

## Broadband Instruments and Systems



Technical Training Seminar on  
*“Identifying Picture Problems in a HFC Network”*  
for CCTA Member Companies  
Week of August 11, 2008 in St. Kitts & San Juan

Mario Sebastiani



Tony Holmes



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# Detailed Agenda

- **Visual Carrier Levels**
- **Aural Carrier Levels**
- **Adjacent Visual Carrier Levels**
- **Carrier to Composite Noise (C/N)**
- **Coherent Disturbances (C/I, CSO, CTB)**
- **Hum Modulation**
- **Digital Channel Power**
- **MER measurements & BER behavior**
- **Leakage and Ingress behavior**
- **Depth of Video and Audio Modulation**

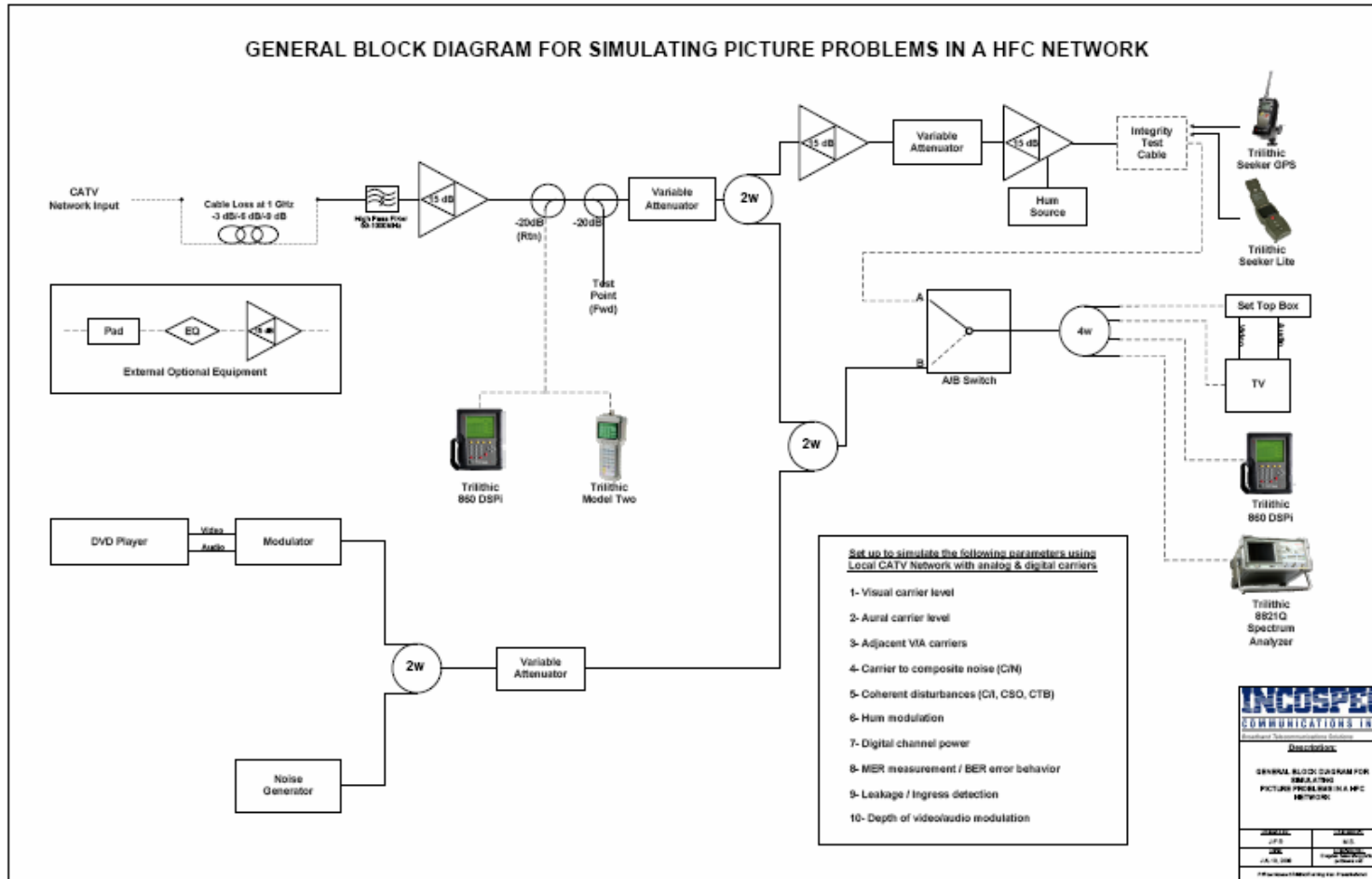


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# Identifying Picture Problems in a HFC Network



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## Identifying Picture Problems in a HFC Network



## Problems Simulator Suitcase



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## Carrier Level Measurements

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# In This Section You Will Learn

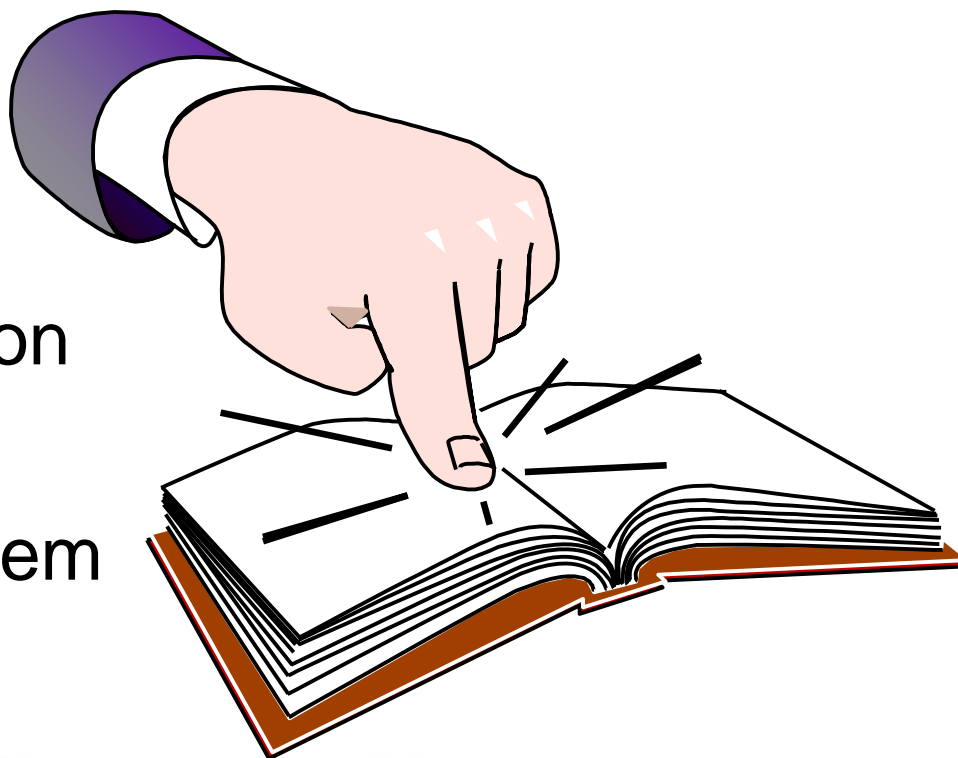
- Why carrier levels are important
- How to accurately measure carrier levels with a spectrum analyzer
- Differences between a spectrum analyzer and a signal level meter





# Why Measure Visual Carrier Levels?

- The FCC Says So!
- Subscriber satisfaction
- Critical for other system performance



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## Identifying Picture Problems in a HFC Network

# Visual Carrier Level FCC 76.605 (a) (3)

**Specification:** 0 dBmV at subscriber terminal

**Picture effect:** Snow on picture as if poor carrier-to-noise level

Spectrum Analyzer Spec:  $\pm 1.0$  dB

Number of Test Points:		Number of Channels		Spectrum Analyzer Settings	
6+		4+		Center Frequency	Center on visual carrier
				Span	6 MHz
				Resolution BW	300 kHz
				Video BW	300 kHz
				Sweep Time	Auto
				Reference Level	Higher than carrier
				Scale	10 dB/div

Frequency of Test	Location of Test:
Two times per year	Subscriber terminal and head end

### Measurement Notes:

None



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## Identifying Picture Problems in a HFC Network

# Aural Carrier Level FCC 76.605 (a) (5)

**Specification:** 10 to 17 dB below visual carrier  
**Picture effect:** Muffled sound, next channel visual modulated by sound  
Spectrum Analyzer Spec:  $\pm 1.0$  dB

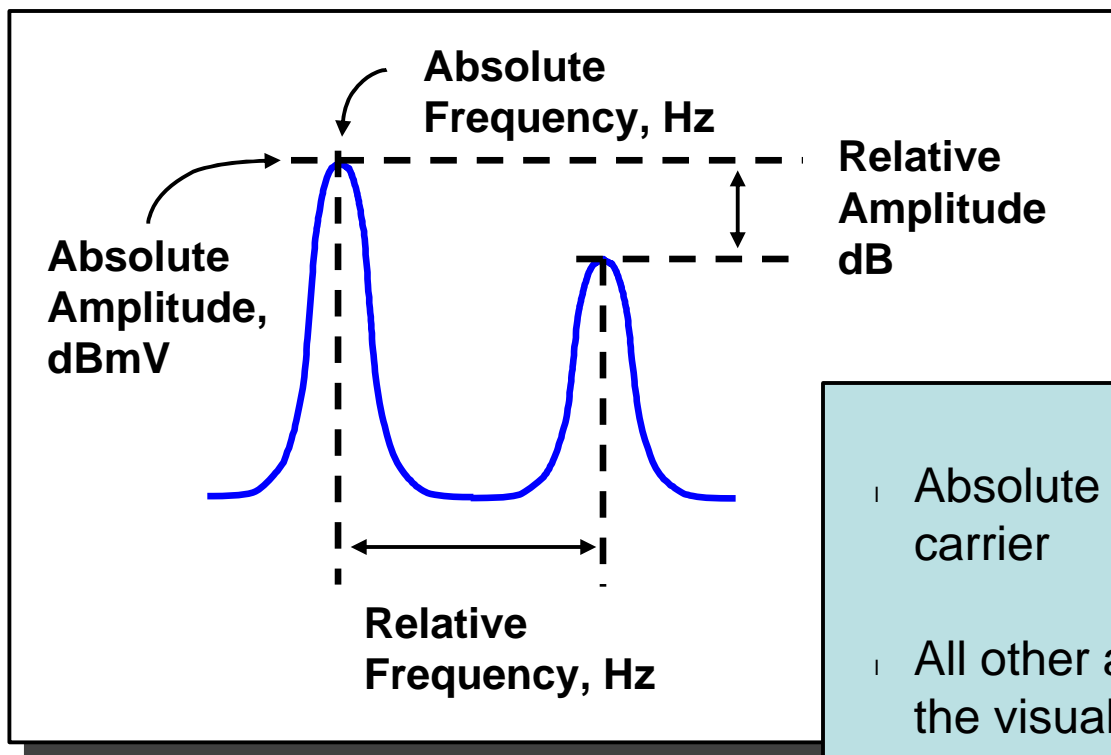
Number of Test Points:		Number of Channels		Spectrum Analyzer Settings	
6+		ALL NTS		Center Frequency	Center on carrier
Frequency of Test Two times per year	Location of Test: Subscriber terminal and head end			Span	6 MHz
				Resolution BW	300 kHz
				Video BW	300 kHz
				Sweep Time	Auto
				Reference Level	Higher than carrier
				Scale	10 dB/div

**Measurement Notes:**  
Use two markers





# Relative and Absolute Amplitudes

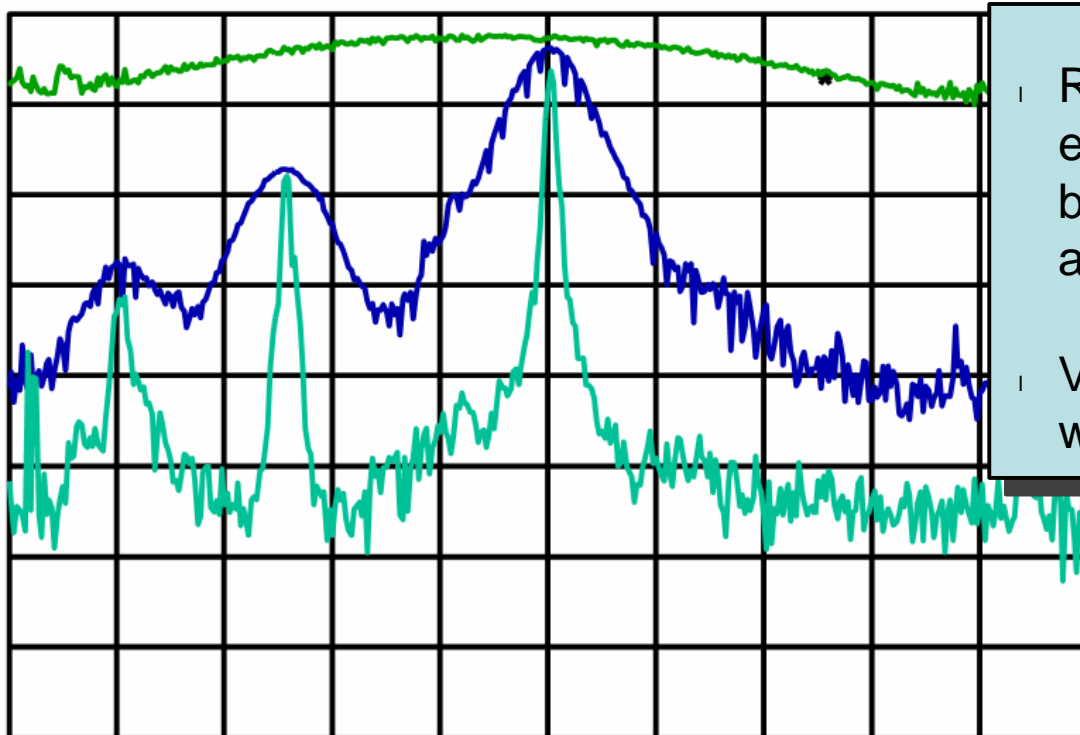


- Absolute levels only on visual carrier
- All other amplitudes relative to the visual carrier





# Resolution and Video Bandwidths



- Resolution BW must be wide enough to "see" picture pulses but narrow enough not to see adjacent signal
- Video BW must be as wide or wider than resolution bandwidth



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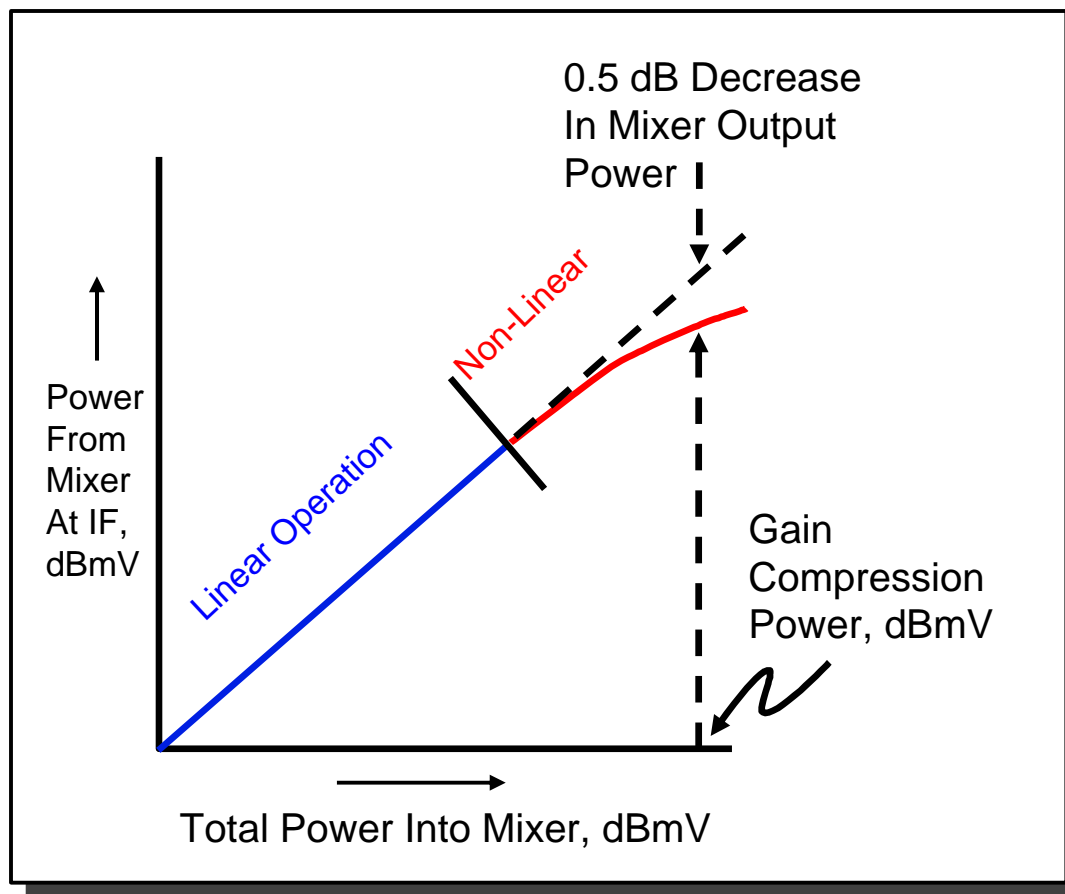
# Levels of Suppressed Sync Scrambled Channels

- Don't change the resolution bandwidth
- Make the signal stay in the IF bandwidth longer by lengthening the sweep time
- Enhance the peak detection by using Trace Maximum Hold





# Overload Causes Inaccuracy



- | High input can cause low readings
- | Compression
- | Same on SLM???





# Accuracy of Visual Carrier Level Reading

- Better than  $\pm 2$  dB
- Self calibration
- Routine maintenance every two years

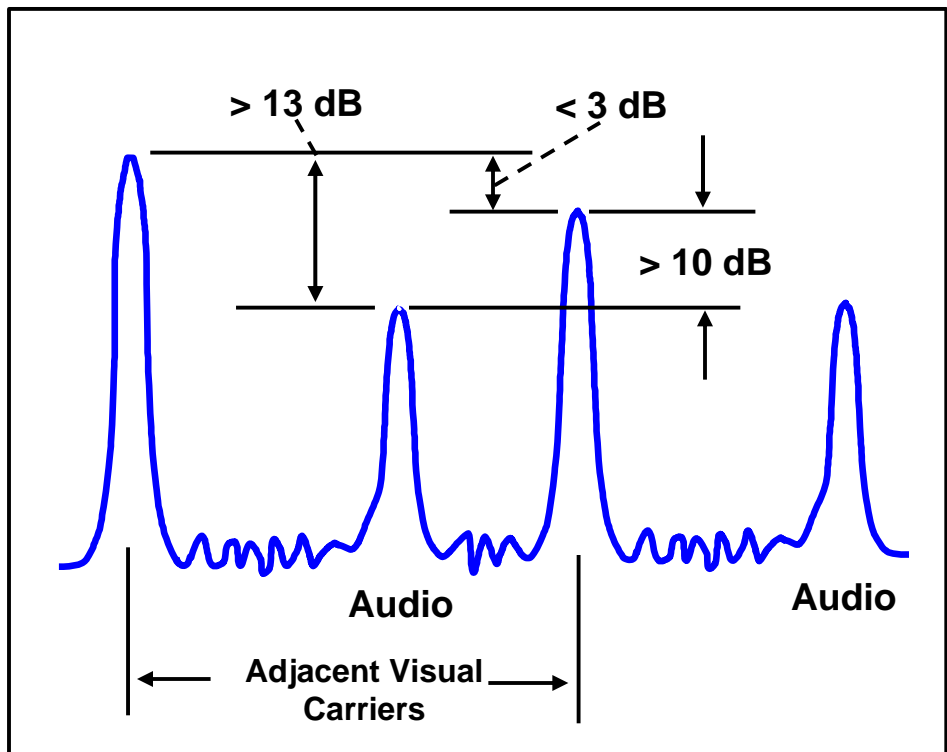


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# Adjacent Visual and Aural Carriers

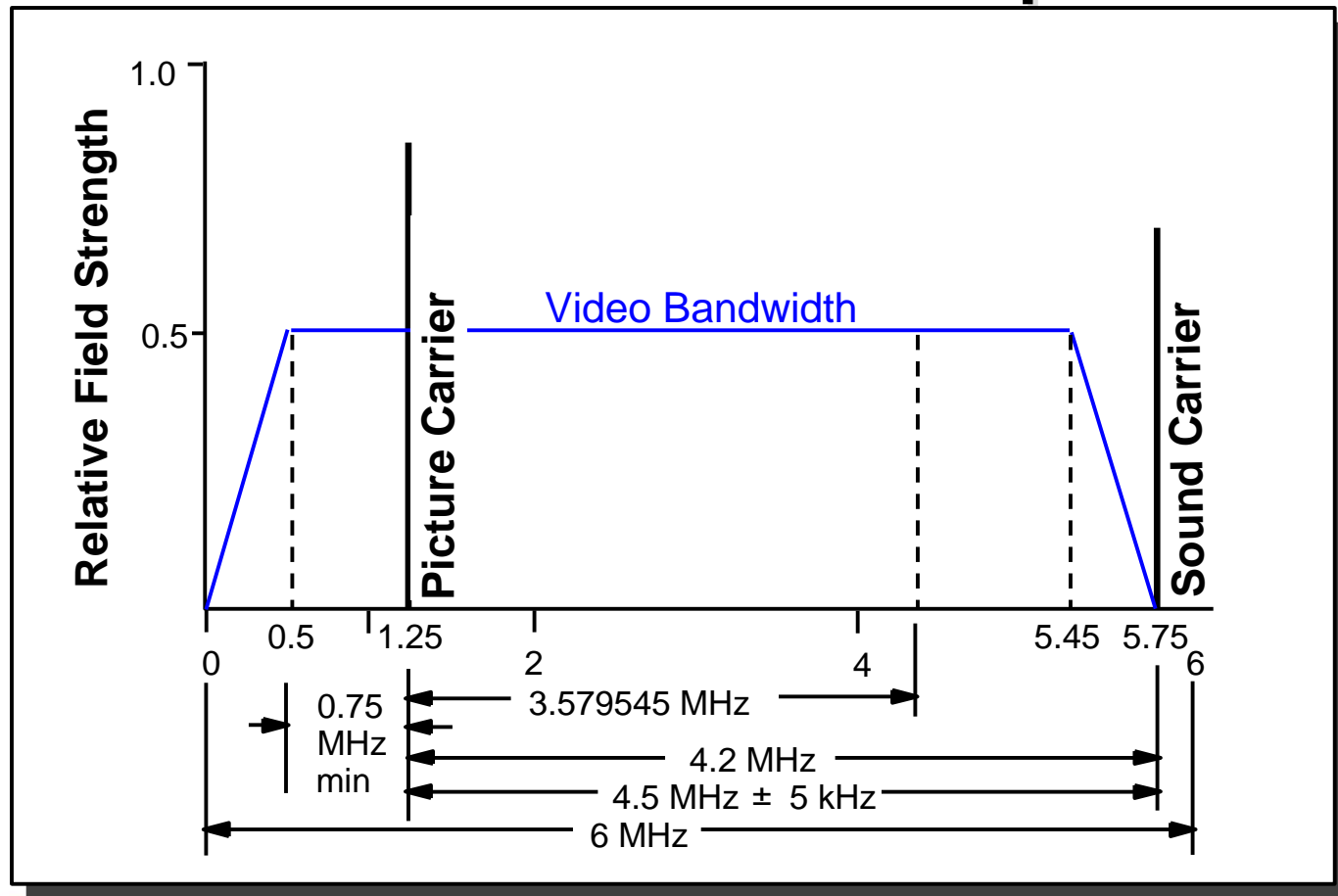


- Sound carrier must be 10 to 17 dB down from picture carrier
- Visual and aural carrier measured with the same analyzer settings
- Measure their differences with both on-screen





# Television Channel Frequencies

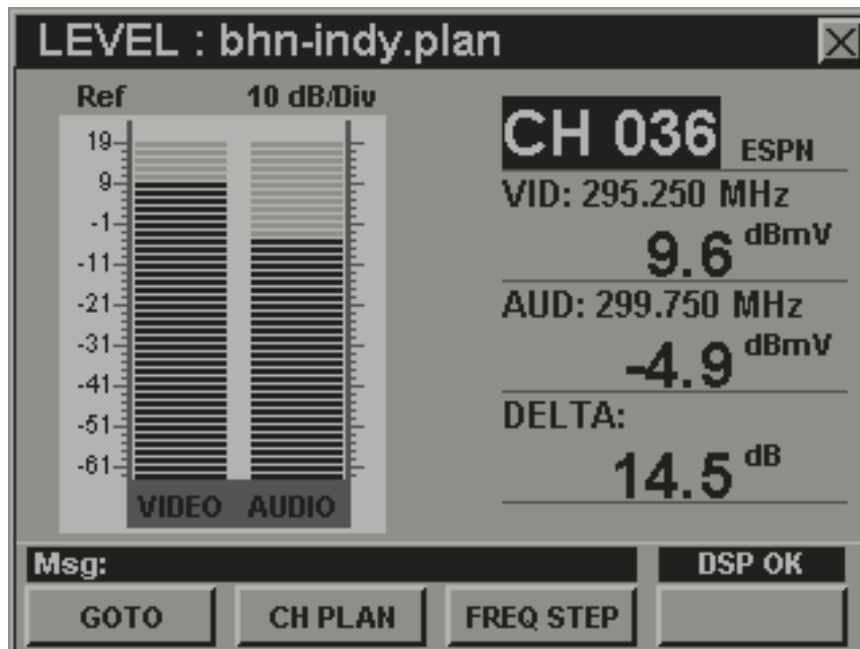


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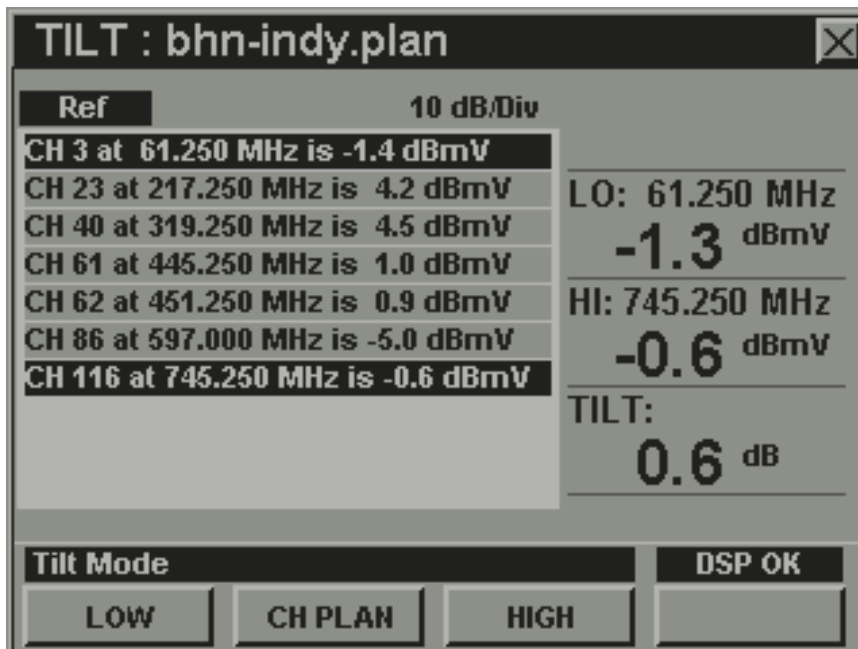
# Level Measurement



- Single Channel Display of
  - NTSC or PAL Video, Audio, SAP, Amplitude
- Function Key: “Goto” Full Scan... Channel Spectrum... or QAM
- Pull-down: Jump to data logging and other functions



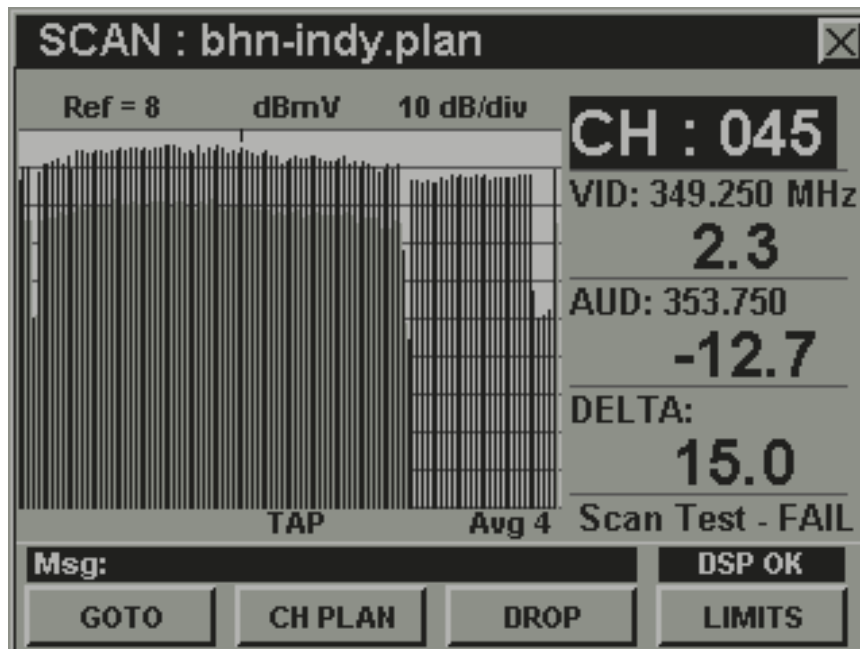
# Channel Tilt



- Up to 10 Pre-Selectable Tilt Channels
- You can toggle the display with the **Fn** button
- Bar Graph Level Measurement Data
- Numeric Display
- The LOW and HIGH SOFTKEYS are used for computing the tilt



# Full Channel Scan



- Scan Refresh Rate: > 1 Sec
- Displays the amplitude of all Visual and Audio carriers in the selected channel plan.
- Choose between a simultaneous line graph (or) a bar graph
- Use the **Fn** button to quickly bring off scale signals on screen when viewing the Level Graph





## Identifying Picture Problems in a HFC Network

# Questions?



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# *Problems Simulation (Levels)*





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# Carrier-to-Composite Noise Measurements

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# Basic Measurement Principals

- Swept Tuned Analyzer



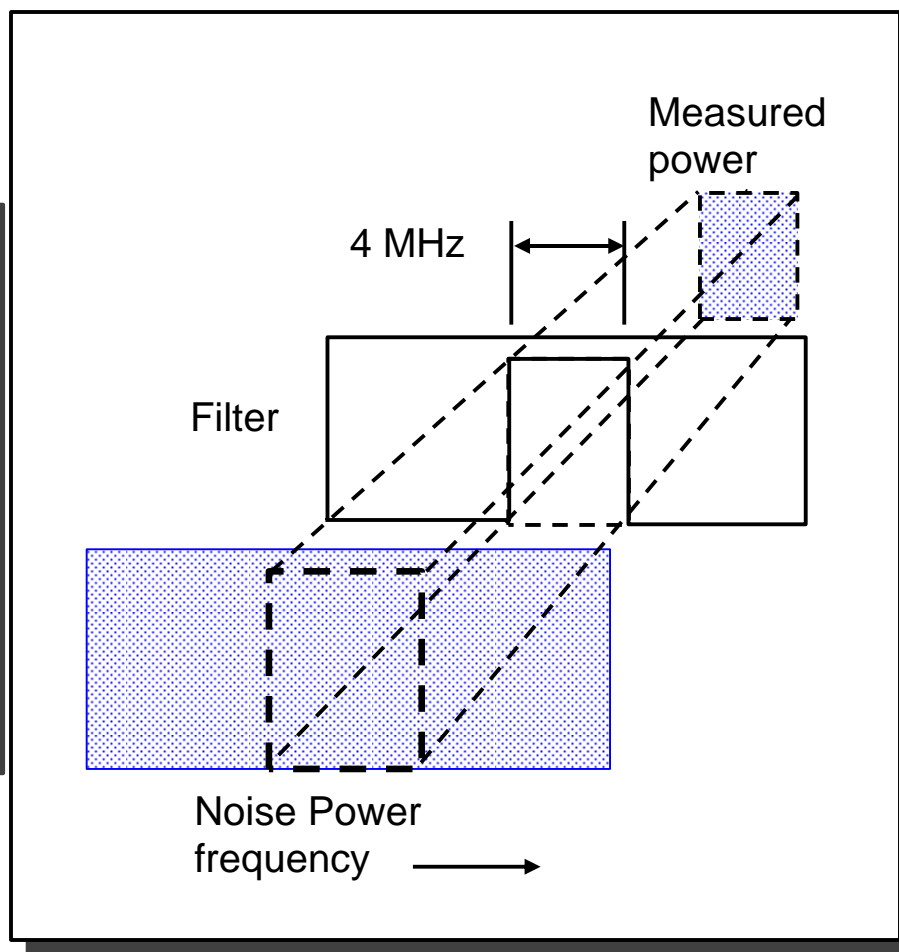
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# Noise Power Measurement

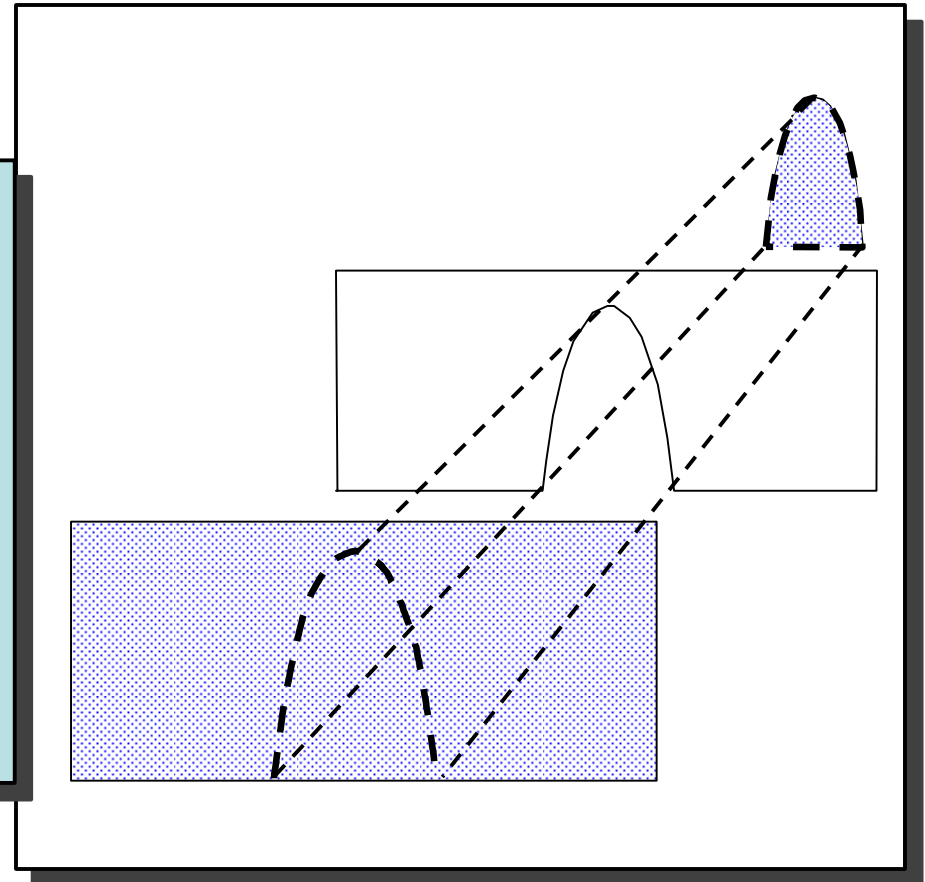
- Noise power contains all frequencies
- FCC requires noise measured in 4 MHz bandwidth
- Simulates the noise power received in a TV (4 MHz video bandwidth)





# Measuring Power with a Spectrum Analyzer

- | The spectrum analyzer resolution filter acts as the noise filter
- | It is not a square filter, so corrections must be made
- | Another correction is made because the analyzer does not have a 4 MHz wide filter



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# Correcting Analyzer Noise Power Measurement

- | Use 30 kHz resolution bandwidth
- | Add 21.25 to the noise to correct for 4 MHz bandwidth
- | Add 2.5 dB because the Spectrum Analyzer isn't a perfect voltmeter

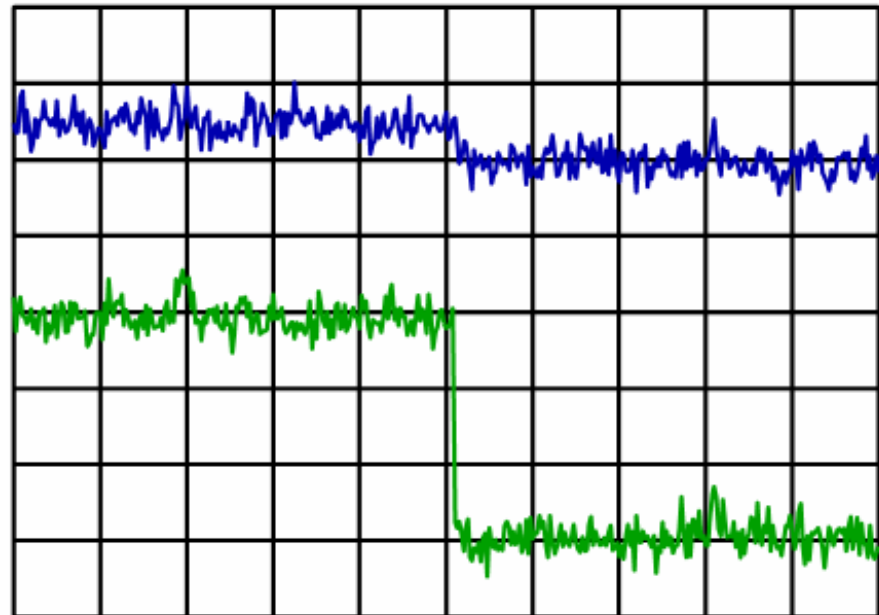
**For Total Noise Correction  
add 23.75 dB**





# Is It System Noise?

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

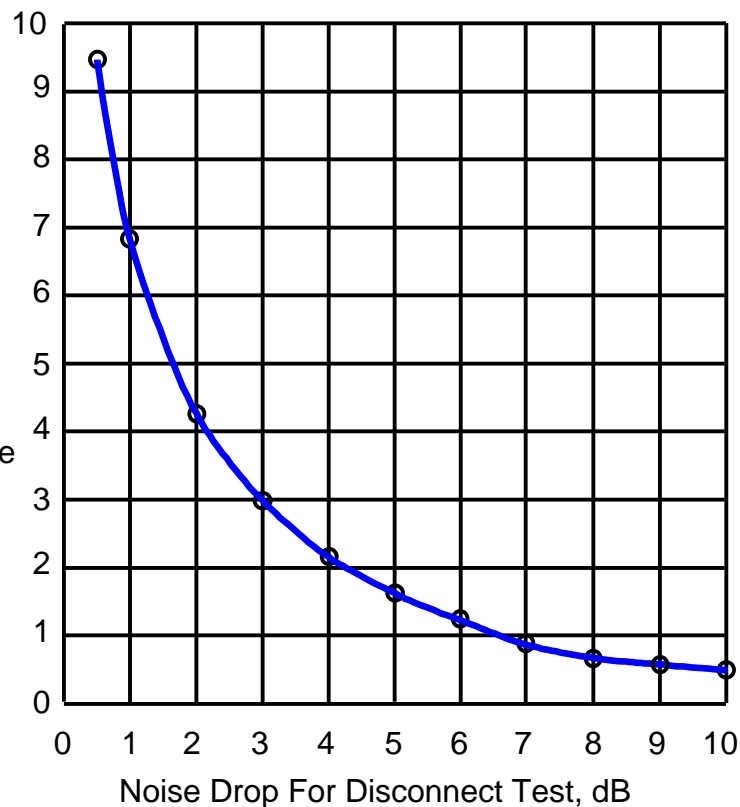




# The Disconnect Test

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

Noise-Near-Noise  
Correction (dB)

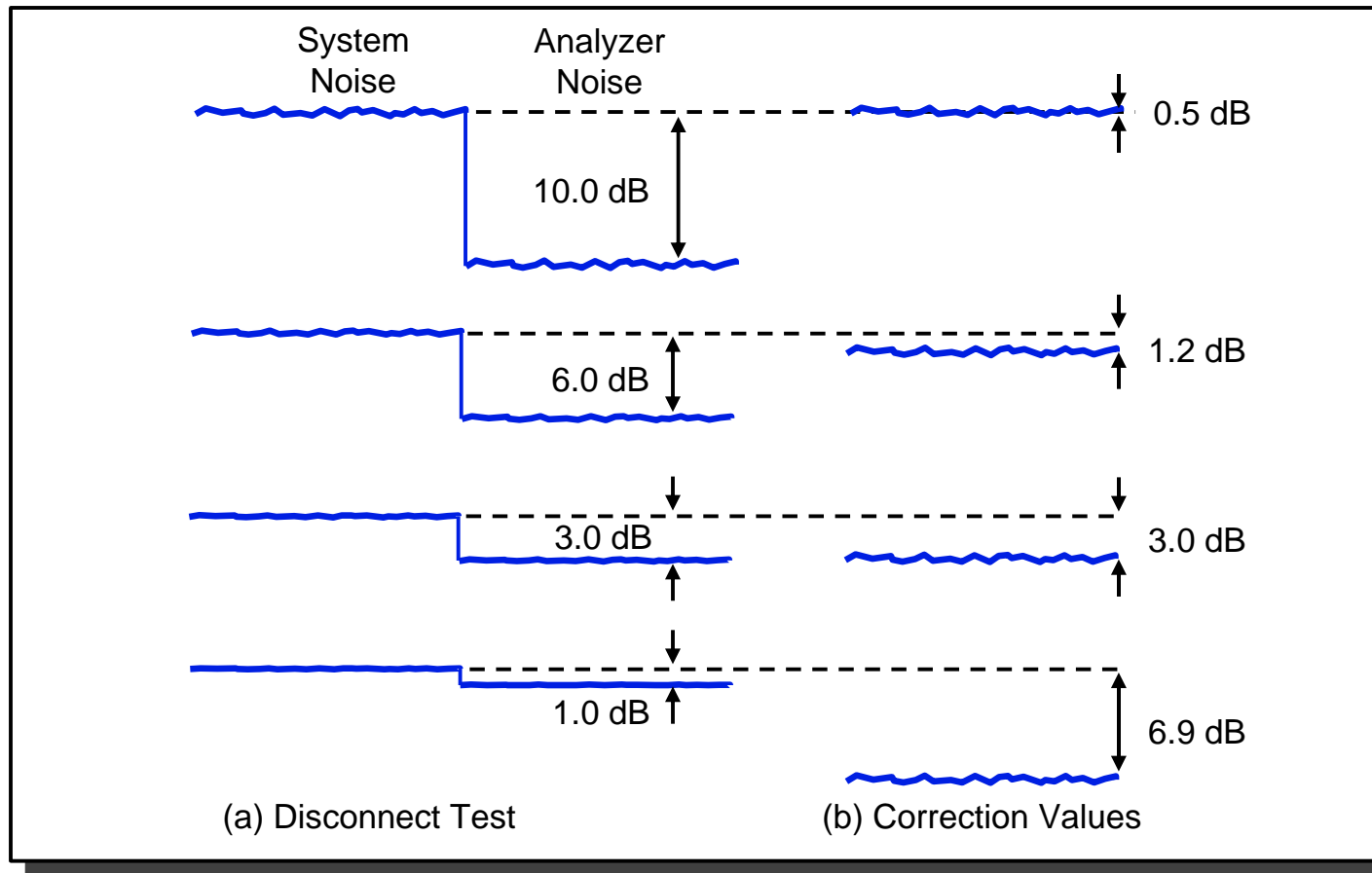


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## Correcting Analyzer for Noise-Near-Noise





# Summary of Analyzer Corrections

- | For voltmeter and bandwidth:  
Add 23.75 dB
- | For disconnect test: Subtract the value on graph
- | Preamplifier correction





# Quick CCN Measurement

- | Measure the carrier peak in 300 kHz resolution and video bandwidths
- | Set the bandwidth to 30 kHz
- | Set video bandwidth to 100 Hz
- | Measure noise 1.2 MHz below the picture carrier
- | Disconnect test



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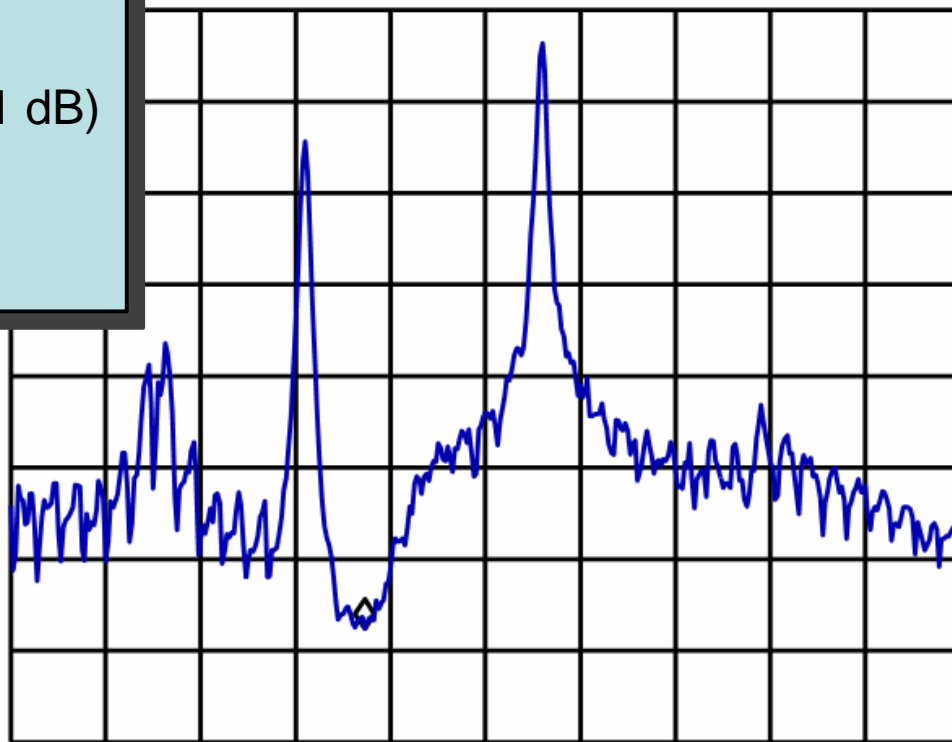
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## Identifying Picture Problems in a HFC Network

# Results Are Worst Case

- | Carrier is 36 dBmV
- | Noise is -37.58 dBmV
- | Add 23.75 dB
- | Disconnect 6 dB drop (Subtract 1 dB)
- | Noise = -14.83 dBmV
- | Carrier/ Noise = 50.83 dB/4 MHz



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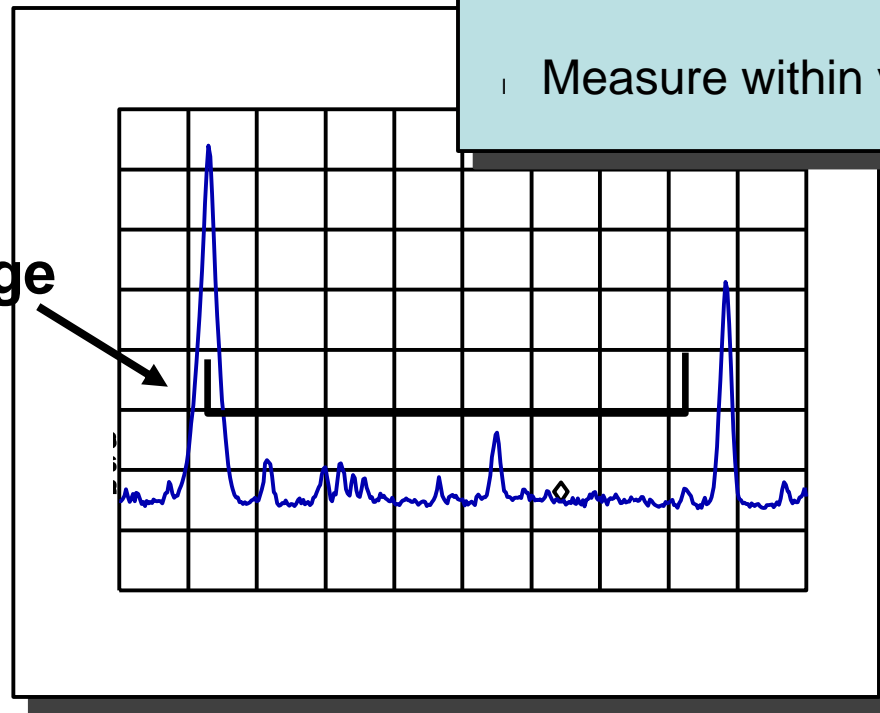
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## FCC CCN Measurement Requirements

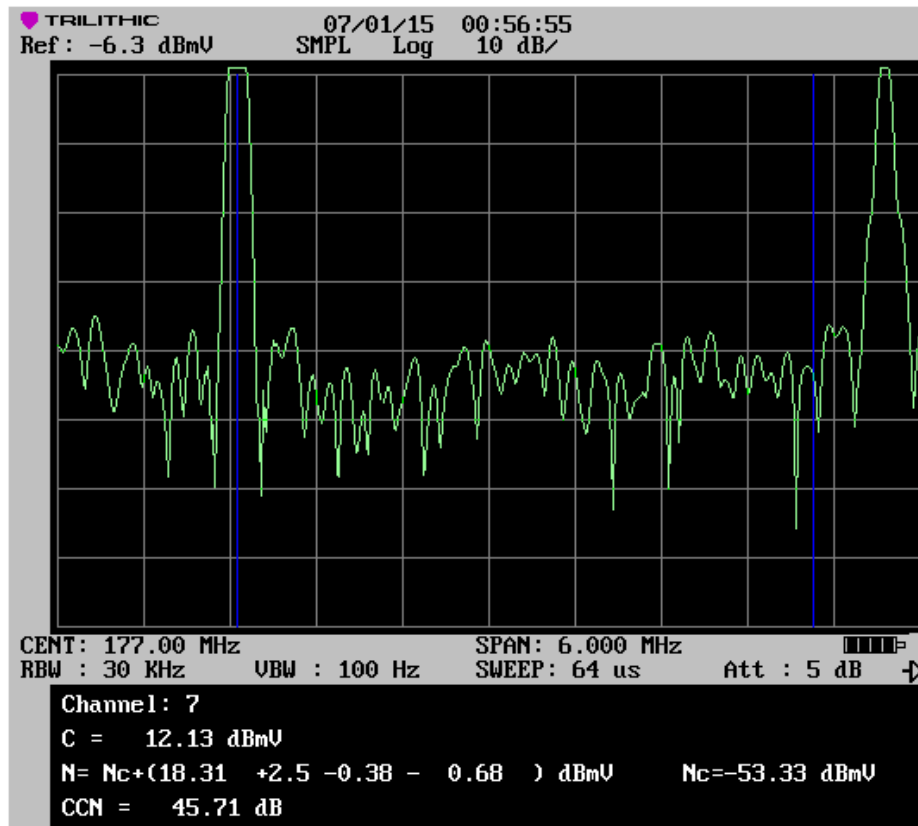
- Video modulation off
- Measure within video frequency range

FCC C/N range





# Automatic C/N Measurement



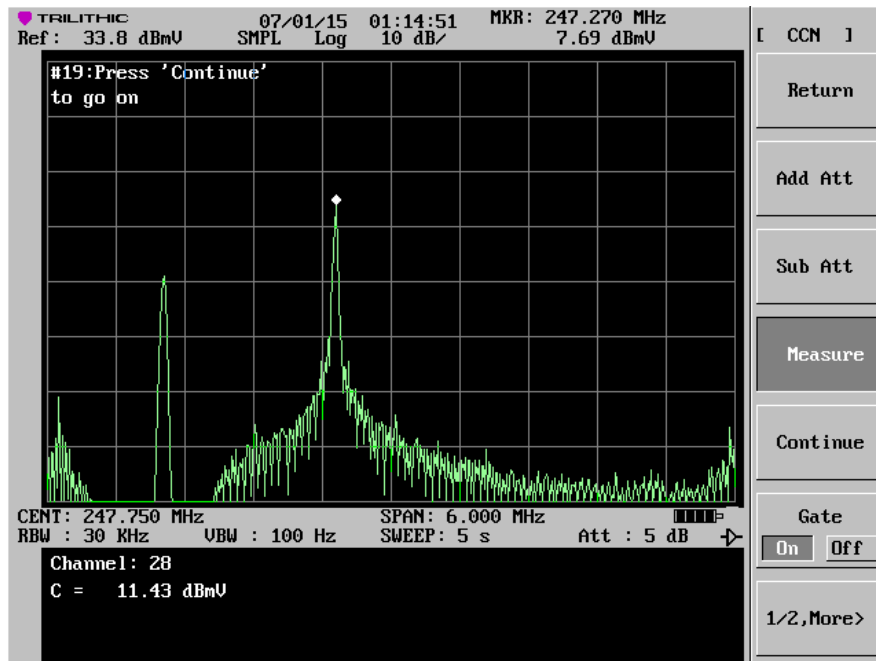
- | Gated analyzer measures modulated carrier in video range
- | No subscriber interference
- | Corrections made automatically
- | Preamplifier added if required
- | Overload avoided





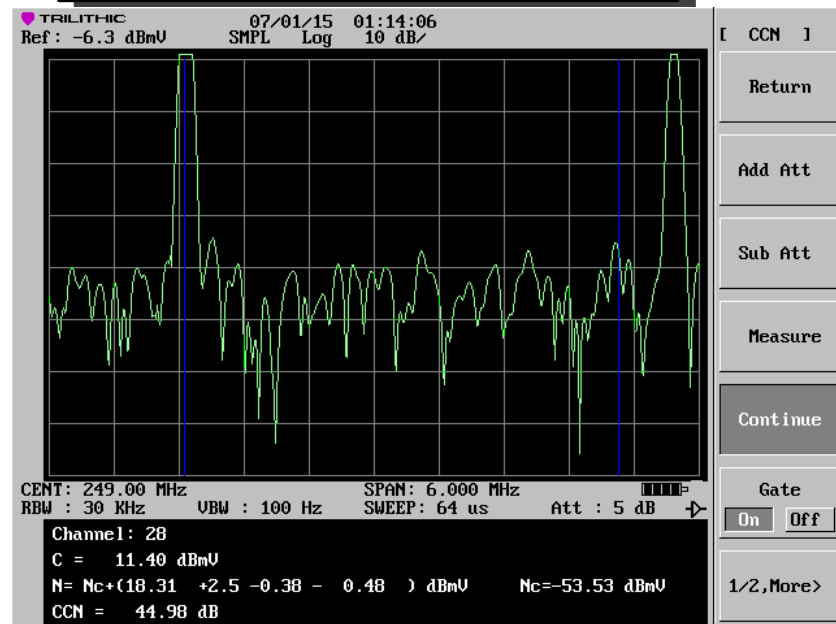
# Identifying Picture Problems in a HFC Network

## Test Choices and Accuracy Assessment



FCC Test (with and without modulation)

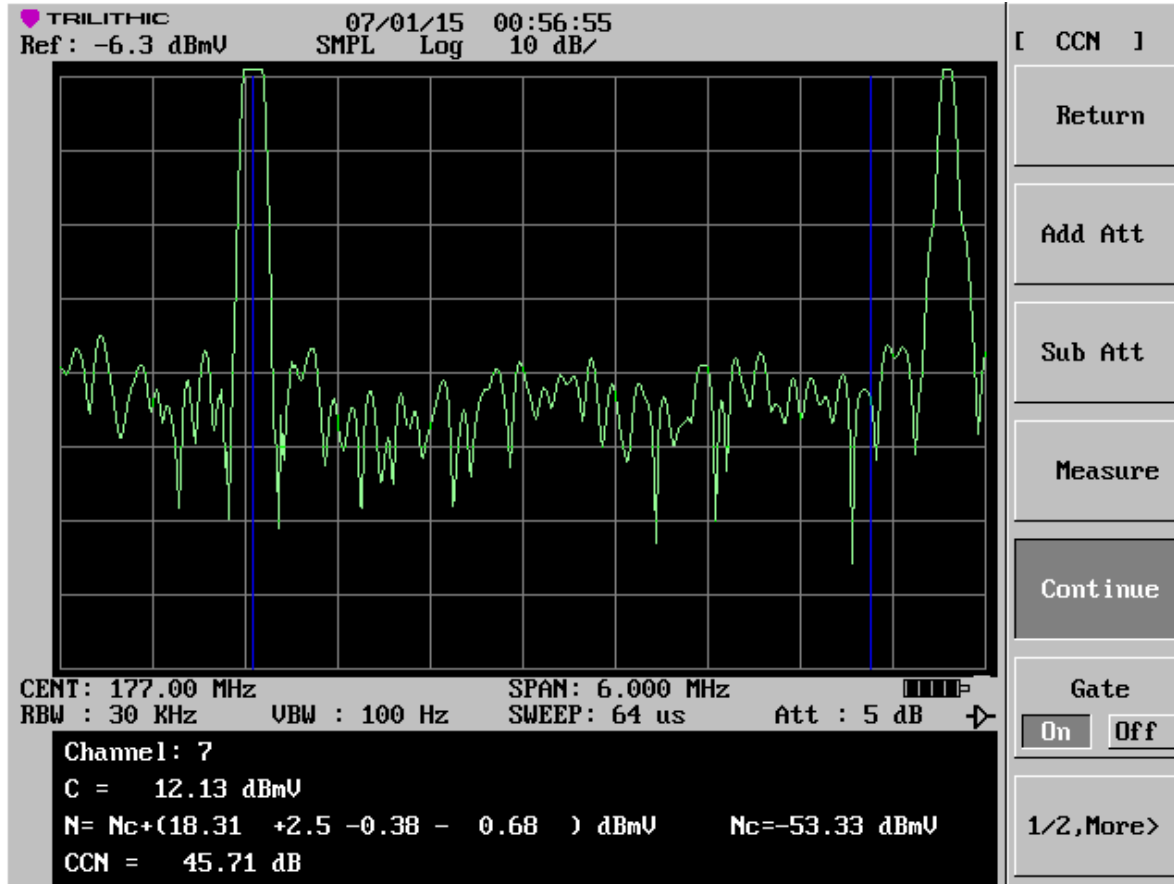
Quick test between Channels





## Identifying Picture Problems in a HFC Network

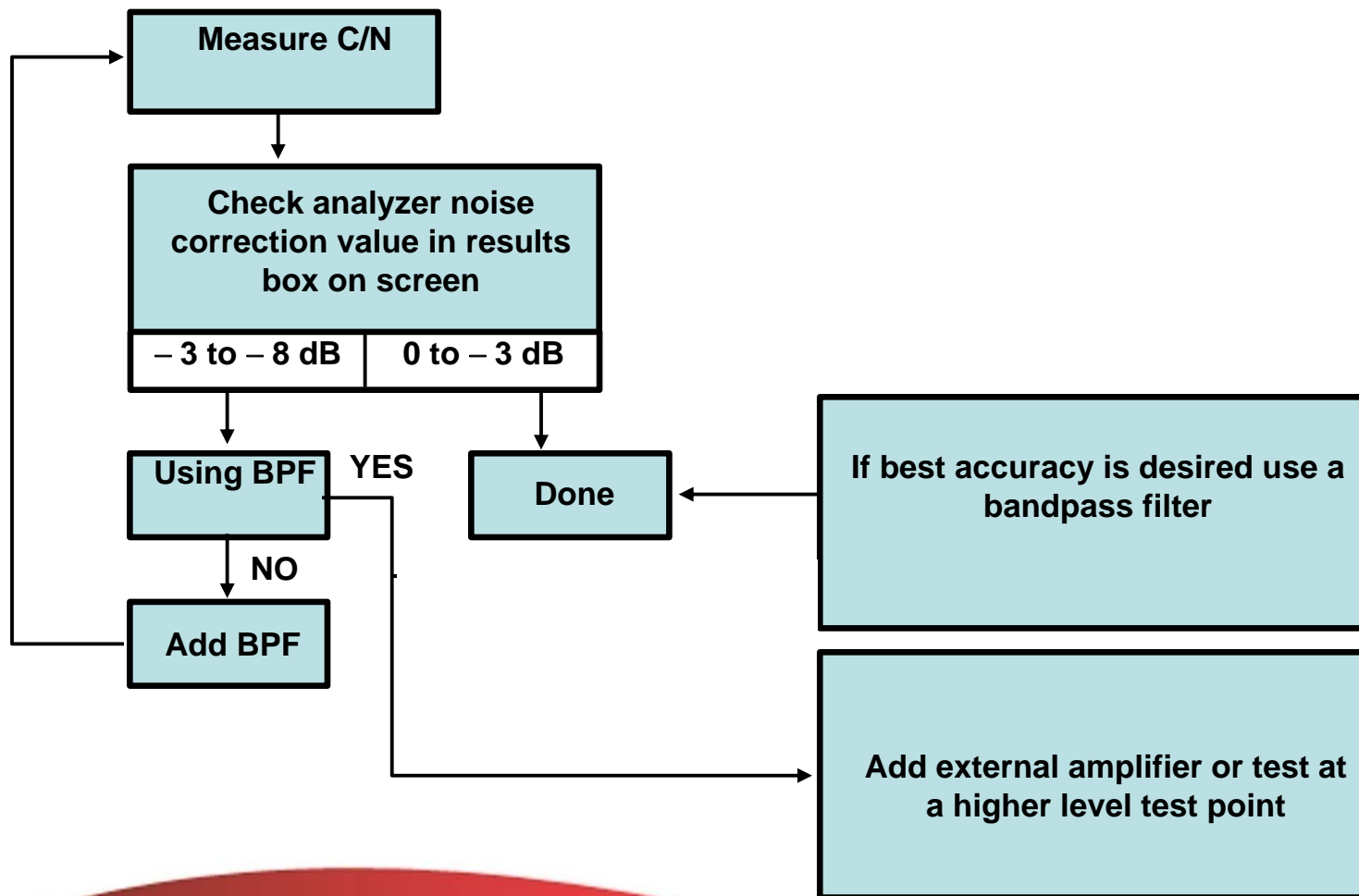
# CCN Test has Built-in Accuracy Evaluation



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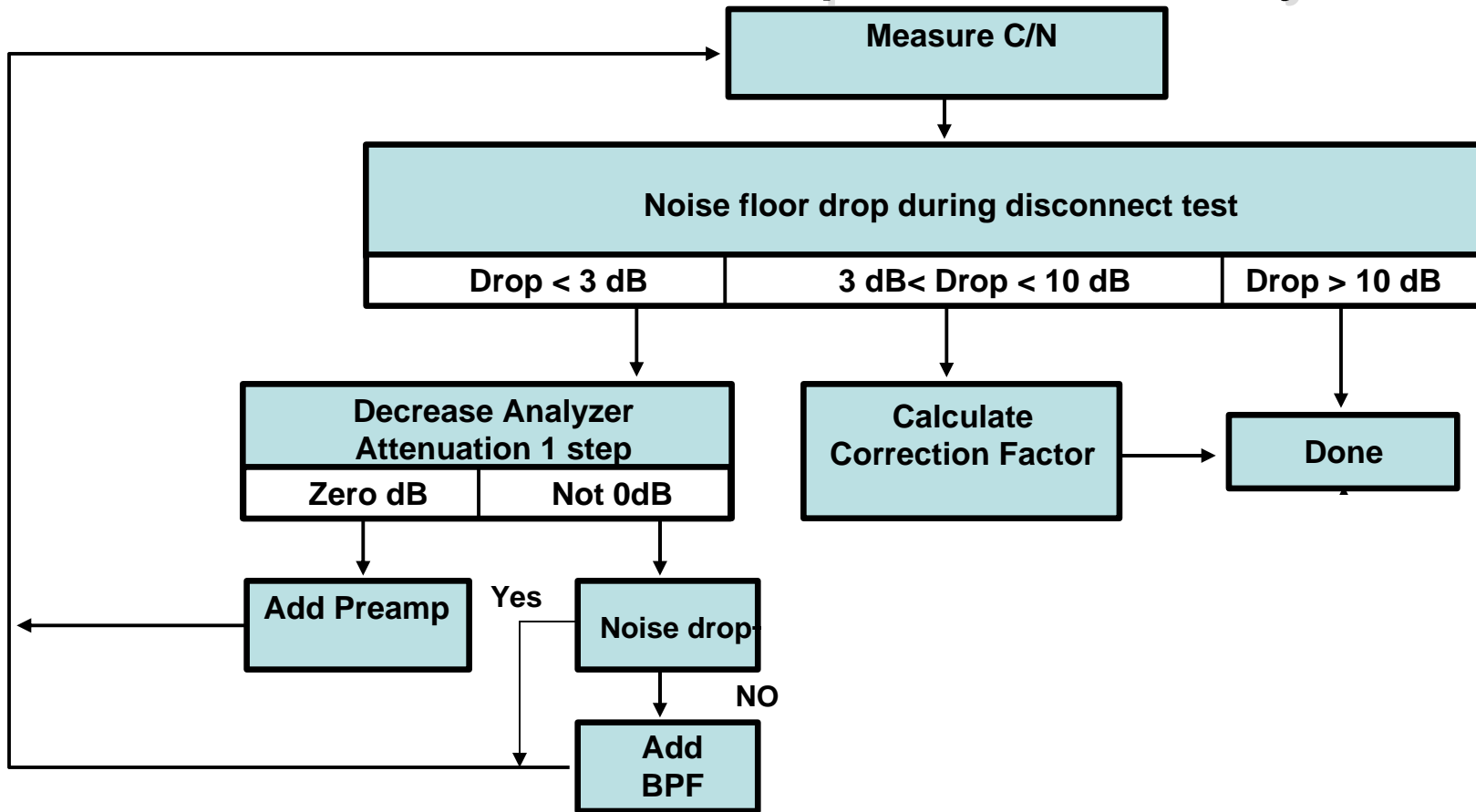


## 8821Q CCN Measurement





## Manual CCN with Spectrum Analyzer





# CATV Analyzer CCN Accuracy

CCN Accuracy vs. Analyzer Noise Correction	
Correction	Uncertainty
1 dB	$\pm 1$ dB
3 dB	$\pm 2$ dB
7 dB	$\pm 3.5$ dB

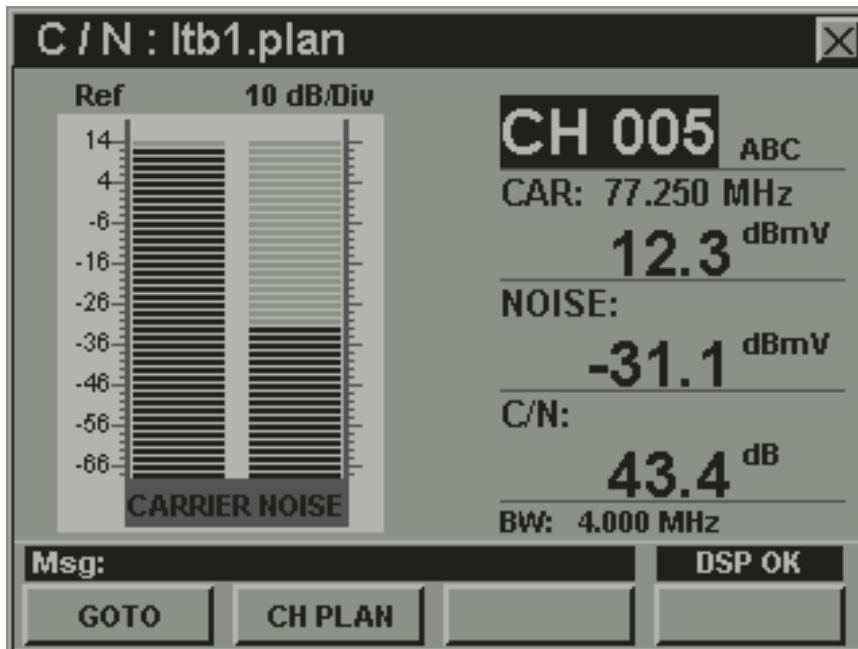
Results Good

Improve Sensitivity





# Carrier / Noise Measurement



- Displays the ratio of the amplitudes of the visual and noise within a single selected channel
- The GO TO SOFTKEY gives a rapid access to the SPECTRUM and SCAN modes
- Use the **Fn** button to quickly bring off scale signals on screen when viewing the Level Graph





# Carrier-to-Composite Noise Summary

- | Noise masks TV picture with snow
- | Spec getting tougher
- | Analyzer Measurement
  - disconnect test
  - correction for BW and voltmeter
- | Manual measurement worst case
- | Automatic measurement meets FCC rules



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## Identifying Picture Problems in a HFC Network

# Questions?



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# *Problems Simulation (C/N)*





## Broadband Instruments and Systems



# Analog Distortion Measurements

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## Identifying Picture Problems in a HFC Network

# Coherent Disturbances FCC 76.605 (a) (8)

**Specification:** 51 dB

**Picture effect:** Interfering line patterns, horizontal line streaks, various

Spectrum Analyzer Spec:  $\pm 1.5$  dB to  $\pm 4.0$  dB

<b>Number of Test Points:</b> 6+	<b>Number of Channels</b> 4+	<b>Spectrum Analyzer Settings</b>	
<b>Frequency of Test</b> Two times per year	<b>Location of Test:</b> Subscriber terminal and head end	Center Frequency	Center on carrier
		Span	6 MHz
		Resolution BW	300 kHz
		Video BW	300 kHz
		Sweep Time	Auto
		Reference Level	Distortion above bottom div
		Scale	10 dB/div

### Measurement Notes:

Carrier measurement same as carrier level, CSO  $\pm 0.75$  and  $\pm 1.25$  from picture, CTB at carrier. May need band pass filter



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# In This Section You Will Learn

- | Sources of distortion
- | How distortion appears on TV
- | Coherent disturbances (C/I, CSO, CTB)
- | What composite means
- | Quick and practical tips
- | Hands-on experience with manual and automatic measurements



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# Coherent Disturbances - Beating C/I, CSO and CTB

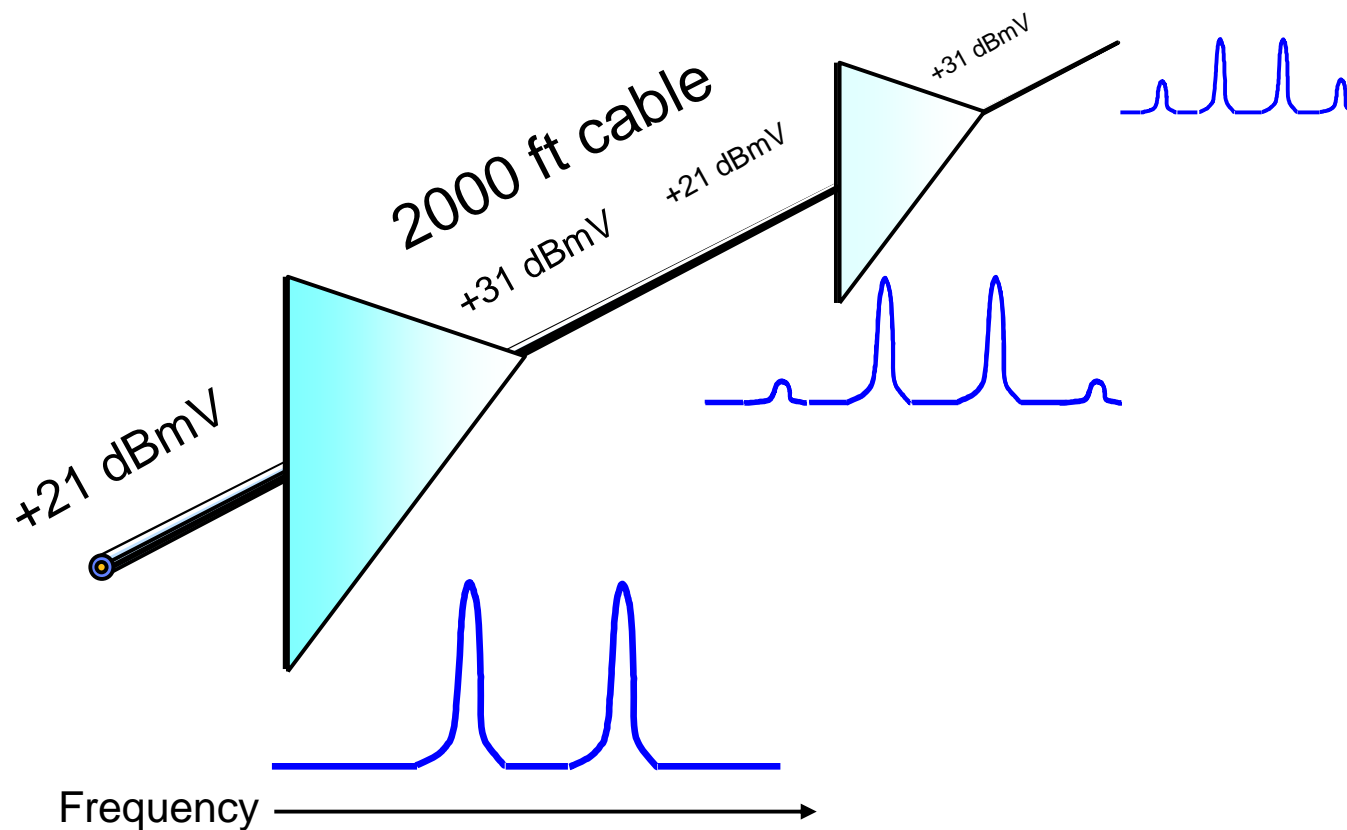
- | Additional signals in the cable frequency range
- | Second order distortion - composite second order or CSO
- | Third order distortion - composite triple beat or CTB
- | From amplifier's non-linear behavior





## Identifying Picture Problems in a HFC Network

# Distortion Increases Through Each Amplifier



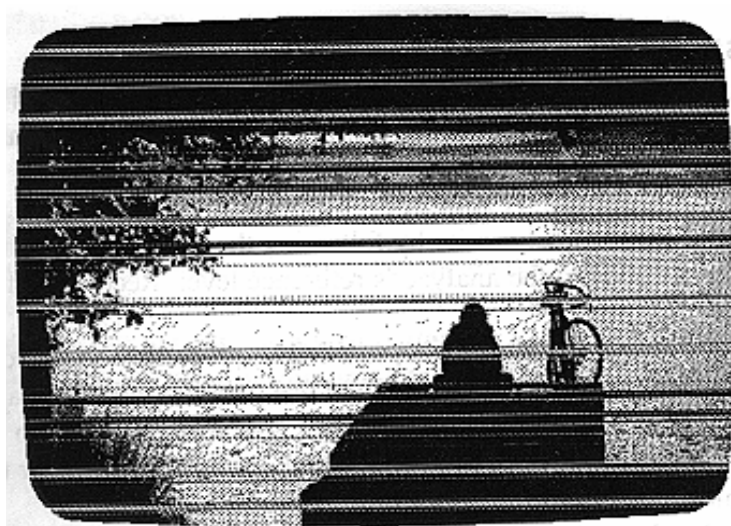


# Why the Subscriber Complains about CSO/CTB Beats

Distortions cause a variety of visual effects



**CSO**



**CTB**





# Composite Distortion

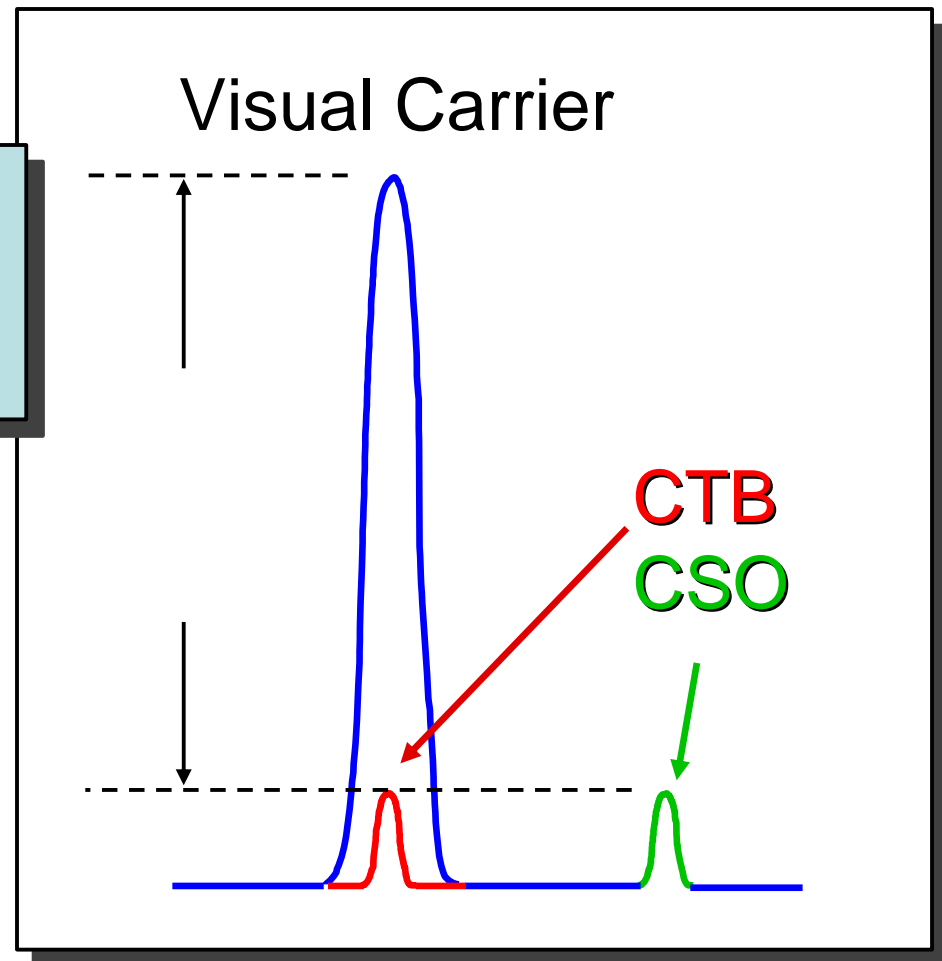
- | The fewer the channels the less composite distortion
- | Many distortion products fall on a single frequency
- | The summation of these is called composite
- | Composite beats are like a noise signal





## CSO/CTB Measurement

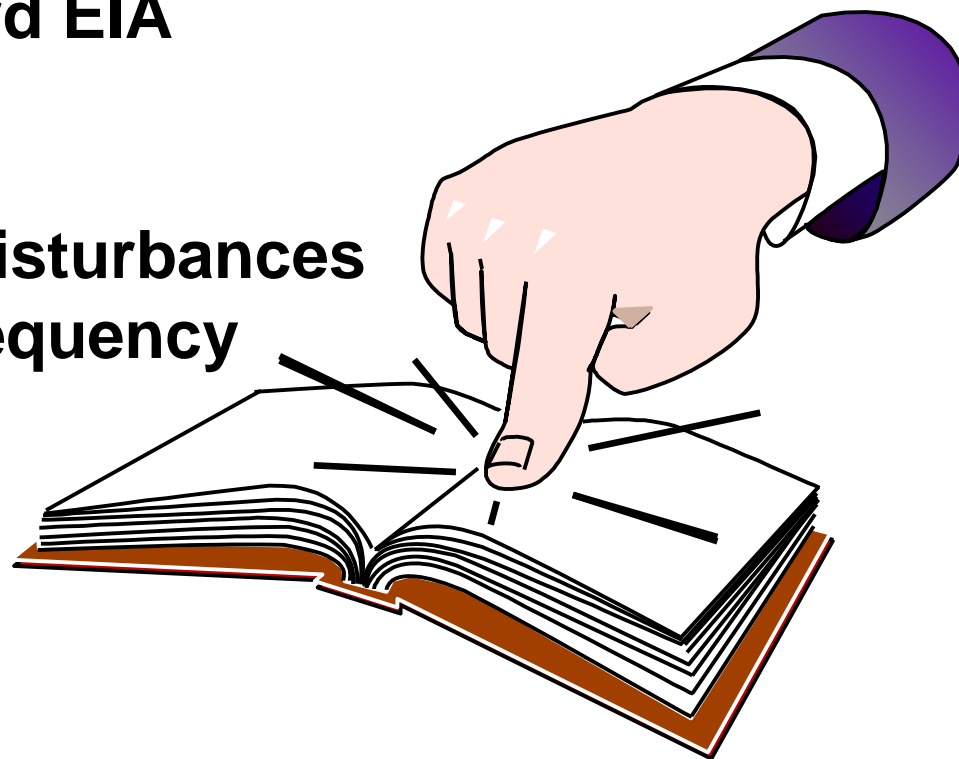
- Composite distortion is measured as dB down from the visual carrier





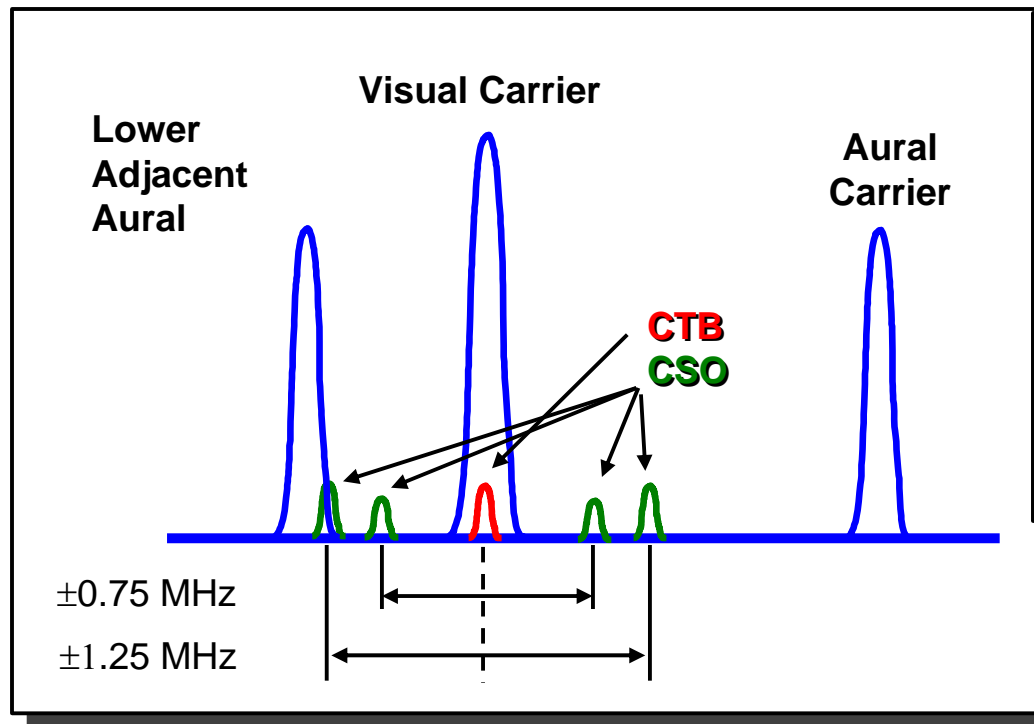
# FCC Compliance

- | **51 dBc for non-coherent disturbances (Standard EIA Frequency Networks)**
- | **47 dBc for coherent Disturbances (Non-standard EIA Frequency Network)**





# Where They Fall

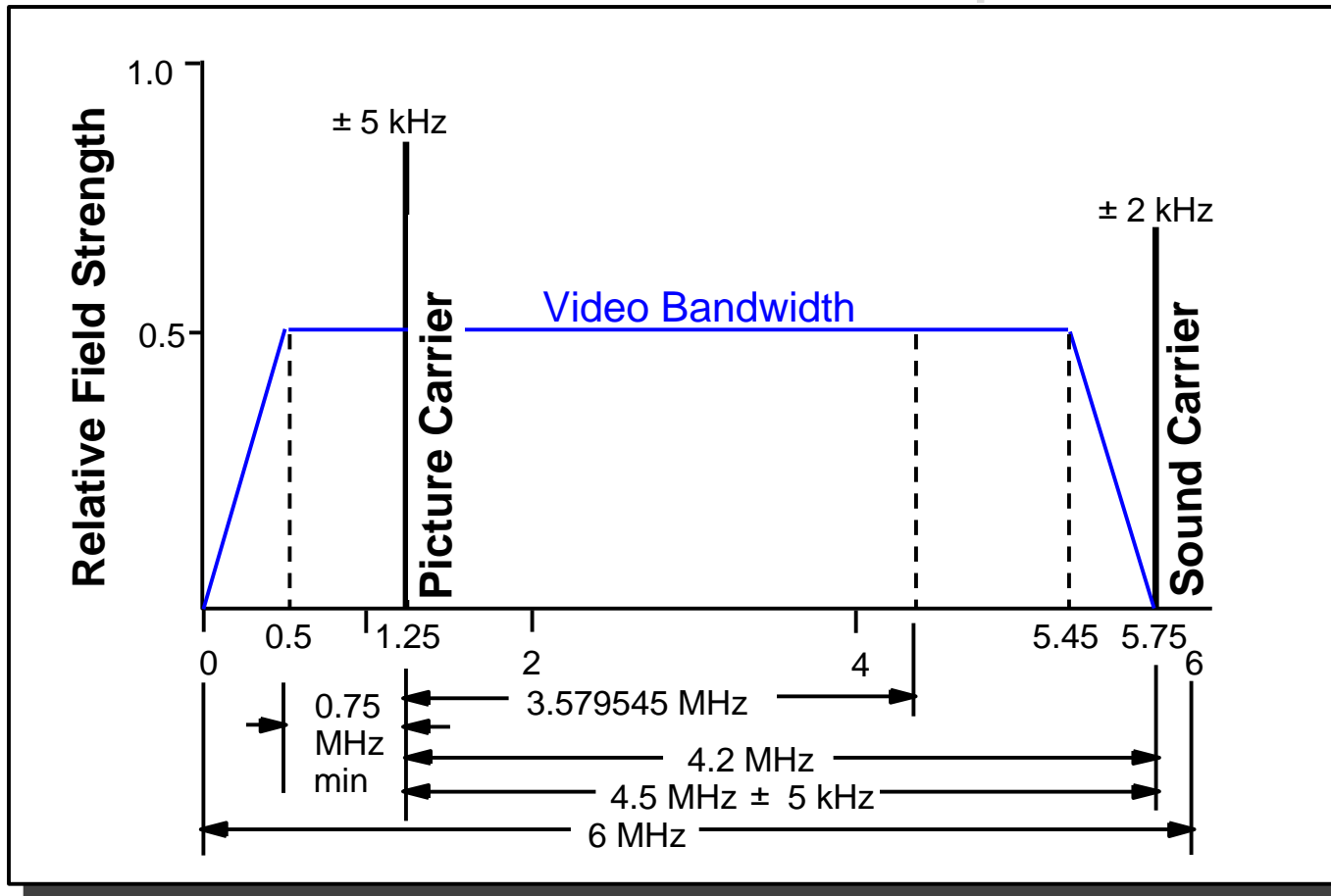


- For Standard frequency allocation systems
- CTB fall on the picture carriers
- CSO fall  $\pm 1.25$  MHz and  $\pm 0.75$  MHz from the picture carrier





## Television Channel Frequencies

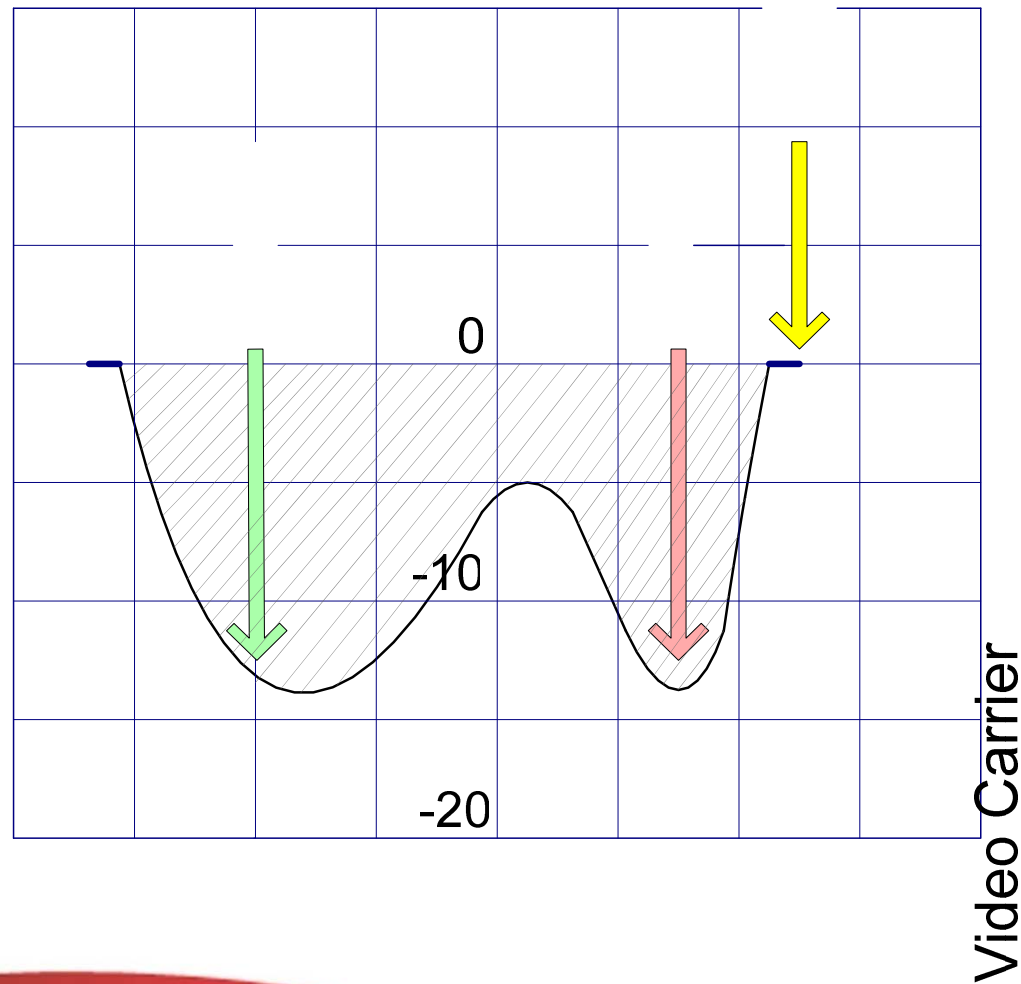


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# Identifying Picture Problems in a HFC Network



- CSO
- 1.25 MHz
- 0.75 Mhz
- +0.75Mhz
- +1.25Mhz

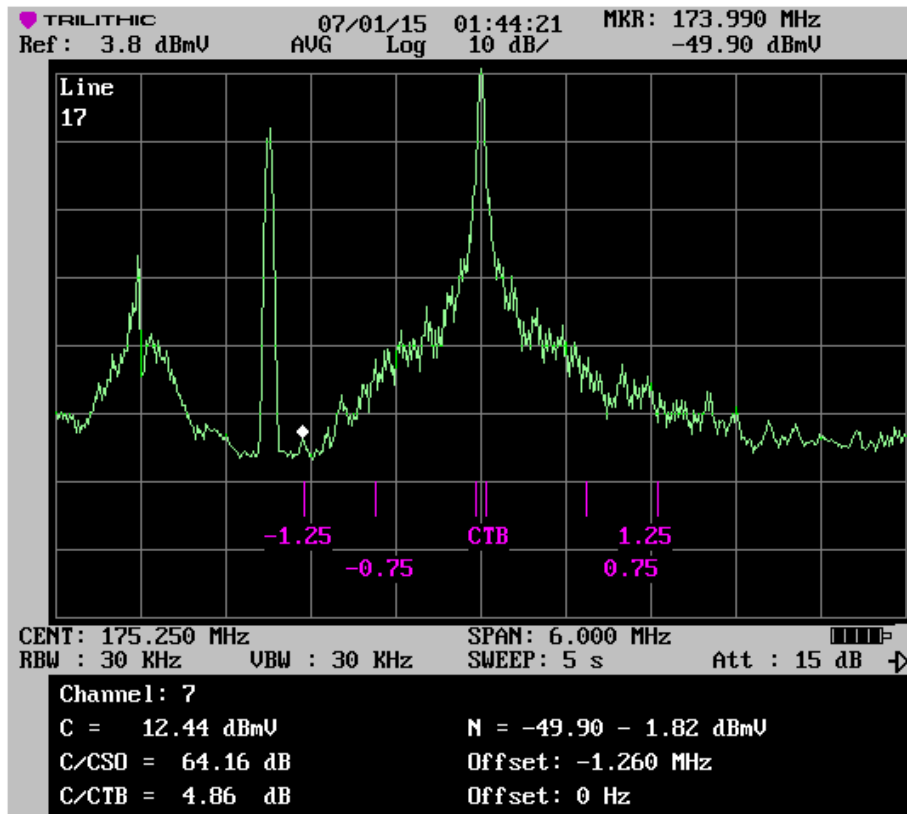


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## Identifying Picture Problems in a HFC Network

# Practical Measurement Procedures



Measure CSO, CTB just like a CW signal

Average the amplitude

Treat low level signals like noise

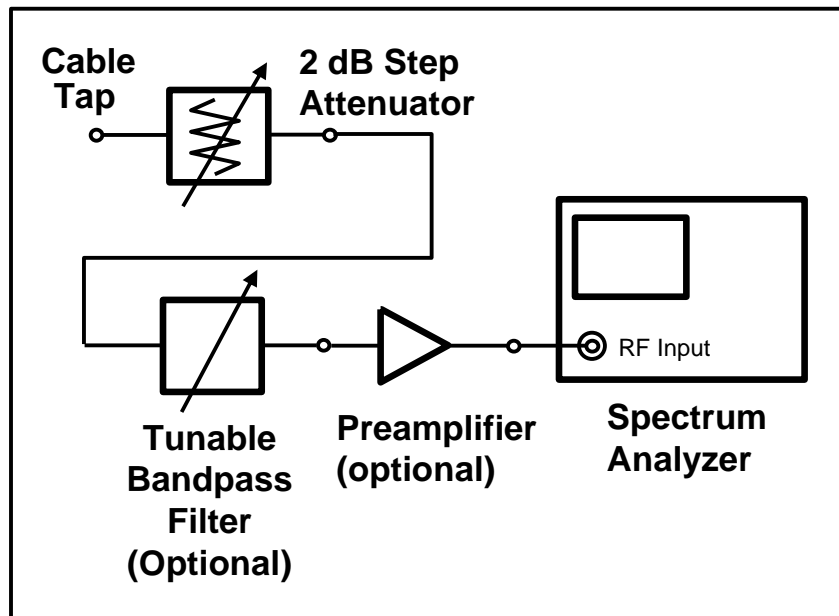
Correct as noise signal in CCN measurements



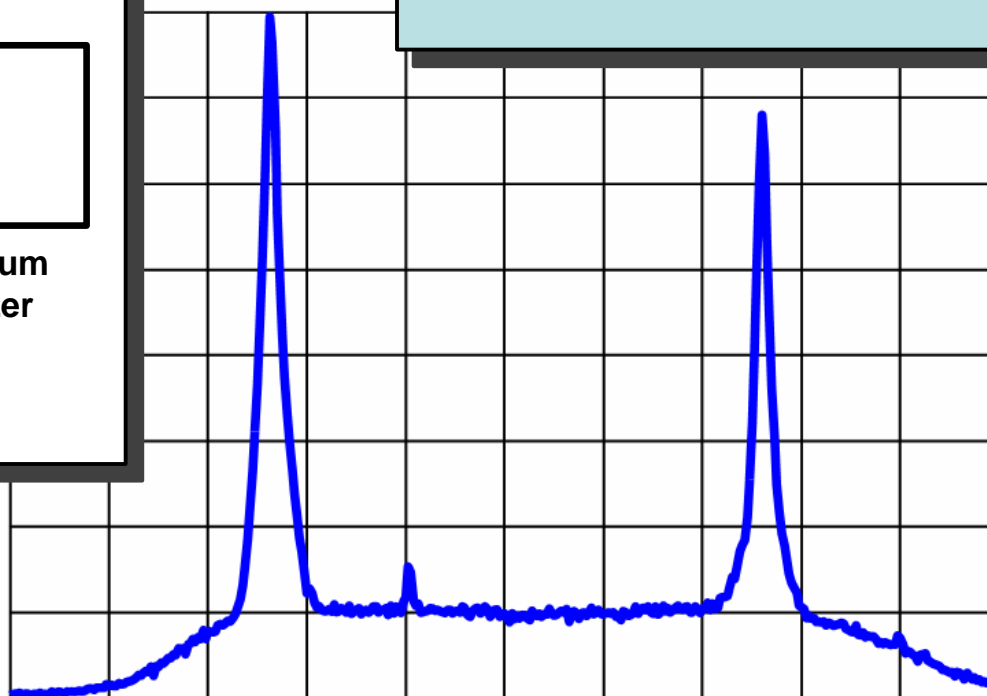


## Identifying Picture Problems in a HFC Network

# Preventing Overload



Tunable bandpass filter recommended





### Measurement Procedure

- | Measure carrier peak
- | Turn off modulation
- | Set 30 kHz resolution bandwidth
- | Narrow video bandwidth to 100 Hz
- | Composite level using marker
- | CSO or CTB = visual carrier - distortion level
- | Automatic cable analyzer can the make CSO measurement without interrupting the subscriber



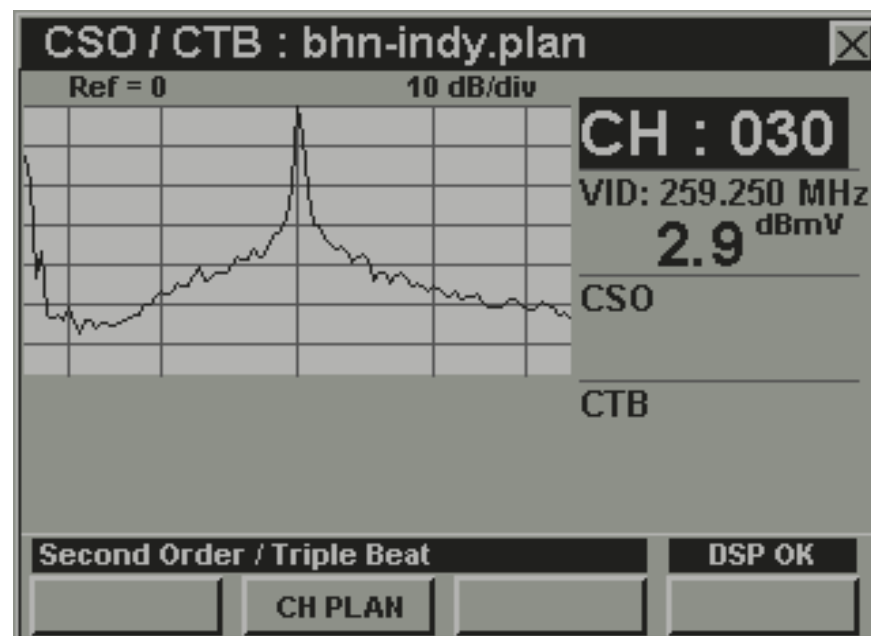
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# CSO/CTB MODE

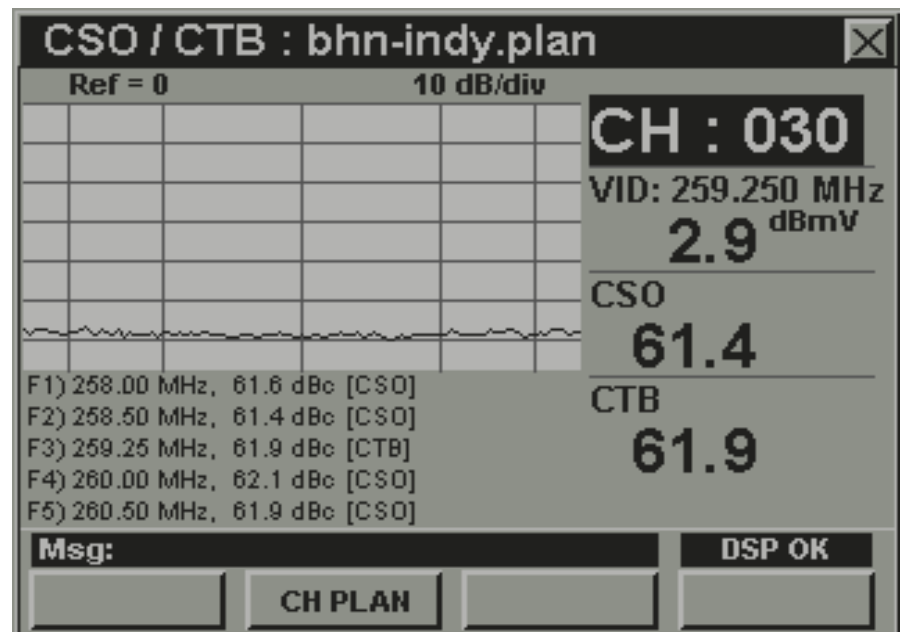
- Measures the amplitude of two common intermodulation products, Composite Second Order and Composite Triple Beat present within a selected analog video carrier
- Displays numerical values for CSO and CTB and a spectrum view
- You will need signal levels of at least 10 dBmv for proper measurements





# CSO/CTB MODE

- Once you have selected the desired channel, the 860 DSP will display the video carrier level
- To measure CSO/CTB you must briefly turn off the video carrier. When the 860 DSP sense that the carrier has been removed, it will measure and display the CSO and CTB

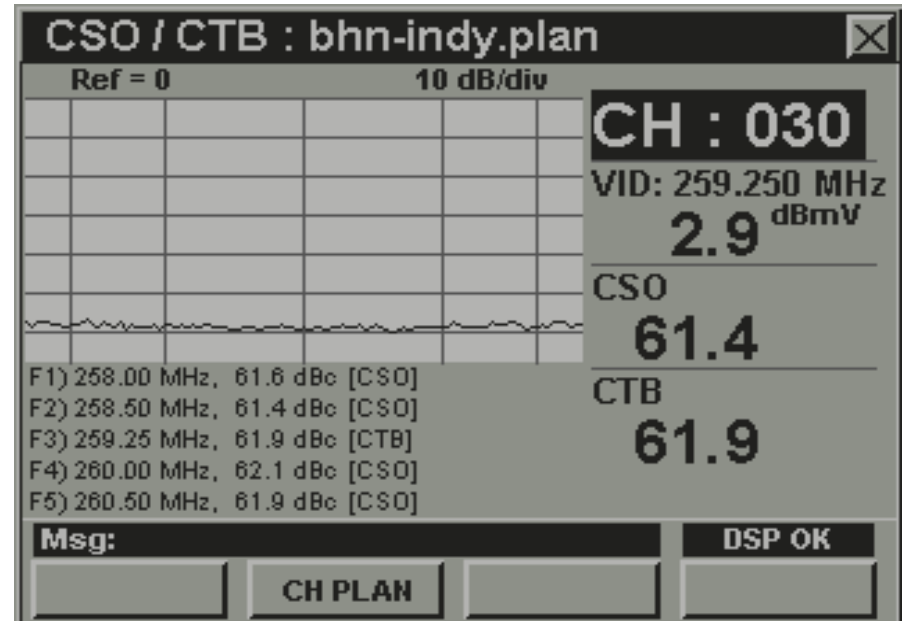




## Identifying Picture Problems in a HFC Network

# CSO/CTB MODE

- The worst case CSO/CTB readings are displayed below the channel.
- A detailed list of CSO/CTB components are displayed in a tabular form at the lower left of the screen.
- The 860 DSP will hold the CSO/CTB reading after you turn the carrier back on.



*Note: CSO is maximum at the lowest and highest frequency, CTB tends to be maximum at the mid-frequencies*





# Distortion Summary

- | Known frequencies
- | Measure relative to visual carrier amplitude
- | Modulation and/or carrier off



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# Questions?



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# *Problems Simulation (C/I, CSO & CTB)*





## Broadband Instruments and Systems



## Hum Measurements

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## Identifying Picture Problems in a HFC Network

# Low Frequency Disturbances – Hum FCC 76.605 (a) (10)

**Specification:** < 3%

**Picture effect:** Horizontal bars or stripes slowly moving up the picture.

**Spectrum Analyzer Spec:**  $\pm 0.5\%$  for levels < 5%

		Spectrum Analyzer Settings`	
<b>Number of Test Points:</b> 6+	<b>Number of Channels</b> 4+	Center Frequency	Center on visual carrier
		Span	Zero Hz
		Resolution BW	1 MHz
		Video BW	1 MHz (mod ON), 1 kHz (mod OFF)
		Sweep Time	Auto
		Reference Level	Distortion above bottom div
		Scale	10 dB/div
<b>Frequency of Test</b> Two times per year	<b>Location of Test:</b> Subscriber terminal and head end		

### Measurement Notes:

NCTA is peak-to-peak to peak level ratio, IEEE is peak to average level ratio. FFT used to see harmonic content.





# In This Section You Will Learn

- The definition and origins of hum distortion
- How it looks to your subscriber
- FCC regulations
- Measurement on signal level meter and spectrum analyzer
- Diagnostics to help find the source



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## Identifying Picture Problems in a HFC Network

# Why the Subscriber Complains About Hum

Hum causes horizontal bars rolling from bottom to top



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# Hum Is Important Because...

- May indicate more serious maintenance problem,
- or it may not
- Either way it upsets subscriber

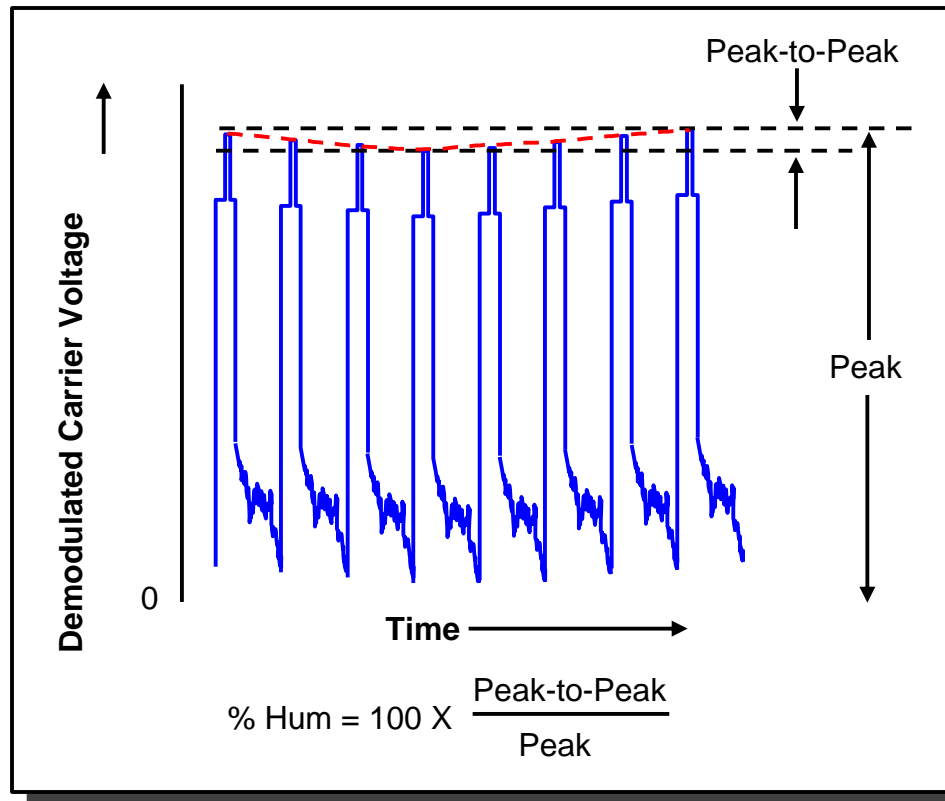


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# Definition and Regulations

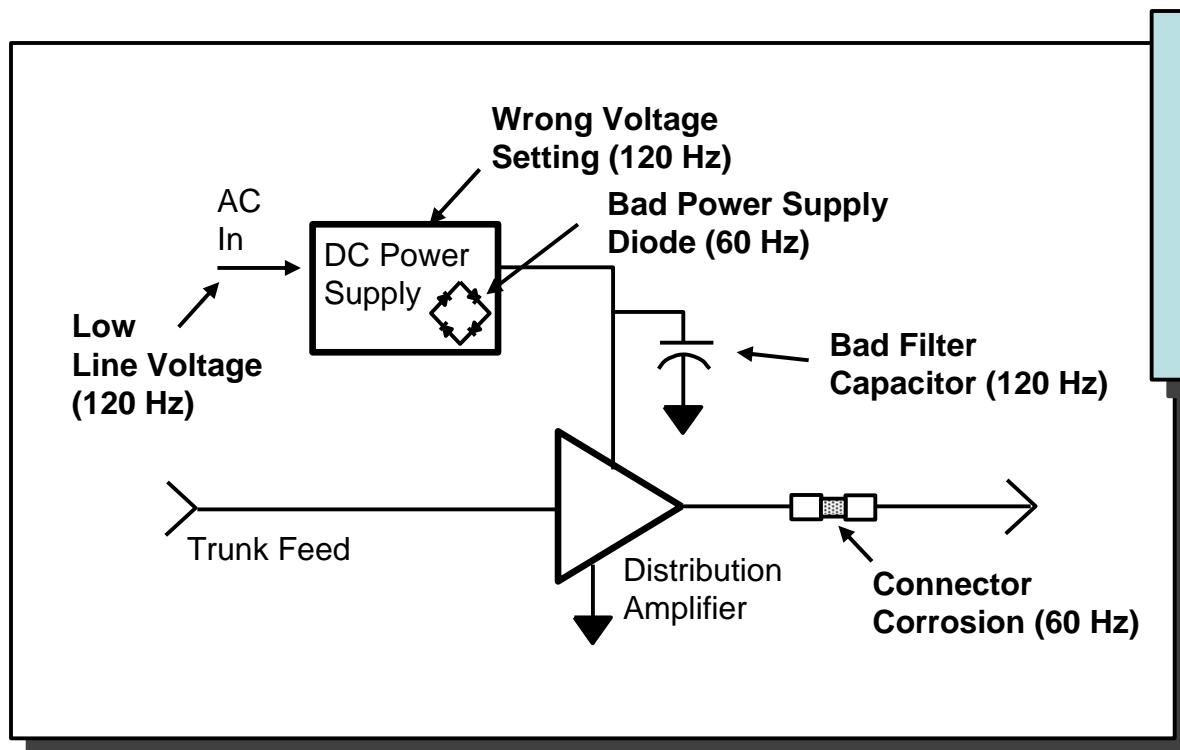


- | Hum is amplitude modulation of the visual carrier
- | The level is a % of the total voltage
- | FCC says 3% is limit





# How Hum is Generated



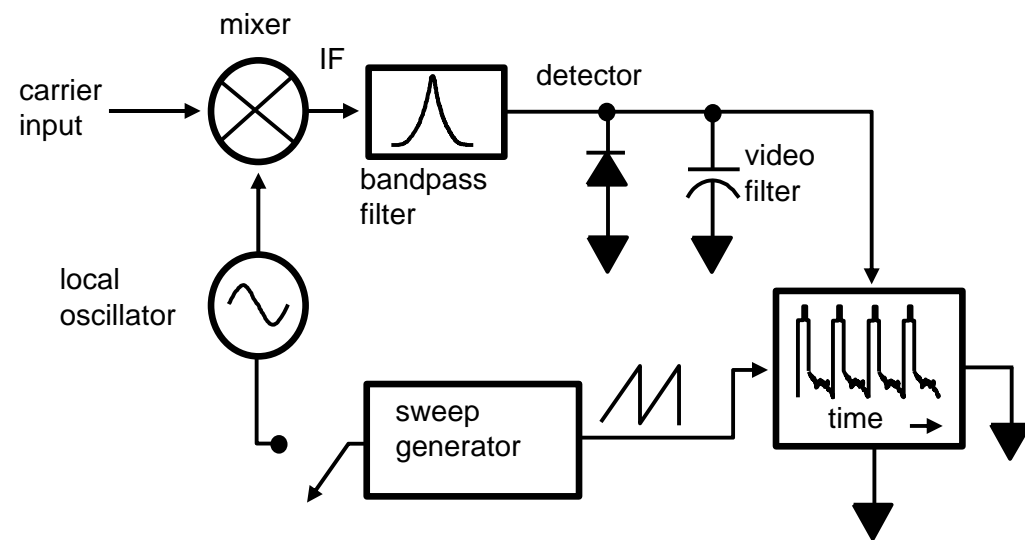
- Power line frequencies: 60 and 120 Hz
- Power supply
- Mains supply
- Ground loops





# Hum Measurement Techniques

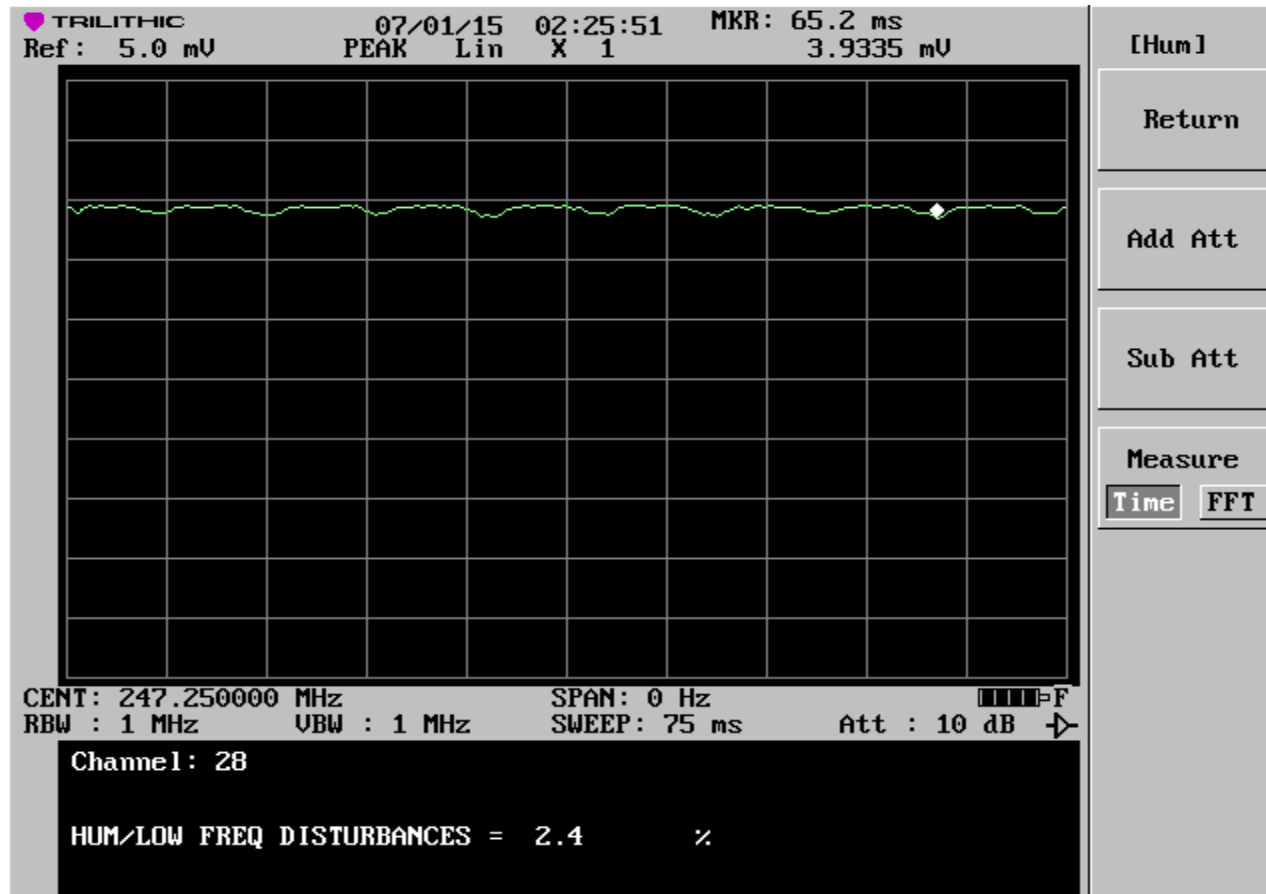
- | Spectrum analyzer demodulates carrier and measures the voltage swings
- | Signal level meter filters and measures the power line components





# Identifying Picture Problems in a HFC Network

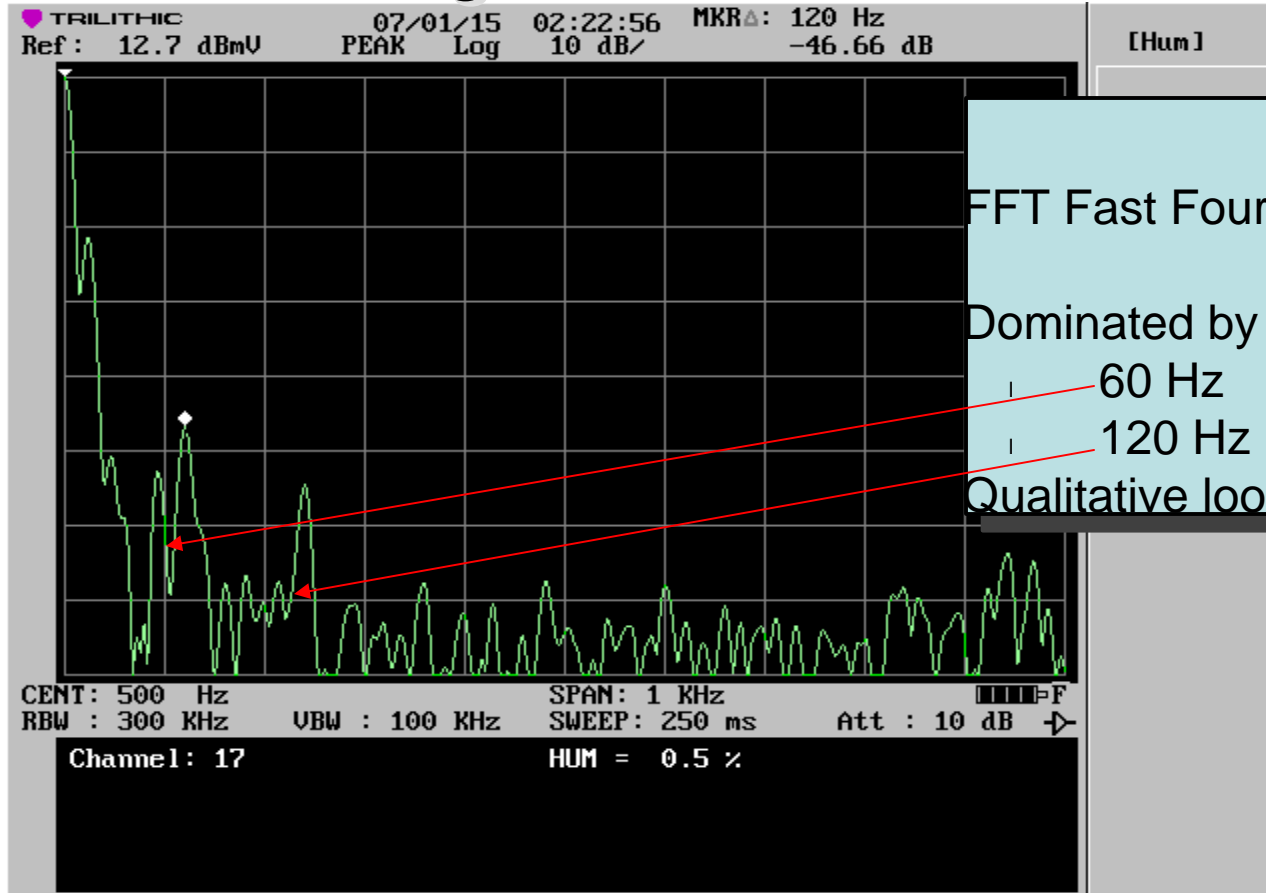
## Hum in the Time Domain





## Identifying Picture Problems in a HFC Network

# Diagnose the Source of Hum



FFT Fast Fourier Transform

Dominated by 60 Hz or 120 Hz?

60 Hz

120 Hz

Qualitative look

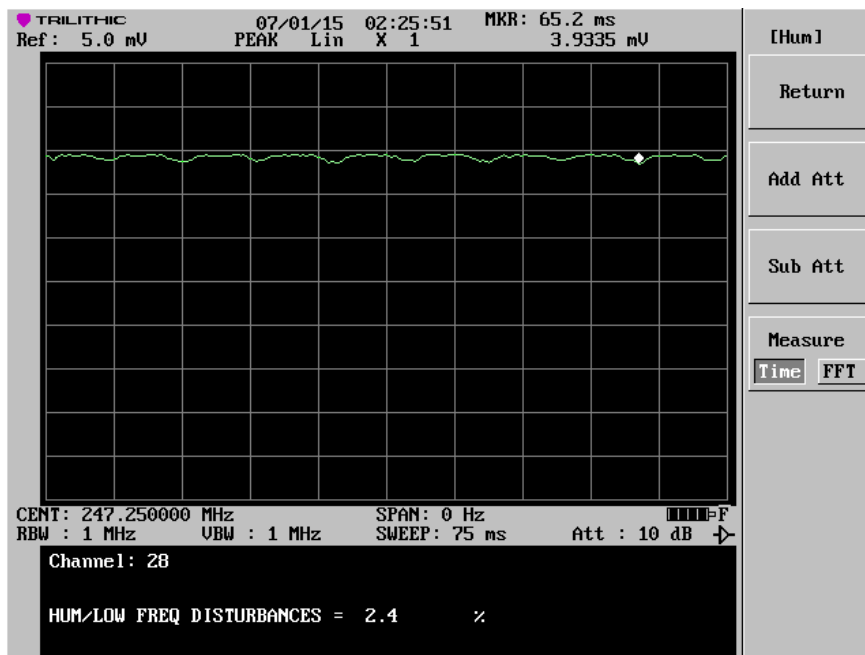


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# Signal Level Meter / Analyzer Comparison



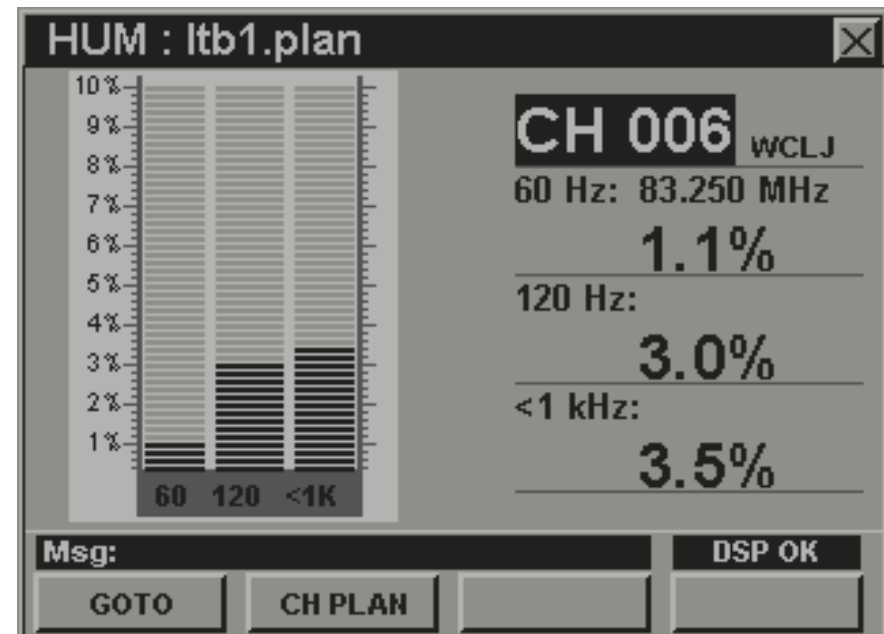
- Cable analyzer more accurate, has wider range
- SLM, portability for quick looks





# Hum Mode

- In HUM MODE the 860DSP displays the amplitude of the 50/60Hz and 100/120Hz and low frequency interference
- HUM MODE requires a minimum signal level of -20dBmV
- The GO TO SOFTKEY gives a rapid access to the SPECTRUM and SCAN modes





# Hum Measurement Summary

- Hum is annoying, but also may point to bigger problems
- Hum may be measured easily and accurately by SLM or cable analyzer





## Identifying Picture Problems in a HFC Network

# Questions?



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# *Problems Simulation (Hum)*





## Broadband Instruments and Systems



# Digital Measurements

What you need to know



think ahead.



# What you will learn

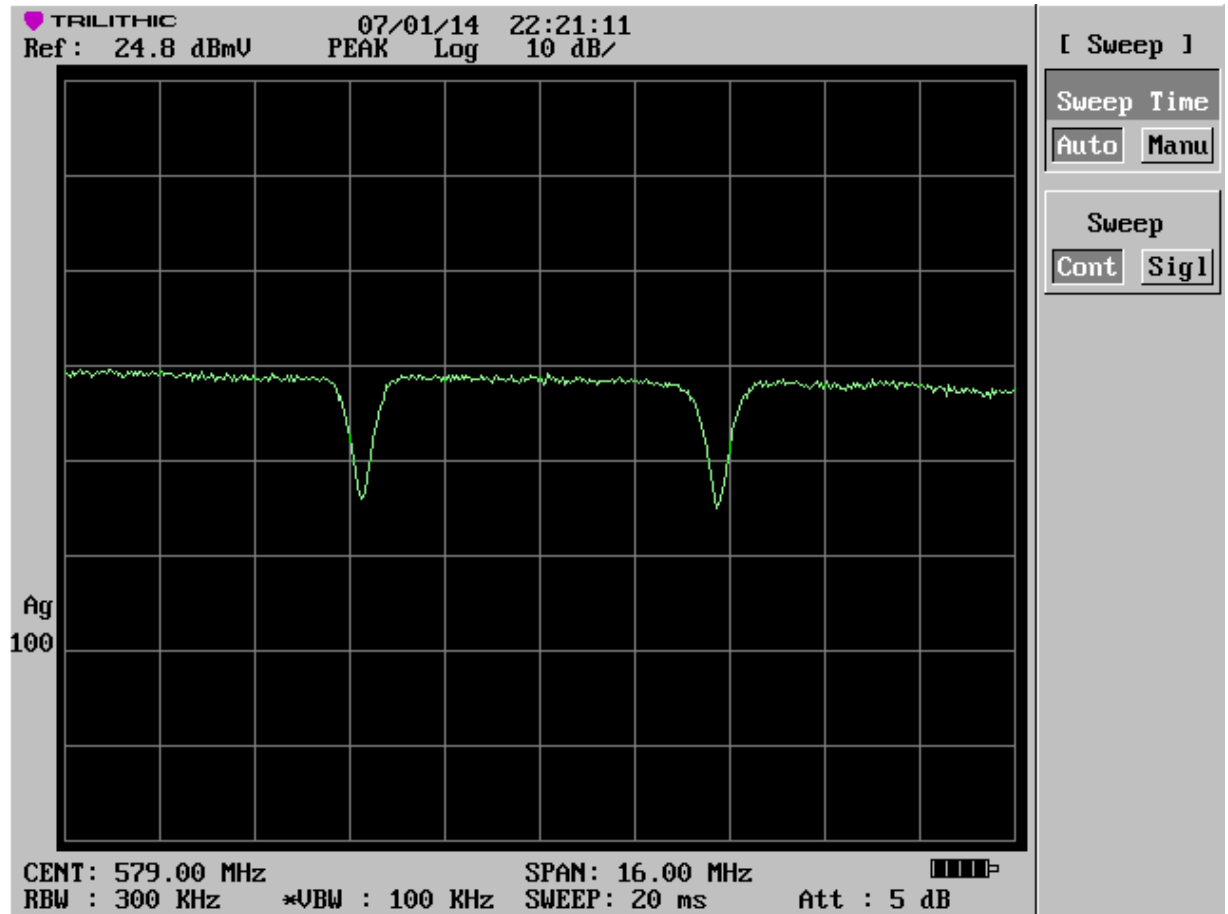
- Channel Power
- Constellation
- MER
- BER
- Equalization
- Statistics
- Settings





# Identifying Picture Problems in a HFC Network

## Channel Power

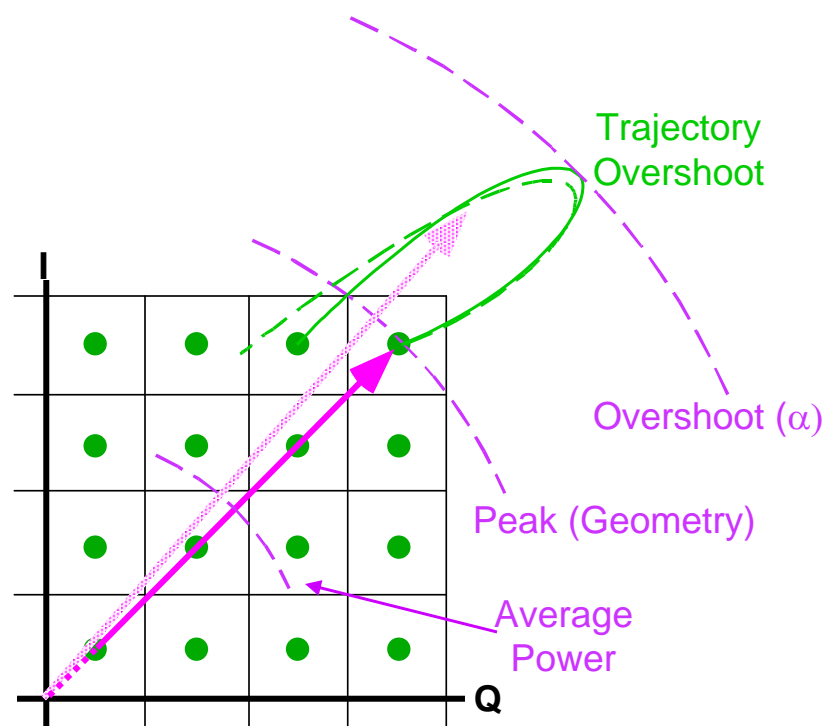


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# Power and Trajectory



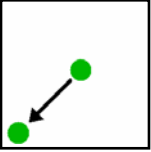
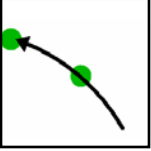
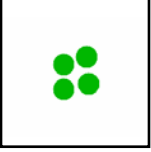

- Average Power
- Peak Symbol Power
- Overshoot Power





## Identifying Picture Problems in a HFC Network

# Error Types & Key Components

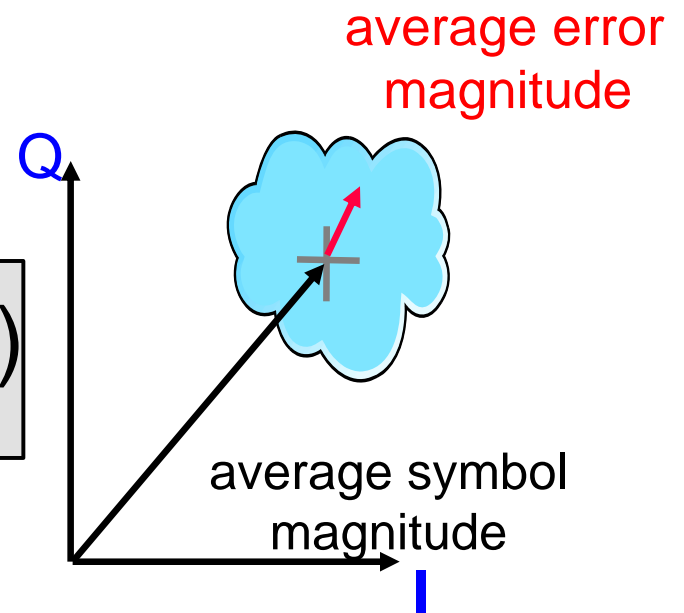
▪ Random Noise		Amplifier	Mod/Demod
▪ Phase Noise		Mod/Demod	Mod/Demod
▪ AM/AM Distortion		Mod/Demod	Amplifier
▪ AM/PM Distortion		Mod/Demod	Amplifier
▪ Group Delay/ISI		Mod/Demod	RF and IF Filters
▪ Interference		Spurious	Power Supply





# MER Calculation

$$\text{MER (dB)} = 20 \times \log \left( \frac{\text{average symbol magnitude}}{\text{average error magnitude}} \right)$$



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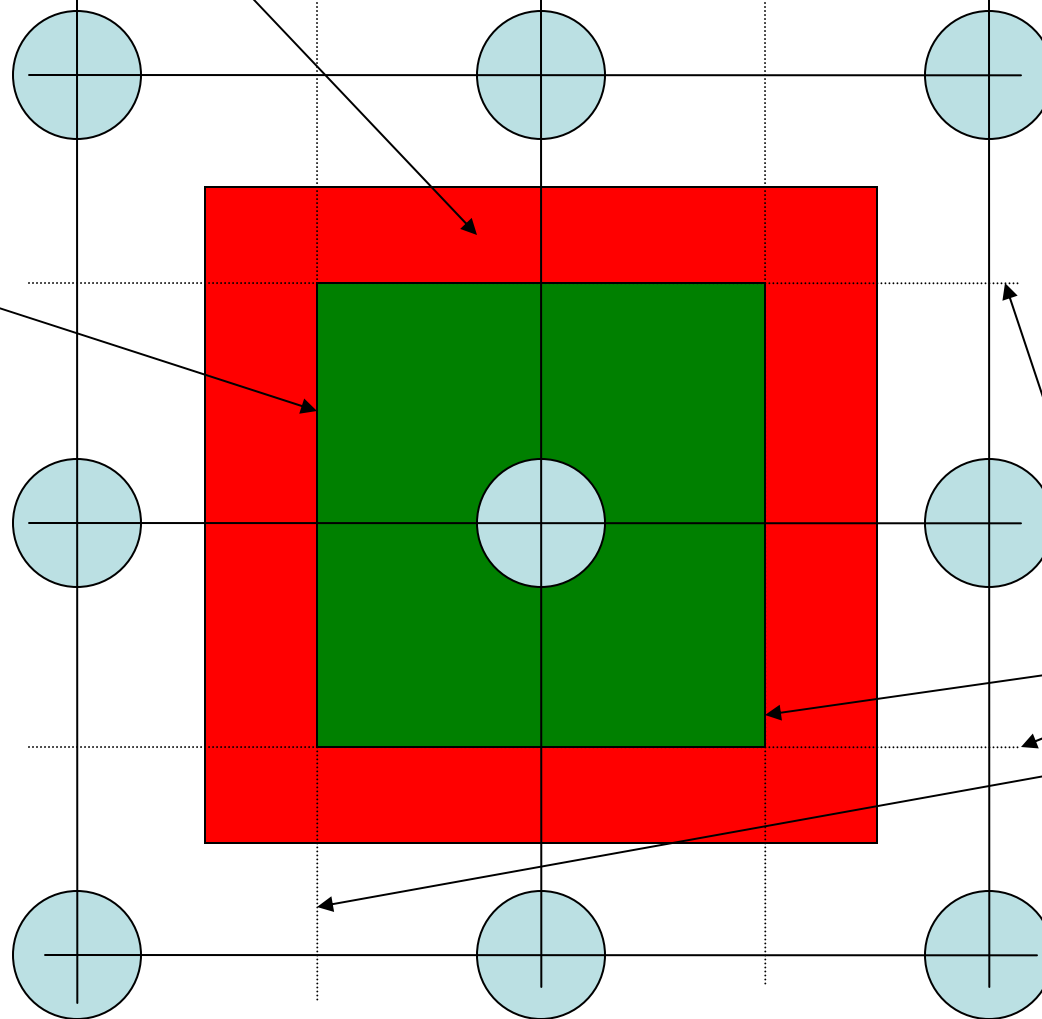
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In this part of the red area beyond the center constellation point the symbol will be incorrectly associated with this point and the measurement is invalid

Maximum size of constellation point which will always be correctly associated with this position

Constellation point target positions

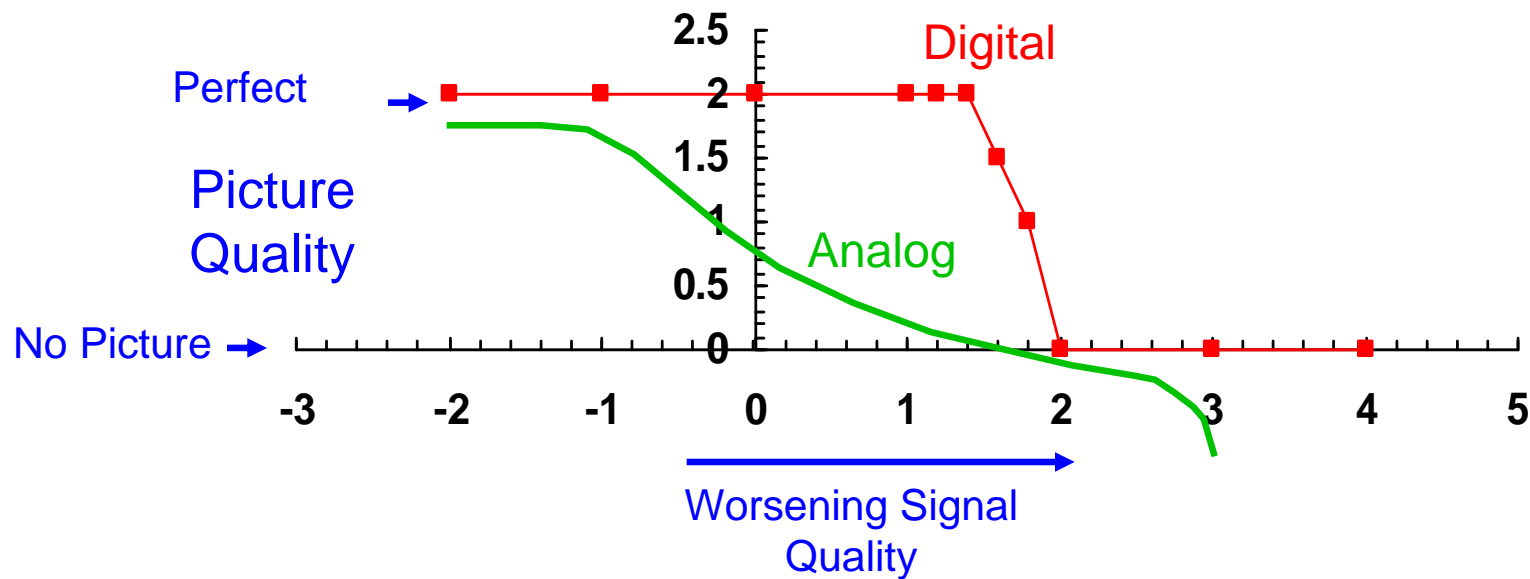
Constellation point decision thresholds





## Threshold and Margin

### Signal Quality versus Picture Quality





# BER - Bit Error Rate

- Before Forward Error Correction
  - Calculated from FEC errors
- After Forward Error Correction
  - Calculated from FEC errors





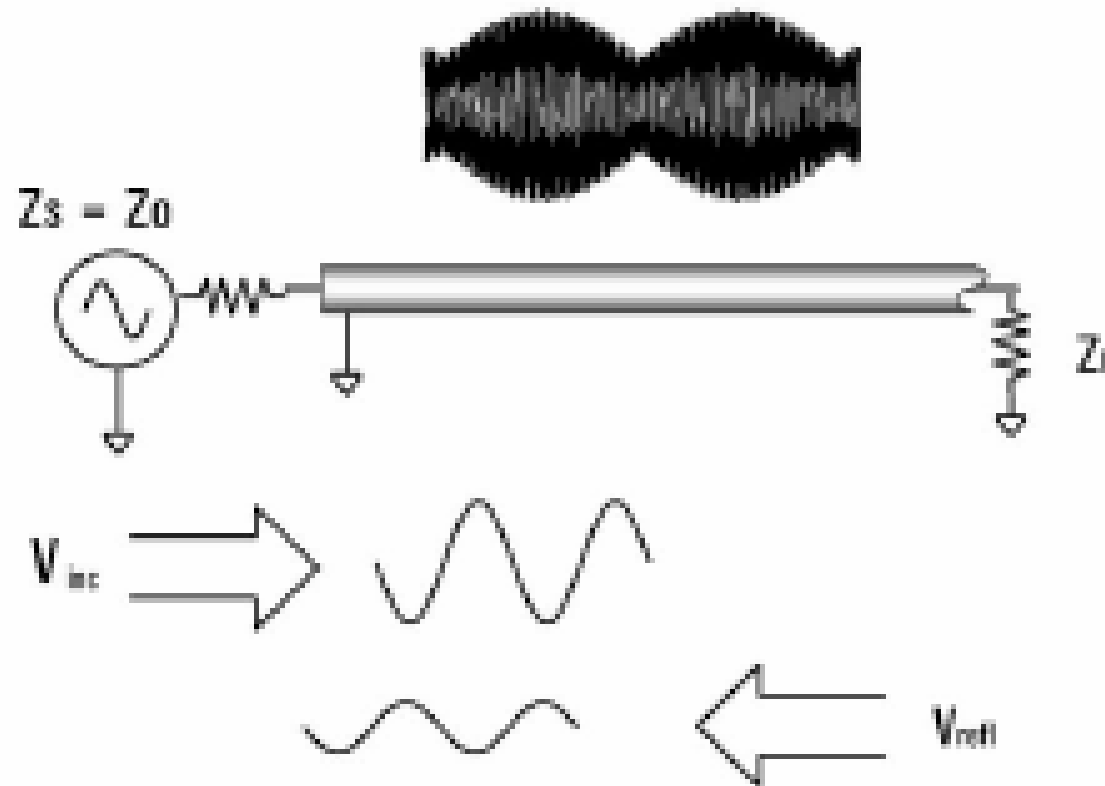
# Equalization

- Equalization can be turned on or off
  - Some like to measure MER with EQ on and off
- 8 Feedforward and 24 Decision Feedback
- Equalizer Coefficients
  - Display of distance to reflection
- In Channel Frequency Response
  - Displays peak to peak flatness result
- Group Delay
  - Displays peak to peak group delay result





## Standing waves





# Return Loss

- Cable modem specified 6dB return loss
  - Incident wave is returned this much lower
- Unterminated ports cause reflections
- Reflections setup standing waves
- Loss is your friend
- Problem for low value tap plates
- Shows up in Equalizer display





# Statistics

- Averaging MER masks transient problems
  - System sweep
  - Ingress/Leakage
  - Distortions
- Long time record confirms problem





# Settings

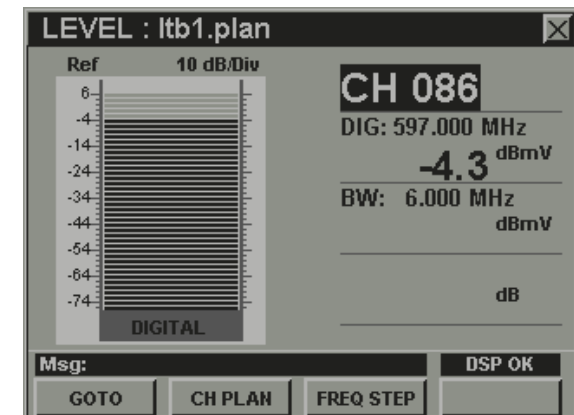
- Select Standard
  - J83 A, B or C (The US uses B)
- Select QAM format
- Non standard symbol rate values
  - Proprietary system
- No FEC
- Optimize measurement





# Digital Power

- Designed for digital carriers
  - USA - 6 MHz filter
  - Europe - 8 MHz filter
- The wider the bandwidth for a given peak power
  - The higher the average power
- Bandwidth must be taken into account for the accurate measurement of digital signals
  - The average power (with digital carriers) is not affected by the programming content
  - The amount of distortion in a system is related to the total power of all of the carriers





# Digital Carrier Levels

- 64 QAM signals
  - 10 dB below video (Typical)
- 256 QAM signals
  - 6 dB below video (Typical)

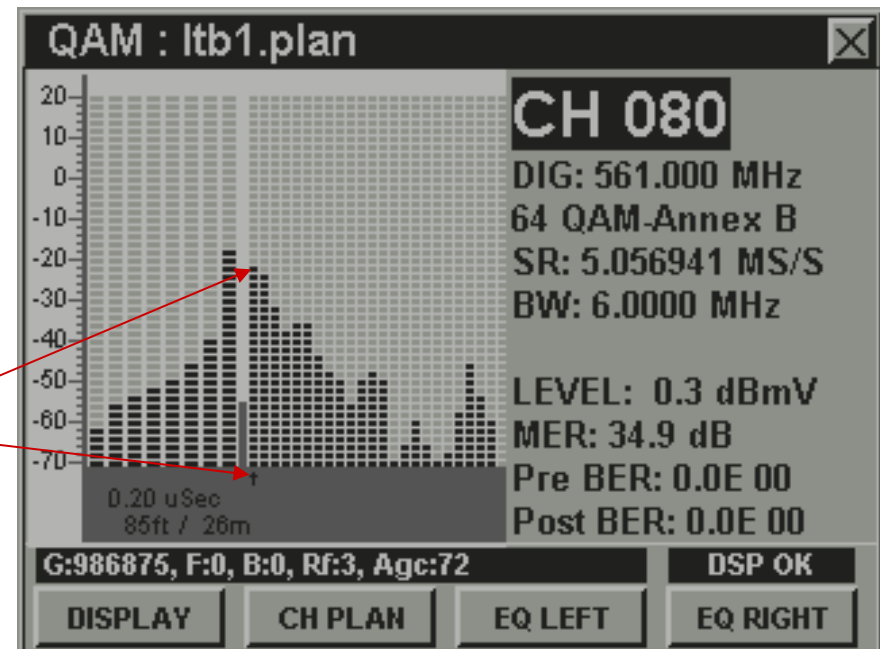




# Adaptive Equalizer Response

- Digital Carriers sensitive to reflections
  - Tree rubs
  - Squirrel chews
  - Loose Connectors

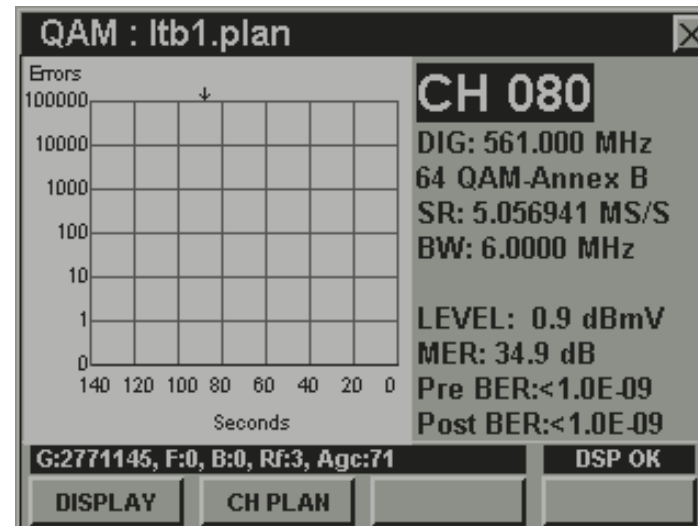
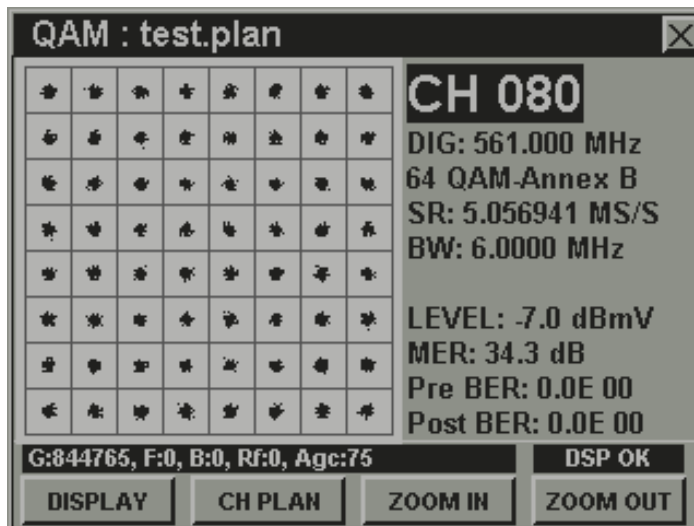
Distance to Fault





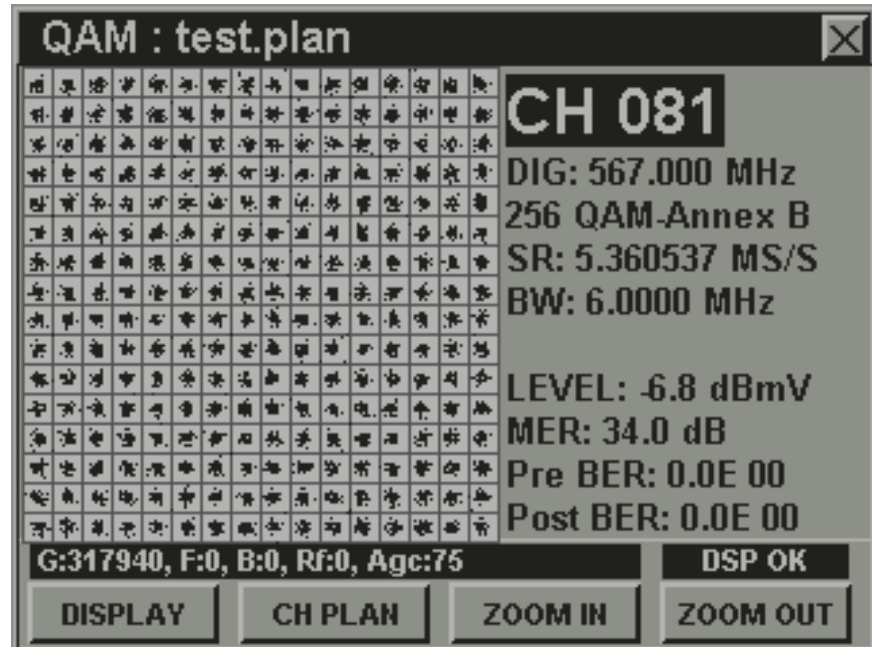
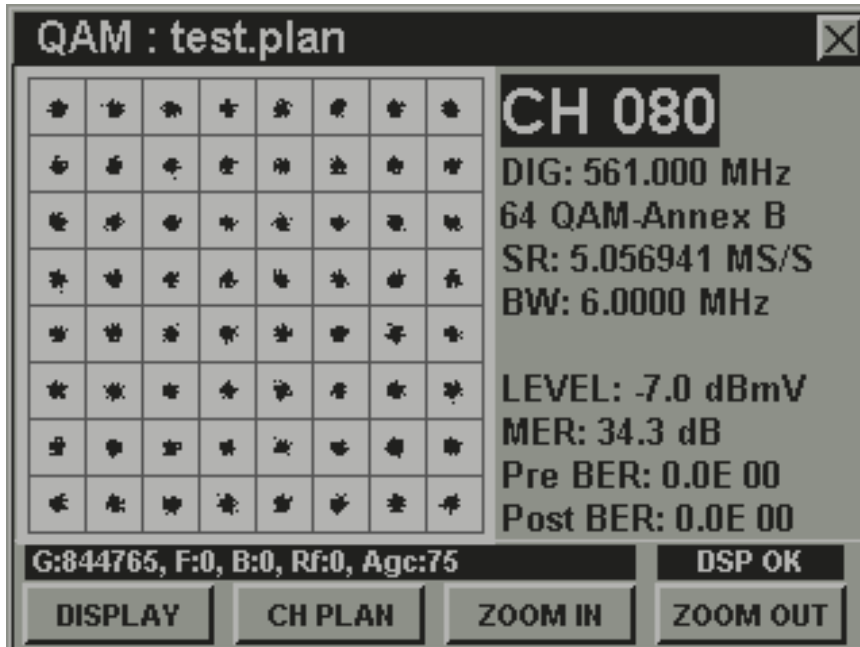
## QAM Measurements

- Constellation Display
- MER
- BER
  - True BER or Estimated





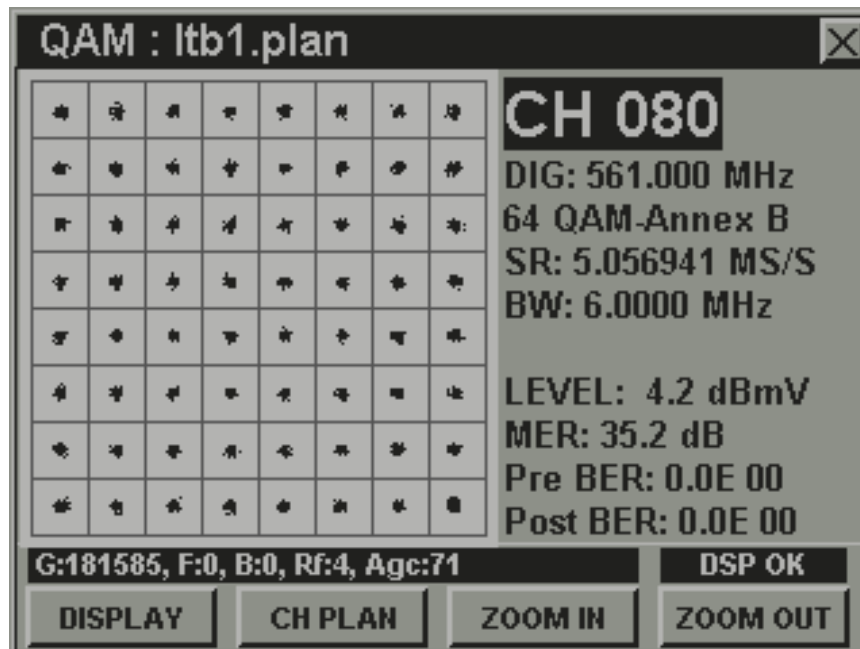
## 64 & 256 QAM Constellations



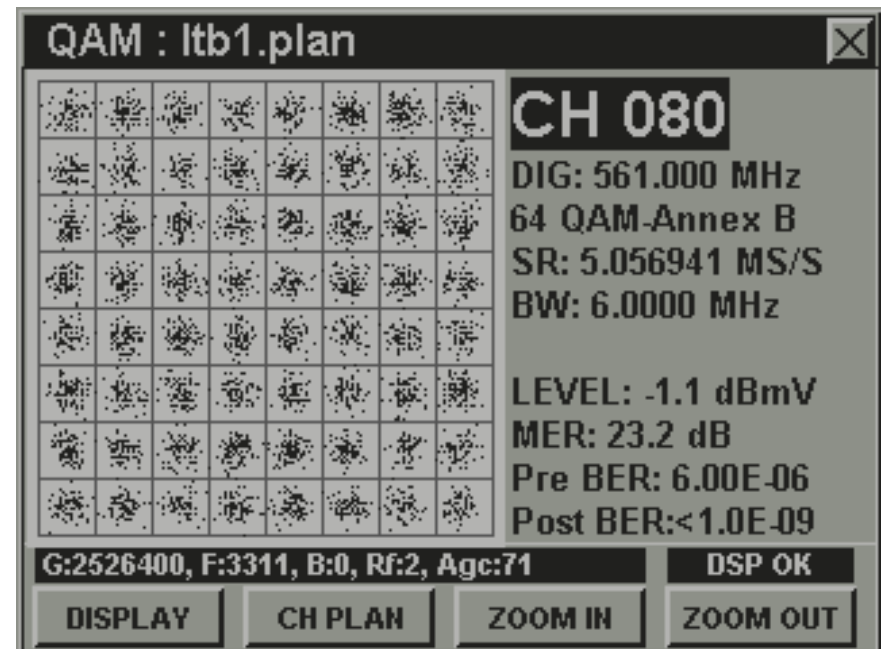


## Constellation

- Deviation from the ideal location



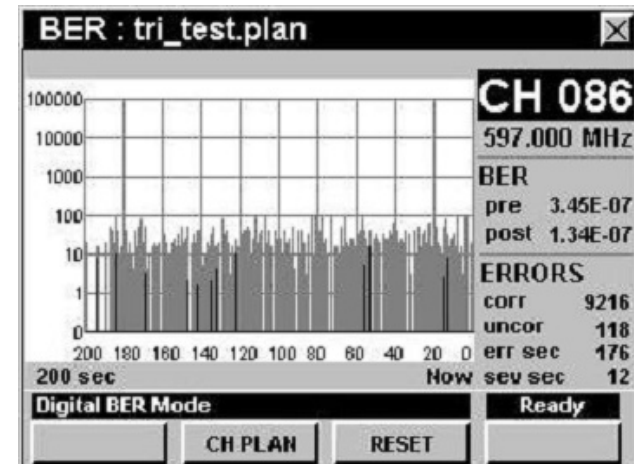
Good MER





# BER

- Digital signals work well until very close to the point of failure
- Measurement of digital carriers critical to determine the system margin
  - Signal level
  - MER
  - BER



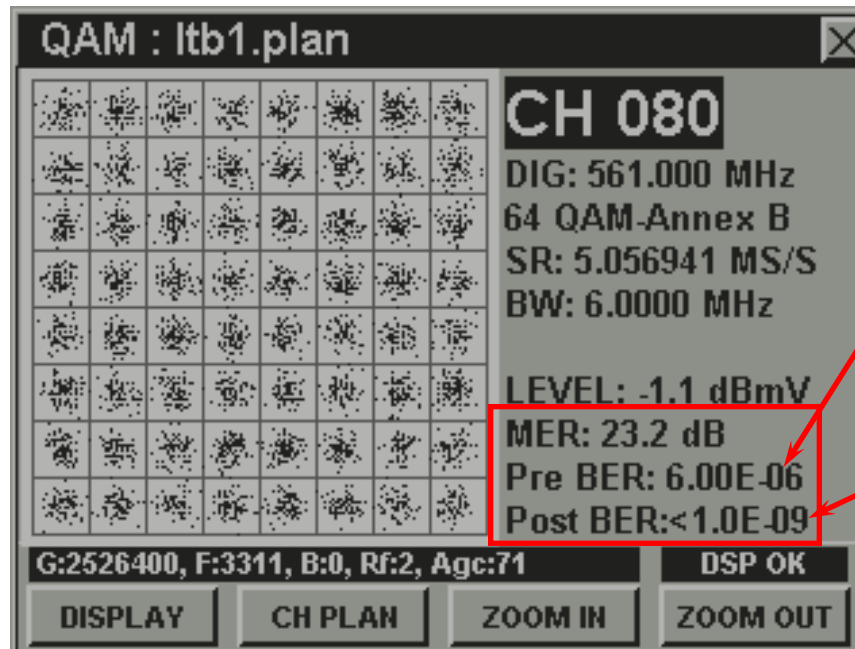
- The BER Mode helps to find problems





# Forward Error Correction

- FEC
  - Corrects errors to a point



Pre FEC BER  
(Before Correction)

Post FEC BER  
(After Correction)





# Forward Error Correction (FEC)

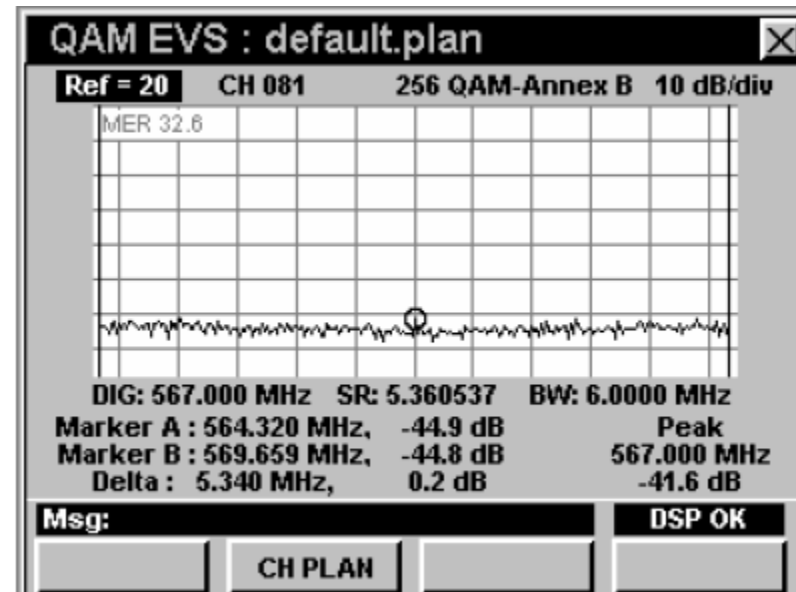
- Pre BER (before FEC) is the sum of all bit errors
- Post BER (after FEC) indicates the number of uncorrectable errors
- Adds information to the data stream (parity bit)
  - Parity Bit
    - Odd
    - Even
  - data size vs error correction





# How Do I see the Noise when the QAM carrier is present?

- Use the QAM EVS (Error Vector Spectrum)
- The QAM carrier is removed from the spectrum

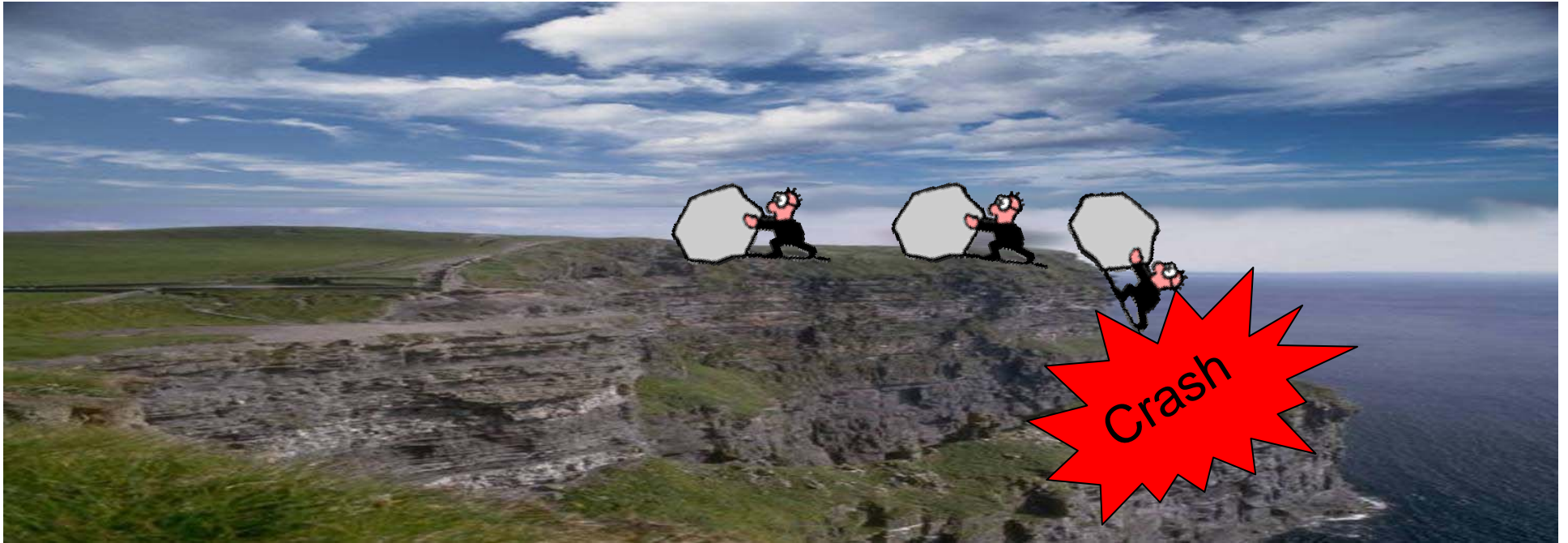




# MER TARGET - *THE “CLIFF” EFFECT*

- What is The “Cliff Effect”?





Operating margin  
Zone

Risk  
Zone

Crash  
Zone

Up/Downstream	16 QAM	>21dB	21dB - 19dB	<17dB
Downstream	64 QAM	>27dB	27dB - 25dB	<23dB
Downstream	256 QAM	>32dB	32dB - 30dB	<28dB



# Summary

- Digital level setting
  - Peak to Average
- MER has its limitations
  - Margin and BER
- Equalizer
  - Can only help so much
- Statistics show transients
- Flexible Digital demodulation





## Identifying Picture Problems in a HFC Network

# Questions?



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# *Problems Simulation (MER & BER)*





## Broadband Instruments and Systems



## Signal Leakage

**INCOSPEC**  
COMMUNICATIONS INC.  
*Broadband Telecommunications Solutions*  
*Solutions efficaces aux télécommunications à large bande*

 TRILITHIC

think ahead.



# Leakage

- Leakage terminology
- What is leakage
- Why do we monitor for leakage
- What causes leakage
- Leakage characteristics
- Locating source of leakage
- Ingress





# Leakage Terminology

- Egress
- Radiation (Never Say!!!)
- Leakage
- Ingress
- uV/M
- Squelch
- Calibration
- Tagging (CT-2 or CT-3)





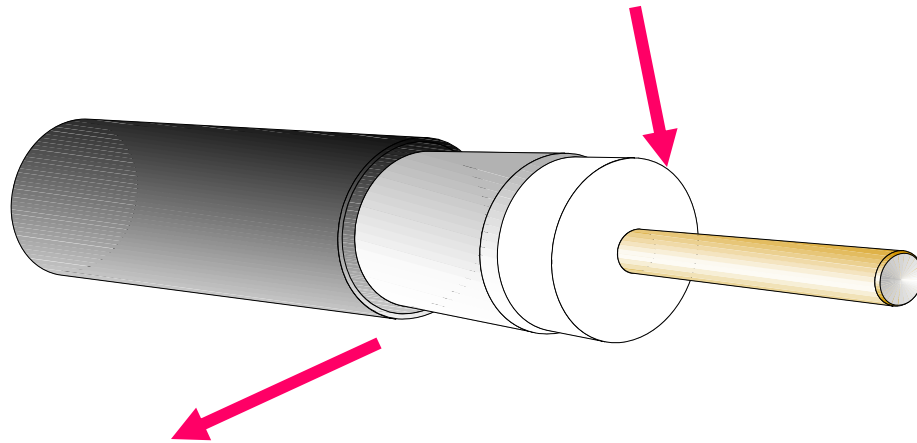
# What is Signal Leakage?

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





# Ingress & Egress



- Ingress

- RF or electrical energy that enters the coaxial environment

- Egress

- RF signal leaking out of the coaxial environment





# Why do we monitor for leakage?



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# Reason #1 to Monitor for Leakage

- Prevent Off-Air Broadcast Interference



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# Spectrum Chart

■ 108MHz

137MHz

Off-air	Aircraft Radio & Navigation				
Cable	CH 98	CH 99	CH 14	CH 15	CH 16





# 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!





# 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





# Required Actions

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





# $\mu\text{V}/\text{M}$

- 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 1 $\mu\text{V}$  of energy





## Reason #3 to Monitor for Leakage

- Eliminates Ingress
- Improves System Performance
- Reduces Repeat Service Calls
- Reduces Drop Calls for VoIP





# Reason #4 to Monitor for Leakage

- Locate Physical problems within the plant



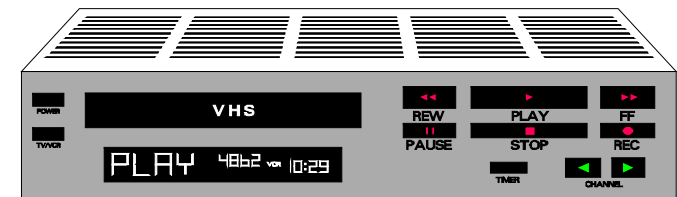
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# Common Causes

- 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

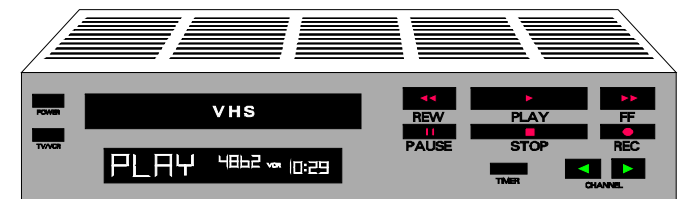


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# Other Causes of Leakage

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



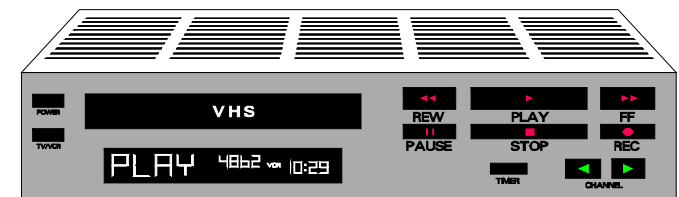
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# Other Causes Continued

- 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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# Acceptable Procedures for Leakage Measurement

- 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 360° in the horizontal plane for maximum reading
- CLI Fly-over



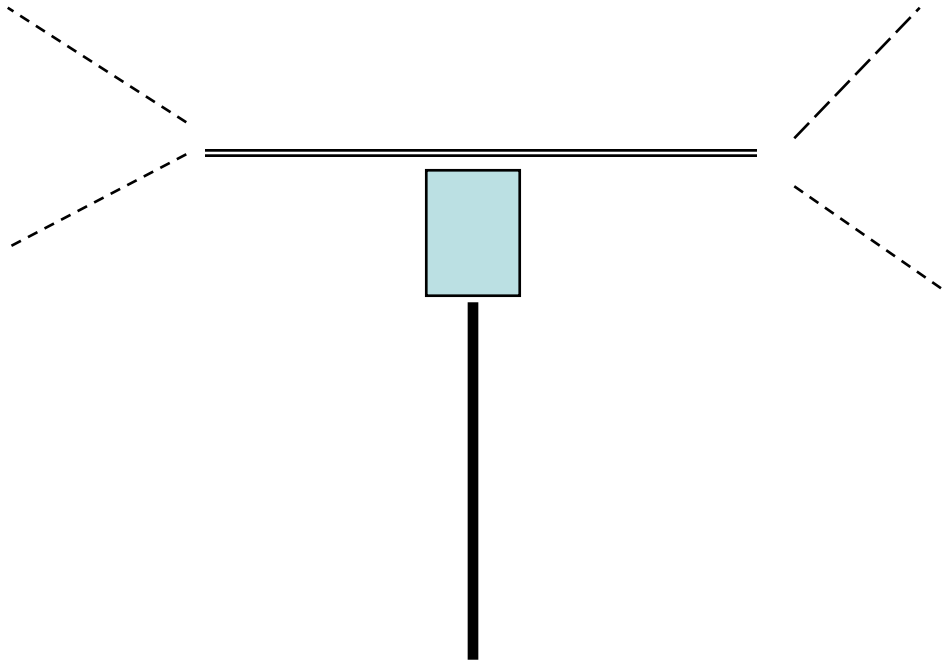
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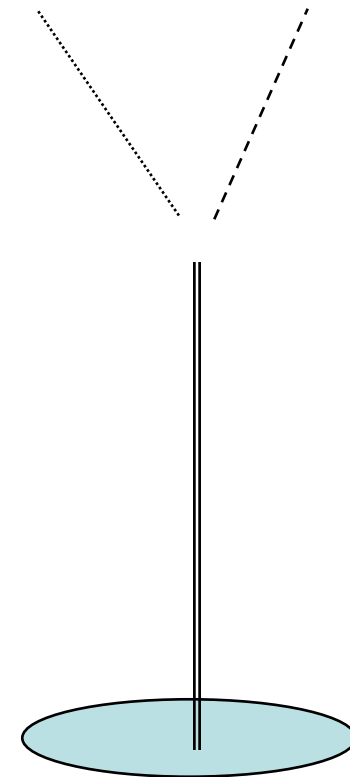


# Polarization Angle

Dipole



Monopole

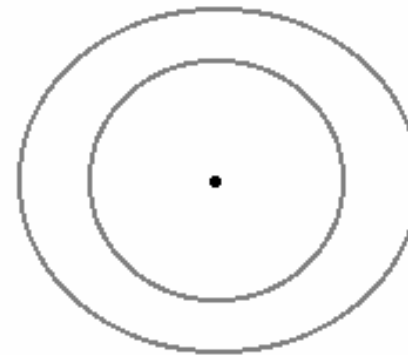
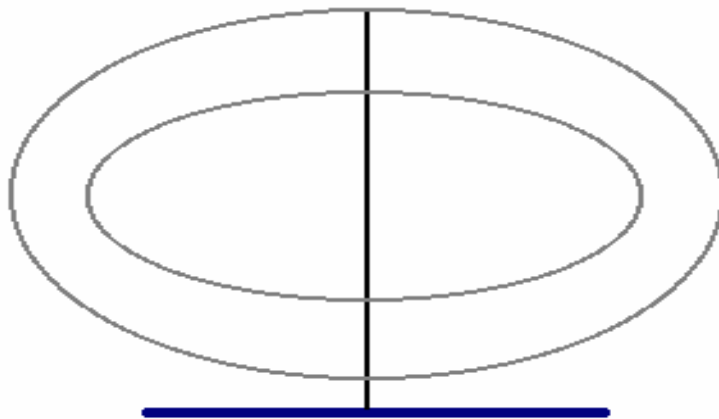


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# Leakage Antennas-Whip

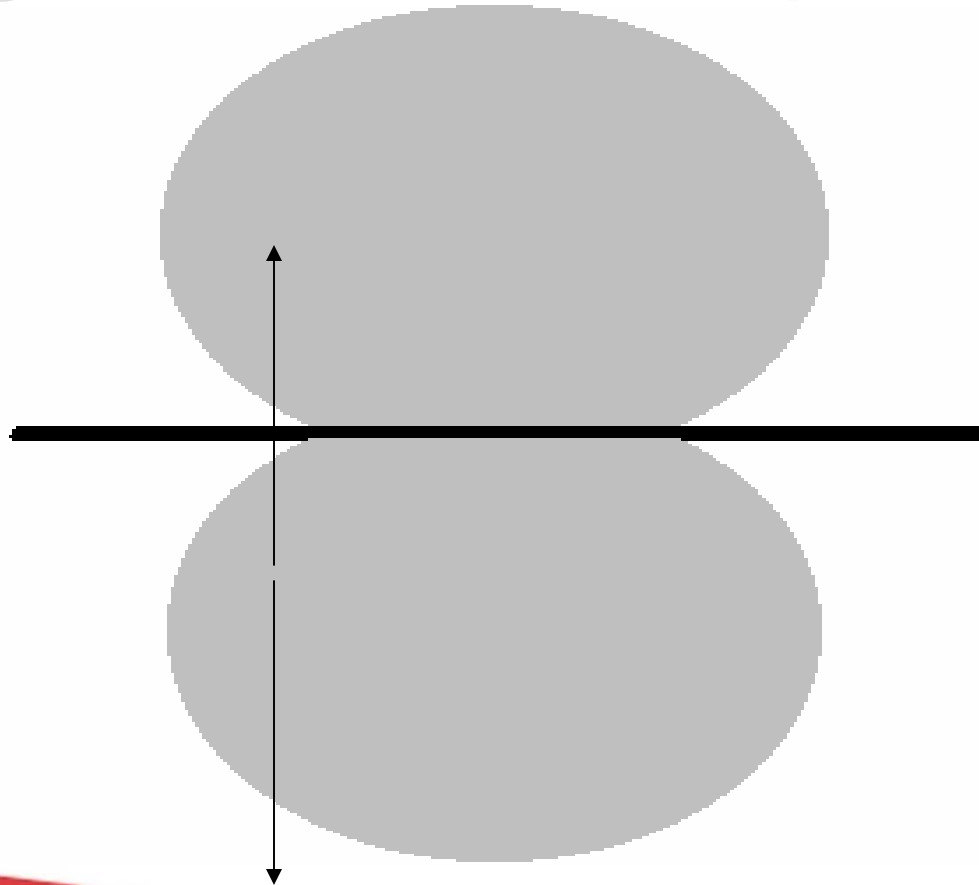


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# Leakage Antennas-Dipole



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# Seeker Lite

- Frequency Agile Leakage Detector
- Built-in directional Antenna





# Seeker GPS



- Data Storage
- GPS Equipped
- WiFi Upload Capable
- MapQuest Mapping
- Server Based

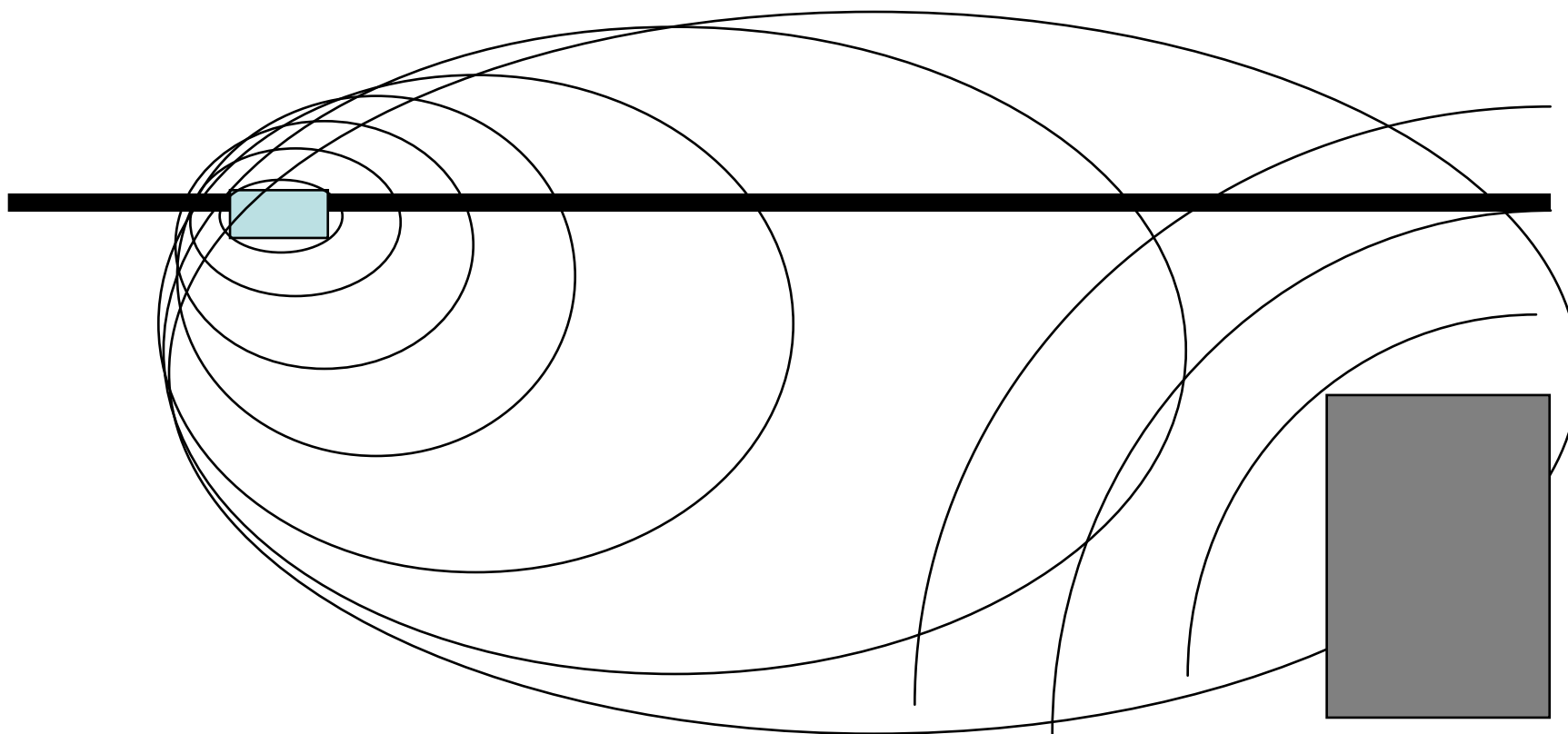


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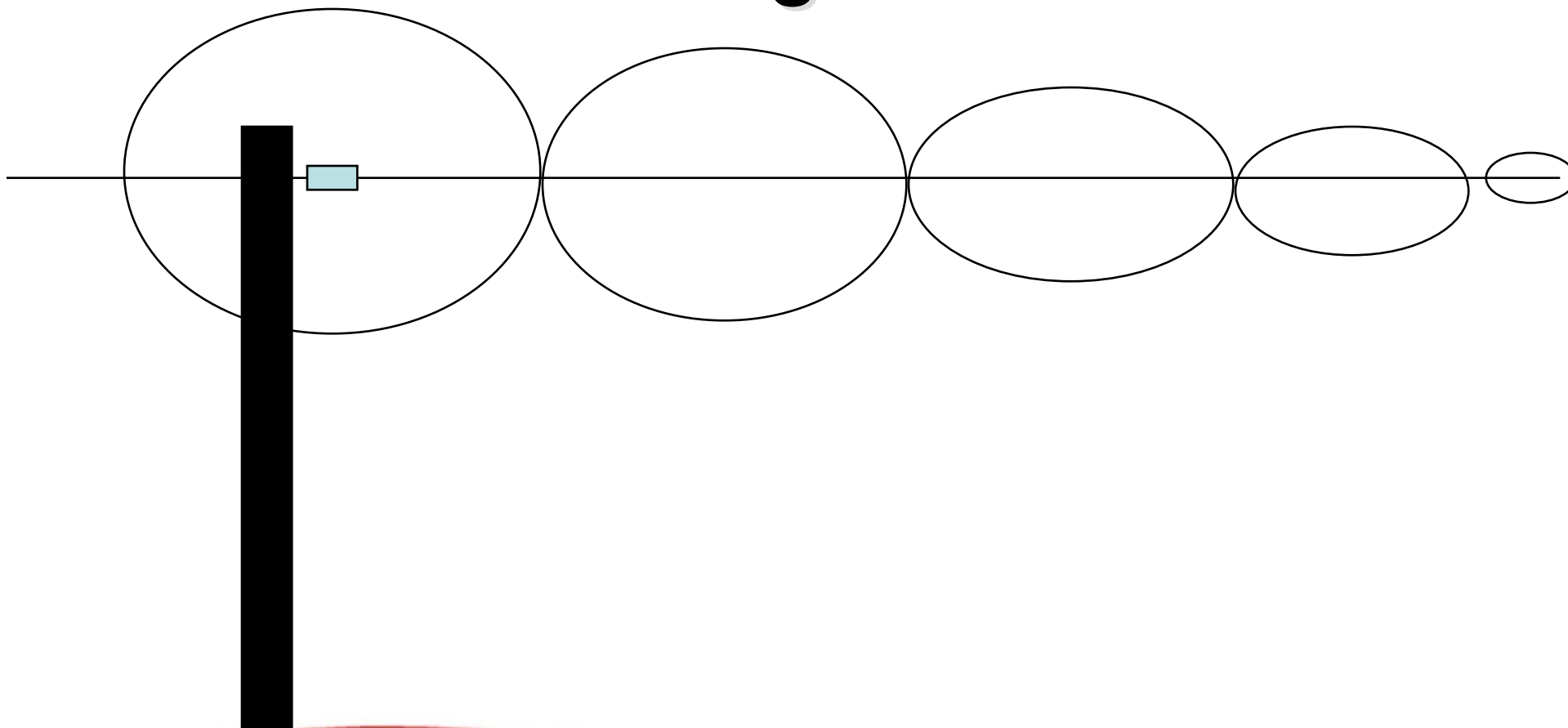


# Signal phasing





# Standing Waves

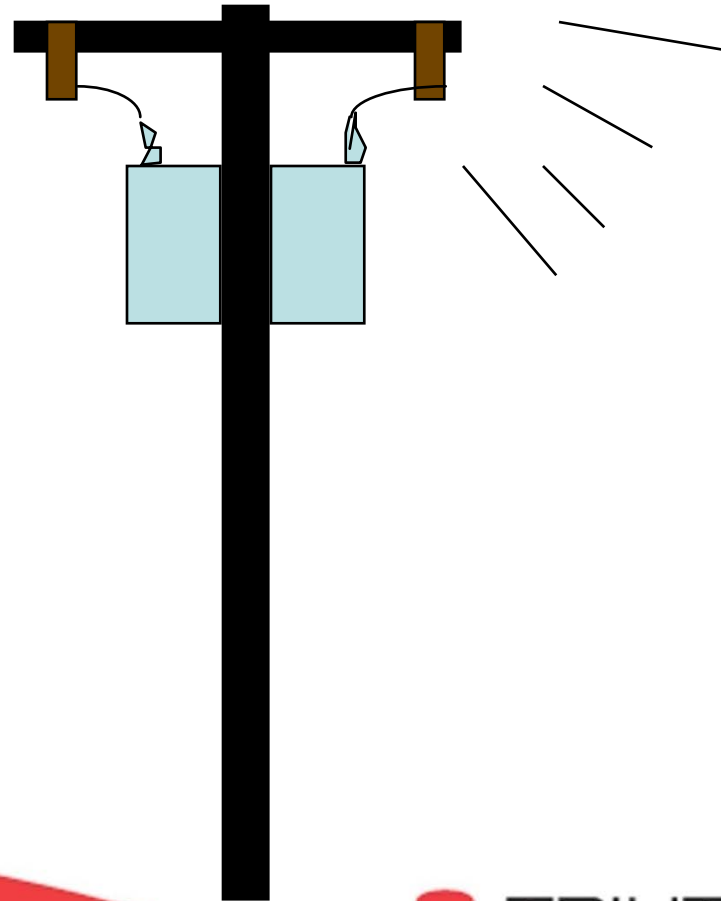


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# Electrical Noise

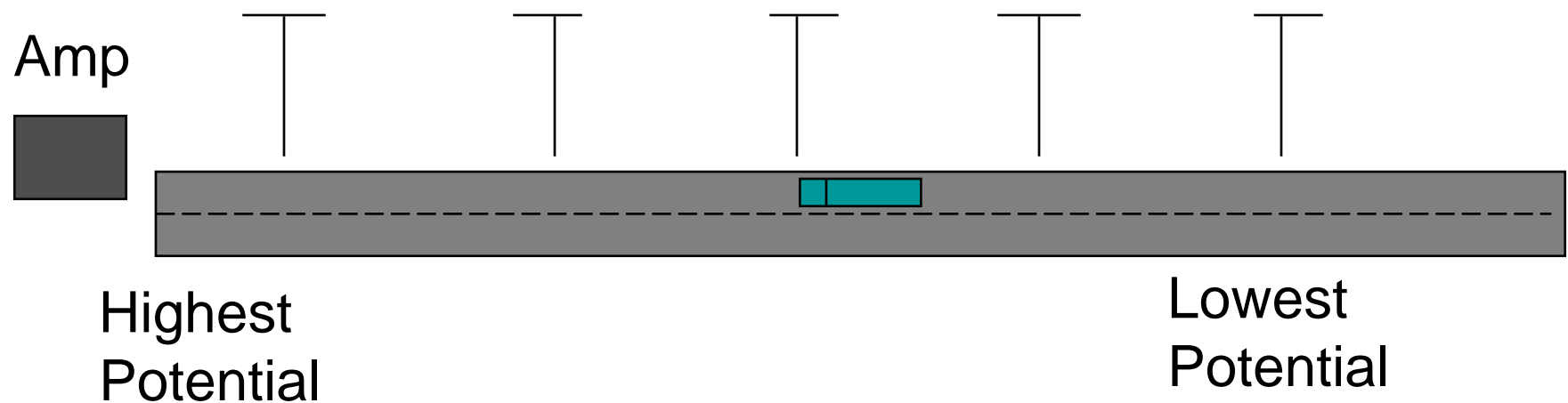


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# Leakage Field Strength





# Distance Correction

Reading x Distance

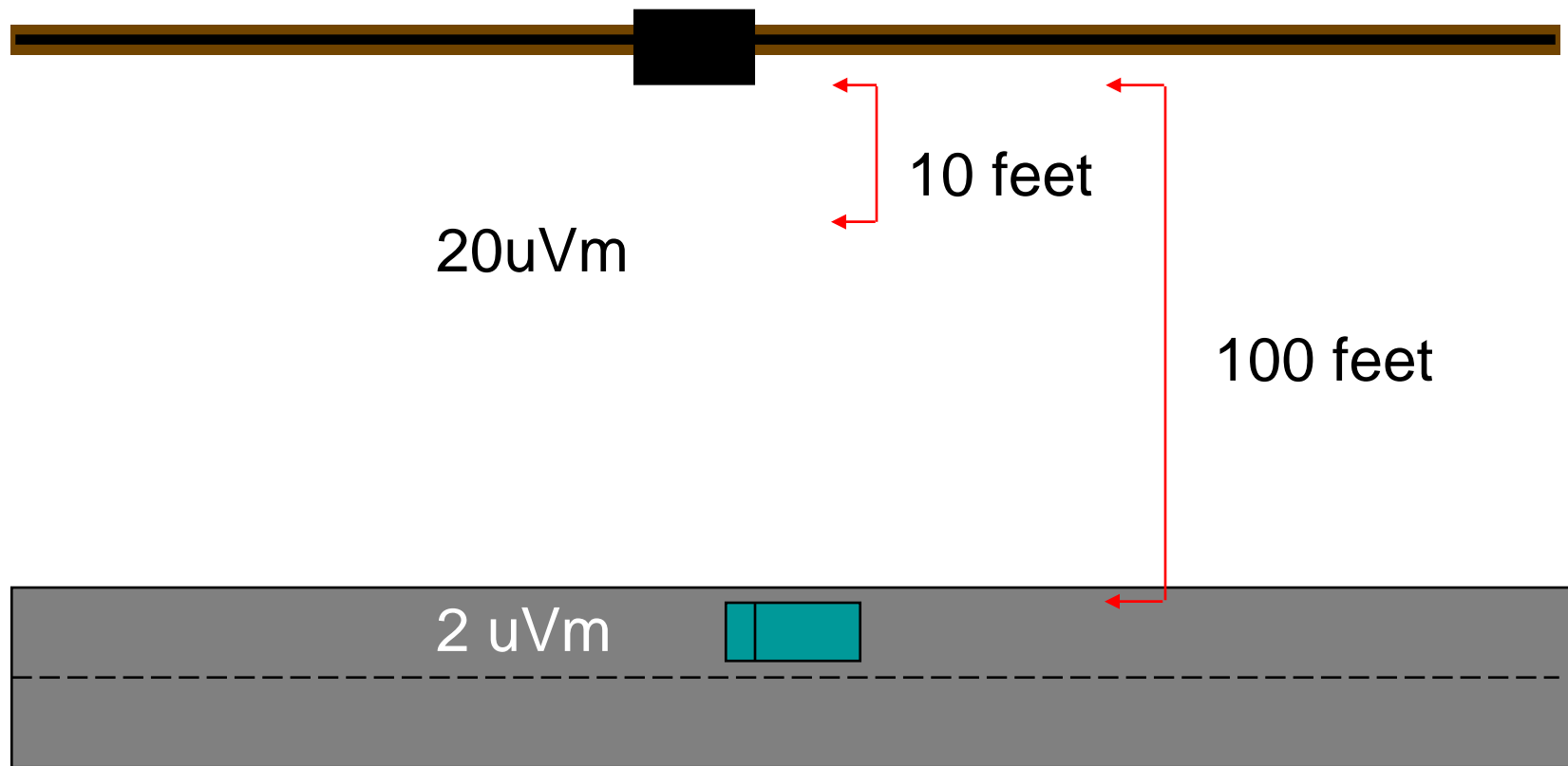
----- = Corrected Reading

10



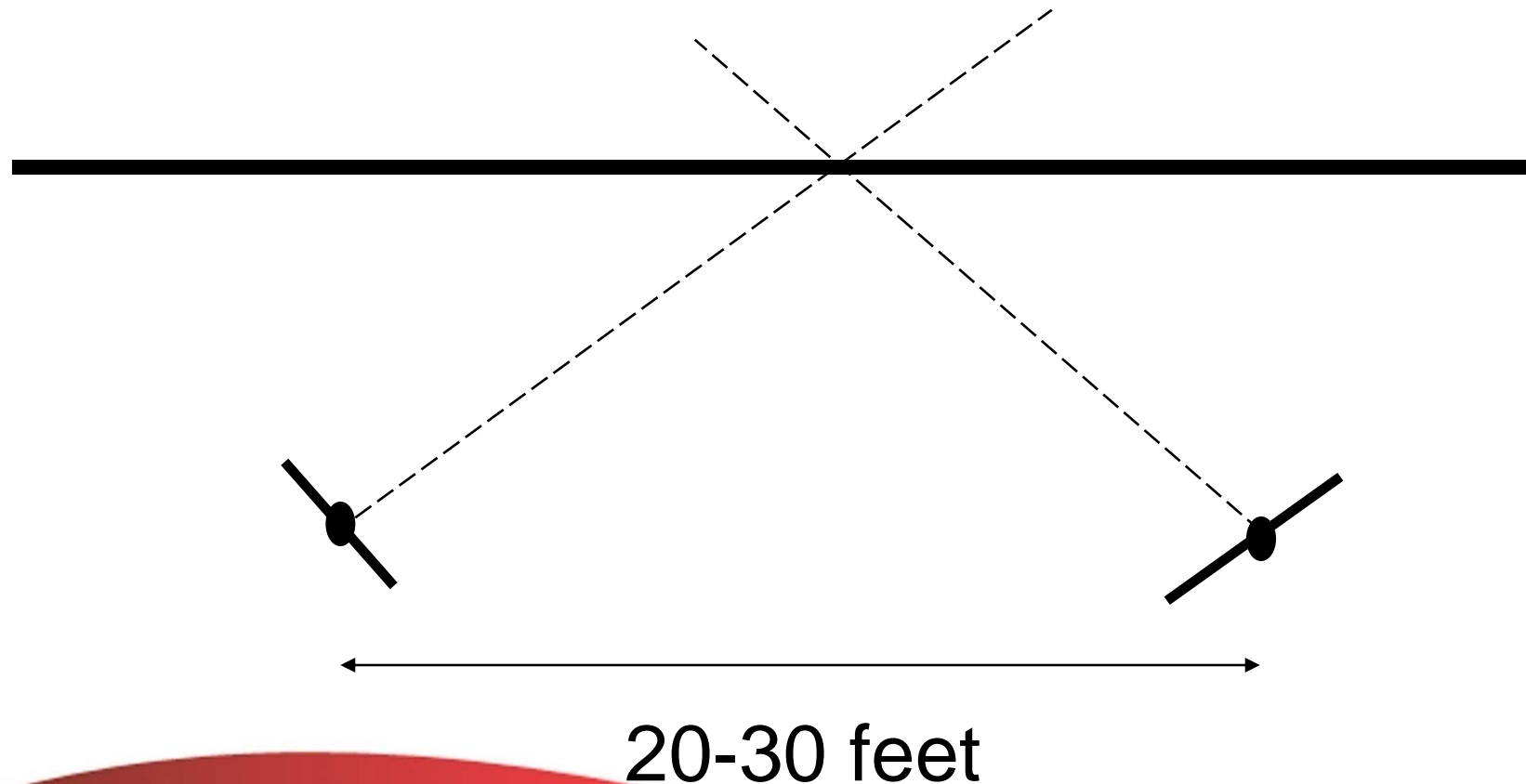


# Patrolling for Leakage





# Walking Out a Leakage Area

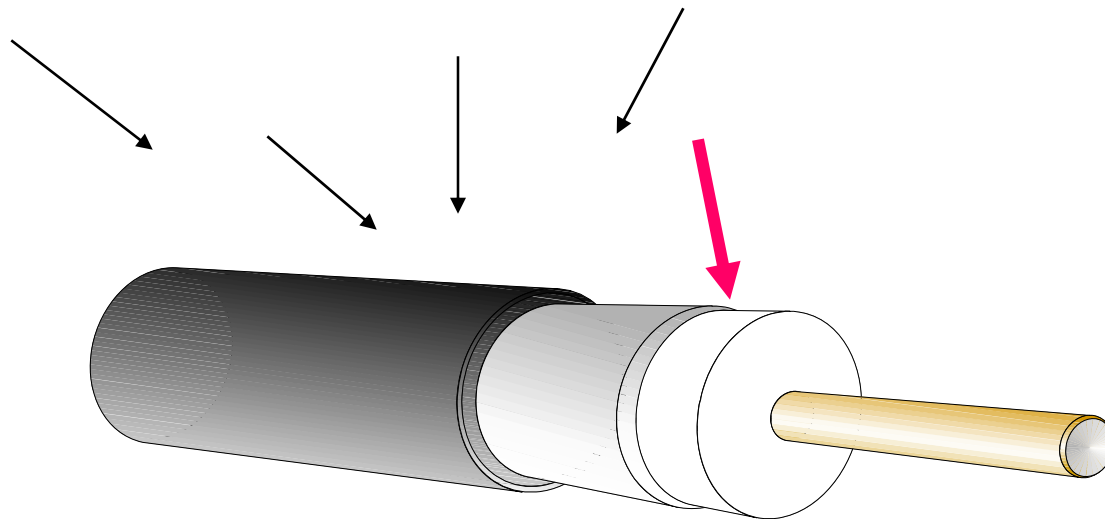


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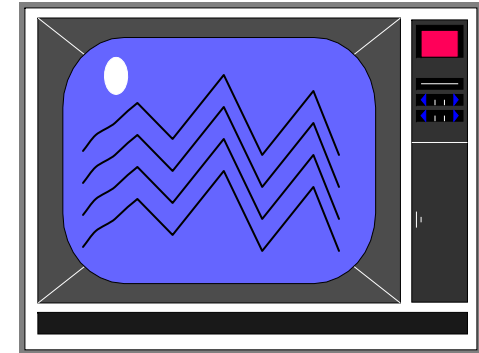
## Ingress





# Ingress on Analog Channels

- Lines in picture
- Ghosting
- Pay-per-view problems
- Interference with two-way radio services using the same frequencies
- Repeat Service Calls





# Ingress on Digital Channels

- Macro Blocking (Tiling)
- Freeze Frame
- Picture and Sound go to black
- Robotic Voice
- Data Packet Loss or slower speeds
- Dropped VoIP Calls
- Repeat Service Calls





## Identifying Picture Problems in a HFC Network

# Why and How to Check for Leakage ?



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- **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





## Identifying Picture Problems in a HFC Network

- 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



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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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## Identifying Picture Problems in a HFC Network

- 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
  - Greater than 20  $\mu\text{V}/\text{m}$  at a distance of 3 meters



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## Identifying Picture Problems in a HFC Network

# Questions?



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# *Problems Simulation (Leakage)*





# Thank you - Gracias

## Trilithic Applications Engineering

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## Incospec Communications Inc.

*Value Adder Trilithic Re-Seller for Caribbean*

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*Short Company Profile*  
*August 2008*



## *Who we are...*

**Incospec** is a **performance-oriented, VAR & expert partner** for its customers in the broadband telecommunications industry.

More specifically, our expertise is in the following fields :

- Headends and HFC networks for CATV
- MMDS and Wireless Broadband
- TVRO/Satcom
- TV/FM Radio Broadcast
- Data Transmission

For over 25 years, from our headquarters in Montréal, Canada, we have been serving customers in North America and around the world.





## *What we offer...*

- We offer system and equipment solutions for the broadband telecommunications markets.
- We also offer equipment modifications & upgrades, refurbished equipment and in or out of warranty repairs in our fields of expertise.
- Our alliances with reputable manufacturers of high quality equipment make a winning combination.
- Trilithic's broadband instruments is a good example





*TRILITHIC's value added reseller for Caribbean...*

## TRILITHIC Test Equipment Core Market

- Signal analysis
- Reverse/Forward maintenance & monitoring
- Leakage detection system





## *Trilithic's equipment...*

### **Installation**

- TR-2
- Model Two
- Seeker Lite
- TR 2040
- RSVP2

### **Supporting Products**

- CT-2 Channel Tag
- FST 8300
- 9581 SSTR4
- 9581 RSA Speed Sweep

### **Service & Maintenance**

- 860 DSPi
- 8821Q
- Seeker GPS

### **Monitoring**

- 860 DSPh
- Guardian II





## *Trilithic's Expertise...*

- **Forward Monitoring & Remote Signal Analysis**
- **Return Path Monitoring & Remote Spectrum Analysis**
- **System Sweep (forward & reverse)**
- **Return Path Loss Testing, Alignment & Certification**
- **Throughput & VoIP RTP Testing**
- **Upstream QAM Testing**
- **Subscriber Premises Installation Service Assurance**
- **Test Data Management for Team Efficiency**
- **Automated CLI Leakage system assisted by GPS**
- **Drop integrity validation**

*What represents us...*



*Contact...*

**For your future cost effective test equipment requirements for the Headend and all parts of the HFC network, we invite you to visit us @**

**<http://www.incospec.com>**

**<http://www.trilithic.com>**

Mario Sebastiani

Business Development

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