Network Maintenance

Welcome

Presented by
Lance Bannister
Technical Services Manager

TRILITHIC

Forward Path

- Analog signals (POP)
  - Signal Level
  - Tilt
  - ▲ Video/Audio
  - HUM
  - C/N
  - CSO/CTB
- Digital Signals

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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

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

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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

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

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

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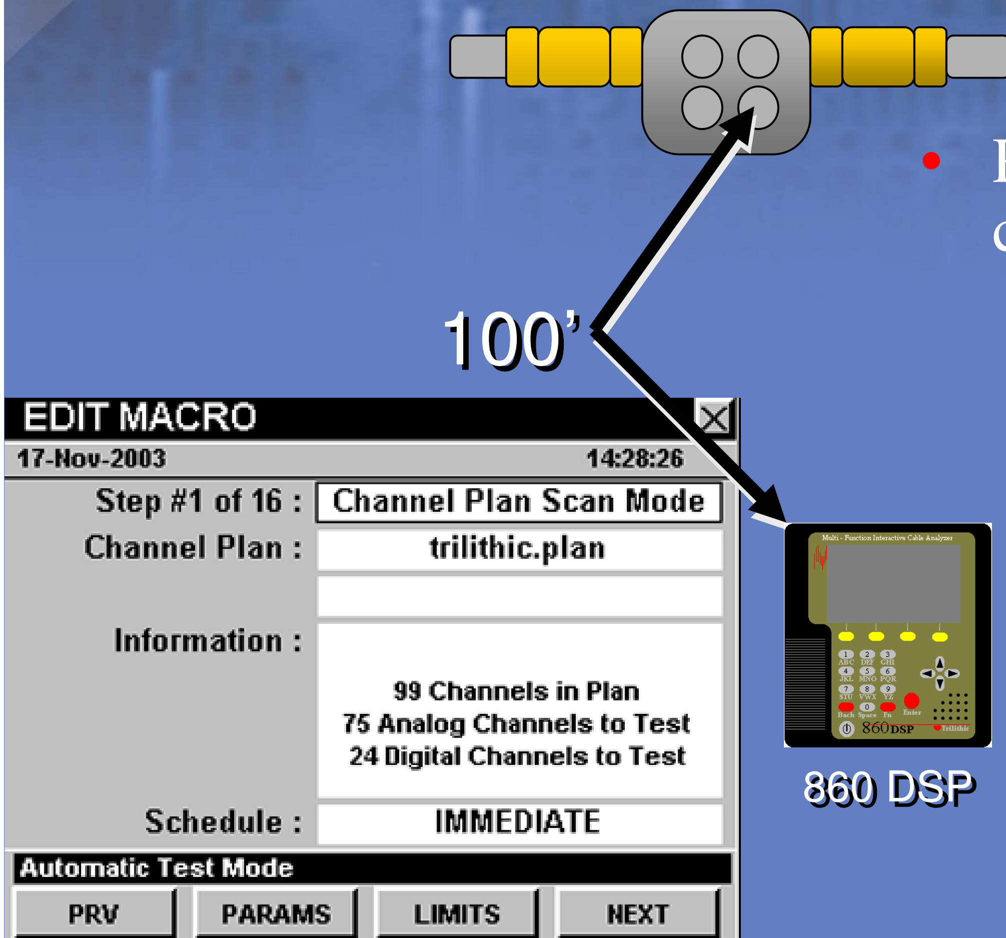
Proof of Performance Measurements

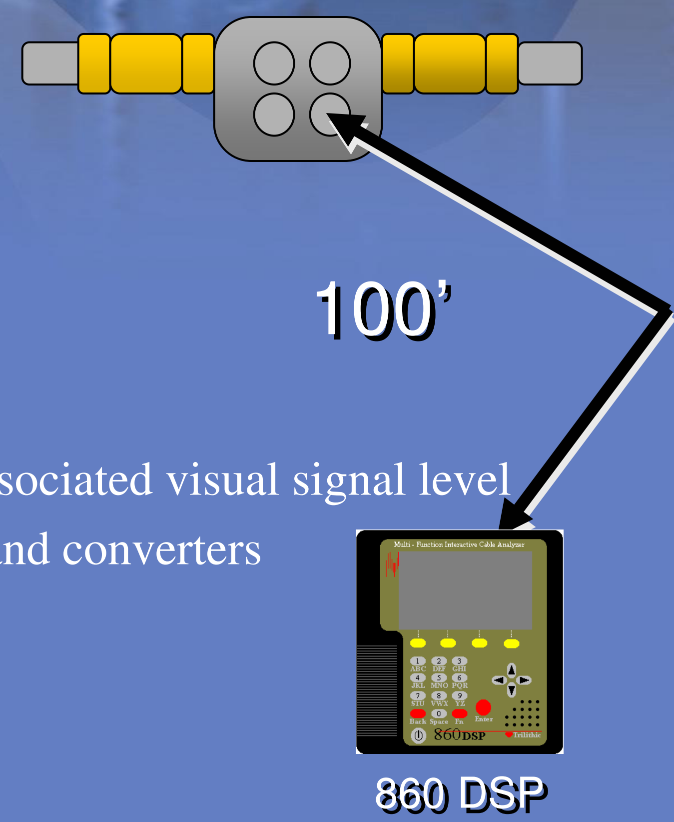
The Visual Signal Level Variance Test



- 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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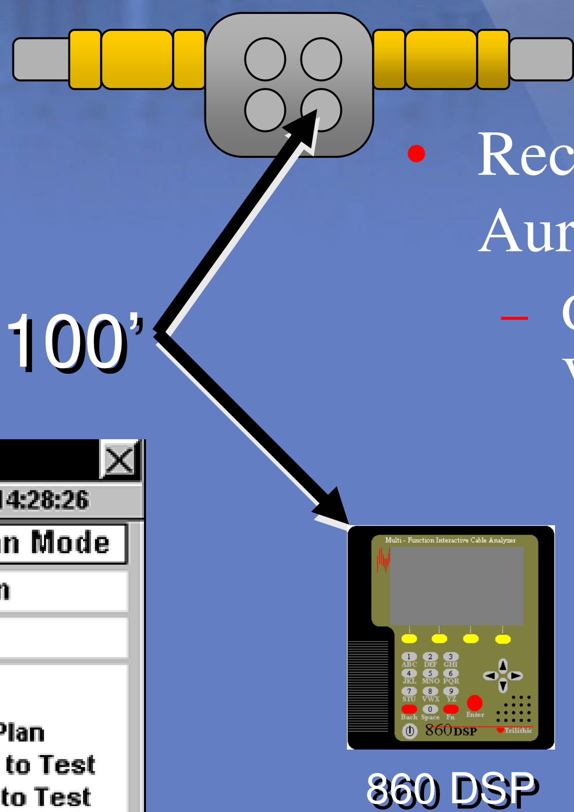
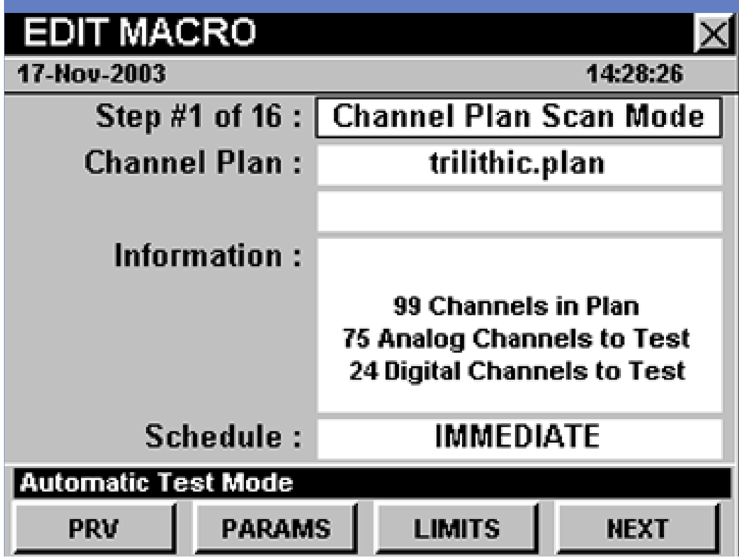
Proof Of Performance Measurements

The Aural Signal Level Test



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



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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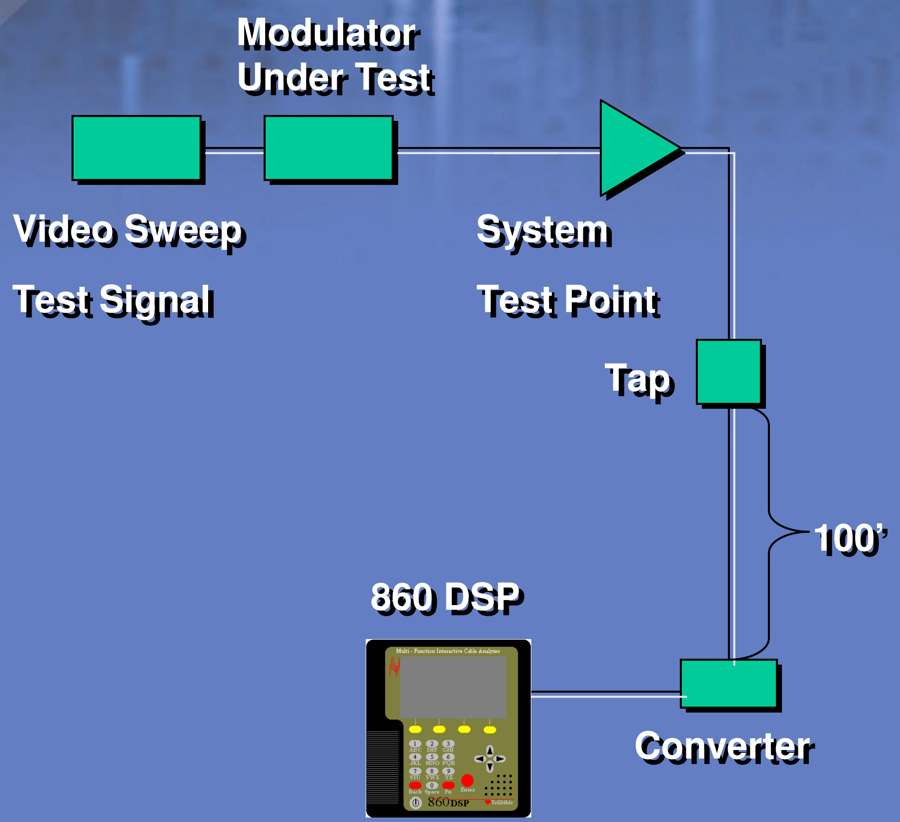
Proof Of Performance Measurements

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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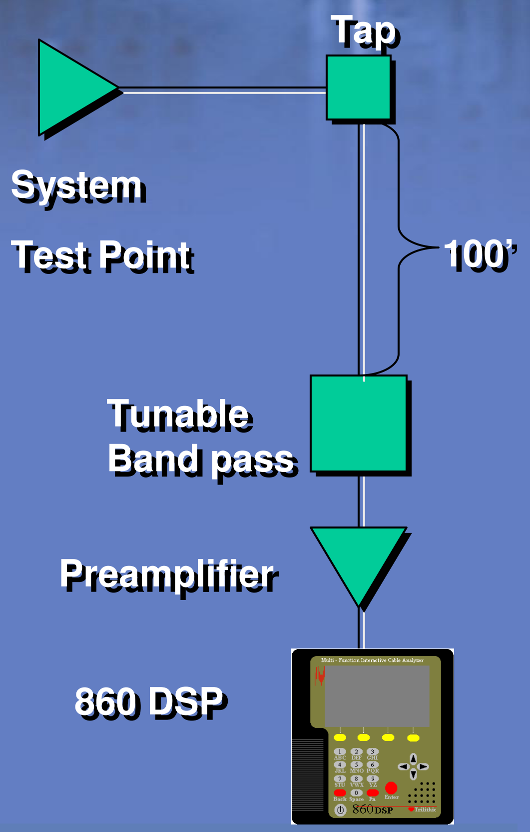
Visual Carrier to Noise Ratio

- 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

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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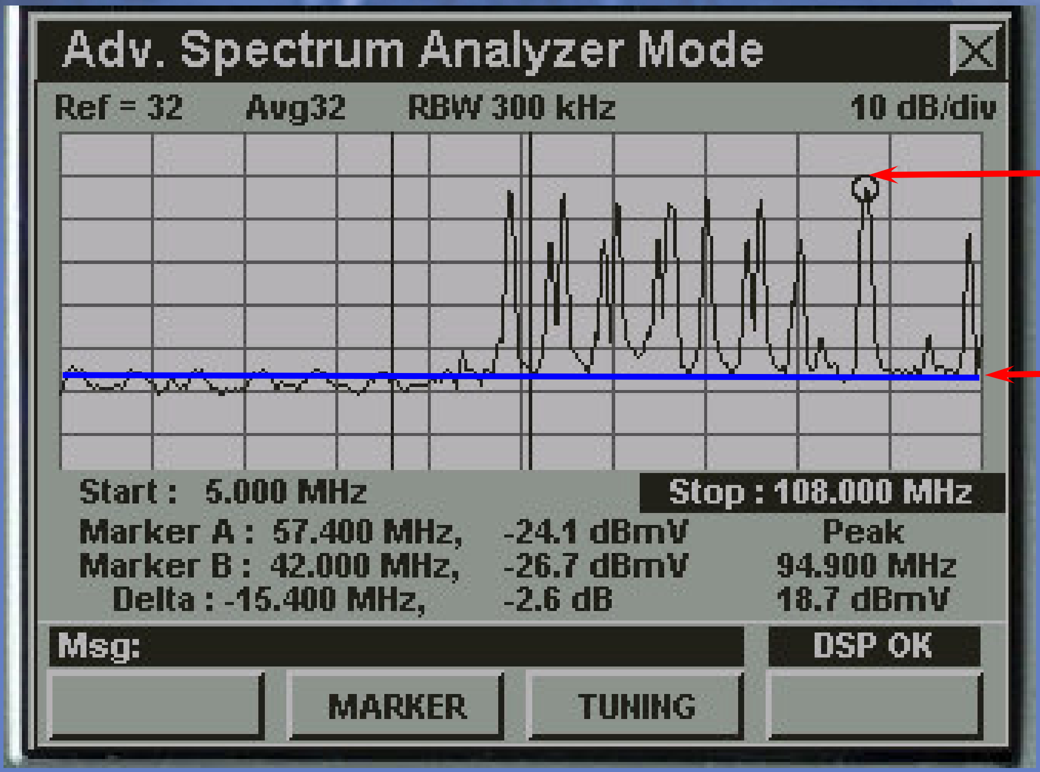
Carrier to Noise



Peak RF level of Carrier

Average level of Noise Floor

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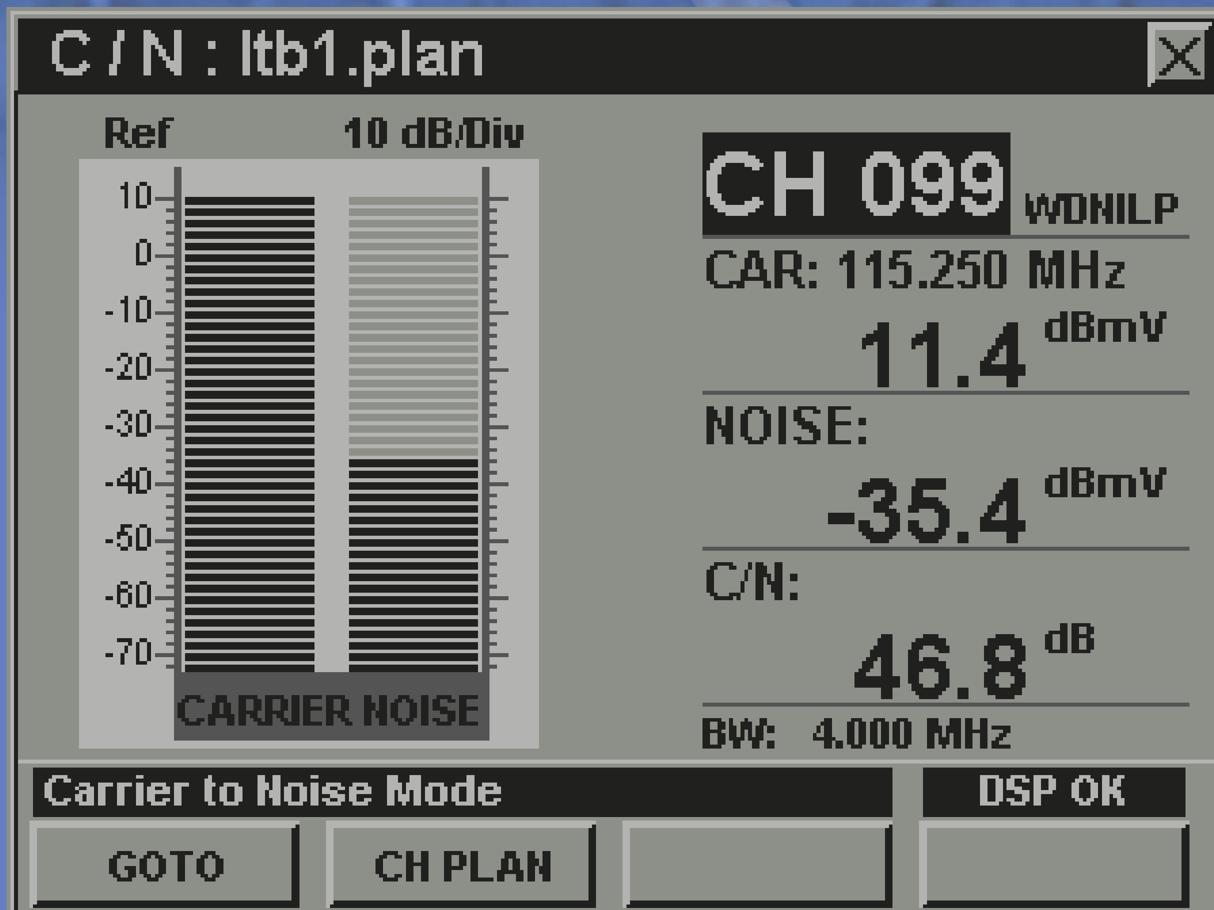
Carrier to Noise



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

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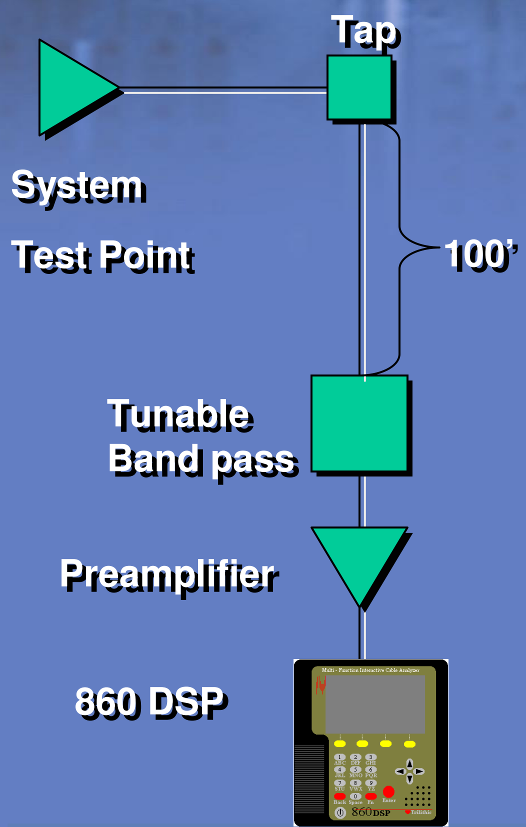
Proof Of Performance Measurements

The Coherent Disturbances Test



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- **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 and record the test carrier**
- **Turn the carrier off**
- **Measure the CSO and CTB beats**
  - CSO beats are .75 and 1.25 MHz above the carrier frequency
  - CTB beats are at the carrier frequency
- **Suggested Analyzer Settings**
  - Detector Sample
  - Span 6 MHz/RBW 30 kHz/VBW 1 kHz
  - Sweep 600ms

Coherent Disturbances CSO & CTB

- Distortions
  - Definition: Undesired change in the waveform of a signal in the course of its passage through the cable system
  - Appears as signals or "beats" added to the cable transmission when viewed on a spectrum analyzer or as horizontal or wavelike lines at the subscriber terminal
  - The number of beats will increase as the square of the number of system channels
    - For CSO the majority of beats will appear at the edges of the channel spectrum and within +/- 0.75 MHz or +/- 1.25 MHz of the video carrier frequency
    - For CTB the majority of beats will appear in the center portion of the channel spectrum and equal to the video carrier frequency

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Coherent Disturbances CSO & CTB

- Harmonic Distortions
  - Anytime a signal passes through a non linear device, whether the device amplifies, attenuates or changes frequency of the input signal, the input signal energy is disbursed to signals other than the exact desired output
    - For example, in an amplifier distortions may show up as harmonic signals, so called because their frequency value are related by an integer such as 2,3, or 4 times the input signal frequency.
  - Harmonic Distortions are discrete because they are the result of a single signals distortion.
  - CSO is the result of harmonic distortion as signals are amplified through a cascaded amplifiers. The power of the distortions are reduced at higher harmonics of the input signal. Limiting the need to measure harmonic distortions above the second or third order.

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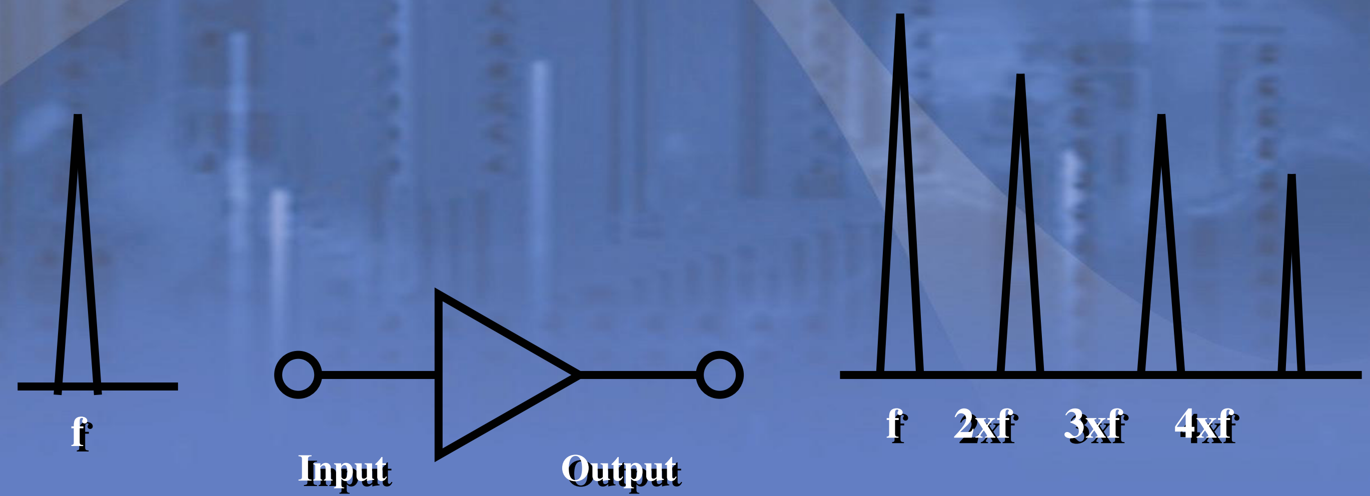
Coherent Disturbances CSO & CTB



Harmonic Distortion Created by an Amplifier

Coherent Disturbances CSO & CTB

- Discrete Third Order Distortion
  - The source of CTB is third order distortion or the mixing of three signals in a non linear device.
  - The third order beats created will be the result of the addition and/or subtraction of any combinations of the three signals and there second harmonics

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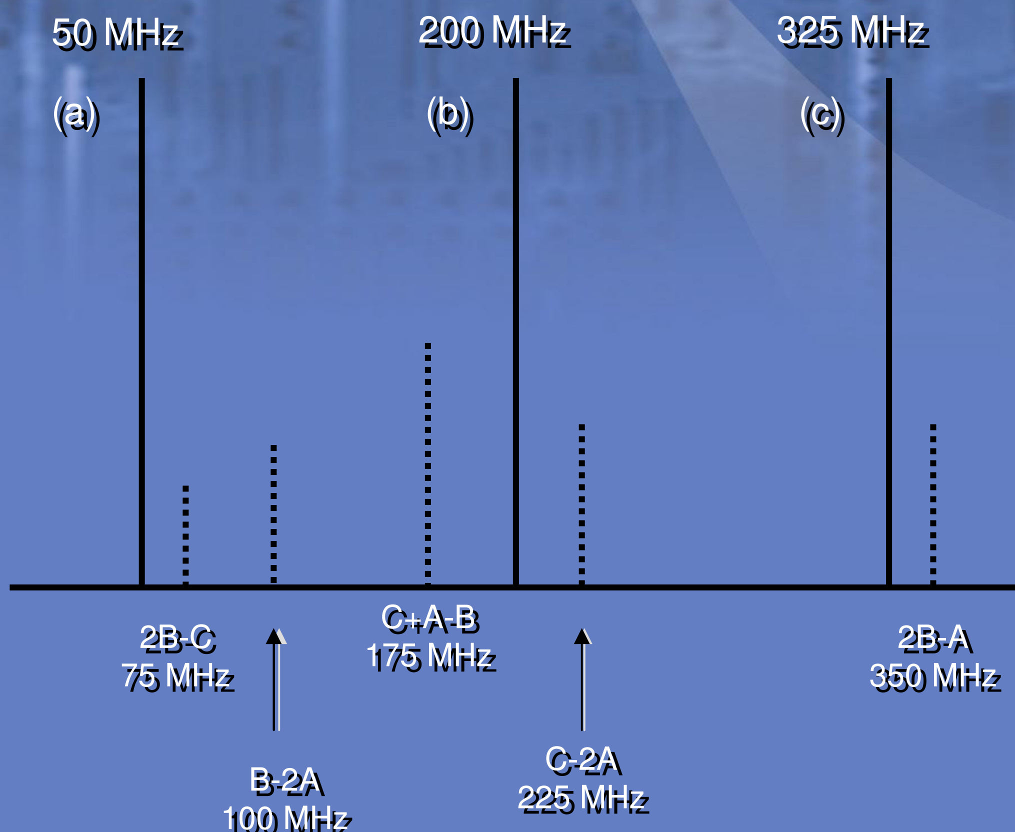
Coherent Disturbances CSO & CTB



Third Order Distortion Products

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Coherent Disturbances CSO & CTB

- Check for Overload
  - Change Analyzers attenuation setting and view the change of the distortion products
    - Using an external attenuator change the attenuation by 2 or 3 dB.
    - Most analyzer attenuators work in 10 dB steps which may bury the distortions in the analyzer noise
    - If using a pre-amplifier place the attenuator ahead of the pre-amplifier and test for overload

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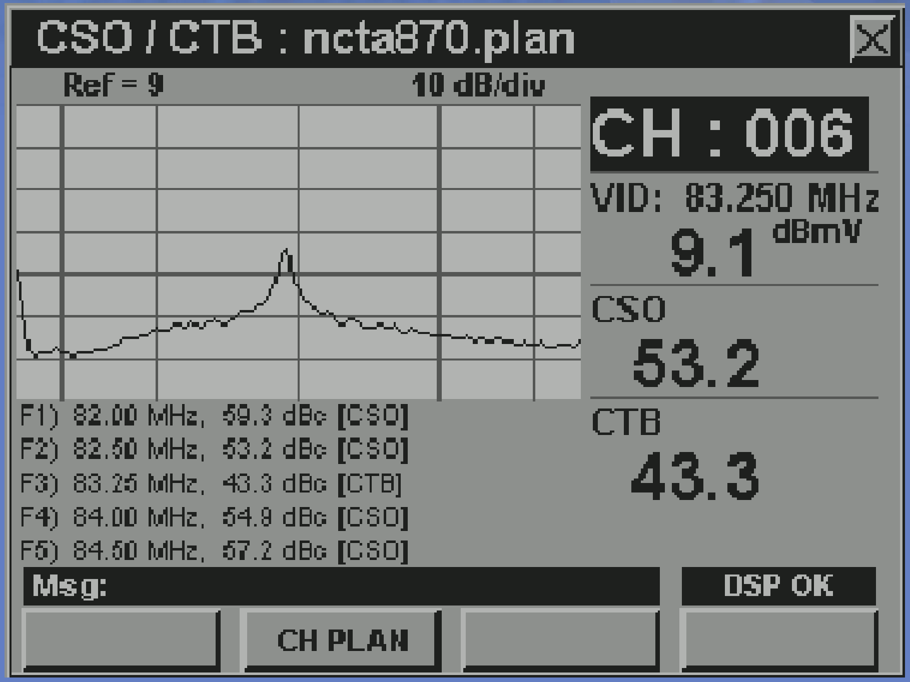
Coherent Disturbances CSO & CTB

- Measuring CSO/CTB for FCC Compliance Testing
  - Pick a channel whose modulation and carrier can be turned off
  - Set span to 6 MHz
  - Set resolution and video bandwidth to 300 kHz
  - Set Reference level equal to carrier level while trace is in max hold
  - Set Detector mode to sample and take trace out of max hold
  - Set Resolution Bandwidth to 30 kHz Video Bandwidth to 30 Hz or 1 kHz if with video averaging set to 5 sweeps
  - Turn off carrier modulation
  - Measure CSO beats at 0.75 and 1.25 MHz above the carrier frequency
  - Check for analyzer overload by adding 2 dB of attenuation, beats should change by 2 dB
  - If beats disappear into display noise reduce power by adding channel or band pass filter, check for overload again

Coherent Disturbances CSO & CTB

- Measuring CTB for FCC Compliance Testing



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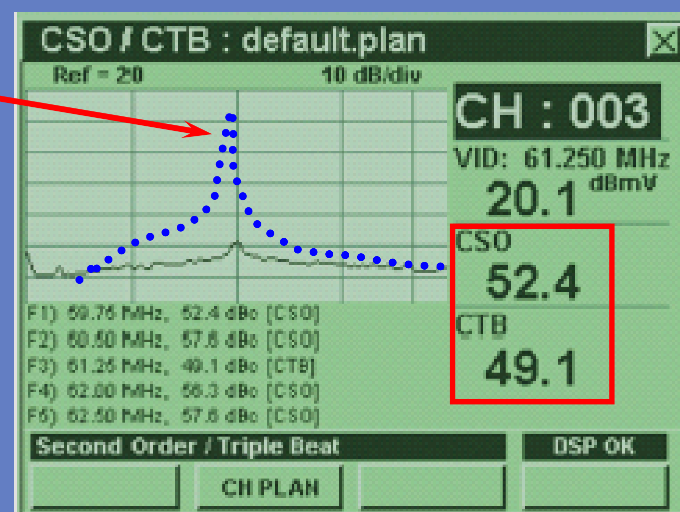
Coherent Disturbances CSO & CTB

- 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.



- ors ase C C is la e elo i fo
- e aile lis of o o e s lis e i a le
- Pi kee s re or of rea i gs af er arrier is r e a k o

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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

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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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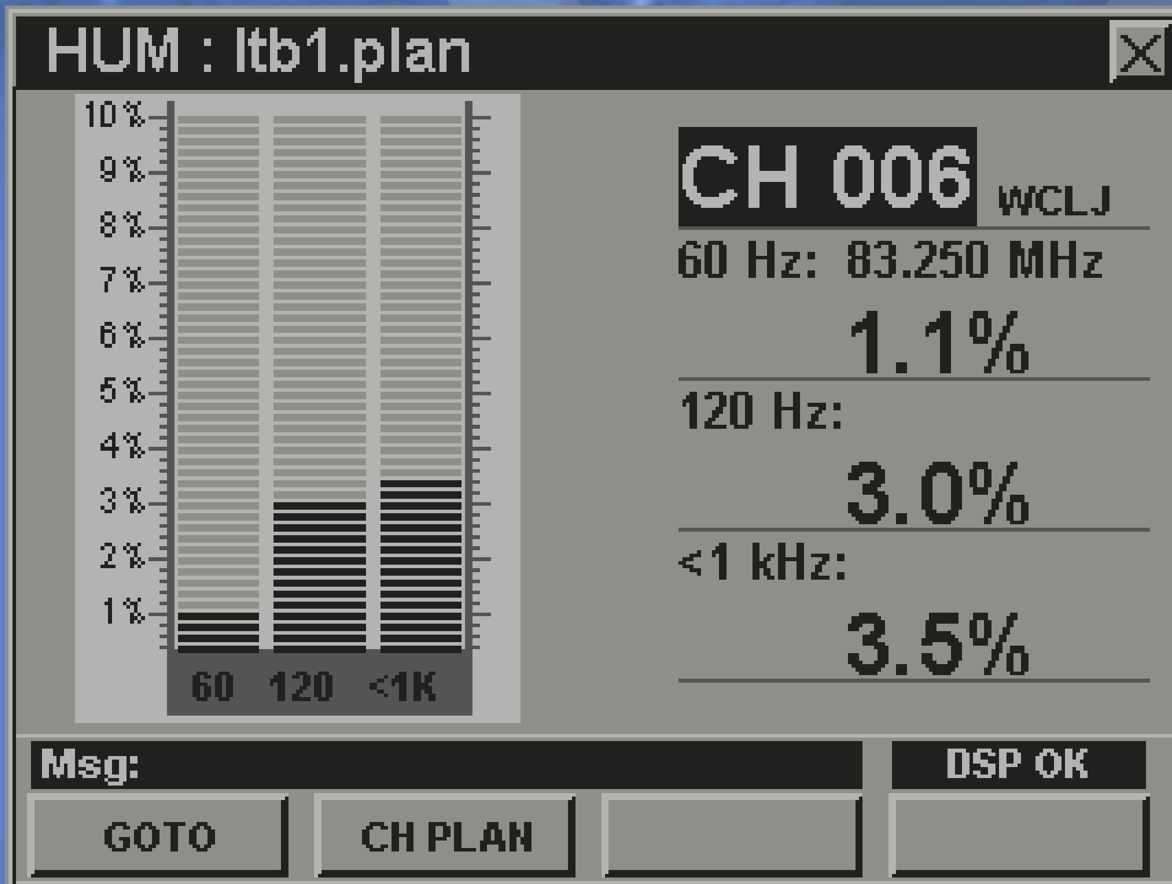
Proof Of Performance Measurements

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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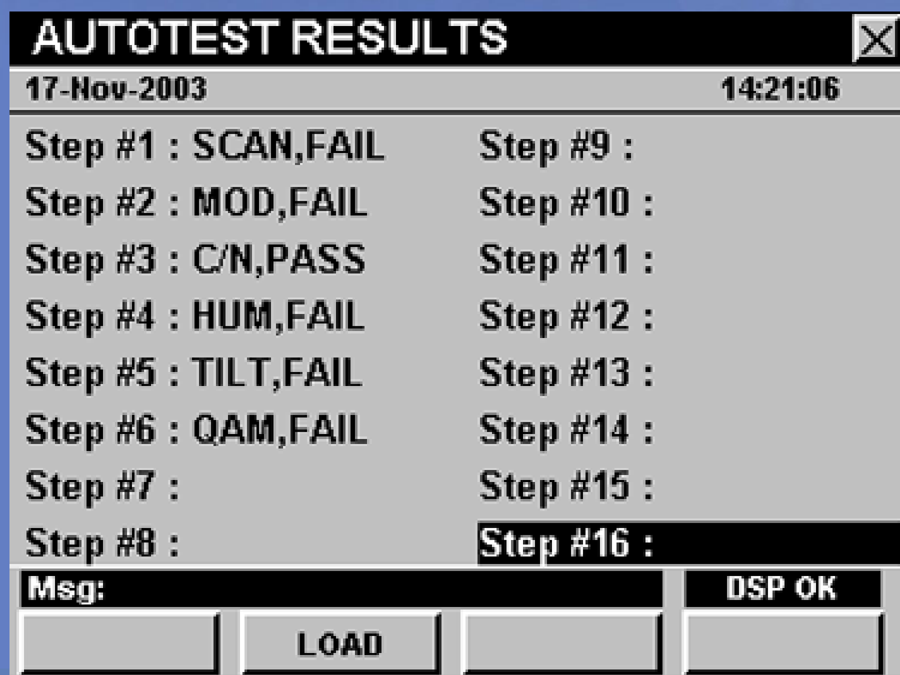
FCC Requirements

- **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)**

FCC Requirements

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



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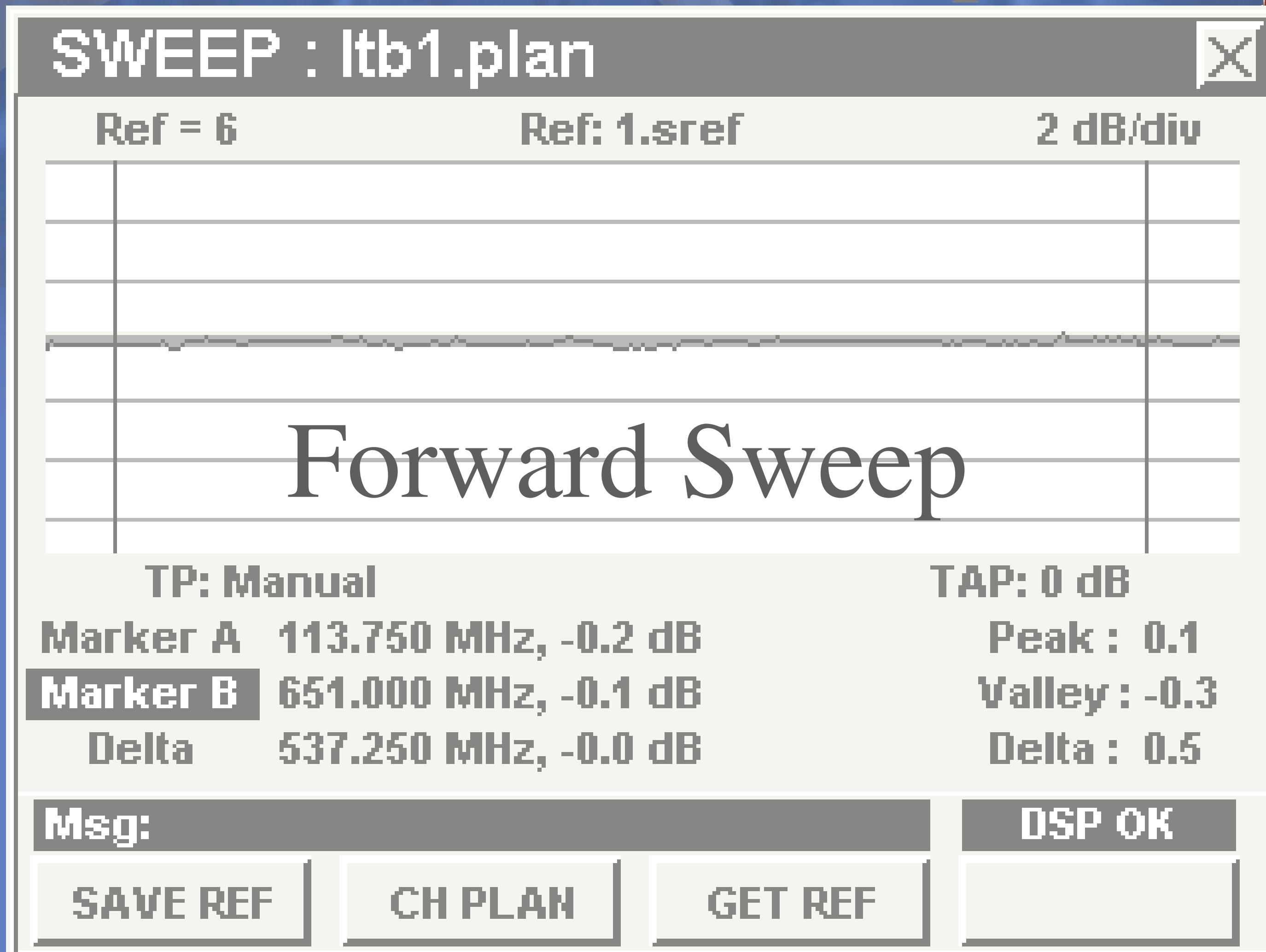
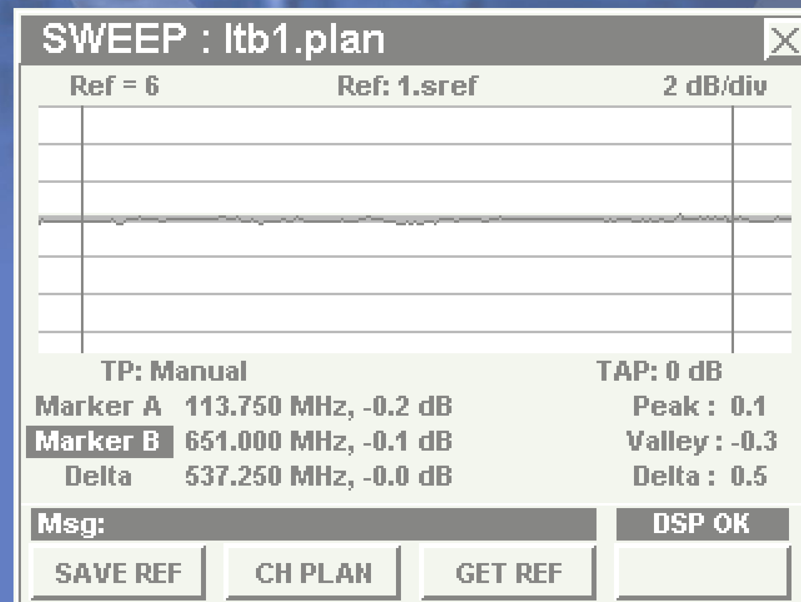
Forward Sweep



Forward Sweep

- Test the cable system's ability to properly transmit signals from headend to subscriber throughout the frequency range
- Sweep to verify performance to design specifications
- Expected Results: *n*/10 + x = max flatness variation
    - where n = number of amplifiers in cascade
    - where x = best case flatness figure (supplied by manufacturer)



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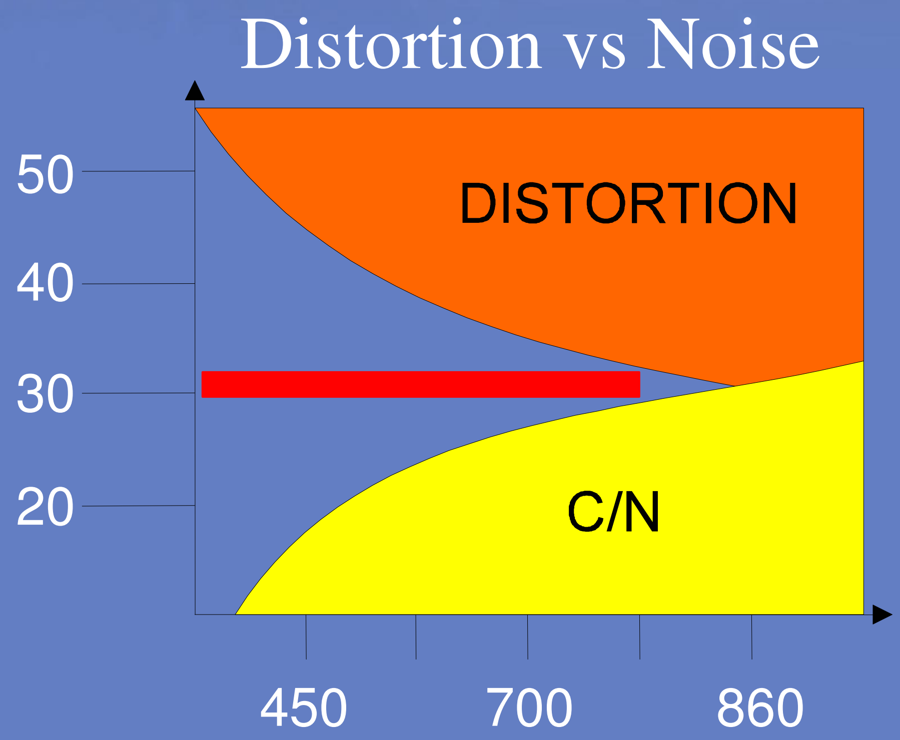
Forward Sweep

- Amplifiers have a trade-off between noise and distortion performance
- Tightly controlling frequency response provides the best compromise between noise and distortion.



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Sweep History

- Low Level Sweep
- High Level Sweep
- Guard band Method
- Vertical Blanking Method
- Sweepless with Headend Reference
- 860DSPi Sweepless

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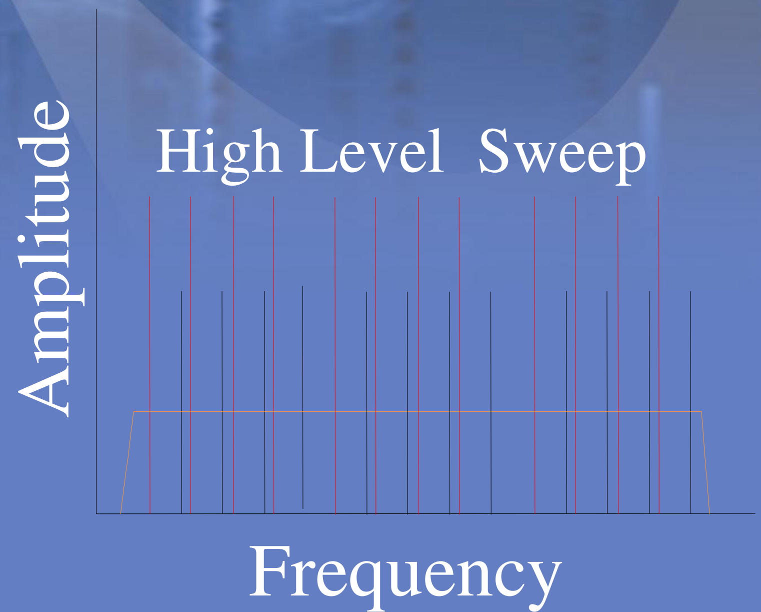
Low Level

- Confusion with system noise
- Hard to see sweep
- Potential interference (continuous sweep)
- Went away with long cascades
- Returned with Fiber



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High Level

- Produced major interference in the TV-picture
- Dead (Obsolete)

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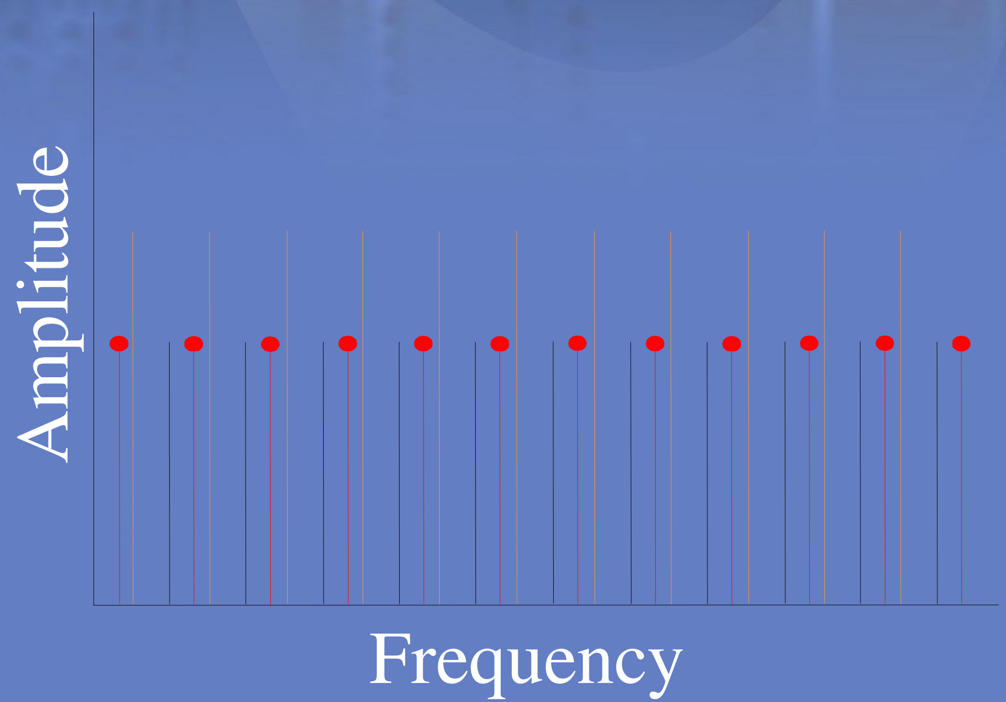
Guard Band

- Inject sweep between video and audio carriers
- Min Interference
  - Potential Interference
- Interference with Digital Carriers



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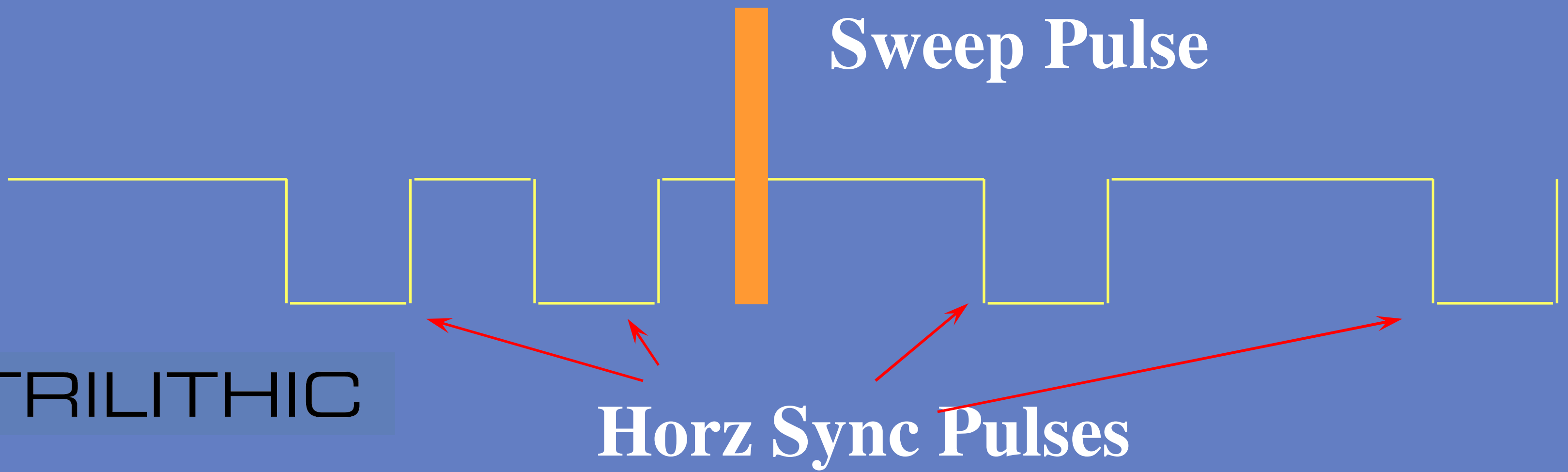
Vertical Blanking

- Insert Sweep timed during the vertical blanking interval
- Not compatible with digital TV-carriers (QAM)
- Blank spectrum not tested
- 600 MHz



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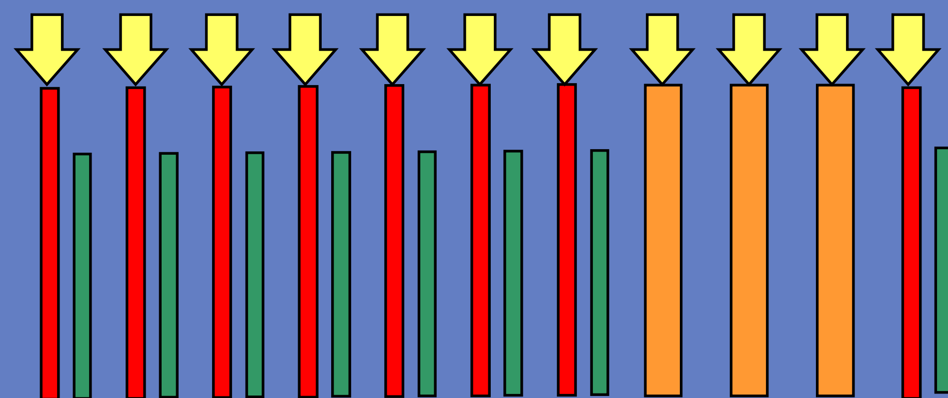
Sweepless with Headend Reference

- Headend unit constantly measures and refreshes ref to field unit
- Sweep unoccupied spectrum
- Expensive
- More Equipment
- May cause interference if misprogramed

860DSPi Sweepless

- Ref at node
- Reference on Analog and Digital Carriers
- Stable - Average sweep trace up to 1024 times (typical 16 to 32 times)
- Low Cost
- Less Equip
- No injection
- No interference



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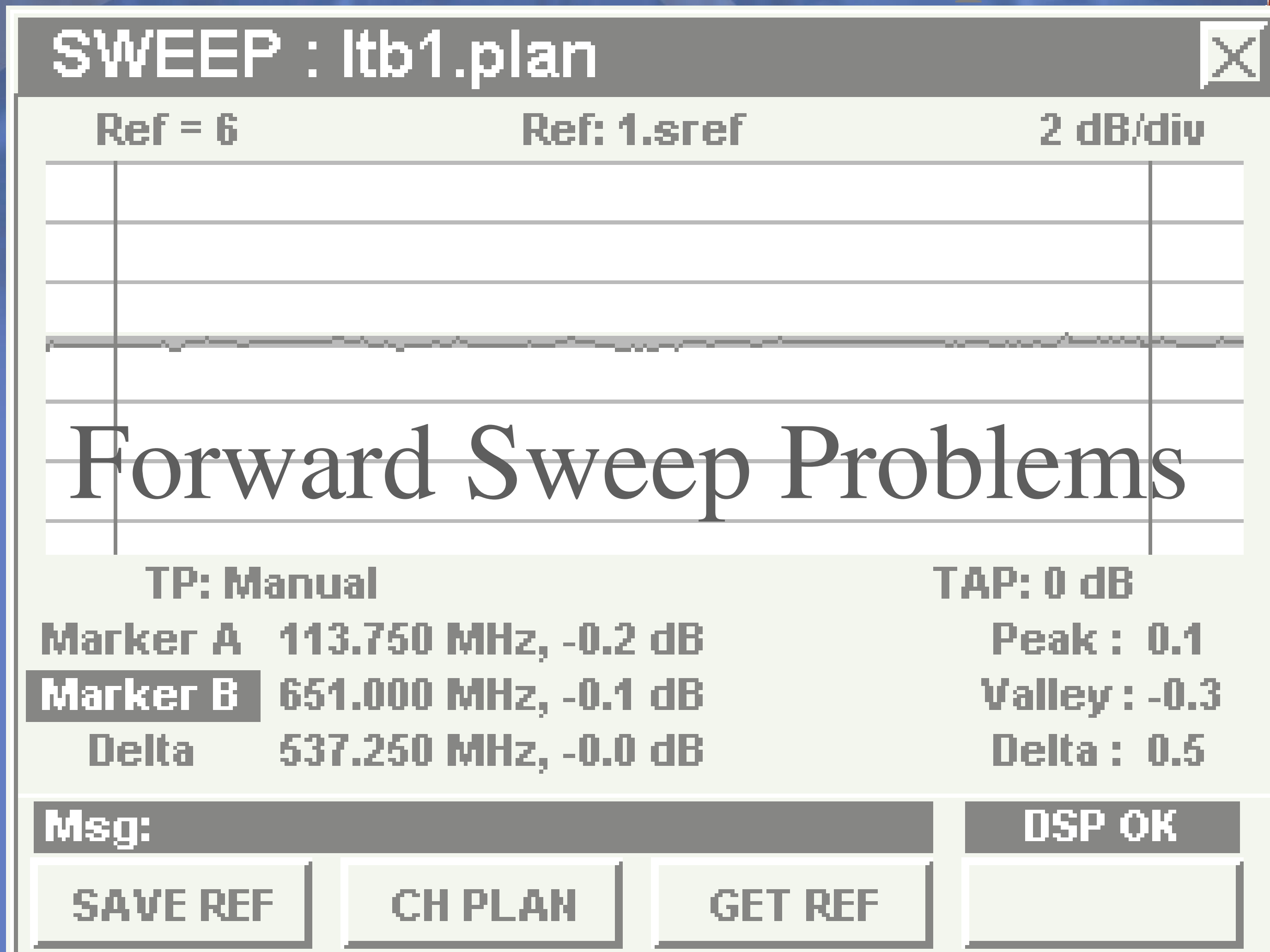
Forward Sweep



Forward Sweep Problems

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Cable Attenuation

A coaxial cable attenuates the signal passing through it by an amount that varies with the signal frequency. High signals are attenuated more than low signals, and the degree of attenuation increases exponentially with frequency.

Rule 1)

Cable Attenuation (in dB) doubles as frequency quadruples.

Rule 2)

Cable Loss increases 1% for every 10 degree rise in temperature.

TRILITHIC

Peak-to-Valley (P-V) Deviation

To determine what degree of overall peak-to-valley deviation is acceptable for the Nth amplifier in a cascade, use this formula:

X (in dB) = N/10 + 1 for 300 MHz systems

Where x is equal to the acceptable Peak-to-Valley deviation and,

N = number of amplifiers in cascade.

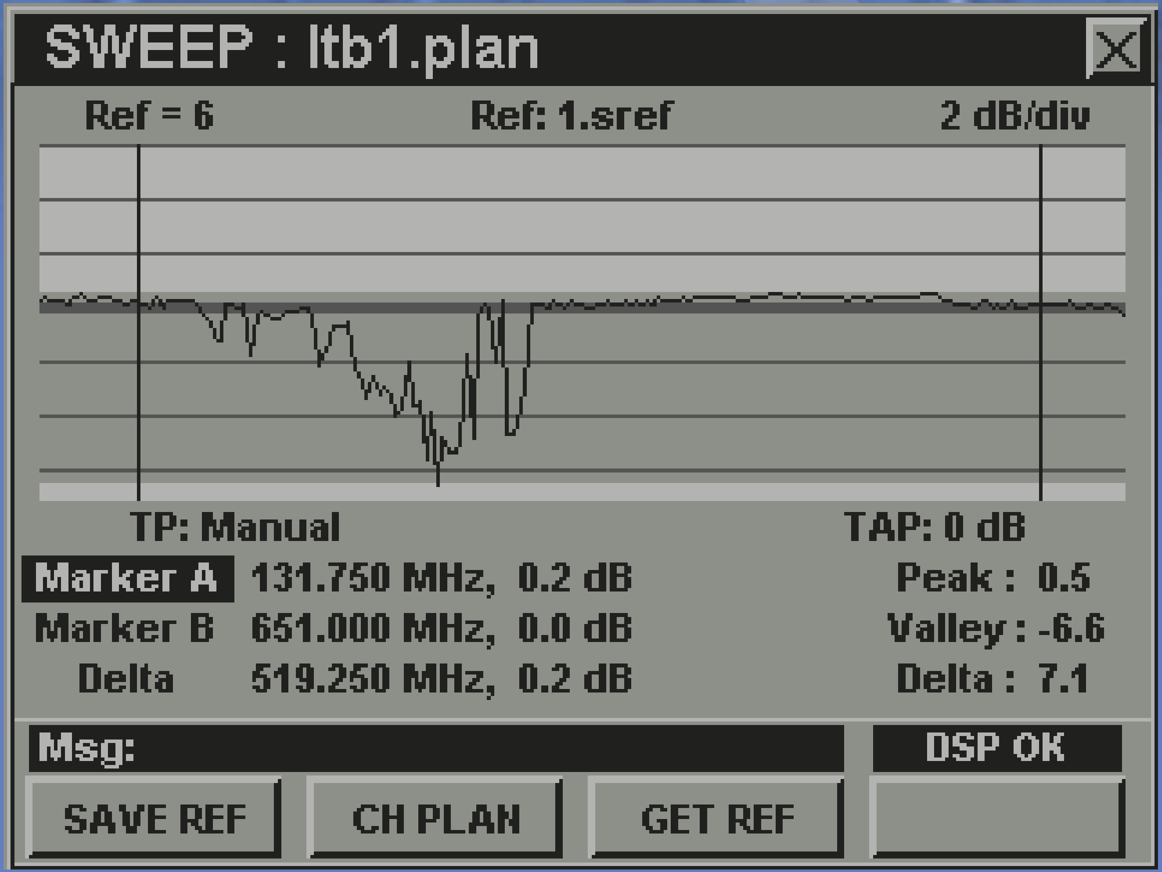
TRILITHIC

Forward Sweep Problems

- Suck-outs
- Standing Waves
  - Loose connecters
  - Damaged cable
- Highend roll-off
- Wrong EQ's

TRILITHIC

Suck - out



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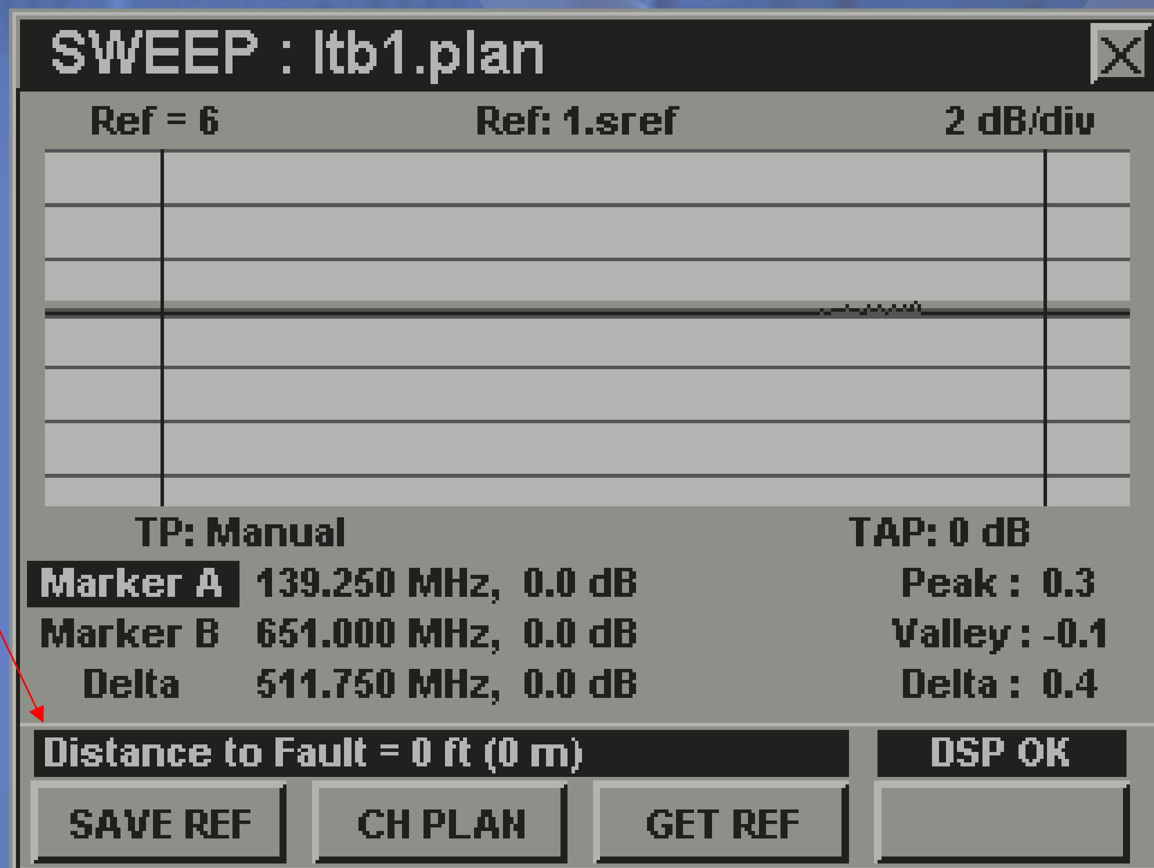
Standing waves

- 860 measures distance to fault automatically



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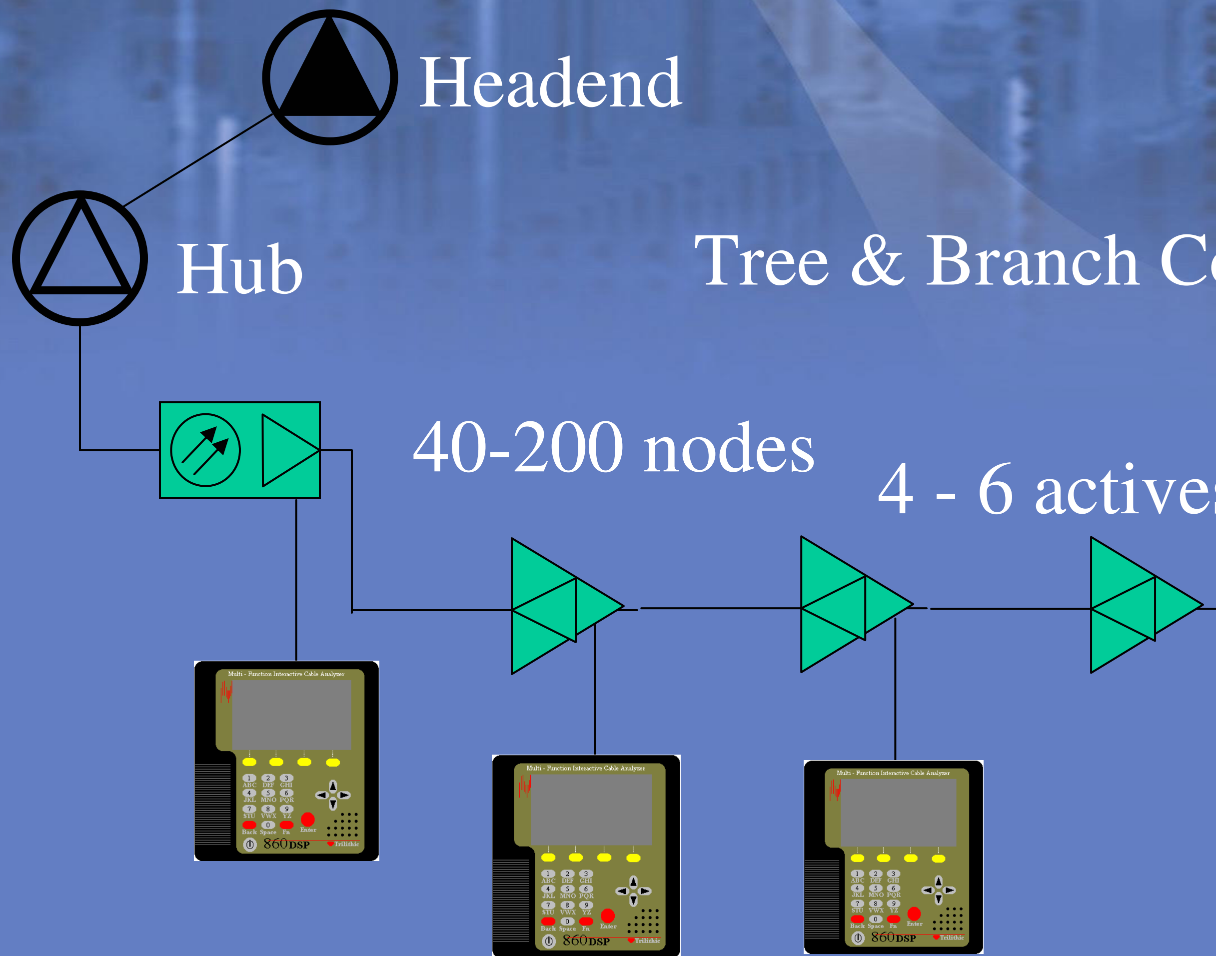
Sweep Forward Path

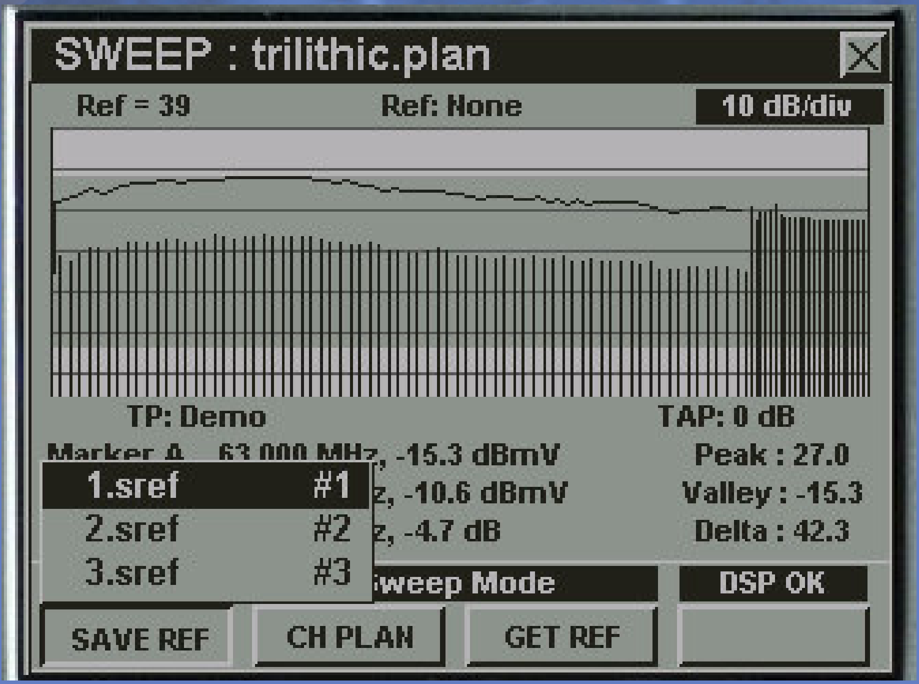
Tree & Branch Configuration



4 - 6 actives per node

TRILITHIC

Reference Trace



- Select TP Location
  - First balance the node
  - Save Reference
  - Verify Frequency response
- Move to next station

TRILITHIC

Sweep Trace

- Get Reference
- Check Levels
  - Adjust pads
- Check Equalization
  - Adjust EQ
- Check Frequency Response
  - Variations in sweep trace should not exceed reference by specified dB

TRILITHIC

Forward Node Setup

Device	Optical	Express	Express	Dist	Dist	Dist	Dist
Amplifier Type		Launch	HGD	LE	LE	LE	HGD
Level Control	Manual	Manual	Automatic	Manual	Thermal	Automatic	Automatic
Fwd Input Level (dBmV)	0 dBm	22.5	8.5/8.5	16.5/11	16.5/11	17.5/12	12.5/12.5
Fwd Operational Gain (dB)	N/A	26	40	32.0	32.0	31.0	36.0
Fwd Output Level (dBmV)	26/26	48.5/36	48.5/36	48.5/36	48.5/36	48.5/36	48.5/36
Fwd Output Tilt (dB)	0	12.5	12.5	12.5	12.5	12.5	12.5
Fwd Interstage Tilt (dB)	0	12.5	12.5	7.0	7.0	7.0	12.5
Fwd Interstage Pad	N/A	N/A	N/A	**5**	0	0	4
Fwd Interstage EQ	N/A	1.5/4.5	10.5	9.0	7.5	9.0	10.5
AGC Pad 450 MHz Pilot	N/A	N/A	8	N/A	N/A	13	8
AGC Pad 550 MHz Pilot	N/A	N/A	9.5	N/A	N/A	14.5	8
Current @ 60 VAC			0.78	0.57	0.57	0.62	0.78
Current @ 50 VAC			0.91	0.61	0.61	0.66	0.91
Current @ 45 VAC			1.01	0.64	0.64	0.69	1.01
Current @ 40 VAC			1.15	0.70	0.70	0.75	1.15

TRILITHIC

Forward Node Setup

Setting up Forward Levels, Model 6940 862 MHz Four-Port Optoelectronic Receiver Station

Parameters – Optical (Forward Only) (Assumes Scientific-Atlanta Optical Transmitters)	**All Freqs**	**Note: Optical input level affects RF output at 2:1 ratio Flatness of RX output is dependant on flatness of headend**				
RF input to transmitter	14	dBmV	Assumes 1310 nm Scientific-Atlanta Transmitter			
Optical Input Level	0	dBm	Range of optical input from – 0 dBm to +1.5 dBm			
RF Output of RX	24	dBmV	Relative to 0 dBm optical input, see note above			
Optical Interface board loss	1.5	dB	2.8 dB with SMC or Narrowcast Interface board			
DC test point voltage	1	Vdc	Test point equals 1 volt per milliwatt			
Parameters – Forward Launch Amplifier	**55 MHz**	**450 MHz**	**550 MHz**	**750 MHz**	**870 MHz**	**Units**
FWD input level from RX +/- 2 dB	22.5	22.5	22.5	22.5	22.5	dBmV
FWD Input pad value (approximate)	-	-	-	-	0 to 2	dB
FWD Operational Gain	13.5	19.5	21	24	26	dB
Fwd Interstage EQ, (varies +/- 2 values) (see parts list)	-	-	-	-	4.5	dB
FWD Output Pad	-	-	-	-	0-3	dB
FWD Output Levels	36	42	43.5	46.5	48.5	dBmV

TRILITHIC

Forward Node Setup

Procedure

Step 1. Verify adequate light level at the Receiver input. 0 dBm (from -.5 to +1.5)

Step 2. Verify RF Level output of RX

Step 3. Achieve specified input level by installing the proper value input pad at the launch amplifier FWD input pad location. (RX output – 22.5 dB)

Note, there is not a forward input test point in the launch amplifier. This pad value is calculated from level measured at RX output.

Step 4. Achieve desired output tilt at port 6 by adjusting Interstage EQ.

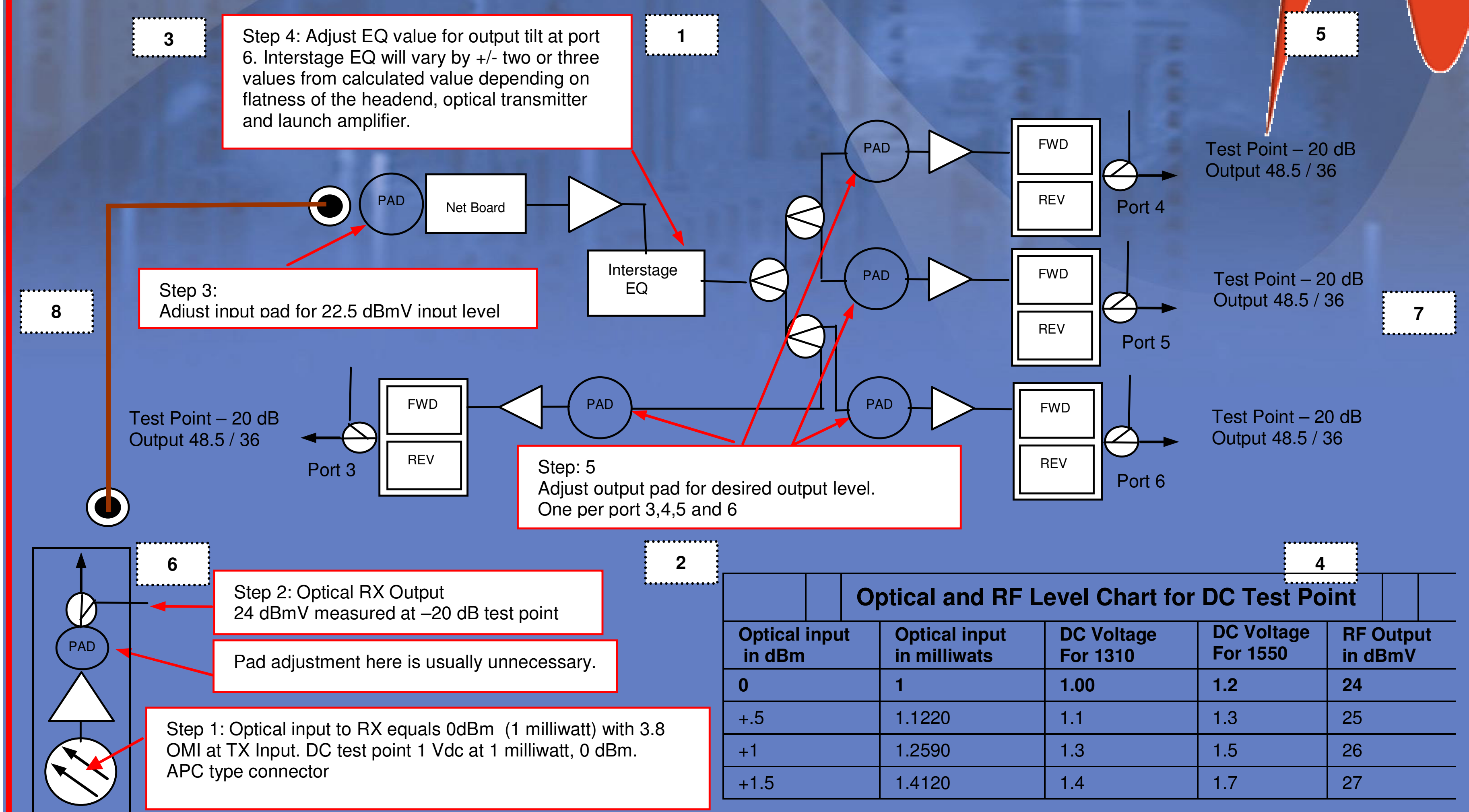
Step 5. Achieve desired output level of port 6, by installing the proper value output pad at the launch amplifier forward output pad location.

Step 6. Repeat for ports 3,4 and 5

Step 7. Close station to specified torque first pass to 25 in lb second pass 60 to 70 in-lb

TRILITHIC

Node Setup



Optical and RF Level Chart for DC Test Point

Optical input in dBm	Optical input in milliwats	DC Voltage For 1310	DC Voltage For 1550	RF Output in dBmV
0	**1**	**1.00**	**1.2**	**24**
+.5	1.1220	1.1	1.3	25
+1	1.2590	1.3	1.5	26
+1.5	1.4120	1.4	1.7	27

TRILITHIC

Reverse Node Setup

Setting up Reverse Levels, 6940 Optical Node with DFB Reverse Transmitter

Parameter	**Value**	**Units**
Injection Level at the reverse injection test point (forward test point –20 dB)	41	dBmV
Design Level at the reverse input port	21	dBmV
Reverse Amplifier Gain	18	dB
Output Level of reverse amplifier	39	dBmV
Input Level at reverse transmitter (prior to padding)	35	dBmV
NPR Operational Level at reverse transmitter	26	dBmV
Total padding required	9	dB
Measured Level at transmitter test point (-14 dB referenced to +26 dBmV NPR level).	12	dBmV
DFB Transmitter Optical Output power	2 / +3	mW / dBm

TRILITHIC

Reverse Node Setup

Preparation

Step 1. A Reverse sweep system or reverse carrier generator should be available for this alignment procedure.

Step 2. Install O dB pads into all reverse input pad sockets.

Procedure

Step 1. Inject 41 dBmV into the reverse injection test point to simulate 21 dBmV at the port.

Step 2. Install attenuator pads at the reverse amplifier output and/or input of the transmitter so that the combined padding equals 9 dB.

Step 3. Measure the level at the test point on the transmitter to verify that it is approximately +12 dBmV (No test point compensation in meter).

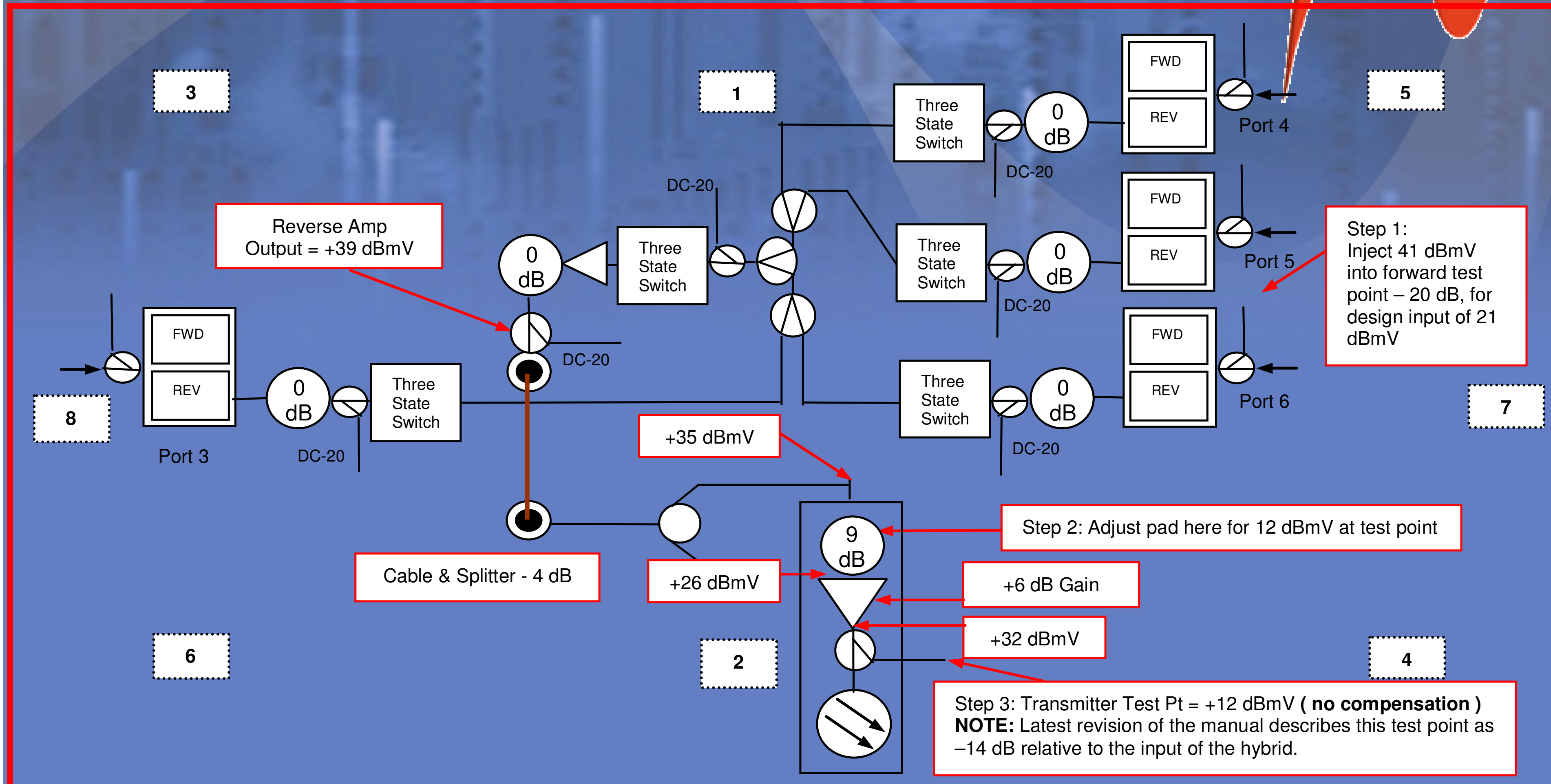
Step 4. Change zero dB pads at reverse inputs only if the design calls for additional input padding on a given reverse leg.

Step 5. Close station to specified torque first pass to 25 in lb second pass 60 to 70 in-lb

Step 6. Follow Sequence indicated on next slide

TRILITHIC

Reverse Node Setup



TRILITHIC

Digital Video

Expected MER & BER Results					
Digital Video		MER			
		64 QAM	256 QAM	Pre FEC BER	Post FEC BER
Headend	Excellent	35 dB	35 dB	0.0 E-00	0.0 E-00
	Acceptable	33 dB	35 dB	1.00E-08	0.0 E-00
	Marginal	30 dB	32 dB	1.00E-07	1.0E-08
Node	Excellent	34 dB	35 dB	0.0 E-00	0.0 E-00
	Acceptable	31 dB	34 dB	1.00E-08	0.0 E-00
	Marginal	28 dB	30 dB	1.00E-07	1.0E-08
Amp	Excellent	33 dB	35 dB	1.00E-09	0.0 E-00
	Acceptable	30 dB	32 dB	1.00E-08	1.0E-09
	Marginal	28 dB	27 dB	1.00E-07	1.0E-08
Tap	Excellent	32 dB	35 dB	1.00E-08	0.0 E-00
	Acceptable	28 dB	31 dB	1.00E-07	1.0E-09
	Marginal	24 dB	28 dB	1.00E-06	1.0E-08
Set-top	Excellent	32 dB	35 dB	1.00E-08	0.0 E-00
	Acceptable	28 dB	31 dB	1.00E-07	1.0E-08
	Marginal	23 dB	27 dB	1.00E-06	1.0E-07

TRILITHIC

Digital Data

Expected MER & BER Results					
Digital Data		MER			
		64 QAM	256 QAM	Pre FEC BER	Post FEC BER
Headend	Excellent	35 dB	35 dB	0.0 E-00	0.0 E-00
	Acceptable	34 dB	35 dB	0.0 E-00	0.0 E-00
	Marginal	30 dB	34 dB	1.0E-08	1.0E-09
Node	Excellent	35 dB	35 dB	0.0 E-00	0.0 E-00
	Acceptable	33 dB	34 dB	1.0E-09	0.0 E-00
	Marginal	30 dB	32 dB	1.0E-08	1.0E-09
Amp	Excellent	33 dB	35 dB	1.00E-09	0.0 E-00
	Acceptable	31 dB	33 dB	1.00E-08	0.0 E-00
	Marginal	28 dB	30 dB	1.00E-07	1.00E-09
Tap	Excellent	33 dB	35 dB	1.00E-08	0.0 E-00
	Acceptable	29 dB	32 dB	1.00E-07	1.0E-09
	Marginal	24 dB	30 dB	1.00E-06	1.0E-08
Modem	Excellent	32 dB	35 dB	1.00E-08	0.0 E-00
	Acceptable	28 dB	32 dB	1.00E-07	1.0E-08
	Marginal	25 dB	28 dB	1.00E-06	1.0E-07

TRILITHIC

Scientific Notation

- BER (bit error rate)
  - expressed in terms of errors divided by the total number of un-errored bits transmitted or received
- one error out of one million bits would be expressed as 1/1,000,000 or 1.0 E-6
  - Confusion arises when a second measurement is compared 7.0 E-7
  - Seven errors out of 10 million bits, which is actually a little better than 1 in one million.

Scientific Notation

Scientific Notation		
1.00E+00	1/1	One
1.00E-01	1/10	One in Ten
1.00E-02	1/100	One in One Hundred
1.00E-03	1/1,000	One in One Thousand
1.00E-04	1/10,000	One in Ten Thousand
1.00E-05	1/100,000	One in One Hundred Thousand
1.00E-06	1/1,000,000	One in One Million
1.00E-07	1/10,000,000	One in Ten Million
1.00E-08	1/100,000,000	One in One Hundred Million
1.00E-09	1/1,000,000,000	One in One Billion
1.00E-10	1/10,000,000,000	One in Ten Billion
1.00E-11	1/100,000,000,000	One in One Hundred Billion
1.00E-12	1/1,000,000,000,000	One in One Trillion
0.00 E-00	0 x 1	Zero (no errors)

TRILITHIC

Digital Measurements: Symbols to Display & MER

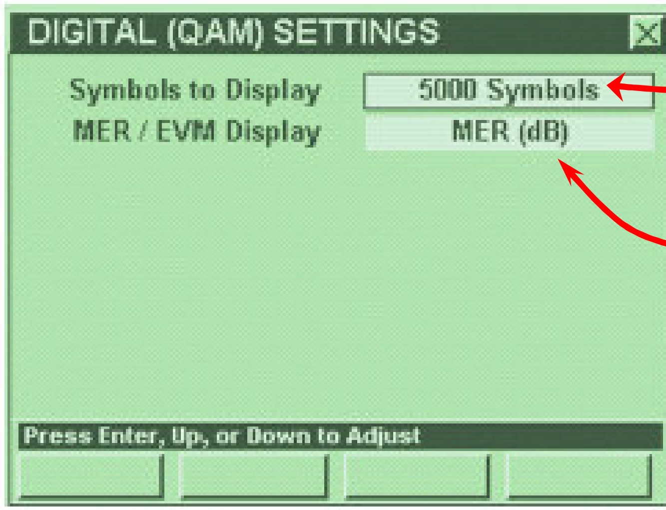
The **SYMBOLS TO DISPLAY** parameter allows you to set the number of symbols that are displayed on a constellation screen to make the constellation more or less dense.

To set this parameter use the ▶ button to select **SYMBOLS TO DISPLAY.**

Use the ▲ ▼ buttons to change number of symbols to be displayed in **1,000 Symbol** Increments.

You can select from **1,000** to **30,000 SYMBOLS TO DISPLAY**, or **DWELL** (infinite symbols).

The change will take effect immediately.



[illegible] s[illegible]ols
[illegible]larger [illegible] e [illegible] e [illegible] ore
[illegible] e[illegible] se [illegible] e [illegible] o[illegible] s[illegible]ella[illegible]io[illegible]

[illegible] R [illegible] is[illegible] la[illegible]

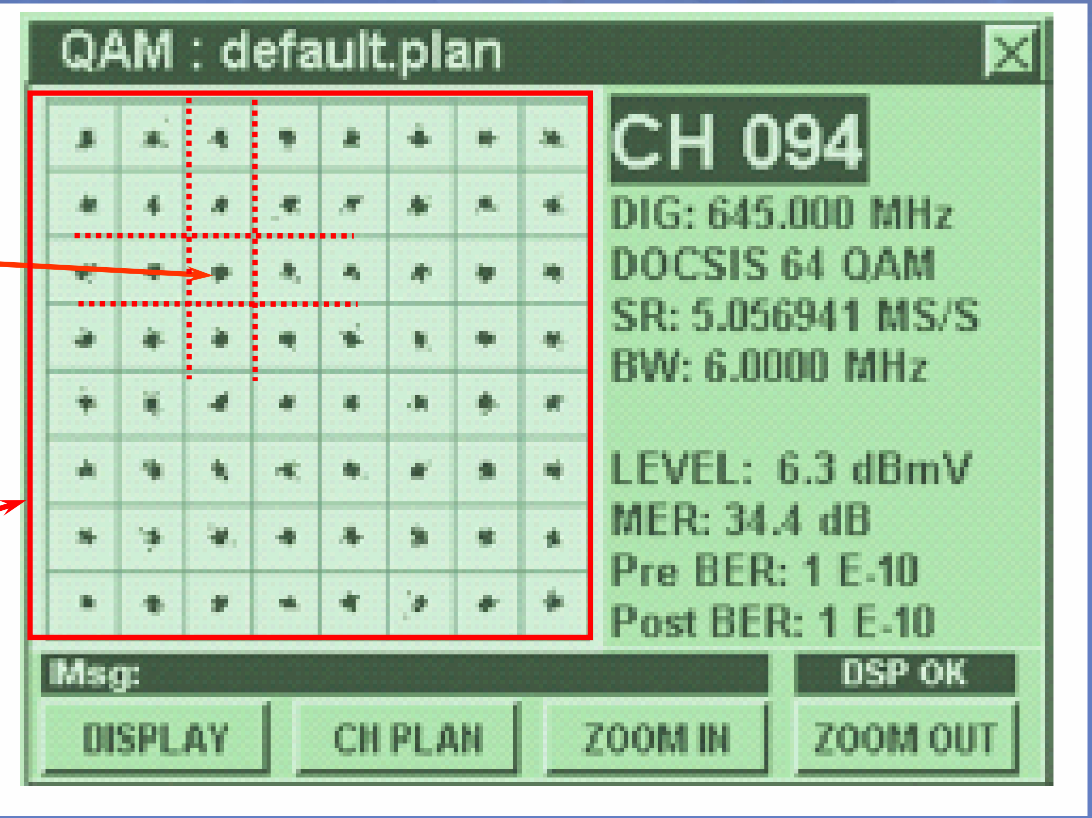
TRILITHIC

Clean Constellation Display

- □□a□ □le of a rela□ivel□ goo□ □□ □A□ □o□s□ella□io□□
- □o□s are reaso□a□l□ □ell □efi□e□ a□□ □osi□io□e□ i□ a s□□are□ i□□i□a□i□g goo□ gai□□□□ase □oise a□□ □o□□la□io□ □rror Ra□io□

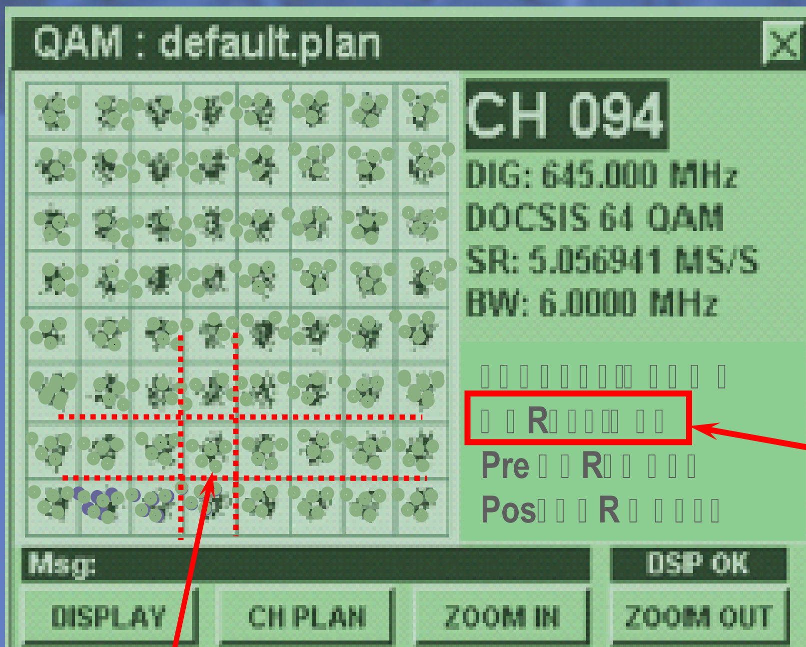
Well Defined and away from the decision boundaries

Well Positioned Dots in a Square

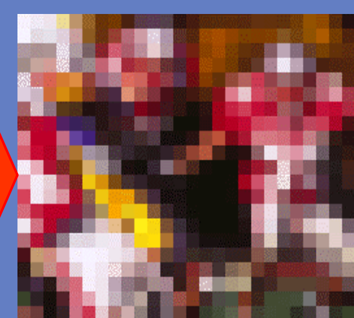


TRILITHIC

System Noise



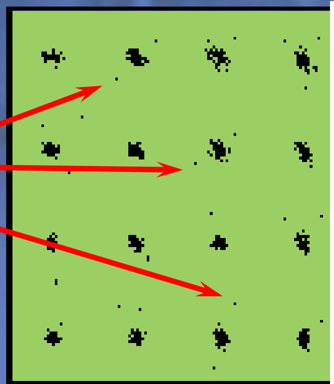
- A constellation displaying significant noise.
- Dots are spread out indicating *high noise* and most likely significant errors.
- Typically due to low power levels, poor C/ N.
- Don’t get fooled by the picture quality – this QAM is about to crash



vs

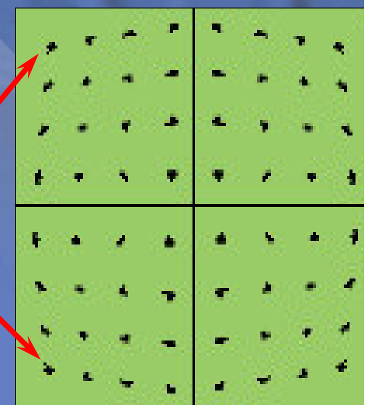
Other Anomalies & Causes

Ra□ □ o□
□ o□s A□ a□
fro□ □□ e
Cl□ s□er



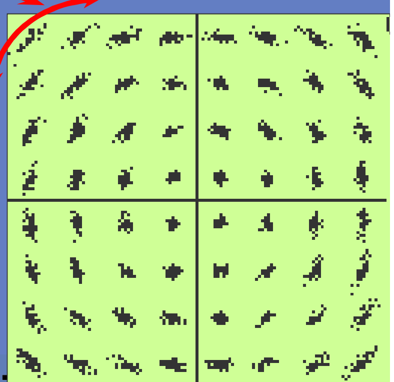
Intermittent Interference
intermittent ingress & laser clipping

□ □ □er
□ o□s
P□ lle□ □□



Gain Compression
caused by IF & RF amplifiers, filters, up/down converters & IF equalizers

Ro□a□io□

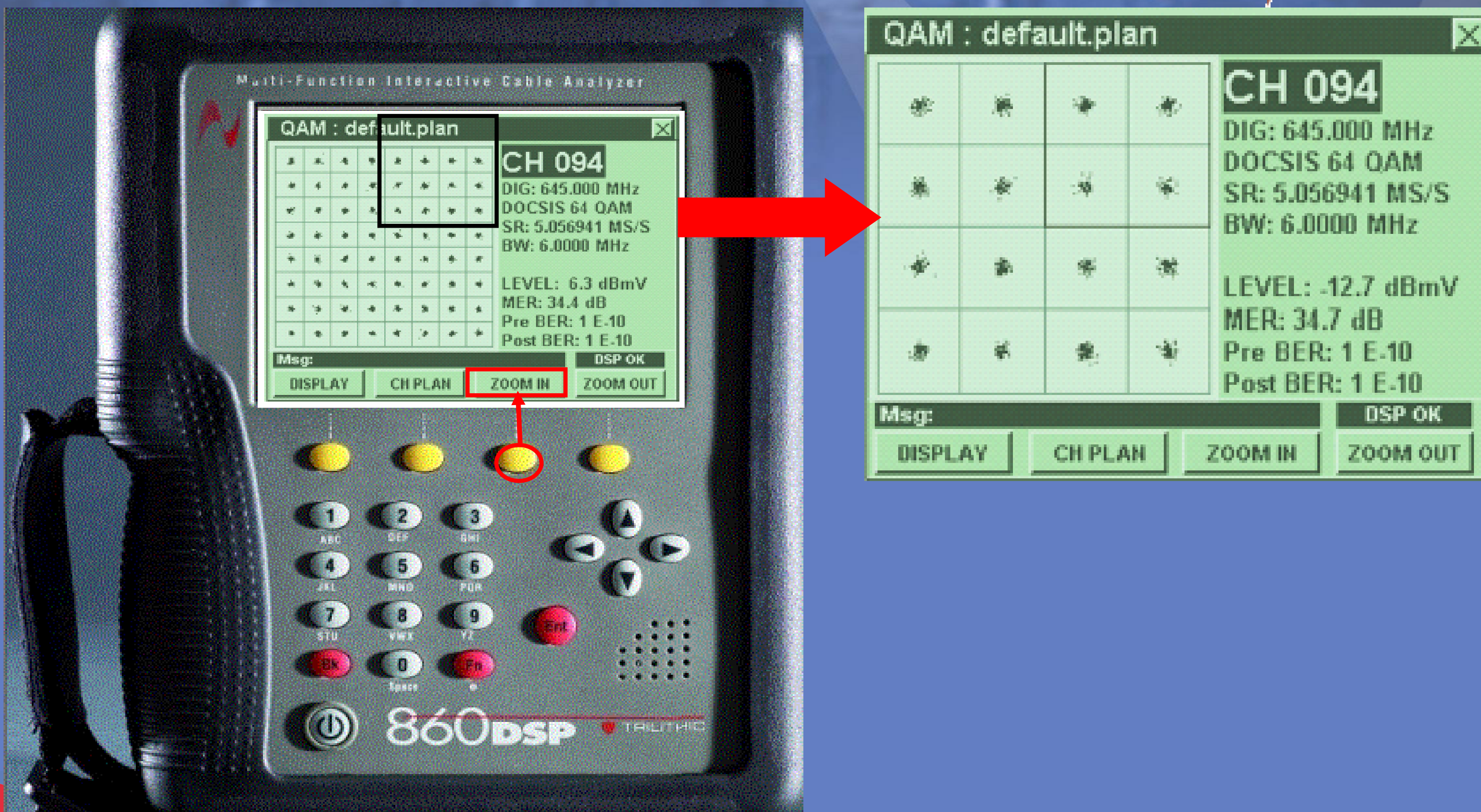


Phase Noise
caused by headend down/up converters.

Cir□ □ lar
Cl□ s□ers

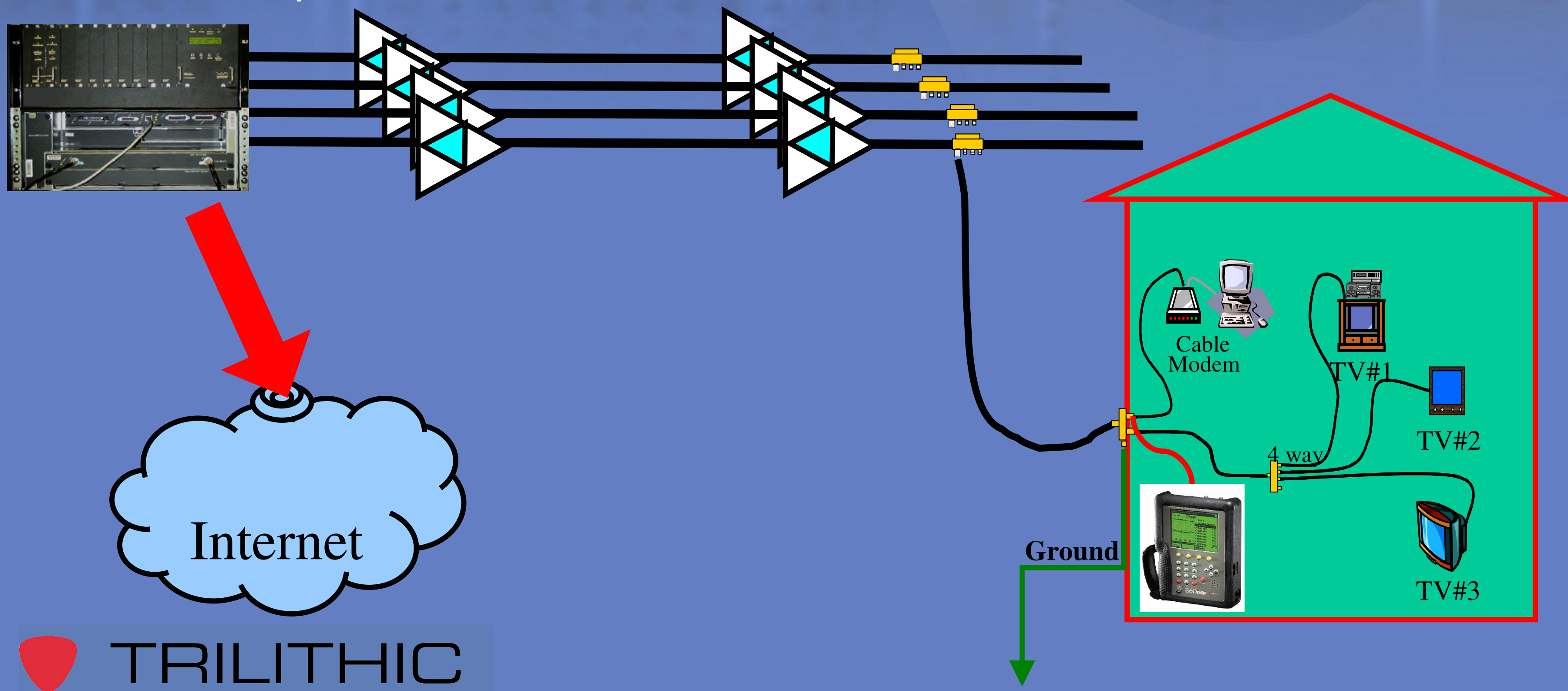
Coherent Interference
CTB, CSO, spurs and ingress.

Zoom


Multi-Function Interactive Cable Analyzer
QAM : default.plan
CH 094
DIG: 645.000 MHz
DOCSIS 64 QAM
SR: 5.056941 MS/S
BW: 6.0000 MHz
LEVEL: 6.3 dBmV
MER: 34.4 dB
Pre BER: 1 E-10
Post BER: 1 E-10
Msg:
DSP OK
DISPLAY
CH PLAN
ZOOM IN
ZOOM OUT
860DSP
QAM : default.plan
CH 094
DIG: 645.000 MHz
DOCSIS 64 QAM
SR: 5.056941 MS/S
BW: 6.0000 MHz
LEVEL: -12.7 dBmV
MER: 34.7 dB
Pre BER: 1 E-10
Post BER: 1 E-10
Msg:
DSP OK
DISPLAY
CH PLAN
ZOOM IN
ZOOM OUT

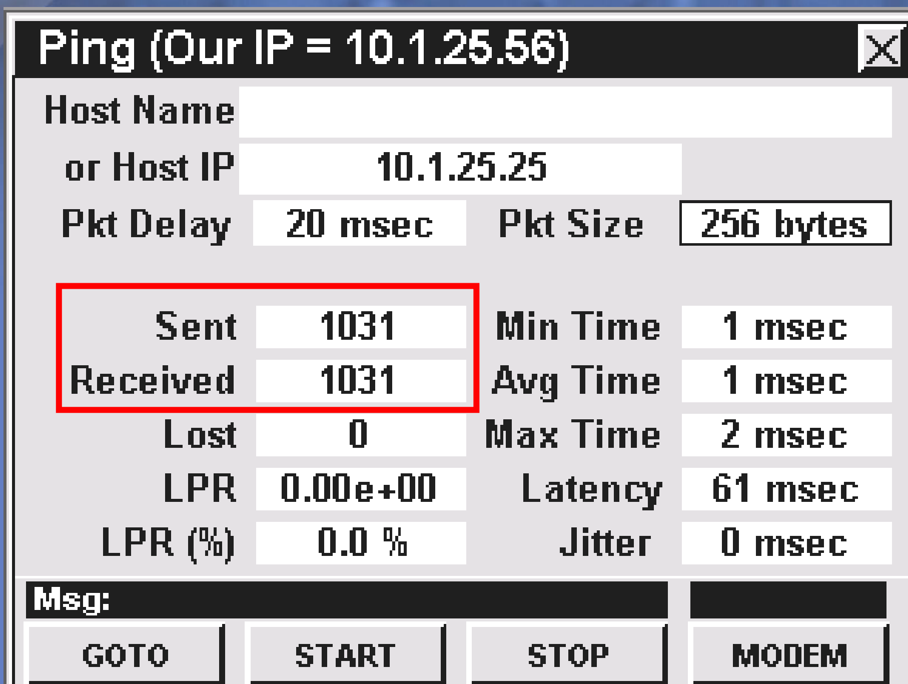
Throughput Testing

- By testing at the various locations between the tap and the subscribers equipment, troubleshooting techs can quickly determine the source of problems and replace only what needs to be replaced.



TRILITHIC

Pinging the Network



To PING the network, press the START **SOFTKEY.**

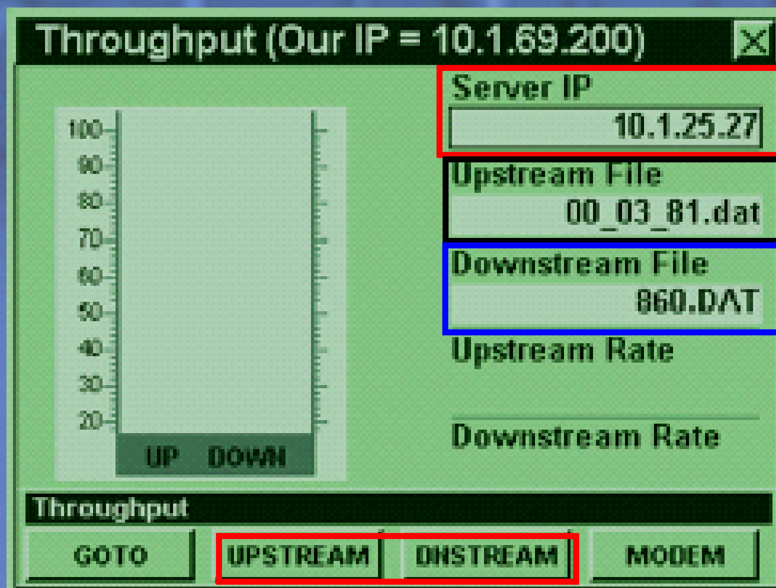
The instrument will continue to **PING** the network and update the status of the test on the screen until you press the STOP **SOFTKEY**.

A successful PING will display zero **Lost** packets as the number of packets **Sent** and **Received** increases.

An unsuccessful **PING** will display an increasing **LPR**

TRILITHIC

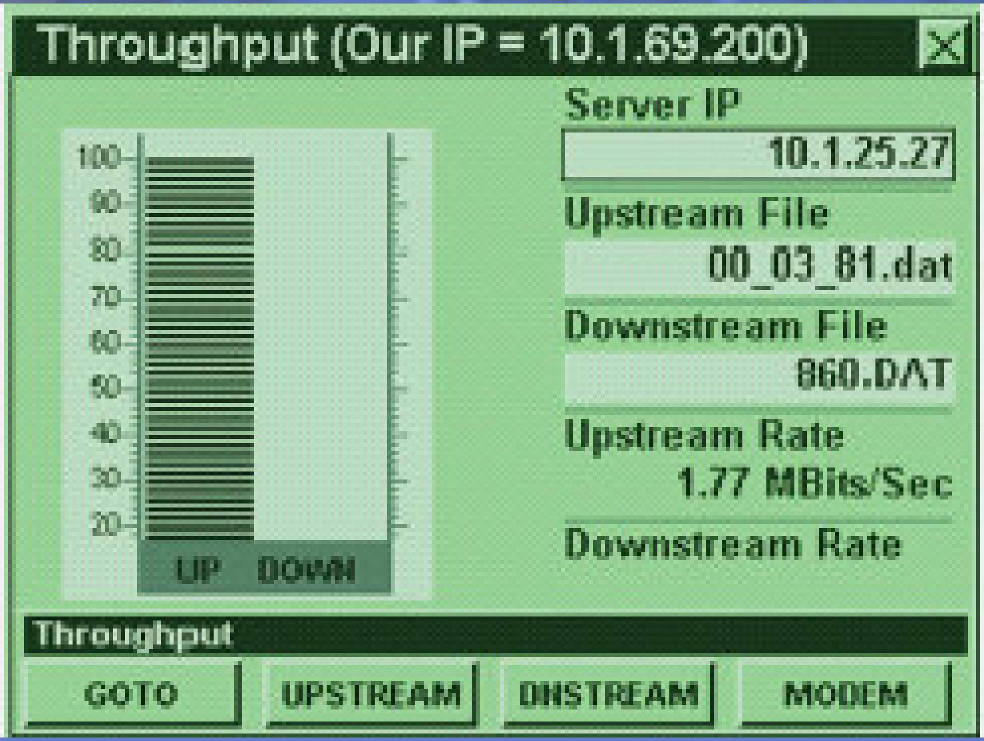
Throughput Testing



- Server IP - that will send & receive files
- Upstream Read Only DAT File - resident on each 860
- Downstream File that resides on Server for test purposes

TRILITHIC

Upstream Throughput Testing



To run an upstream throughput test, press the UPSTREAM **SOFTKEY.**

The 860 DSP will display the progress of the upstream file transfer on the bar graph.

When the test is complete, the 860 DSP will display the effective upstream data rate.

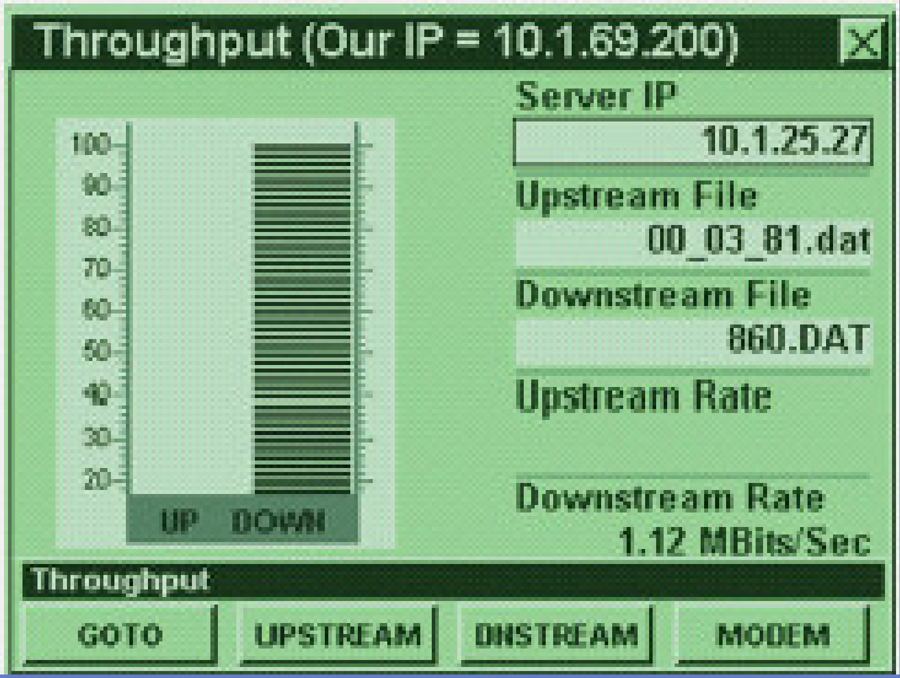
TRILITHIC

Downstream Throughput Testing

To run a downstream throughput test, press the DNSTREAM **SOFTKEY.**

The 860 DSP will display the progress of the downstream file transfer on the bar graph.

When the test is complete, the 860 DSP will display the effective downstream data rate.



TRILITHIC

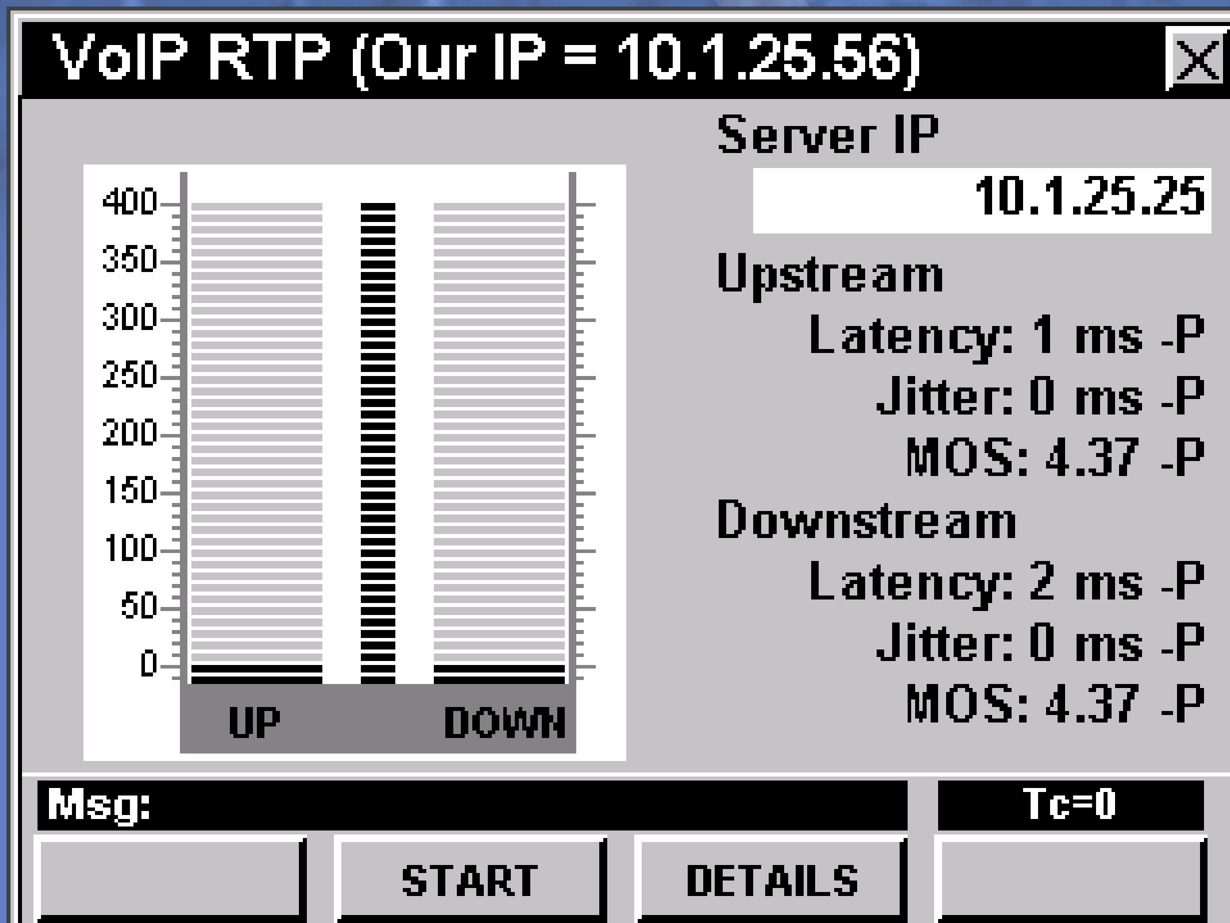
VoIP

- VoIP is a real-time application, so you can't just retransmit the damaged packets.
- VoIP is much more sensitive to transient interference than a Internet application.
- A click in the ear is a lot more likely to prompt customer complaints than an extra second lost in downloading an Internet page.
- Depending of course on what is downloading

TRILITHIC

VoIP RTP

Patent pending



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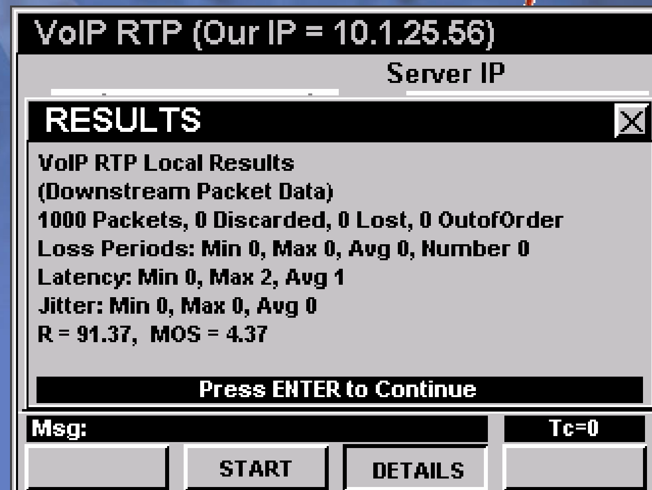
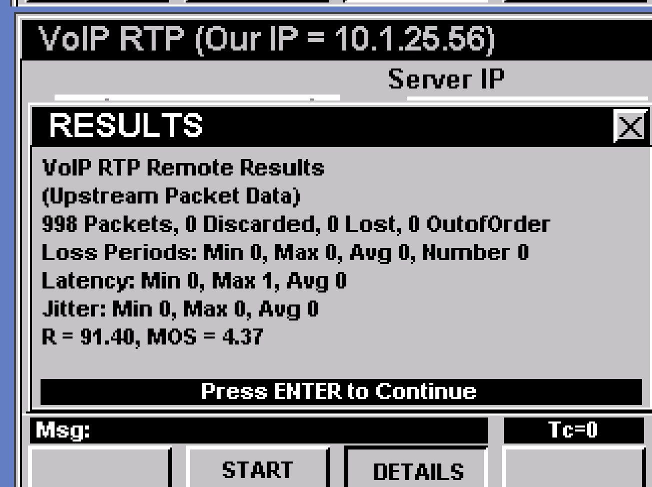
VoIP RTP

- Once the test is finished, press the details button to view both upstream and downstream detailed information
- This includes min, max, and average latency and jitter as well as packet arrival information

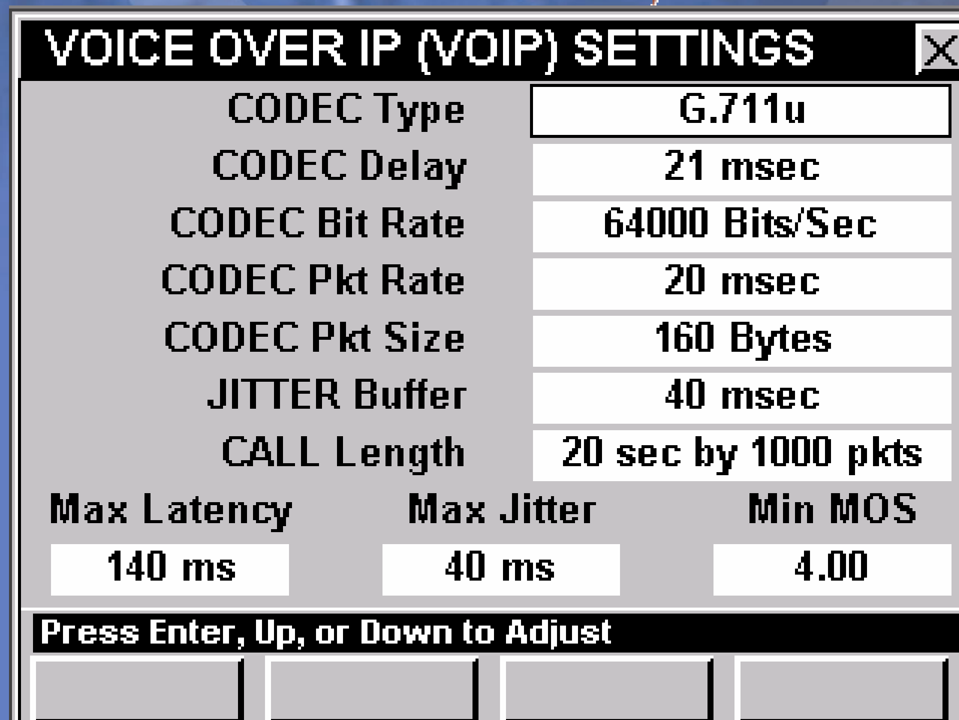




TRILITHIC

VoIP

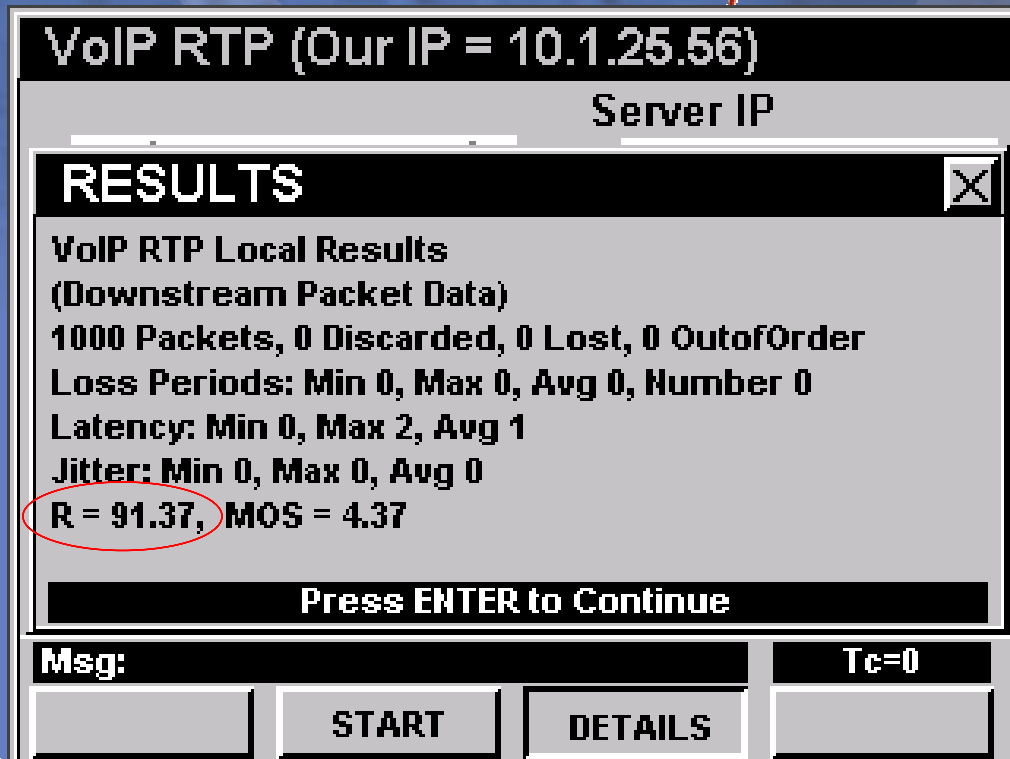
The setup menu allows you to choose the CODEC (G.711u, G.711a, G.728, G.729e, G.729a) that you are using in your system. Once you choose the proper CODEC, the associated bit rate and delay are displayed. The unit also provides you with standard packet rate and packet size. You can then adjust the packet rate, packet size, jitter buffer length, and overall call length. The final items to set are the associated VoIP limits.



TRILITHIC

The R-Factor

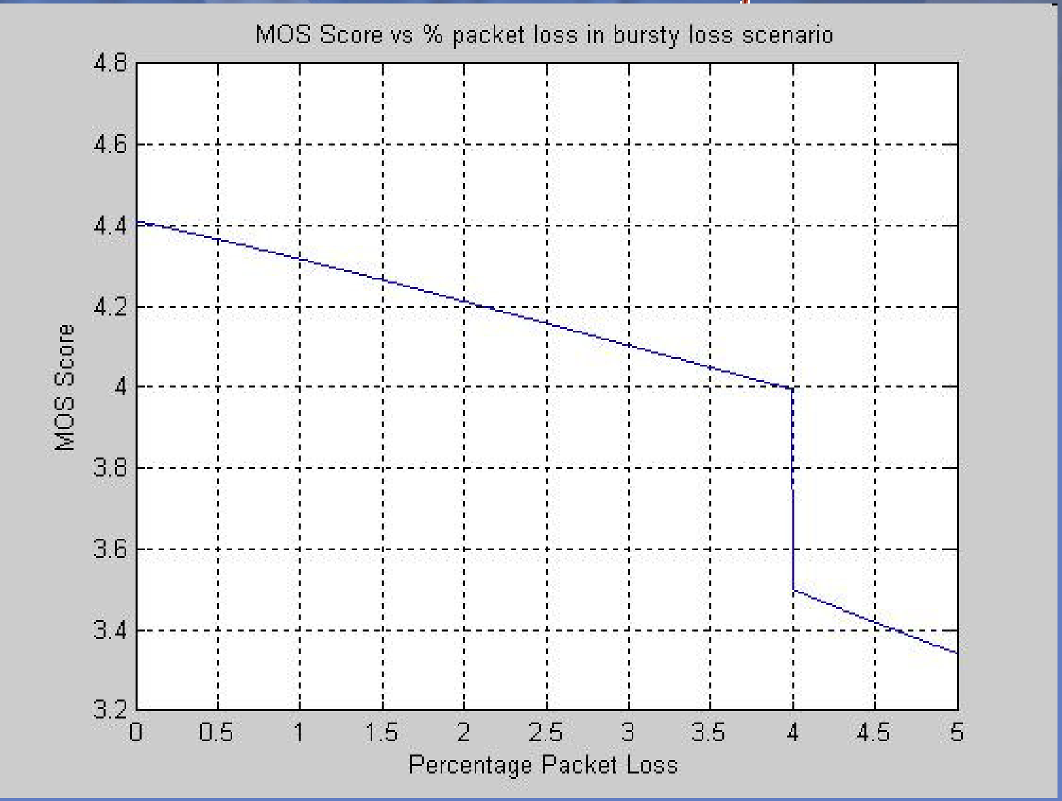
- The R-factor is a measure of voice quality ranging from a best case of 100 to a worst case of 0
- The R-factor uniquely determines the familiar Mean Opinion Score (MOS)
- The R-factor is defined in terms of several parameters associated with a voice channel across a mixed Switched Circuit Network (SCN) and a Packet Switched Network (PSN)
- The parameters included in the computation of the R-factor are fairly extensive covering such factors as echo, background noise, signal loss, codec impairments, and others



TRILITHIC

Packet Loss vs MOS

- How much packet loss can be tolerated before MOS begins to slip
  - Not very much
- Because of the real-time nature of VoIP traffic, very little damage to the data stream can be repaired
  - 1% packet loss will noticeably degrade phone service
  - 4% packet loss renders phone service unusable.



TRILITHIC

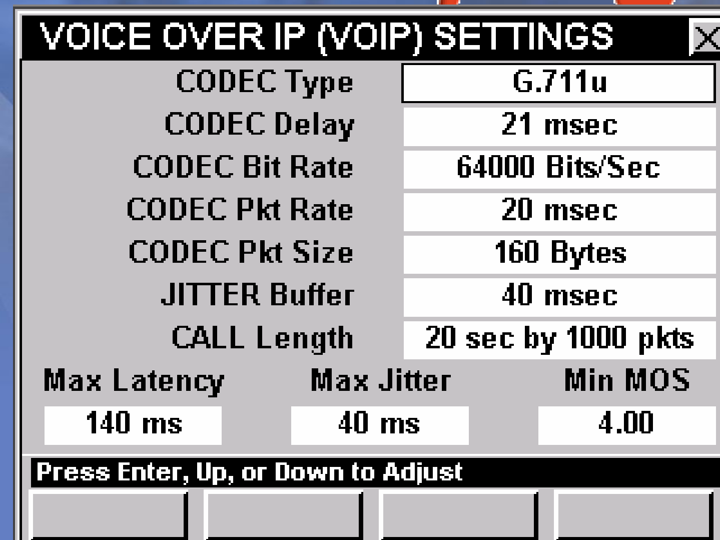
Mean Opinion Score (MOS)

- MOS is a “highest level” figure of merit for telephone connection clarity, developed by the POTS industry long ago for expressing a subscriber’s “opinion” of quality of service as a number
  - The scale was developed subjectively, with a very large number of subjects rating audio quality from zero to five as different impairments were inserted into phone traffic
  - A formula was developed for relating the total impact of all common impairments to the MOS score

TRILITHIC

Mean Opinion Score (MOS)

- Compressor/decompressor (codec) systems and digital signal processing (DSP) are commonly used in voice communications because they conserve bandwidth. But they also degrade voice fidelity
- The best codecs provide the most bandwidth conservation while producing the least degradation of the signal
- MOS scale tops out at a theoretical 5.0
  - Max for quality-preserving G.711 codec is 4.4
  - Max for low-bandwidth G.729 codec 4.2



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Mean Opinion Score (MOS)

Rating	Definition	Description
5	Excellent	A perfect speech signal recorded in a quiet booth
4	Good	Intelligent and natural like long distance telephone quality
3	Fair	Communication quality, but requires some hearing effort
2	Poor	Low quality and hard to understand the speech
1	Bad	Unclear speech, breakdown

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Latency, Jitter, and Packet Loss

- How do they affect my calls
- Once a call has successfully been setup, latency, jitter, and packet loss effects are important predictors of overall call quality

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Latency

- A measure of the delay in a call
  - The round-trip delay between when information leaves point A and when a response is returned from point B, and the one-way delay between when something was spoken and when it was heard
  - The largest contributor to latency is caused by network transmission delay. Round-trip latency affects dynamics of conversation and is used in MOS calculations
  - Round trip latencies above 300 ms or so, users may experience annoying talk-over effects
  - Delay of less than 150ms is considered acceptable, while delay of more than 400ms is considered to be unusable

Jitter

- Jitter variable latency in a network
  - High jitter < 50 ms can result in both increased latency and packet loss
  - When talking to someone it's important that they hear what you say in the same order that you say it, otherwise they won't understand what you're telling them.
  - Jitter causes packets to arrive at their destination with different timing or in a different order than they were sent (spoken)
- VoIP collects packets in a buffer and put them back together in the proper timing and order before the receiver hears them
  - Processing that buffer adds delay to the call, so the bigger the buffer, the longer the delay
  - Remember the effects of latency? Keep in mind, no matter how big the buffer is, it is finite in size. If voice packets arrive when the buffer is full then packets are dropped and the receiver will never hear them (packet Loss)

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Packet Loss

- Just as it's important to hear what someone says in the order they say it
  - it's also important to hear all of what they're saying
- If you miss one out of every 10 words or 10 words all at once
  - chances are you're not going to understand much of the conversation
- This is packet loss
  - voice packets are dropped by network routers or switches or discarded by the jitter buffer

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Test Parameters

Test Parameter	Recommended Results
MOS	> 3.6
Latency	< 300 msec
Jitter	< 50 msec
Packet Loss	< 1%

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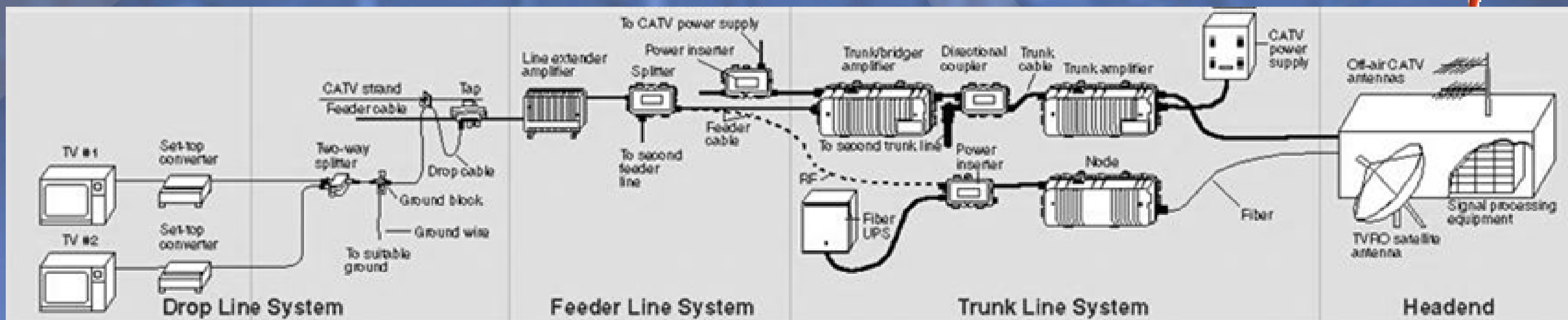
System Diagram



Installation/Provisioning
Leakage: Seeker Lite
Reverse: RSVP, Isometer, 860DSPi
Simple Install: Model Two

Field Service/Troubleshooting
Leakage: Searcher Series
Signal Analysis: 860 DSPi; SR-1 Reverse Sweep; VF-4/-5

Headend
Signal Analysis: 860 DSP H/I
Reverse Monitoring: SST, Viewer II
Leakage: CT-2/-3 Channel Tagging

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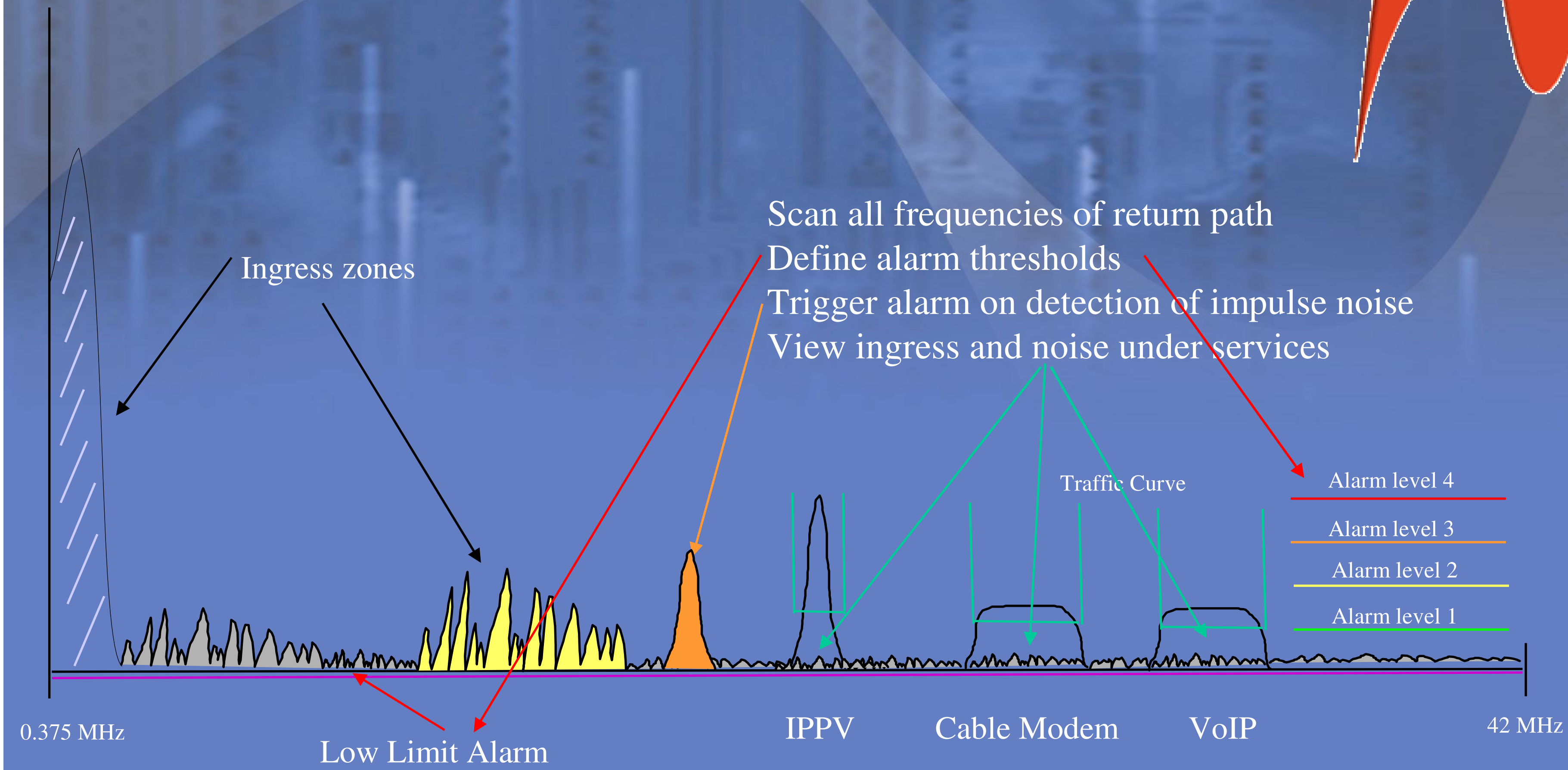
Return Path



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Return Path

- The return band has always been more contentious than the forward band
- With the addition of VoIP services, the hygiene of this band is increasingly more critical

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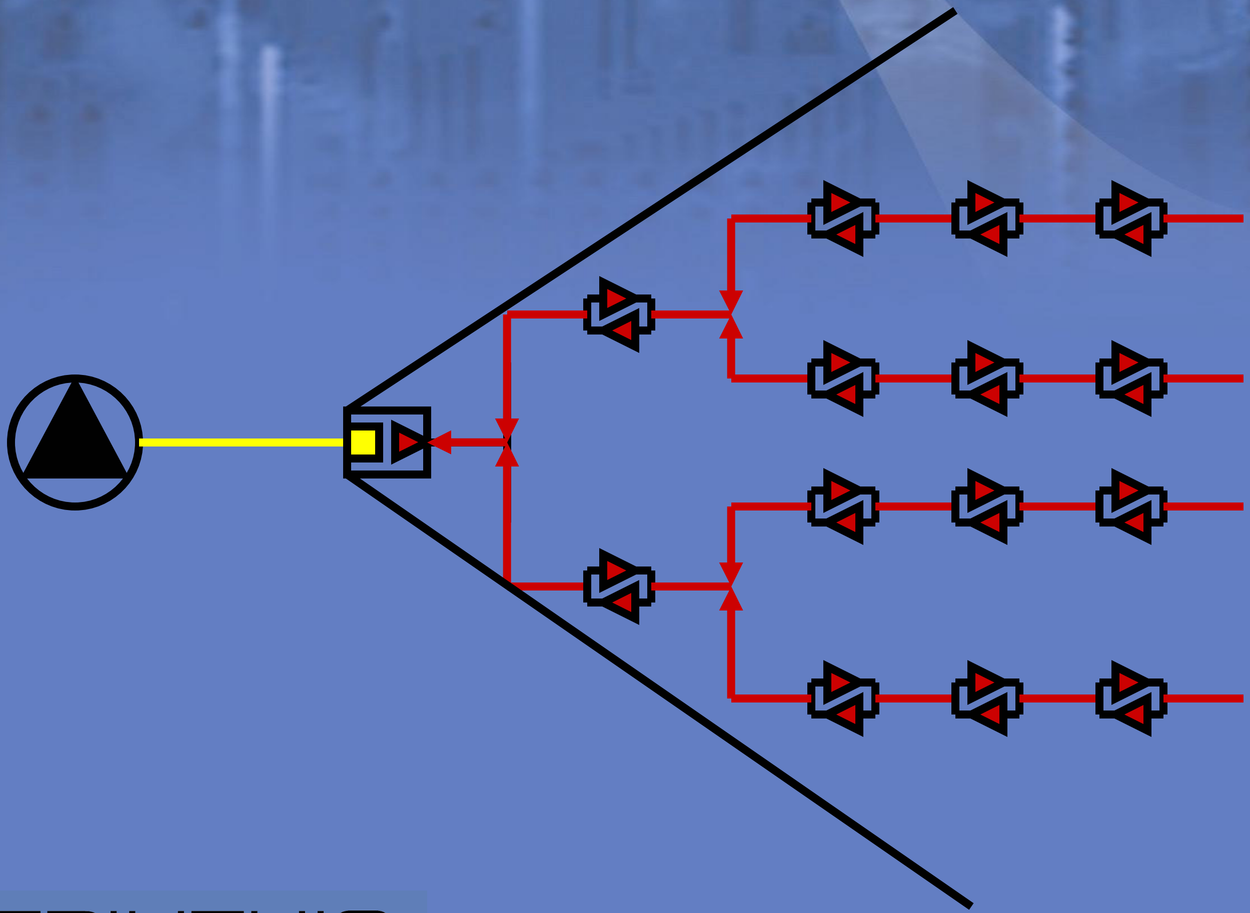
Return Path

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

Noise Funneling



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

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Thermal Noise

- Defined by Noise Bandwidth
  - Downstream Typically Defined in 4 MHz Bandwidth
  - Upstream defined by Bandwidth of Service under test
- Determining the thermal Noise in an occupied band
  - Formula
    - = 10Log(Noise Bandwidth, in Hz) – 125.2 dBmV

    Where
    - –125.2 dBmV is the thermal noise in Hz bandwidth for 75 Ohm system

3 dB Rule

- Whenever you double the cascade of "like" amplifiers
- Double the bandwidth of a noise measurement
- The noise power will change by 3 dB

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Amplifier Noise Figure

- The process of amplification adds noise
- The amount of noise added at each amplifier station is equal to noise figure of the amplifier
- NF Formula
  - NF = Return Amp IC Noise Figure + Internal Loss

Noise Contribution

- Adding 4 Identical Branches
  – Noise From (2) LE and (2) DA = -41.5 dBmV
  – Noise at input to node (4 Identical Branches)
  – = - 35.5 dBmV
  – Noise Contribution of Node = -45.2 dBmV
  – Total RF Noise to Optical Link = -35.4 dBmV

Noise Contribution of the Optical Link

- Fiber Optic Noise
  - Primary Sources
    - Laser
    - Fiber
    - Headend Receiver
  - Dominates Carrier to Noise for all return services

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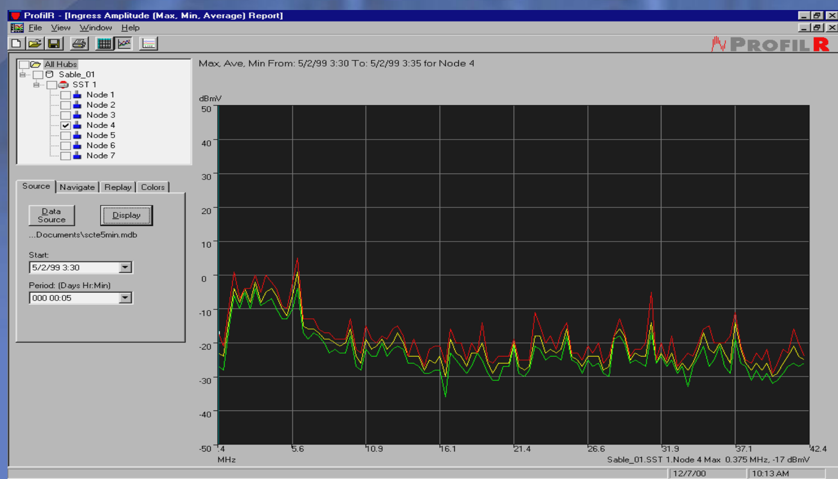
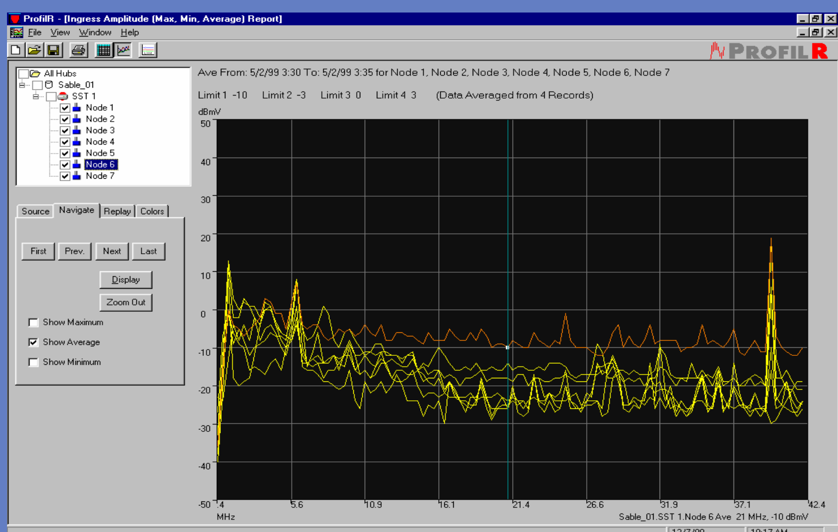
Observations about Ingress

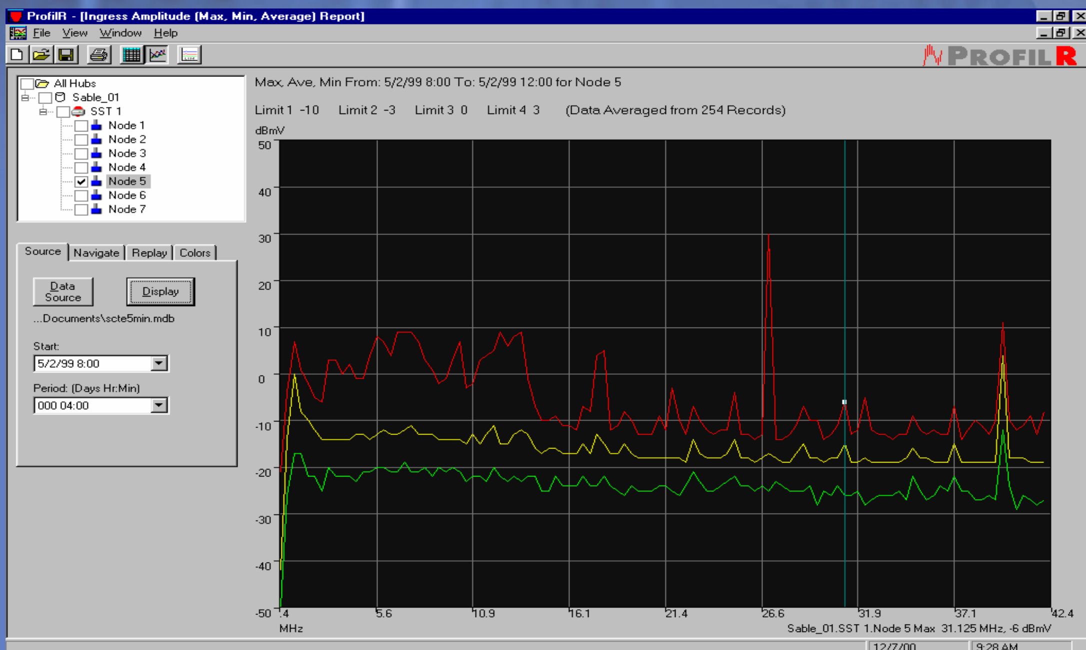




- Ingress levels vary in the return path
  - Over Time
  - From Node to Node
  - Discrete or Broadband
- Ingress Signatures
  - Highest under 15 MHz
- Vary between nodes
  - Noise Floor Node 1 -25dBmV @ 21 MHz
  - Noise Floor Node 6 -10dBmV @ 21 MHz

Observations about Ingress

- Ingress Varies Over Time
  - Changes between 8:00AM and 12:00 midnite
    - 8:00AM -6dBmV at 31.125 MHz
    - 11 dB between 8AM and 4PM
    - 7 dB between 4PM and 12 midnite



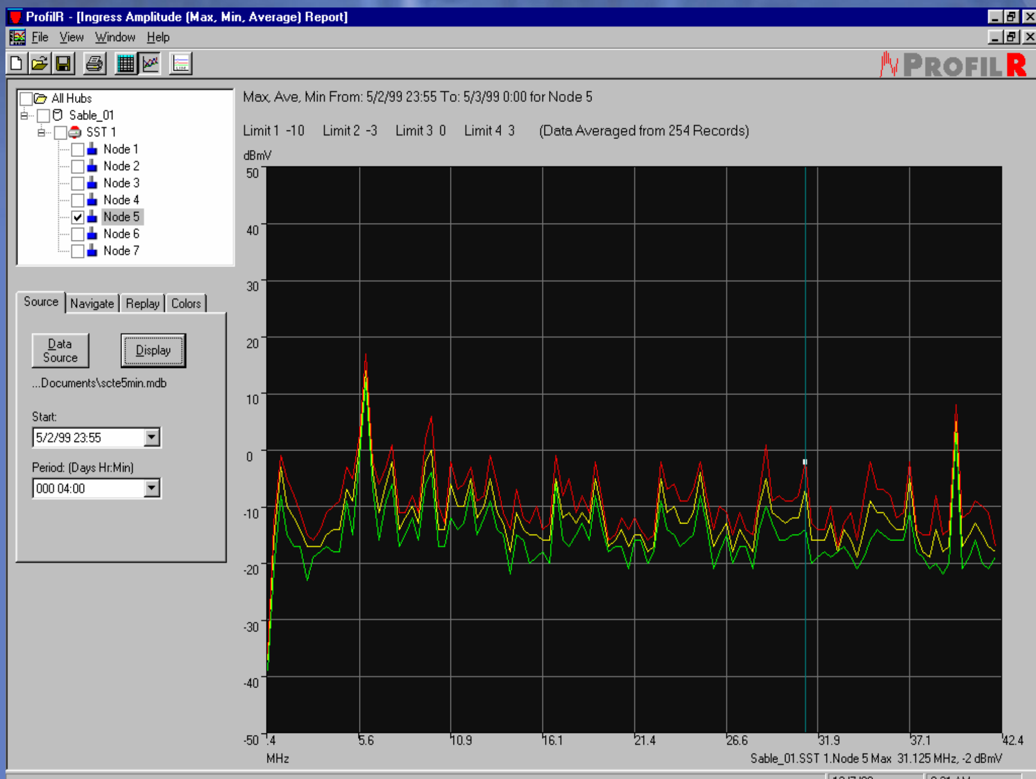
TRILITHIC

Observations about Ingress

- Ingress Varies Over Time
  - Changes between 8:00AM and 12:00 midnite
    - 4:00PM 5dBmV @ 31.125 MHz
    - 11 dB between 8AM and 4PM
    - 7 dB between 4PM and 12 midnite

TRILITHIC

Observations about Ingress



- Ingress Varies Over Time
  - Changes between 8:00AM and 12:00 midnite
    - 12:00AM -2dBmV @ 31.125 MHz
    - 11 dB between 8AM and 4PM
    - 7 dB between 4PM and 12 midnite

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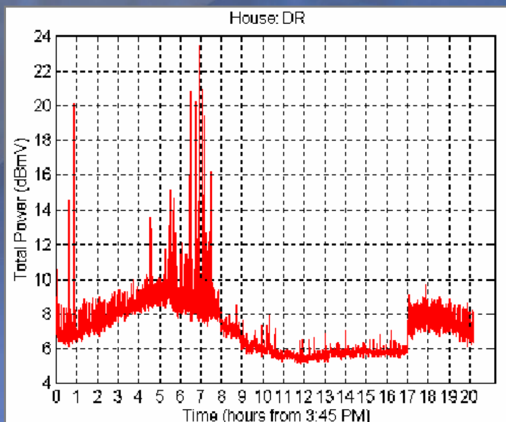
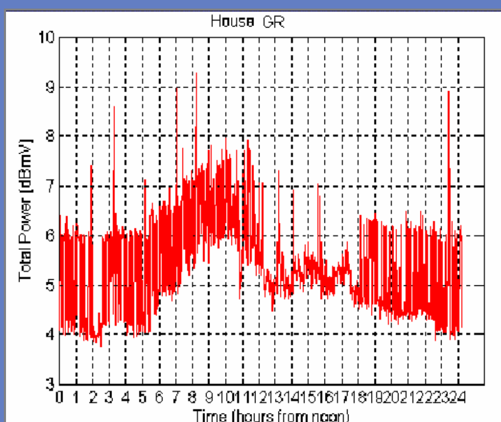
Subscriber Ingress is highly variable





- Subscriber #1
  - Baseline Noise 7 dBmV
  - Peak Noise 23 dBmV Occurred around 10:00pm
- Subscriber #2
  - Baseline Noise 5 dBmV
  - Peak Noise 9 dBmV Occurred around 8:00pm

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System Operating Levels

- C/N Margins may be improved by raising Carrier Levels - But Only to a Point
- Carrier Levels are limited by the Return Laser

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System Operating Levels

- Select an operating level that provides:
  - Adequate Noise Power Ratio (NPR)
  - Prediction of BER based on
  - Ratio of Carrier Power to Noise and Intermods
  - Allows for the deployment of new services
  - Allocates Power in the dBmV per Hertz Method

Power per Hertz

- Divides the total available power into one Hertz increments.
- Applies the Power per Hz to each channel based on the occupied bandwidth
- Advantages
  - Consistent C/N for all services
  - Simplifies Power allocation for all services
  - Reserves power for new services

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Power per Hertz

- Calculating Power Per Hertz
  - Input(dBmV)-10 log(total BW)=dBmV/Hz
  - 45-10log(35,000,000) = dBmV/Hz
  - 45-10(7.544) = dBmV/Hz
  - 45-75.44 = dBmv/Hz
  - - 30 = dBmV/Hz
    - Where 45 dBmV = total power to the laser
    - Where all 35 MHz in the return path is available for use

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Aligning the Return Path

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Two Steps

- Align Fiber Optic Link
- Balance Distribution Amps

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Aligning the Fiber Optic Link

- Node Locations:
  - Set Optical links and Receivers to Unity Gain @ headend
  - Verify Optical Link Gain
  - Set Node Return Gain

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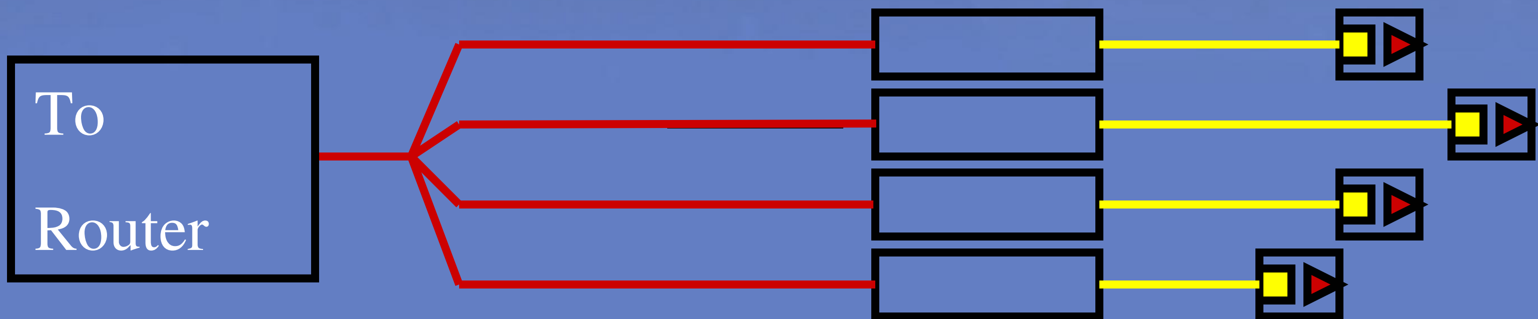
The Fiber Link

- Record RF levels out of fiber receivers for all nodes
- Balance RF levels



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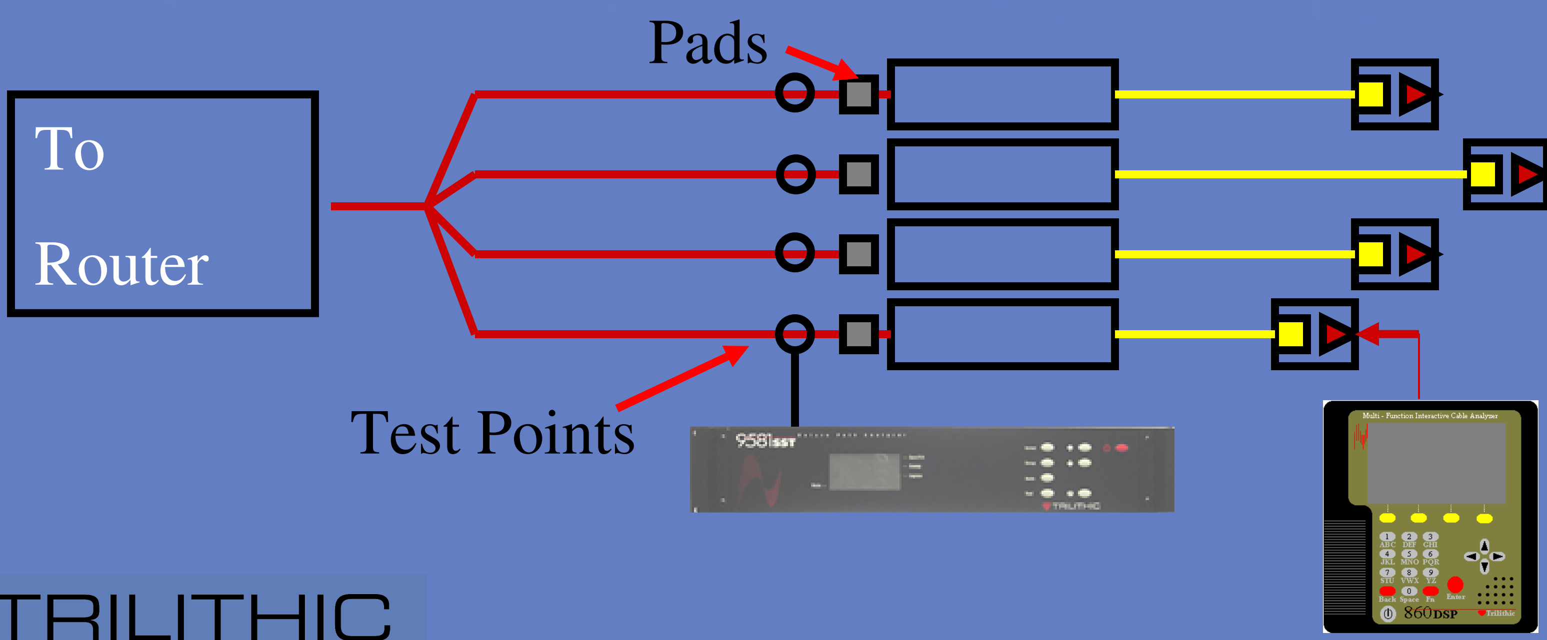
The Fiber Link

- Check Link Loss (high loss may require amplification)
- Setting the RF output level



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Balancing the System

- Carrier/noise of all paths to headend approximately equal
- All “standard amplitude” signals arrive approximately equal at headend

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The Distribution Amplifiers

- Desired input level to the headend sweep receiver
- Test point locations for all nodes and amps.
- Injection level for all nodes and amps.

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Headend Setup: Test Noise/Ingress Levels

- Balancing system “noise” limits:
  - “Noise”, any kind: >10dBc
  - Coherent signals, within 50 kHz of test frequencies: > 20 dB

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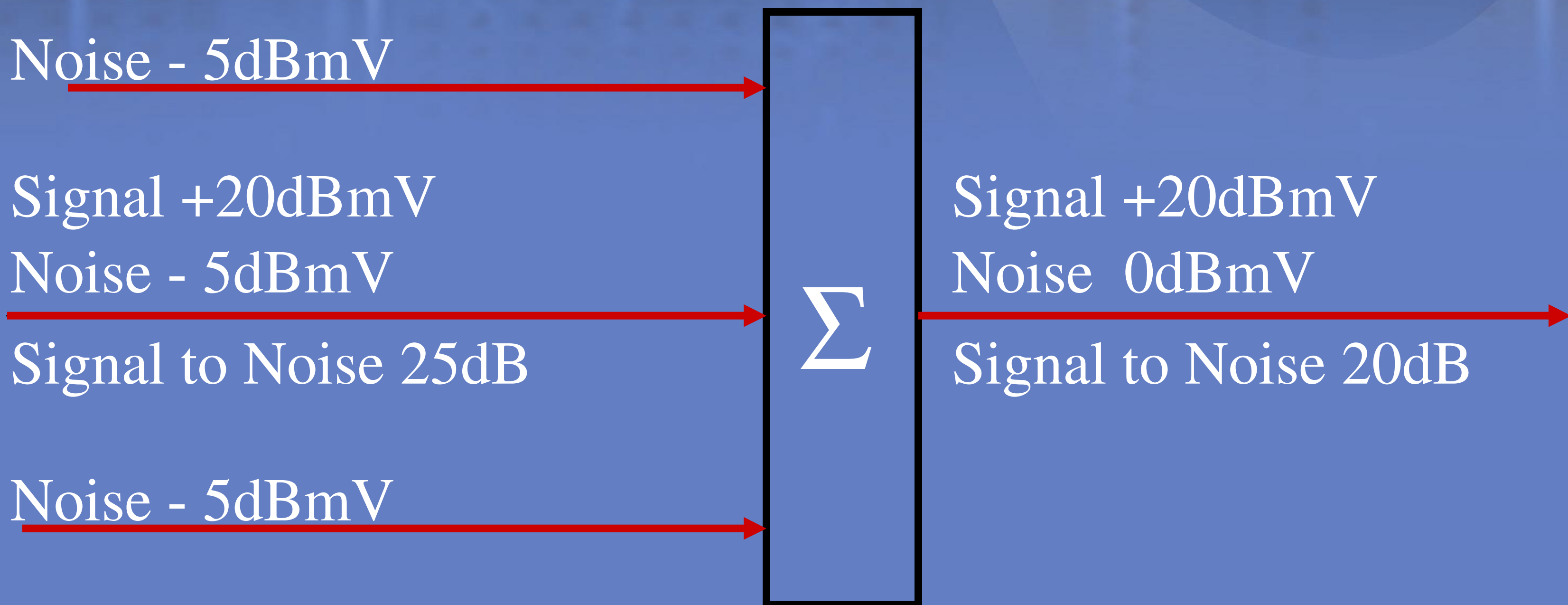
Carrier to Noise

All Branches Balanced



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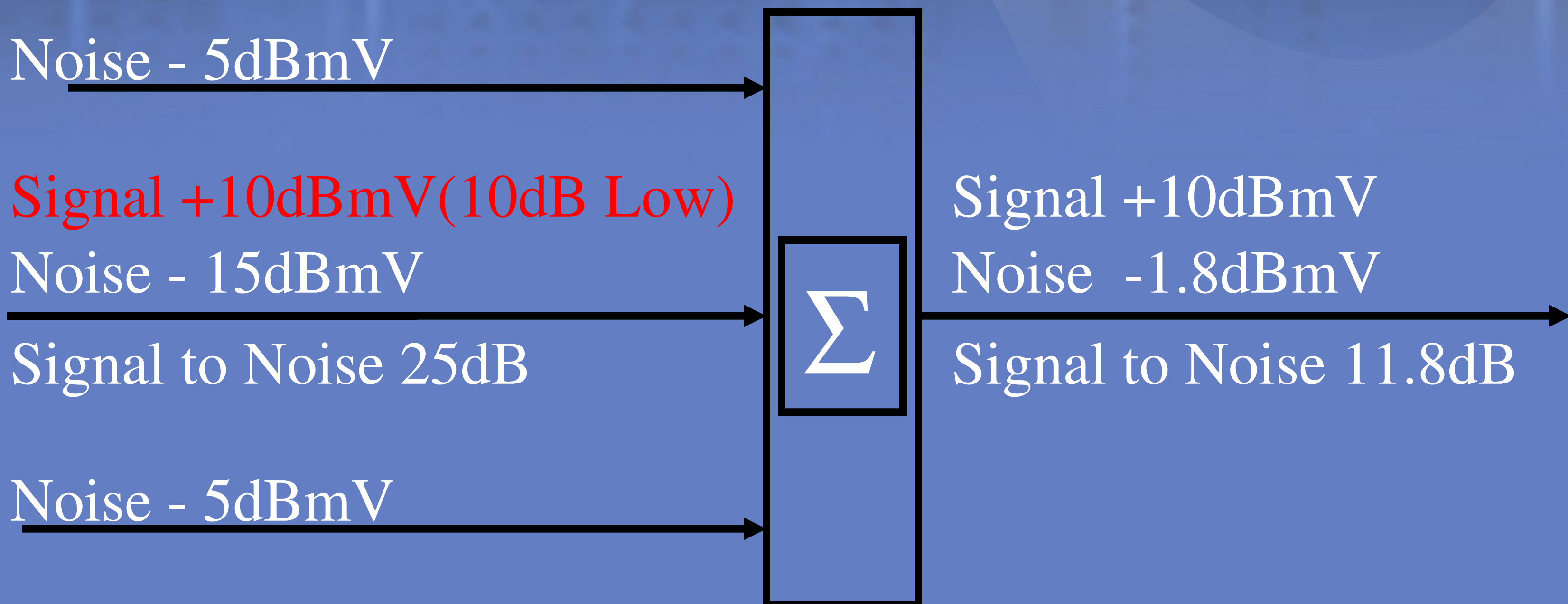
Carrier to Noise

One Branch With Lower Gain



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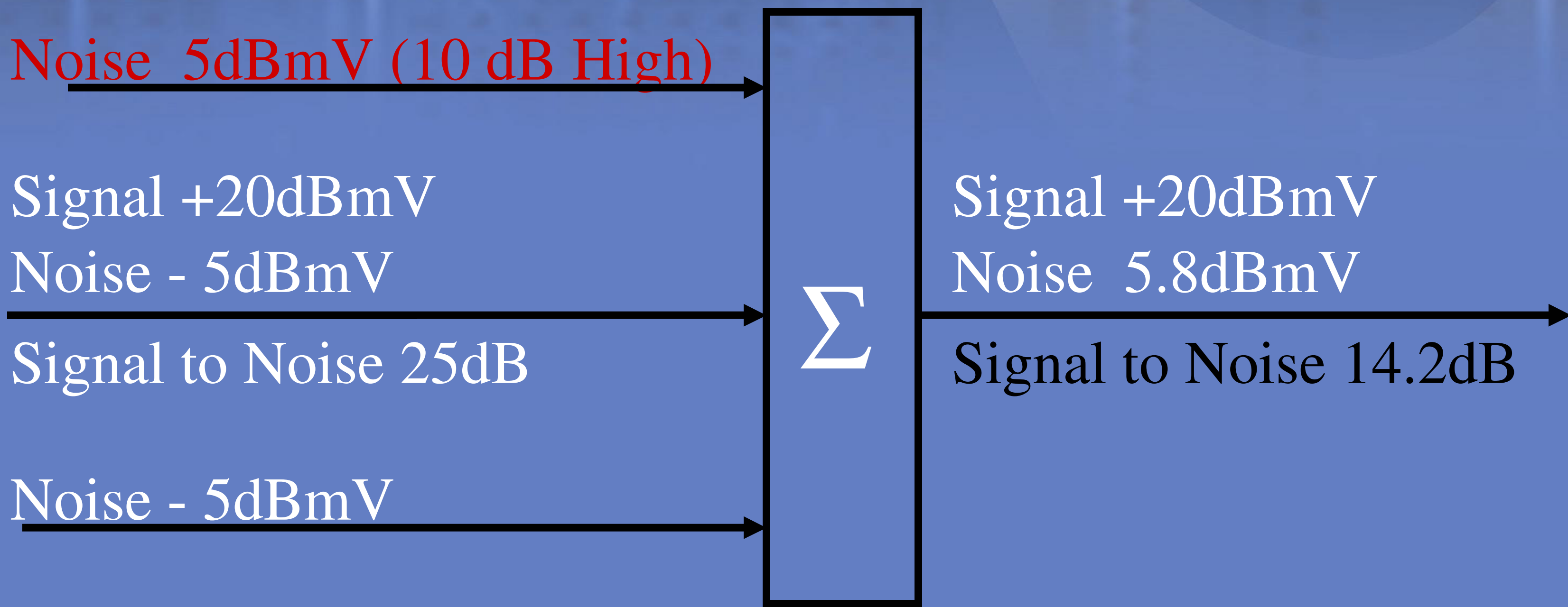
Carrier to Noise

One Branch With Higher Gain



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Ingress Troubleshooting

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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

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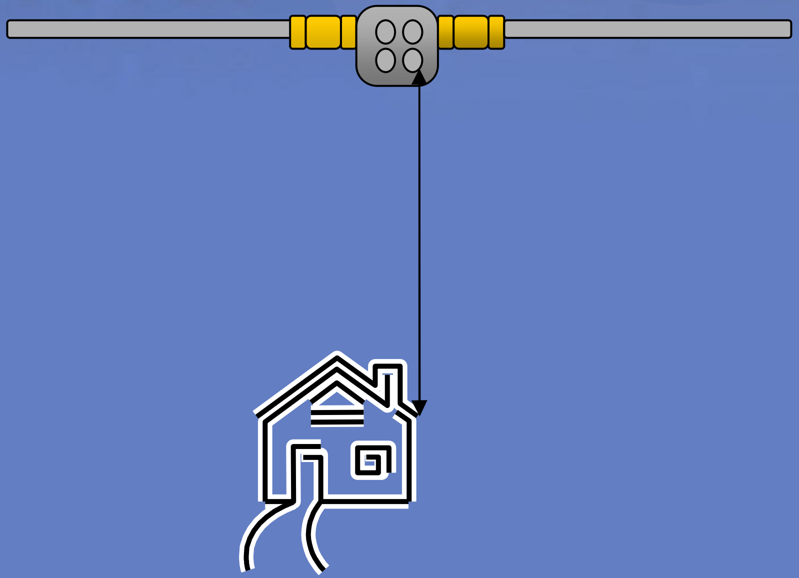
Common Sources of Ingress

- 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 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

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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 time to 20ms 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

TRILITHIC

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, no hot tapping please
- Leakage Detectors
  - Locate cracked cable 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

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Settings for Ingress Troubleshooting

- Span & Center Frequency
  - The portion of the spectrum to be displayed on the meters display equally divided at the center frequency
- Resolution Bandwidth (RBW)
  - Sets the meters ability to measure carriers which are closely spaced in frequency
  - Measure the amplitude of carriers with wide bandwidths
- Averaging
  - The average power at each frequency point over selected number of samples

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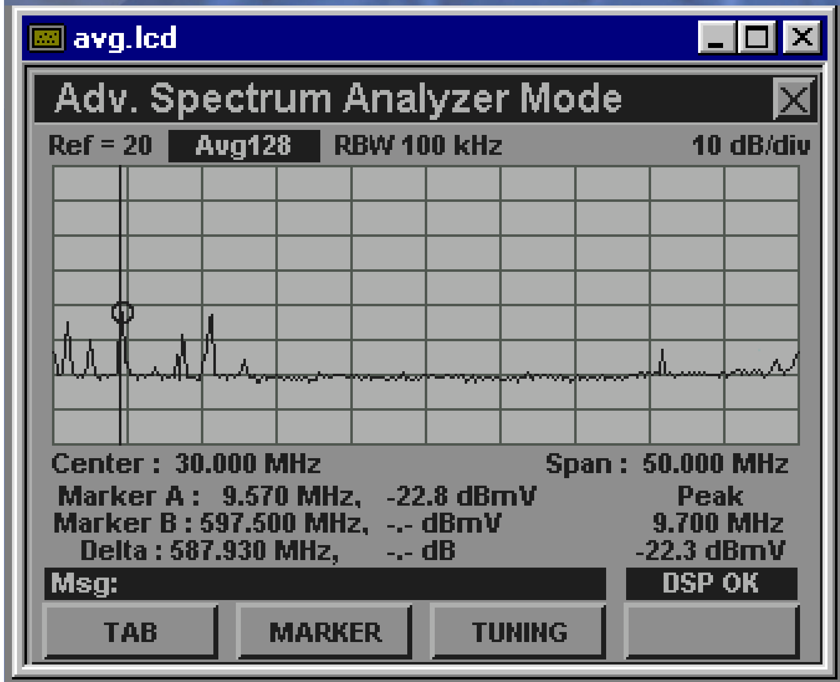
Correct Meter Settings



- When Troubleshooting Ingress made up of Discrete Carriers
  - Short-wave
  - CB
  - CPD
  - HAM
- Span 5-40 MHz or sufficient to cover the frequencies of interest
- RBW 300 kHz
- Dwell (Averaging) sufficient to suppress random noise

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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

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General 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 the ingress has been eliminated

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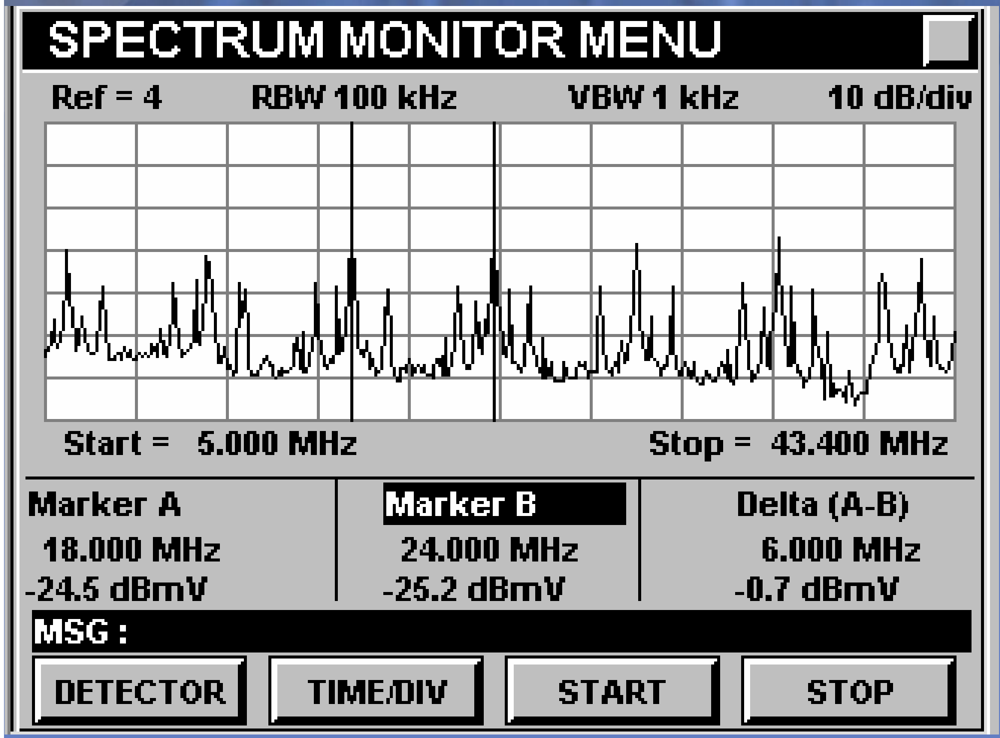
System Induced Ingress



- 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

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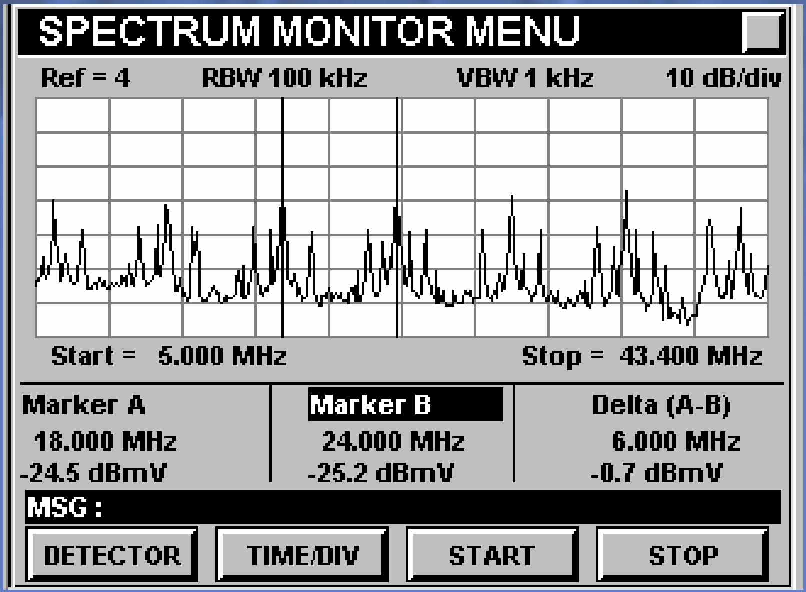
System Induced Ingress



- 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

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Laser Clipping

- Results from overloading the input to the return laser
  - Produce noise like interference –termed Composite Intermodualtion noise (CIN)
  - Noise Levels increase rapidly once saturation point is reached
  - Fill entire return spectrum
  - Short in duration
  - Typically caused by system devices exceeding transmit specifications

Fiber Optic Noise

- Spurious Emissions
  - Generated by reflections of laser light from the fiber back to the laser
  - Appear as intermittent spikes of short duration
  - Most commonly seen under 20 MHz

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Sources and Descriptions of Ingress

- Discrete Ingress Carriers
- For HAM Interference
  - Location of known HAM operators in effected area
- Pirate Set Tops
  - Time of carrier transmission, Set Top may be queuing up to transmit data at set intervals during the day
- Off Air Transmit Towers
  - Municipal Services
  - Voice of America, etc

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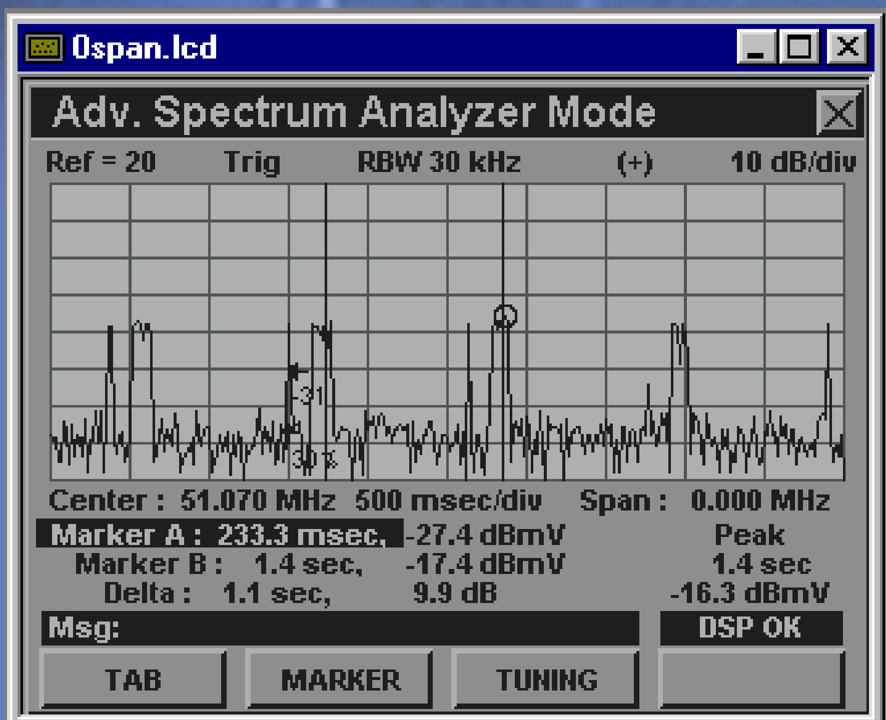
Sources and Descriptions of Ingress



- Impulse Noise
  - Description
    - Fast Rise Times
    - Short Duration
    - Impacts Entire Return Spectrum
  - Sources
    - power line switching transients
    - electric switches
    - Household Appliances
    - Manufacturing

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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)

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

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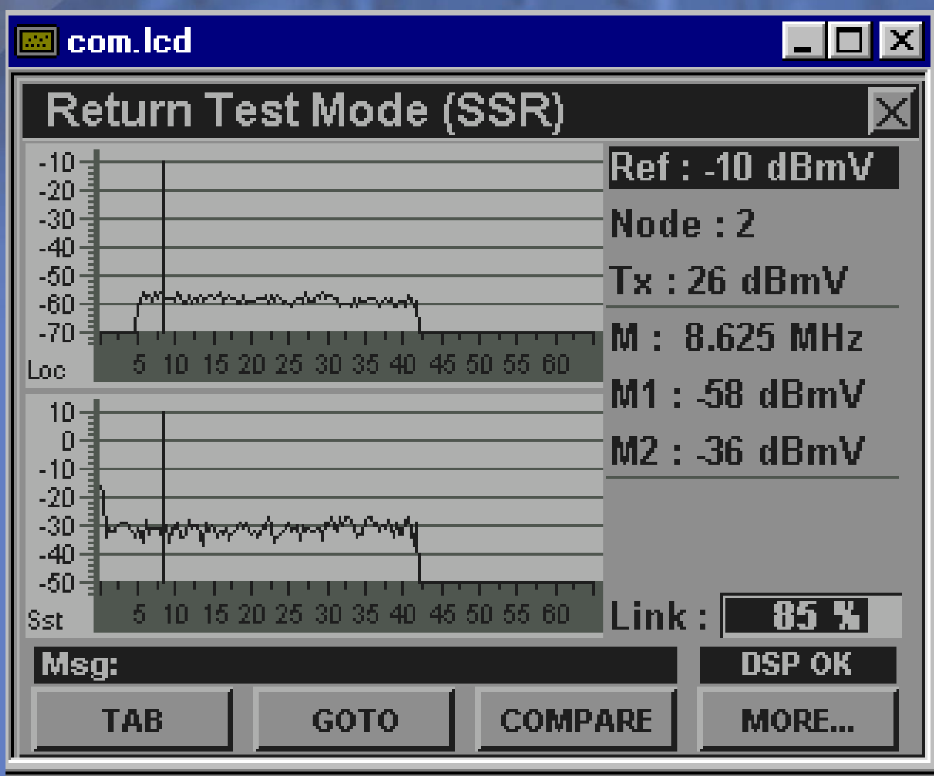
Field Access



- Return Display
  - Helps in isolating ingress locations by viewing changes in headend ingress levels
  - Cause level fluctuations by
    - pulling pads
    - using wink switches
  - Or Use a headend overlay to deduce the ingress contribution by a leg or span
  - Compare ingress levels without breaking continuity

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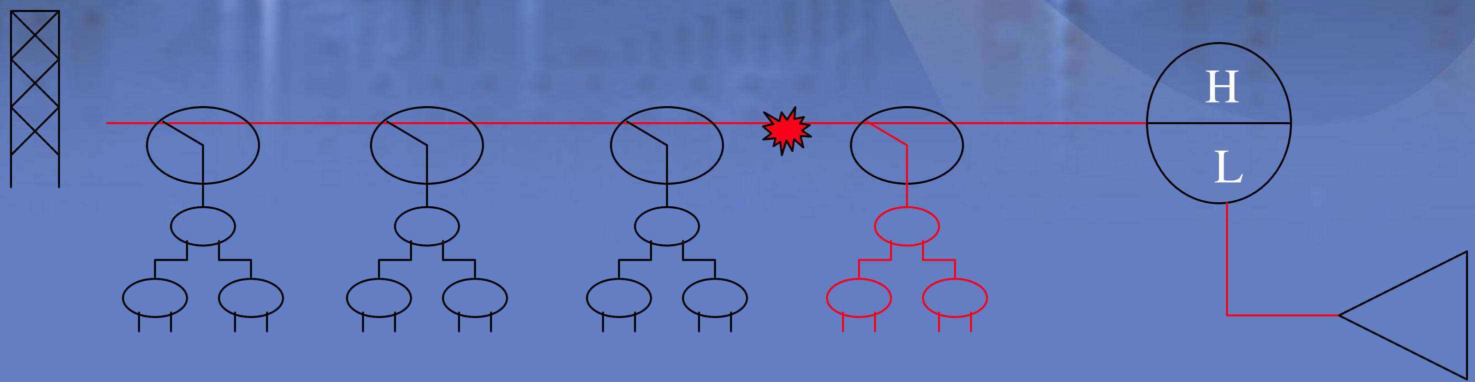
Ingress From Damaged Cable

Ingress Levels Influenced by External Sources



Ingress Travels in both directions

Dies at Amplifier Output

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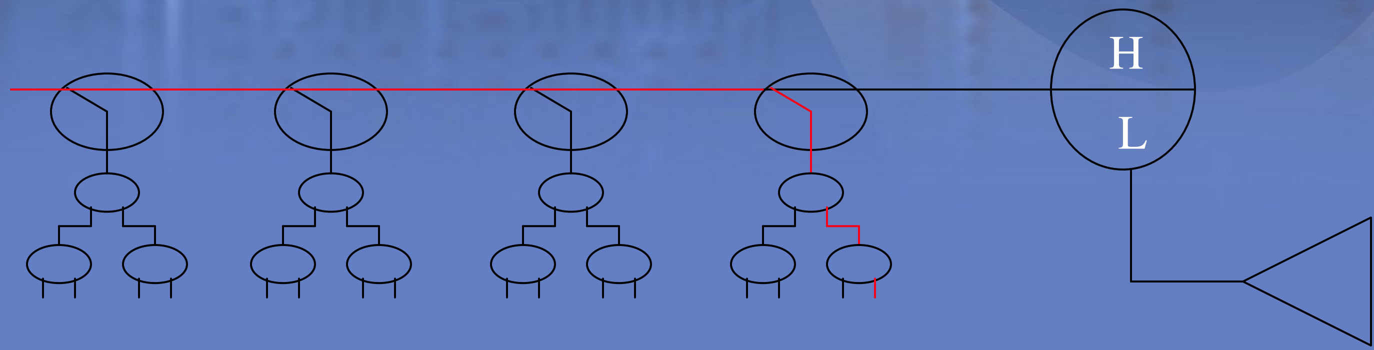
From the House

Ingress Level Reduced by Tap Value



60 dB Port to Port Isolation