Viavi ONX – Ingress Mitigation and Troubleshooting Field Use Case using Ingress Expert

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Purpose:

The Viavi ONX-CATV, equipped with the Ingress Expert mode, is a very effective noise mitigation and troubleshooting tool. The purpose of this document is to review findings and recommendations based on field use cases with technicians who focus on mitigating CATV ingress, provide details to the configurations available on the mode, and make recommendations that may help users better utilize the ONX's Ingress Expert.

Use Case Procedure:

Utilizing live XperTrak and PathTrak data to determine nodes with issues. A few which looked interesting enough to go out and troubleshoot were identified. The first node "A", showed consistent noise present under active upstream SC-QAM channels. After Node "A" the group then went to Node "B" which showed symptoms of the presence of CPD.

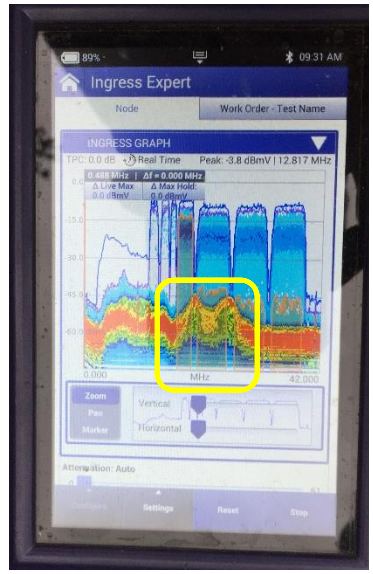
After reviewing PathTrack data the team identified the location of the node and proceeded to the physical location of the node. With the intent to identify the noise then localize and mitigate the noise source using the ONX's Ingress Expert mode on Port 2.

Real World Application and Use Case Findings:

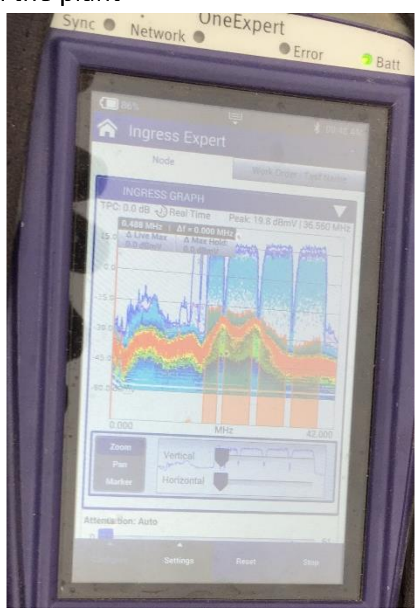
Consistent Noise – Node A:

1. Started at Node A
2. Below is the PathTrak view prior to going into the field

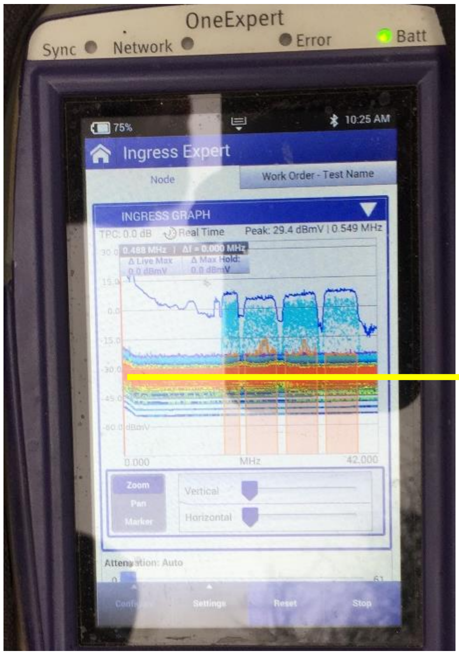
3. At node A, connected the ONX to the combined return test point and observed the noise coming from the field into the node



4. Using an I-Stop the tech could determine the noise was present on the powered leg. When the I-Stop is button was pressed on the offending leg the noise dropped 4-6dB, signaling that the leg connected to the I-Stop contained the noise source.
5. Went to 2nd active, amp, about half way to end of the line. Noise was still present so we know it was coming from further down in the plant

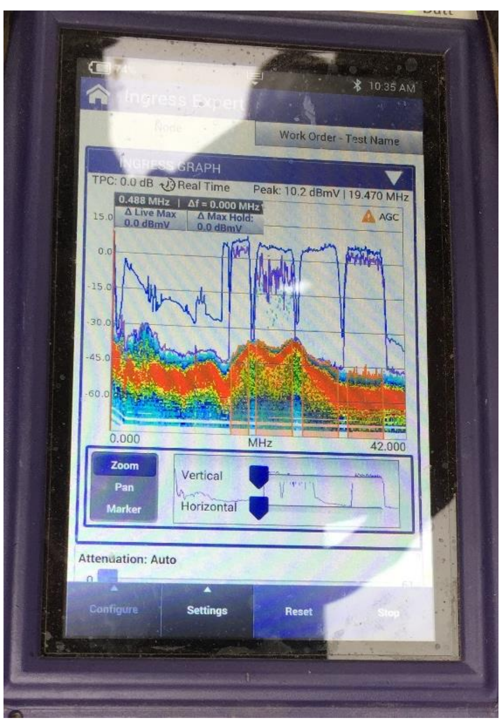


6. Went down the leg and noise was present again, so we knew we were on the correct leg
7. Using probes contacting the seizure screw at the taps allows the Tech to see the noise without extra attenuation and this technique was utilized at every tap and active tested
8. Several Taps later the noise was not visible on the mode while simultaneously showing a very high noise floor on the ONX

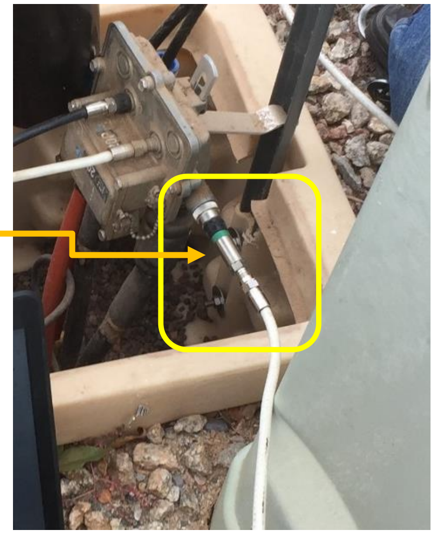


The yellow line is at about -30dBmV on the display. A higher a noise floor than previously seen at directional test points off the active devices.

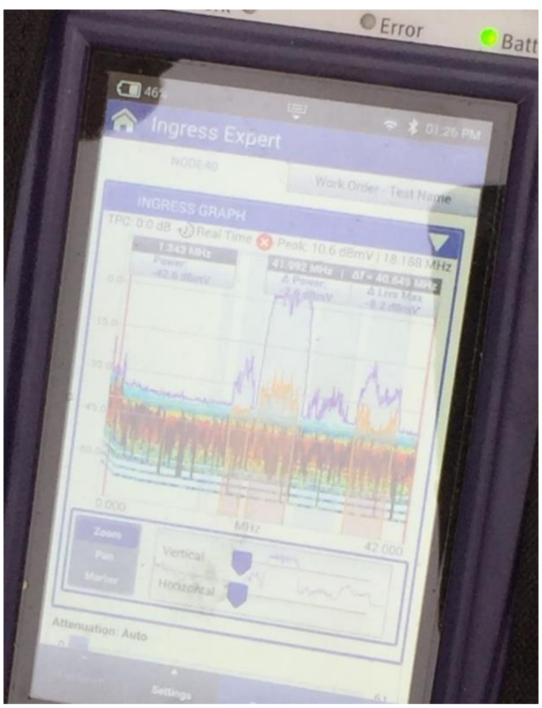
9. The Noise floor of the ONX was around -30dBmV, when previously the noise floor was in the -45 dBmV range. We inserted a 42MHz low pass filter (LPF) between the seizure screw probe and the coax jumper going into Port 2 of the ONX
    a. Because the ONX's Port 2 is always open from 0.4MHz to 110MHz, even when 42/65/or 85MHz views are selected, this LPF cuts out the higher powered downstream signals from entering Port 2 between 42MHz to 110MHz.
10. This LPF helped the ONX achieve a much lower noise floor, about -45dBmV, allowing us to see the noise again and determine which direction the noise was coming

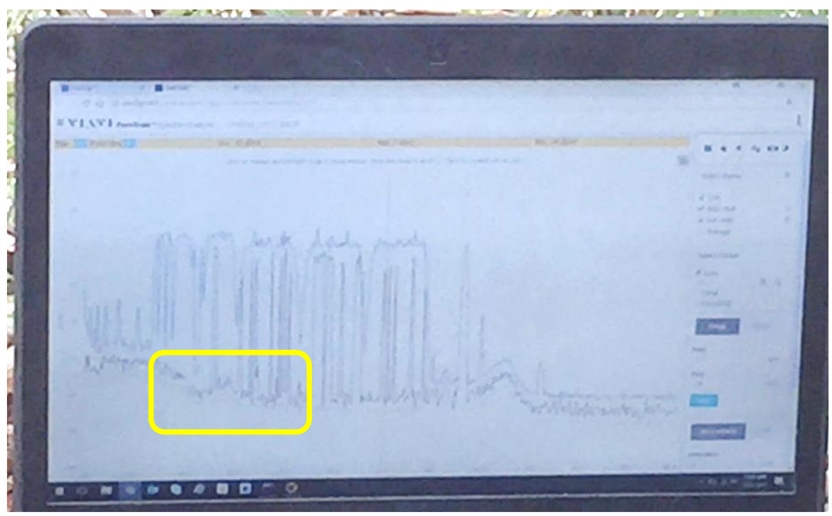


11. The local techs decided they could use green data filters to accomplish the same task, using one verified similar results as the LPF



12. Testing continued for a few Taps until it was was determined we were successful at finding the noise source. It was one house emitting the noise humps.
13. Disconnecting the drop of the home showed the noise disappear from both the ONX and PathTrak

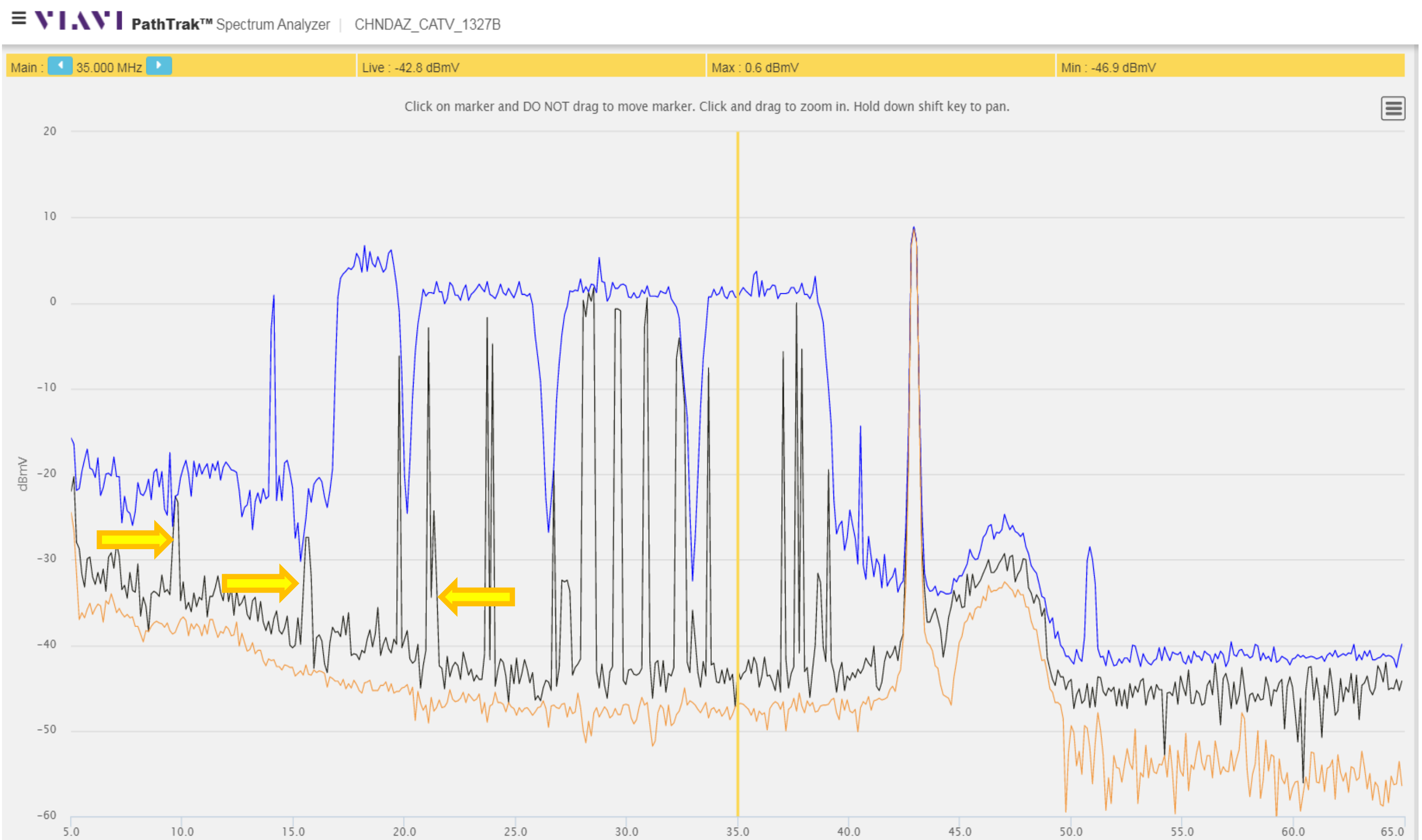




14. **Note on Traces:** During the investigation into this consistent noise source it appeared to be best visualized by activating the Live Max, Max Hold, and Heatmap traces. Other traces added little additional information while also cluttering up the screen, making it appear too busy.

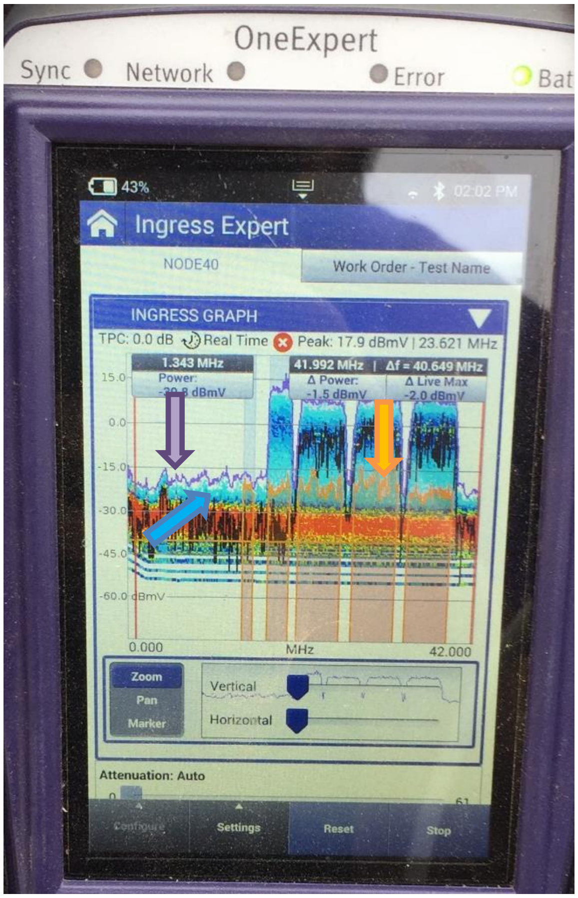
Intermittent Noise – CPD – Node B

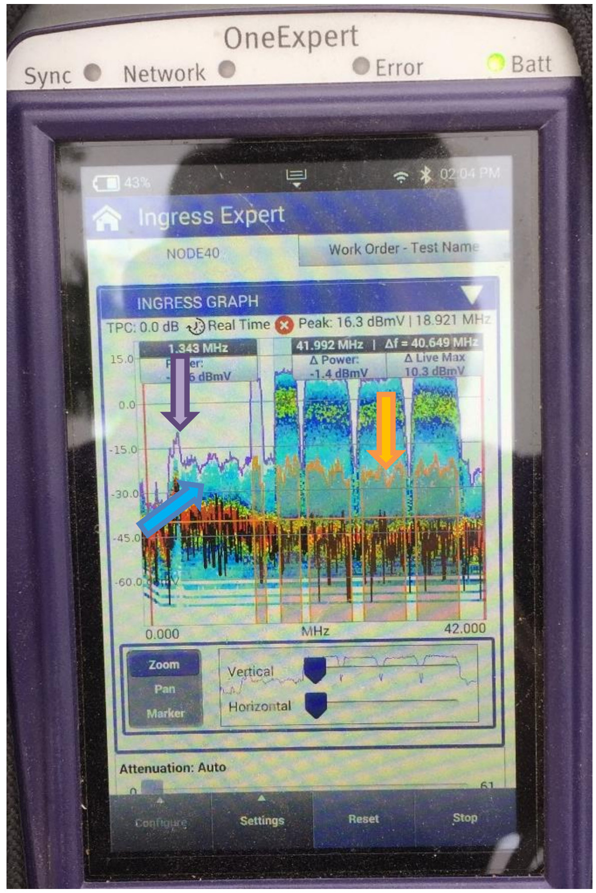
1. Second node we went to was Node B
2. Below is the PathTrak view of this node prior to going into the field



3. Using PathTrak the techs determined the presence of CPD, showing up as lower level spikes (examples of the CPD are pointed out by the yellow arrows above)
   a. 
4. Connected off the seizure screw of the DC or Splitter with the leg showing the CPD

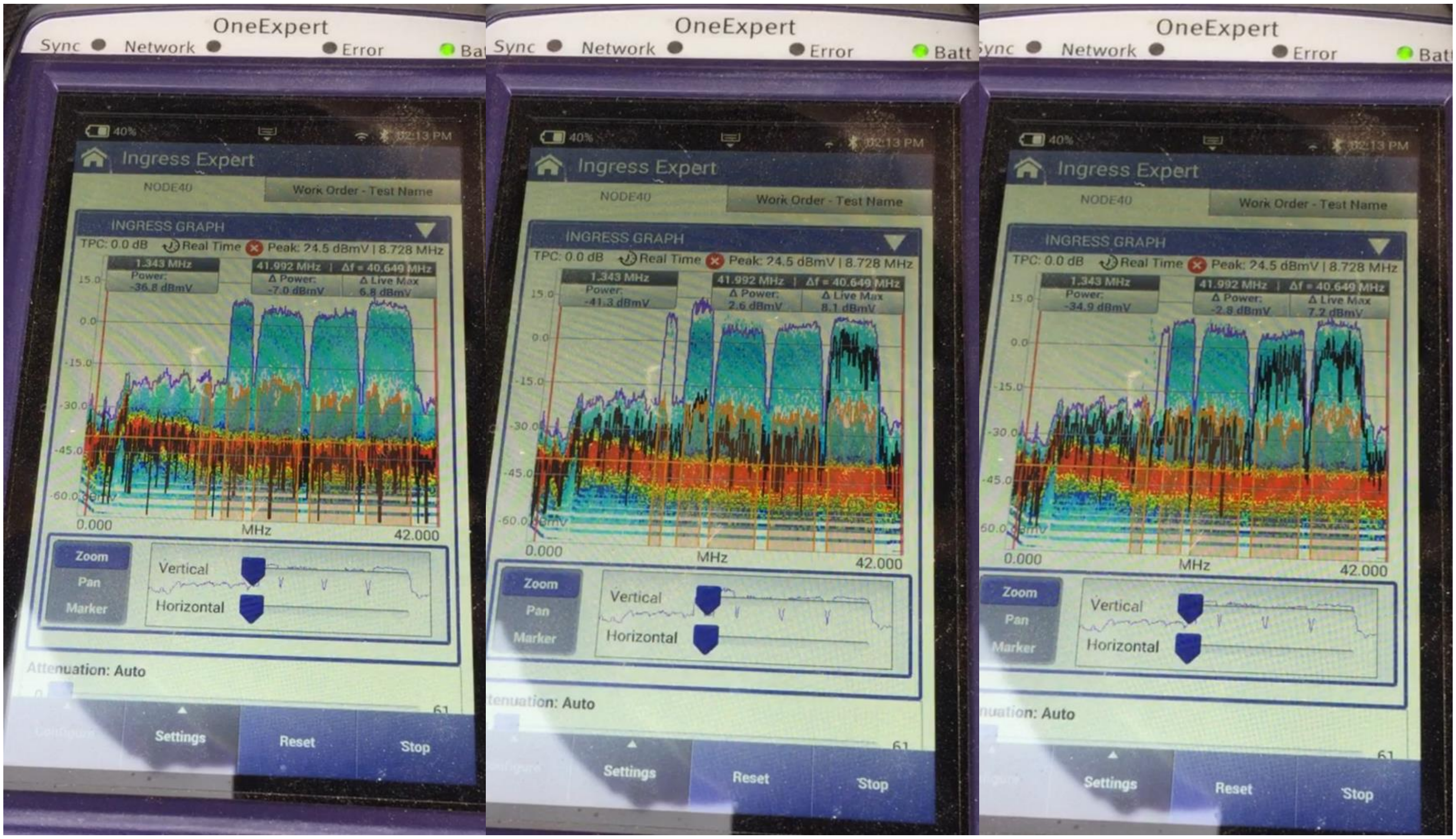
5. First without the data trap filter (LPF) showed the CPD but without a lot of margin between noise floor and peak of the CPD (Below Left Photo). Then put the green data trap filter in line with the ONX Port 2 and noticed a 10-15dB noise floor drop on this bidirectional test point (Below Right Photo).





6. Toggled several of the traces On / Off while at this node to determine which ones may help the most with this type of intermittent noise source. It was determined the Live Max, Noise, Heatmap, and Power traces when enabled appeared to best show this noise was present.
   a. Live Max (Purple trace on display) showed the signal was repeating at least once every 200ms as this trace never decreased in amplitude (Purple arrow in right photo above)
   b. Noise trace (orange trace under active carriers on display) showed the CPD noise was present under the live upstream QAM carriers and connects the Live Max traces on either side of the QAM haystacks (Orange arrow above)
   c. Heatmap (filling in areas with colors) filling in blue just below the Live Max trace showed that the noise was present but not consistently present like the red portion of the Heatmap representing the noise floor of the system (light blue arrow above).
   d. Power trace (Black trace on display) was showing the CPD bursting through the upstream when it would occasionally raise up to the live max trace then back down to the noise floor of the system (see photos below for examples).
      i. Below left – Shows the black power trace during most of the testing, where it remains around the noise floor of the system
      ii. Below Middle – Shows the black power trace of CPD noise closely matching the Live Max and Noise traces, and shows the 4th QAM's active QAM burst

iii. Below Right – Shows the black power trace outlining the CPD burst, again closely matching the Live Max and Noise traces, and the 3rd and 4th QAM bursts were captured as well.



7. It was concluded the ONX was able to quickly detect the CPD on this node, however, due to time we were unable to track down the root cause of this particular issue.

Additional Information about Ingress Expert and Configurations:

Real-Time Spectrum Analyzer vs Swept Spectrum Analyzer:

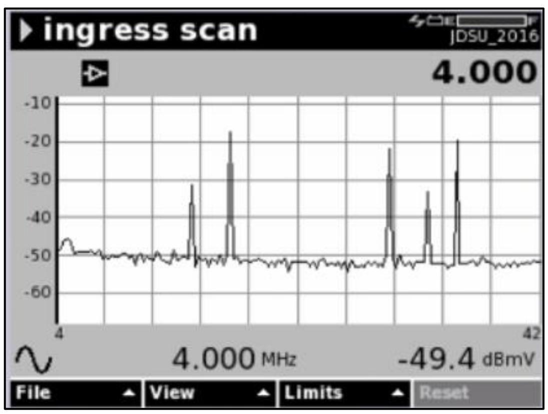
The ONX’s RF Port 2 has what is called a Real-Time Spectrum analyzer used for ingress testing in the upstream frequency bands. This is a different, more modern, technology than older and much more common swept spectrum analyzers.

The real-time analyzer of the ONX takes advantage of a more recent development in spectrum analyzer technology which utilizes full band capture with overlapping FFTs. This technology allows the ONX to catch many samples of the whole upstream spectrum much more quickly than other more traditional swept spectrum analyzers.

Swept spectrum analyzers work by tuning to one frequency taking measurements within an RBW (resolution bandwidth) then moving to the next frequency. This continues until it reaches the highest measurement frequency and then starts over at the beginning. This means that if the analyzer is not already looking at the frequency when a noise signal is present then that noise may not be detected or measured. It depends on how long the noise signal is present and if the analyzer was tuned to that frequency and within the RBW. Meaning that many fast transients are not able to be detected or only a small sliver will be measured.

The real-time spectrum analyzer on the ONX, however, is looking at the whole upstream spectrum and taking thousands of full band measurements per second. While one measurement is being taken the previous measurement is being processed simultaneously. Because the ONX is looking at the whole upstream band, if noise is present then it is more likely to be detected. These noise signals, which may have appeared as spikes with swept spectrum analyzers, now may appear as larger continuous mounds of energy on the ONX.

One example that can be easily seen is upstream cable modem signals. Like intermittent noise, cable modem traffic is bursty. Where a 6.4MHz wide carrier is present for a brief period and then disappears until the modem is actively transmitting again. With a swept spectrum analyzer, it may take many passes, and require peak hold to be active, before the full 6.4MHz wide carrier is seen. This is because the modem carrier might not be active at the time the swept spectrum analyzer was looking at that frequency. For this reason, modem traffic often looks like spikes rather than a haystack with swept spectrum Analyzers. On the ONX, if the 6.4MHz wide carrier is active then the full 6.4MHz carrier will be visible immediately.



1 - Swept Spectrum Analyzer showing spikes where Cable modem traffic is present since it can only measure energy at frequencies it is currently turned to

2 - Real-Time Analyzer showing all signals at all frequencies, clearly shows the outline of 4 active upstream QAM channels. Note the difference in view of the same signal between the real-time (above) vs swept spectrum analyzer (Left).

External Low Pass Filter:

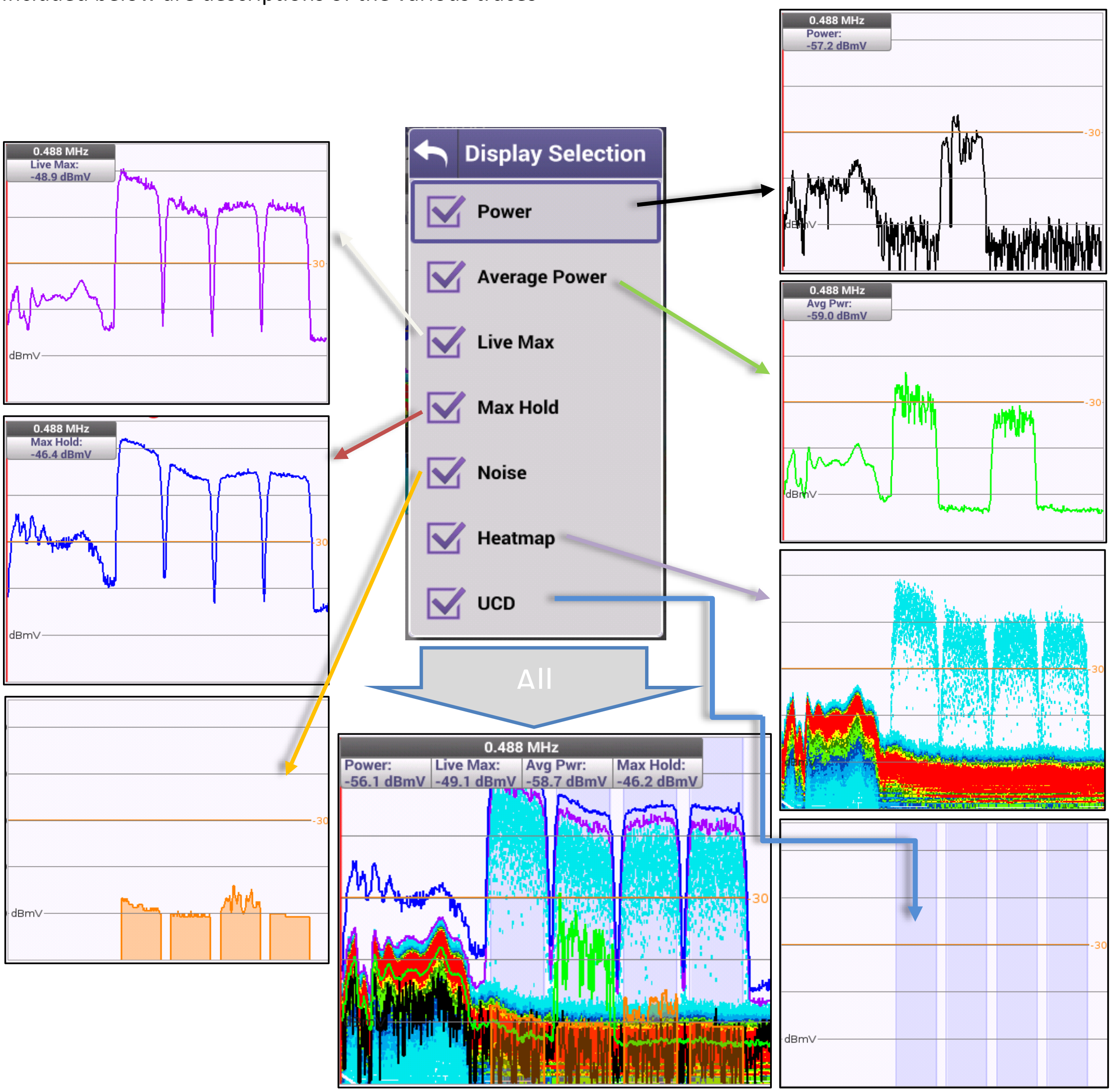
The ONX's Port 2 is always open from 0.4MHz to 110MHz so FM frequencies can be used to test for ingress back feeding into the plant. When troubleshooting upstream ingress out in the plant, however, it may be necessary to test at a location where both upstream and downstream signals are present. These downstream signals below 110MHz, will also be detected by the ONX's Port 2 and as a result may overdrive the ONX circuits due to the relatively high levels of the downstream channels. This may trigger an "Overrange" warning on the ONX. If Auto-AGC is enabled the ONX will attempt to optimize internal attenuation settings to best take a valid measurement. In these scenarios, the ONX's noise floor will adjust upward as it sets itself to reach the optimal attenuation setting for the higher signal power.

This means users may benefit by inserting a low pass filter (LPF) between the test point probe and the Port 2 of the ONX when testing at bidirectional test points, such as seizure screws. This LPF will drastically attenuate or eliminate the downstream energy from entering the ONX's Port 2 and the result will be a lower noise floor, better suited for troubleshooting low level noise under upstream carriers.

There are noticeable differences of the ONX noise floor when testing at active device return test points and bidirectional test points. When connected to an active's return test point the diplex filter of the node, amp, or line extender will cut out downstream channels from entering the ONX's Port 2. In these cases, the LPF may or may not be required to achieve a low noise floor.

Trace Definitions:

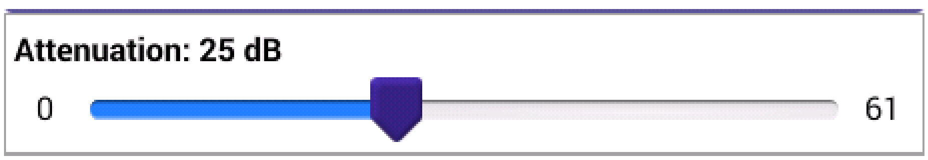
Included below are descriptions of the various traces



Power – A single trace randomly selected from the several thousand taken each second by the Real-Time analyzer
Average Power – The average power over the last second
Live Max – The highest power at each frequency over the last 200ms
Max Hold – The highest power at each frequency since test began
Noise – Signals within the highlighted UCD frequencies which occur less frequently but are higher than the average noise floor below the carriers
UCD – Highlights where upstream carriers should appear – The Upstream Channel Descriptors are acquired from the last DOCSIS test performed – This knowledge helps the ONX perform additional level based measurements

Automatic Gain Control (AGC) Settings and Manual Attenuation:

If the Auto AGC setting is enabled the ONX will make its best attempt at optimizing the measurements based on the input signal level. If the input signal level is high the ONX will automatically add attenuation to the signal to prevent overdriving the measurement circuitry. If the AGC is fluctuating constantly then it is likely there is a high intermittent signal present causing the ONX to exceed its current measurement settings causing it to attempt to find more optimal attenuation. This automatic attenuation can be disabled by disabling the Auto AGC setting. If Auto AGC is not checked then a manual attenuation bar becomes available for manual adjustment from 0dB to 61dB of attenuation. As the attenuation is adjusted to a higher value, the ONX's noise floor will also rise in level corresponding to the dynamic range of the ONX. Use low attenuation when troubleshooting low level noise sources and use more attenuation when dealing with higher power signal sources.



Automated Upstream Channel Level and SNR Measurements:

The ONX will automatically populate the UCD (Upstream Channel Descriptor) information into the Ingress Expert mode, based on the last successful DOCSIS range with a CMTS. Using this information, the ONX automatically attempts to measure the upstream signal levels and SNR (signal to noise ratio) for all discovered UCDs. This information can be found in the UCD Information table below the active Ingress Expert graph.

UCD INFORMATION

Frequency (MHz)	Level (dBmV)	SNR (dB)
36.800	-20.0 dBmV	42.2 dB
30.400	-19.9 dBmV	35.2 dB
24.000	-18.8 dBmV	35.0 dB
17.600	-10.6 dBmV	50.3 dB

Heatmap Persistence:

The Ingress Expert mode has 3 different persistence settings: Low, Medium, and High. These correspond to a rolling window of time, detailed below. The window of time helps determine which color each pixel becomes based on the percentage of time a signal was active at a specific amplitude

(Heatmap colors are described later in this document) and how long the heatmap colors remain on the screen before falling off once the ingress or QAM signal is removed. A persistence settings may show certain ingress better than another. The recommendation is to start with medium persistence and adjust as needed:

Persistence Setting	Duration of Persistence
Low Persistence setting	2-3 seconds
Med Persistence setting	6-7 seconds
High Persistence setting	11-12 seconds

Heatmap Colors Defined:

The Heatmap is a color coding of the upstream signals based on how often a signal at a specific frequency reaches a certain amplitude. The ONX measures the number of times a signal is present per amplitude compared to the total number of hits for each frequency slice. It then tracks this as a percentage of time that pixel had signal present. Based on this percentage the pixel on the screen is drawn with a color which corresponds to that percentage of time.

The ONX will not draw a color at any pixel that does not see any energy, which correlates to a 0% presence of signals. The other percentages are shown below:

Percentage of time signal is present	Color
0%	No Color
0% to 0.25%	
0.25% to 0.5%	
0.5% to 0.75%	
0.75% to 1.0%	
1.0% to 1.25%	
1.25% to 1.5%	
Greater than 1.5%	

If any color is present then that means there was a signal at that frequency and amplitude. Light blue being the least consistent presence of signals, going up to Red being the most frequent presence of signal.