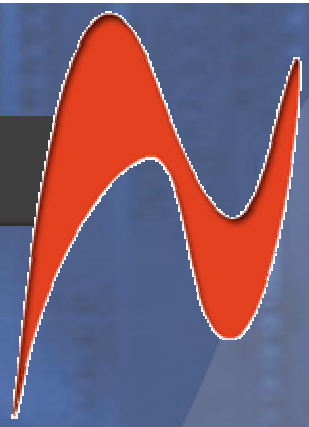
Network Maintenance



Welcome

POP & CLI

Presented by
Lance Bannister
Technical Services Manager
Trilithic Inc.

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Proof of Performance

- **Reference Document** Title 47 CFR Subpart K Technical Standards
  - 76.601 Performance Tests
  - Defines When tests are to be conducted, how many test points are required and where the test points are located
    - Paragraph (c)
      - Requires that performance tests be made twice a year at six month intervals for parts 76.605(a) (2) through (10) described later
      - Test results be maintained for five years
    - Paragraph (c) (1) Number and Location of Test Points
      - For cable systems with 1,000 to 12,500 subscribers
        - » 6 test points
      - For each additional 12,500 subscribers
        - » add 1 test point
      - For Portions of the System which are not "Mechanically Continuous" (Microwave Hubs)
        - » add 1 test point

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Proof of Performance

- **Reference Document** Title 47 CFR Subpart K Technical Standards
  - 76.601 Performance Tests
    - Location of Test Points
      - Represent all geographic areas served by the cable system
      - One Third of which must be located at subscriber terminals most distant from the system input (headend or hub site)
    - Identification of Test Equipment, Procedures and Technician
      - Instrument includes Make, Model and Date of Calibration
      - Procedures Used (NCTA Standard Practices, etc.)
      - Identity and Qualifications of the technician

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Proof of Performance

- **Reference Document** Title 47 CFR Subpart K Technical Standards
  - 76.601 Performance Tests
    - Paragraph (c) (2) Number of Channels to be Tested
      - Requires each channel to be tested for
        - » Visual Carrier Frequency
        - » Visual Signal Level and Variance
        - » Aural Signal Level
      - Requires four channels to be tested for
        - » Aural Carrier Frequency
        - » Characteristics Frequency Response
        - » Visual Signal to Noise
        - » Coherent Disturbances
        - » Isolation
        - » Chroma Display
        - » Differential Gain
        - » Differential Phase
        - » Requires an additional channel for every 100 MHz

Proof of Performance

- **Reference Document** Title 47 CFR Subpart K Technical Standards
  - 76.601 Performance Tests
    - **Paragraph (c) (3) Specifies Dates and Time Interval for the Visual Signal Level Variance 24 Hour Test**
      - Requires that measurements are made every six hours
      - Requires Date and Time information for each measurement
      - Requires Measurements to be made in Jan/Feb and Jul/Aug
    - **Paragraph (c) (4) Requires that performance tests be made every three years for**
      - Chroma Display
      - Differential Gain
      - Differential Phase
    - **Paragraph (d) Requires that all subscriber terminals meet the technical specifications outlined above**

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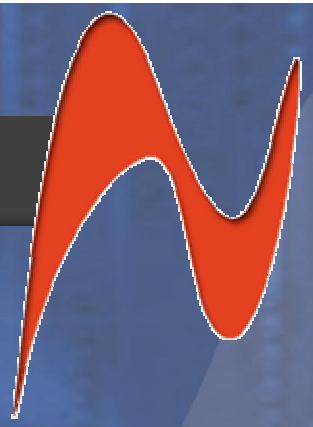
The Visual Carrier Frequency



- Compliance Testing for Part 76.605 (a) (?)
  - Test All Channels
  - Performed Twice per Year
  - Test Locations
    - Subscriber Terminal (or equivalent) test points
  - Specification
    - The center frequency of the aural carrier must be 4.5 MHz above visual carrier
  - Tolerance +/- 5 kHz

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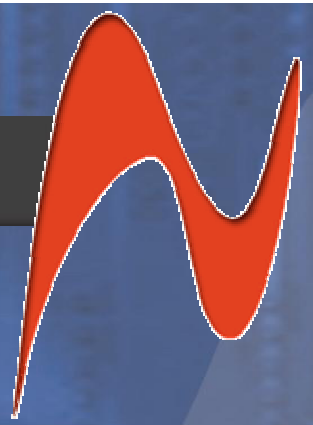
The Aural Carrier Frequency



- Compliance Testing for Part 76.605 (a) (2)
  - Performed Twice per Year
  - Test 4 Channels
    - Plus 1 per 100 MHz of upper frequency distribution
    - Example a 550 MHz plant would be required to test 10 channels
  - Test Locations
    - Headend
    - Subscriber Terminal
  - Specification
    - The center frequency of the aural carrier must be 4.5 MHz above visual carrier
  - Tolerance +/- 5 kHz

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The Visual Signal Level Test

- Compliance Testing for Part 76.605 (a) (3)
  - Performed Twice per Year
  - Test All Channels
  - Test Locations
    - Subscriber Terminal
  - Specification
    - Maintain 0 dBmV at subscriber terminal
    - Maintain 3 dBmV at the output of a 100’ drop connected to the subscriber tap

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The Visual Signal Level Variance (24 Hr Test)

- Compliance Testing for Part 76.605 (a) (4)
  - Performed Twice per Year
  - Test All Channels
  - Test Locations
    - Subscriber Terminal
    - Test at six hour intervals
  - Specification
    - Maintain 8 dB or less variation in visual signal level over a six month interval when connect to a subscriber tap through a 100’ drop
    - Maintain 3 dB or less variation in visual signal level for carriers within a 6 MHz nominal frequency separation
    - Maintain 10 dB or less variation from any other channel up to 300 MHz (add 1 dB for each 100 MHz to the upper frequency limit)

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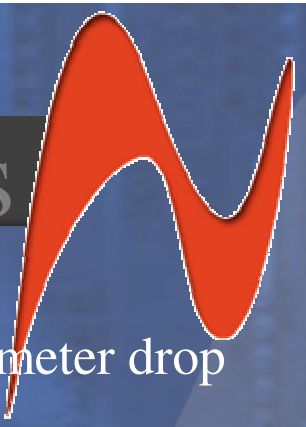
Visual Carriers-System Flatness



- Regulation FCC 76.605 (a) (4) and (5)
  - The signal level on each channel, as measured at the end of a 30 meter drop shall not vary more than 8 dB within any six month interval
  - Tests must be performed twice a year during Jan or Feb and during July or August
  - Each test shall consist of 4 measurements made over a 24 hour period at six hour increments
  - Visual signal levels shall be maintained within 3 dB of any visual carrier within a 6 MHz nominal frequency separation
  - Visual signal levels shall be maintained within 10 dB of any other visual signal on a cable television system of up to 300 MHz
  - For systems with operational bandwidths greater than 300 MHz add 1 dB to the above for every 100 MHz or part there of
  - Limit the maximum signal level such that overload at the subscriber terminal does not occur

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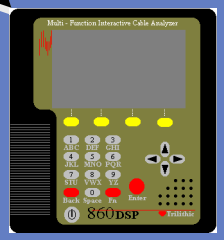
Separation of Visual and Aural Carriers

- Regulation FCC 76.605 (a) (4) and (5) Continued
  - The RMS voltage of the Aural signal shall be maintained between 10 and 17 dB below the associated visual signal level.
  - For subscriber terminals that use equipment which modulate and re-modulate the signal (baseband converters) the RMS voltage of the aural signal shall be maintained between 6.5 and 17 dB below the associated visual signal level
  - Requirements must be meet at the subscriber terminal and at the output of processing and modulating equipment

Proof of Performance Measurements

The Visual Signal Level Variance Test

100’

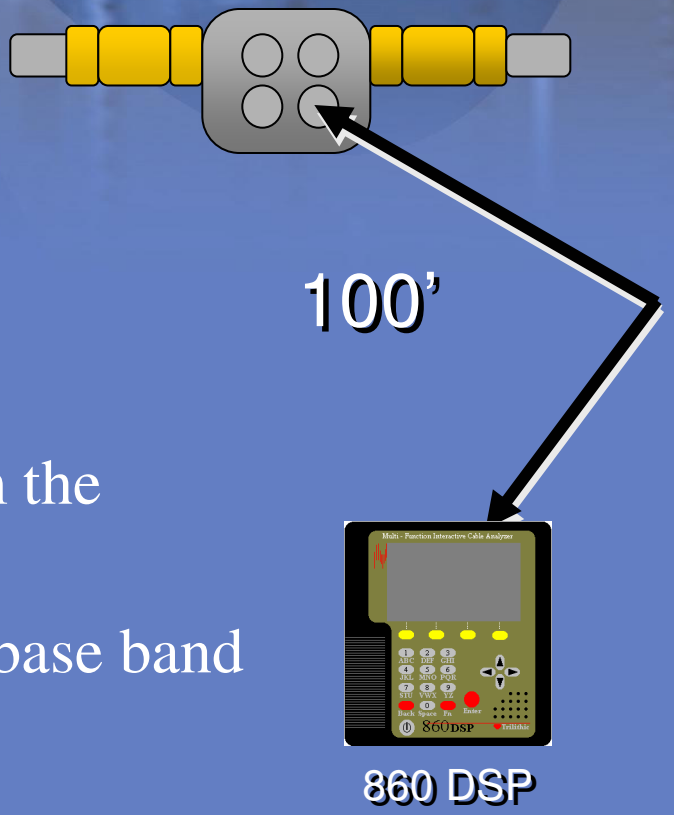


860 DSP

- Record Levels for each visual carrier
  - Calculate Pass/Fail on 3 dB requirement for 6MHz
  - Calculate Pass/Fail on system “flatness”
    - Function automated on most SLMs
  - Calculate Pass/Fail 6 month variation

Aural Signal Level

- Compliance Testing for Part 76.605 (a) (5)
  - Performed Twice per Year
  - Test All Channels
  - Test Locations
    - Subscriber Terminal
    - Headend
  - Specification
    - Maintained 10 to 17 dB down from the associated visual signal level
    - Maintained 6.5 to 17 dB down for base band converters



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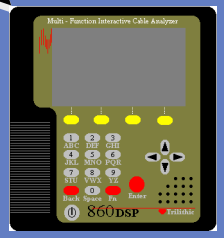
Proof Of Performance Measurements

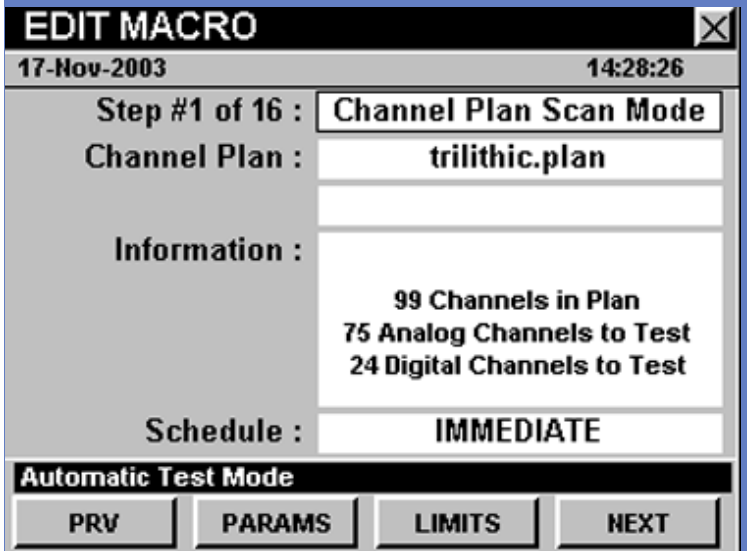
The Aural Signal Level Test

100’

- Record Levels for each Aural carrier
  - Calculate Pass/Fail on Video - Aural delta
    - Function automated on most SLMs



860 DSP



Characteristic Frequency Response

- Compliance Testing for Part 76.605 (a) (6)
  - Performed Twice per Year
  - Test 4 Channels
    - Plus 1 channel for every 100 MHz of upper frequency distribution
  - Test Locations
    - Subscriber Terminal (after converter effective 12/30/99)
  - Specification
    - Maintain +/- 2dB flatness from 0.75MHz to 5.0 MHz above the lower boundary of the Cable TV channel

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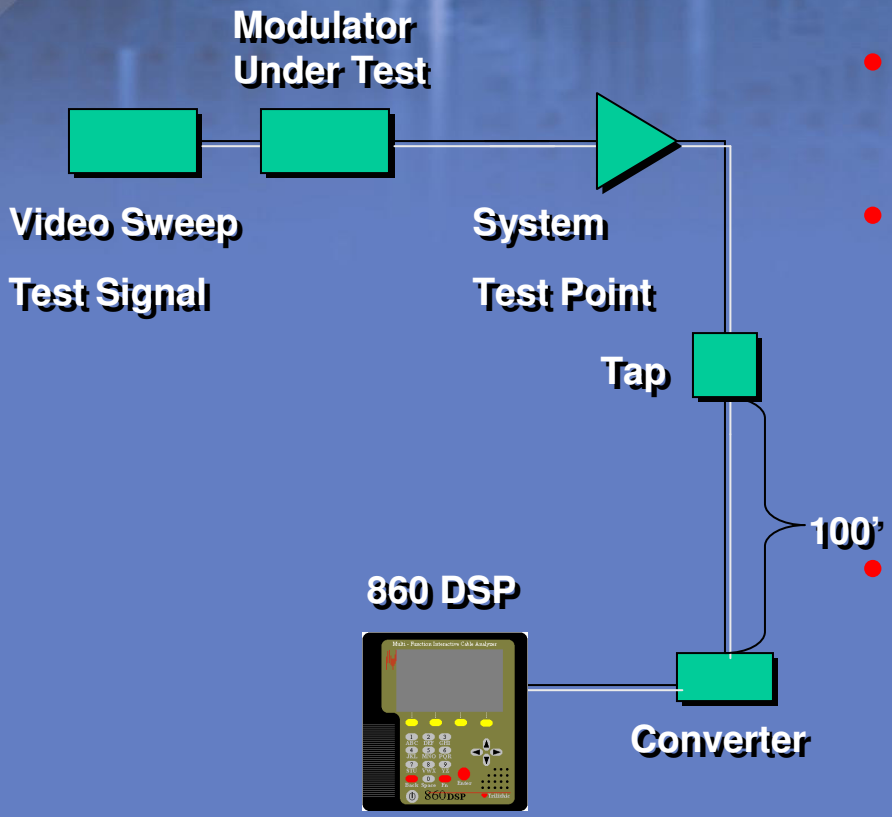
Proof Of Performance Measurements

The Characteristic Frequency Response Test



- Set video generator for full field sweep
- Set Analyzer to test frequency
  - Place the analyzer in Max Hold
  - set markers on on min and max points
  - Divide delta by 2 to obtain the +/- variation and record
- Suggested Analyzer Settings
  - Span 6 MHz
  - RBW 300 kHz
  - VBW 300 kHz
  - Sweep 750ms

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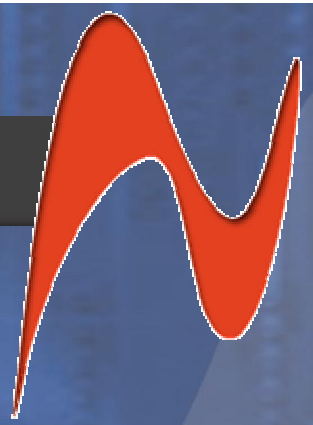
Visual Carrier to Noise Ratio



- Compliance Testing for Part 76.605 (a) (7)
  - Performed Twice per Year
  - Test 4 Channels
    - Plus 1 channel for every 100 MHz of upper frequency distribution
  - Test Locations
    - Subscriber Terminal
  - Specification
    - Maintain 43 dB or better for signals that are:
      - Delivered by the Cable TV system within the predicted Grade B contour for that signal
      - Each signal that is first picked up within its grade B contour
      - Each signal that is first received by the cable TV system by a direct video feed from a TV broadcast station, a low power TV station or a TV translator station

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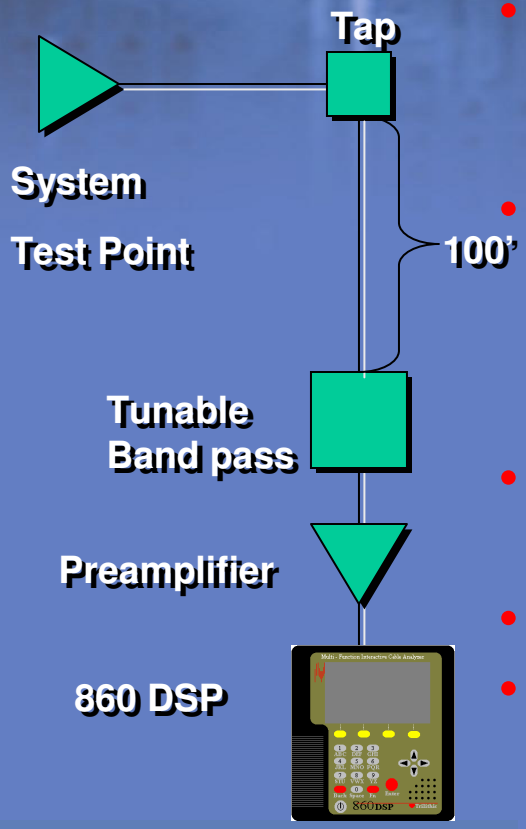
Proof Of Performance Measurements

The Visual Signal to Noise Ratio Test



- Determine if preamplifier is needed
  - Check for <3 dB drop in floor when signal is disconnected
- Determine if Band pass Filter is needed
  - Check for change in signal level when analyzer input attenuator is changed
  - Signal level should not change
- Do not change reference level or attenuator settings
  - use external attenuator if necessary
- Measure noise and correct for 4 MHz B/W
- Suggested Analyzer Settings
  - Use sample detection mode
  - RBW 30 kHz
  - VBW 100 Hz

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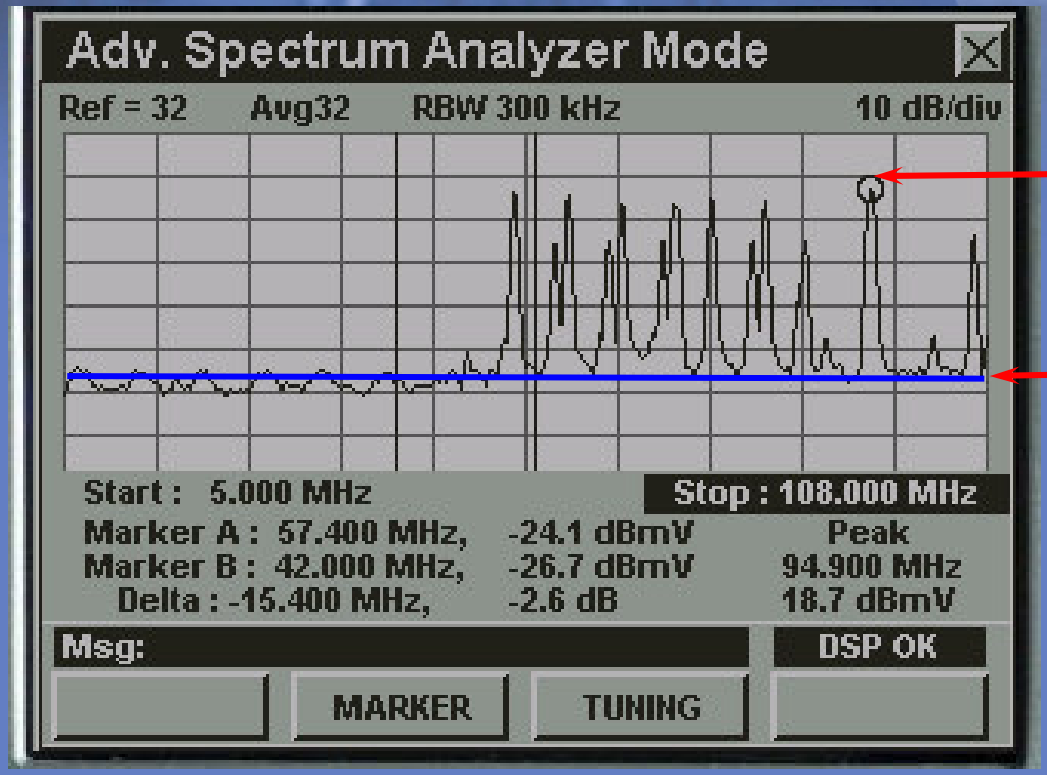
Carrier to Noise



Peak RF level of Carrier

Average level of Noise Floor

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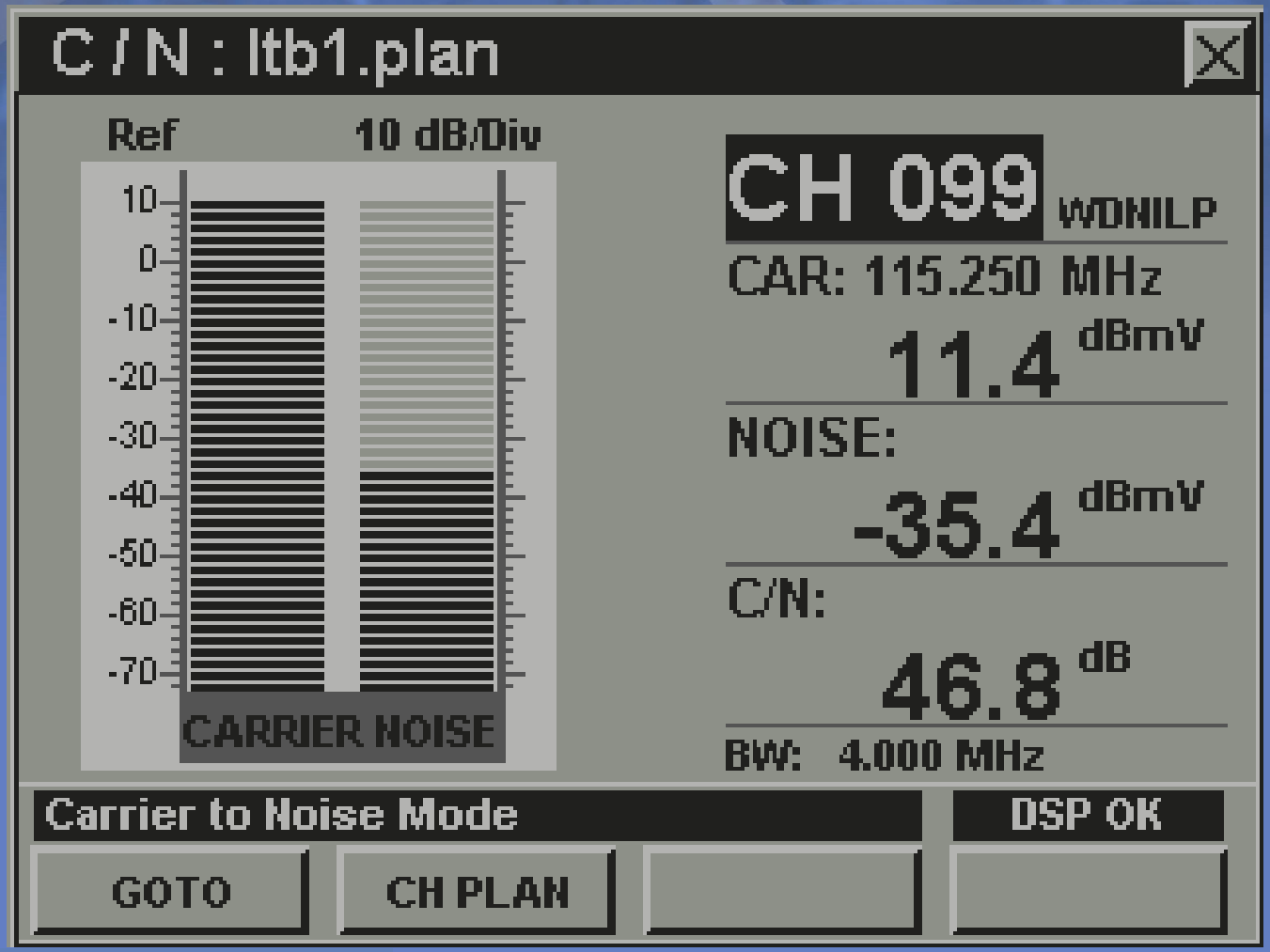
Carrier to Noise



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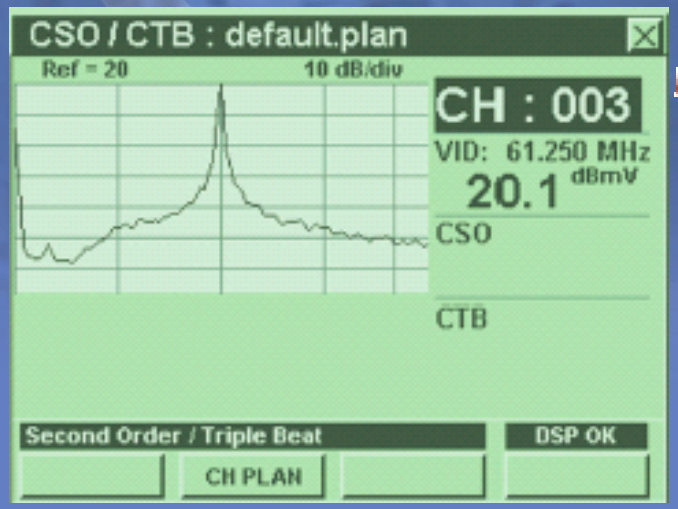
Coherent Disturbances

- Compliance Testing for Part 76.605 (a) (8)
  - Performed Twice per Year
  - Test 4 Channels
    - Plus 1 channel for every 100 MHz of upper frequency distribution
  - Test Locations
    - Subscriber Terminal
  - Specification
    - Maintain 51 dB or better ratio for non coherent channel cable TV systems when measured with modulated carriers and time averaged
    - Maintain 47 dB or better for coherent channel cable systems when measured with modulated carriers and time averaged

Coherent Disturbances CSO & CTB

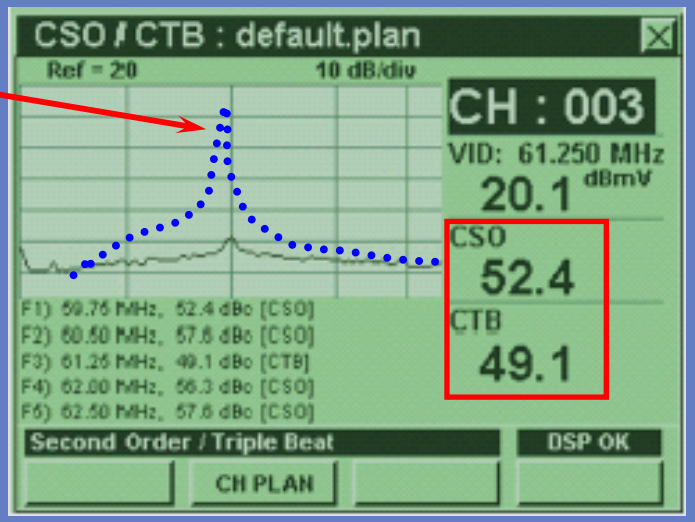
- CSO - max is at the lowest and highest frequency channels
- CTB - max is in the mid frequency channels



To measure **CSO/CTB** you must briefly turn off the video carrier.

860 DSP senses that the carrier has been removed, it will measure and display CSO and CTB.

- **Worst case CSO & CTB displayed below ch info**
- **Detailed list of 5 components listed in Table**
- **860 DSPi keeps record of readings after carrier is turned back on.**



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Coherent Disturbances CSO & CTB

- Composite Triple Beat (CTB) has Traditionally required the channel to be turned off because the disturbance is located below the carrier
- New devices have been produced to combat this problem. They can turn the channel off at a specified time for a very short duration that is invisible to subscribers
- The devise settings usually allow for the choice of the particular line to be tested (deleted)

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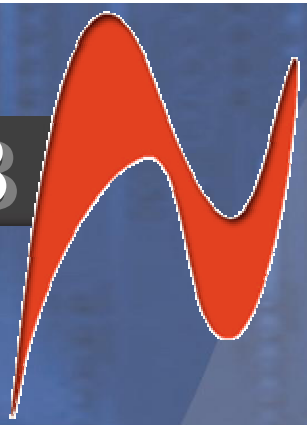
Coherent Disturbances CSO & CTB



- The video line to be “deleted” is selected
- The effect is the carrier will be off during the measurement interval and CTB can be measured without actually disrupting the channel
- The Trilithic 860DSP can utilize this effect without the need to perform a special set up to synchronize with the test line

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Line Deletion & 860DSP

- Using the Advanced Spectrum Analyzer (Option SA-1) set the analyzer for the channel under test
  - Select the RBW and reduce it to 30 kHz
  - Change the averaging to MAX
  - Place Marker A on the video carrier and record level
  - Change the averaging to MIN
  - When the carrier is gone
    - observe the CTB as a small hump in the noise
    - Place the marker on that peak and record the level
    - Use Marker B to measure CSO and record level
    - Add absolute values of video level to CSO/CTB level
    - Example:
      - » Carrier at 10 dBmV, CTB at -50 dBmV
      - » add the absolute values 10 + 50 = 60 dBc

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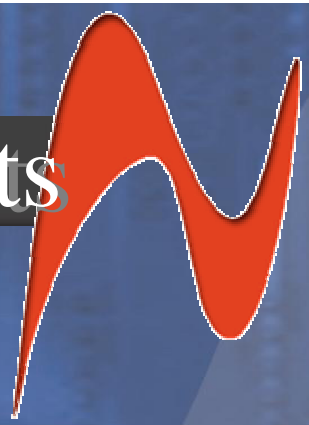
Terminal Isolation

- Compliance Testing for Part 76.605 (a) (9)
  - Performed Twice per Year
  - Test 4 Channels
    - Plus 1 channel for every 100 MHz of upper frequency distribution
    - Or provide written specifications from equipment manufacturer
  - Test Locations
    - Subscriber Terminal
  - Specification
    - Maintain 18 dB or better isolation for each subscriber terminal
    - Prevent reflections caused by open circuit or short circuited subscriber terminals from causing visible picture impairment at any other subscriber terminal

Proof Of Performance Measurements



The Terminal Isolation Test

- Submit vendor specifications

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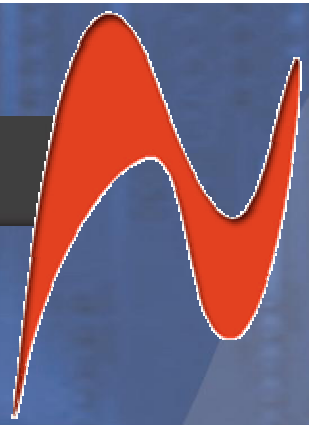
Low Frequency Disturbances



- Compliance Testing for Part 76.605 (a) (10)
  - Performed Twice per Year
  - Test One Channel
  - Test Locations
    - Subscriber Terminal
  - Specification
    - Maintain less than 3% peak to peak variation in visual signal frequency level caused by undesired low frequency disturbances (HUM) as measured on a unmodulated carrier

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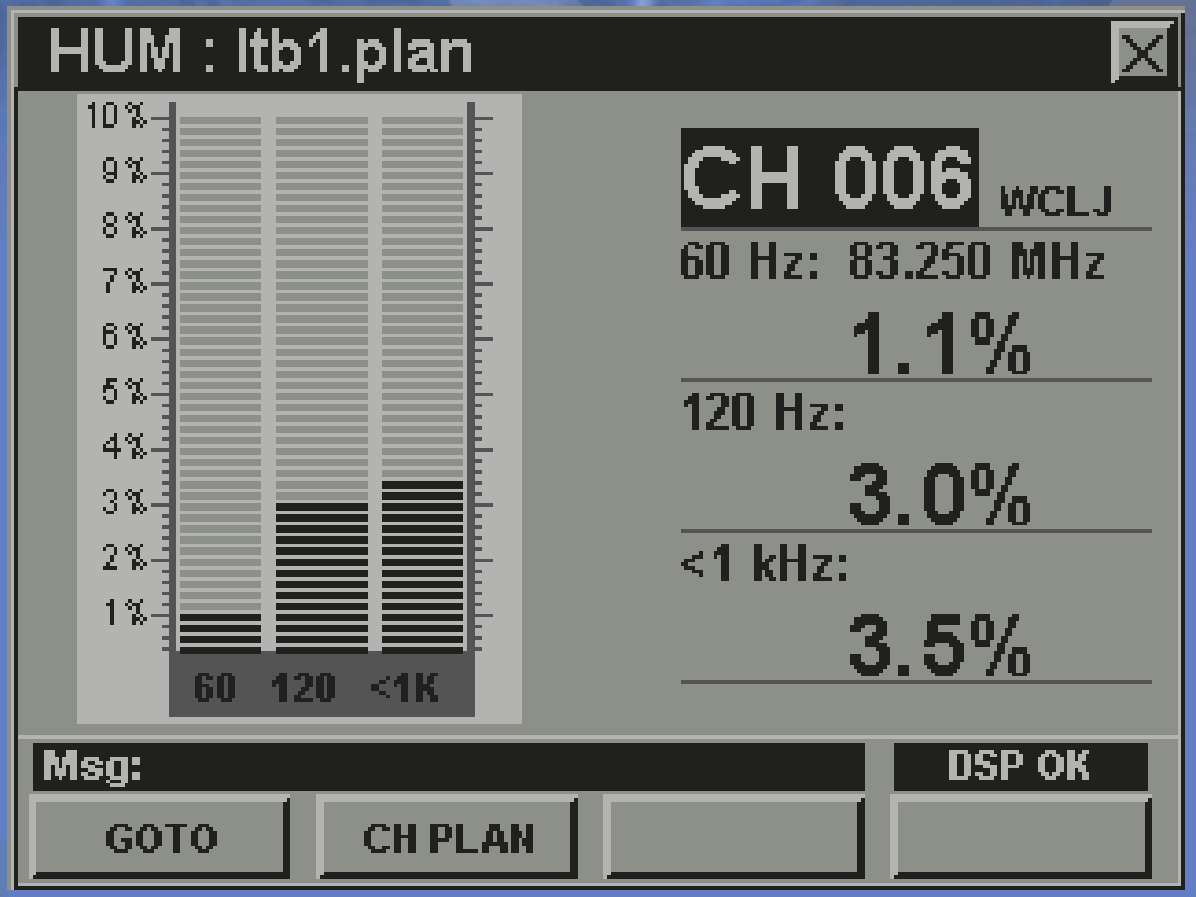
Proof Of Performance Measurements

The Low Frequency Disturbances Test

- Test
  - < 1 KHz
- Troubleshoot
  - 60 Hz
  - 120 Hz



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Differential Gain for the Color Subcarrier

- Compliance Testing for Part 76.605 (a) (11) (ii)
  - Performed Every Three Years
  - Test 4 Channels
    - Plus 1 channel for every 100 MHz of upper frequency distribution
  - Test Locations
    - Headend
  - Specification
    - Ensure that differential gain does not exceed +/- 20%
    - Measured as the difference in amplitude between the largest and smallest segments of the chrominance signal (divided by the largest and expressed in percent)

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Differential Phase for the Color Subcarrier

- Compliance Testing for Part 76.605 (a) (11) (ii)
  - Performed Every Three Years
  - Test 4 Channels
    - Plus 1 channel for every 100 MHz of upper frequency distribution
  - Test Locations
    - Headend
  - Specification
    - The phase difference shall not exceed +/- 10 degrees
    - Measured as the largest phase difference in degrees between each segment of the chrominance signal and the reference segment (the segment at the blanking interval of 0 IRE)

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Chrominance - Luminance Delay Inequality

- Compliance Testing for Part 76.605 (a) (11) (i)
  - Performed Every Three Years
  - Test 4 Channels
    - Plus 1 channel for every 100 MHz of upper frequency distribution
  - Test Locations
    - Headend
  - Specification
    - Ensure that Chrominance - Luminance delay does not exceed 170ns

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Chrominance - Luminance Delay Inequality

- Compliance Testing for Part 76.605 (a) (11) (i)
  - Performed Every Three Years
  - Test 4 Channels
    - Plus 1 channel for every 100 MHz of upper frequency distribution
  - Test Locations
    - Headend
  - Specification
    - Ensure that Chrominance - Luminance delay does not exceed 170ns

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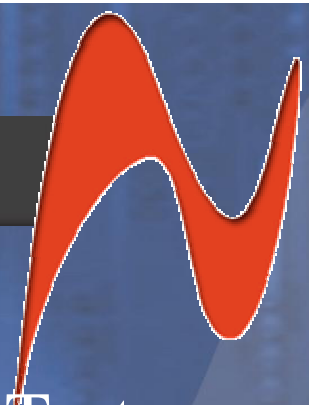
Proof Of Performance Measurements



The Chrominance – Luminance Delay Inequality Test

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Differential Gain for the Color Subcarrier

- Compliance Testing for Part 76.605 (a) (11) (ii)
  - Performed Every Three Years
  - Test 4 Channels
    - Plus 1 channel for every 100 MHz of upper frequency distribution
  - Test Locations
    - Headend
  - Specification
    - Ensure that differential gain does not exceed +/- 20%
    - Measured as the difference in amplitude between the largest and smallest segments of the chrominance signal (divided by the largest and expressed in percent)

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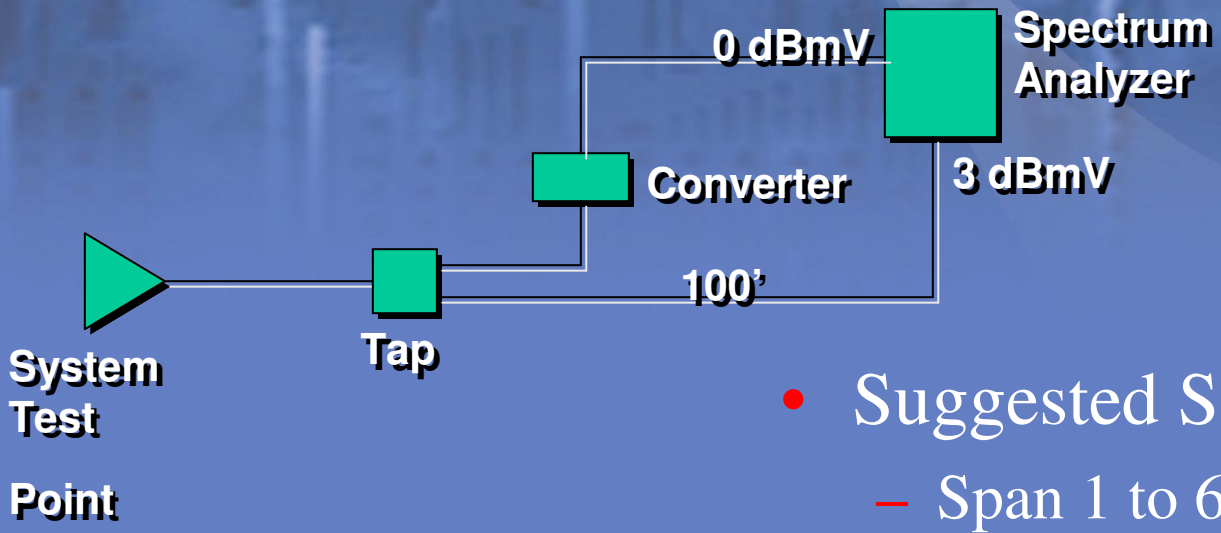
Proof Of Performance Measurements

The Test



- Suggested Settings
  - Span 1 to 6 MHz
  - RBW 300 kHz
  - VBW >300 kHz
  - Sweep 20ms

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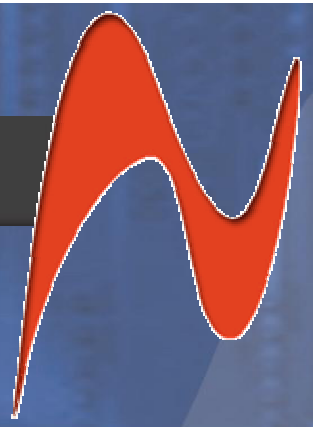
Differential Phase for the Color Subcarrier



- Compliance Testing for Part 76.605 (a) (11) (ii)
  - Performed Every Three Years
  - Test 4 Channels
    - Plus 1 channel for every 100 MHz of upper frequency distribution
  - Test Locations
    - Headend
  - Specification
    - The phase difference shall not exceed +/- 10 degrees
    - Measured as the largest phase difference in degrees between each segment of the chrominance signal and the reference segment (the segment at the blanking interval of 0 IRE

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Measurement Techniques

- Amplitude Measurements with a Spectrum Analyzer
  - Measuring carriers over wide frequency ranges
    - Set Span to display the frequencies of interest
    - Set RBW and VBW for single carrier
    - Calculate sweep time
      - Vertical sync pulses occur every 16ms
      - Measurement points 400 (Span set to 400 MHz)
      - Allow for 10 sweeps of the spectrum
        - » Calculate sweep time as
        - » Sweep time = Vertical sync pulse * # sweeps * # sweep points
        - » Sweep time = 16.7 * 10 * 400
        - » Sweep time = 67 seconds
    - Or Use Max Hold until the carrier amplitude peaks

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Differential Gain

- The measurement of the change in the color saturation as the luminance, or brightness changes
- Appears as “washed out” or pale portions of color
- Luminance is the distance from zero voltage to the average of each packet in the VITS (Vertical Interval Test Signal)
- The Peak to Peak height of each burst of chroma, at 3.58 MHz, is the magnitude of the signal. The heights of the packets should be the same, representing a uniform gain for the different levels of luminance. If video processing changes these burst heights, different al gain distortion results.

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Differential Gain

- Different Gain = [(max-min)/(max+100)]*100

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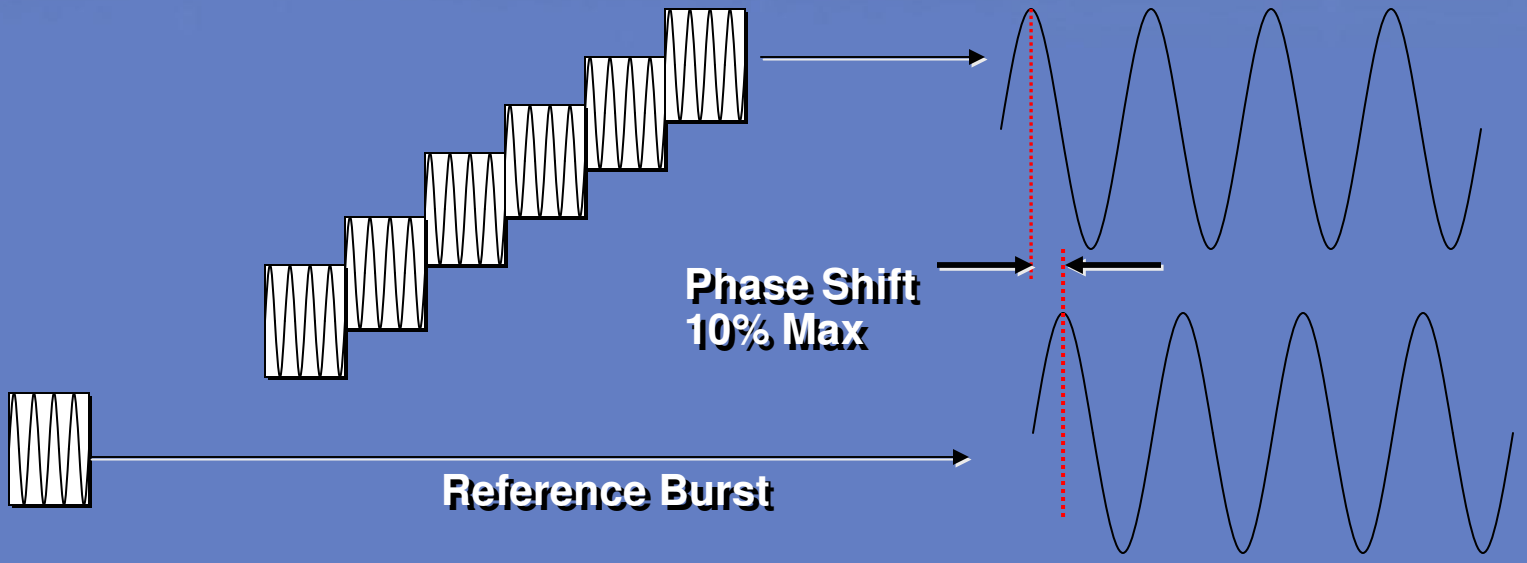
Differential Phase

- The phase of the video signal determines it's color hue.
- Changes in color hue as brightness changes is due to poor differential phase



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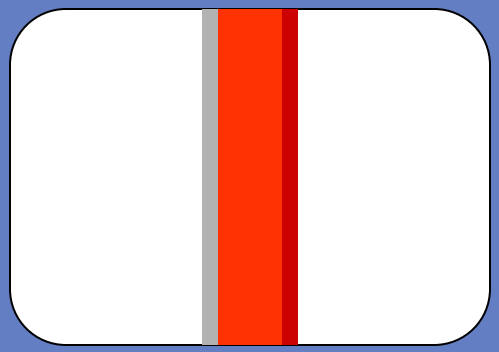
Chrominance to Luminance Delay

- Measure of difference in the time it takes the chrominance and luminance parts of the signal to pass through the system
- Delays appear as colored shadows or “ghosts” in the picture
- In the example below the luminance is arriving at the TV sooner than the color information causing the three colors to appear instead of one.



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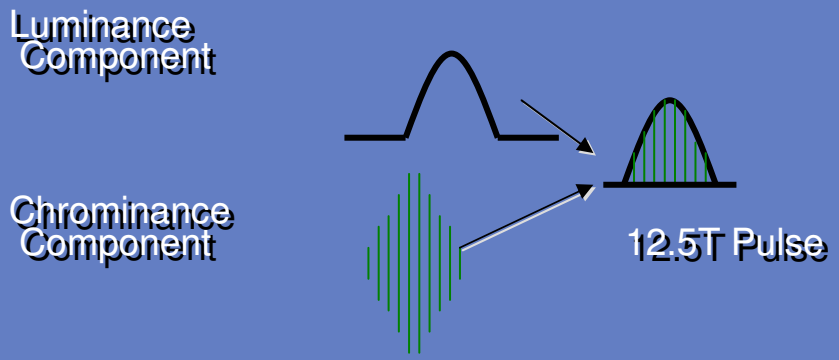
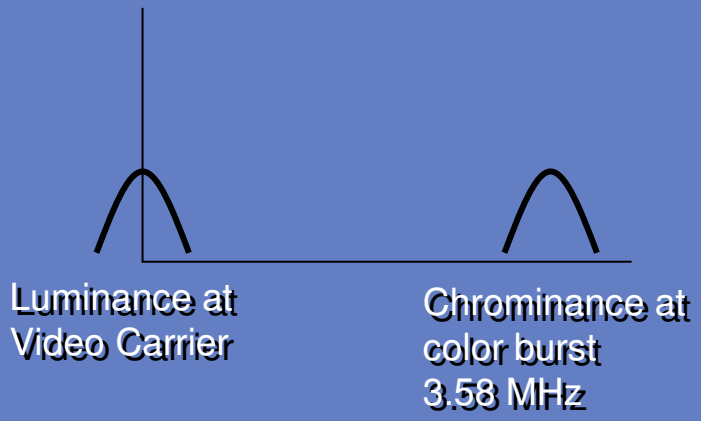
Chrominance to Luminance Delay

- Measuring Chrominance to Luminance Delay
  - The 12.5 T Pulse
    - Special test signal that rides in the VITS
    - Produces two pulses in the video base band
      - luminance at the carrier frequency
      - a color burst at the sub carrier frequency

Time Domain



Frequency Domain



TRILITHIC

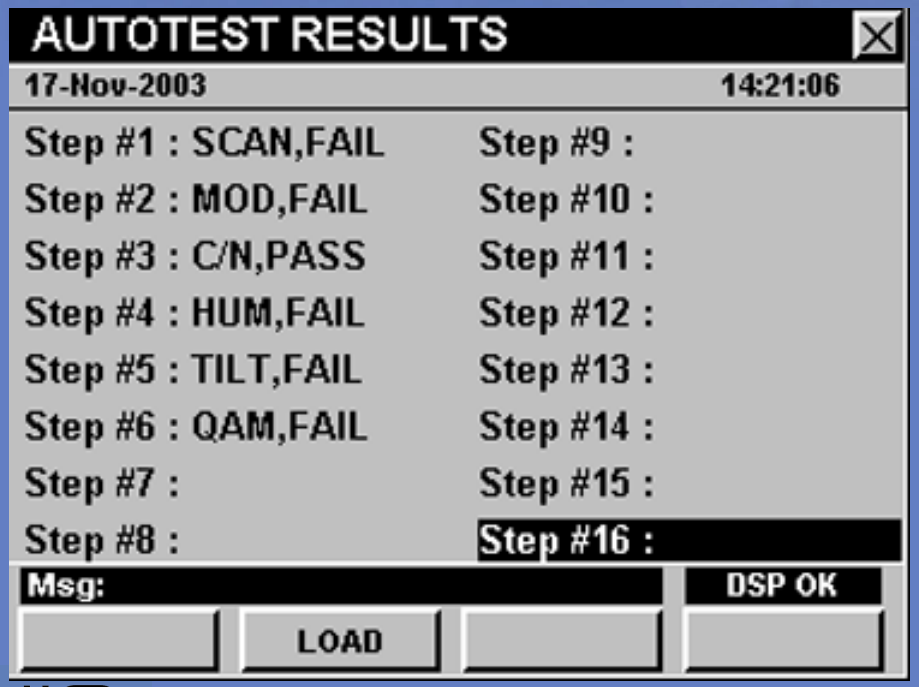
FCC Requirements

- **Tests to be performed as outlined in Part 76.605 (a)**
  - **Aural Carrier Frequency - 76.605 (a) (2)**
  - **Visual Carrier Frequency - 76.605 (a) (3)**
  - **Visual Signal Level Reference - 76.605 (a) (4)**
  - **Aural Signal Level - 76.605 (a) (5)**
  - **Characteristics Frequency Response - 76.605 (a) (6)**
  - **Visual Signal to Noise Ratios - 76.605 (a) (7)**
  - **Coherent Disturbances - 76.605 (a) (8)**
  - **Isolation - 76.605 (a) (9)**
  - **Hum - 76.605 (a) (10)**
  - **Chroma - 76.605 (a) (11) (i)**
  - **Differential Gain 76.605 (a) (11) (ii)**
  - **Differential Phase 76.605 (a) (11) (iii)**

TRILITHIC

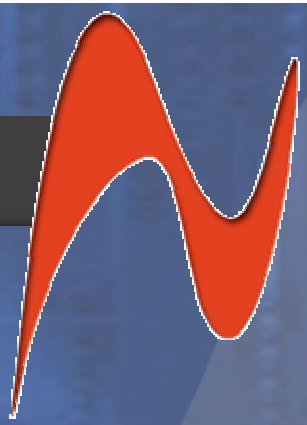
FCC Requirements

- Testing Requirements 76.601
  - Tests outlined in 76.605 (a) (2) through (10)



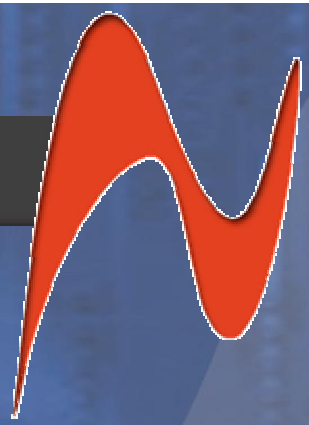
TRILITHIC

Leakage in an HFC Network



TRILITHIC

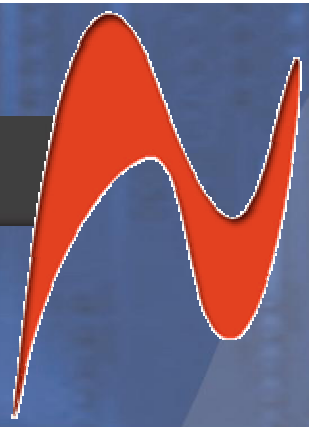
Leakage in an HFC Network



- Leakage terminology
- What is leakage?
- Why do we monitor for leakage?
- What causes leakage?

TRILITHIC

Leakage in an HFC Network



- Leakage characteristics
- Locating source of leakage
- Ingress
- Quiz for Review

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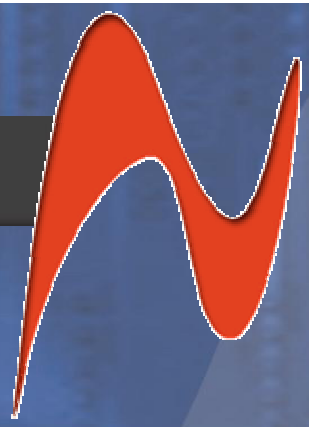
Leakage in an HFC Network



- Egress
- Radiation
- Leakage
- Ingress
- uV/M
- Squelch
- Calibration

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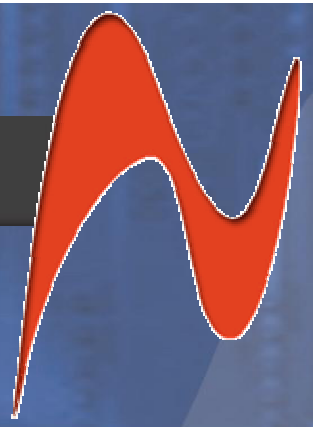
What is Signal Leakage?



- Definition:
  - Undesired emission of signals out of an HFC network

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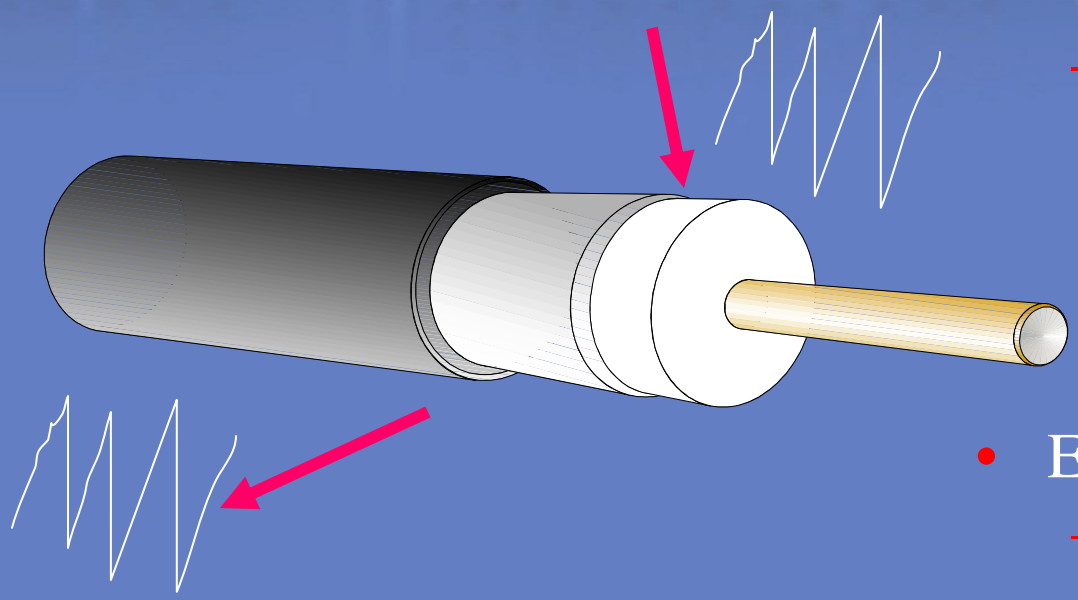
Ingress & Egress



- Ingress
  - RF or electrical energy that enters the coaxial environment
- Egress
  - RF signal leaking out of the coaxial environment

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Why do we monitor for leakage?

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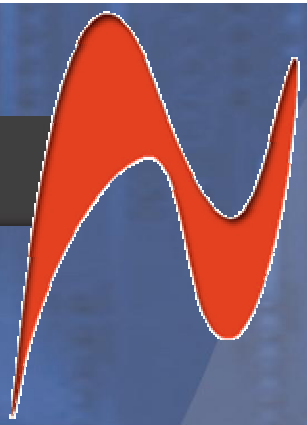
Signal Leakage History



- Mid-band expansion
- Aeronautical interference discovered (1976)
- Frequency offsets (1979)
- Radiant dome (1980)
- Mandatory FCC enforcement (1980s)
- Cumulative Leakage Index (1990)

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Reason #1 to Monitor for Leakage

Prevent Off-Air
Broadcast Interference

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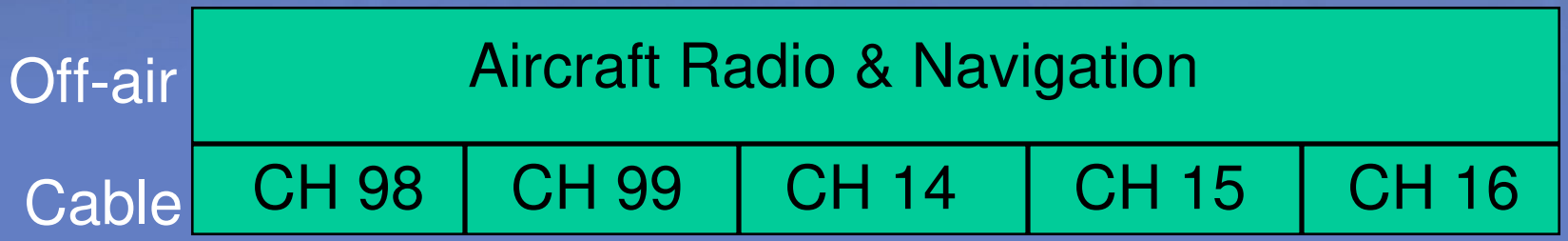
Spectrum Chart

- 108MHz 138MHz



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Reason #2 to monitor for leakage

Meet FCC Compliance

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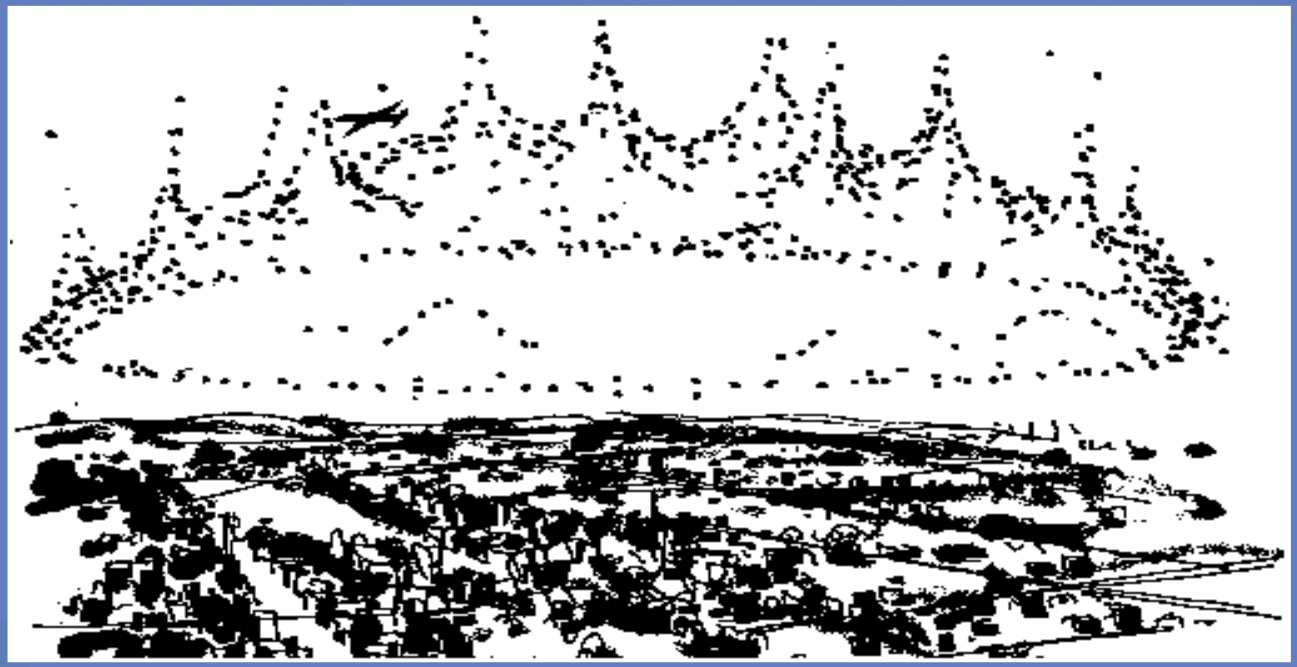
Cumulative Leakage Index (CLI)

- CLI is the net effect of the combination of all the leaks in the system added together
- These cumulative leaks form an invisible cloud of unwanted RF energy over the cable system



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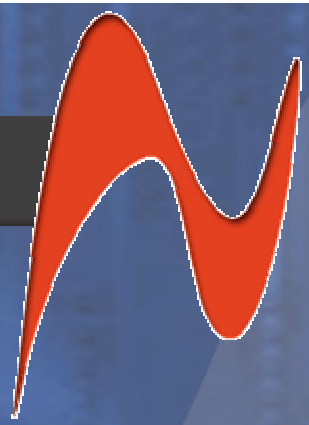
CLI Quarterly Rules



- Ride out 100% of system and log all leaks
- Log should include Date found and Date fixed
- Documenting leakage levels isn't required for this drive out
- *Actual practice for your system may vary!*

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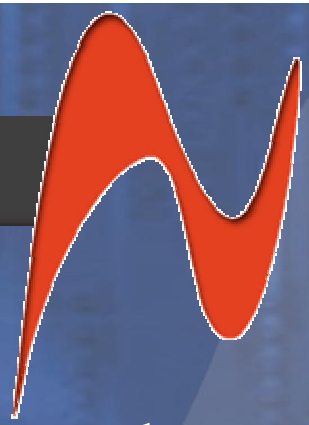
CLI Annual Rules



- Ride out 75% of the oldest part of the system and log all leaks location and measured level
- Must be performed within a reasonable period of time
  - Usually within 2 wks of due date

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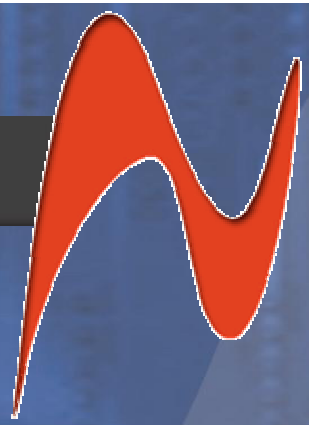
Required Actions



- All leaks 20uV/m must be logged and fixed
- Only leaks above 50 uV/m are used in CLI calculation
- All measurements taken outside 108-137 MHz must be converted as if they were taken within the band

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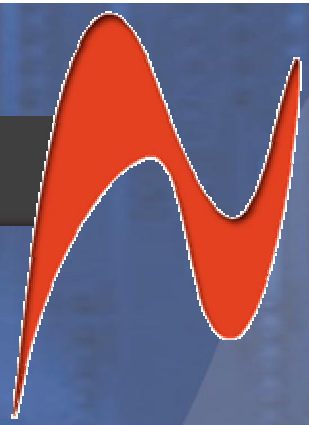
uV/M



- Standard unit of measure for CLI
- 50 Ohm off air measurement
- Voltage developed in 1 meter of infinitely thin section of wire submerged in a leakage field produces 1uV of energy

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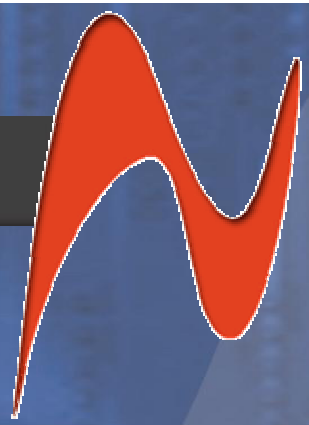
C.L.I.



- Cumulative Leakage Index
- Mathematical summation of leakage in a system designed to approximate the interference to aircraft flying overhead
- Figure of merit for system performance
- 1 leak of 1588uV/M within a system is enough to fail C.L.I.

TRILITHIC

Cumulative Leakage Index

$$10 \times \text{LOG}\left[\left(\frac{\text{Total Plant}}{\text{Miles Driven}}\right) \times \left(\text{sum of Leak}^{2}\right)\right]$$

Compliance = 64 or less

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Reason #3 to Monitor for Leakage

- Eliminates ingress
  - Improved System Performance
- The prevention of leakage also aids in the prevention of ingress.
- The elimination of ingress will provide
  - Fewer service calls
  - Clearer pictures over the HFC system
  - Better public relations over competitors

TRILITHIC

Reason #4 to Monitor for Leakage

- Locate Physical problems with plant
- In most cases, when you pinpoint a leakage problem, you will discover some type of physical problem has occurred.
  - Loose F-connector
  - Loose hardline connector
  - Loose tap face
  - Cracked hardline
  - Punctured or chewed RG coax
  - Loose amp housing
  - Signals emanating from someone's rooftop antenna
  - Illegal installations

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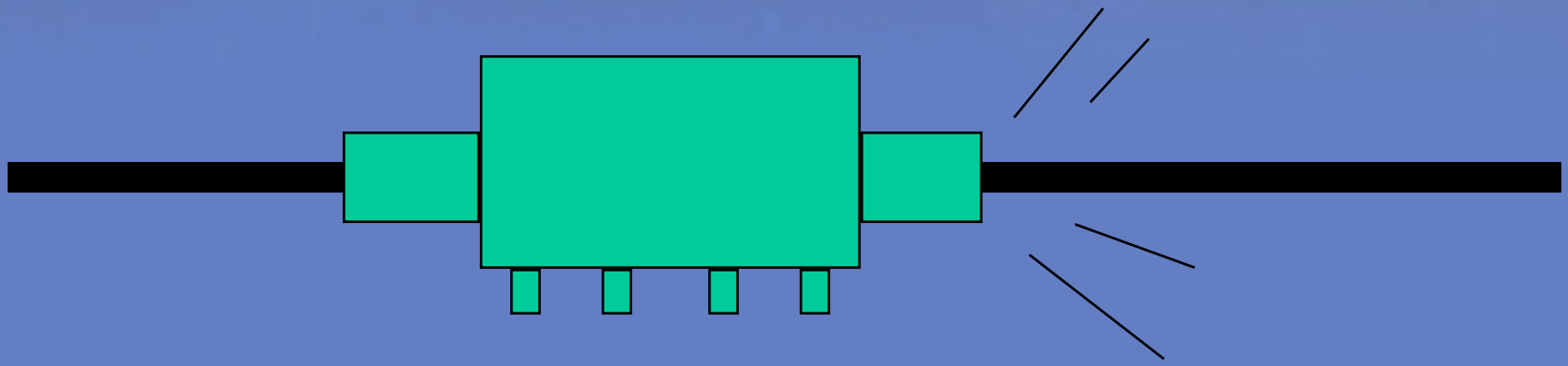
Common Causes of leakage?



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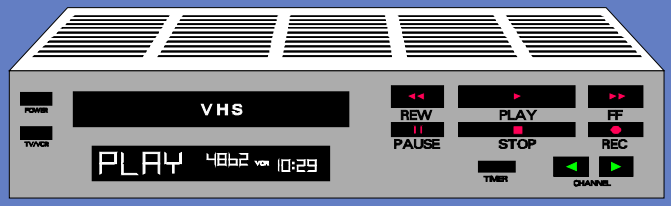
Common Causes *continued*

- 70% of all leakage is caused by problems between the tap and entry to the house
  - Aging and environmental stress
  - Physical trauma to cables or connectors
  - Loose drop connectors
  - Inferior quality coaxial cable, passives, or connectors
  - Loose hard line connectors



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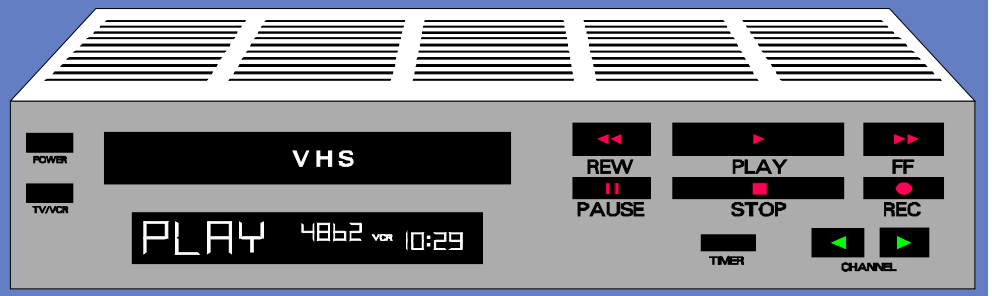
Other Causes of Leakage

- Improperly installed connectors
- Cracks in the trunk and feeder cable
- Animal chews
- Poorly-shielded drop cable
- Bad connectors at the tap
- Corroded connectors



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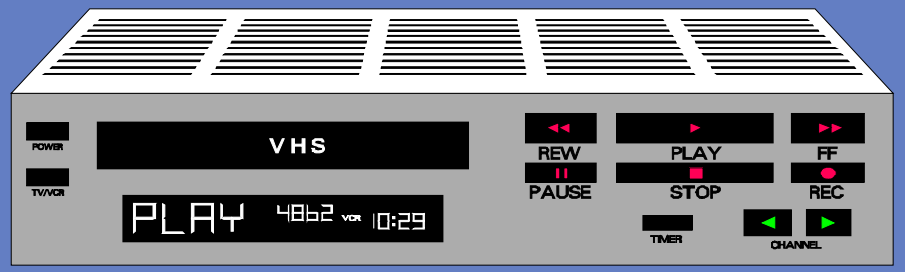
Other Causes *Continued*

- Customer installed equipment
- Damaged amplifier housing or loose amplifier housing lids
- Broken tap ports
- Poor installation of splices and connectors
- Poorly-shielded customer premise equipment



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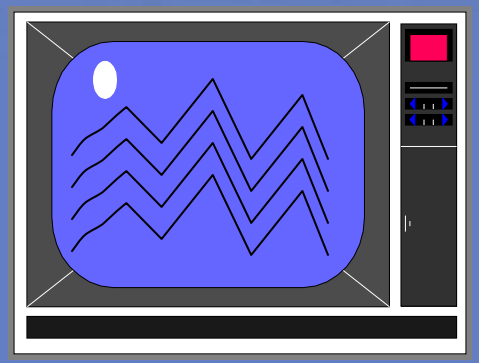
Problems Caused by Ingress & Egress

- Lines in picture
- Ghosting
- Pay-per-view problems
- High speed data problems
- De-scrambling problems
- Interference with two-way radio services using the same frequencies



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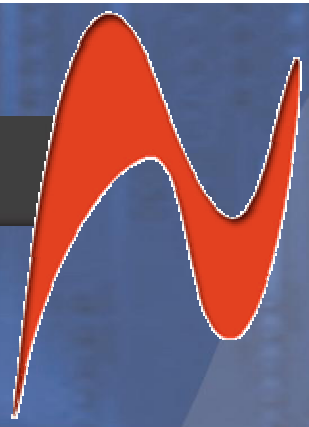
Ingress on Digital Channels



- Mosaic
- Freeze Frame
- Picture and Sound go to black

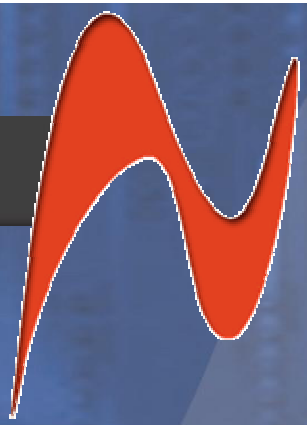
TRILITHIC

Leakage Measurement Procedures

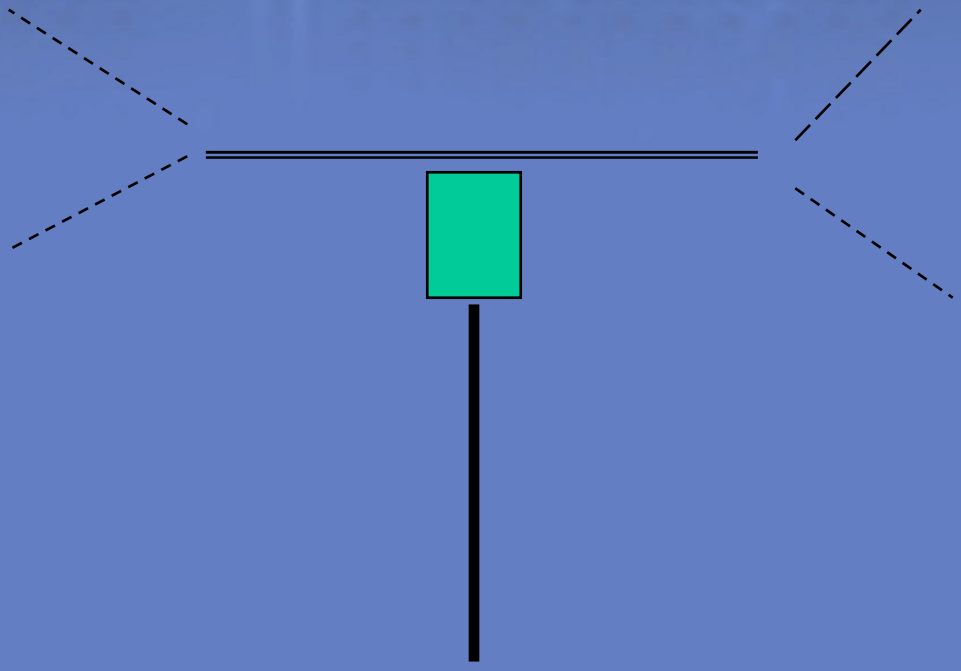
- Use a calibrated halfwave dipole antenna
- Antenna must be elevated 3 meters off the ground and positioned 3 meters from the leakage source
- Antenna must be rotated 360º in the horizontal plane for maximum reading
- This is the ONLY acceptable procedure for leakage measurement by the FCC

TRILITHIC

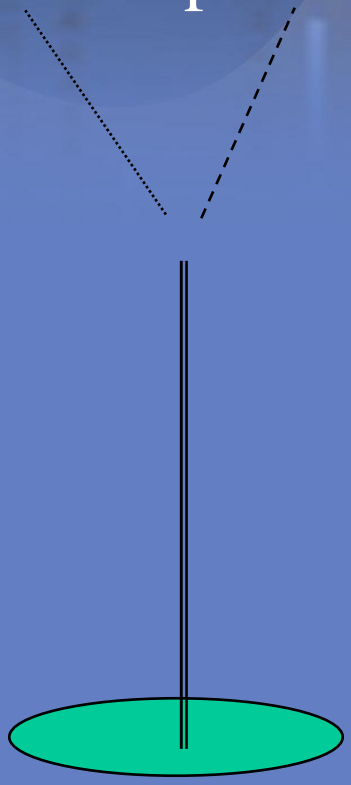
Polarization Angle



Dipole

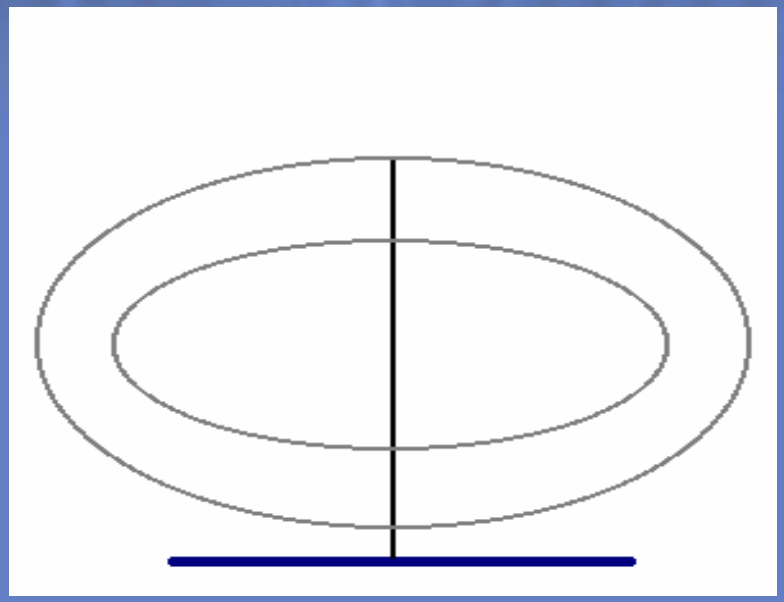


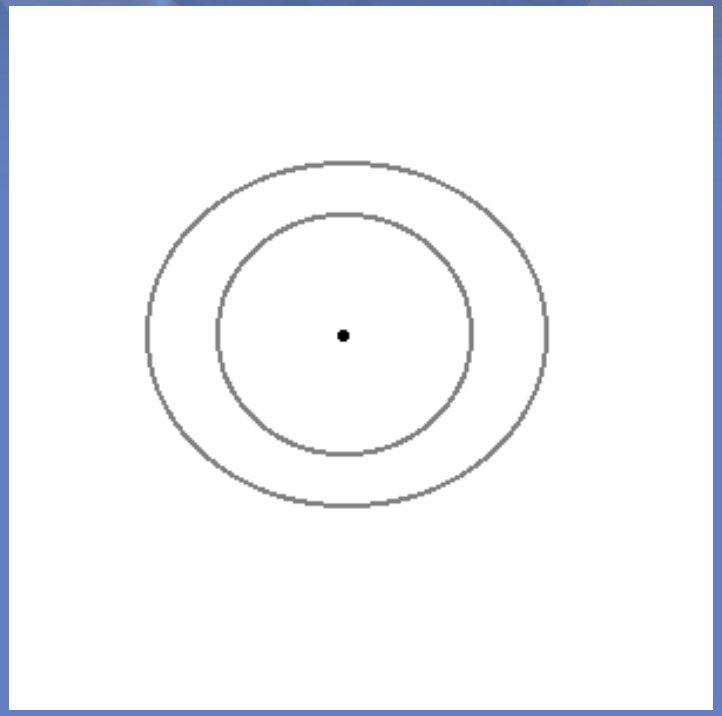
Monopole



TRILITHIC

Leakage Antennas-Whip





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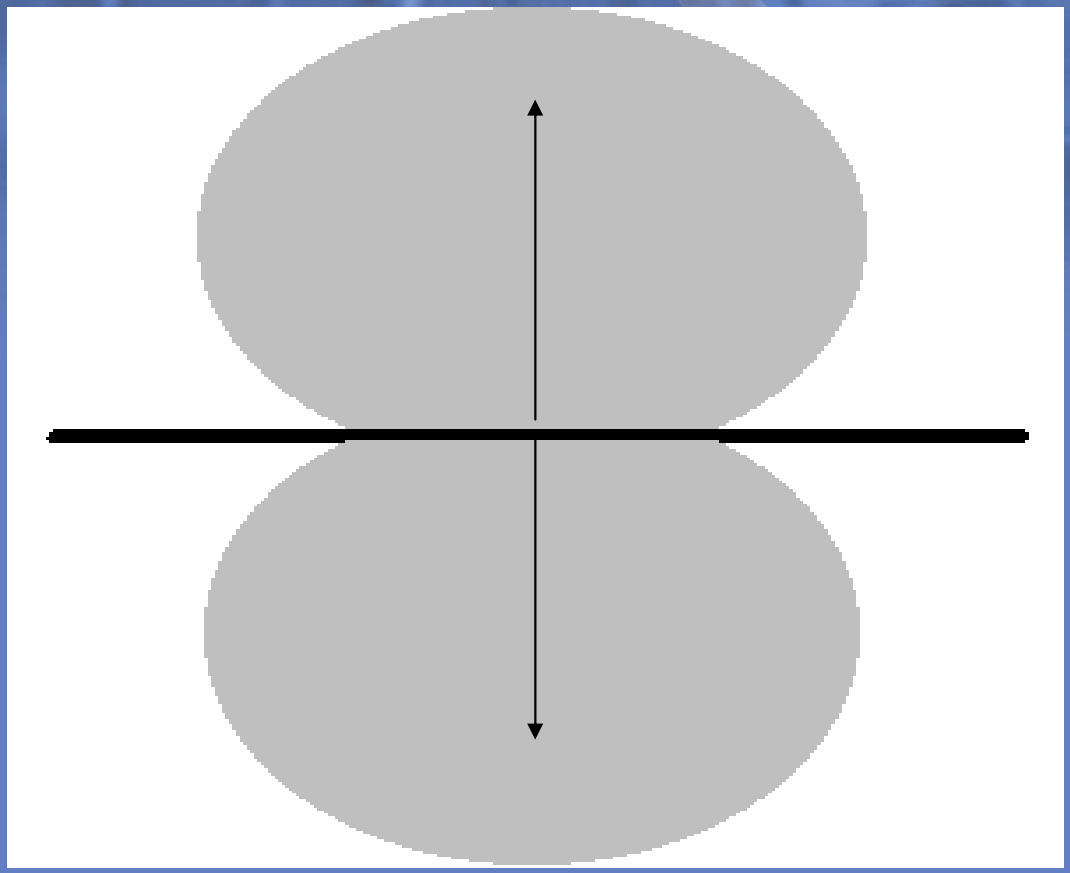
Leakage Antennas-Dipole



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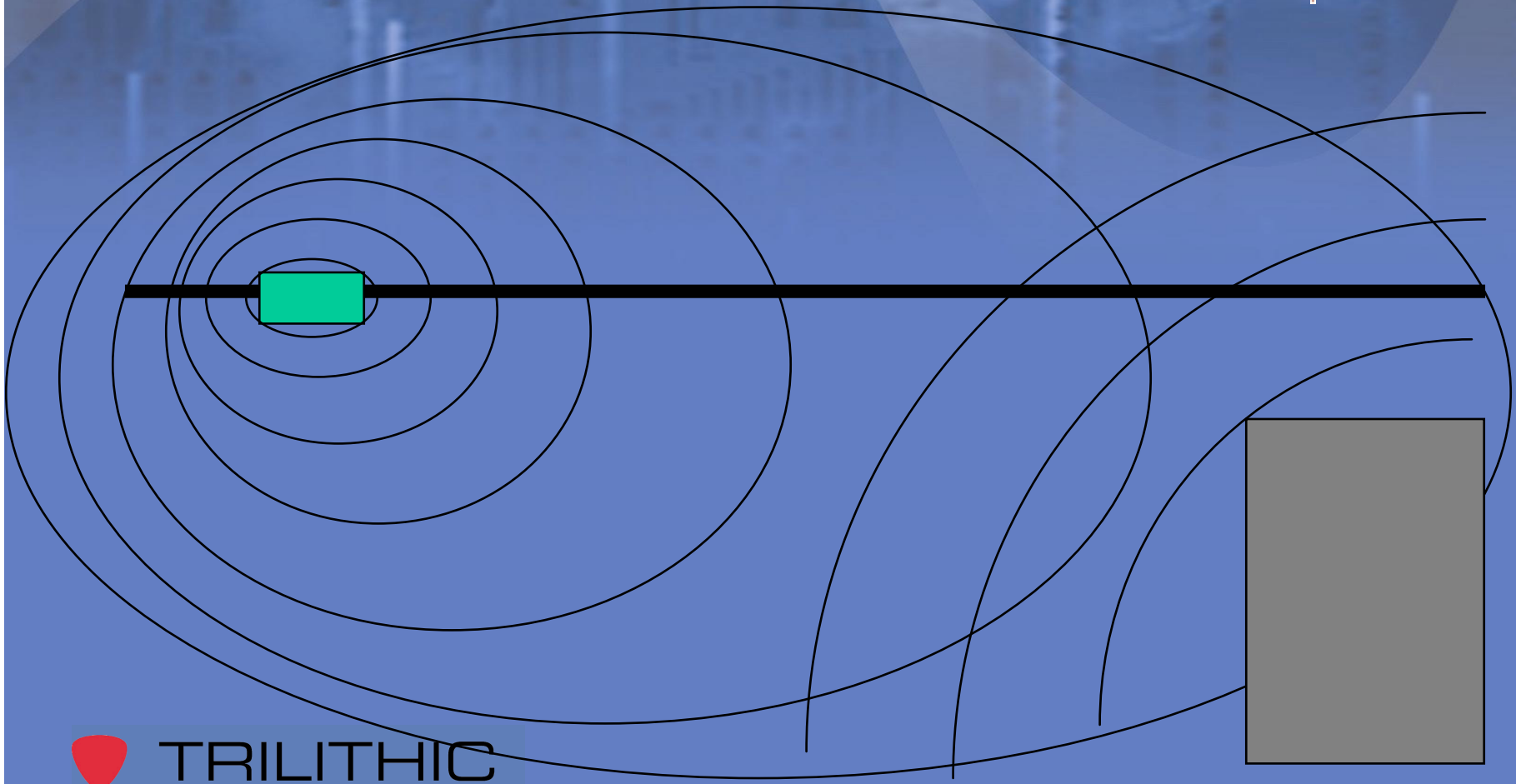
Signal Reflections

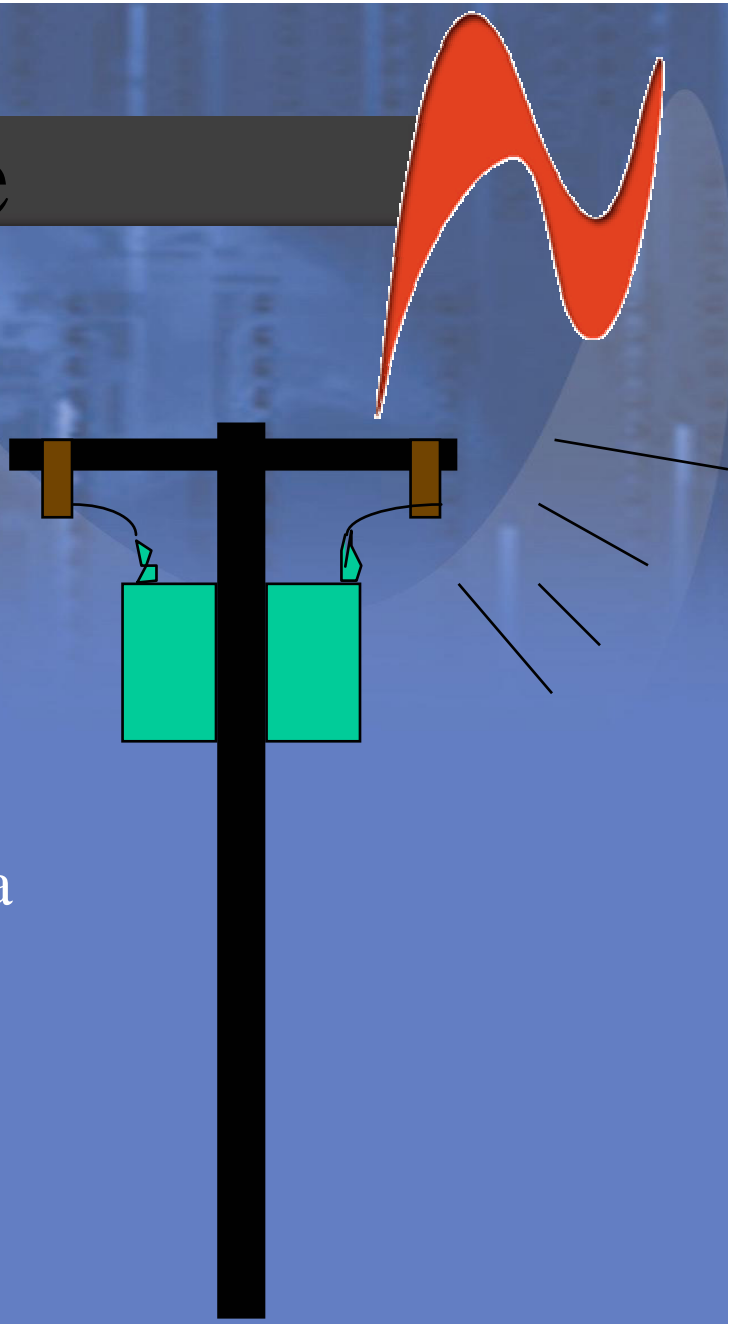


TRILITHIC

Standing Waves

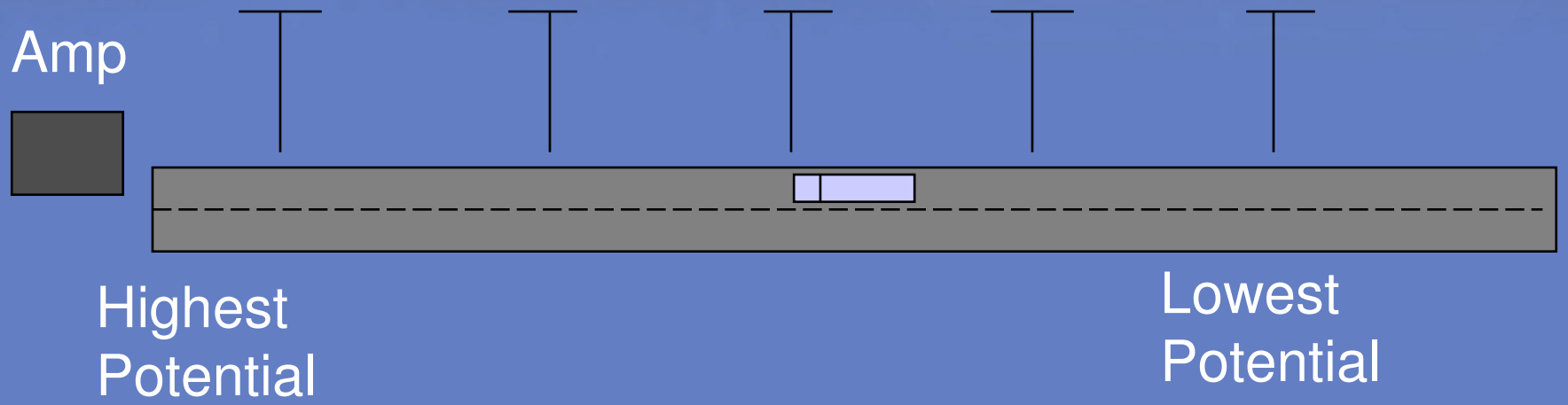
Electrical Noise

- Electrical noise is an interesting annoyance to the leakage technician.
  - In most cases, electrical noise is caused by “spark gap energy” at power line insulators. This energy can manifest itself as RF!
  - This spark gap energy (RF) may reach the leakage frequency range and cause a buzzing noise on the audio circuit of a leakage detector.
  - Channel tagging usually eliminates this problem.



TRILITHIC

Leakage Field Strength



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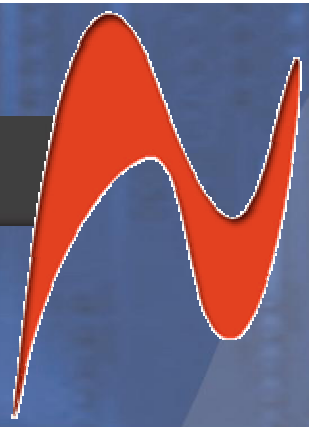
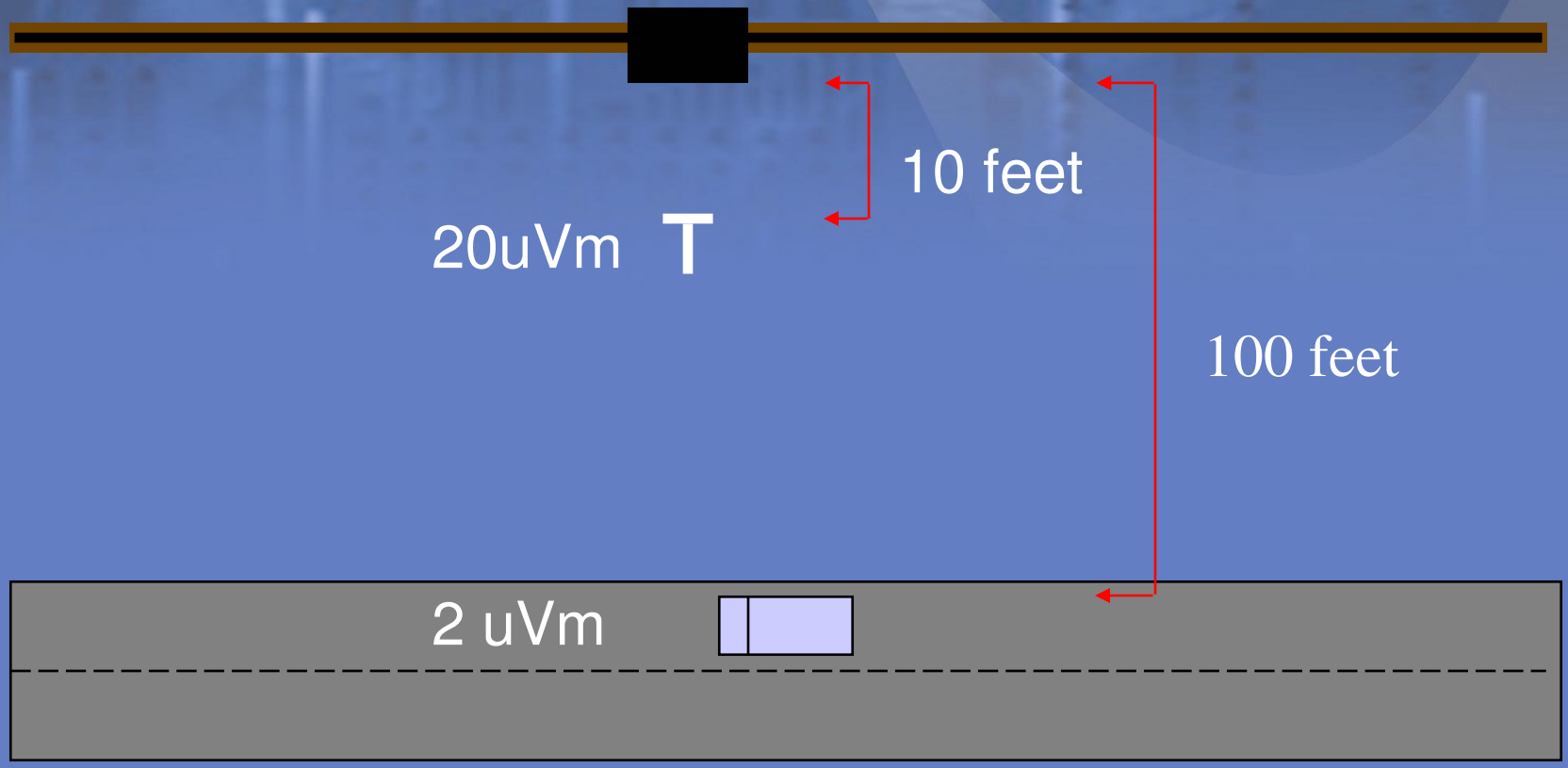
Distance Correction



$$\frac{\text{Reading} \times \text{Distance}}{10} = \text{Corrected Reading}$$

TRILITHIC

Patrolling for Leakage



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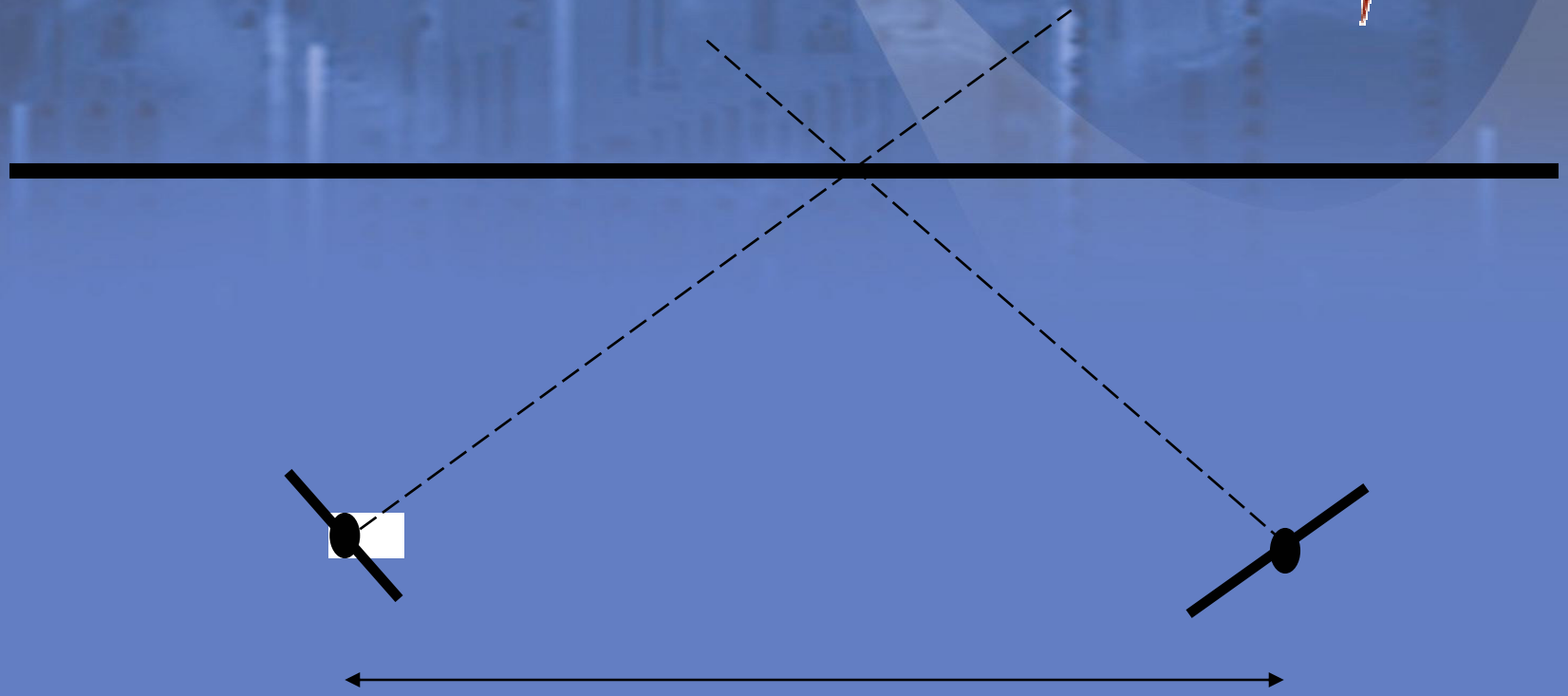
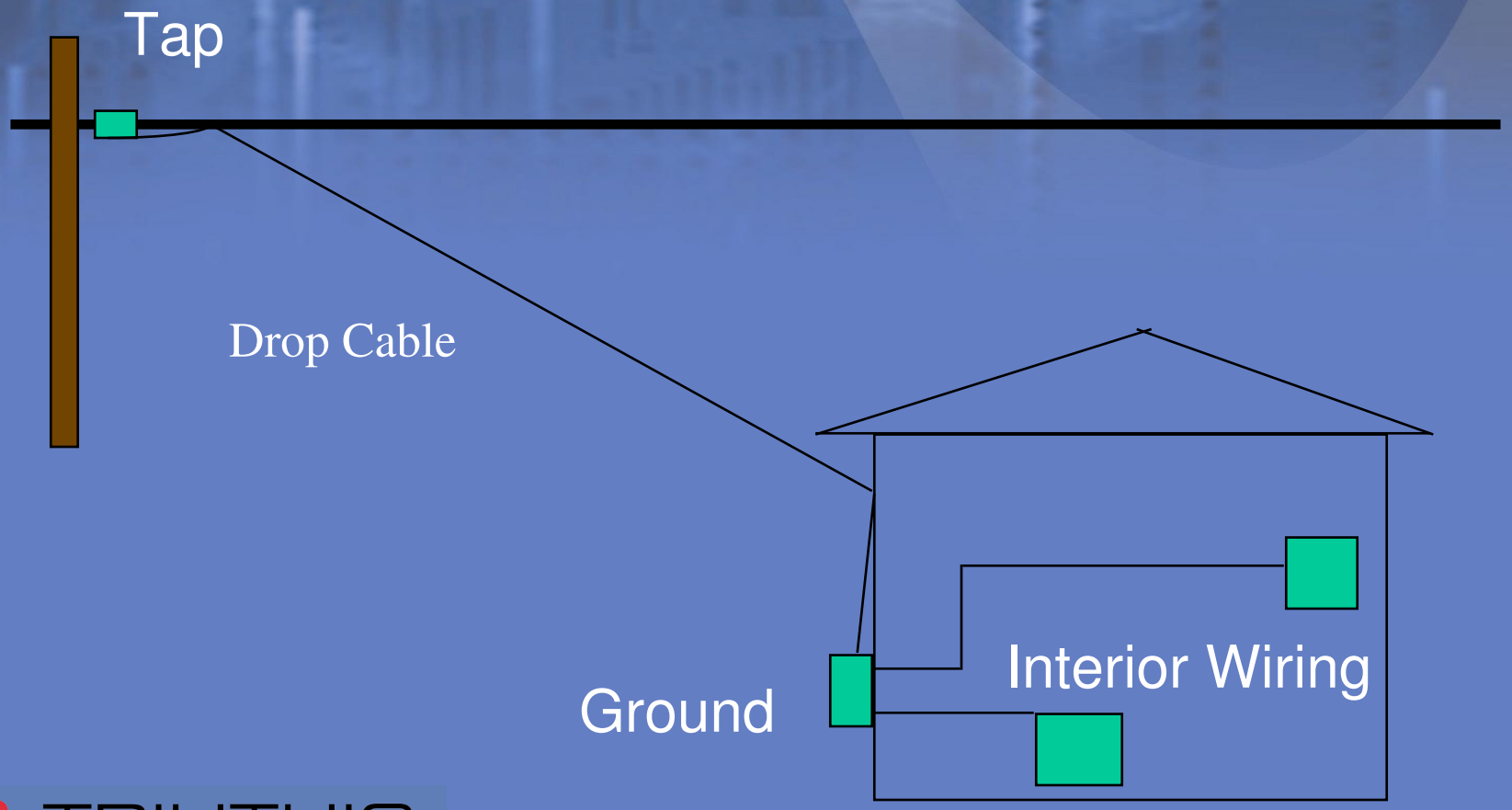
Walking Out a Leakage Area



TRILITHIC

Installation Leakage



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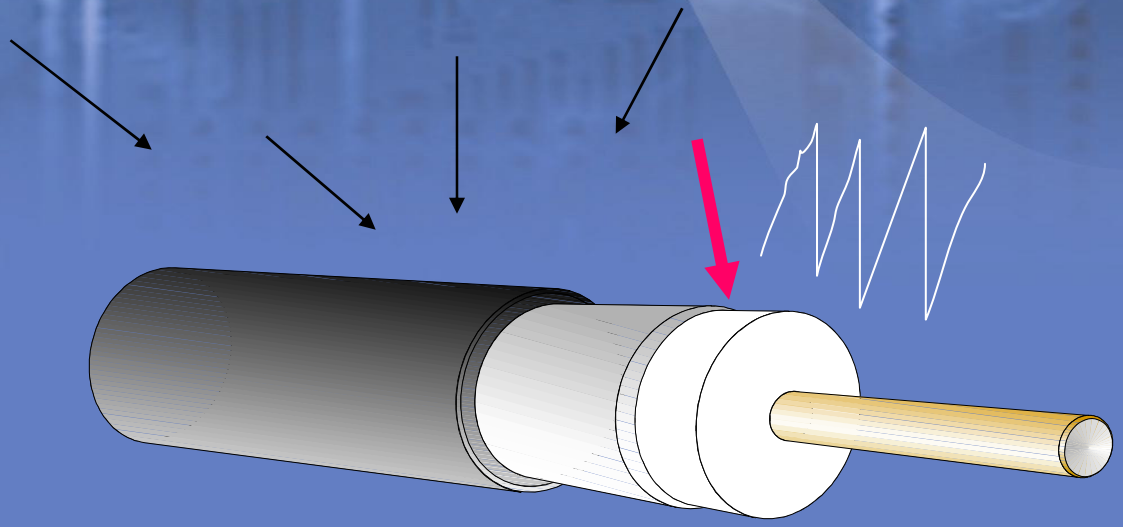
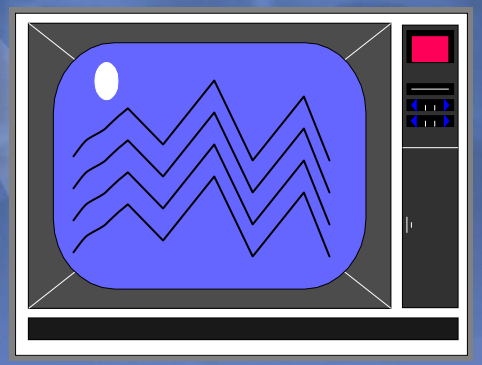
Ingress



TRILITHIC

Ingress on Analog Channels



- Lines in picture
- Ghosting
- Pay-per-view problems
- High speed data problems
- De-scrambling problems
- Intermittent lines in the picture and possibly audio buzz. Possible causes are:
  - CB radio effecting channel 5
  - Local pager services effecting channels 19 & 20
  - Ham radio effecting 5-40 MHz return band and 550-750 MHz band

TRILITHIC

Ingress on Digital Channels

- Mosaic
  - This happens when ingress has created marginal Bit Error causing the loss of a packet(s) of video compression data
- Freeze Frame
  - This happens when ingress has created significant Bit Error causing the loss of an entire refresh frame
- Picture and Sound go to black
  - This happens when ingress is severe enough to completely destroy a data stream into unusable garbage
- Circular pattern around the ideal plot on Constellation

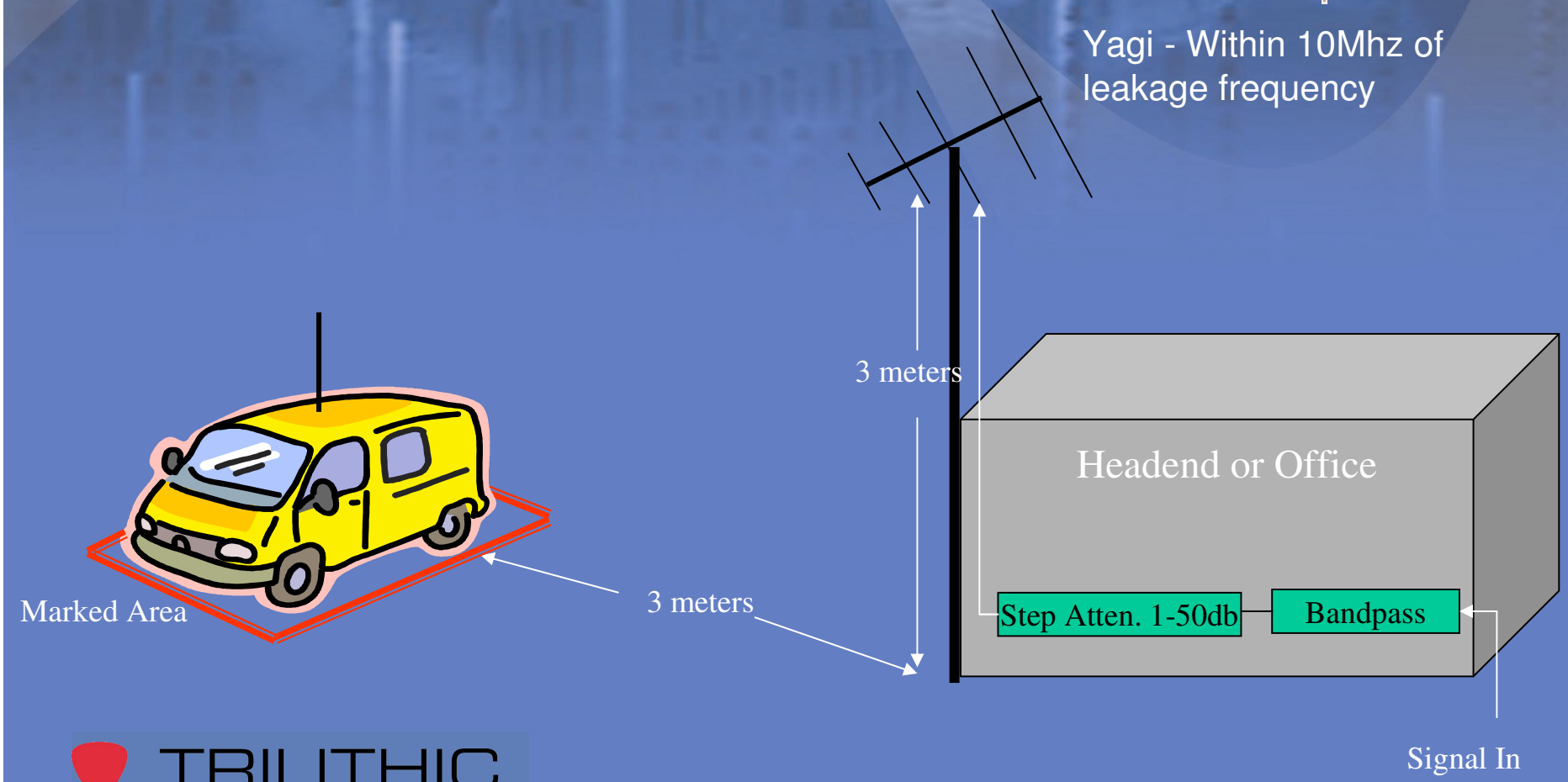
TRILITHIC

Calibrating Leakage Detection Equipment

- Connect calibrated signal source set at 20 µV/m
- Position the dipole antenna
- Adjust meter to read 20 µV/m

TRILITHIC

Drive-up Calibration Point



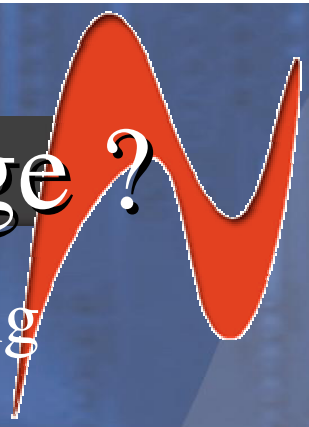
TRILITHIC

Why and How Check for Leakage ?

- Public Safety.
  - Potential interference with aircraft communication/navigation.
  - The cable system could interfere with off-air signals.
- Quality of Service.
  - Ingress impairs picture quality.
  - Ingress/Egress (leakage) usually is a sign of a pending equipment failure.

TRILITHIC

Why and How Check for Leakage ?



- Increased implementation of services requiring return path activation.
  - If a system has egress it will most likely have ingress.
  - Ingress brings the viability of two-way services into question.
  - VOIP demands higher network reliability.
- European CENELEC EN 50083-8 standards (Feb. 1996).

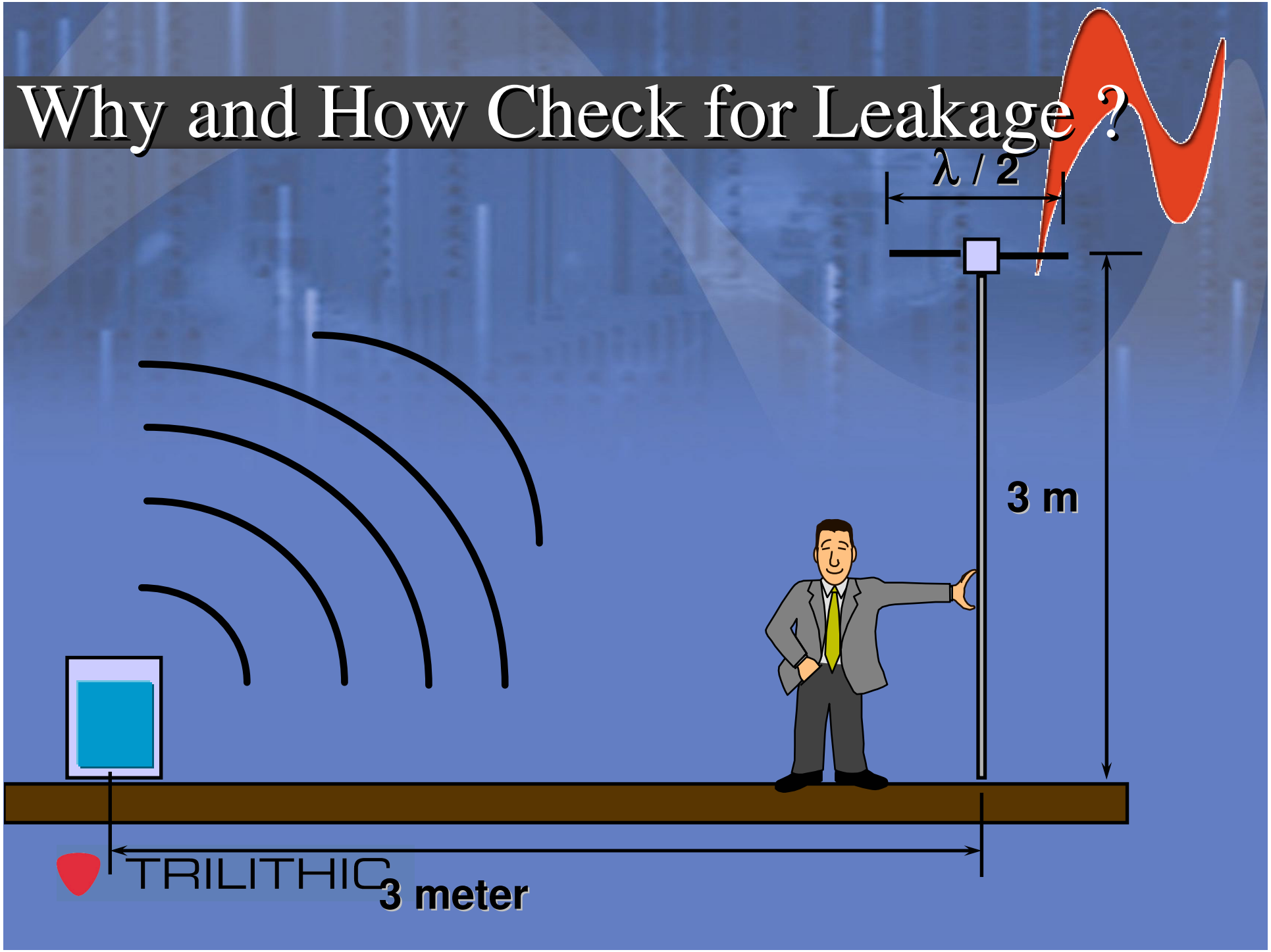
TRILITHIC

Why and How Check for Leakage ?

- Recommended frequency range is 108-140MHz
- Measurements must be repeatable
  - Dipole 3 meters from leak above the ground
  - Dipole should be rotated about a vertical axis and maximum reading recorded
  - Other conductors must be 3 or more meter away from the measuring antenna
  - The measurement range should be free from obstacles
  - Less than 20 uV/m at a distance of 3 meters

TRILITHIC

Why and How Check for Leakage ?

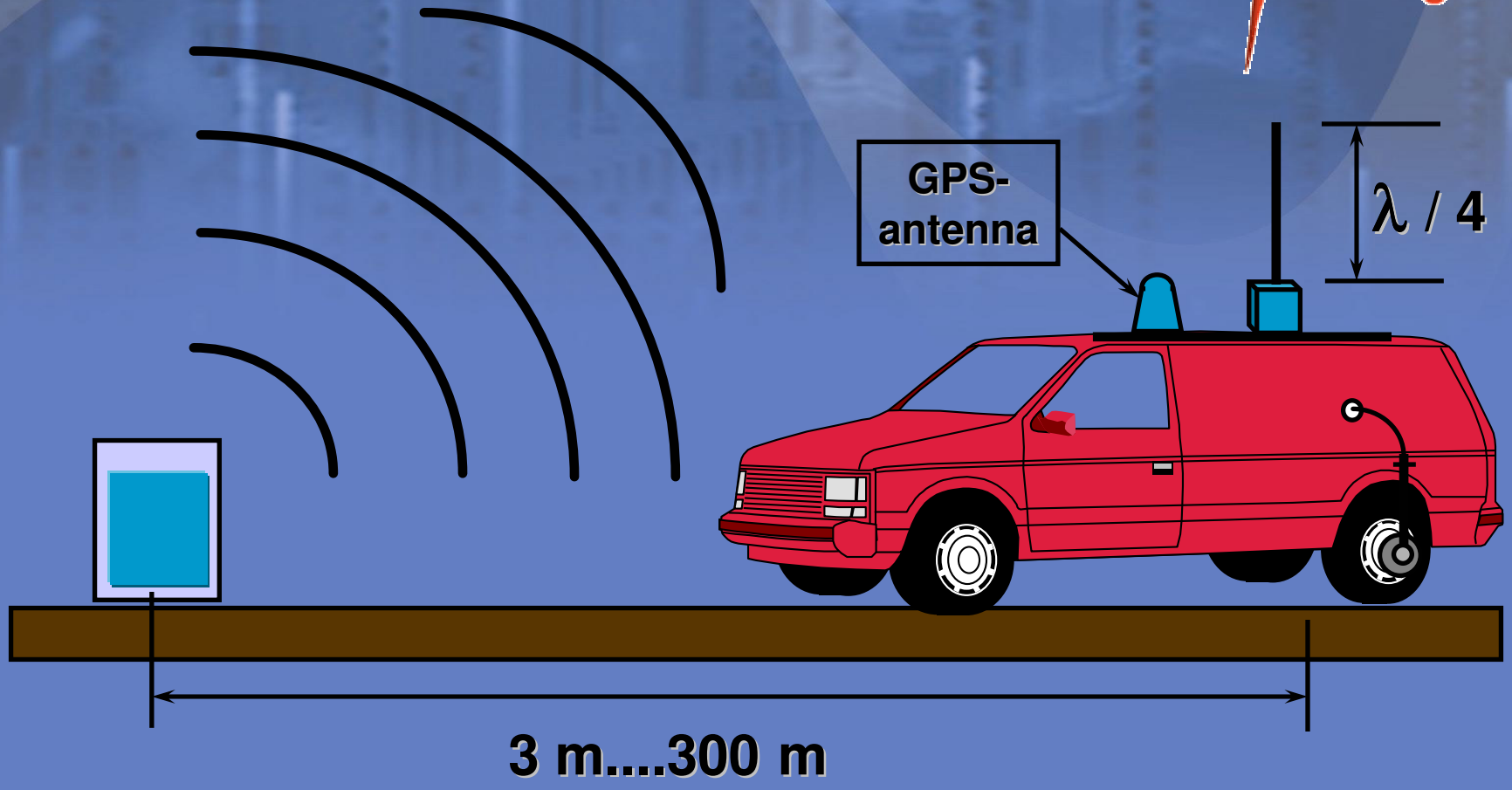


Why and How Check for Leakage ?

- Monopole antenna typically used
  - Mounted near the center to enable detection from both sides of the road (road is smaller then 6 meters)
- If less then 10 % of probabilities exceeds the lower threshold, that part of the network fulfils the limits.

TRILITHIC

Why and How Check for Leakage ?



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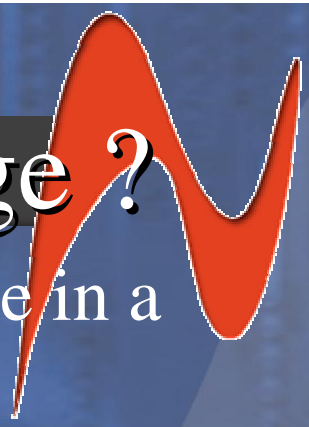
Why and How Check for Leakage ?



- While patrolling, a leak may travel along the cable in a standing wave
  - Leak strength peaks and ebbs
  - Source can be located at point of highest peak
- Use Triangulation to “vector-in” on leak source
  - Rotate dipole to determine location of peak signal strength
    - Source is perpendicular to dipole elements
  - Repeat process at some distance from first test
  - Leak source will be close to point where vectors cross
- Use common sense, look for logical cause of leakage
  - connectors, tree branch rubs, damaged poles, etc..

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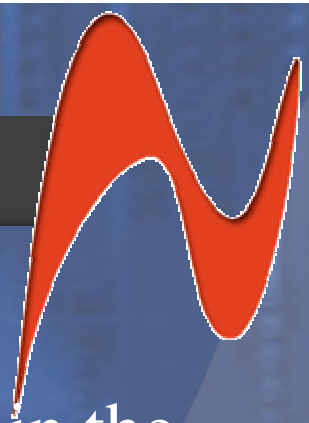
Zooming In On The Leak



- Rubber duck has a radial pattern with a null in the direction it is being pointed
  - holding meter with antenna sideways in orientation to the leak will produce the strongest signal strength
  - pointing the antenna at the suspected source will null the field strength

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Common Leakage Sources

- Splices and fittings- Water and weather can result in pulled out, loose or corroding fittings.
- Splices at taps, line extenders, splitters, amps and ground blocks.
- Illegal hookups involving twin leads, cheap passive devices, house amplifiers, poor or no connectors, and improperly terminated splitters.
- 15% jumpers from drops to taps or ground blocks.
- 75% of leaks come from subscribers home.

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Quiz

1) What is the unit of measure for leakage as specified by the FCC?
   a) dBuV = Decibel per microvolt
   b) uV/m = Microvolt per meter
   c) dBm = Decibel per milliwatt
2) What is signal leakage?
   a) The undesired emission of signal out of an HFC network
   b) The loss of signal amplitude from loose connectors
   c) Off-air signal getting into an HFC network
3) What is a common cause of signal leakage?
4) Leakage characteristics are always the same
   a) True
   b) False

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Quiz

5) At what leakage level does the FCC require logging and repair?
   a) 10 uV/m at 20 feet
   b) 20 dBmV at 10 feet
   c) 20 uV/m at 10 feet
6) What are the 4 primary reasons for monitoring for leakage?
7) The leakage characteristic “Standing waves” describes:
   a) The reflective nature of signal leakage
   b) The conductive nature of signal leakage
   c) The amplitude nature of signal leakage

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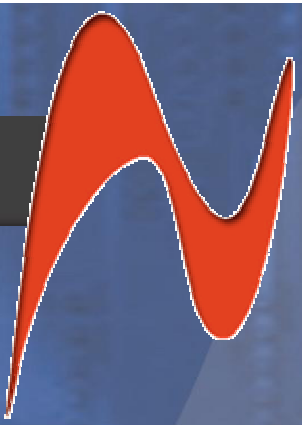
Questions



Lance Bannister

Technical Services Manager

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lbannister@trilithic.com

317-895-3600