



Broadband Instruments and Systems



Return Path Noise Troubleshooting

Piedmont Chapter/ SCTE
Technical Session



think ahead.



Presentation Outline

- Return Path Overview
- Physical Network Preparation & Maintenance
- Field Operations
- Return Path Testing





Return Path

- The problems that operators are having with the return path typically comes from noise and ingress
- Ingress is the most common problem that operators of two-way services are struggling with





How Testing Helps

- Must be quick to identify, isolate, and solve problems – know system health
- Provides long-term retention
 - Recruiting customers is expensive and is critical to the ROI
 - Loss of voice customer may also mean loss of the rest of the triple-play revenue





Broadband Instruments and Systems



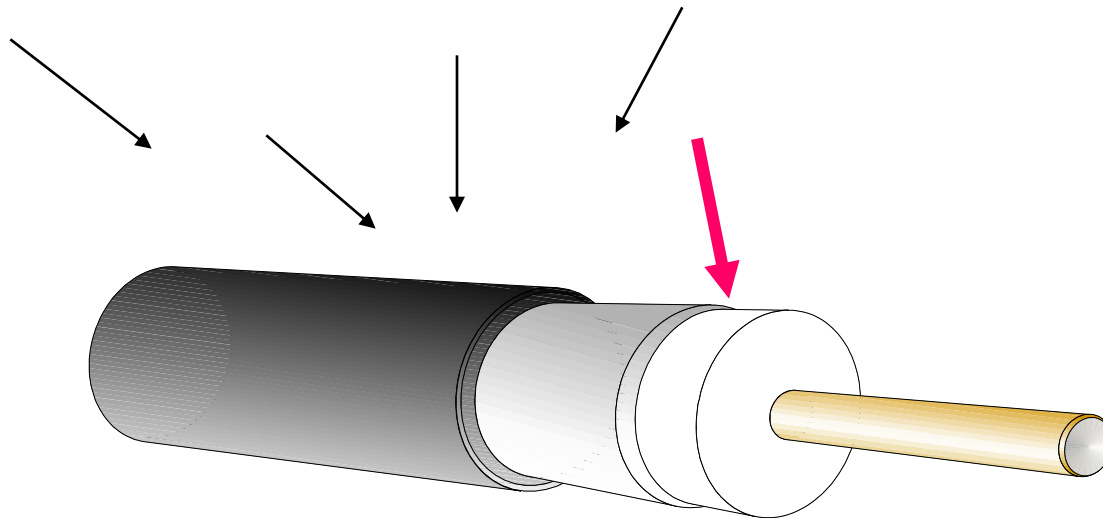
Return Path Ingress Troubleshooting Techniques



think ahead.



Ingress



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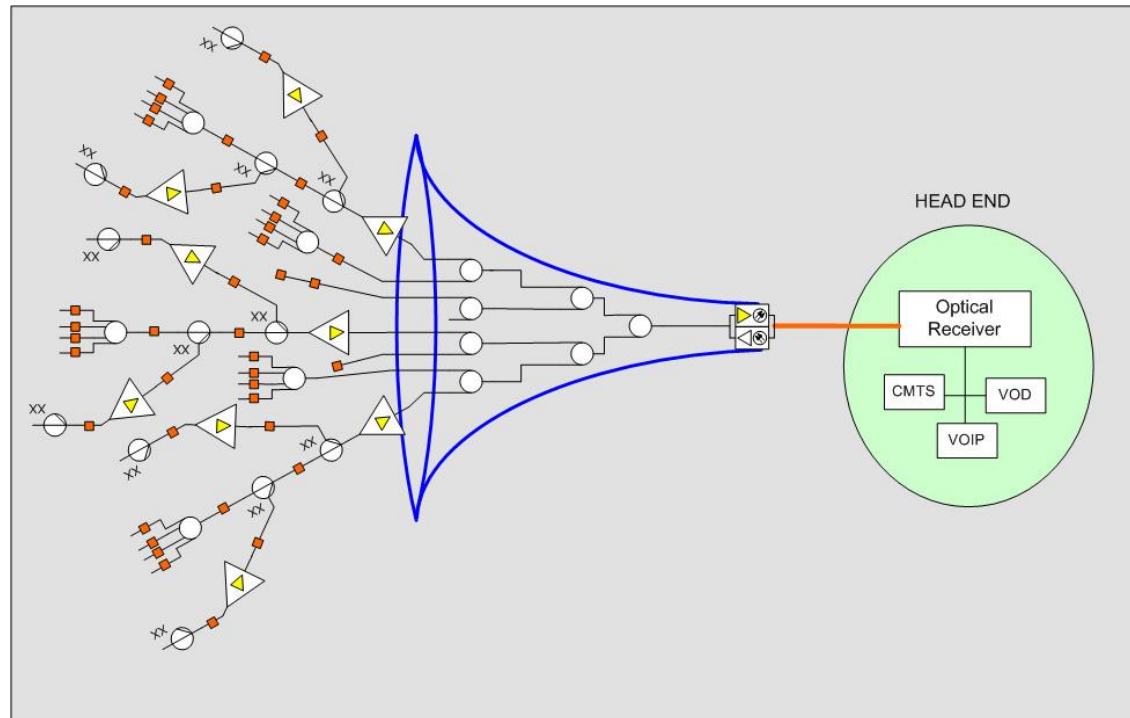
Common Sources of Ingress

- Off Air
 - Short Wave Radio (4.75 to 10 MHz)
 - Ham Operators (7, 10, 14, 18, 21, 24 & 28 MHz)
 - CB Radios (27 MHz)
 - Broadband noise (things with electric motors, PCs, etc)
 - Impulse Noise (shorts bursts of Broadband noise)
- Plant Induced
 - Common Path Distortion (6MHz beats across entire spectrum)
 - Transient Hum Modulation
 - Excessive Gain
- Subscriber Induced
 - Direct Pickup
 - Malfunctioning Subscriber Devices
 - Broadband noise from appliances
 - Self Installs





Ingress Funneling Effect



Bi-directional system return path funnelling effect



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Enhanced Testing and Maintenance

- Before the service is rolled out
 - Align and test each node to assure operating margin for optimal quality
- Adequate digital video and HSD performance does not guarantee adequate VoIP performance
 - these services are relatively robust
 - able to withstand interference that causes packet loss and jitter





Alignment & Maintenance Required

- In order to provide the highest quality service and mitigate service calls
- The return path should be swept and balanced
- Verify carrier-to-noise ratio operating margin
- Ingress and impulse noise must be monitored for at least a 24-hour period
 - occurs at various times of the day
 - has a wide variety of causes



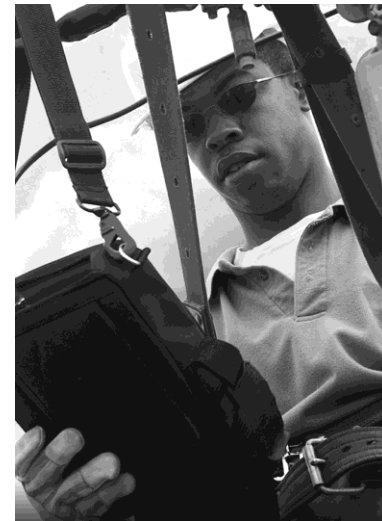
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Return Sweep

- Proper alignment of the system is critical to service quality and reliability
- Problems uncovered while sweeping can also cause ingress
 - Bad, or loose connections
 - Cable damage
 - Misalignment (can cause laser clipping)





Return Path

- Impact of Noise & Ingress on System Services
 - Noise Funneling
 - Noise Contribution
 - Ingress Contribution
- Required System Maintenance
 - Return Sweeping
 - Ingress Troubleshooting
 - Alternative Maintenance Techniques
- Required Monitoring
 - Monitoring of the Spectrum
 - Correlating Monitoring information with system performance





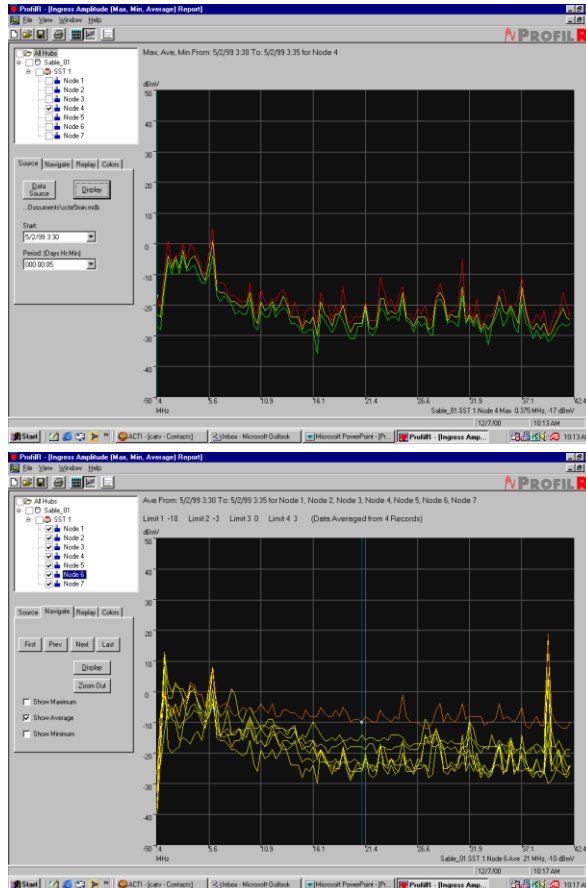
Primary sources of return path noise

- Thermal Noise
 - generated in each active component
- Fiber Optic-Noise
 - From the Return Path Laser
 - Fiber Optic Receiver
- Ingress
 - Discrete
 - Broadband
 - System Induced





Observations about Ingress



- Ingress levels vary in the return path
 - Over Time
 - From Node to Node
 - Discrete or Broadband
- Ingress Signatures
 - Highest under 15 MHz
- Vary between nodes
 - Noise Floor Node 1
-25dBmV @ 21 MHz
 - Noise Floor Node 6
-10dBmV @ 21 MHz



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Ingress Monitoring Tools for Maintenance

- Real time access to headend ingress levels via PC or SLM
 - Check ingress levels remotely, saving time traveling to remote locations to troubleshoot ingress that is not longer there
 - Allow comparisons of Ingress levels at the test point and hubsite locations
- Provide documentation of areas in need of maintenance
 - Alarm violations by node
 - Playback spectral information that caused alarm conditions
 - Spectral information by node over time

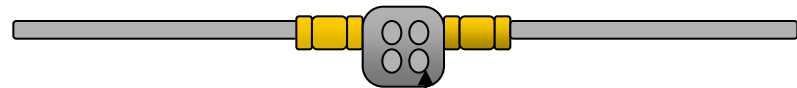




Ingress Studies

Where does ingress enter the system?

Hard-line Cable	5%
Tap to Ground Block	25%
Subscriber Wiring	70%



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The Daily Routine

- Make a cross reference of service groups (router card/blades) and system nodes
- Compare trouble tickets from HSD, IPPV and Telephony to determine problem nodes
- Use alarm information from status monitoring system to verify if service degradation is due to ingress
- Use remote access through a PC or connect a spectrum analyzer to system test points and verify the problem still exists





The Daily Routine

- Utilize good installation practices
- Install devices need to be of a good quality
- Conduct pre and post reverse testing on installations
- Monitor and repair signal leakage
- Check the performance of the return path
- Issue the reverse trouble tickets to the techs

Potentially one bad drop cable or one poor connection can wipe out an entire node for reverse services.





Tools of the Trade

- Spectrum Analyzer
 - take advantage of RBW and VBW settings to resolve and smooth ingress levels for measuring discrete carriers and CPD
 - adjust sweep and sampling times to capture ingress or zero span to look for transients
 - Use Peak hold to monitor ingress over night when return monitoring systems are not available
- Signal Level Meters/Return Display Meters
 - Localize ingress in the field by comparing ingress levels at test points with headend ingress levels





Tools of the Trade

- Sweep Systems
 - Check the system alignment; excessive gain applies to ingress levels too
- Test Probe
 - Provide access to return signals outside of amplifier test points
- Leakage Detectors
 - Locate cracked cables and may help locate an ingress source. Small leaks in the presence of large fields are still a problem
- Practice &Patience
 - Ingress Levels change over time
 - Know which type of troubleshooting technique to use





Using The Tools



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Ingress Troubleshooting Techniques

- Verify that the ingress is still there
 - Before arriving onsite if possible
- Start at the Node
 - Verify Ingress is from the RF plant and not the fiber link
 - Which distribution leg is contributing the most ingress?
- Isolate to the Span
 - Ingress travels upstream like other system carriers
 - Get ahead of the ingress ingress
- Troubleshoot the Problem
 - Pinpoint the source
 - Take corrective action
- Verify that the ingress has been eliminated





Understanding the Spectrum Analyzer

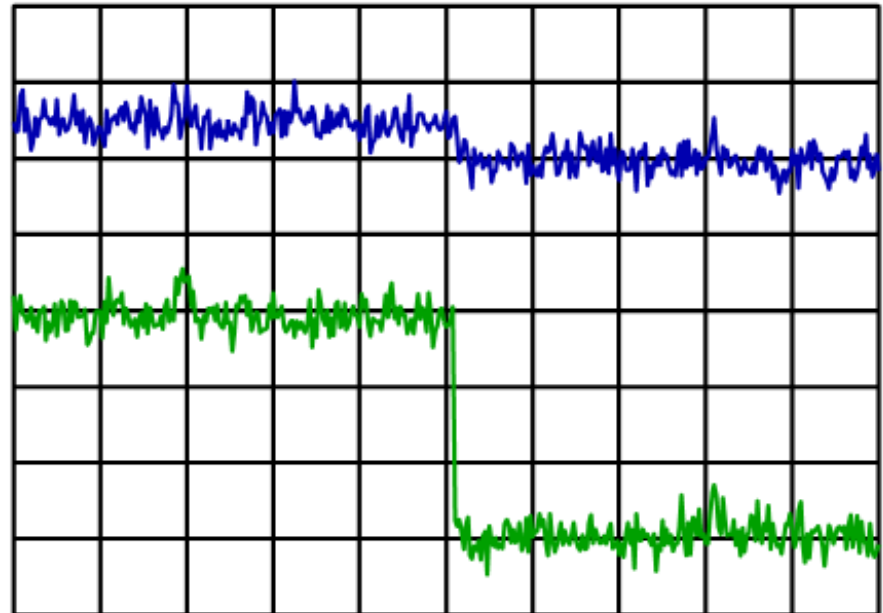
- Reference / Input
- Detector
- Sweep Time
- RBW
- dB/Div
- Frequency Tuning
- Max Hold





Is It System Noise?

- | Internal spectrum analyzer noise may be too high to allow system noise measurement
 - * **use the disconnect test**

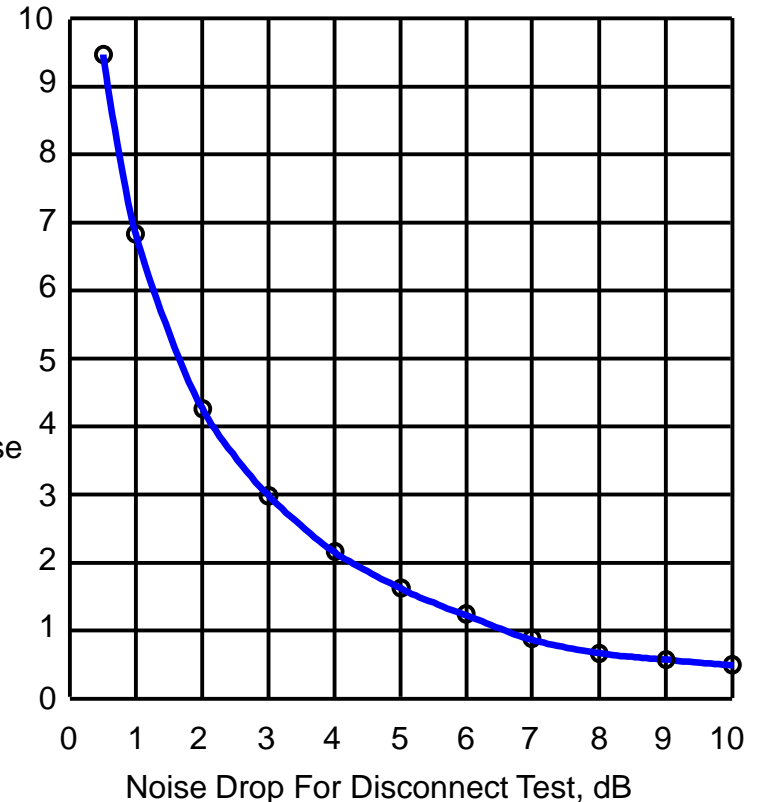




The Disconnect Test

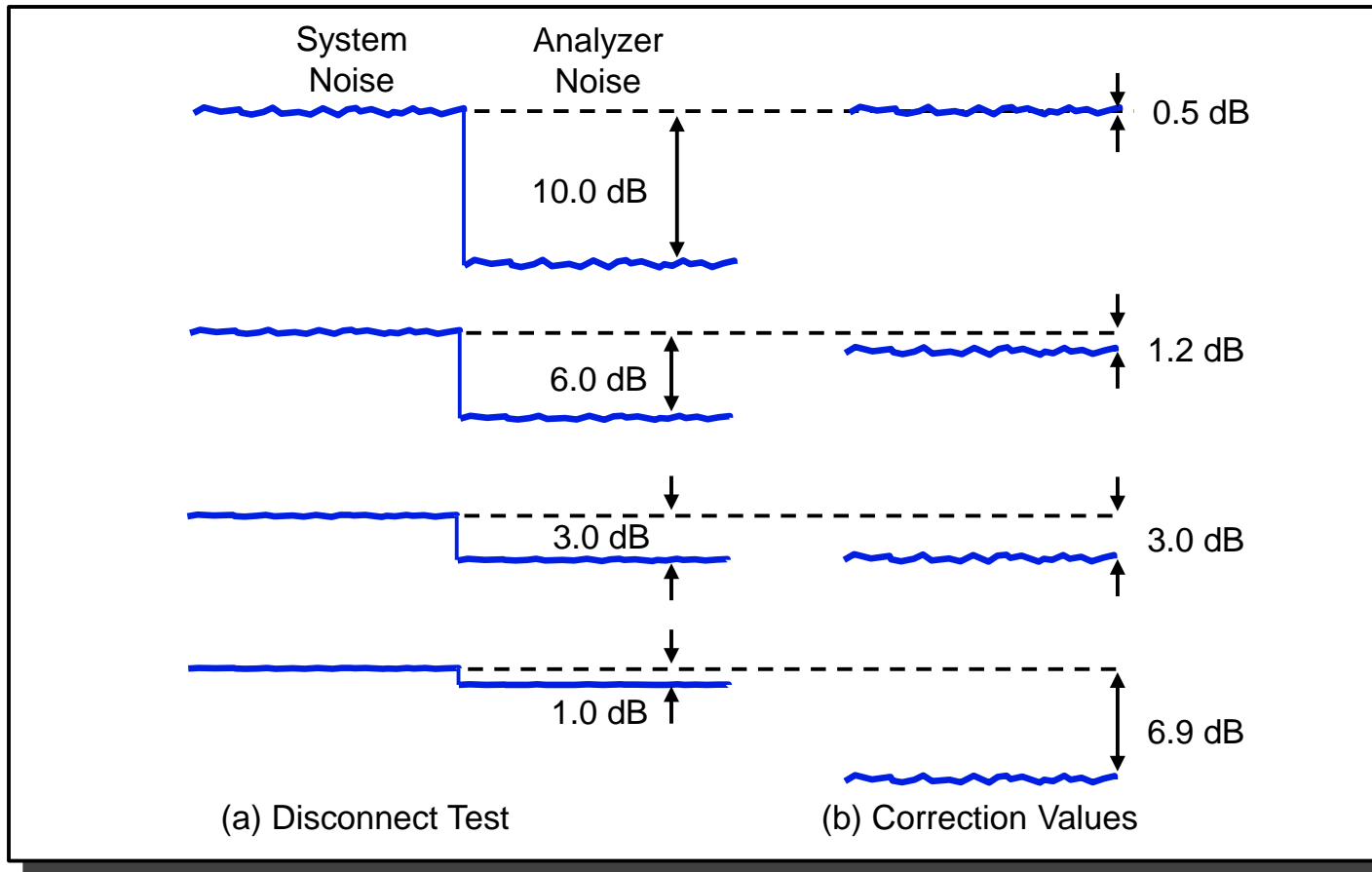
- If > 10 dB drop, no corrections needed
- If > 3 dB drop, correct by using the graph below
- If < 3 dB drop, use a 20-30 dB gain, < 10 dB noise figure preamplifier

Noise-Near-Noise
Correction (dB)





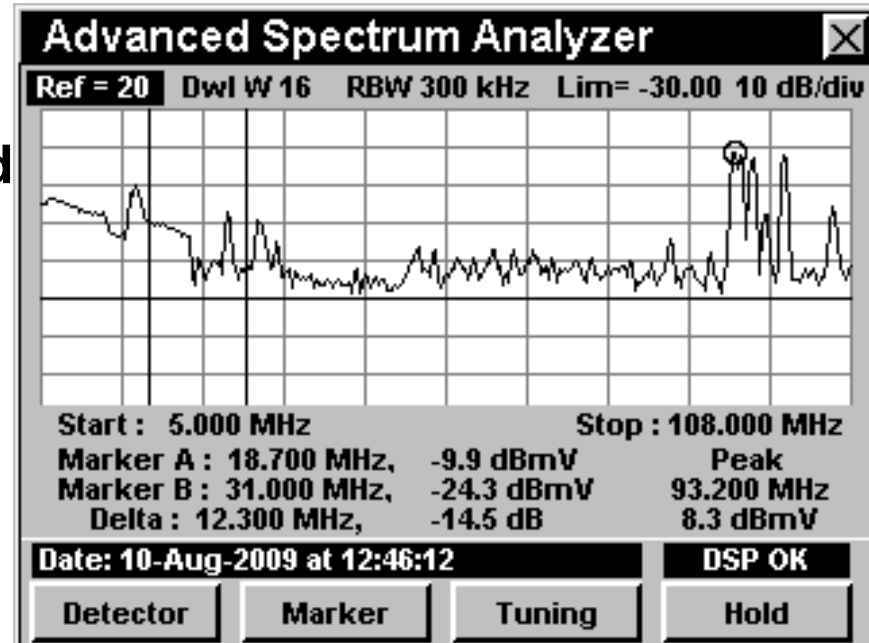
Correcting Analyzer for Noise-Near-Noise





Ingress Mitigation Test

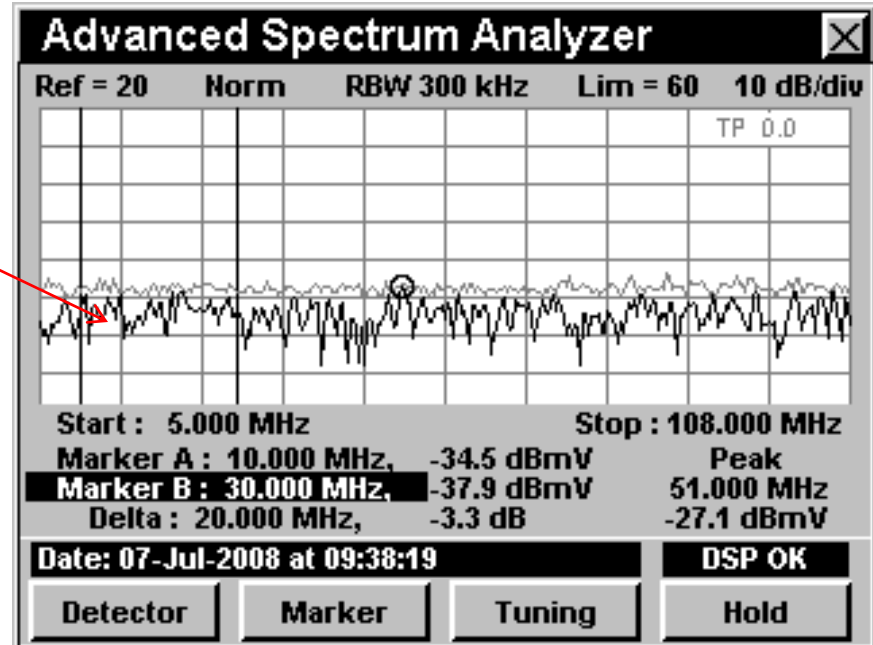
- This is a test where you can quickly check the drop and home wiring for ingress
- Set Ref level so as to not over-load the meter
- Detector set for averaging
- RBW at 300 KHz
- 10 db/div
- Spectrum 5-108 MHz
- Use peak hold





Ingress Mitigation Test

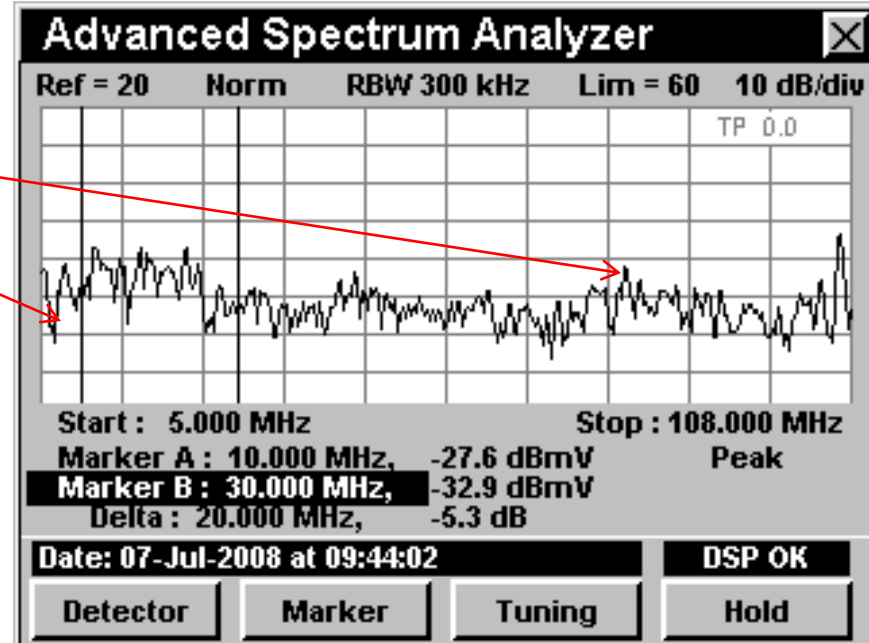
- What you should see is NOTHING!
- Just the noise floor





Ingress Mitigation Test

- Look for ingress by using the “Peak Hold” function
- Identify the problem by working back towards the house





Correct Meter Settings

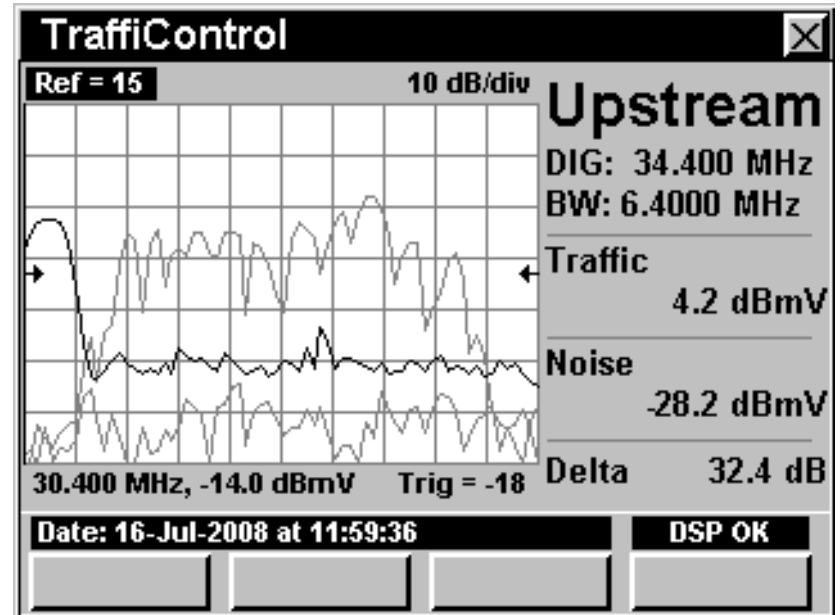
- When Troubleshooting Ingress made up of transient or bursty carriers/noise:
- Increase RBW Setting
 - This reduces the amount of time the meter requires to resolve the spectrum
- Averaging
 - Set to normal or minimum
- Use Peak Hold





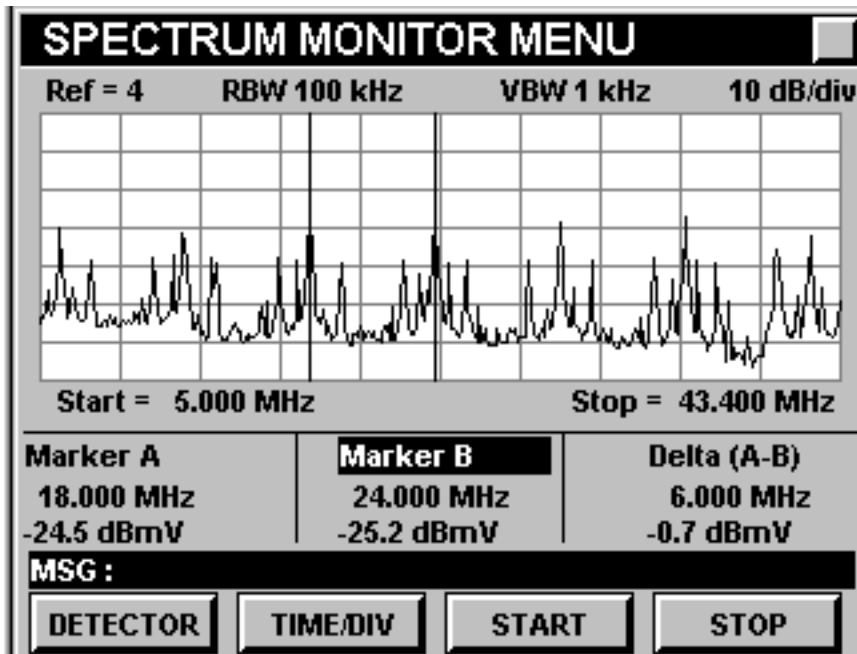
In-channel Upstream Spectrum Analysis

- Return spectrum is getting crowded, making inspection of spectrum problems difficult
- Test mode can be used to see the ingress or distortion “underneath” an upstream cable modem carrier, VoIP carrier, or any bursty signal
- Troubleshooting made easy
 - Divide & Conquer
 - Source typically a home





System Induced distortions

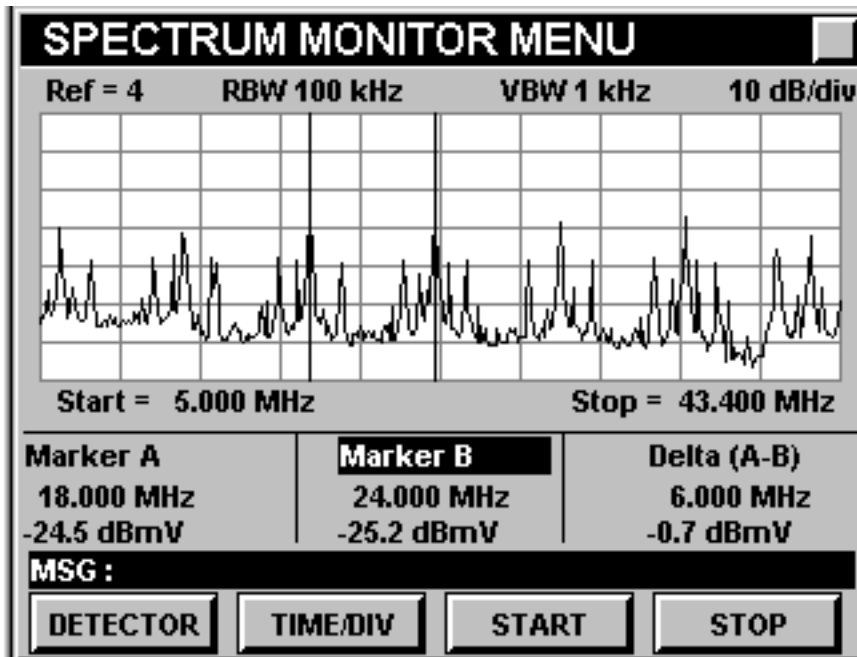


- Common Path Distortion
- Signature of CPD
 - Distinctive 6 MHz beats across the spectrum, but most easily viewed in the return path
 - CPD will add to CTB in the downstream, subscribers complaining of “lines” in their picture may help pinpoint the location of CPD
- Causes of CPD
 - Corrosion which forms a diode junction producing a non linear mixing of downstream carriers





System Induced distortions



- Causes of CPD continued
 - The mixing follows the formula of
 - $f_1 + f_2$ and $f_1 - f_2$ for all system carriers and their beats. Its is the subtraction of the lower frequency video carriers from higher frequency video carriers that creates the distinctive 6 MHz beats
- Places to Look
 - Terminators
 - Loose Seizure Screws





Sources and Descriptions of Ingress

- Transient Hum Modulation
 - Description
 - Low frequency disturbance to system carriers
 - Sources
 - amplifier switching power supply modules
 - Power Inserters (Saturation of ferrite material in RF choke)
 - Ground loops
 - House ground with voltage present





Alternative Maintenance Techniques

- High Pass Filters
 - Attenuate Return Path Noise and Ingress coming from the subscriber premise
 - Isolate entertain services from data services
- Return Path Attenuators
 - Increase the tap loss in the return path only
 - Equalize the loss for subscriber devices and increase isolation between subscriber premise and cable system
- Drop Testing
 - Testing the integrity of the subscriber wiring





Broadband Instruments and Systems



Field Operations

think ahead.





Troubleshooting Ingress

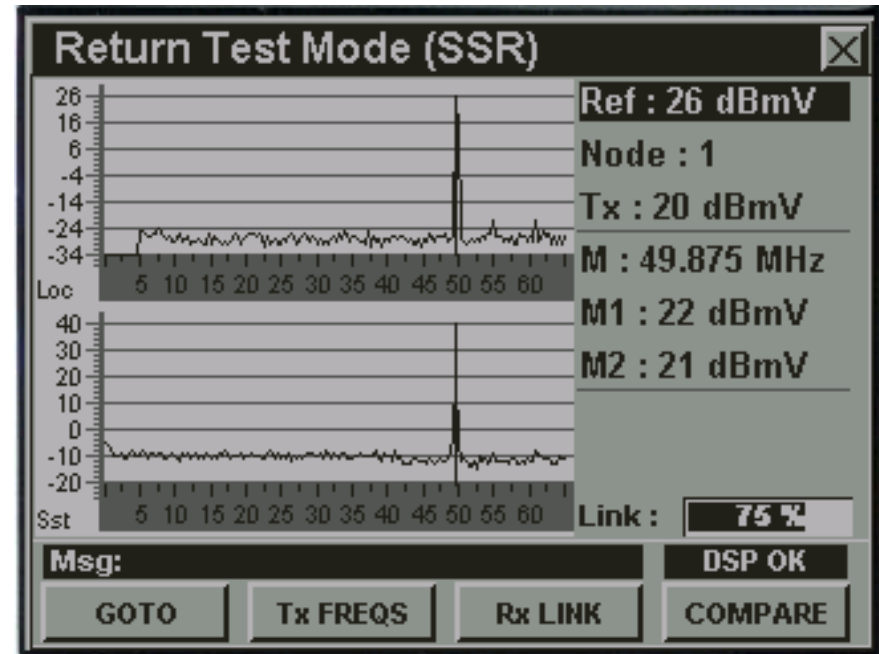
- Compare local test point spectrum to headend/hub spectrum
- Use I-stop probe to load local test point and see if headend spectrum drops
 - If it drops the problem is farther down the line
 - If it doesn't the problem is closer to the headend/hub
 - Low-pass filter is also recommended





Using the I-Stop Probe

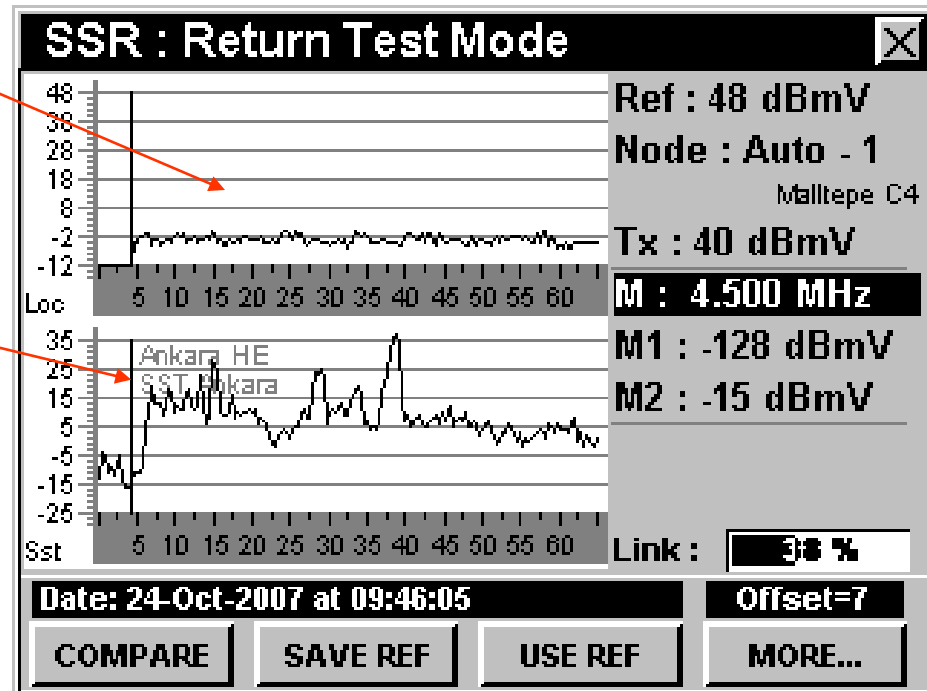
- Press the button on the side of the probe
 - If the ingress decreases by 4-6 dB when the button is depressed, the source of the ingress is farther from the node than you are
 - Ingress that doesn't decrease is entering the system nearer to the node than you are.
- The I-Stop Probe has little or no visible effect on forward path signals.





Reverse Ingress

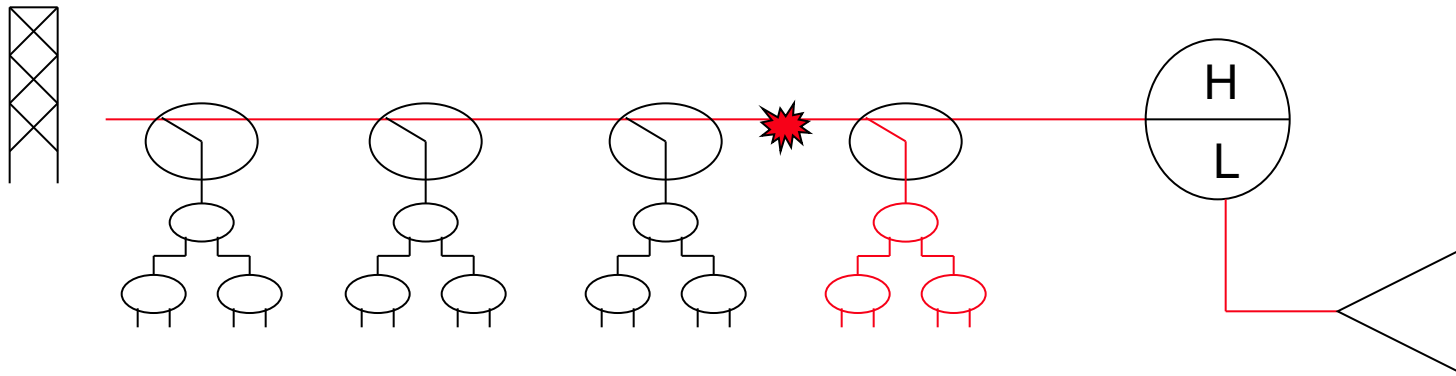
- Top displays Local
- Bottom displays headend
- Move your location until you find the source of the ingress





Ingress From Damaged Cable

Ingress Levels Influenced by External Sources



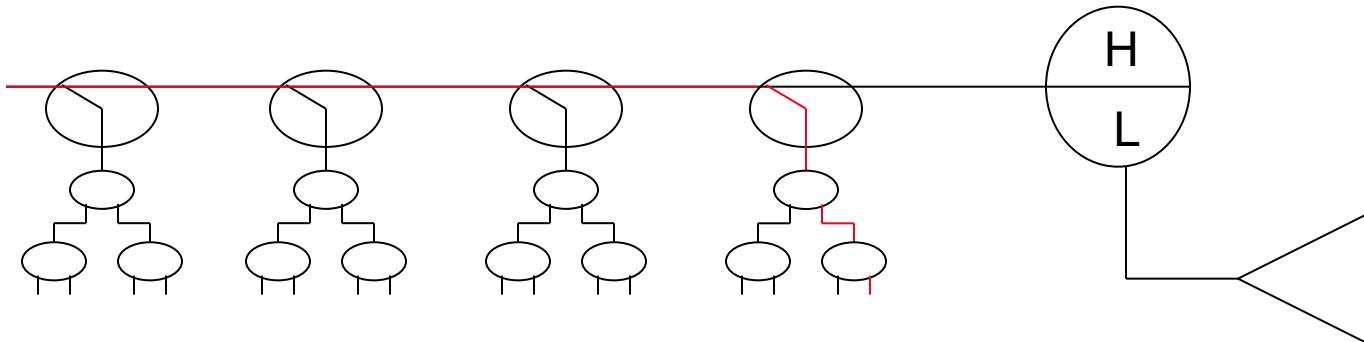
Ingress Travels in both directions





From the House

Ingress Level Reduced by Tap Value

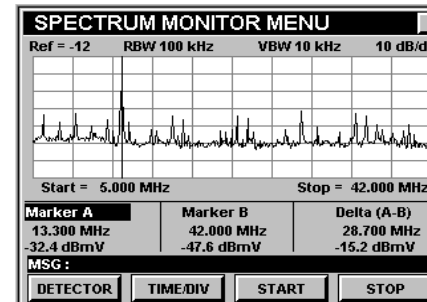
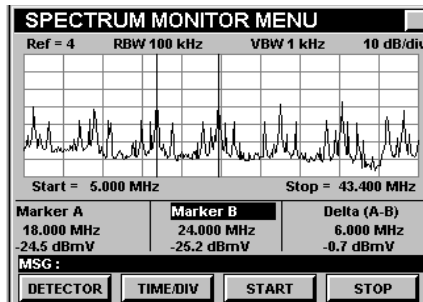
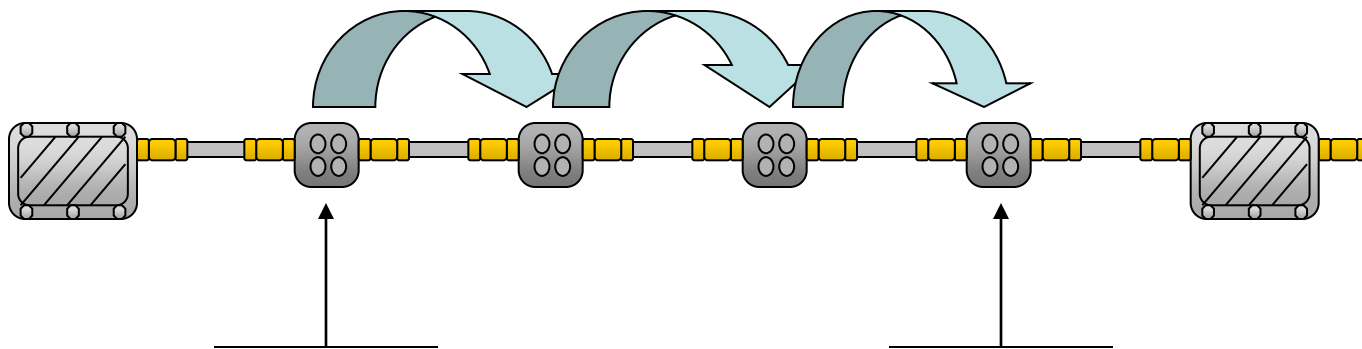


60 dB Port to Port Isolation





Isolate the Tap

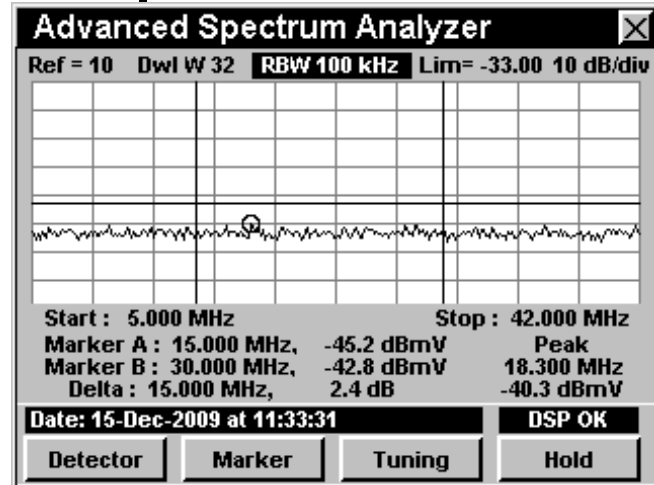
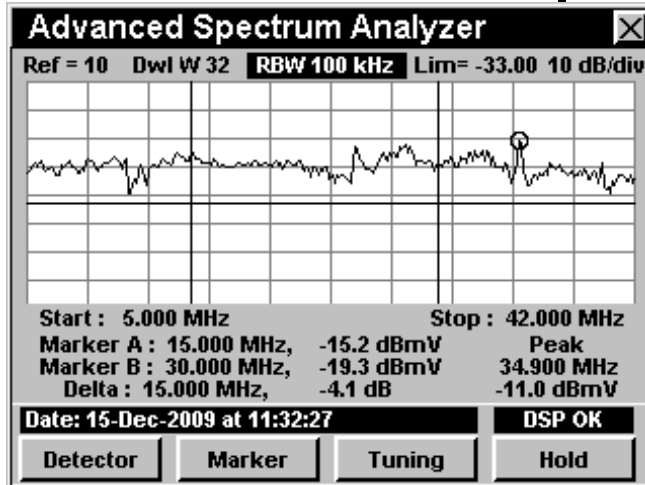
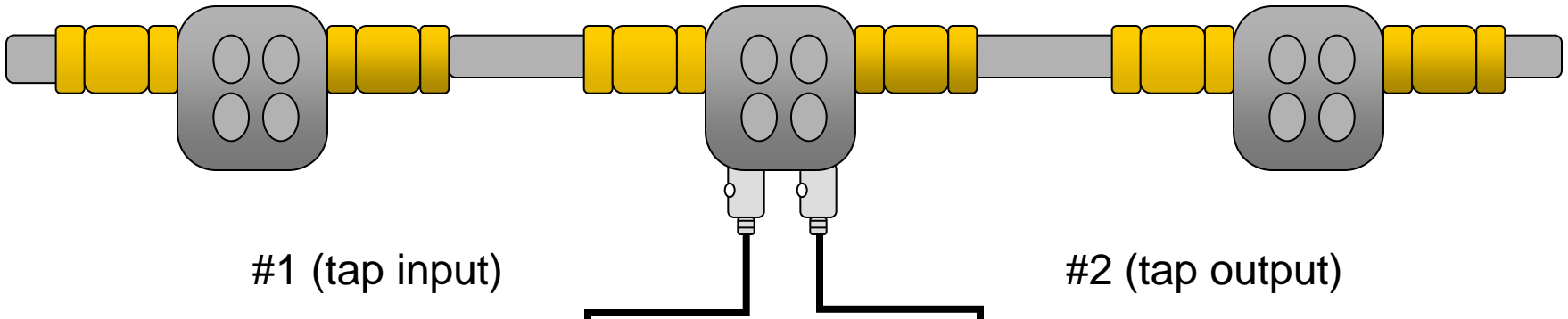


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Ingress Mitigation Test





At the Node

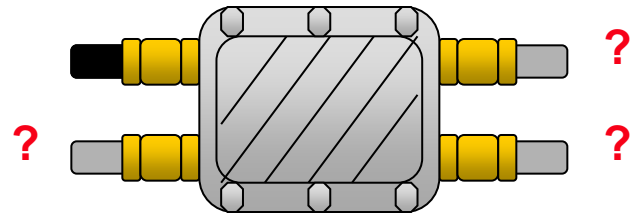
- At the node location, determine which leg(s) are contributing to the CPD. Do not pull pads to isolate the leg.
- The diode junctions that cause CPD are very sensitive to voltage! Voltage transients that occur when pads are pulled and replaced are likely to “fry” the diode junction and cause the CPD to disappear, at least for a little while.





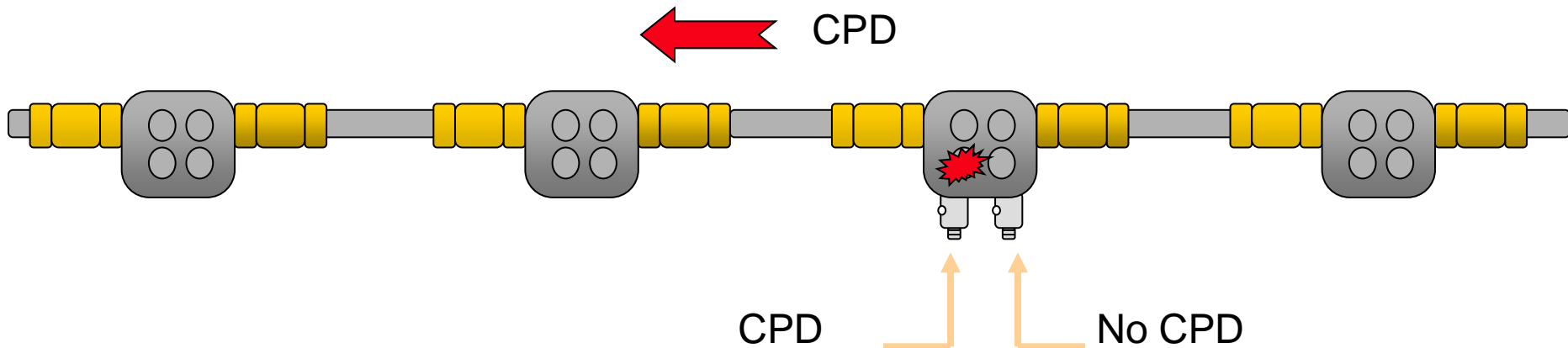
At the Node

- Measure the CPD levels at the return input test point
- Troubleshoot the leg with the highest CPD levels first.
- Do Not break continuity





Isolate the Tap



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Conclusion

- Adding services on the return can be a challenge, but with the right test equipment and procedures you can succeed!
- Vigilant monitoring, proper alignment and installation testing are crucial.





Questions?



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