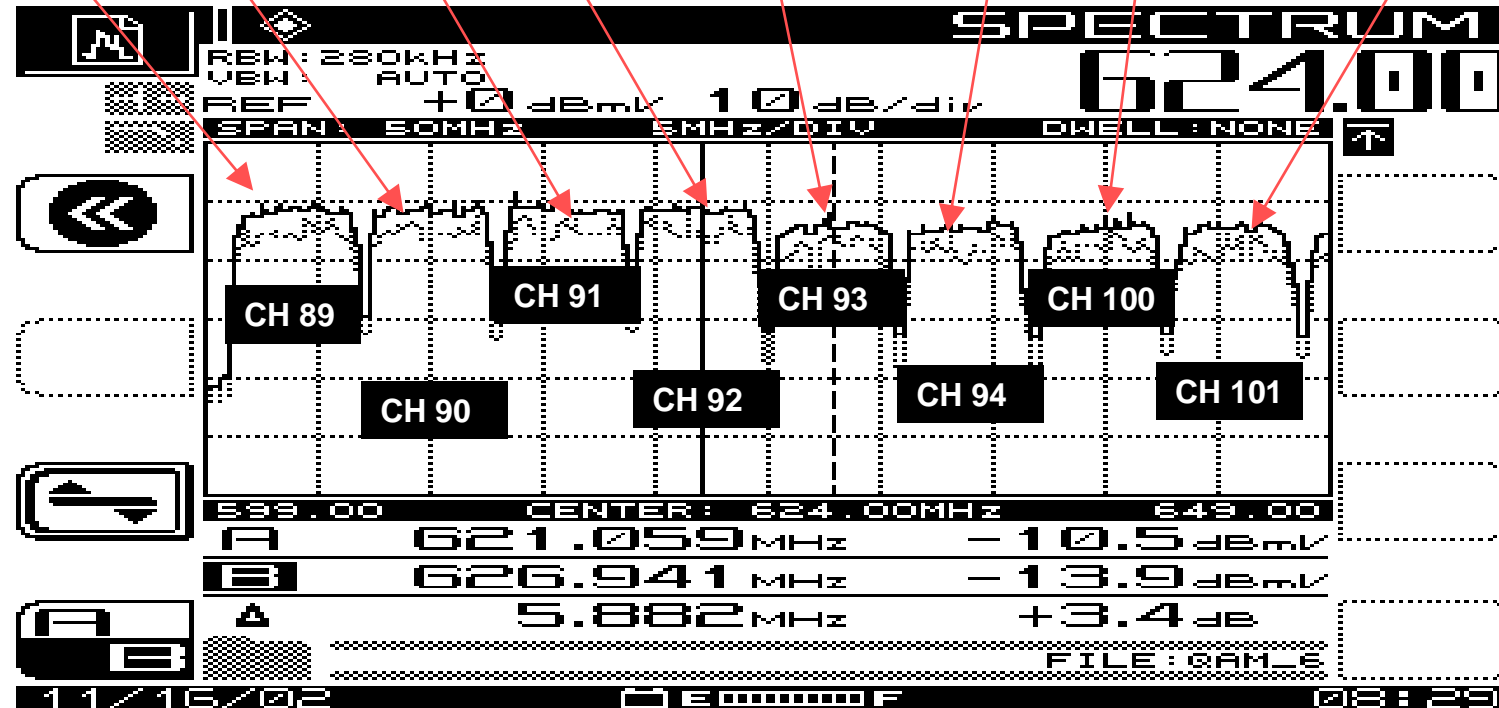
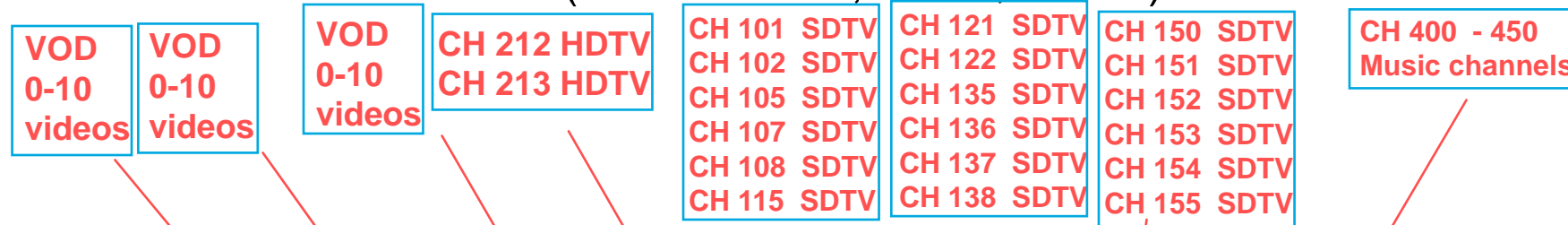
- Video and audio source compressed
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- Transmission by cable/satellite/MMDS/terrestrial
- Demultiplexing
- Decoding
- View on TV

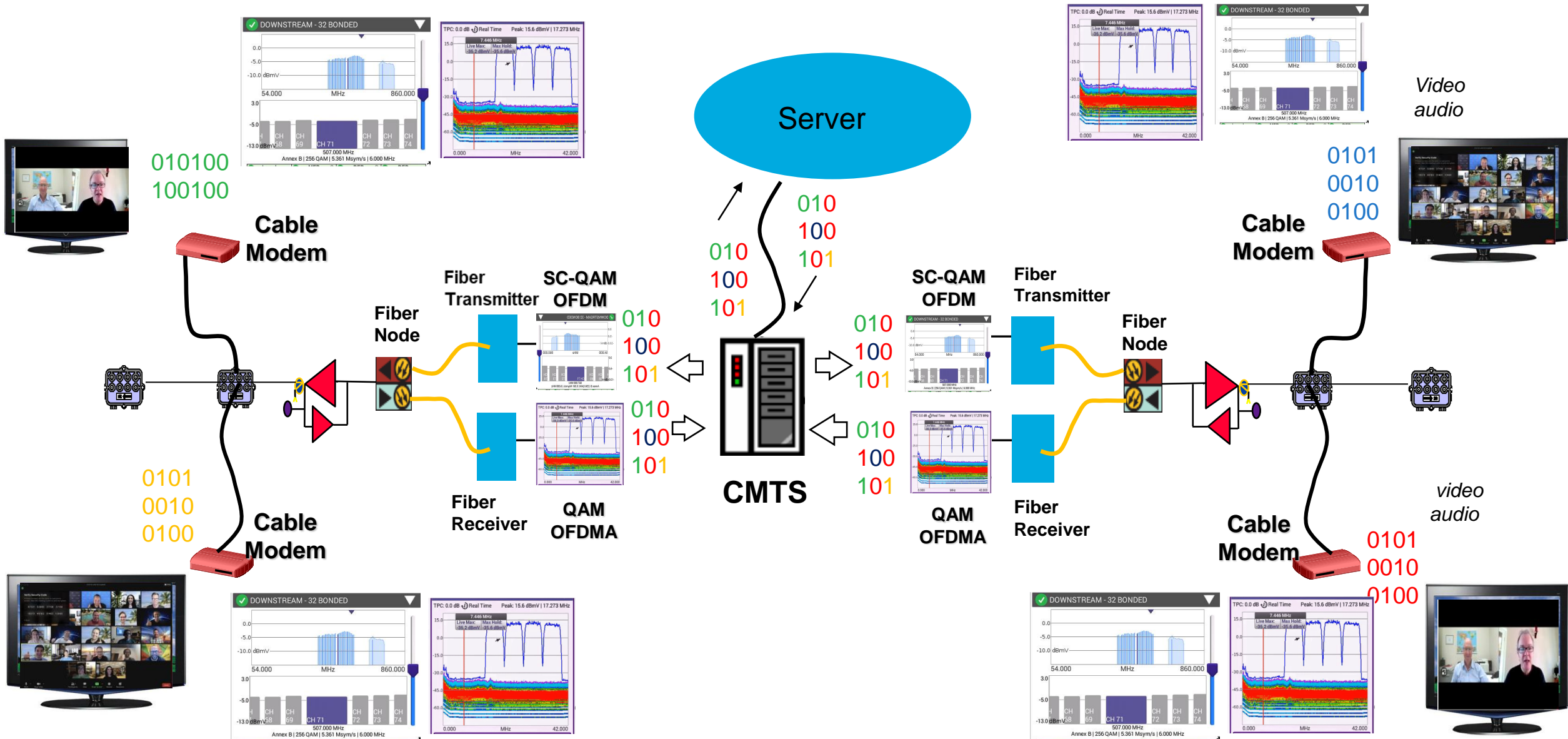


What's in those QAM signals?

- MPEG-2 Data Streams (data of video, audio, tables)



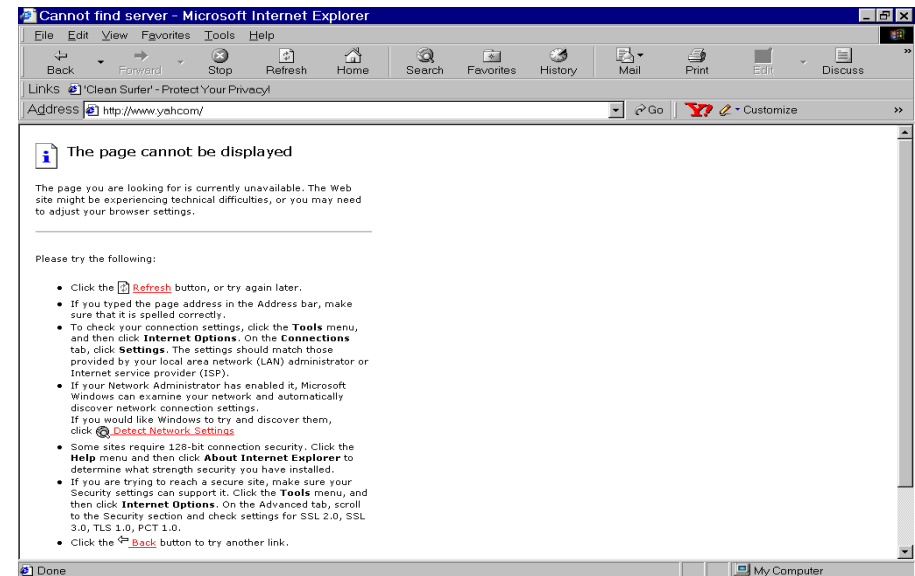
MPEG on the DOCSIS RF Network example



Ingress in QAMs

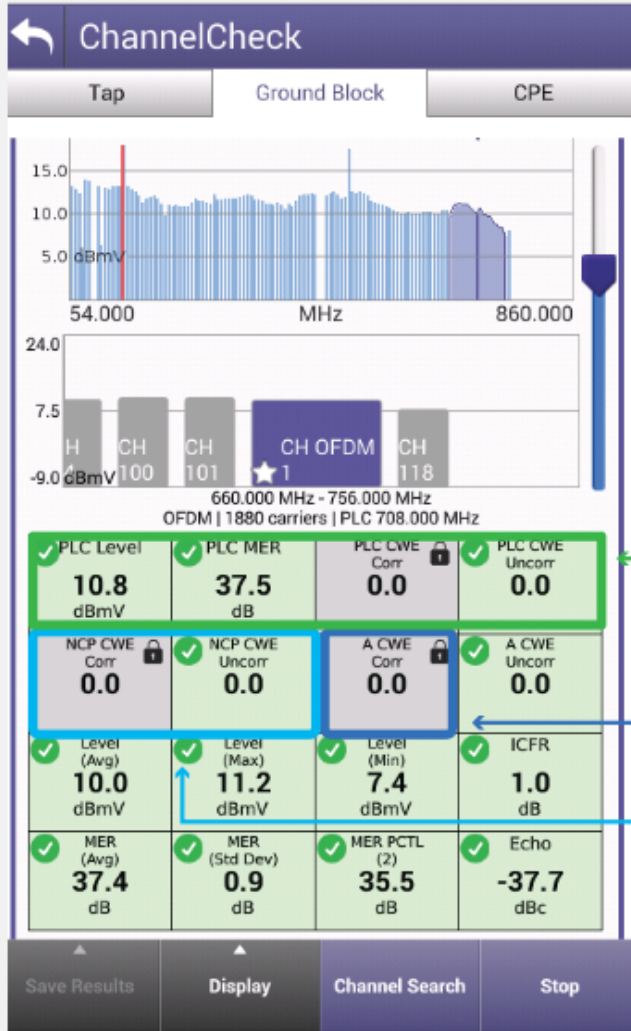
→ Ingress causes Digital signals to Degrade.

→ This causes Tiling and Loss of high Speed internet access.



What to Look for on OFDM Carrier

Testing PLC —PHY Link Channel



PLC

PLC contains critical OFDM PLC signal decoding information.

✓ THINGS TO CHECK

Level: >-15 dBmV (6 MHz) **MER:** >15 dB (min) **Lock status:** locked **Uncorrectable CWE:** none **Other info:** PLC center frequency

Testing Next Codeword Pointer (NCP)

NCP

The NCP tells the modem which codewords are present and in which profile to find each codeword (codeword error analysis); it is critical for proper data communication.

✓ THINGS TO CHECK

Lock status: locked **Uncorrectable CWE:** none

Testing Profile A

Profile A

Profile A is the boot profile; all 3.1 modems must be able to use profile A.

- ▶ Profile A is key to D3.1 modem communication via an OFDM carrier. This is where command and control, range, and registration occurs.
- ▶ In practice, many operators are migrating to running 256 QAM or 1024 QAM on profile A. It is expected and common that there will be Correctable Codeword Errors. This is OKAY since LDPC is so effective.

✓ THINGS TO CHECK

Lock status: locked
Uncorrectable CWE: none

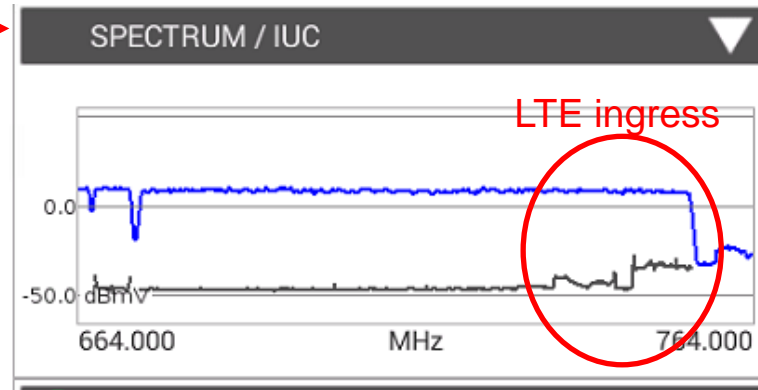
- ▶ If profile A isn't locked or has uncorrectable CWE, a modem may roll back and use only SC QAMs in 3.0 mode.

OFDM Ingress Under the Carrier (LTE Band Ingress)

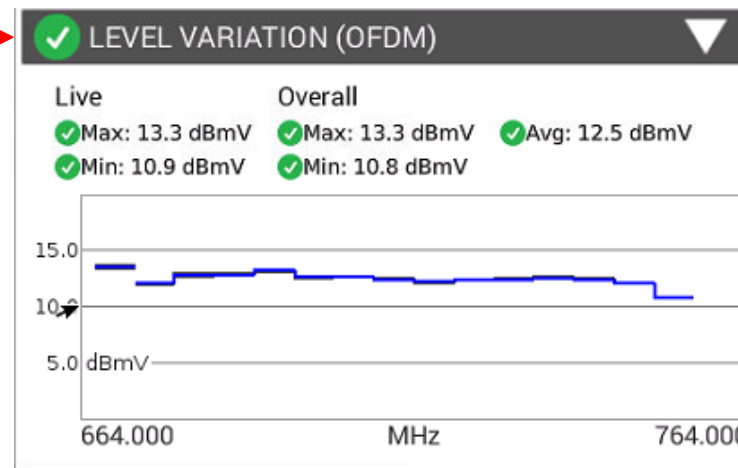
Channel Expert
+20.0 dB TPC1
Work Order - Test Name

- DASHBOARD
- Downstream (100 %) Level (dBmV) Max: 15.3 Min: -3.7 Forward TPC: 20.0 dB MER (dB) Max: 45.7 Min: 26.5
- CHANNEL VIEW
- SPECTRUM / IUC
- LEVEL VARIATION (OFDM)
- MER VARIATION (OFDM)
- PROFILE ANALYSIS
- IN-CANNEL FREQUENCY RESPONSE
- TILT
- SMARTSCAN
- MER
- FAVORITES

Configure Display Channel Search Stop



IUC Ingress under carrier



Level of OFDM carriers measures at 6 MHz spacing

Where are the problems?

Node Health Parameters

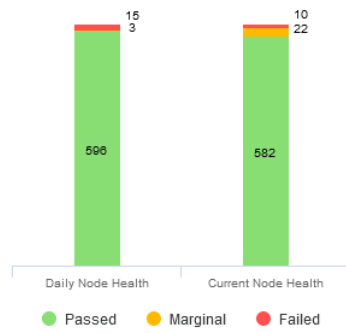
- CM with High Uncorrectable CER”
- CM with High Correctable CER
- CM with Low SNR
- CM with Low Transmit Levels
- CM with High Transmit Levels
- CM with High T3 Time outs
- CM with High T4 Time outs
- CM with High Range Aborts

Node Health



Node / Modem ▼

Node Health

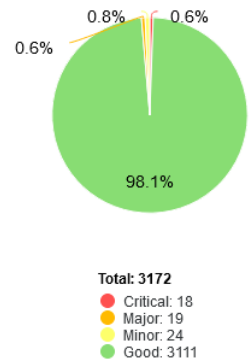


Churn Priority List 100 of 614 (Show All)

Current Node Health ▼ Actions ▼ Clear Filter

Node	Score ↑	Impacted	Stressed	Total	History
7	46	120	27	166	
RWS	65	32	0	56	
FR.	69	72	41	149	
30	75	46	7	68	
KIN_	75	25	0	26	
CLC	77	43	3	166	
IV	78	38	2	105	

Alarms Summary



Alarms List 63 items

Actions ▼ 🔄 12:51:48 PM Clear Filter

<input type="checkbox"/>	Timestamp (1) ↓	Severity (2) ↑	Node	Event	Ack Req	ID (3) ↓
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Critical	AYA-A	Violation - Node Health Critical	No	388439
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Critical	ST	Violation - Node Health Critical	No	388434
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.N	Violation - Node Health Marginal	No	388433
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.CO	Violation - Node Health Marginal	No	388424
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.UDE	Violation - Node Health Marginal	No	388412
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.RHL	Violation - Node Health Marginal	No	388231
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.UNR	Violation - Node Health Marginal	No	388230
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.HEN	Violation - Node Health Marginal	No	388221
<input type="checkbox"/>	Jul 28, 2021 12:47 PM	Critical	FRRM	Violation - Node Health Critical	No	388324
<input type="checkbox"/>	Jul 28, 2021 12:47 PM	Critical	WTWK-B	Violation - Node Health Critical	No	386477

DOCSIS Codeword Errors

- Encoder and the decoder “Cable Modem” “CMTS”
- Take a Large sections of Data from Encoder called Codeword
- Add two bytes of data for correction
- IF codeword were corrupted due to RF impairments it will use the two bytes of correction data to attempt to fix the corrupted bits.
- If the bits can be repaired, then the decoder reports back with a correctable codeword.
- If not repaired the it is an uncorrectable code word.

Return Path Noise and Spectrum Analyzer Tests

Advance Spectrum Analyzer Tests

VIAMI XPERTrak™ QAMTrak™ Analyzer | Node: HH1139

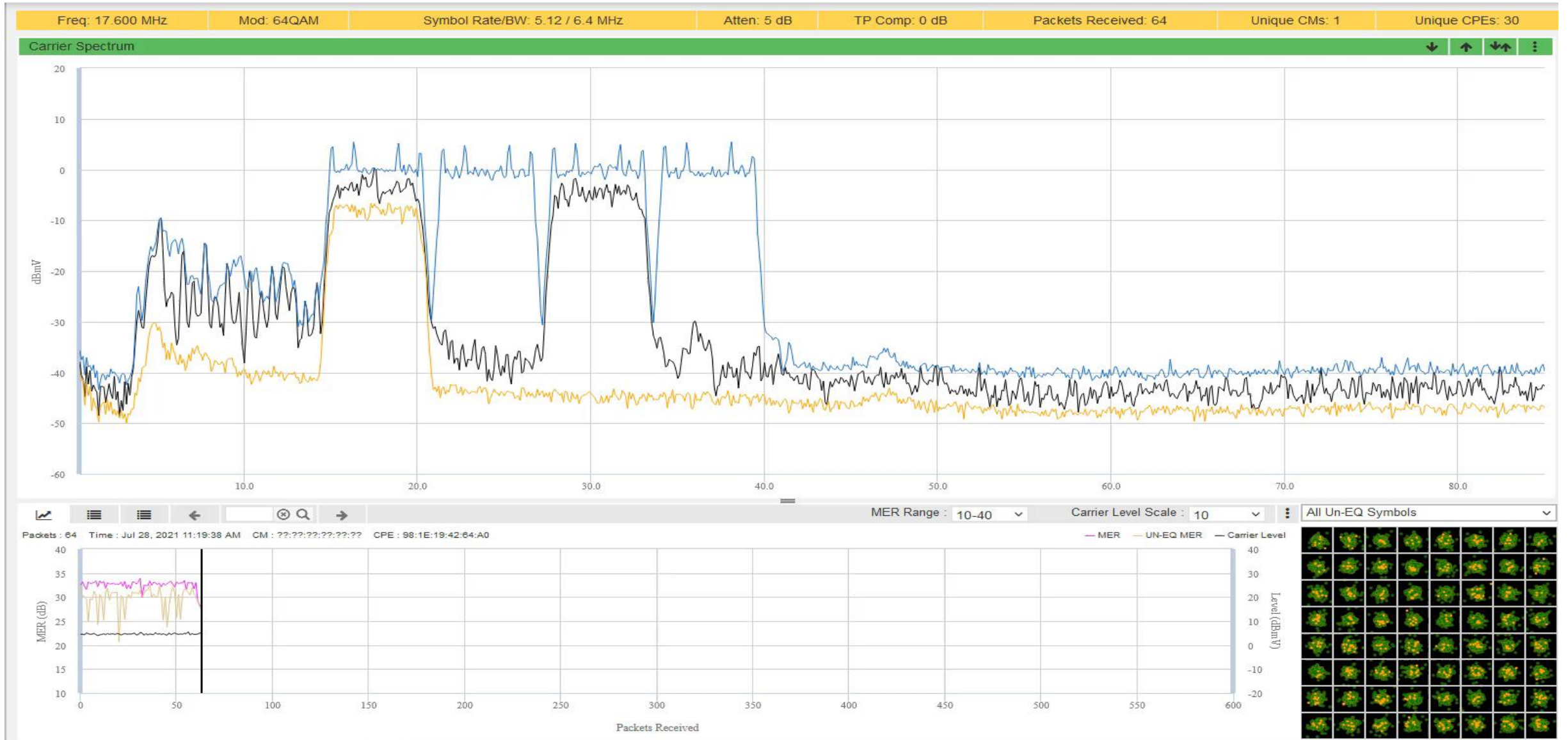
Jul 28, 2021 11:15:29 AM



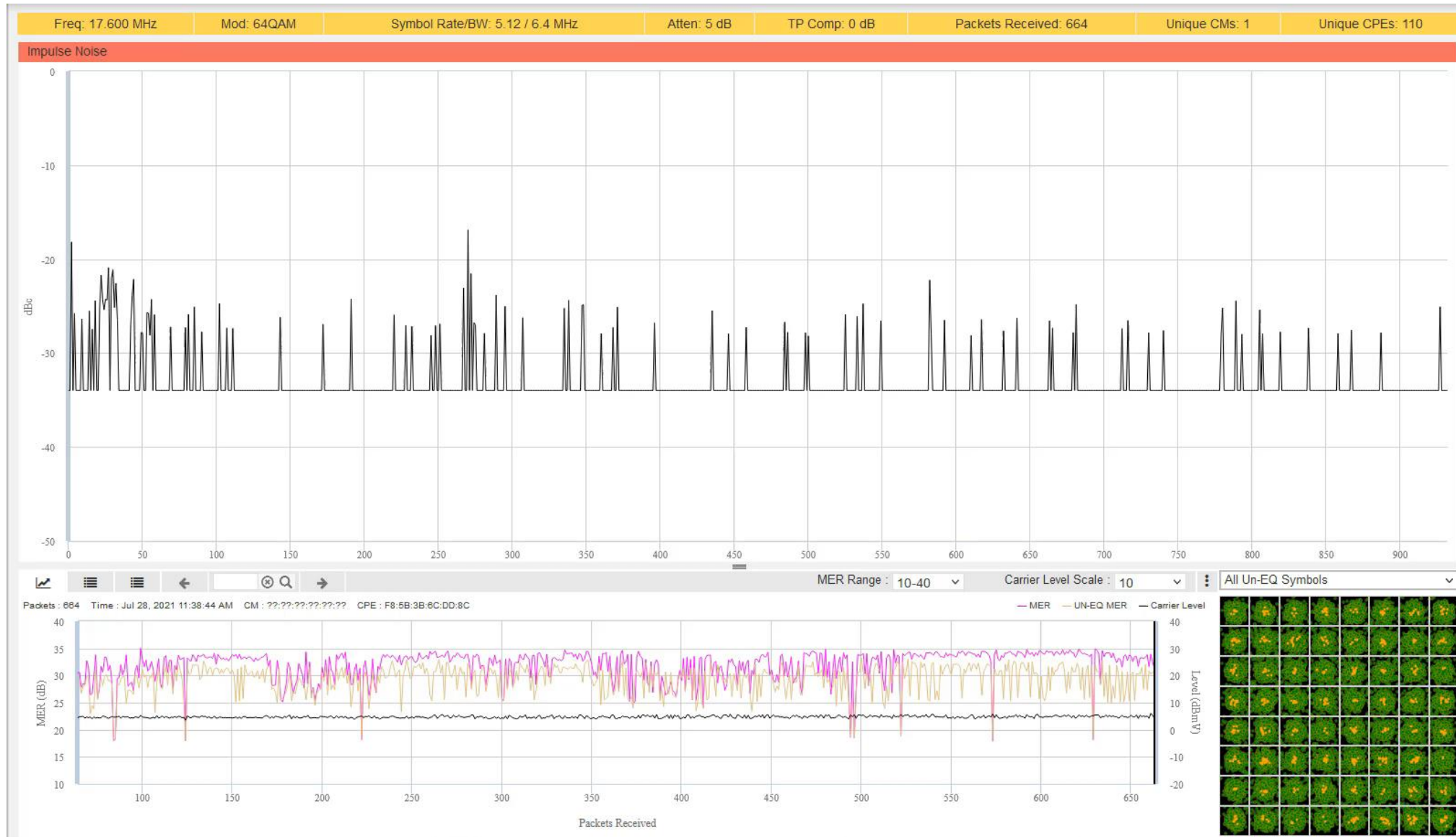
Codeword Errors



Advance Spectrum Analyzer Tests



Advance Spectrum Analyzer Tests “Impulse Noise”

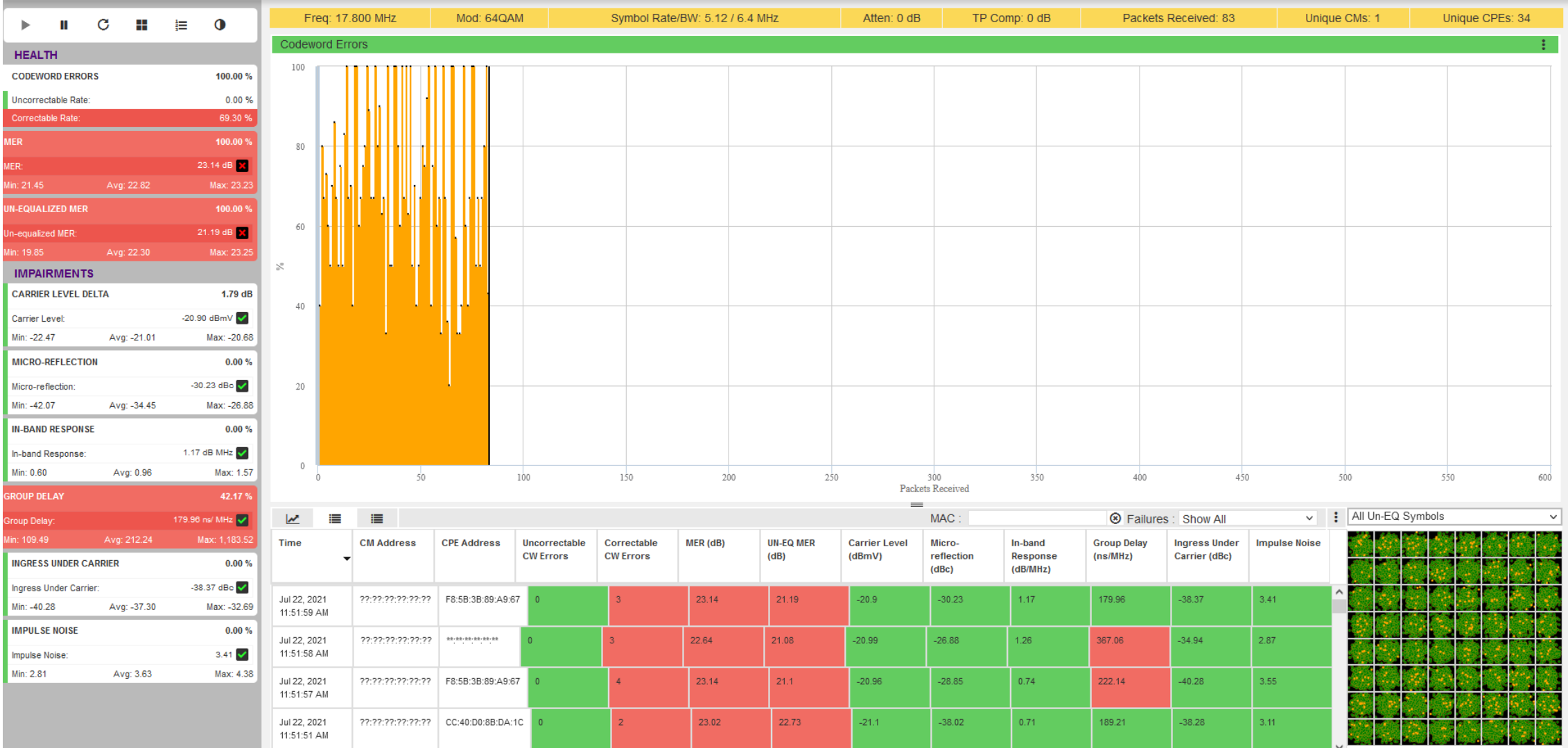


Advance Spectrum Analyzer Tests

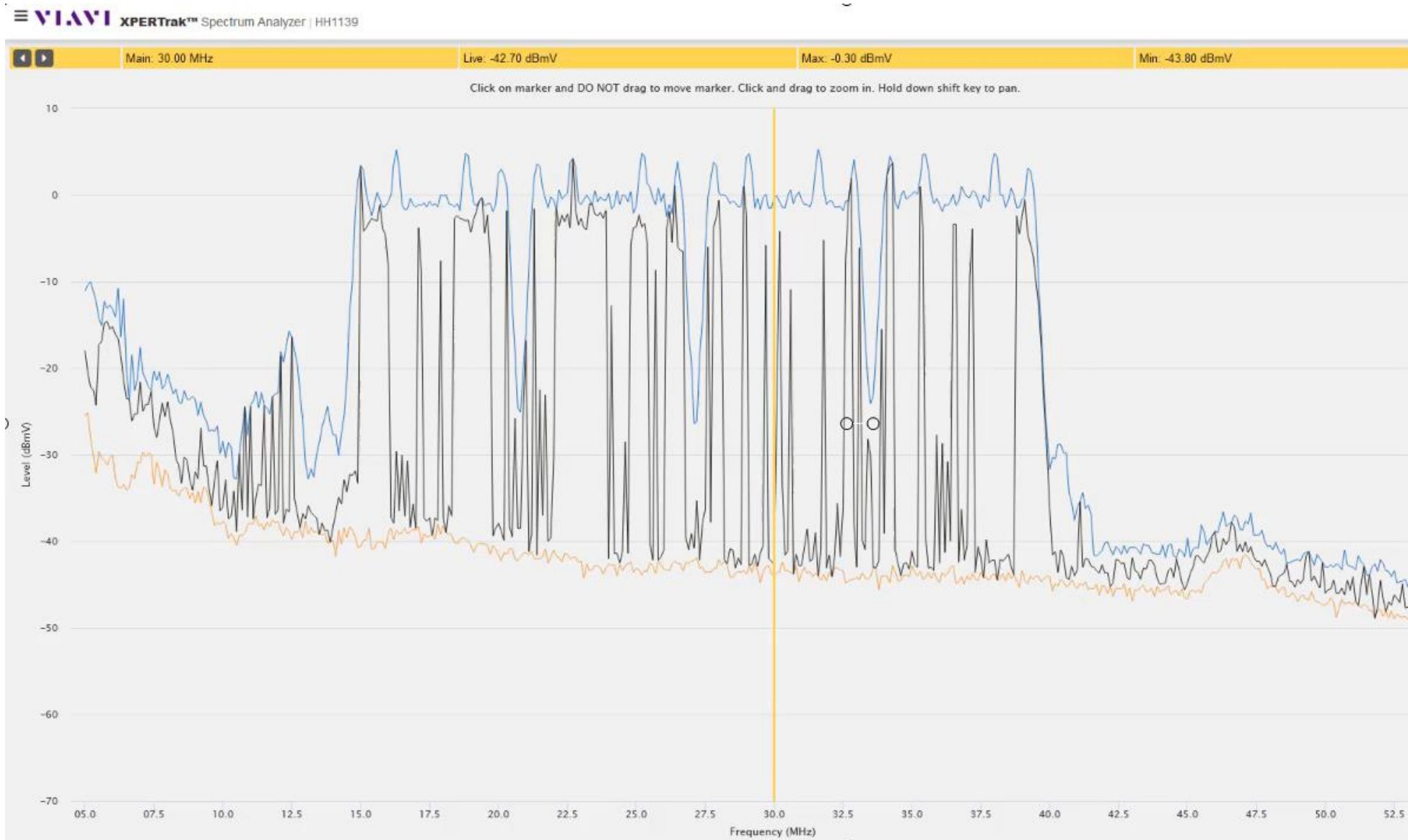
VIAMI XPERTrak™ QAMTrak™ Analyzer | Node: CR1408

Requesting new data...

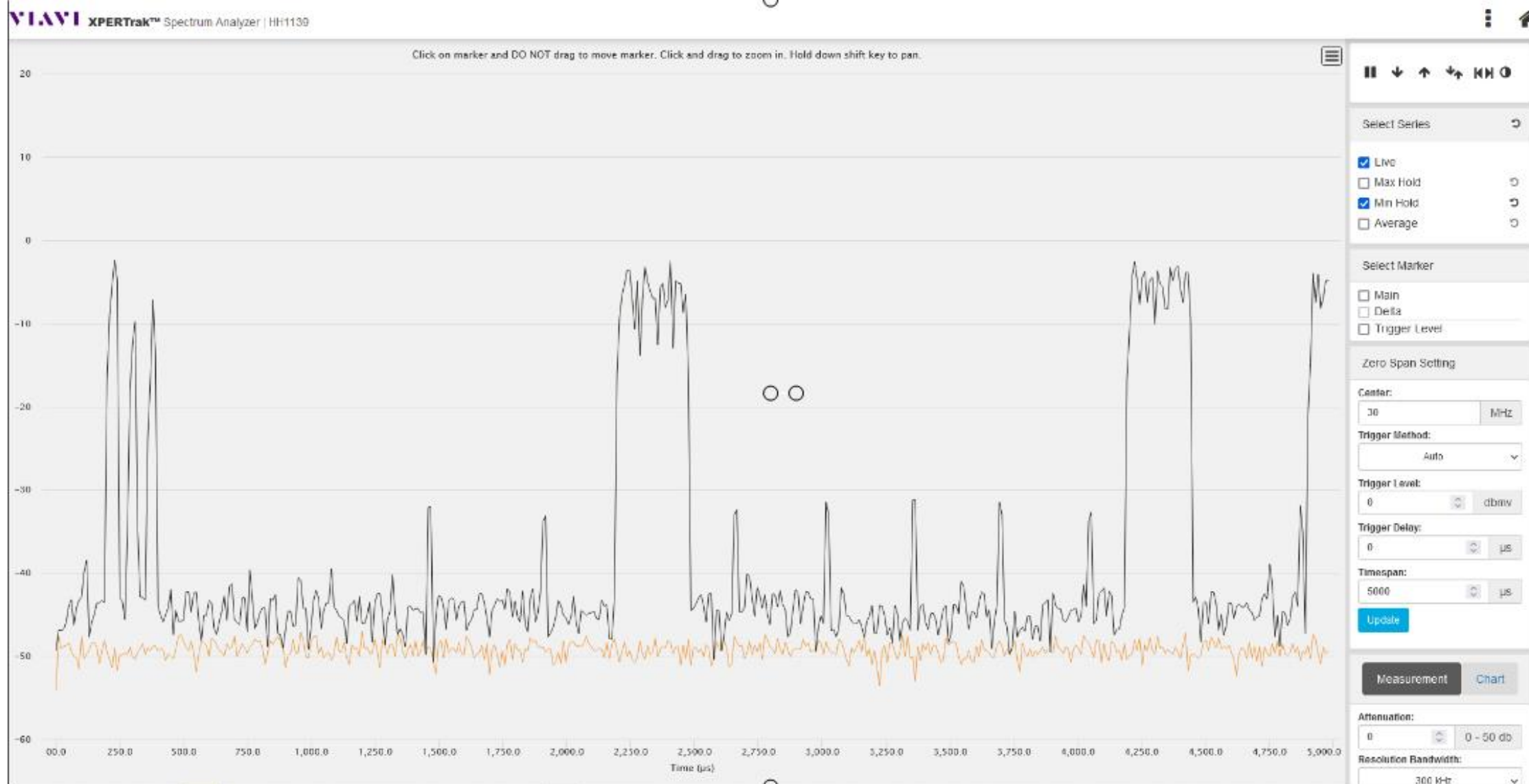
Jul 22, 2021 11:52:08 AM



Advance Spectrum Analyzer “Traditional”

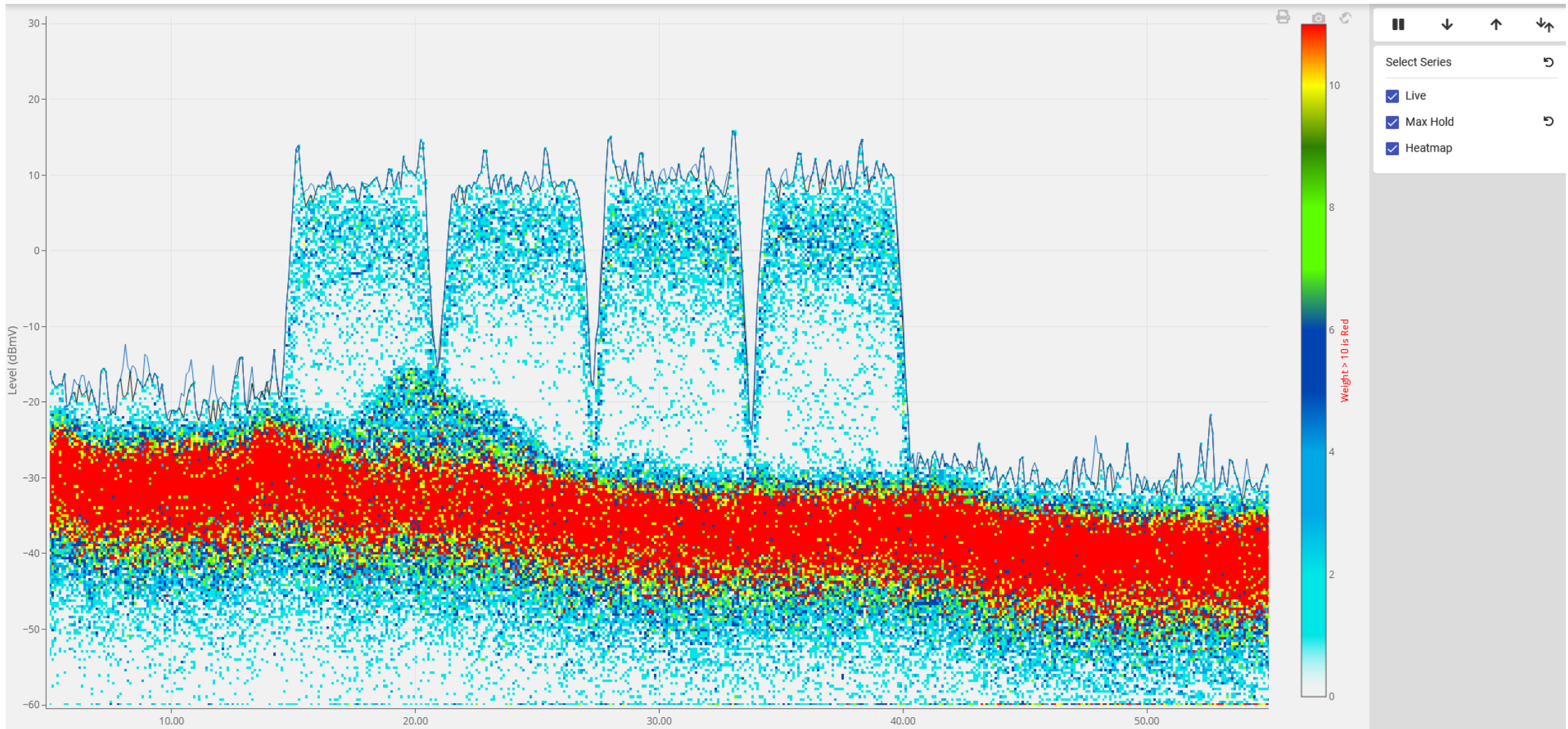


Advance Spectrum Analyzer “Zero Span”



Advance Spectrum Analyzer “Heat Map”

VIAMI XPERtrak™ Heatmap | NODE 7/ SC



Advance Spectrum Analyzer Tests

▶ || ↺ 🏠 ☰ 🔔

HEALTH

CODEWORD ERRORS 27.45 %

Uncorrectable Rate: 2.83 %

Correctable Rate: 5.58 %

MER 48.53 %

MER: 28.02 dB ❌

Min: 20.76 Avg: 31.02 Max: 38.04

UN-EQUALIZED MER 9.80 %

Un-equalized MER: 28.45 dB ✅

Min: 23.02 Avg: 29.07 Max: 33.72

IMPAIRMENTS

CARRIER LEVEL DELTA 5.67 dB

Carrier Level: 10.00 dBmV ❌

Min: 8.78 Avg: 9.78 Max: 14.45

MICRO-REFLECTION 0.00 %

Micro-reflection: -38.32 dBc ✅

Min: -44.73 Avg: -36.79 Max: -28.93

IN-BAND RESPONSE 0.00 %

In-band Response: 0.51 dB MHz ✅

Min: 0.30 Avg: 0.55 Max: 1.16

GROUP DELAY 2.94 %

Group Delay: 70.56 ns / MHz ✅

Min: 42.21 Avg: 95.74 Max: 293.56

INGRESS UNDER CARRIER 0.00 %

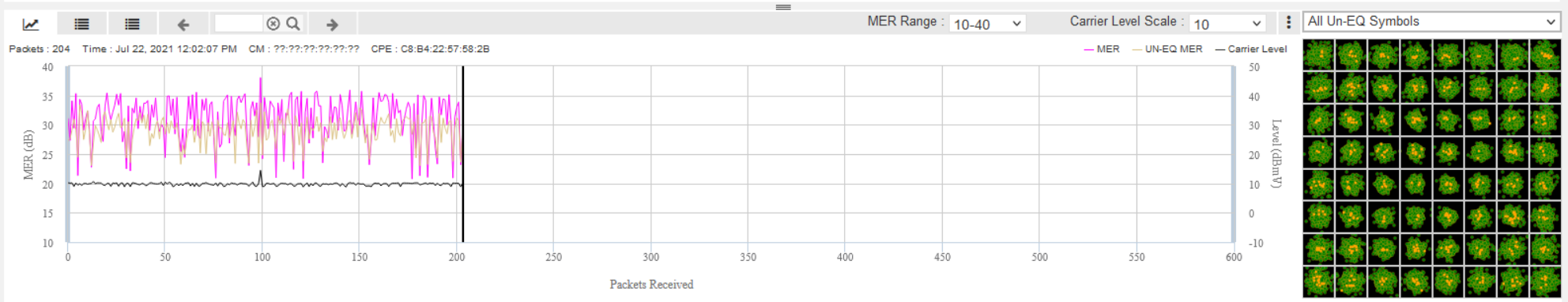
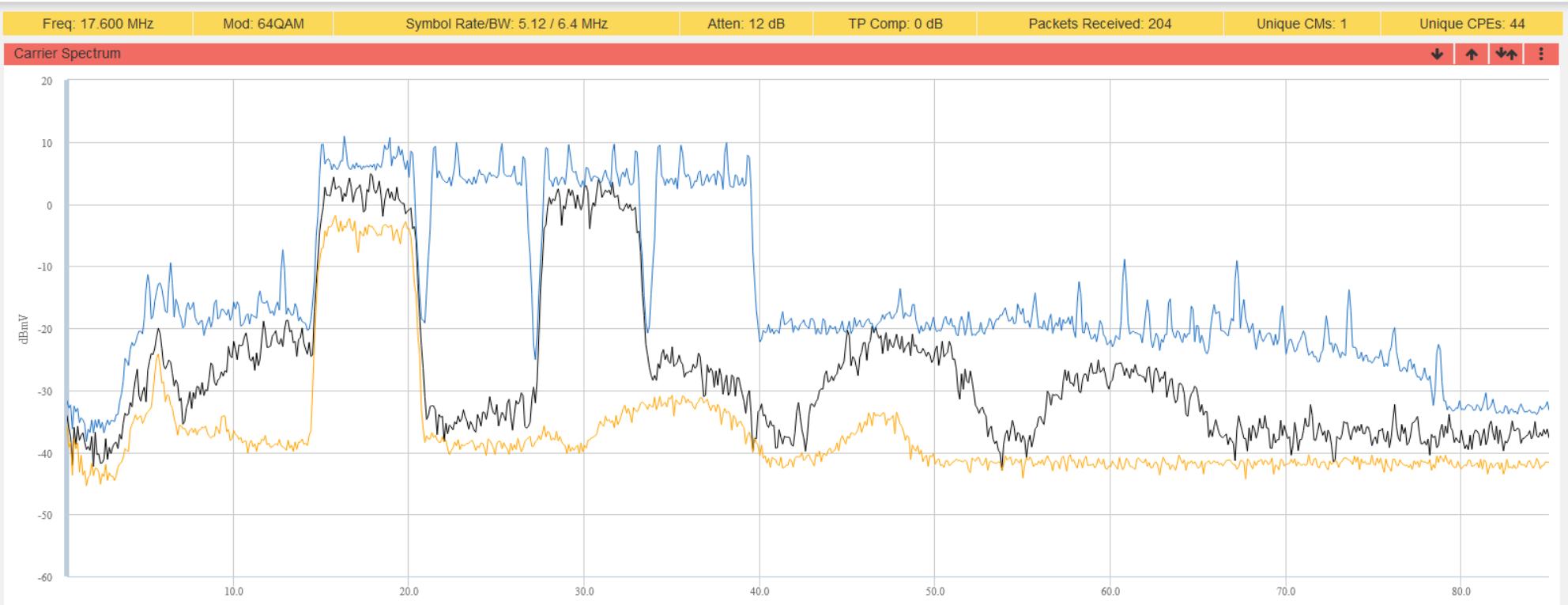
Ingress Under Carrier: -40.86 dBc ✅

Min: -52.69 Avg: -45.02 Max: -34.76

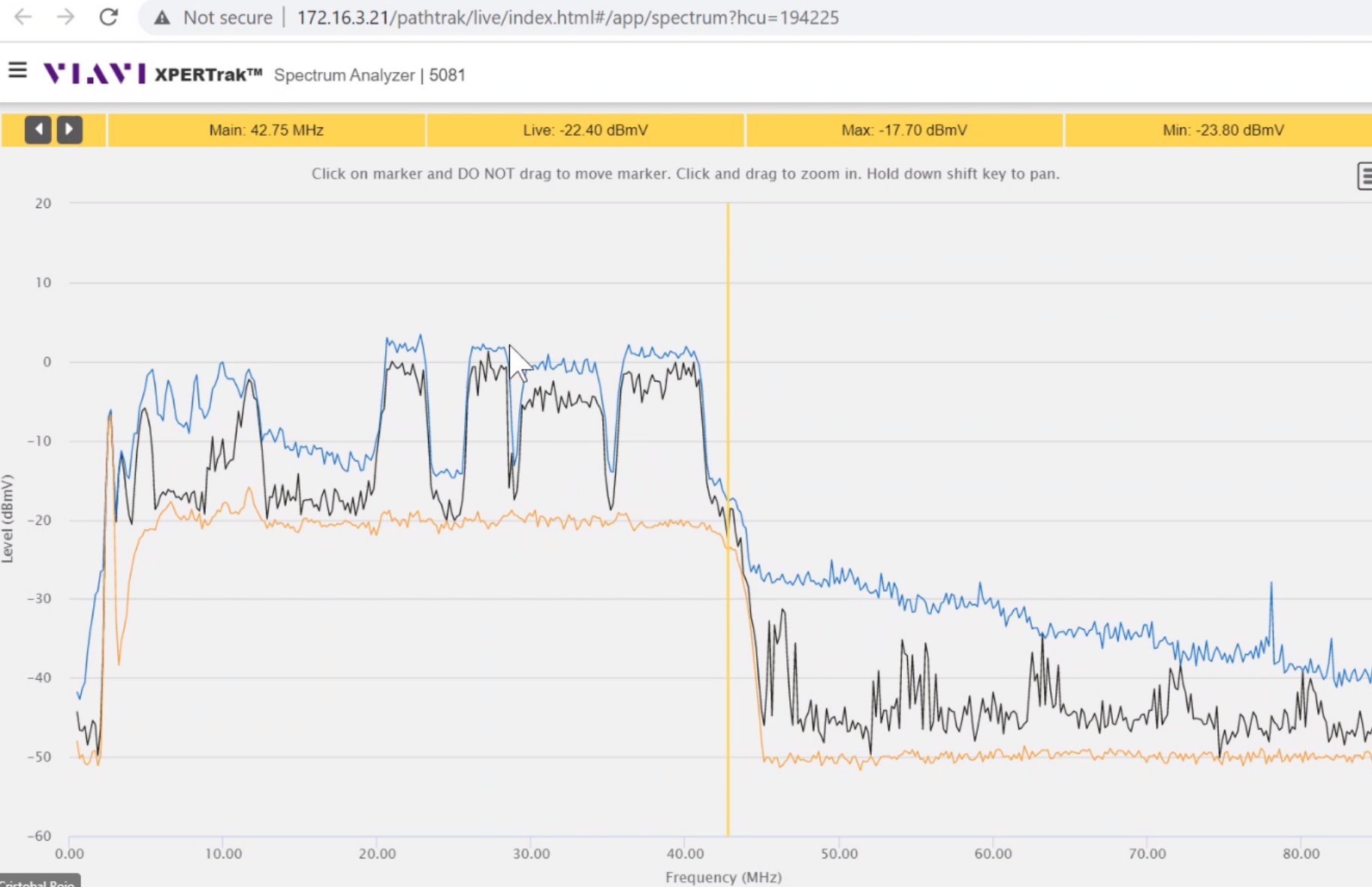
IMPULSE NOISE 12.25 %

Impulse Noise: 5.09 % ✅

Min: 2.57 Avg: 5.91 Max: 11.06

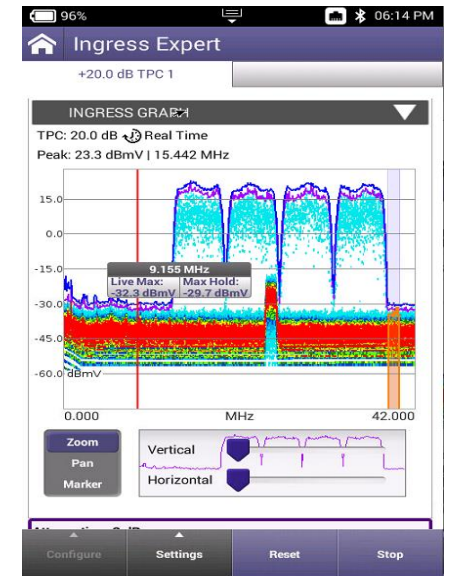
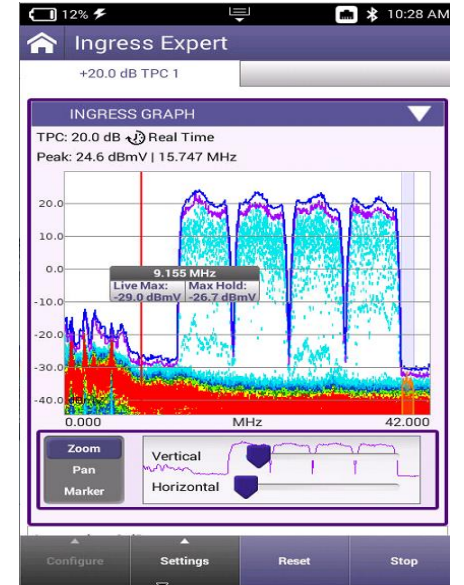
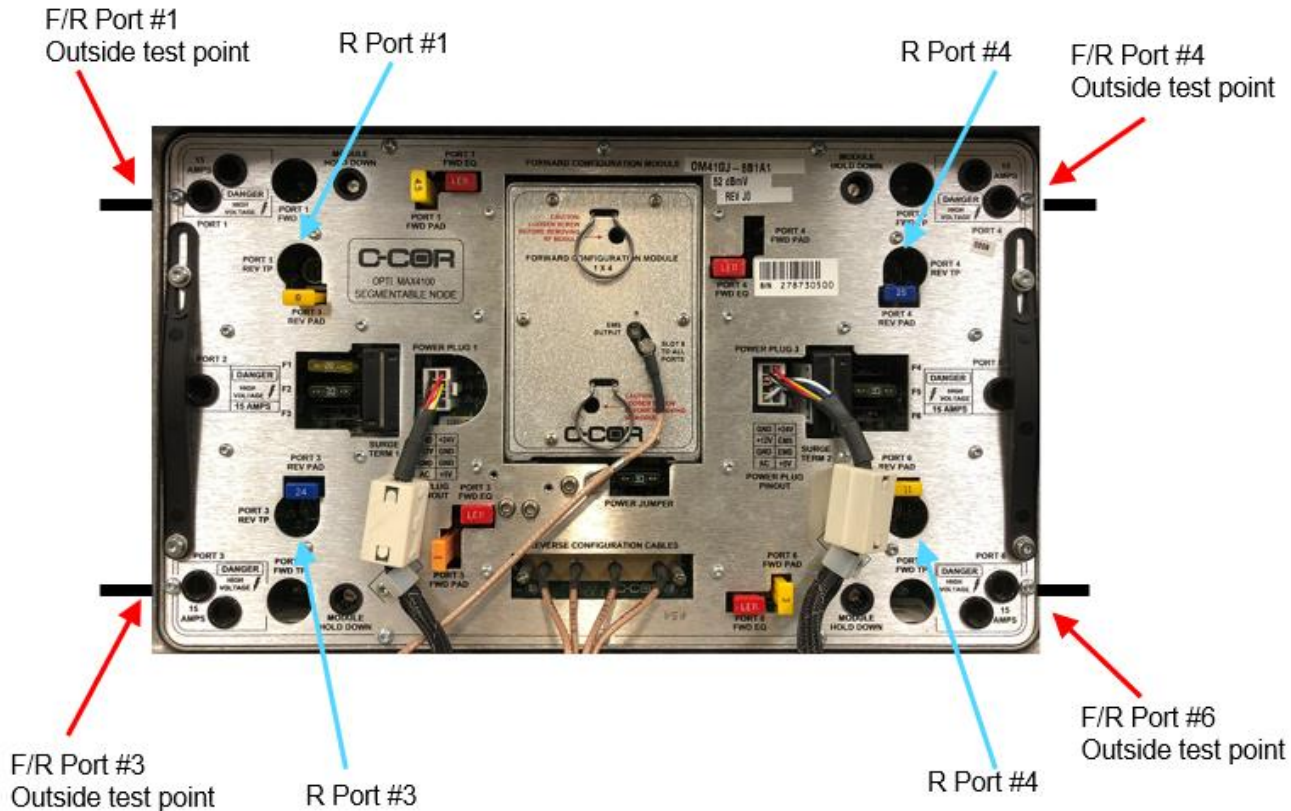
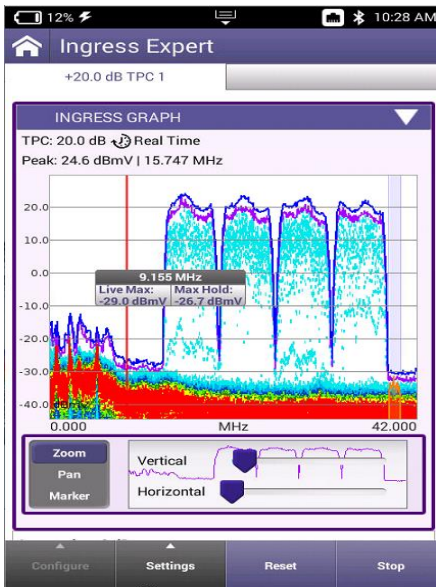
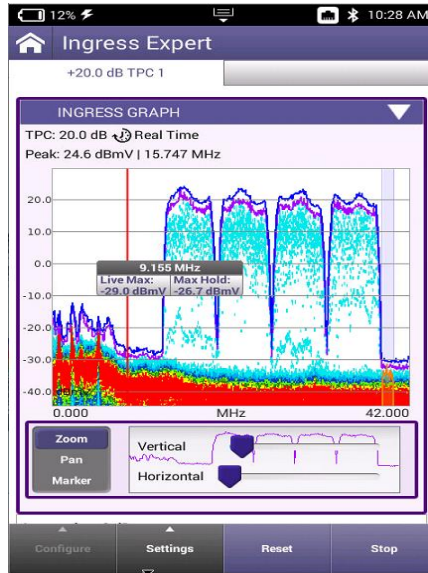


Advance Spectrum Analyzer Tests

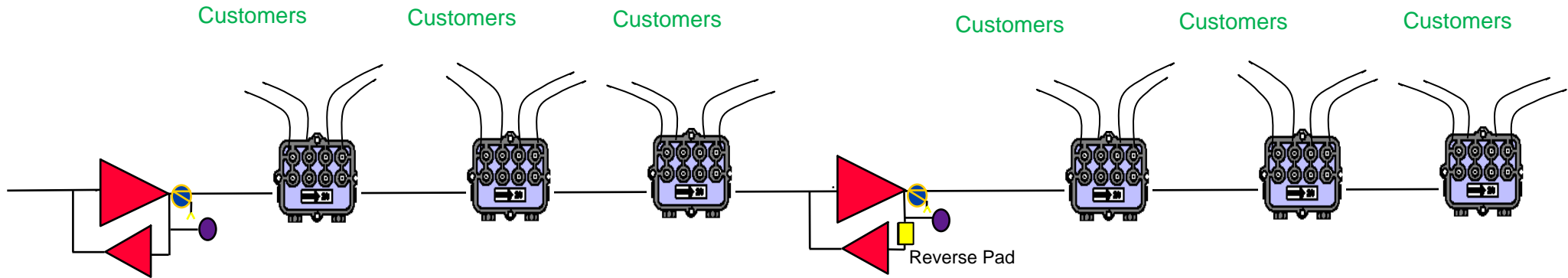


Using Meter to see the Ingress Fiber node

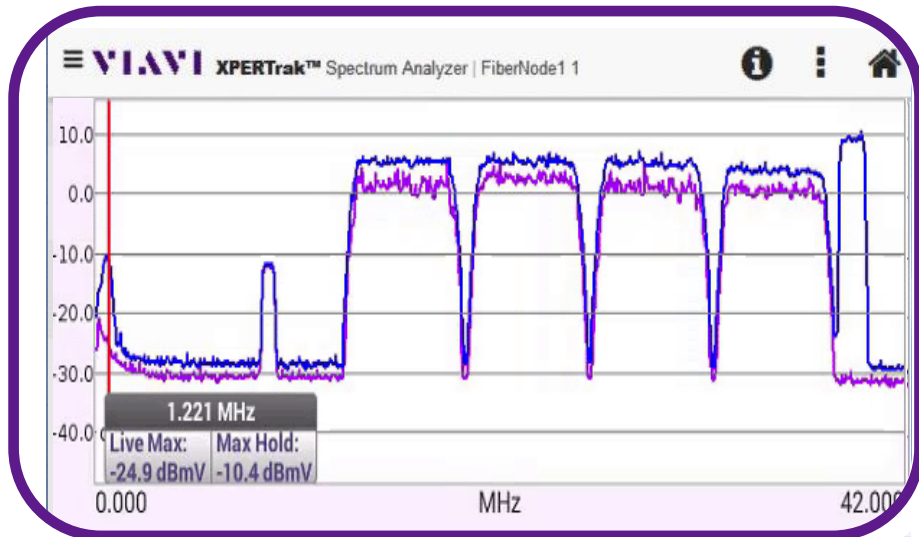
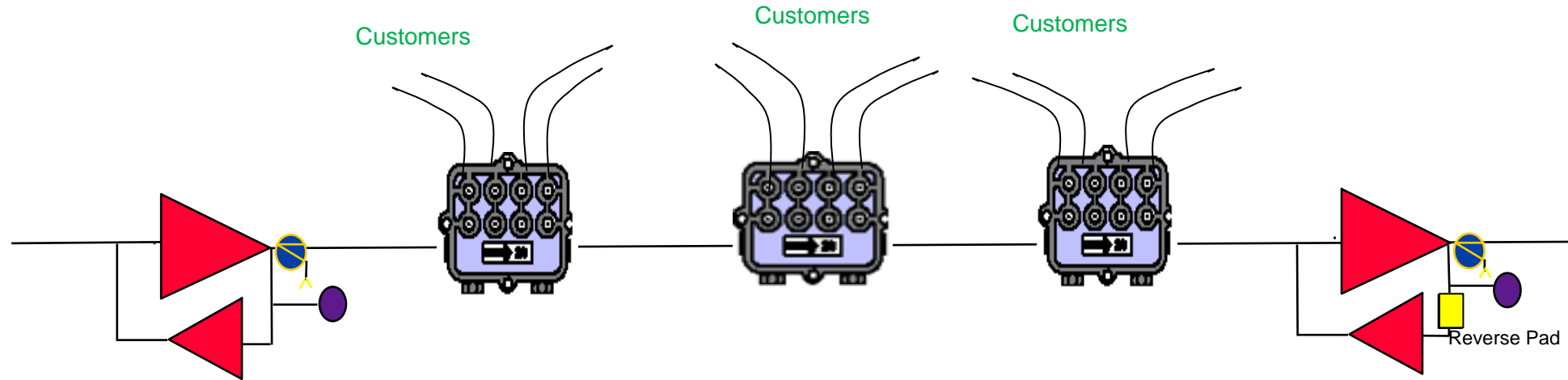
This is a better way
not as intrusive !



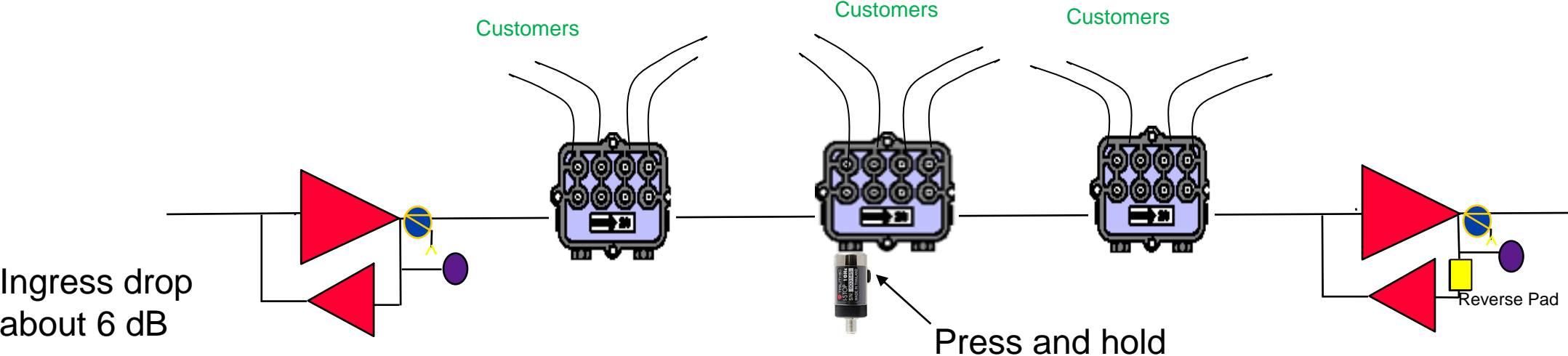
Check the Upper half of Node



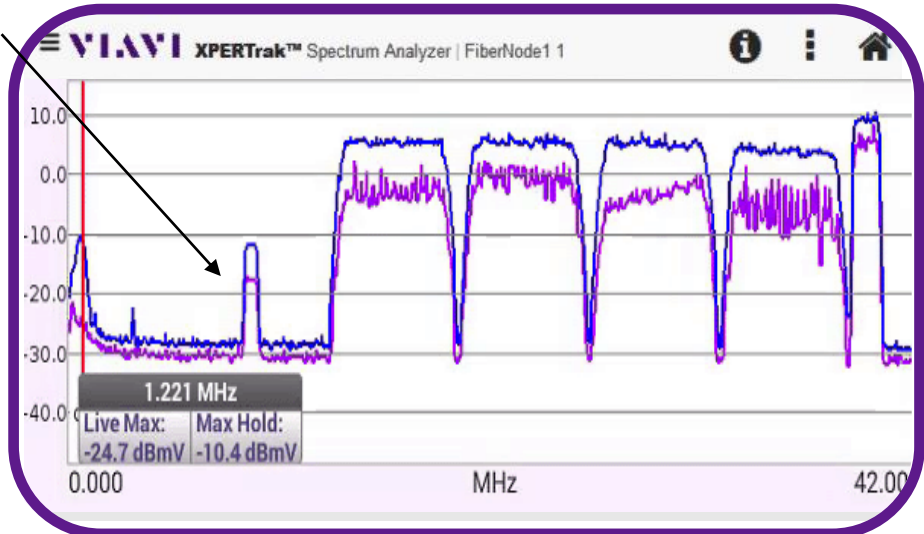
Insert I-Stop probe into the left side of Tap



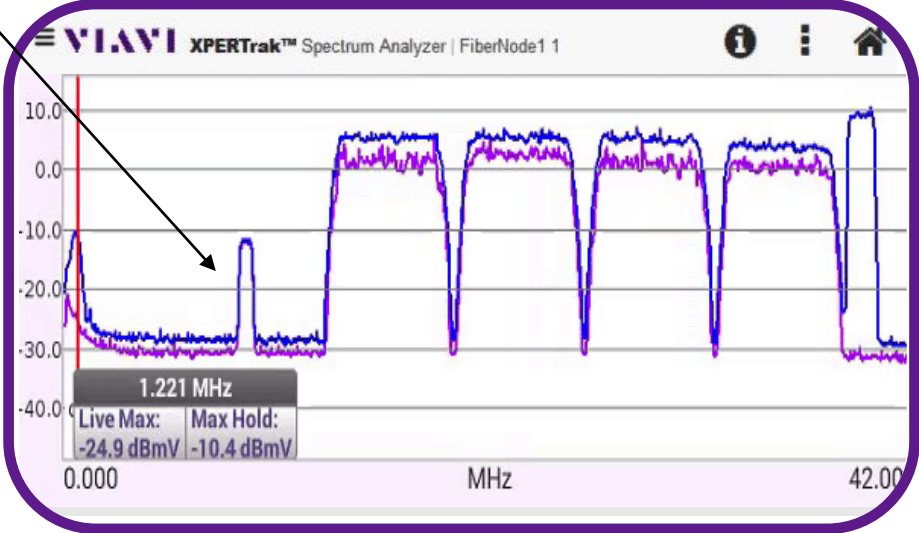
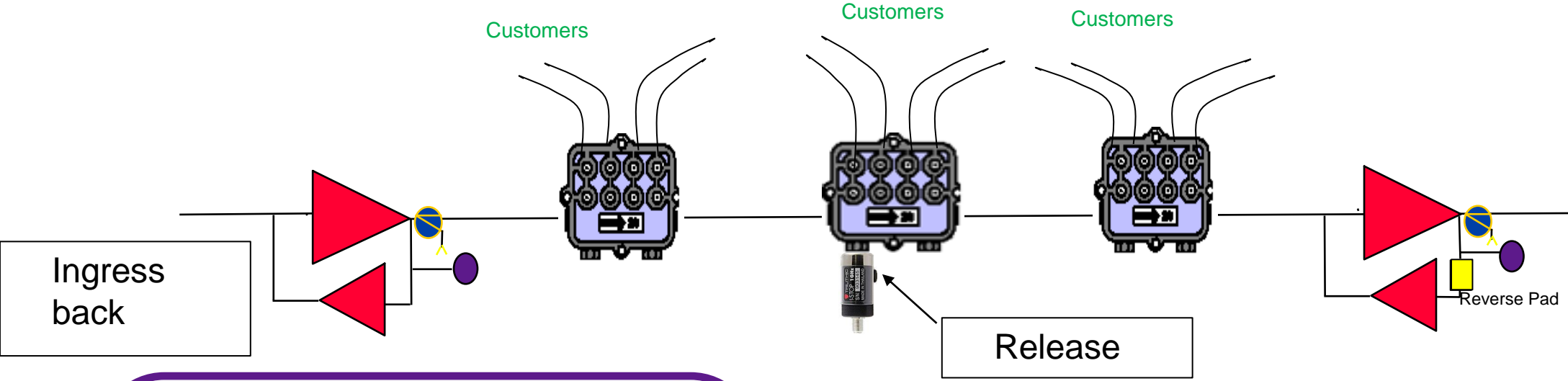
Press and Hold to see if Ingress is Reduced



Ingress drop about 6 dB

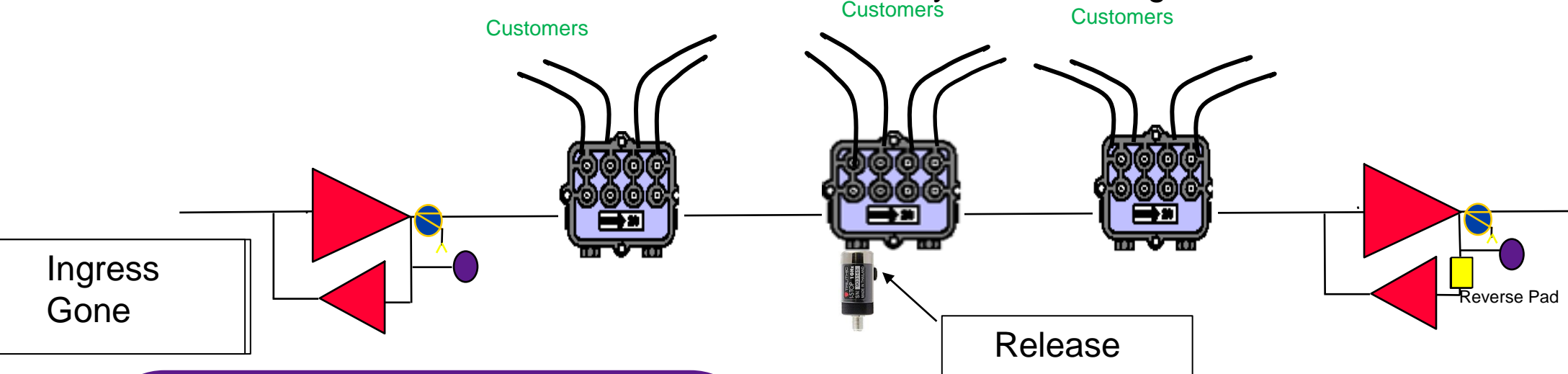


Release to see if Ingress comes back.

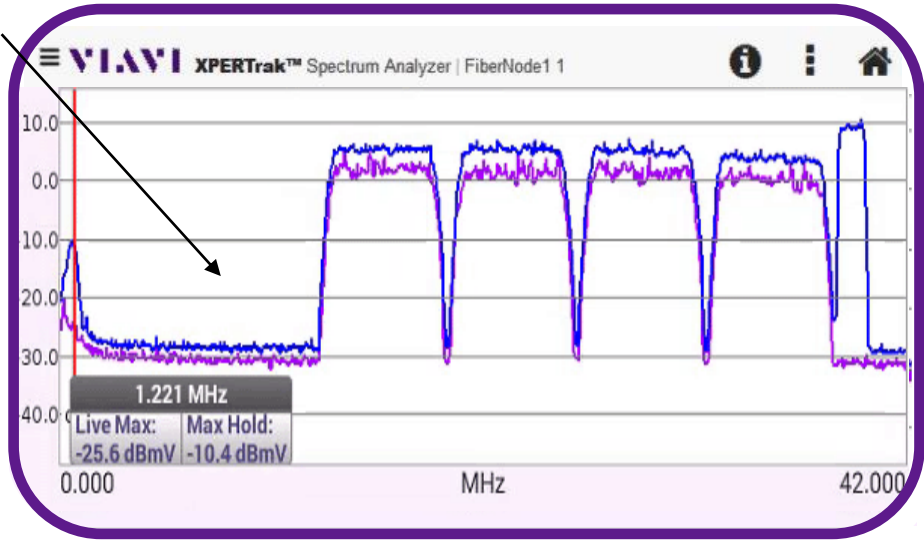


Find the ingress

Disconnect and reconnect customer 1 by 1 until you find the ingress



Ingress Gone



Live View

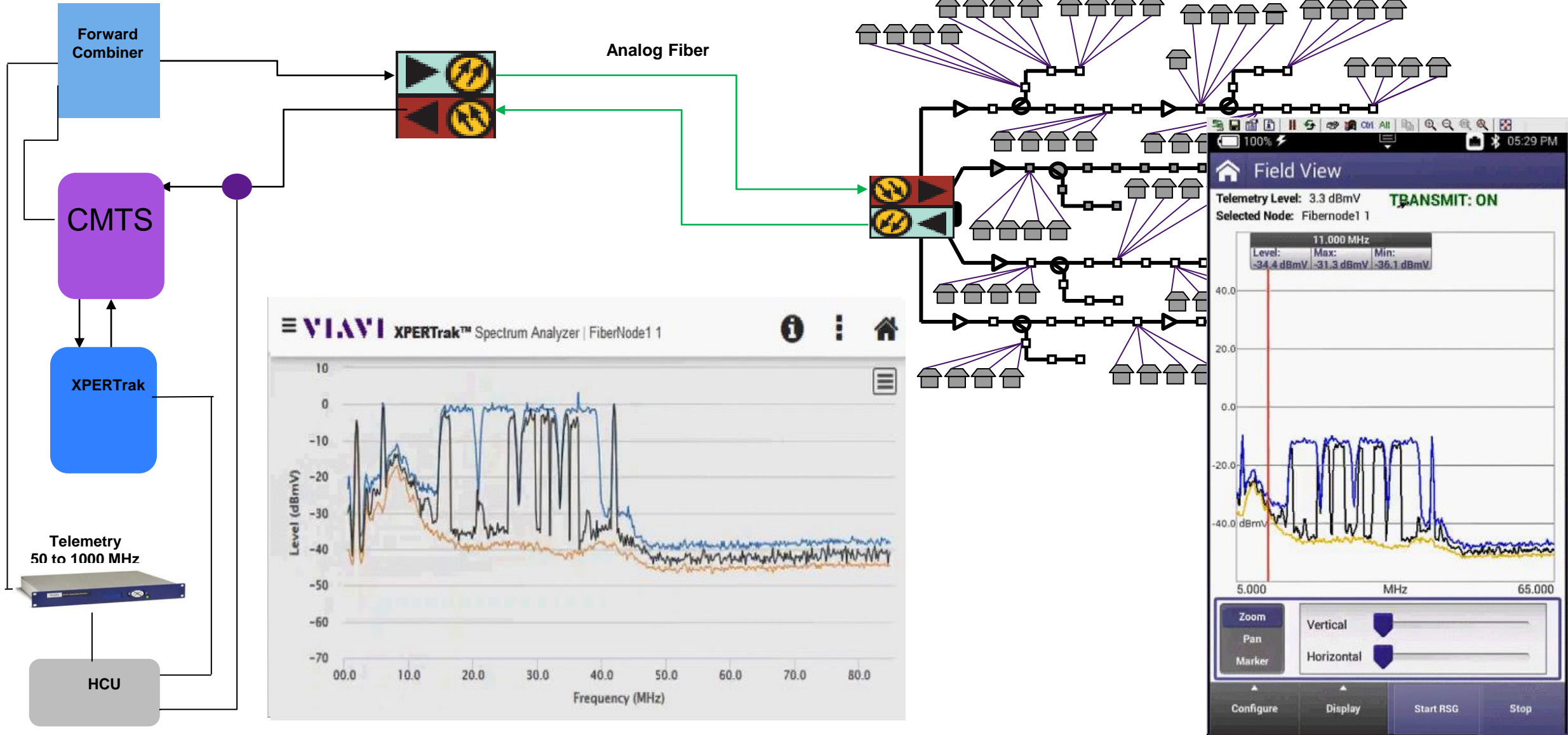
The image displays a software interface for a spectrum analyzer, titled "Ingress Expert", running on a "TightVNC Viewer". The interface shows a spectrum plot with two traces (blue and purple) and a frequency marker at 12.146 MHz. The plot shows a signal with a peak at 12.146 MHz and a frequency difference of -29.846 MHz. The vertical axis is labeled "dBmV" and ranges from -40.0 to 10.0. The horizontal axis is labeled "MHz" and ranges from 0.000 to 42.000. The interface includes controls for Zoom, Pan, Marker, and Attenuation (set to 18 dB). A "UCD INFORMATION" section is visible at the bottom. The software is running on a "WEBCAM VIEWER" window, which shows a live video feed of a technician in a blue shirt working in a laboratory setting. The technician is wearing a headset and is adjusting a device on a rack. The lab is filled with various electronic equipment, including a spectrum analyzer, a power supply, and a test bench. The video feed is titled "Running USB Camera at 1280 x 1024" and has a "STOP" button at the bottom right.

Live View

The image displays a software interface for a spectrum analyzer, titled "Ingress Expert", running on a "TightVNC Viewer". The interface shows a spectrum plot with a frequency range from 0.000 to 42.000 MHz. The plot displays a signal with a peak at 41.992 MHz. The vertical axis represents power in dBmV, ranging from -40.0 to 10.0. A data box indicates a frequency of 12.146 MHz, a frequency difference of $\Delta f = -29.846$ MHz, a live maximum power of 1.1 dBmV, and a maximum hold power of 1.0 dBmV. The interface includes controls for Zoom, Pan, Marker, Vertical, and Horizontal adjustments, as well as an Attenuation slider set to 18 dB. At the bottom, there is a "UCD INFORMATION" section and buttons for Configure, Settings, Reset, and Stop.

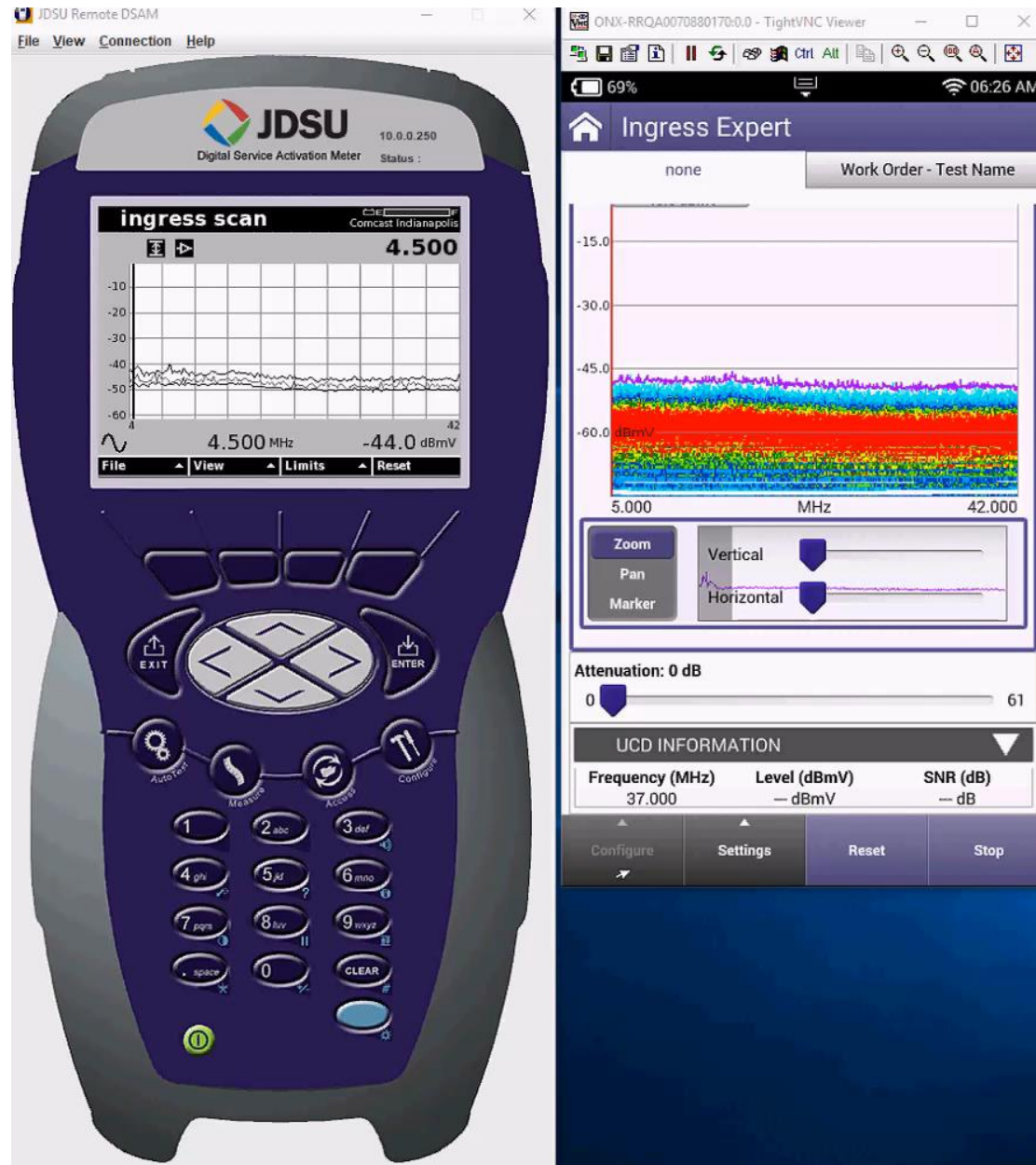
On the right side, a "WEBCAM VIEWER" window shows a live video feed of a technician working in a laboratory. The technician is wearing a headset and is positioned in front of a desk with various electronic equipment, including a spectrum analyzer, a power supply, and a rack of components. The technician's head and shoulders are visible in the foreground. The video feed includes a "STOP" button at the bottom right and a status message "Running USB Camera at 1280 x 1024" at the bottom left.

FieldView RSG



Ingress Expert VS DSAM Impulse Noise No QAMS

Swept
Tune

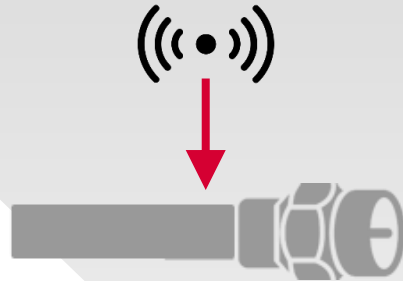


FFT
fast Fourier transform

Paradigm Shift:

Look for RF entering and exiting your network

Divide and Conquer



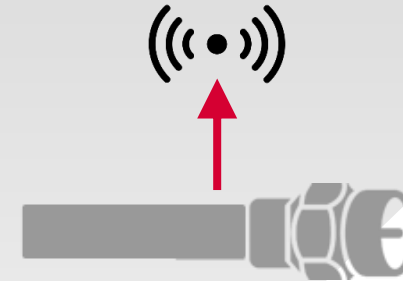
Chasing **INGRESS** is typically looking for RF getting **INTO** the Network

Goal: Find and fix shielding weaknesses

Challenges

- ✓ Funnel effect
- ✓ Intermittent noise
- ✓ Disrupts services

Leakage Detection



Focus on **EGRESS** RF leaking **OUT OF** the Network

Goal: Find and fix shielding weaknesses

Benefits

- ✓ Precise localization
- ✓ Tag always present
- ✓ Not service impacting

PNM Tools

VI.AVI

VI.AVI Solutions



PNM Tools

What Tools can I use for PNM?

- CMTS
- Spectrum Analyzers
- DOCSIS Meters
- Hum
- Sweep

What can PNM do for networks?

Proactively Detect and Address Plant Weaknesses Before Customers Impacted

Detect physical plant impairments on DOCSIS performance and reliability

Remotely Localise Location of Plant Weaknesses

- Dispatch to fix, not to find

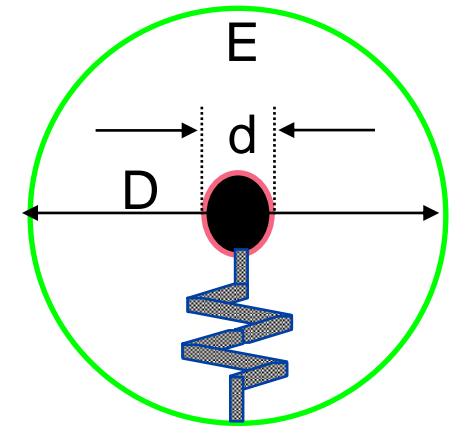
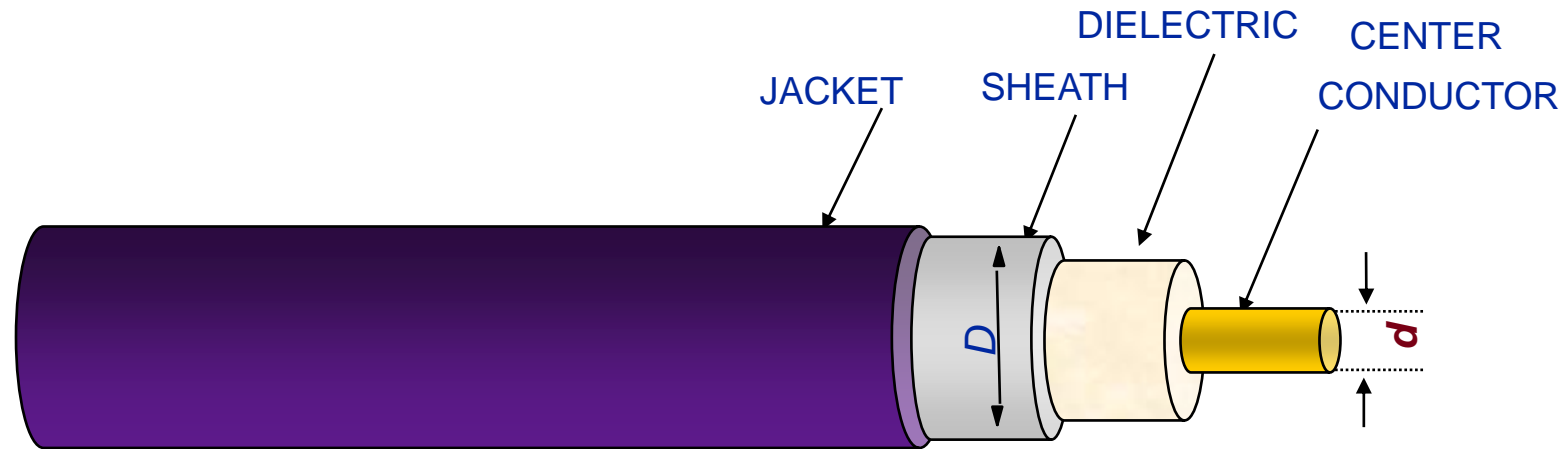
Determine ***Scope*** and ***Severity*** of Plant Weaknesses

- Which to fix immediately, which to keep an eye on

Identify common causes of faults – Use this information to augment technician efficiency or target network elements for proactive remediation.

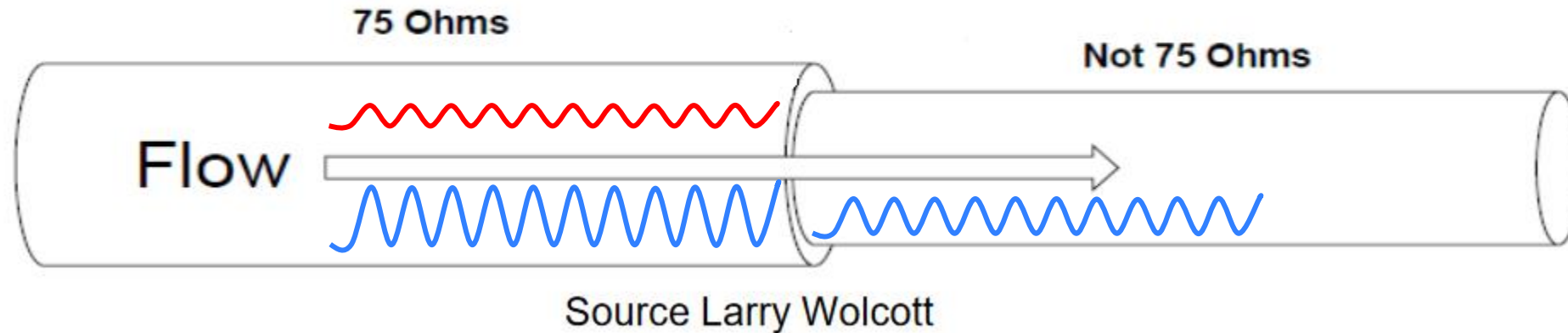


Cable Properties



$$Z_0 = \frac{138}{E^{.5}} * \log\left(\frac{D}{d}\right)$$

Impedance and Reflections



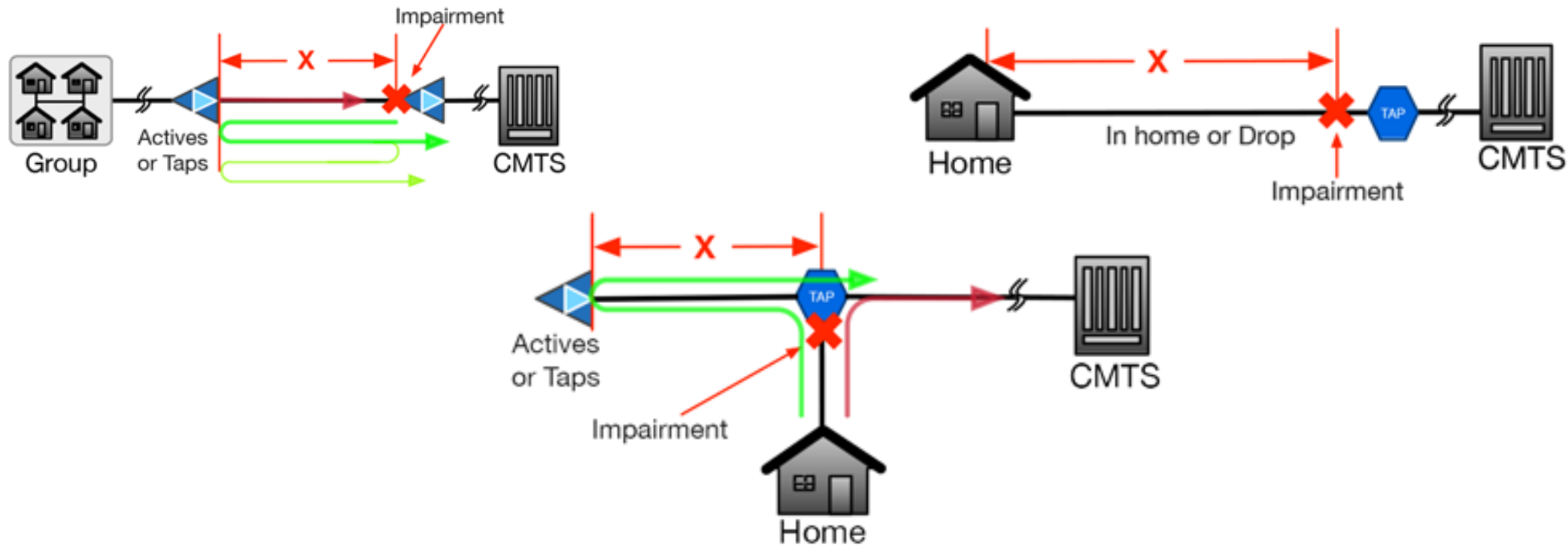
- Transmitted signal arrives at the impedance mismatch and some of the energy is reflected toward the source.
- We can measure the amplitude of the reflected energy.
- We can measure the amount of time it takes for the reflected energy to arrive back at the source.
- Since we know how fast signals travel through the cable, we can calculate the approximate distance to the fault.

Impedance Mismatch

- Mismatches occur for many reasons
 - Damaged cable
 - Equipment problems
 - Poor connectorization
 - Lack of proper termination
- Kinking of coax changes the inner diameter of the shield
- The use of staple guns for cable attachment can cause standing waves, because they “flatten the cable
- Terminators can be harmed by an AC surge if not protected
- Every connection is an impedance mismatch

Micro-Reflections

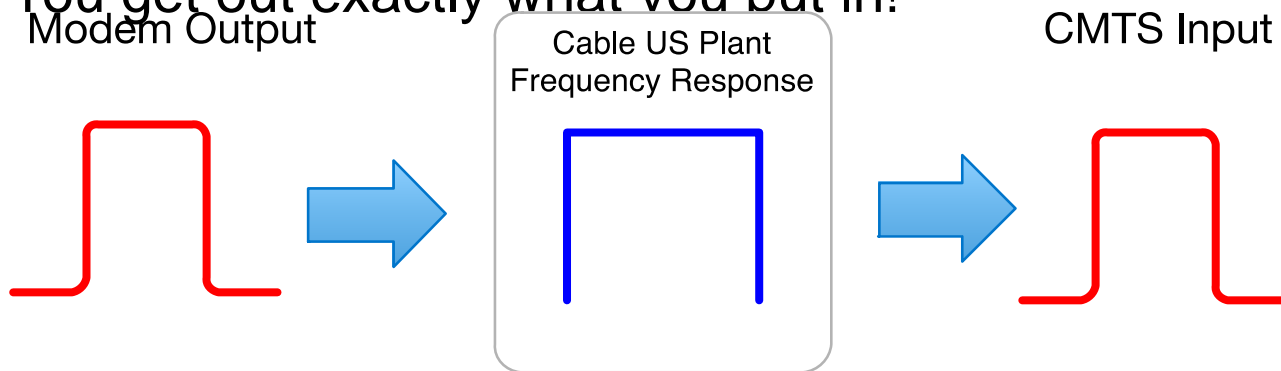
- Micro reflections are caused by impedance mismatches in the transmission line.
- Due to an impedance mismatch a small portion of the signal is reflected and arrives at the CMTS delayed. The delayed signals sum with the main signals and cause standing waves (Ripples in the response).



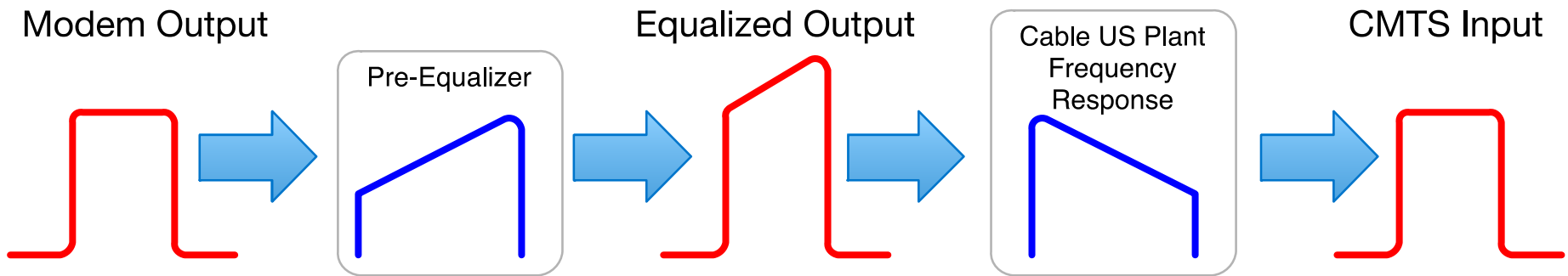
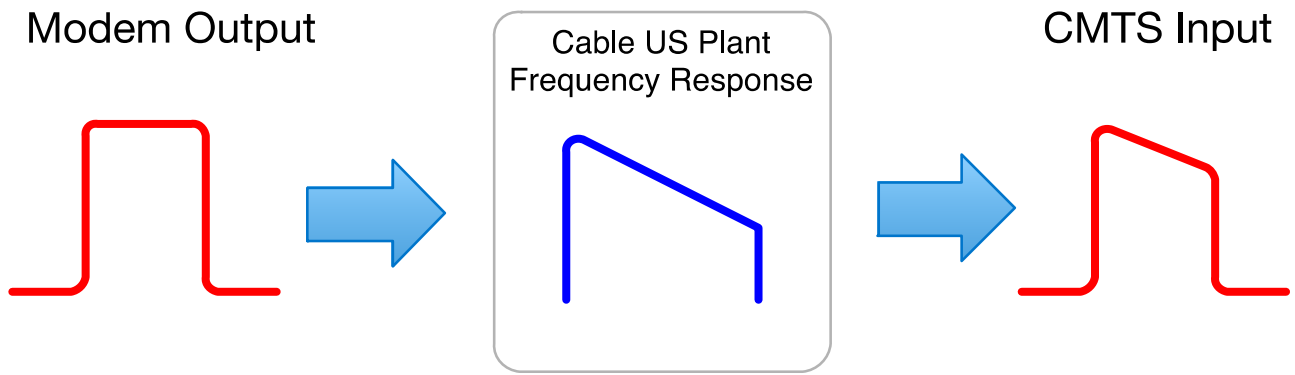
How Does Pre-Equalization Work

- CMTS looks at the RNG-REQ messages and determines the corrections required to improve the response and sends them to the modem
- Then Modem pre-distorts its transmission to counteract network issues, resulting in the CMTS receiving a flat signal.
- In an ideal world cable plants have perfect frequency response

- You get out exactly what you put in!

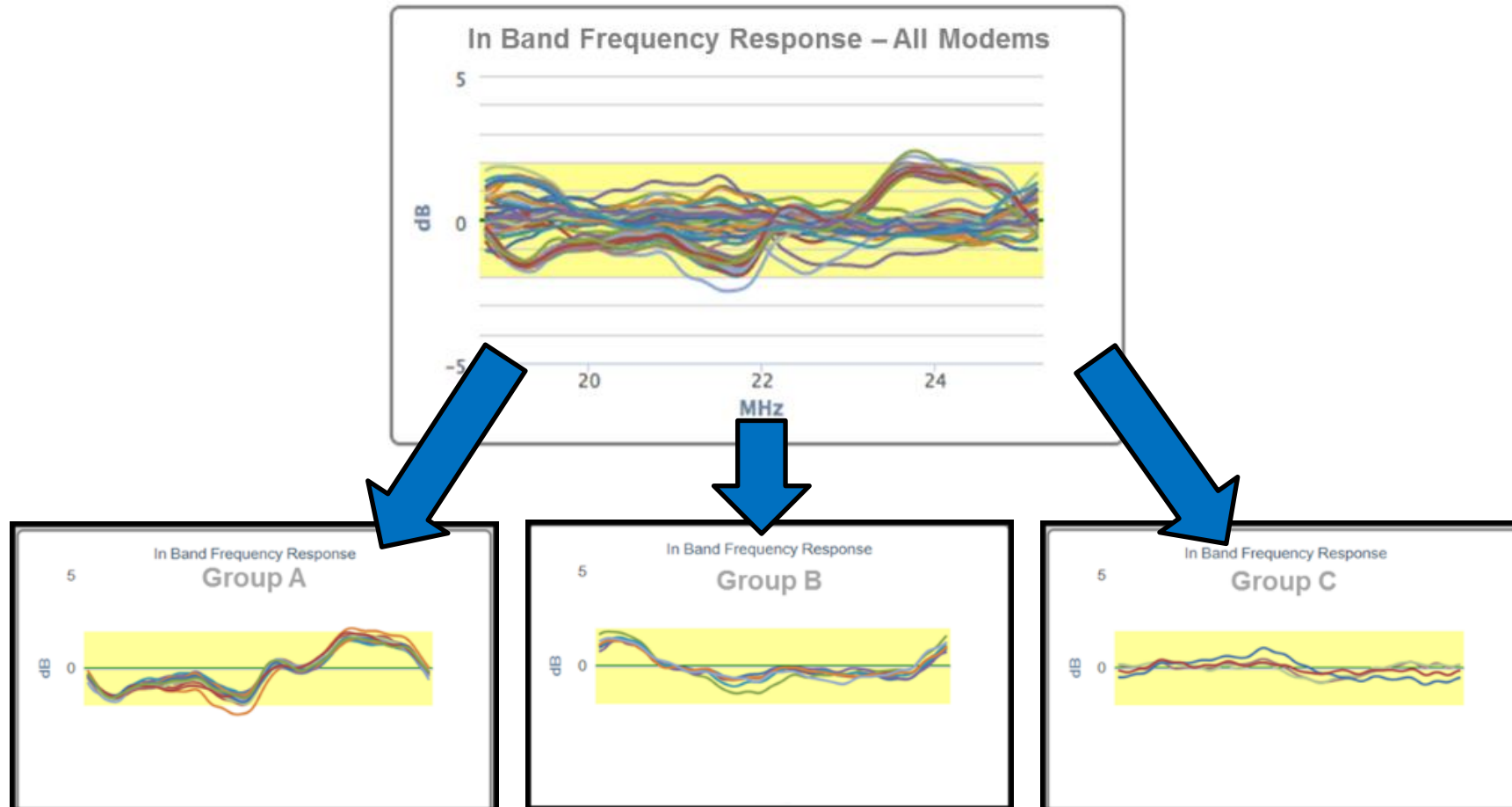


The Real World



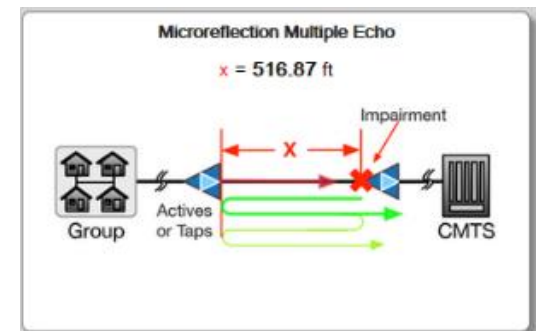
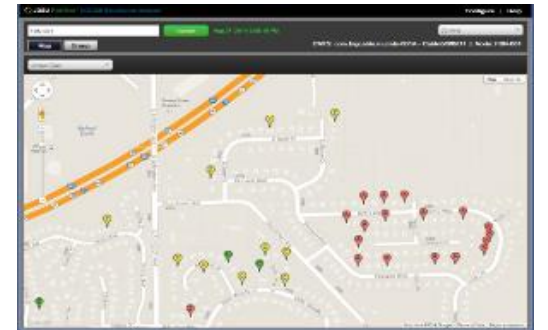
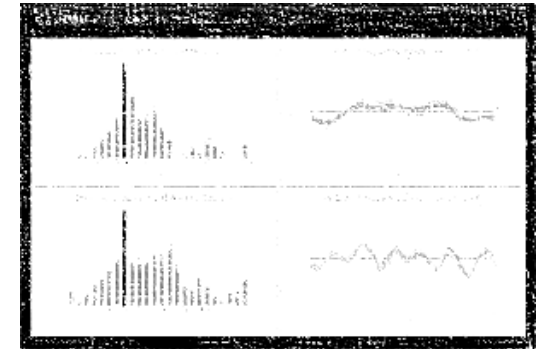
How Pre-Equalization Data Can Help Cable Operators

- **Correlate:** Automatically Separate Modems With Statistically Similar Frequency Responses Into Groups
 - Premise: Their packets are passing through the same impairment(s)



How PNM Can Help Cable Operators

- **Correlate:** Automatically Separate Modems With Statistically Similar Freq Responses Into Groups
 - Their packets are passing through the same impairment(s)
- **Localize:** Plot Modem Groups on Google Map To Allow Identification of Last Common Isolation Point
 - Where to start field find and fix from
- **Pinpoint:** Use Microreflection Data To Calculate “Echo Cavity” distance
 - Dispatch to fix, not to find



Common Pre-Equalization Use Cases

- **Proactive Plant Hardening**

- Find nodes with worst impedance mismatches and proactively fix
 - High # of CPE affected by moderate microreflection
 - Moderate # of CPE affected by large microreflection
- Address problems often responsible for “intermittent” issues

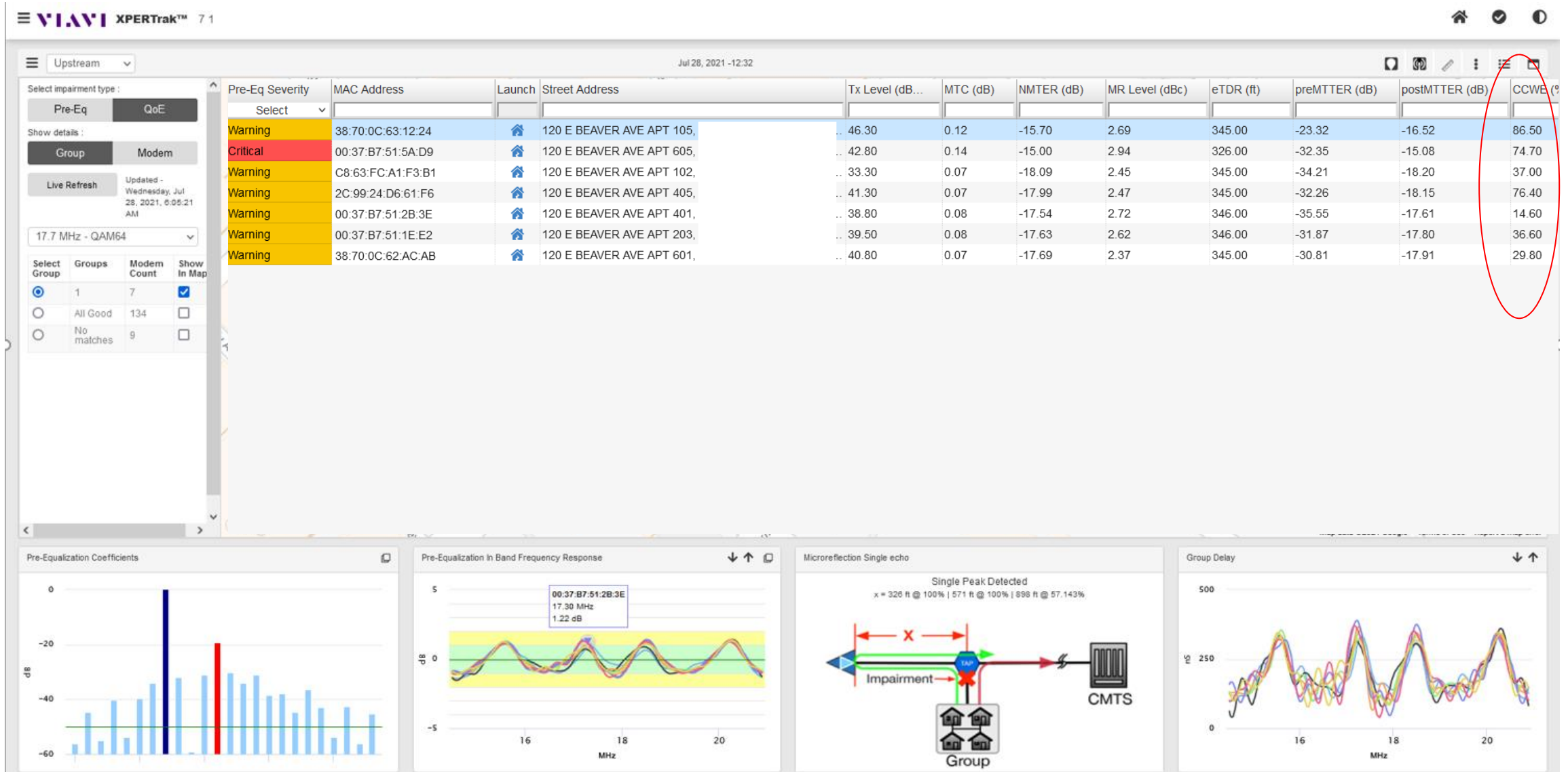
- **Part of Customer Trouble Ticket Triage Process**

- Does customer modem show significant microreflection?
 - Is microreflection relevant to customer complaint?
 - Is it part of a larger group (plant problem vs home)?

- **New Service Install Verification**

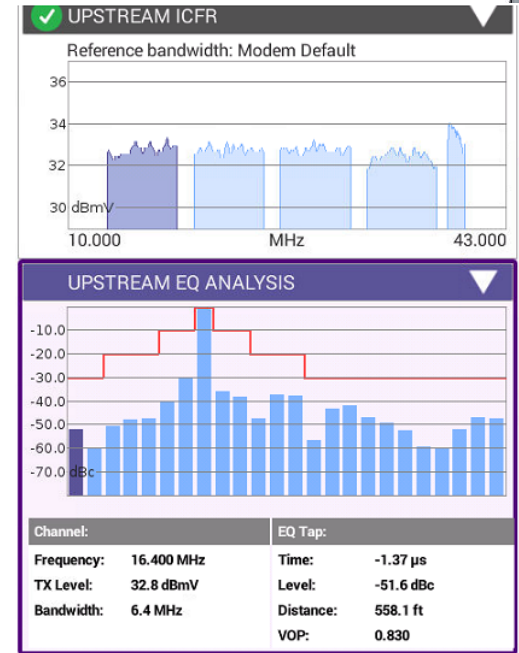
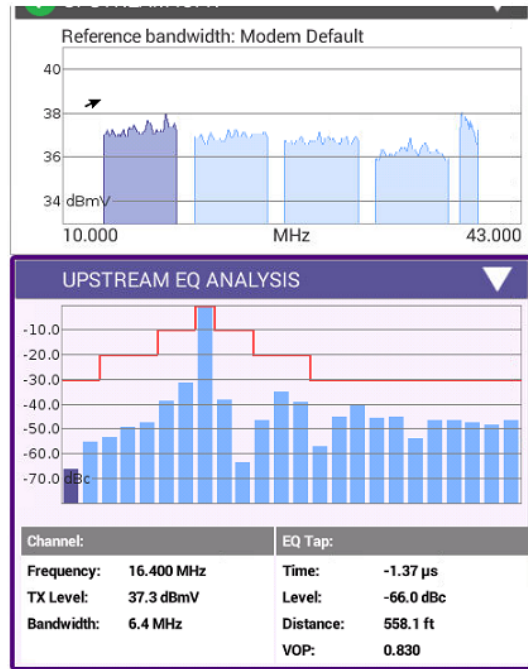
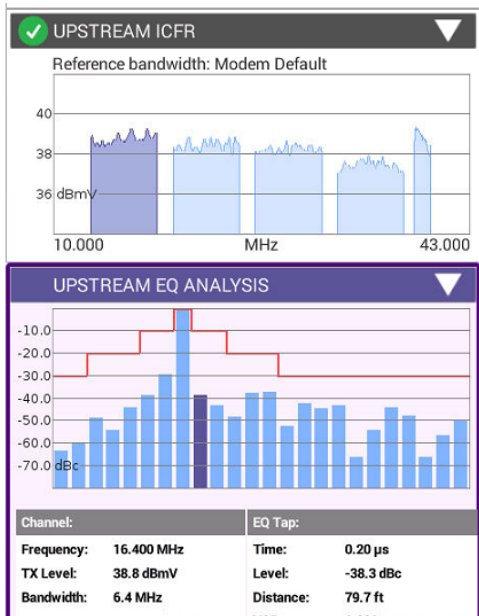
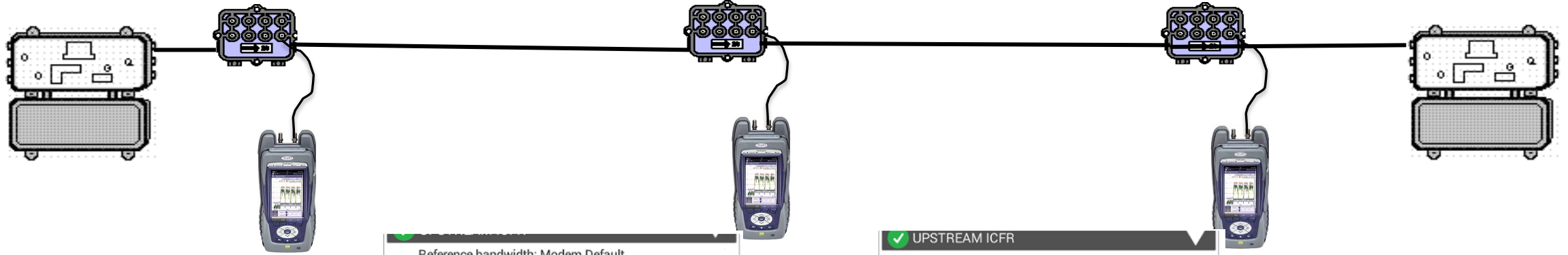
- Install process not closed if tap-down microreflection remains

PNM in Action



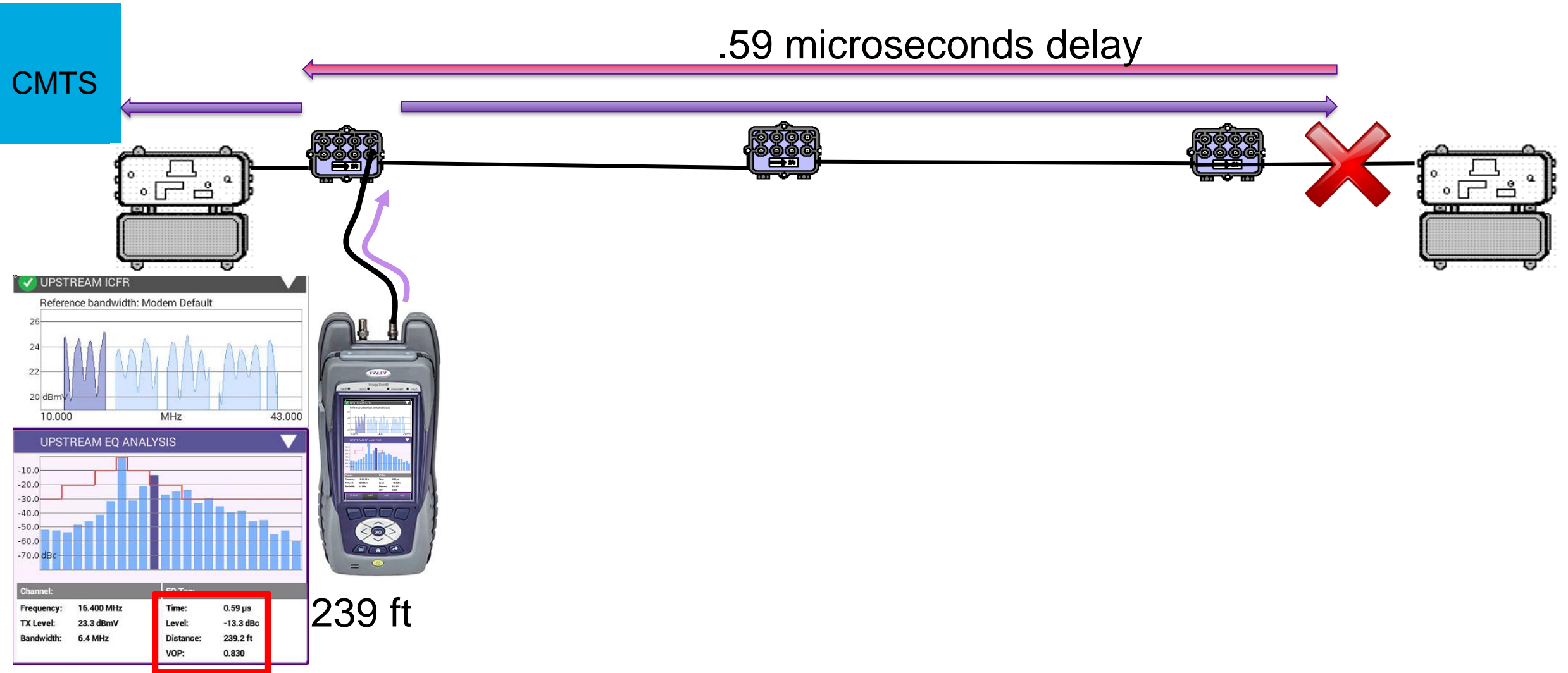
How Pre-Equalization Data Can Help Cable Operators

- No impairments



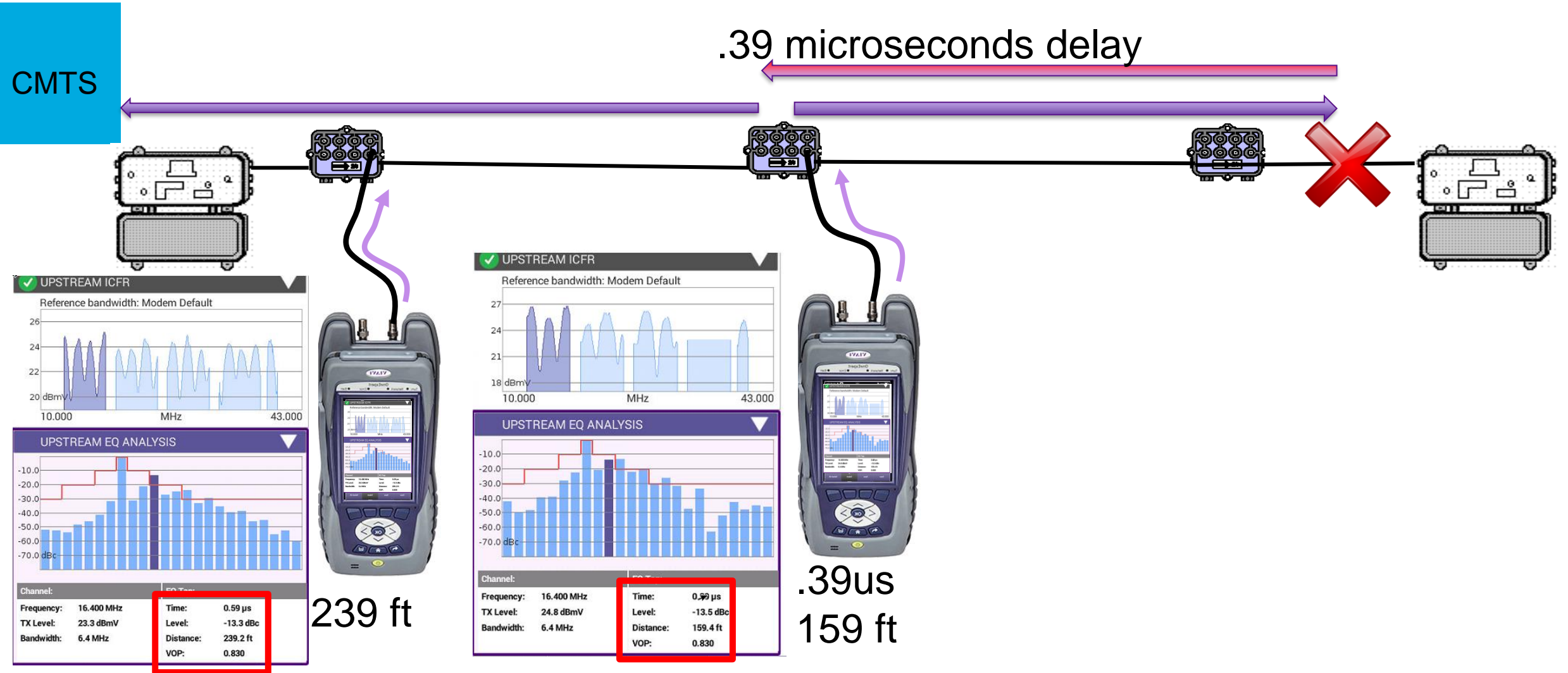
How Pre-Equalization Data Can Help Cable Operators

- **DOCSIS Pre-Equalization in Action**



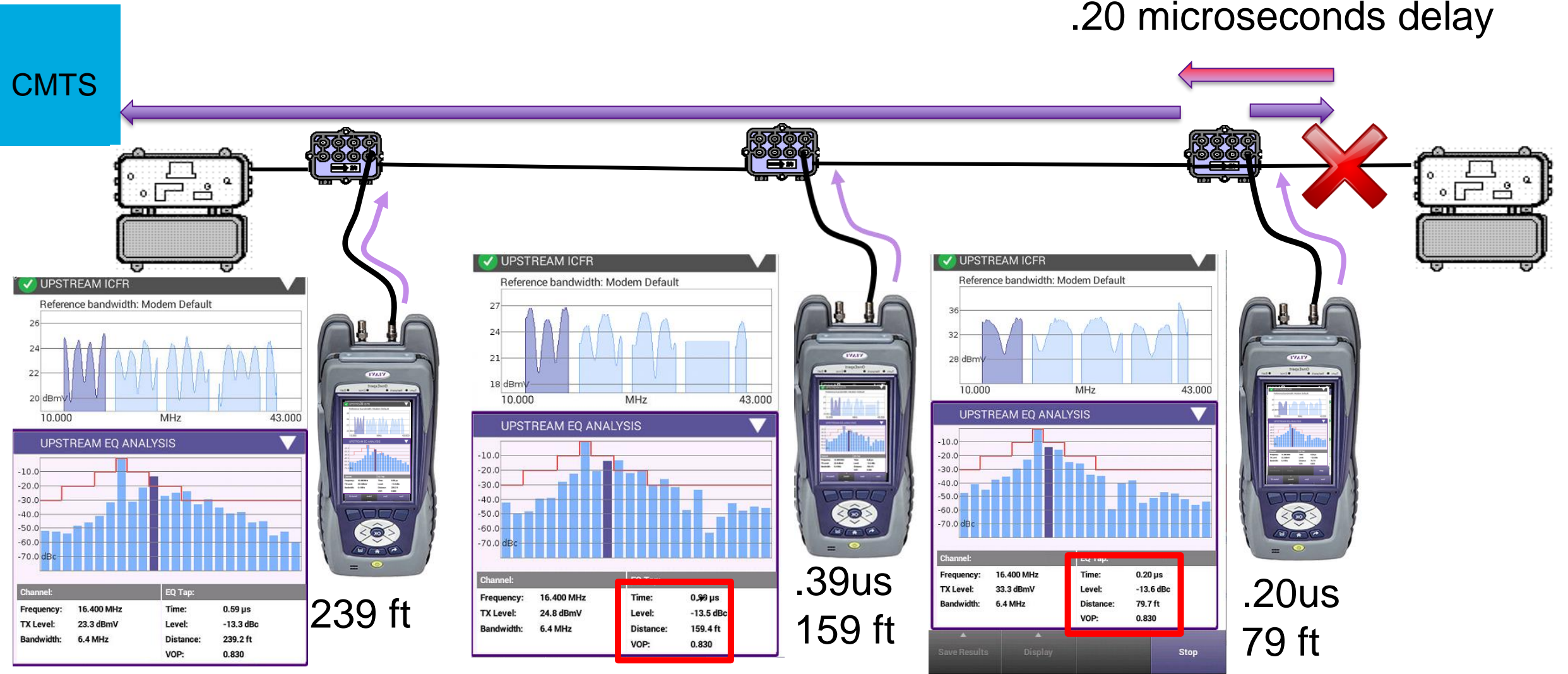
How Pre-Equalization Data Can Help Cable Operators

- **DOCSIS Pre-Equalization in Action**



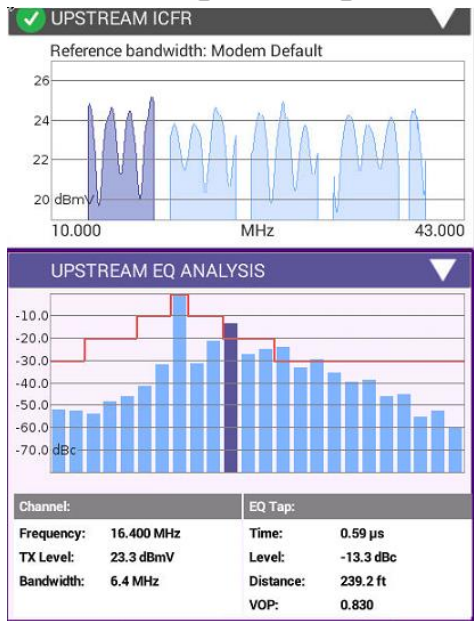
How Pre-Equalization Data Can Help Cable Operators

- **DOCSIS Pre-Equalization in Action**

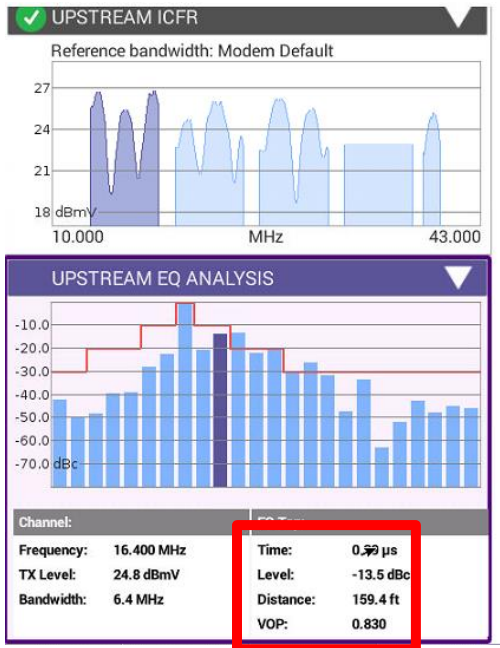


CMTS

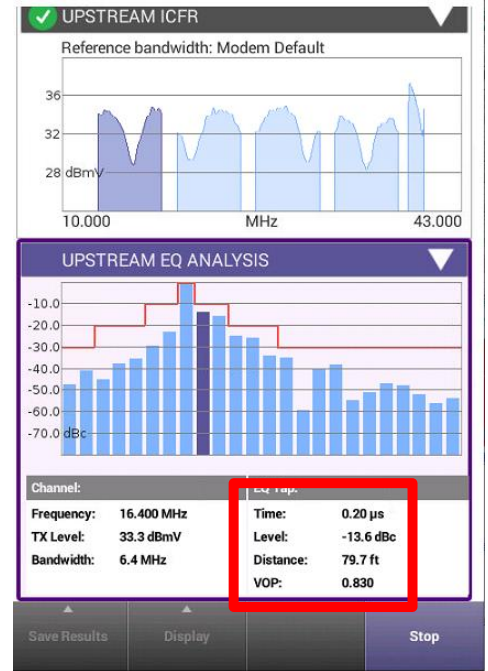
.20 microseconds delay



239 ft



.39 μ s
159 ft



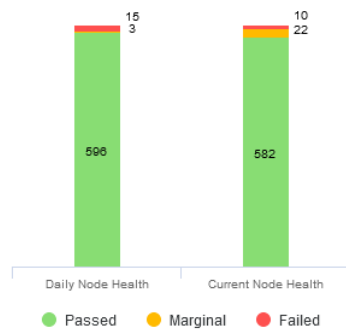
.20 μ s
79 ft

Node Health



Node / Modem ▼

Node Health

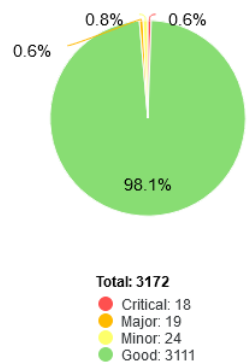


Churn Priority List 100 of 614 (Show All)

Current Node Health ▼ Actions ▼ Clear Filter

Node	Score ↑	Impacted	Stressed	Total	History
7	46	120	27	166	
RWS	65	32	0	56	
FR	69	72	41	149	
30	75	46	7	68	
KIN_	75	25	0	26	
CLC	77	43	3	166	
IV	78	38	2	105	

Alarms Summary

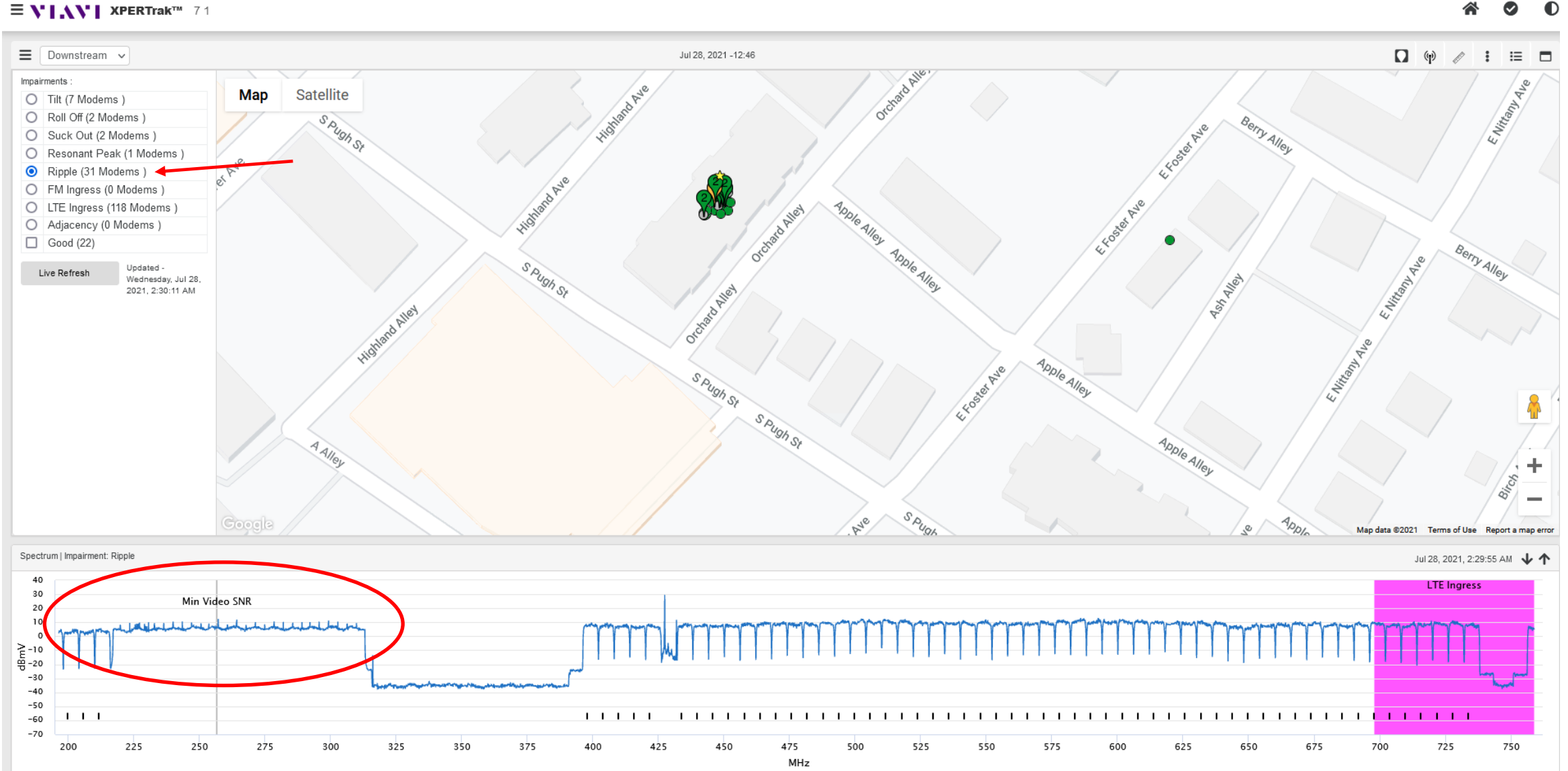


Alarms List 63 items

Actions ▼ 🔄 12:51:48 PM Clear Filter

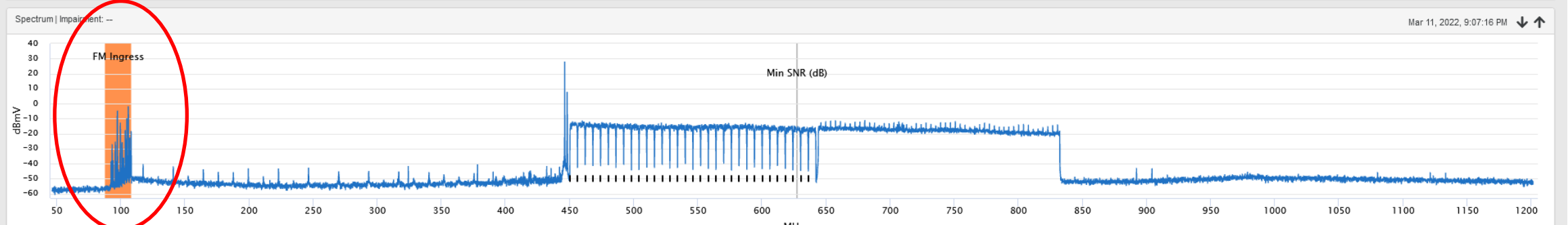
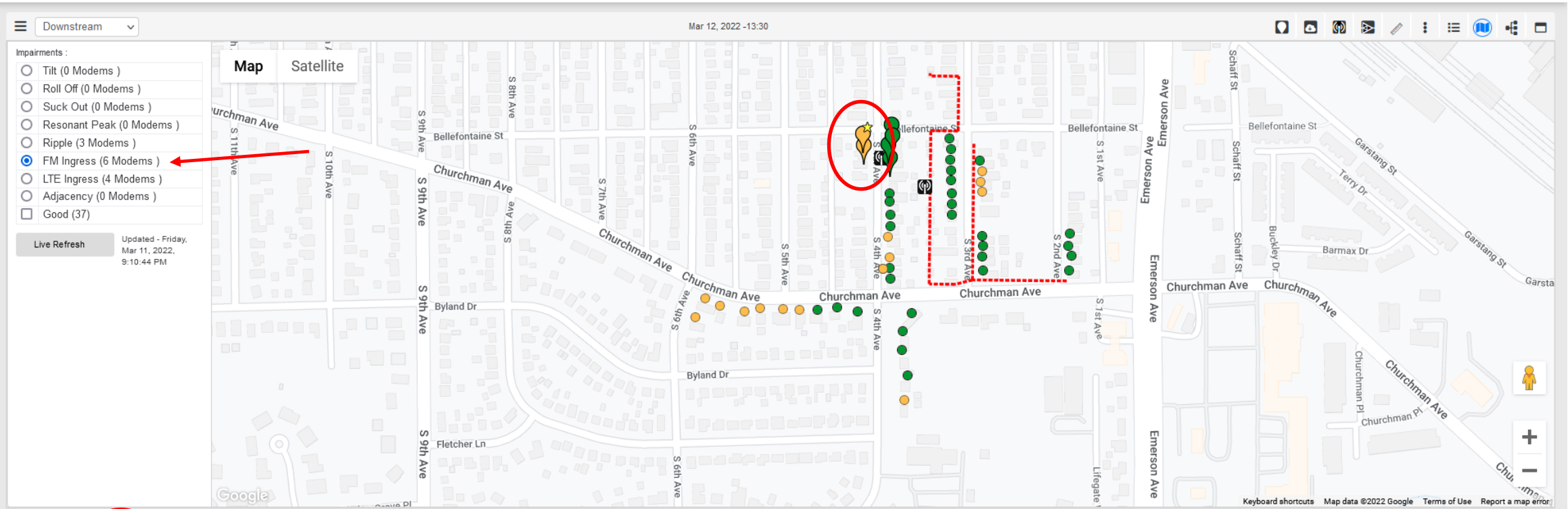
<input type="checkbox"/>	Timestamp (1) ↓	Severity (2) ↑	Node	Event	Ack Req	ID (3) ↓
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Critical	AYA-A	Violation - Node Health Critical	No	388439
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Critical	ST	Violation - Node Health Critical	No	388434
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.N	Violation - Node Health Marginal	No	388433
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.CO	Violation - Node Health Marginal	No	388424
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.UDE	Violation - Node Health Marginal	No	388412
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.RHL	Violation - Node Health Marginal	No	388231
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.UNR	Violation - Node Health Marginal	No	388230
<input type="checkbox"/>	Jul 28, 2021 12:49 PM	Major	.HEN	Violation - Node Health Marginal	No	388221
<input type="checkbox"/>	Jul 28, 2021 12:47 PM	Critical	FRRM	Violation - Node Health Critical	No	388324
<input type="checkbox"/>	Jul 28, 2021 12:47 PM	Critical	WTWK-B	Violation - Node Health Critical	No	386477

Modem Forward Path Measurements

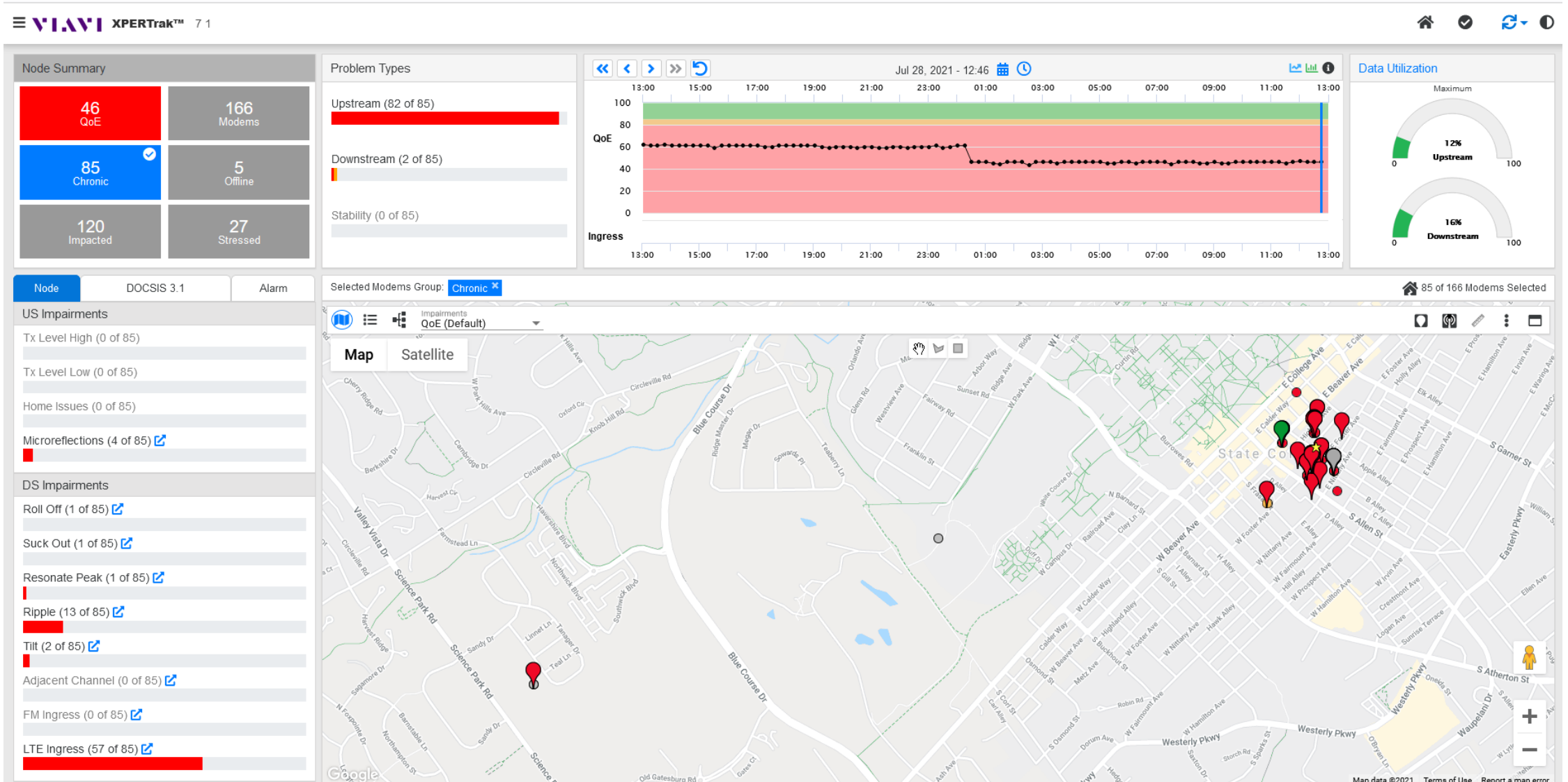


Modem Forward Path Measurements

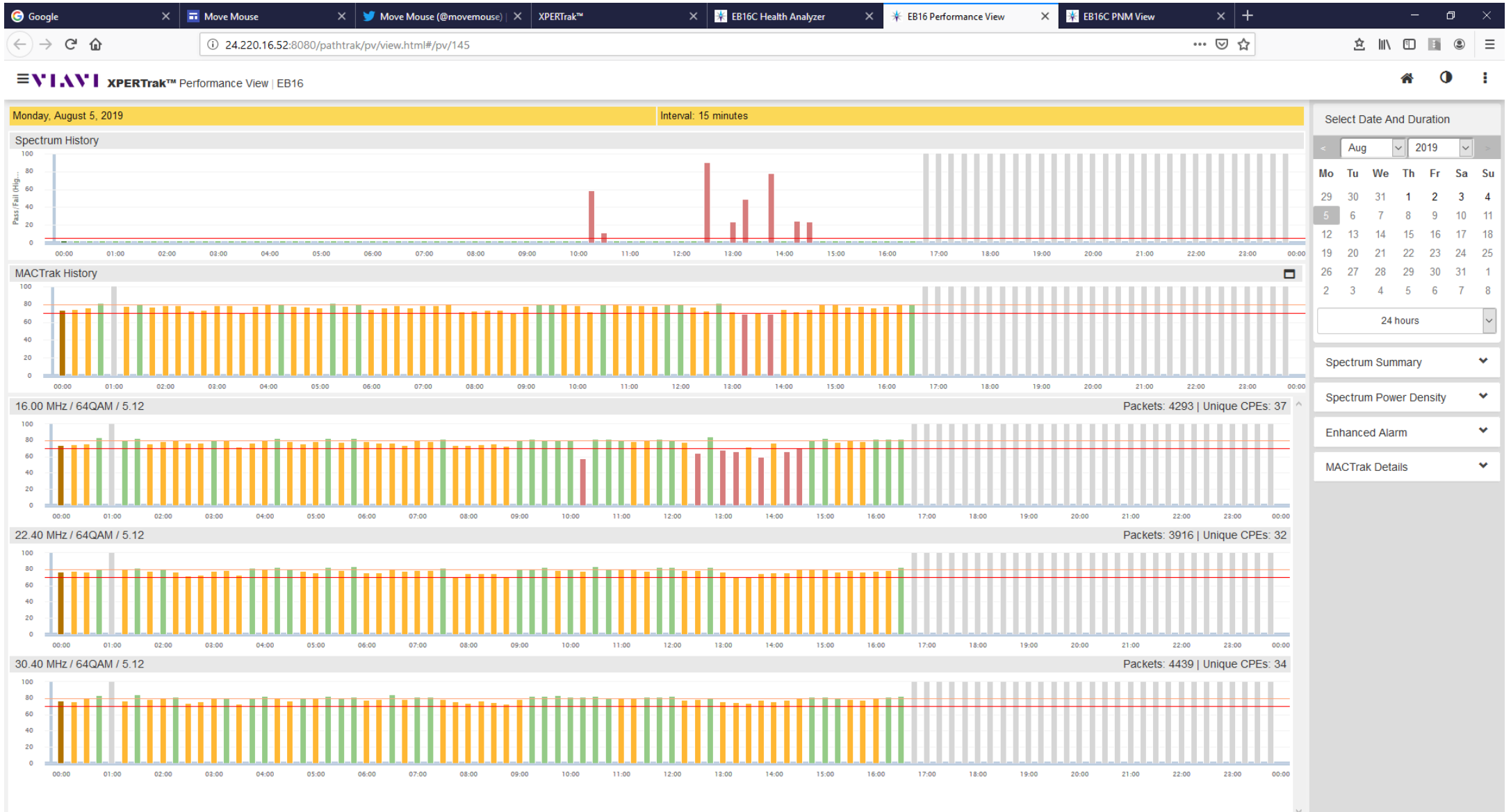
VIAMI XPERTrak™ CBR8-3/0/2-0-IDFR-NT



Specific Node Issues



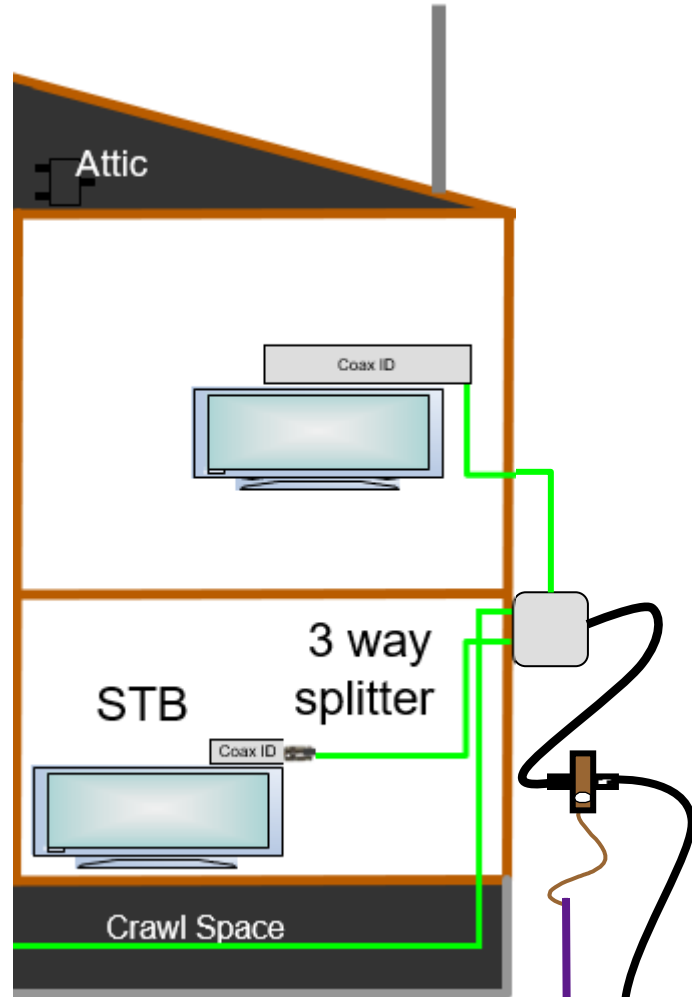
Performance View Over Time



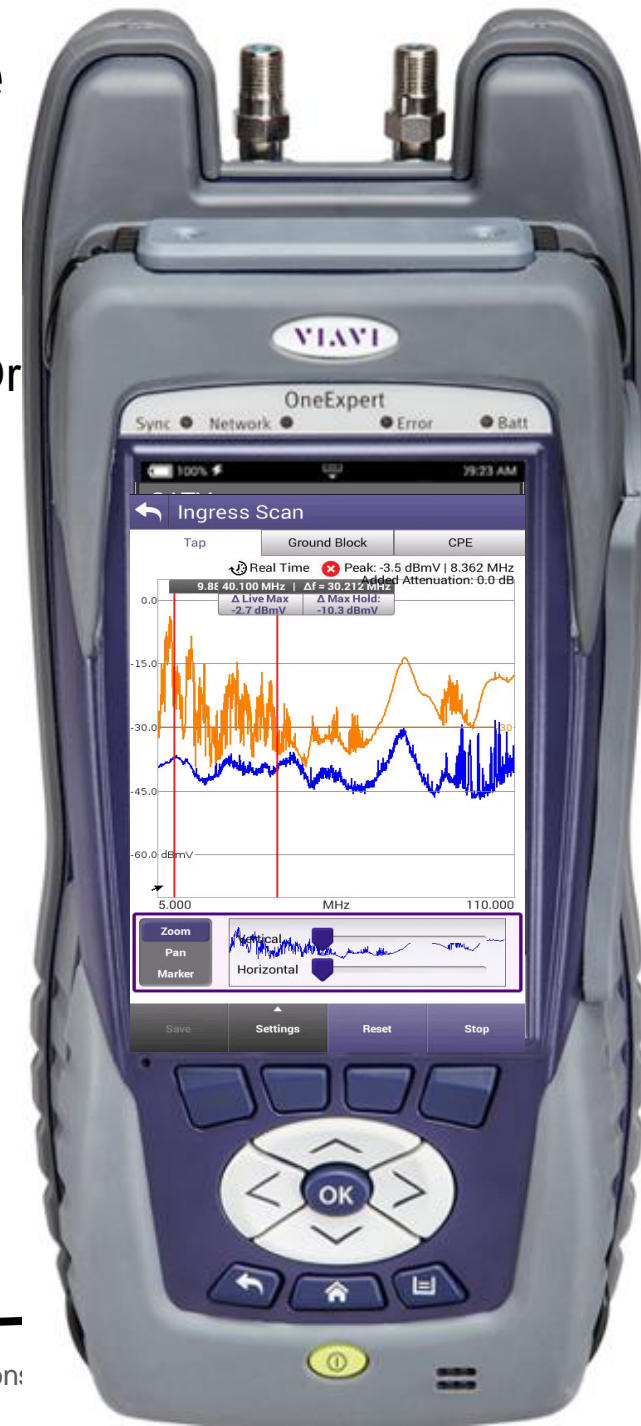
Certify the Drop Ingress at the

Certify the Drop

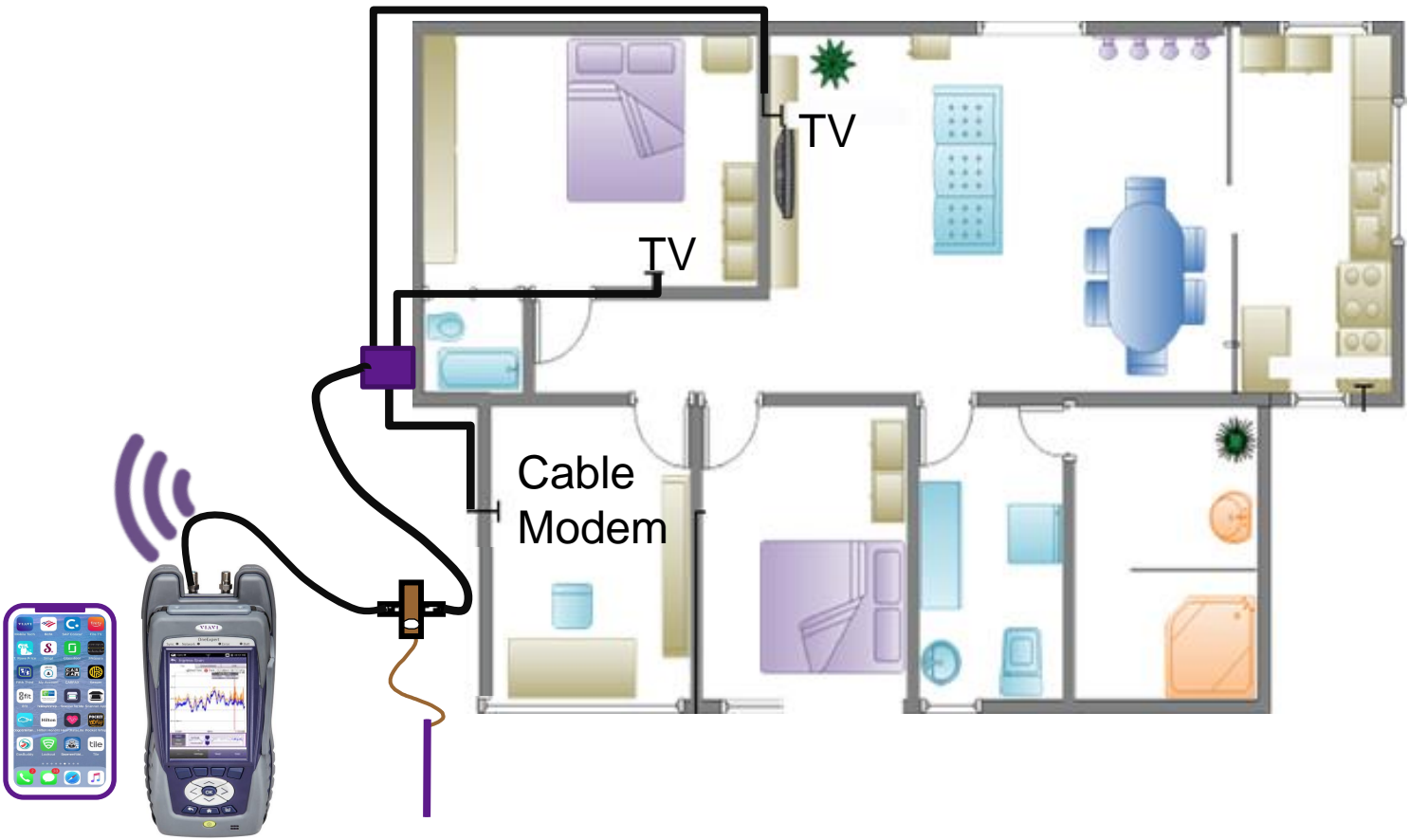
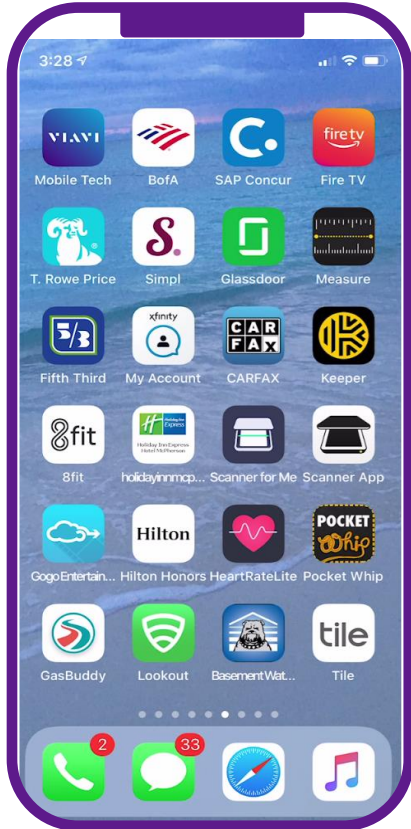
Connect port 2 to the drop and verify the ingress using the ingress test



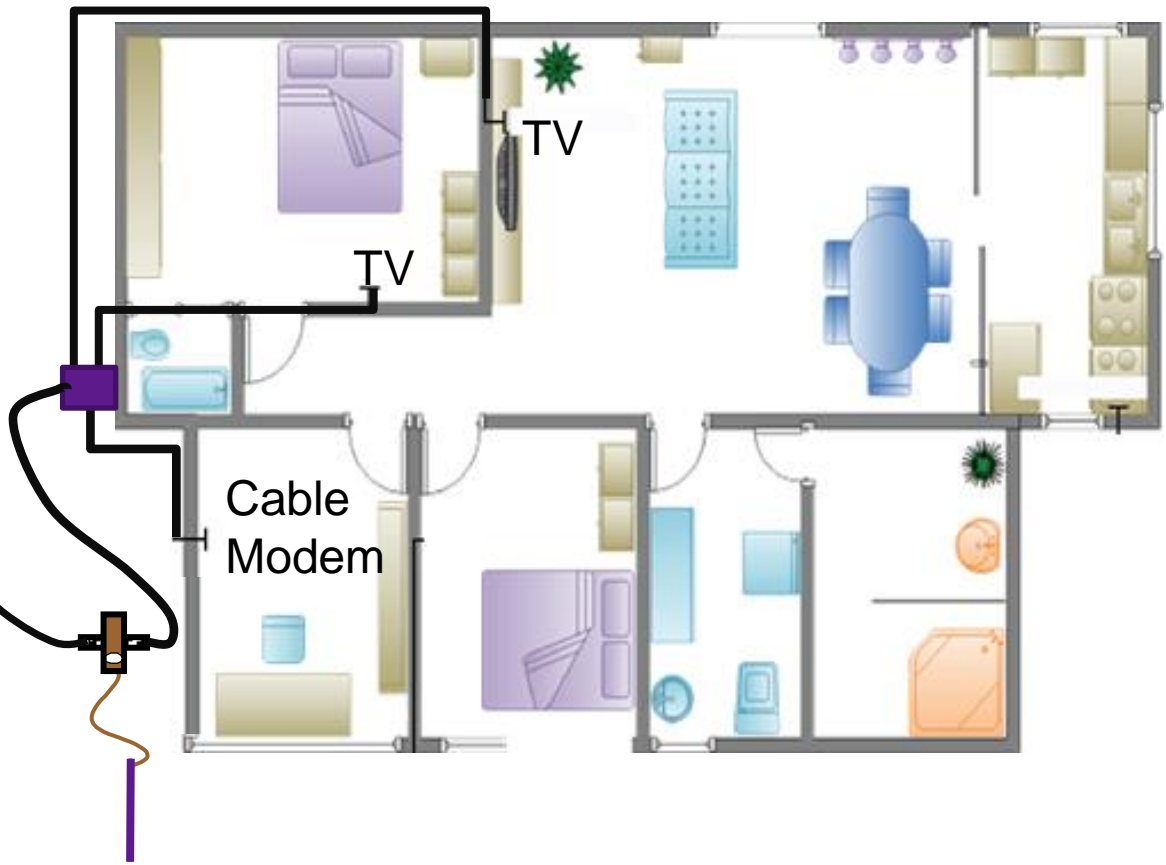
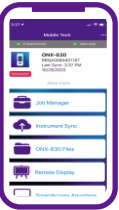
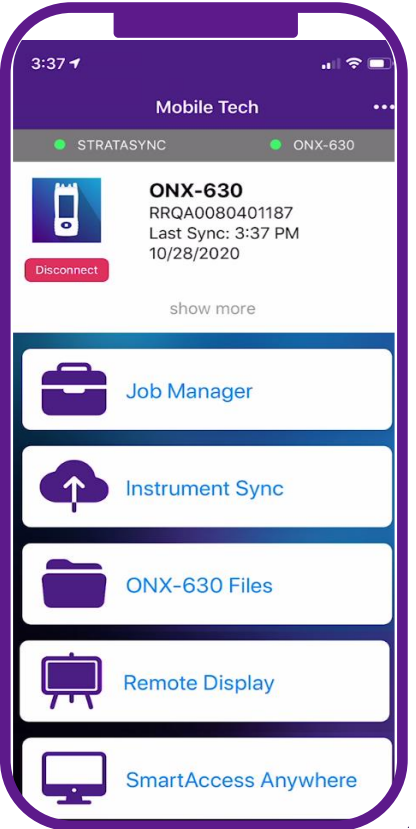
Drop



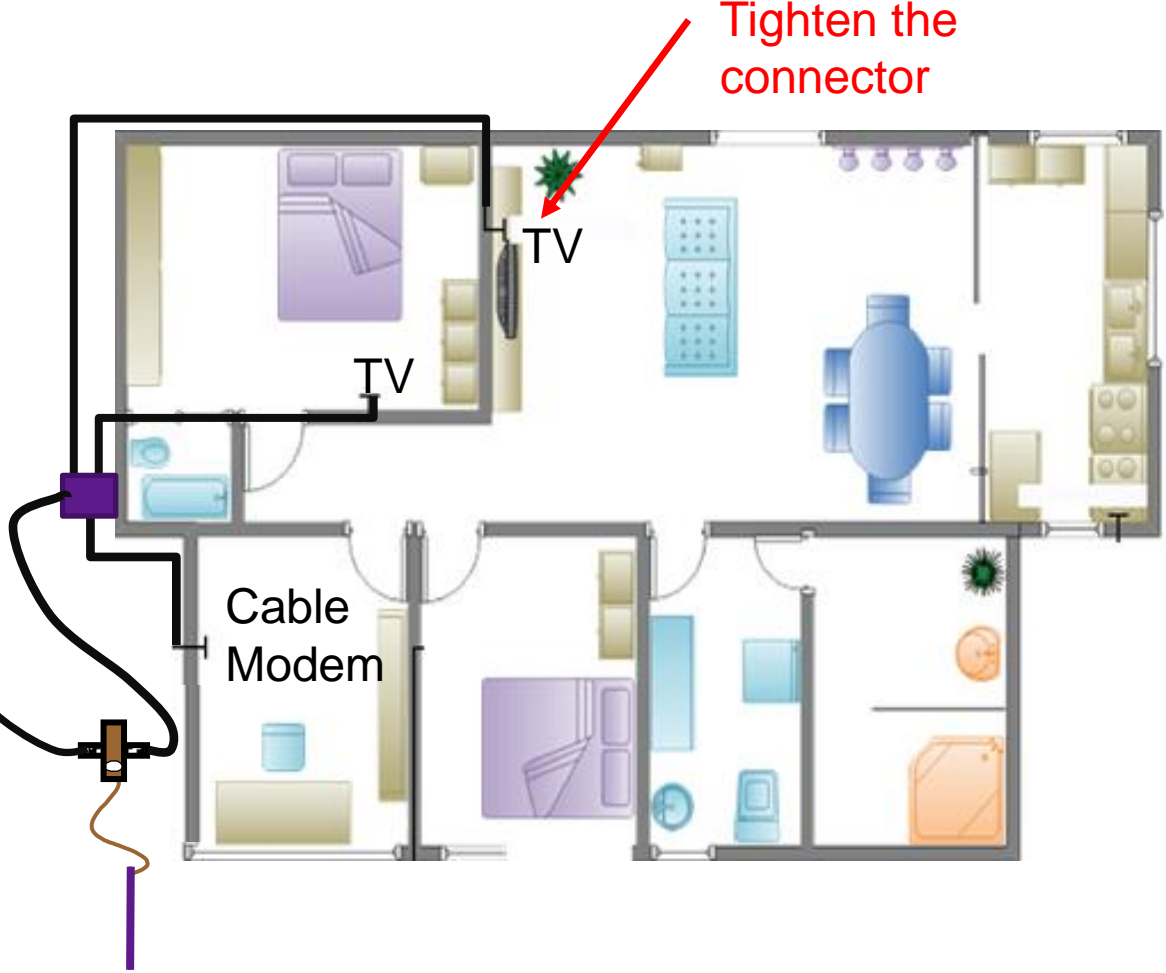
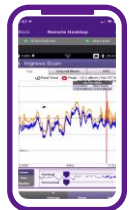
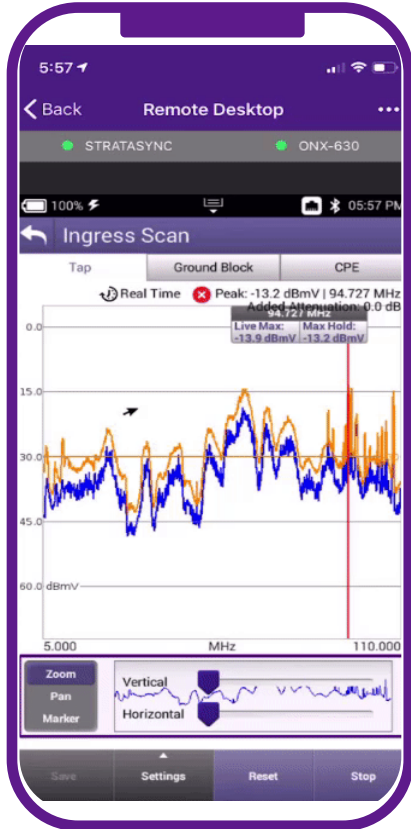
Remote Display



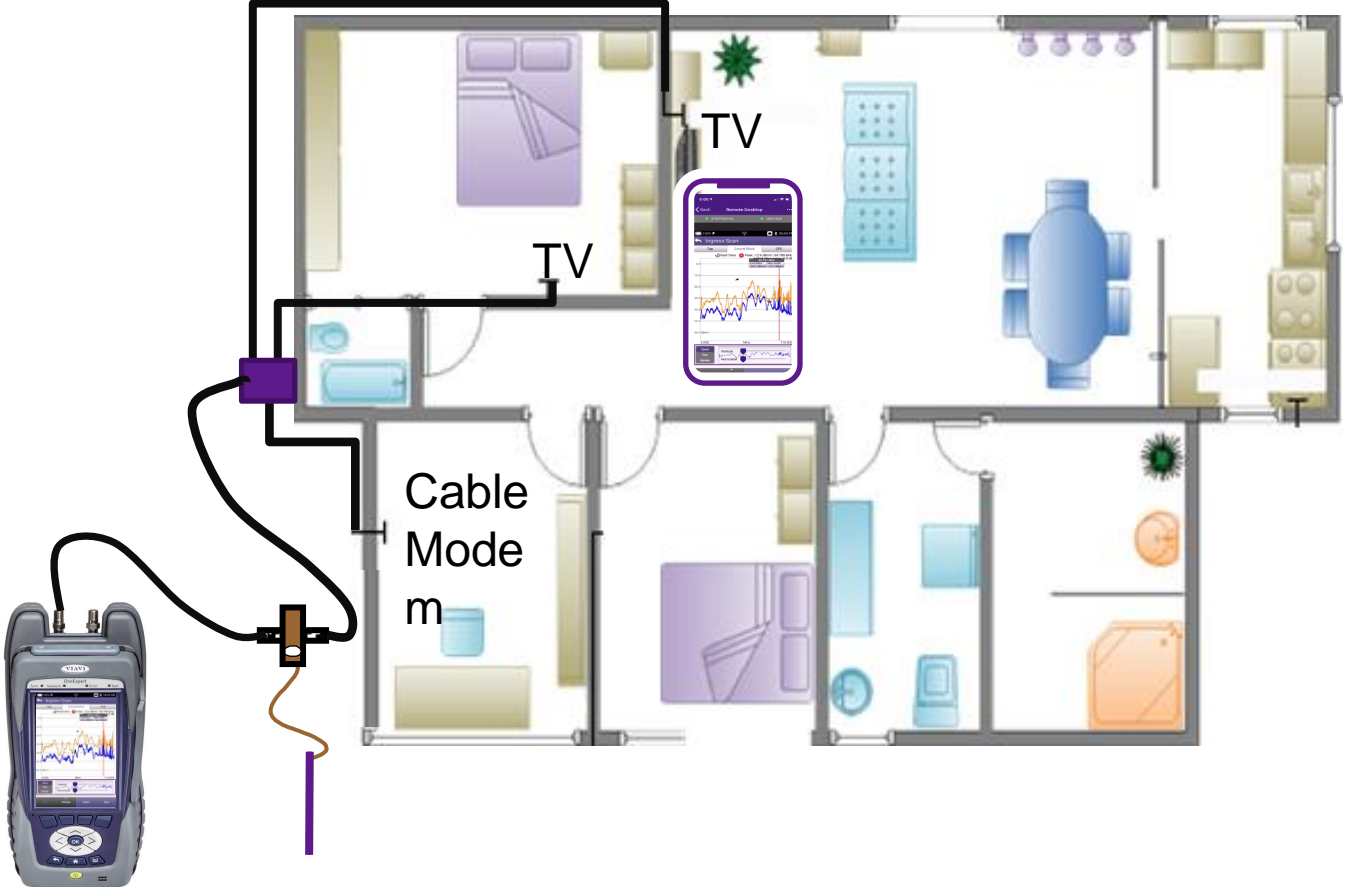
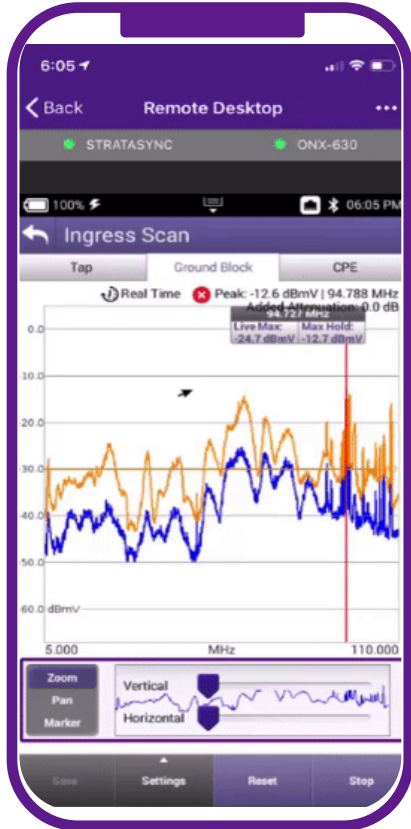
Remote Display



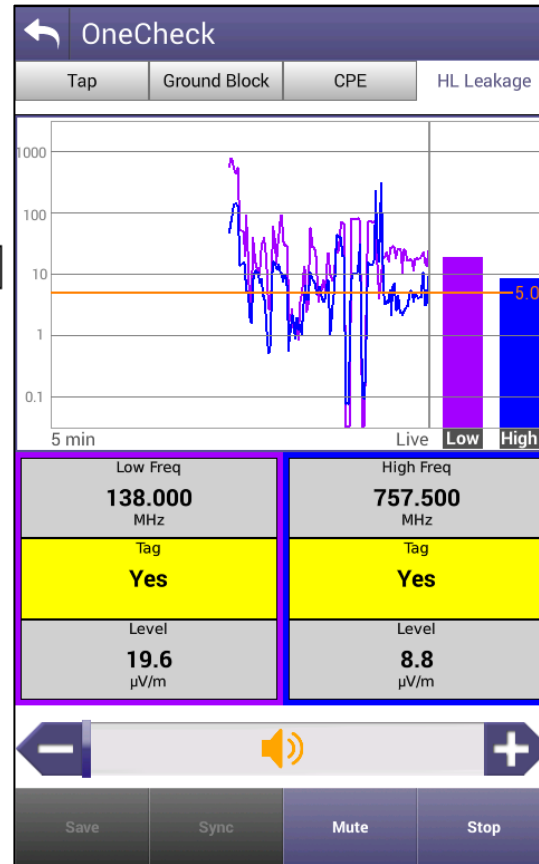
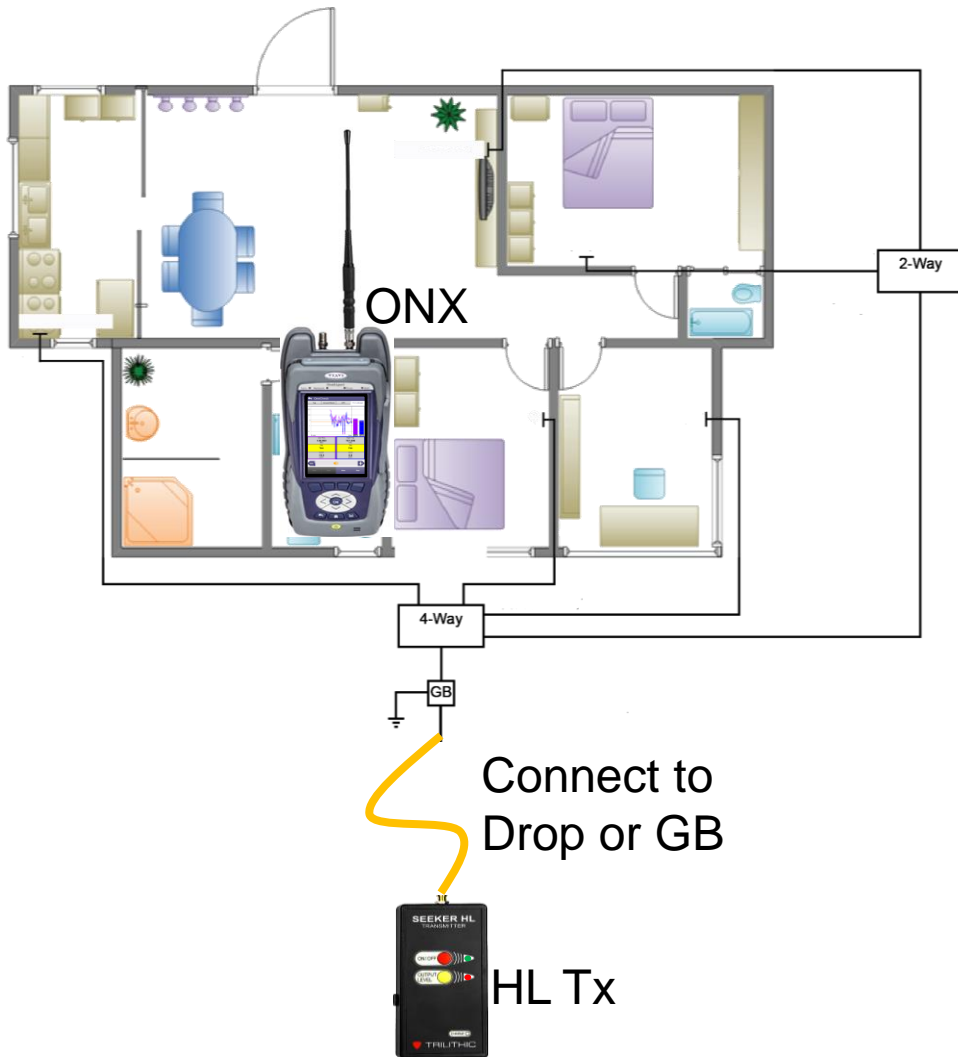
Remote Display



Remote Display



HL Leakage – Advanced Coax Shielding Integrity Testing



- Connect the HL Transmitter to the subscriber's premises coax and turn on the transmitter
- Now walk the subscriber's premises looking and listening for leaks coming out of the coax
- As the measures leakage levels those values will be updated live
- Also a historical graph will be shown representing both Low and High measured frequencies over time
- When complete press the "Stop" button
- Press the back button to return to the OneCheck Selection screen

ONX-220 HL Leakage

Tim Miller
January 2022

ONX HL Leakage mode overview

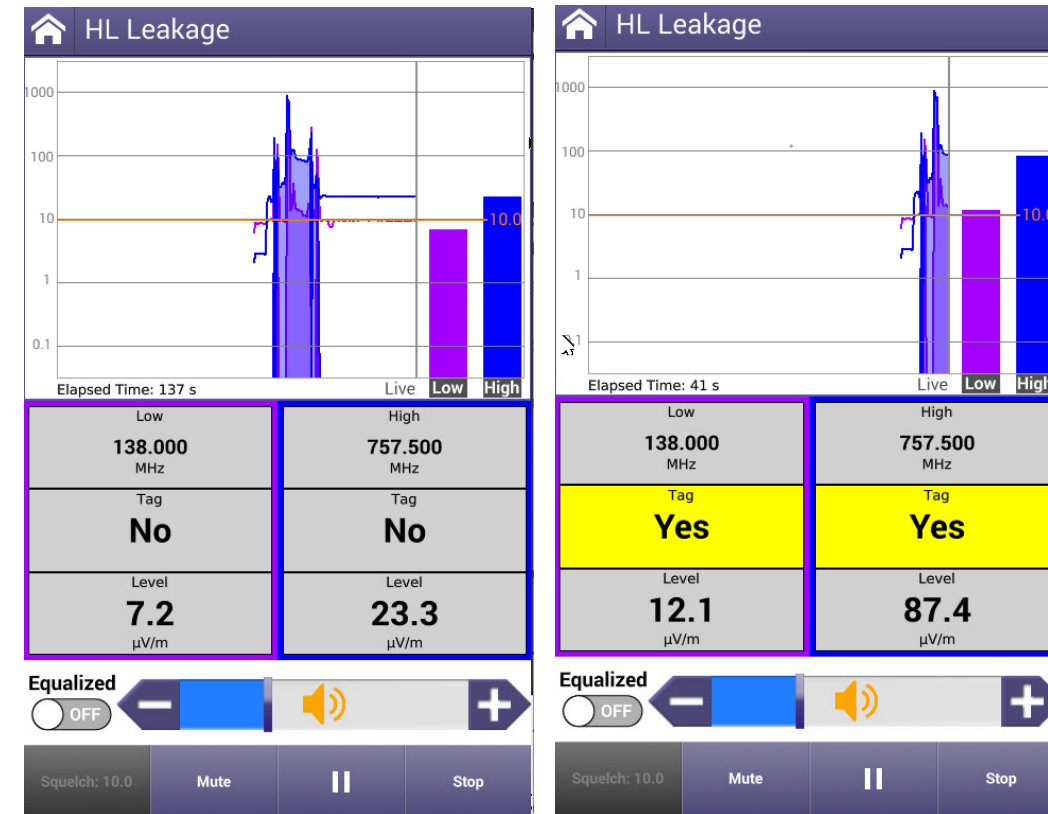
As you walk the subscribers drop with the ONX in HL mode, it is measuring signals off the air looking specifically for the HL Transmitter's two leakage signals. Each signal has a special identification modulation called a "Tag". When either of these two signals are detected, the signal level and Tag are displayed. If the signal's Tag is detected and its measured level exceeds the configured squelch level, then the ONX emits an audible tone and the "Tag" box changes to yellow.

When the Tag box turns Yellow, this is the indication that a leak has been detected above the minimally acceptable level.

In this example the squelch was set to $10\mu\text{V/m}$, so the level of the signal must exceed $10\mu\text{V/m}$ and the Tag must be detected (Yes) to turn the box yellow.

As you get closer to the leak, the measured signal level will rise. The bar graph and history chart are continuously updated to reflect these level variations.

Adjust the audio sound volume using the volume bar at the bottom of the screen, or fully mute the audible tone when desired with the Mute button.



Seeker HL Source Transmitter



→ Power On / Off:

- Green – normal operation
- Red – Low Battery
- Blinking Red – Very Low Battery

→ Output Level:

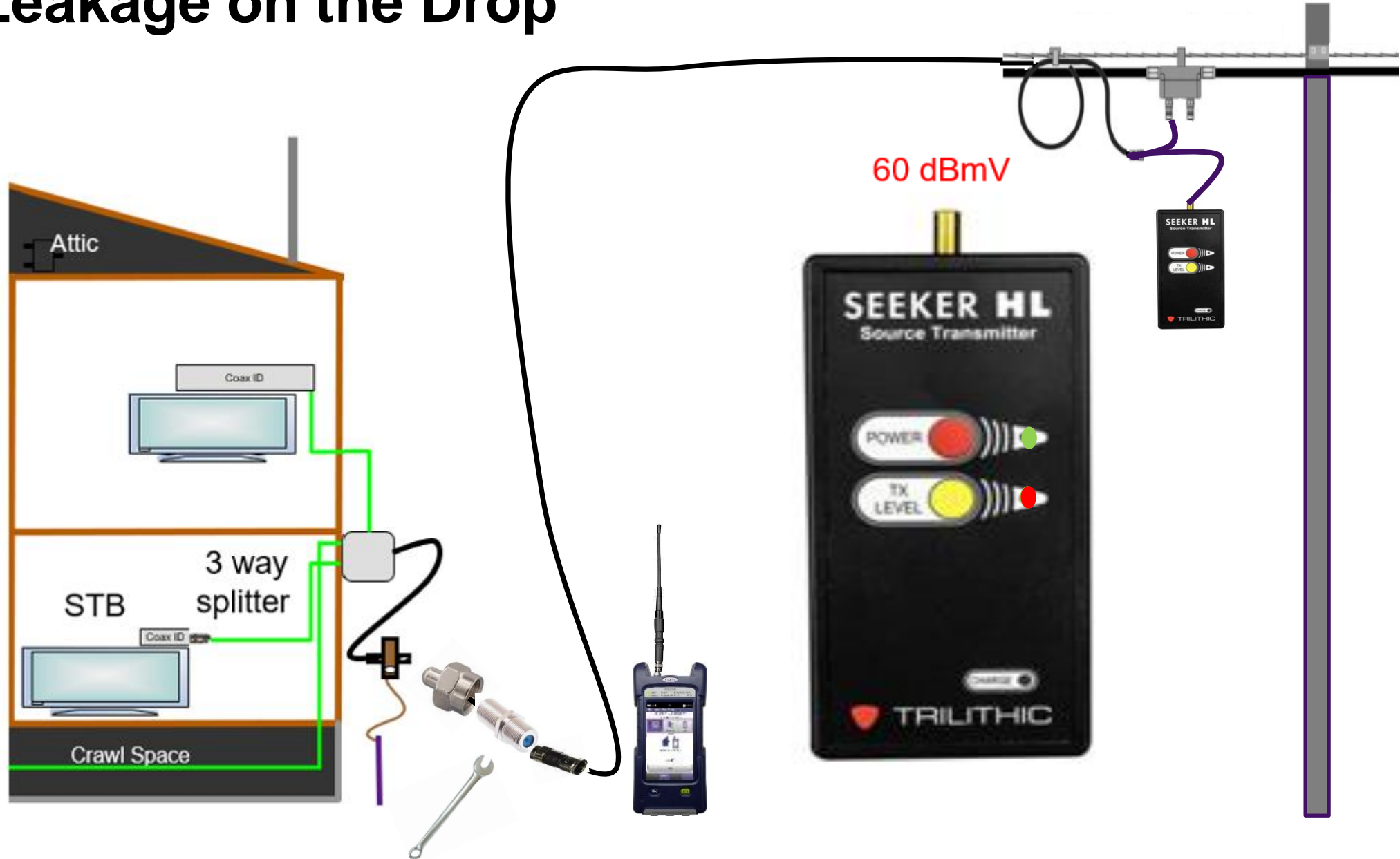
- Green – Low Output (40 dBmV)
- Red – High output (60 dBmV)
- Blinking Red/Green – Device Error

→ Charge:

- Green – Done
- Red - Charging

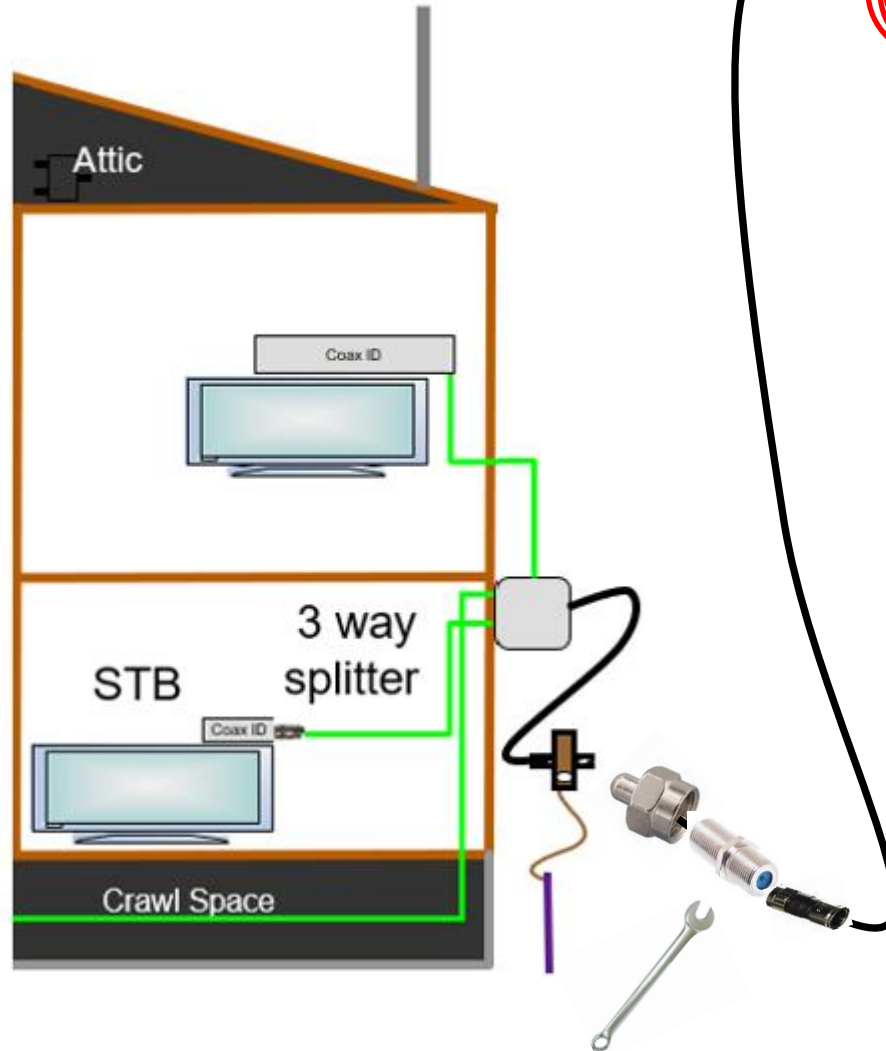
ONX HL Leakage on the Drop

- Install HL pressure test transmitter to the drop
- Wrench tighten terminator at the Ground block
- Walk the Drop with then HL leakage application.



ONX HL Leakage on the Drop

- Install HL pressure test transmitter to the drop
- Wrench tighten terminator at the Ground block
- Walk the Drop with then HL leakage application.



SEEKER HL Source Transmitter

HL Leakage

1000

100

10

0.1

10.0

Elapsed Time: 36 s

Live Low High

Low	High
138.000 MHz	757.500 MHz
Tag	Tag
No	No
Level	Level
8.6 $\mu\text{V}/\text{m}$	3.9 $\mu\text{V}/\text{m}$

Equalized

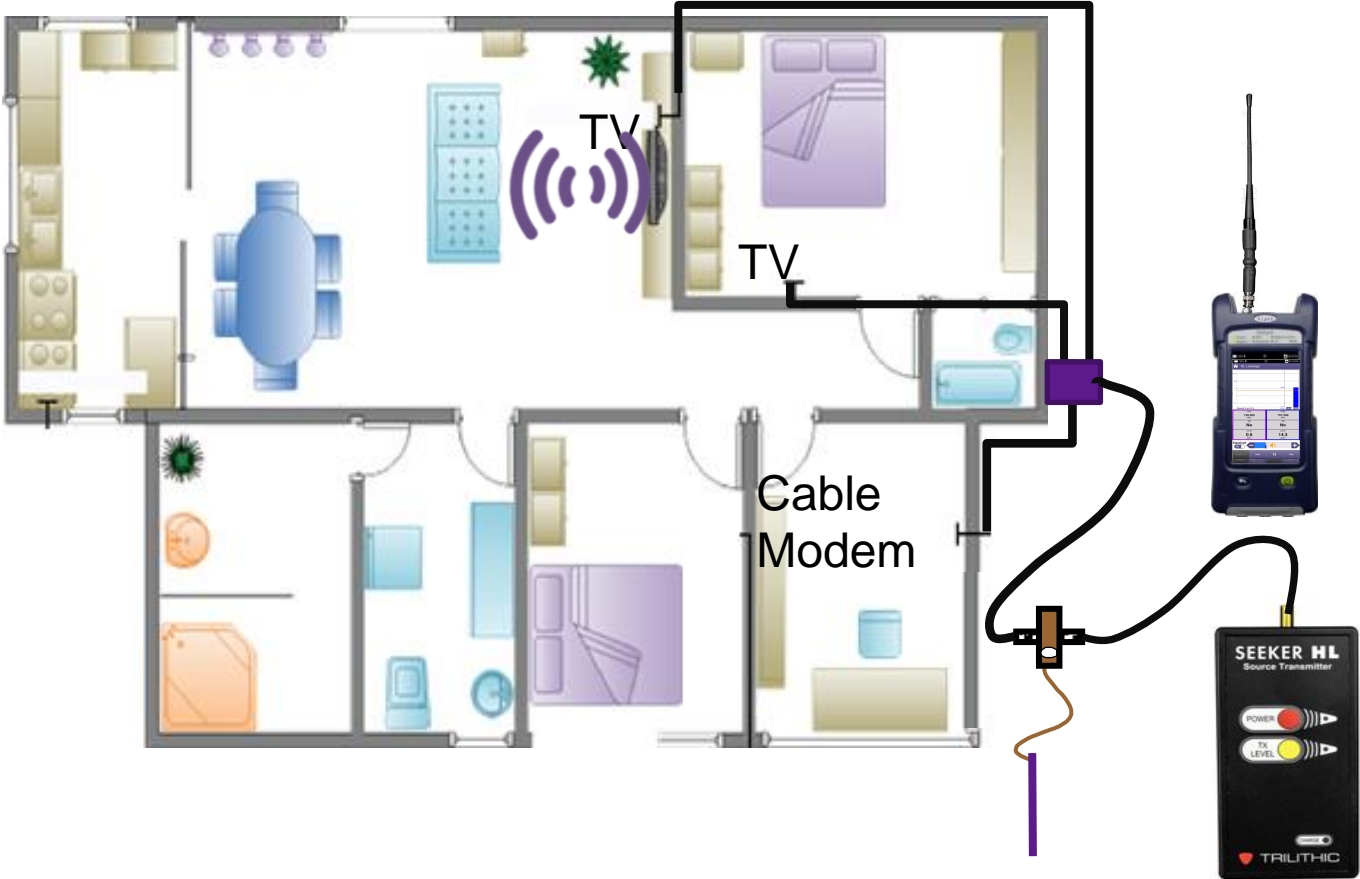
OFF

Squelch: 10.0

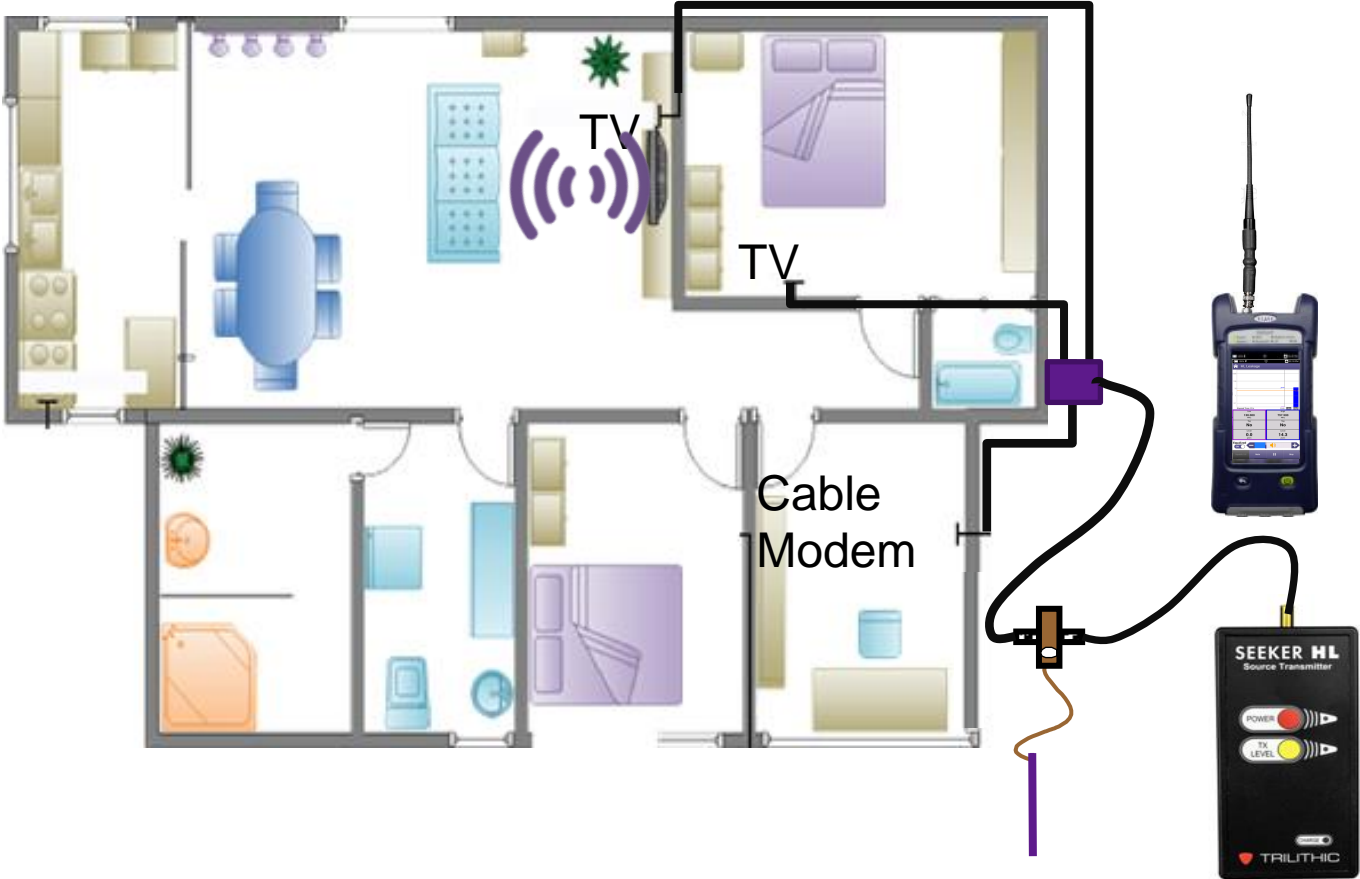
Mute

Stop

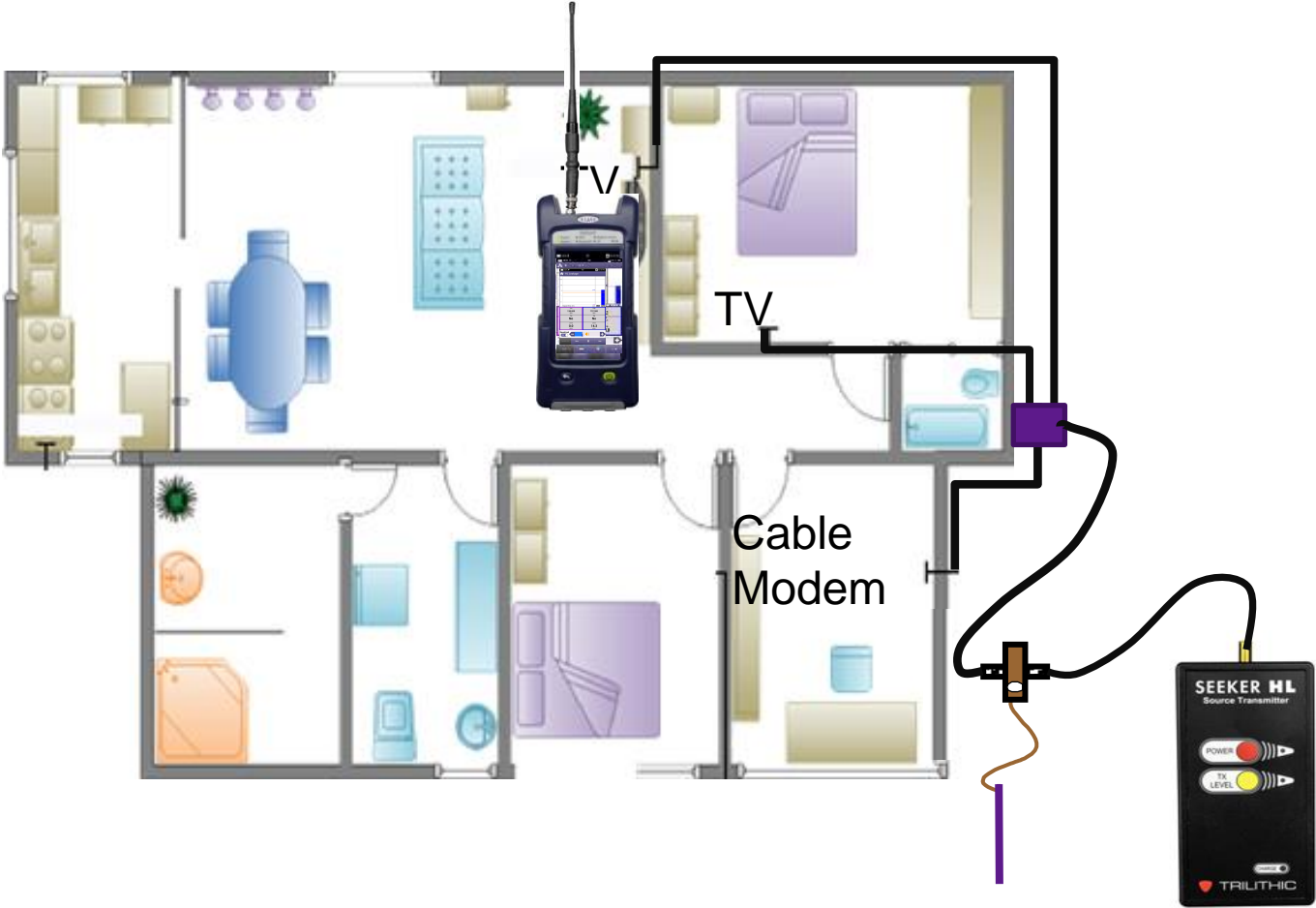
Finding Leaks



Finding Leaks



Finding Leaks



Cable Pressure Test

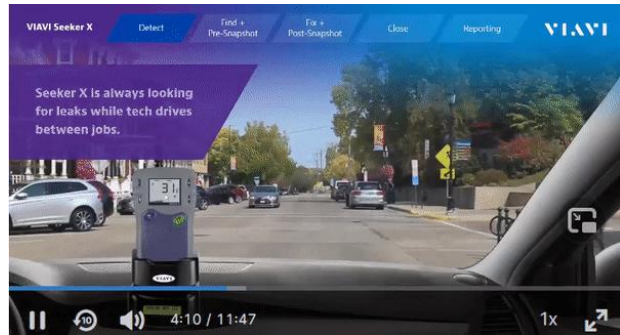
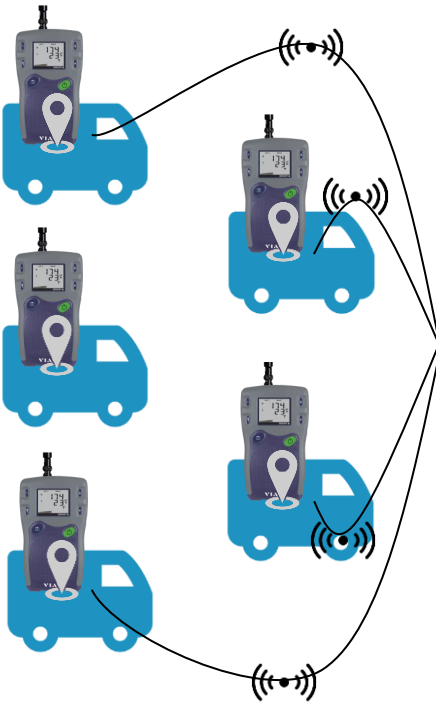


Cable Pressure Test Live

Checking FM Ingress and LTE Live

Finding Leaks

1. MCAIII's sync Seeker X leak data to LAW Server via Wifi



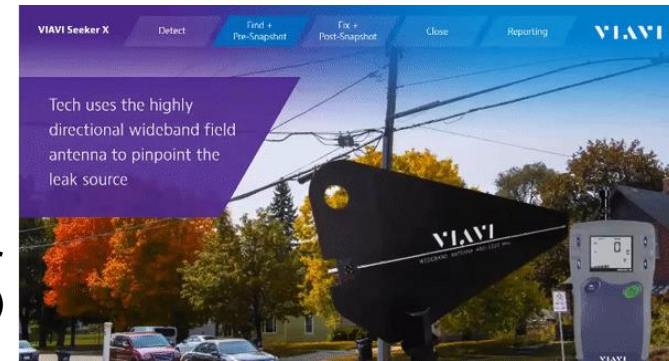
5. Leaks sent via API to XPERTrak for overlay with PNM, QoE data



2. LAW Quadrangulates data, localizes & prioritizes leaks



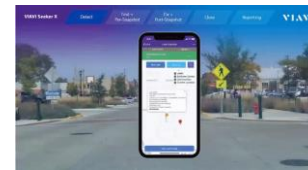
4. Tech fixes leak, closes out work order via Mobile Tech (GPS)



6. NOC uses with XPERTrak to triage issues



7. Director trends overall performance



3. Work order created, assigned to Tech

Leakage Maps in PNM

Node Summary

73 QoE	7 Modems
0 Chronic	3 Offline
0 Impacted	0 Stressed

Problem Types

Upstream (0 of 7)

Downstream (0 of 7)

Stability (0 of 7)

QoE Chart

Jul 28, 2021 - 10:00

QoE: 100 (Green), 70 (Red)

Data Utilization

Maximum

0% Upstream

1% Downstream

Node

DOCSIS 3.1 | Alarm

US Impairments

Tx Level High (4 of 7)

Tx Level Low (0 of 7)

Home Issues (0 of 7)

Microreflections (0 of 7)

DS Impairments

Roll Off (0 of 7)

Suck Out (0 of 7)

Resonate Peak (0 of 7)

Ripple (1 of 7)

Tilt (0 of 7)

Adjacent Channel (0 of 7)

FM Ingress (0 of 7)

LTE Ingress (3 of 7)

Selected Modems Group: All Modems

7 of 7 Modems Selected

Impairments: QoE (Default) | OTU Fiber Status

Map
Satellite

Leak: 17332

Work Order:

- Level: 78 $\mu\text{V}/\text{m}$ @ 612 MHz
- Location: 6847 E Hanna Ave, Indianapolis, IN 46203-6179
- Date Detected: 3/9/2020
- Detected By Tech: trilit
- Assigned Tech: No tech assigned
- Community: Indy1
- Comment: No comment specified

VI.VI

Hum Test Results

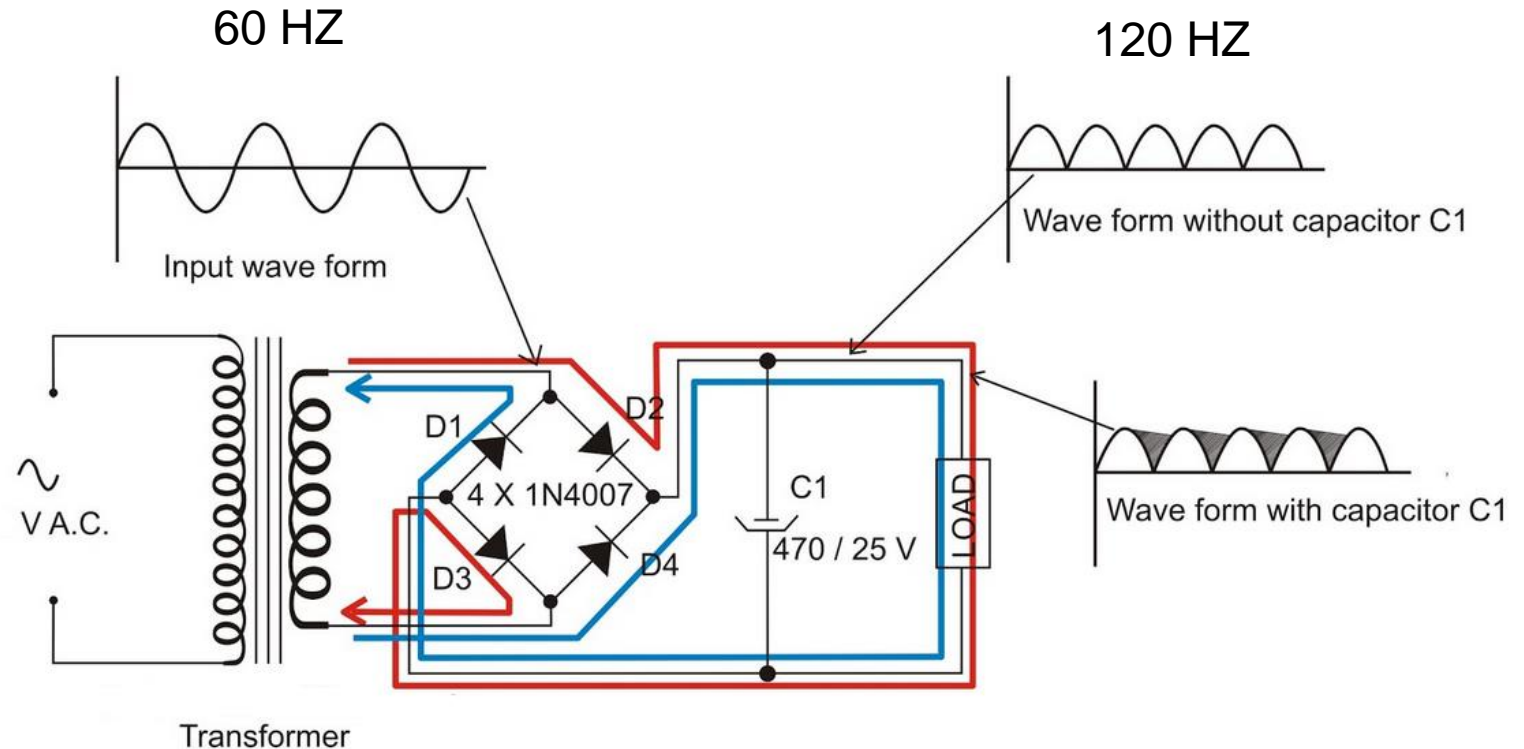
What is Hum?

Hum is a signal impairment which causes the amplitude of a modulated carrier to vary.

Hum is often caused by poor filtering in an amplifier's power supply.

In an analog TV signal, hum causes horizontal lighter/darker bands in the picture

In a digital QAM signal, it can cause a low modulation error ratio (MER), and can raise the bit error ratio (BER) when the hum is severe



How Much Hum Is Too Much?

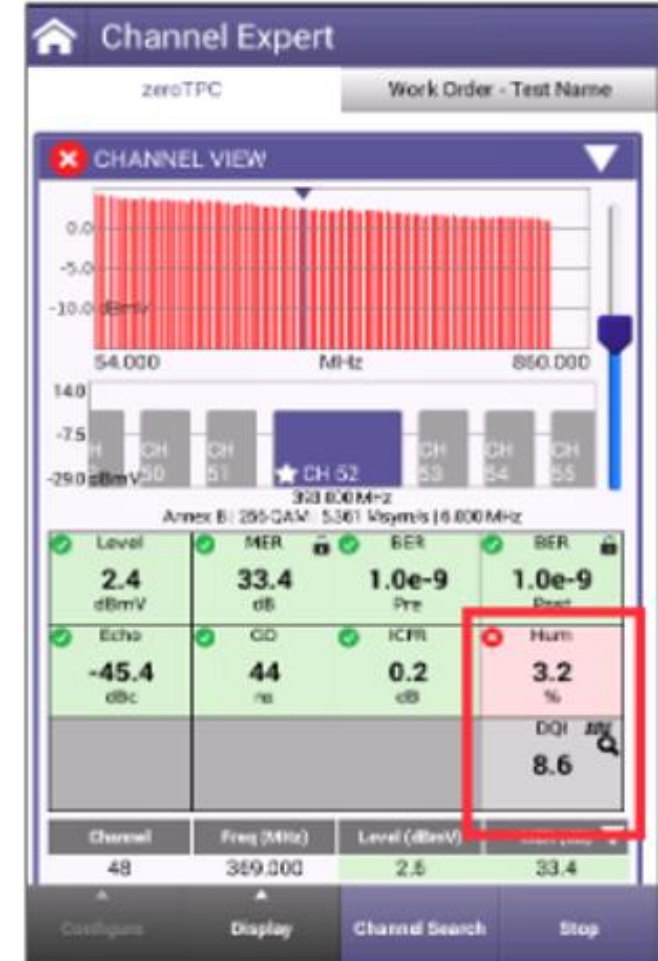
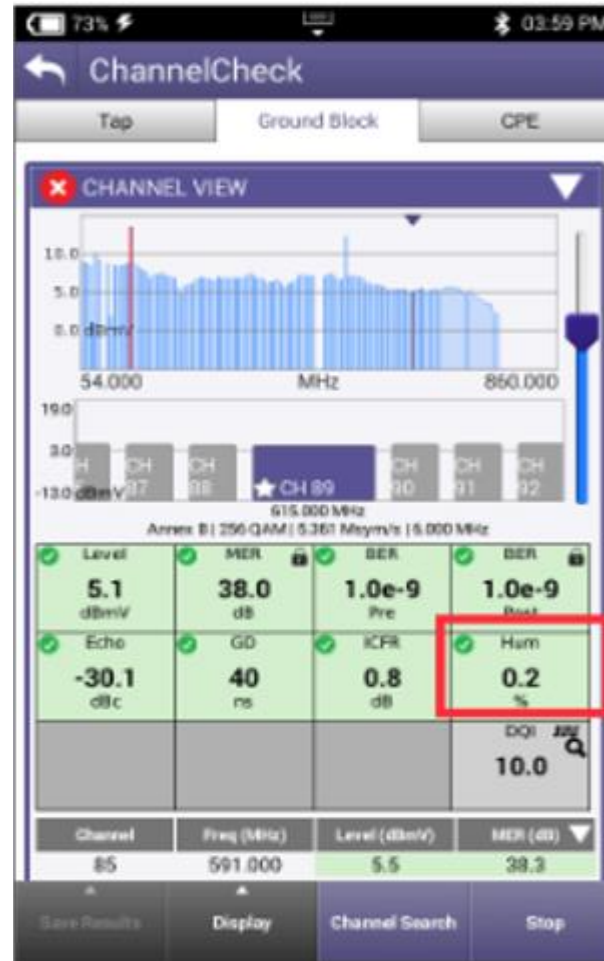
The FCC mandates that TV signals have no more than 3% total hum.

QAM demodulators used in cable modems and set-top boxes vary widely in their ability to cancel hum. They are designed to cancel at least 3% hum, the amount allowed by the FCC

They will typically operate to 5% hum without problems. If the hum reaches 7%, some demodulators will report a MER below 32 dB and will exhibit uncorrected bit errors.

Hum could appear on 1 QAM carrier due to a faulty modulator.

Note: Modern Broadcom demodulators are really good at cancelling out hum and other amplitude problems. We even turn it up to make it better than stock Broadcom cable modems. Customer equipment can't cancel out what our CM can so the ONX may not see Pre or Post BER but will see it in DQI.

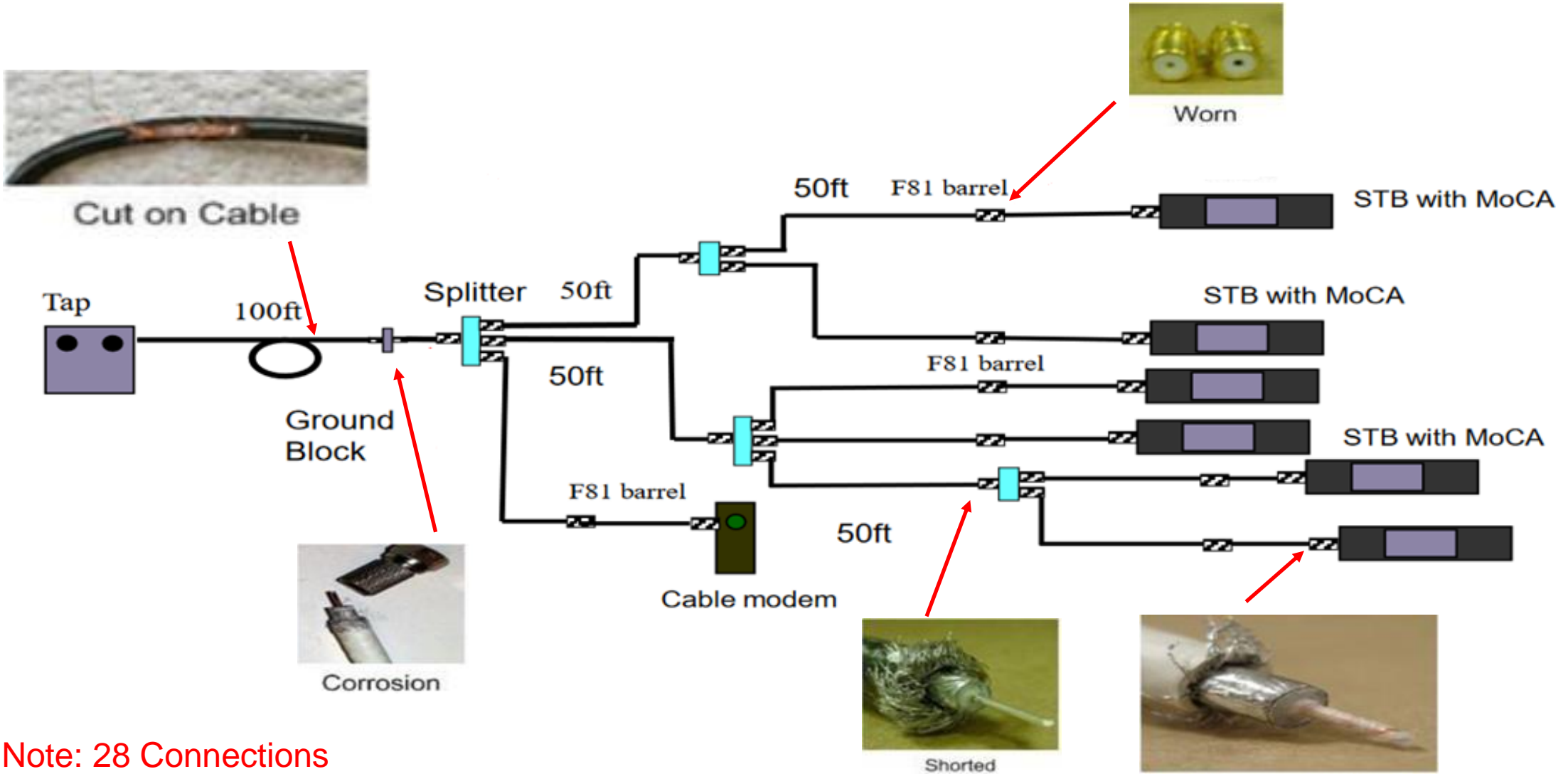


What's one of the best tools for fixing ingress?



<https://eguides.viavisolutions.com/>

What to look for ?



Note: 28 Connections

Conclusion

- Understand the RF Noise
- Spectrum analyzers are still great tools to see the noise in the network.
 - Zero span
 - Heat Map
- Node Health
- PNM
 - Locate the problem faster

Pressure test the tap to the house for egress

- find points of ingress

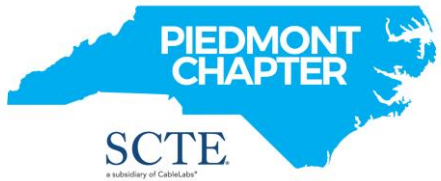


VI.AVI Solutions



<https://eguides.viavisolutions.com/>

[viavisolutions.com](https://www.viavisolutions.com)



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May 19th, 2022

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