


VeEX
The Verification Experts

Home Certification and Troubleshooting Technics

SCTE Piedmont Chapter

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Technical Session Overview

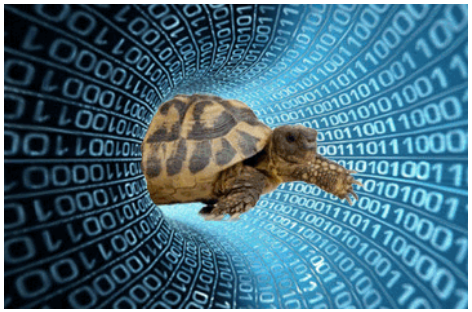
- Troubleshooting the Triple Play
- Return Path Analysis
- Digital Testing
- Auto Testing and Home Certification
- Perpetual Install

Challenges faced by the Customer

Slow Internet

Poor Picture Quality

Dropped calls



Slow Transmission Network Challenges

What Is a Home Certification

- Verifying the health of the subscribers network
- Taking corrective actions to ensure network performance
- Creating a birth certificate for future references

Challenges faced by the technician

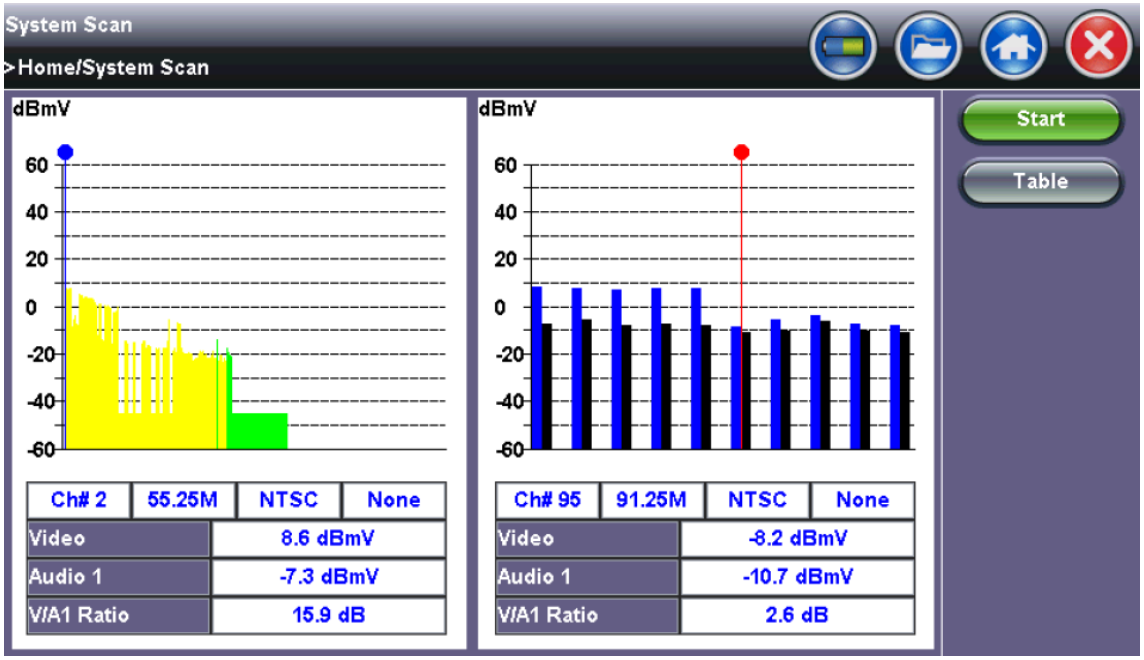
- Increased SD and HD services
- Higher Demand for QoS & Reliability
- More Competition from Telecom & Others
- Must Reduce Truck Rolls & Service Calls
- Additional Products and CPE to learn
- Operational Costs are greater
- Enhancing Customer Satisfaction

Troubleshooting the Triple Play

Step by Step Procedures

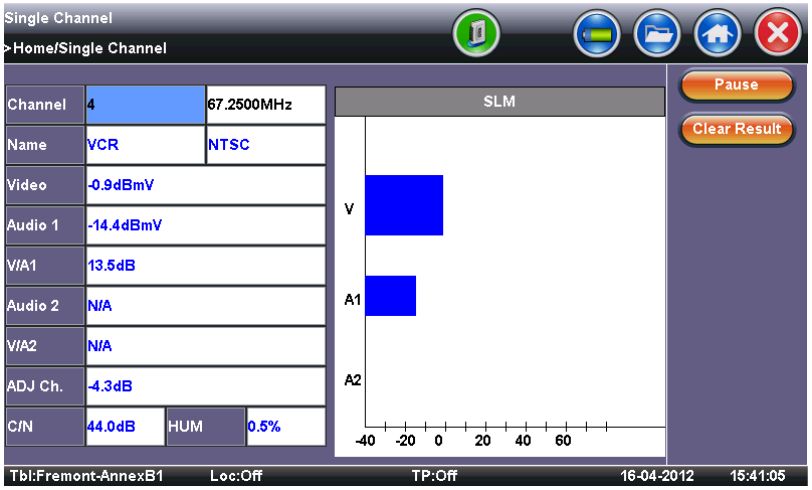
System Scan

- Provides graphical view of the entire channel plan based on the selected channel table.
- Both Analog and Digital channels are measured
- Fast visual snapshot of Analog, Digital, or DOCSIS carrier levels.
- Digital channels should be 6 to 10 dB below Analog channels
- DOCSIS/Digital channel levels should range between -8 to +7 dBmV



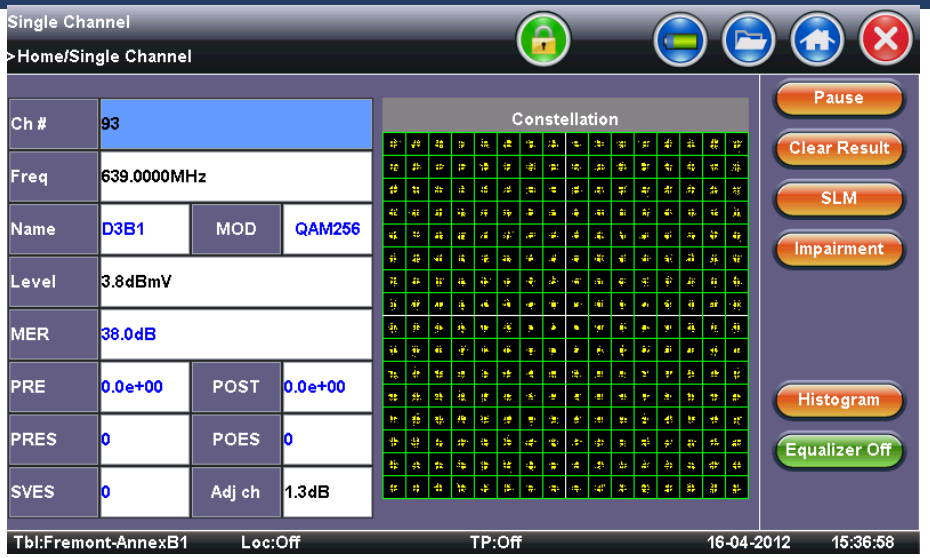
Single Channel Analog Measurement

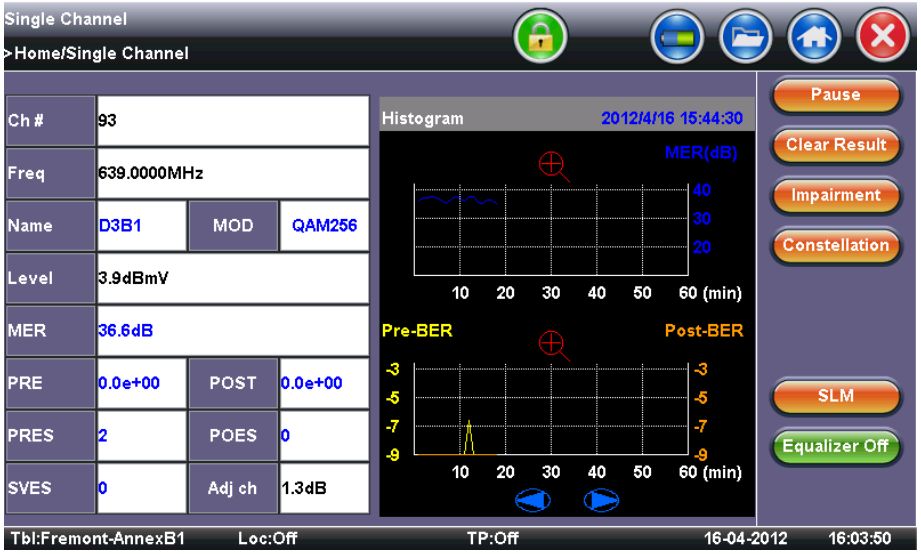
- Measurement of selected frequency or a Channel that is active in the Channel Table
- Content differs for Analog or Digital signals
- Analog Signal
  - Video Levels
  - Audio Levels
  - Video/Audio (V/A) Delta
  - Carrier to Noise (C/N) Ratio

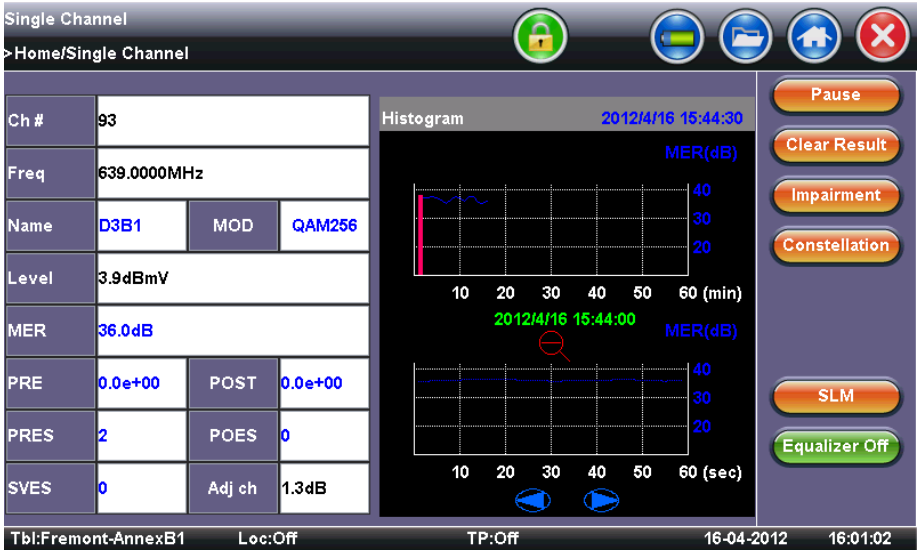


Single Channel Digital Measurement

- Digital Signal
  - Average power of QAM
  - MER
  - BER: Pre FEC and Post FEC
  - Pre/Post Errored Seconds
  - Severely Errored Seconds







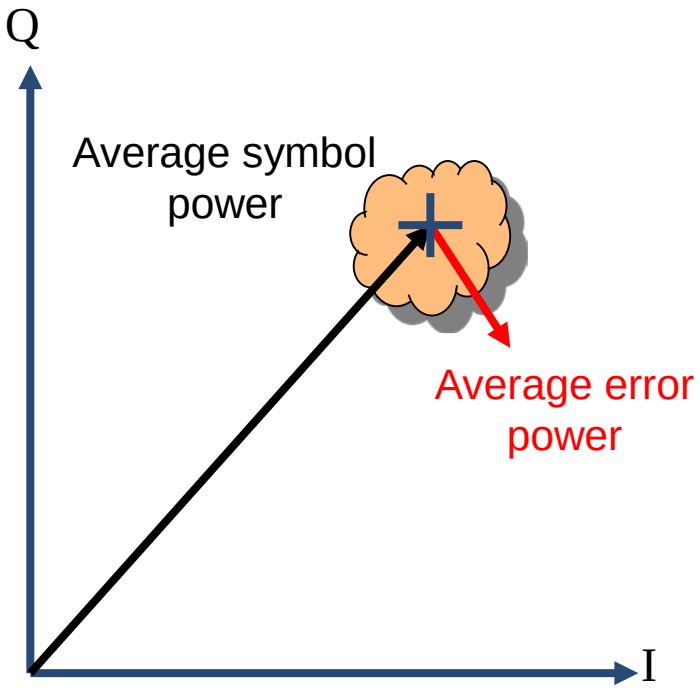
QAM Overview

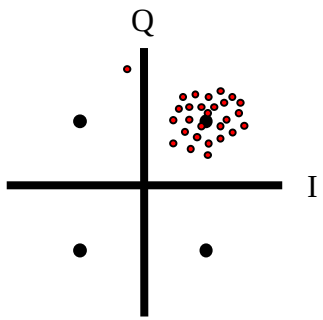
- What is QAM?
  - QAM stands for Quadrature Amplitude Modulation.
  - A scheme that transmits data by changing the amplitude of two carrier waves
  - The two carrier waves are out of phase with each other by 90 degrees
  - Each carrier represents half the transmitted symbol.
  - Multiple levels of amplitude & phase modulation

- Digital Cable uses QAM to transmit signals - two major QAM schemes are;
  - 64QAM which has a data throughput around 28 Mbps
  - 256QAM which has data throughput of 38.8 Mbps

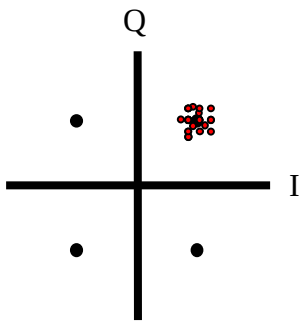
Modulation Error Ratio (MER)

- Modulation Error Ratio (MER)
  - Measures the “signal-to-noise ratio” (SNR) in a digitally modulated carrier
  - Expressed in dB, indicates the system margin available before a failure can be expected
  - Considers amplitude, phase noise and other impairments on the signal
  - Is a direct measure of modulation quality and is linked to the bit error rate of signal





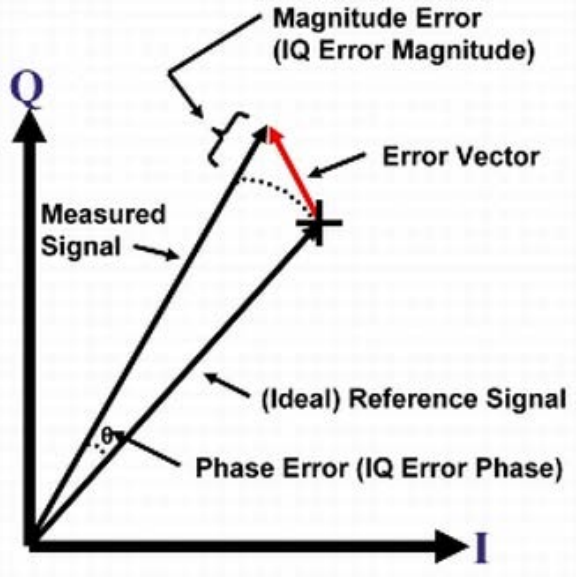
A large “cloud” of symbol points means low MER - this is not good !

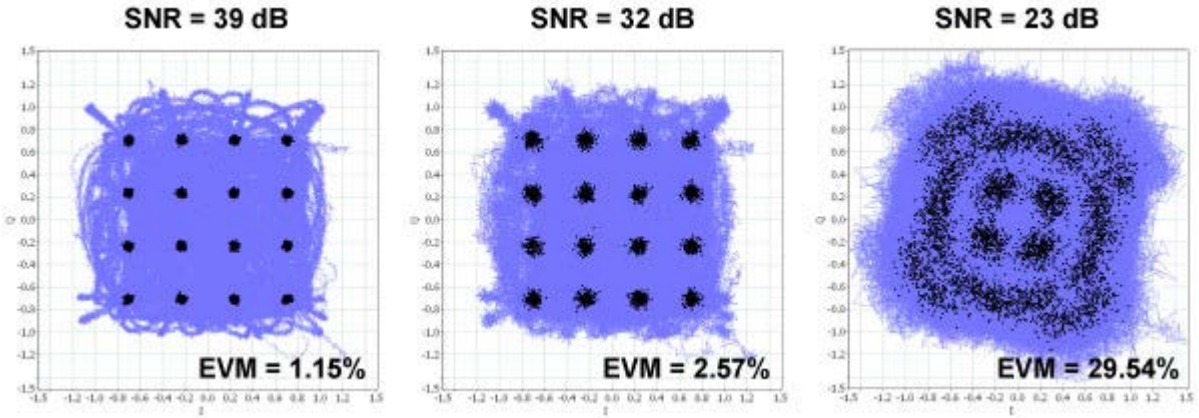


A small “cloud” of symbol points means high MER - this is good !

Error Vector Magnitude (EVM)

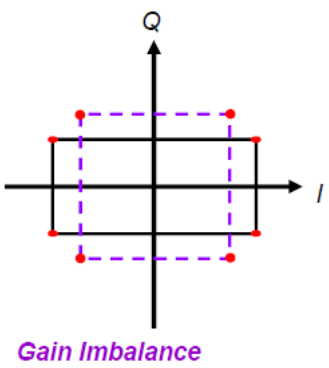
- Error Vector Magnitude (EVM)
  - Noise, distortion, spurious signals, and phase noise all degrade EVM - these impairments cause symbol “landing” points to be spread out from their ideal positions
  - Informally, EVM (%) is a measure of how far the points are from the ideal locations
  - MER and EVM are inter-related - see diagram below

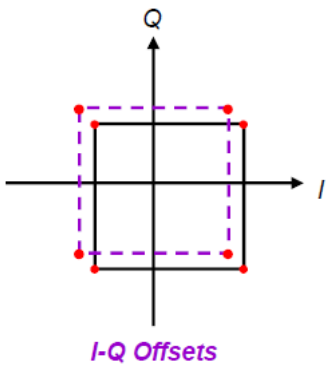


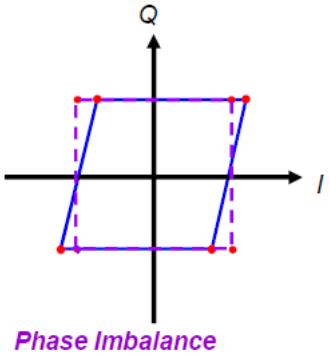


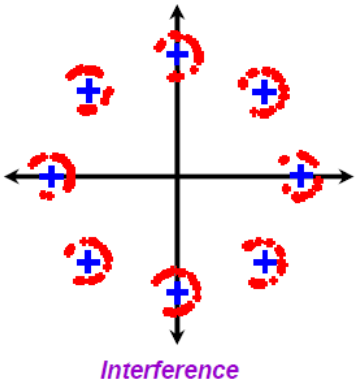
QAM Impairments

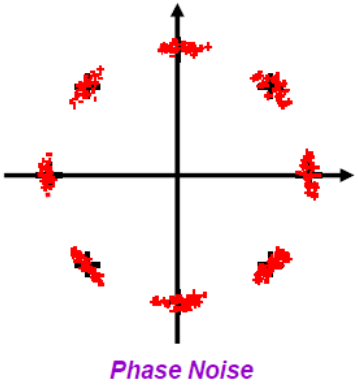
- Common QAM impairments include;
  - Additive white Gaussian noise (AWG)
  - Coherent interference
  - Gain compression
  - RF phase noise
  - I/Q phase error
  - I/Q gain error

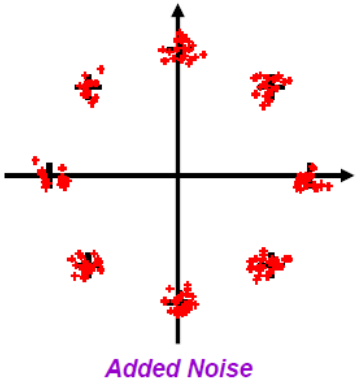






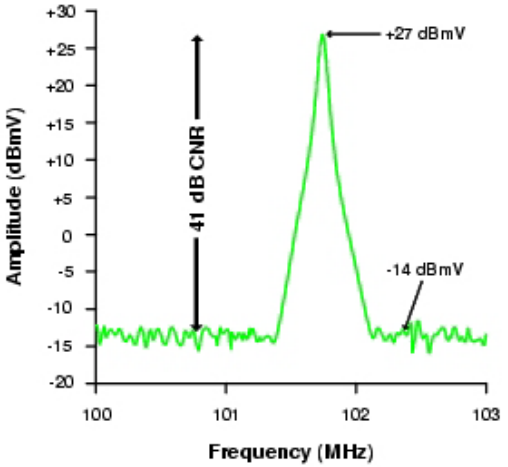






C/N vs MER/SNR

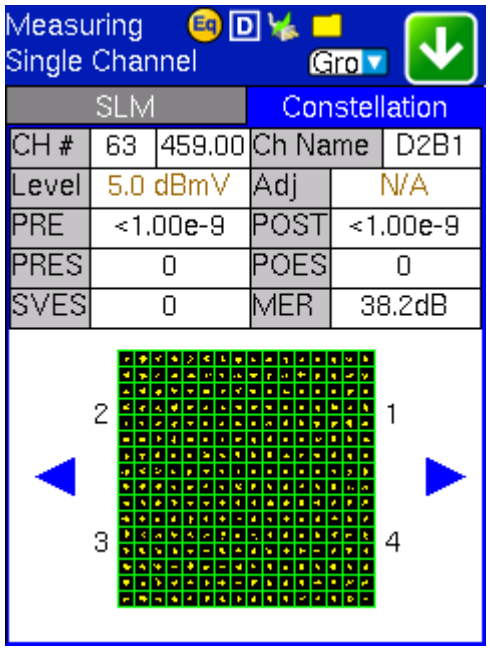
- Carrier-to-Noise (C/N) ratio
  - Used in analog systems – measures ratio of peak video carrier power over the noise in the channel, over the system bandwidth expressed in dB.
  - Can be performed on digital signals, but does not provide a complete picture.



- MER and SNR
  - Used in digital systems however the terms "SNR" and "MER" are often used interchangeably
  - MER is digital complex baseband signal-to-noise ratio (SNR) and is the ratio, in dB, of average symbol power to average error power.

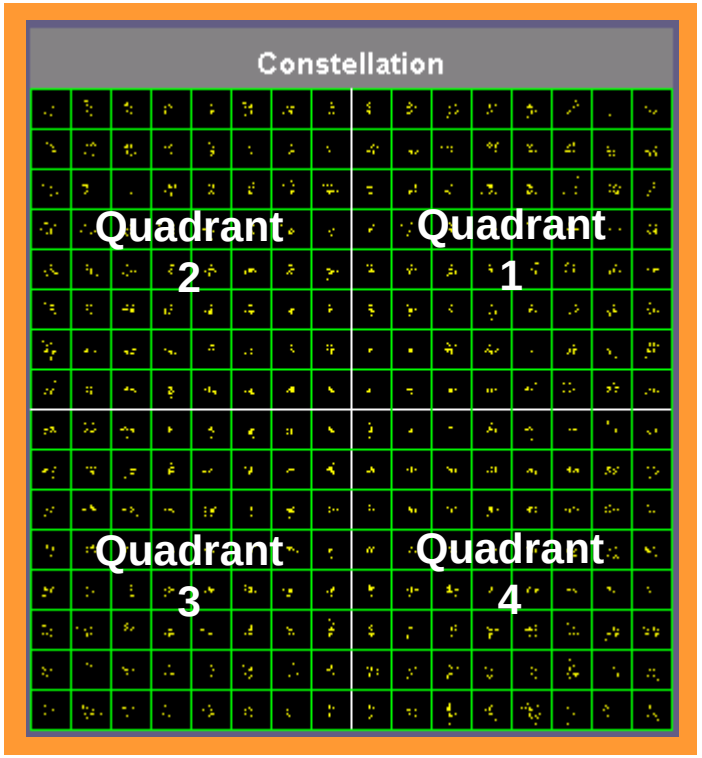
Constellation Display

- Constellation display
  - Provides a graphical view of the demodulated QAM signal.
  - Allows quick identification of impairments such as gain compression or IQ imbalance.
  - The visual appearance of the constellation can be used to isolate and troubleshoot problems.



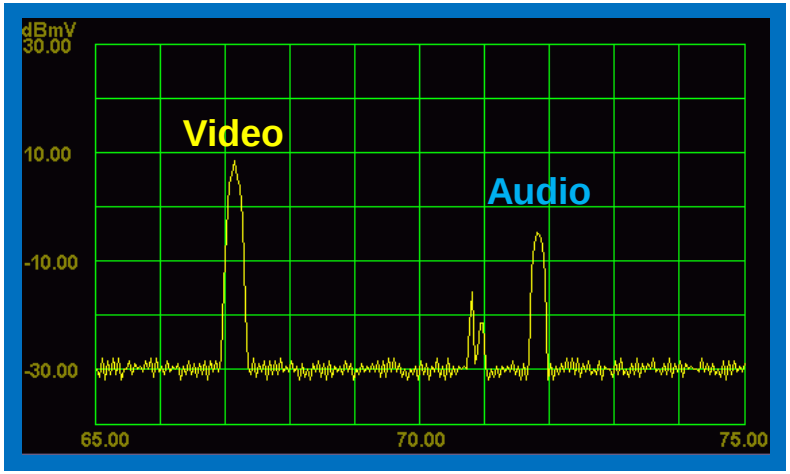
Constellation Diagram

- Quadrants/Boxes
  - Each box in the diagram contains one symbol
  - 64QAM: 6 bits per symbol, thus 64 boxes
  - 256QAM: 8 bits per symbol, thus 256 boxes
- Decision Boundaries/Build-Up
  - Each location on the constellation is framed by decision boundaries
  - If the signal falls within these boundaries, the correct data will be received
  - If it falls in an adjacent area, the data will be in (bit) error
  - Locations on the constellation build up over time
- Purpose
  - Shape and distribution of dots are indicative of signal impairments and help you interpret and understand QAM Modulation related problems



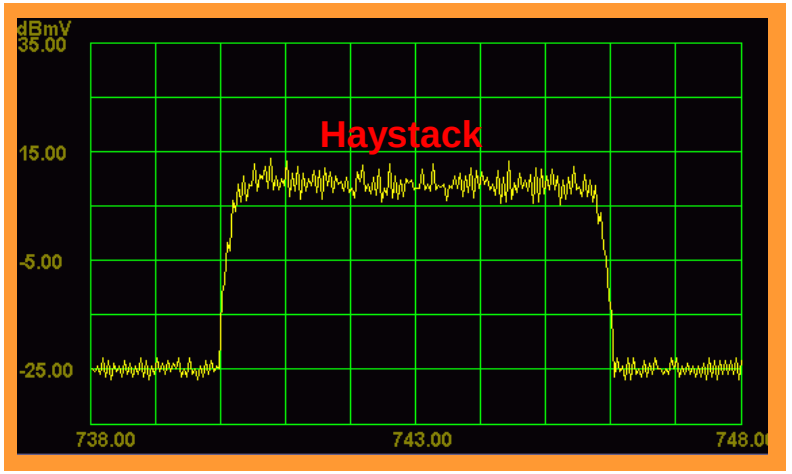
Digital vs Analog carriers Spectrum

Analog



- Video & two audio channels are modulated in three separate frequencies in a 6 MHz bandwidth.
- Transmitted at different levels. Normally, a video channel is about 10dB higher than the audio channels.
- Signals are in analog nature, therefore, more resistance to noise.

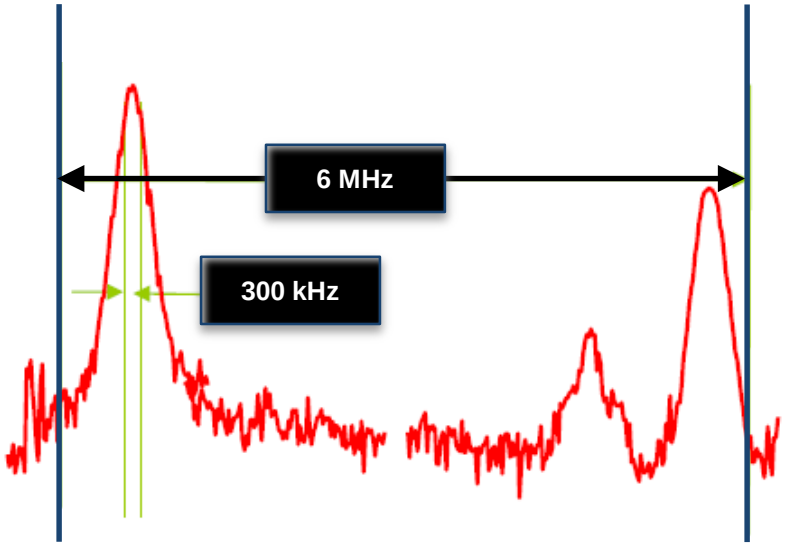
Digital

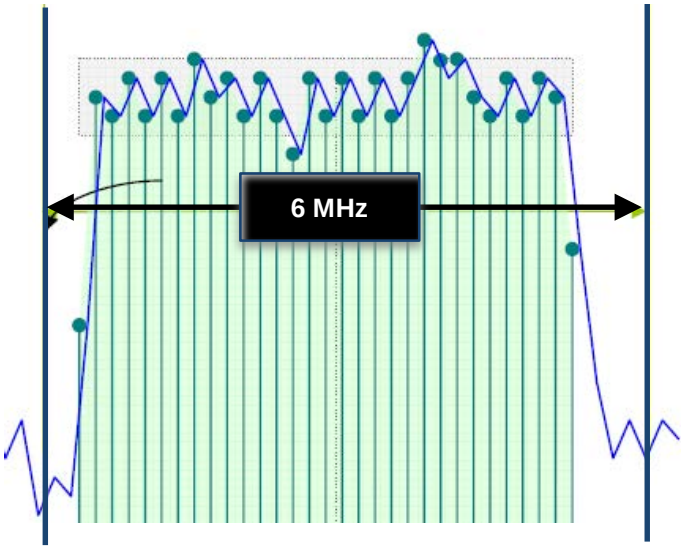


- Video and Audio signals are digitized, then modulated (QAM16/64/256), and transmitted in a 6MHz band
- Digital symbols (bits) are embedded in the Haystack.
- Noise can affect the digital bit streams
- FEC (forward error correction) is used to correct errors caused by noise

Digital vs Analog carriers
Key differences

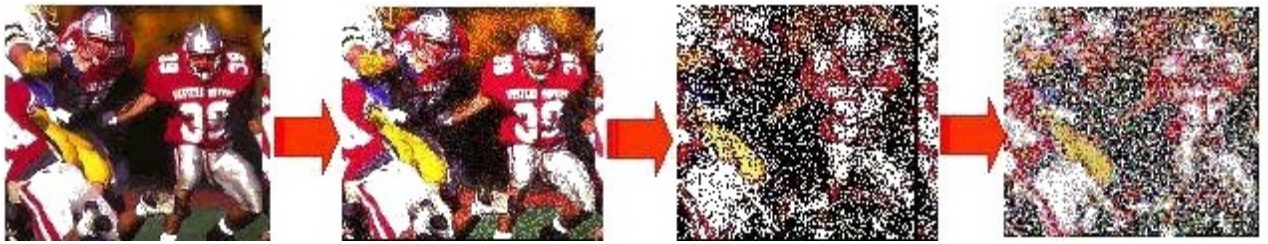
- Digital carriers are generally more robust than analog carriers
- Downstream digital data is in the form of a “haystack”
- Level/Power Measurement
  - Analog carrier levels are measured using a peak detection method
  - Digital carriers use an averaging method





Digital vs. Analog carriers Noise Impact

Effect of noise on Analog Systems (Gradually Poorer C/N)



45dB C/N | 35dB C/N | 25dB C/N | 20dB C/N

Effect of noise on Digital Systems (Gradually Poorer MER)

35dB MER | 32dB MER | 30dB MER | 28dB MER

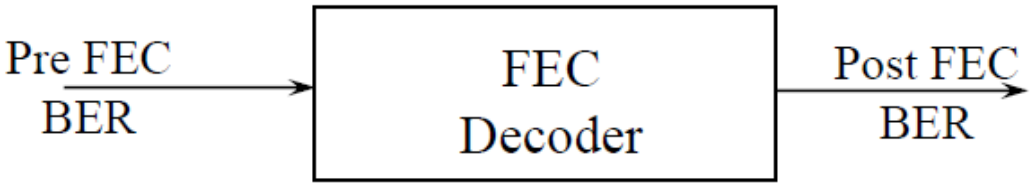
- Noise has little effect on digital signals until the system fails completely – commonly referred to as the “cliff effect”
- When a minimum signal quality (Max bit error rate i.e. Post-FEC error rate) is reached, the digital decoder (QAM demodulator) is no longer able to recover the digital bit stream.

Bit Error Rate (BER)

- What is BER?
  - Major indication of system health
  - As data is transmitted some of the bits may not be received correctly
  - The more bits that are incorrect, the more the signal will be affected
- BER Definition
  - BER is defined as the ratio of the number of wrong bits over the number of total bits.
  - BER is displayed in Scientific Notation.
  - The more negative the exponent the better
  - >1.0E-6 Pre-BER is the minimum for an installation
- Typical Problems
  - FEC can typically correct errors that are spread out are due to noise problems
  - FEC may not be able to correct errors that are grouped are due to intermittent problems such as ingress or loose connectors.

Forward Error Correction (FEC)

- What is FEC?
  - The FEC process adds information to each packet in the transport stream, to enable the correction of transmission errors.
  - Additional data is generated using Reed Solomon encoder calculated from the original data stream before transmission
  - Using the same Reed Solomon decoder at the receiving end, bit errors can be detected as are called Pre-FEC errors
  - By going through the error correction algorithm, some Pre-FEC errors can be corrected.
  - When Pre-FEC errors become significant and some errors cannot be corrected, they are termed Post-FEC errors
  - Post-FEC errors cause poor TV signal quality and/or Internet data retransmission
  - Since analysis can be made on live data, this is the method recommended for non-intrusive in-service bit error ratio estimation.



Adaptive Equalization

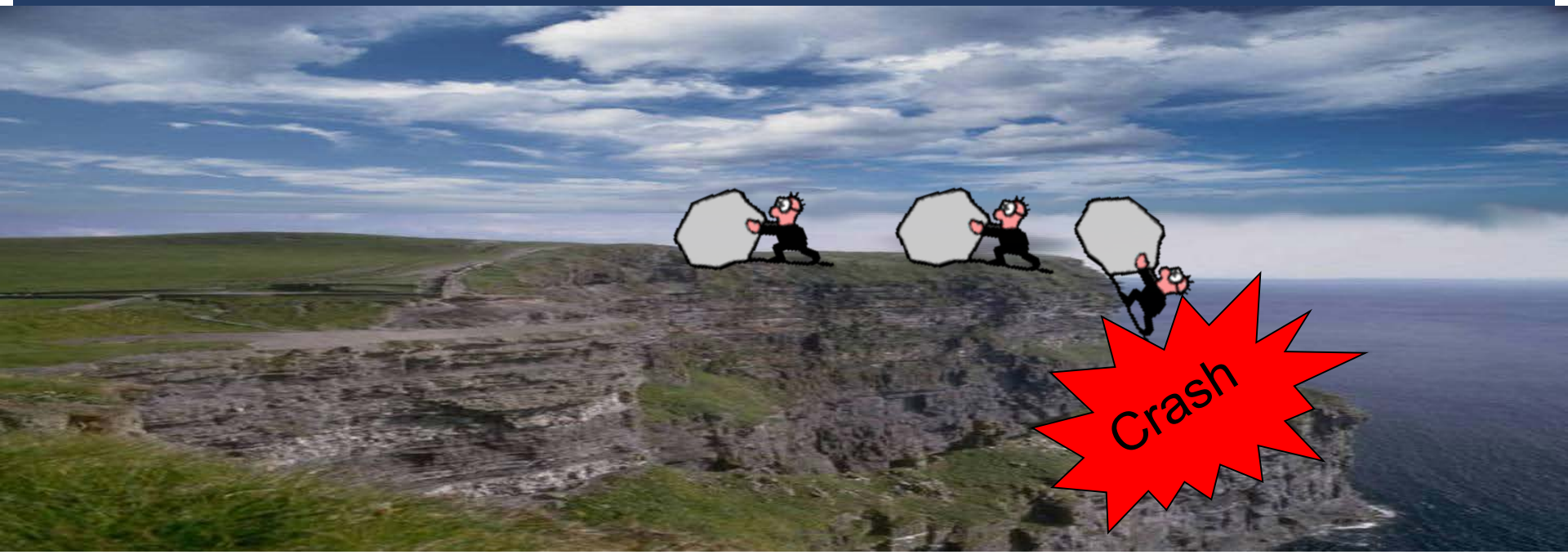
- Most Receivers have internal Adaptive Equalizers
  - Its important to measure a signal the way a real receiver would
- Adaptive Equalizer may be required for QAM symbol lock
  - Some signals cannot be measured without equalization.
- Valuable Troubleshooting tool
  - Distinguish between linear gain/phase errors and non-linear distortion.
  - Measure real systems while in service.
  - Quantify amount of stress put on receiver's equalizer.

Acceptable MER

- General Operating Guidelines (MER)
  - 64QAM set top converters usually require >23dB MER to operate
    - Allow a margin of 3 or 4dB for system degradation
  - 256QAM set top converters usually require >28dB MER to operate
    - Allow a margin of 3 or 4dB for system degradation
  - 256QAM picture tiling begins around 28dB MER
  - “Digital Cliff” effect begins around;
    - 22dB for 64QAM
    - 28dB for 256QAM
  - A good MER is usually around 31dB for 256QAM at customer device

MER TARGET - *THE "CLIFF" EFFECT*

- What is The "Cliff Effect"?



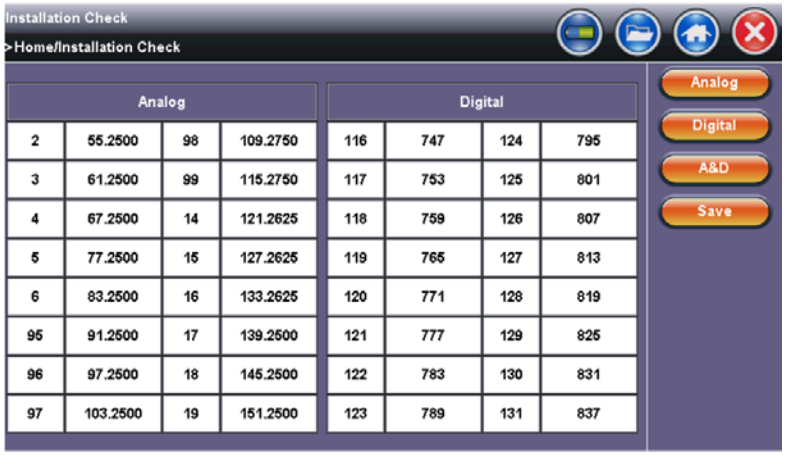
Operating margin Zone

Risk Zone

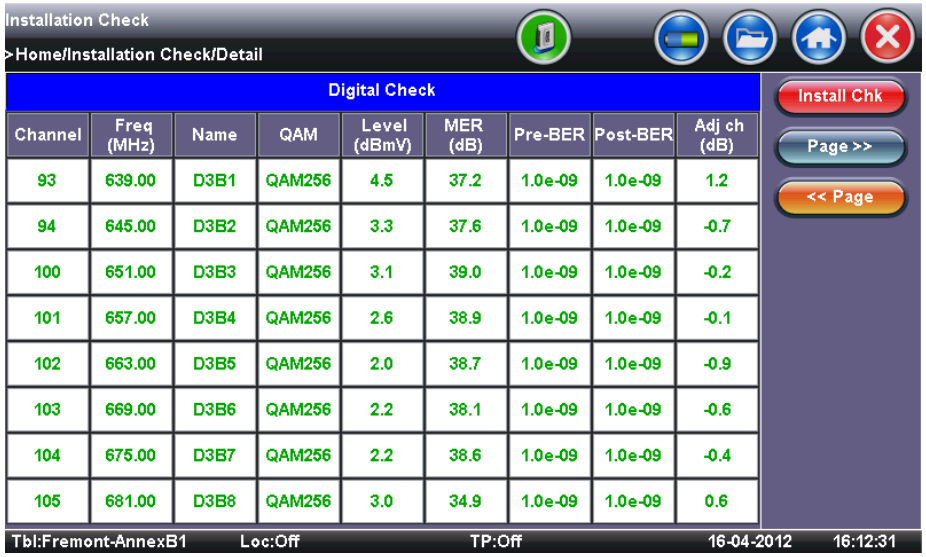
Crash Zone

Installation Check

- Performs more detailed measurements on pre-defined channels
- Can test multiple channels
- Can test both Analog and Digital channels



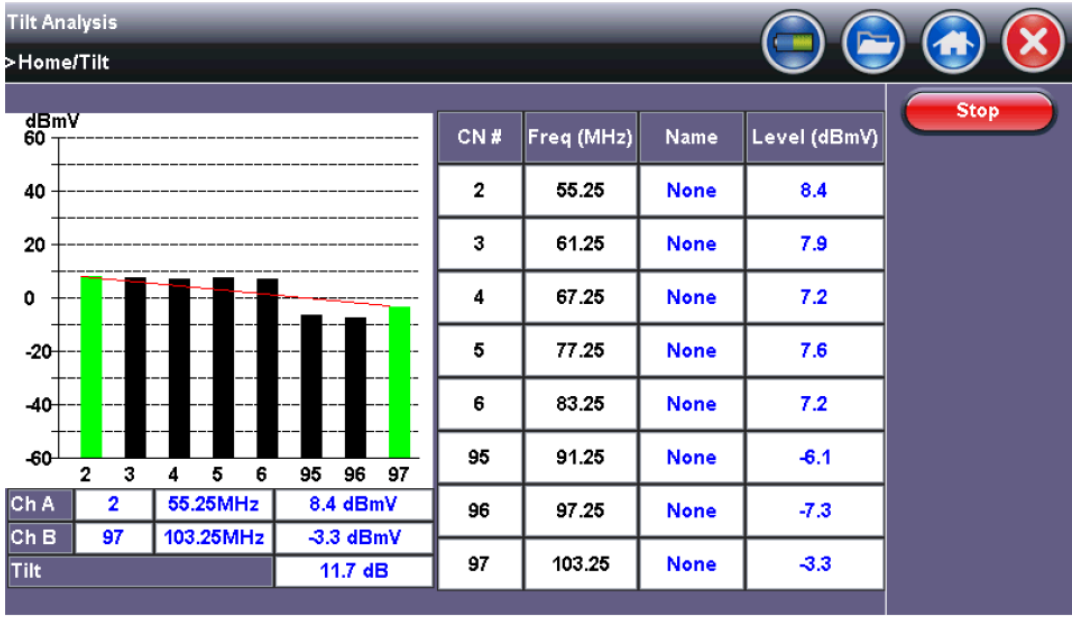
Analog				Digital			
2	55.2500	98	109.2750	116	747	124	795
3	61.2500	99	115.2750	117	753	125	801
4	67.2500	14	121.2625	118	759	126	807
5	77.2500	15	127.2625	119	765	127	813
6	83.2500	16	133.2625	120	771	128	819
95	91.2500	17	139.2500	121	777	129	825
96	97.2500	18	145.2500	122	783	130	831
97	103.2500	19	151.2500	123	789	131	837



Channel	Freq (MHz)	Name	QAM	Level (dBmV)	MER (dB)	Pre-BER	Post-BER	Adj ch (dB)
93	639.00	D3B1	QAM256	4.5	37.2	1.0e-09	1.0e-09	1.2
94	645.00	D3B2	QAM256	3.3	37.6	1.0e-09	1.0e-09	-0.7
100	651.00	D3B3	QAM256	3.1	39.0	1.0e-09	1.0e-09	-0.2
101	657.00	D3B4	QAM256	2.6	38.9	1.0e-09	1.0e-09	-0.1
102	663.00	D3B5	QAM256	2.0	38.7	1.0e-09	1.0e-09	-0.9
103	669.00	D3B6	QAM256	2.2	38.1	1.0e-09	1.0e-09	-0.6
104	675.00	D3B7	QAM256	2.2	38.6	1.0e-09	1.0e-09	-0.4
105	681.00	D3B8	QAM256	3.0	34.9	1.0e-09	1.0e-09	0.6

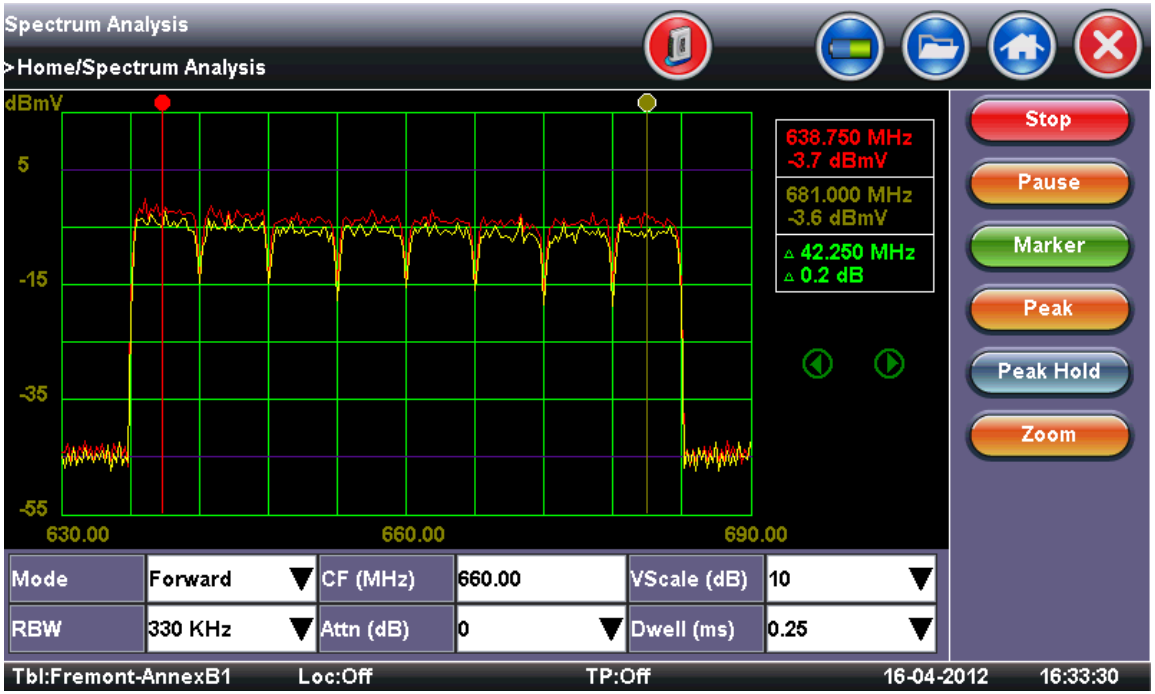
Tilt Analysis

- Used to check the channel levels at the lowest and highest frequencies
- Level variations across the frequency spectrum are indicative of distortion.
- Efficient tool for balancing distribution amplifiers.
- Useful to identify excessive cable lengths at the customer premises



Spectrum Analysis

- Provides a frequency domain view of the signal
- Convenient way to measure the amplitude of digitally modulated carriers
- Troubleshoot ingress in both Forward and Reverse paths.



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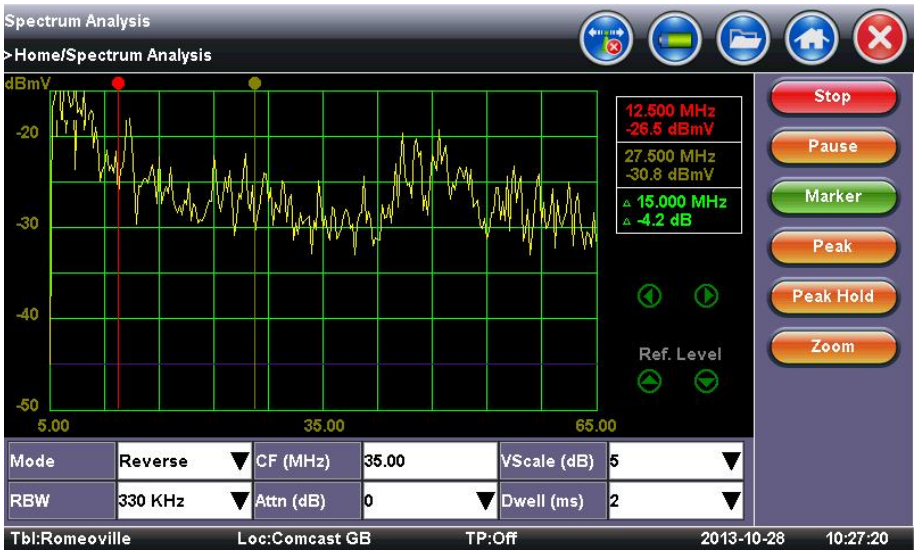
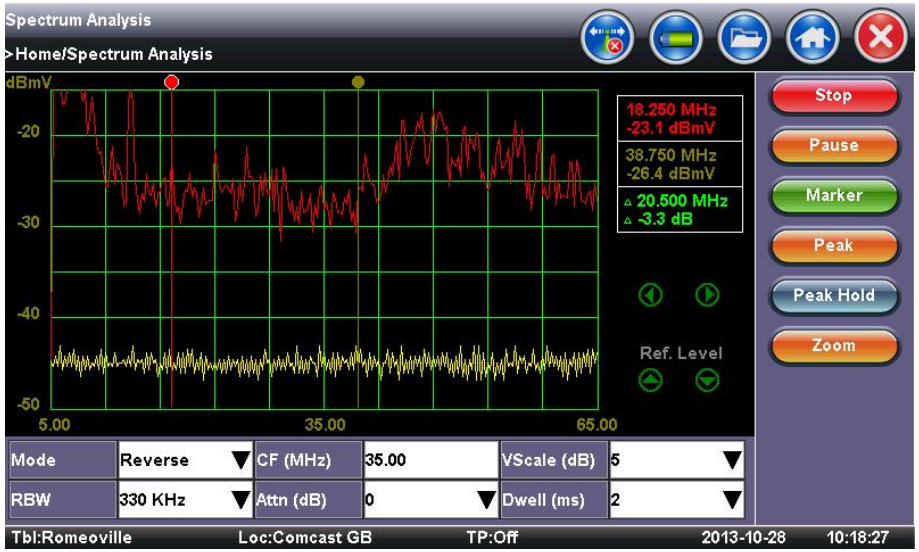
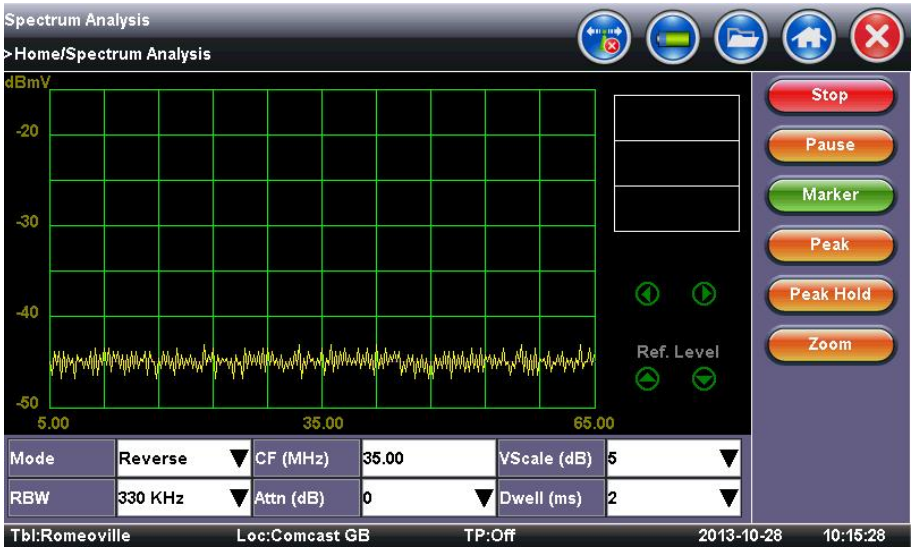
Ingress on Analog and Digital Channels

- Lines in picture
- High speed data problems
- Interference with two-way radio services using the same frequencies
- Macro Blocking
- Freeze Frame
- Loss of Picture and Sound

- Check for ingress on the drop
- Use the Max Hold







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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HSD Troubleshooting Tips

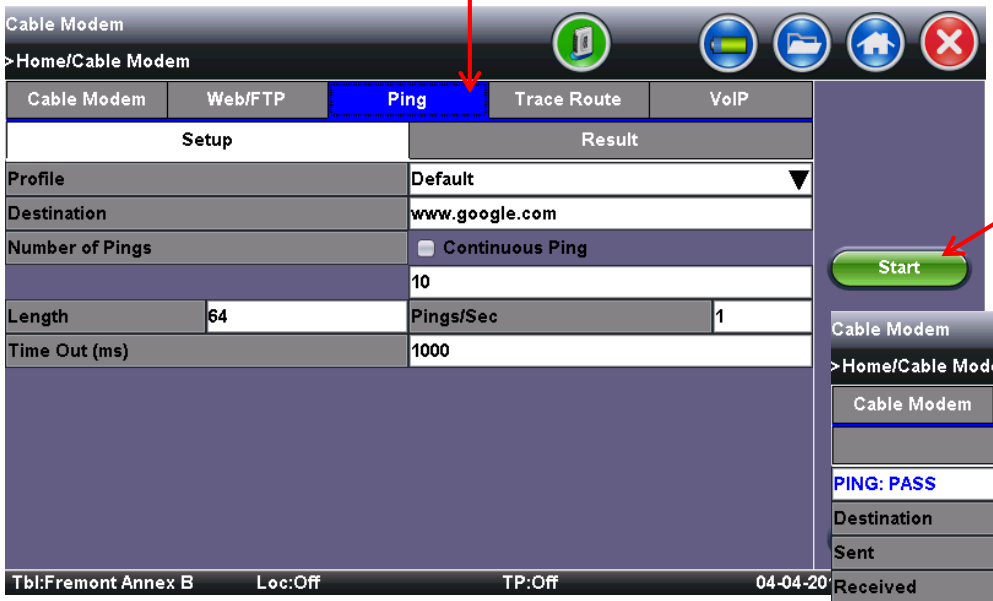
Activate the Cable Modem

- Check the DS and US power levels
- '**Results**' should be displayed

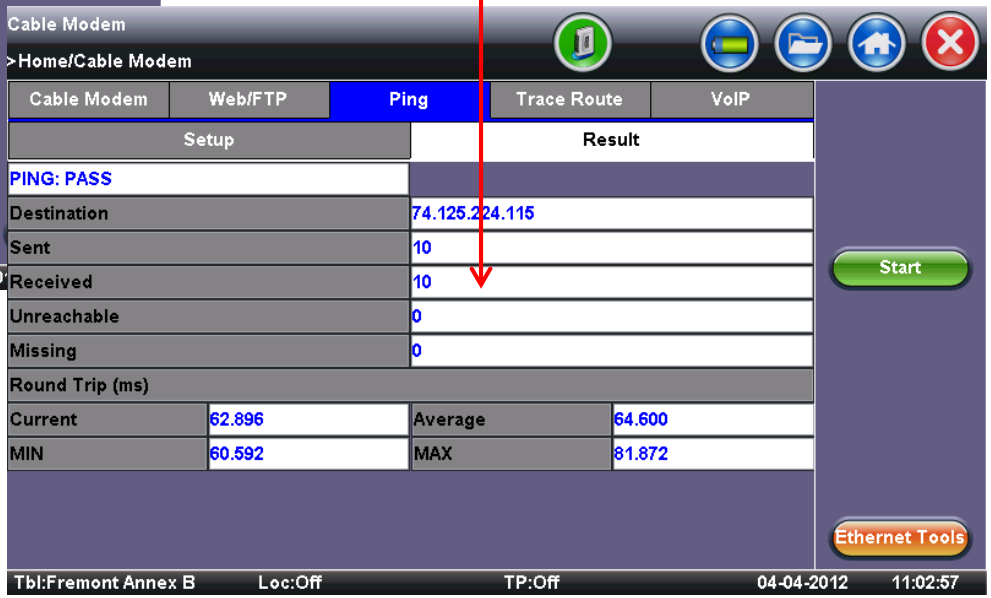
Access to All Downstream Carriers and Upstream

Cable Modem Is Online
Verify IP Connectivity

- Go to the '**Ping**' tab and run a quick Ping test

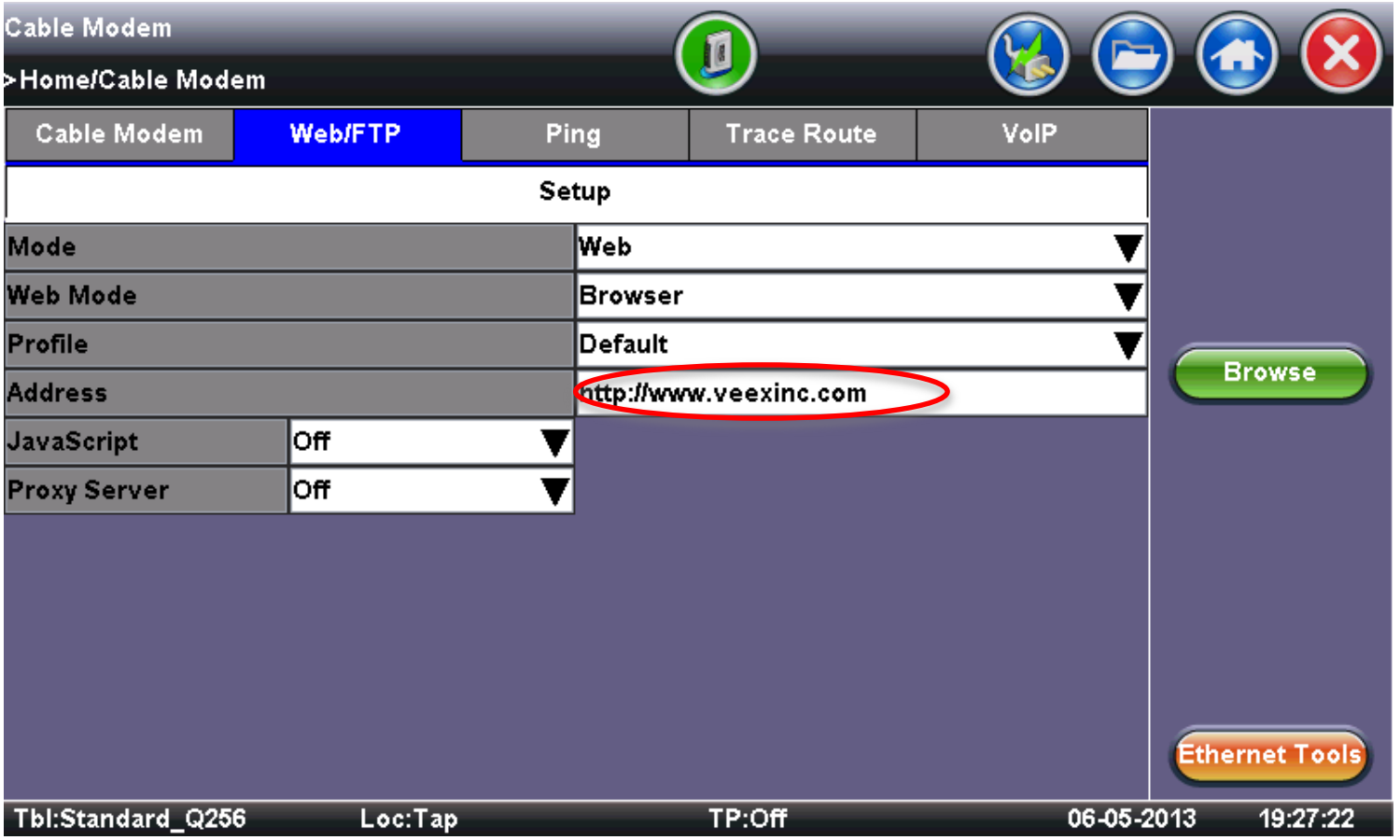


Press '**Start**' and confirm that IP Packets are received.

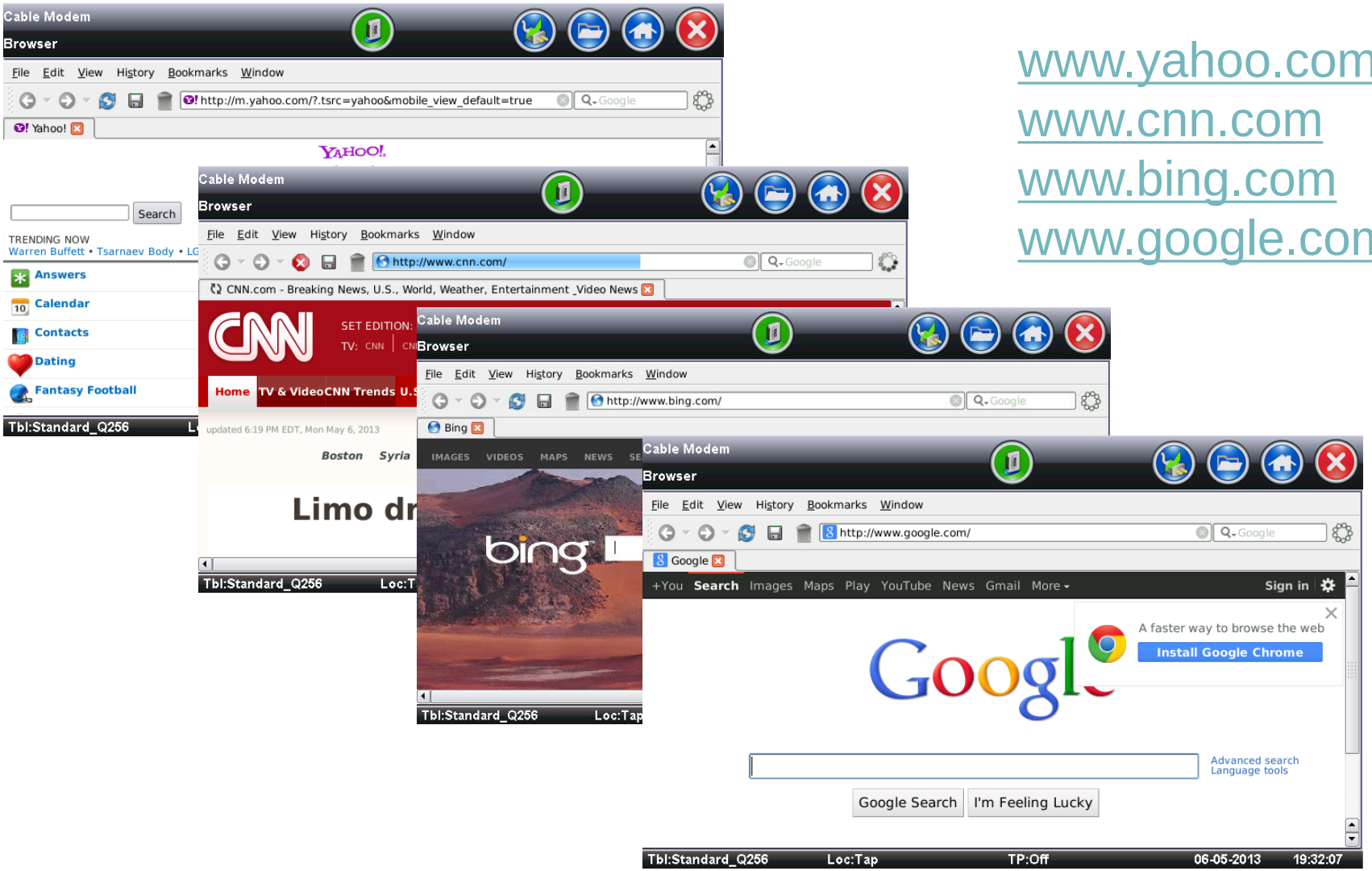


Note: If the PING packets are not received, it is likely the meter's Cable Modem has not been provisioned properly and cannot go beyond the Walled Garden/Brick.

Web Browser


Cable Modem
>Home/Cable Modem
Cable Modem
Web/FTP
Ping
Trace Route
VoIP
Setup
Mode
Web
Web Mode
Browser
Profile
Default
Address
http://www.veexinc.com
JavaScript
Off
Proxy Server
Off
Browse
Ethernet Tools
Tbl:Standard_Q256
Loc:Tap
TP:Off
06-05-2013
19:27:22

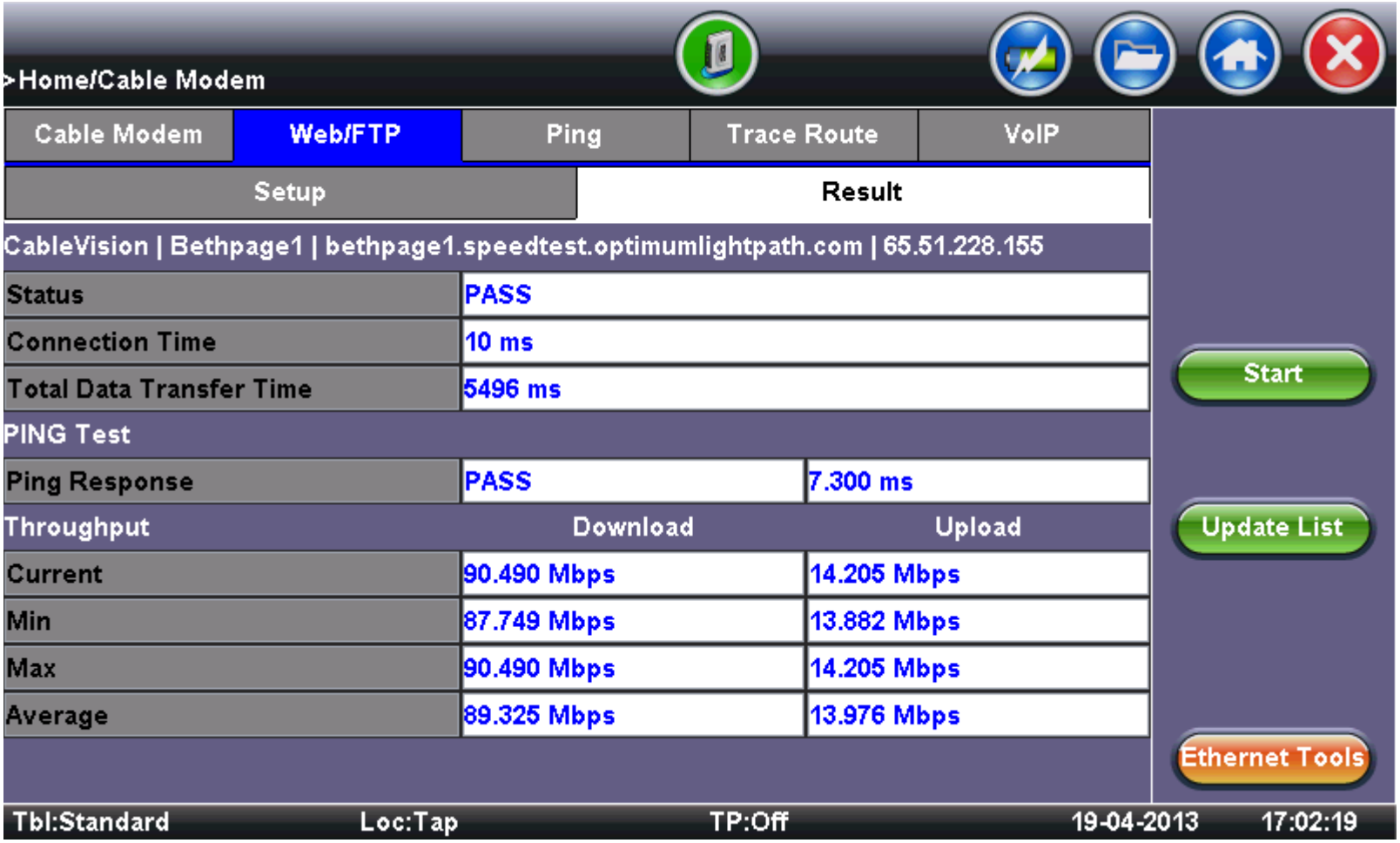
Sample Websites to Use



www.yahoo.com
www.cnn.com
www.bing.com
www.google.com

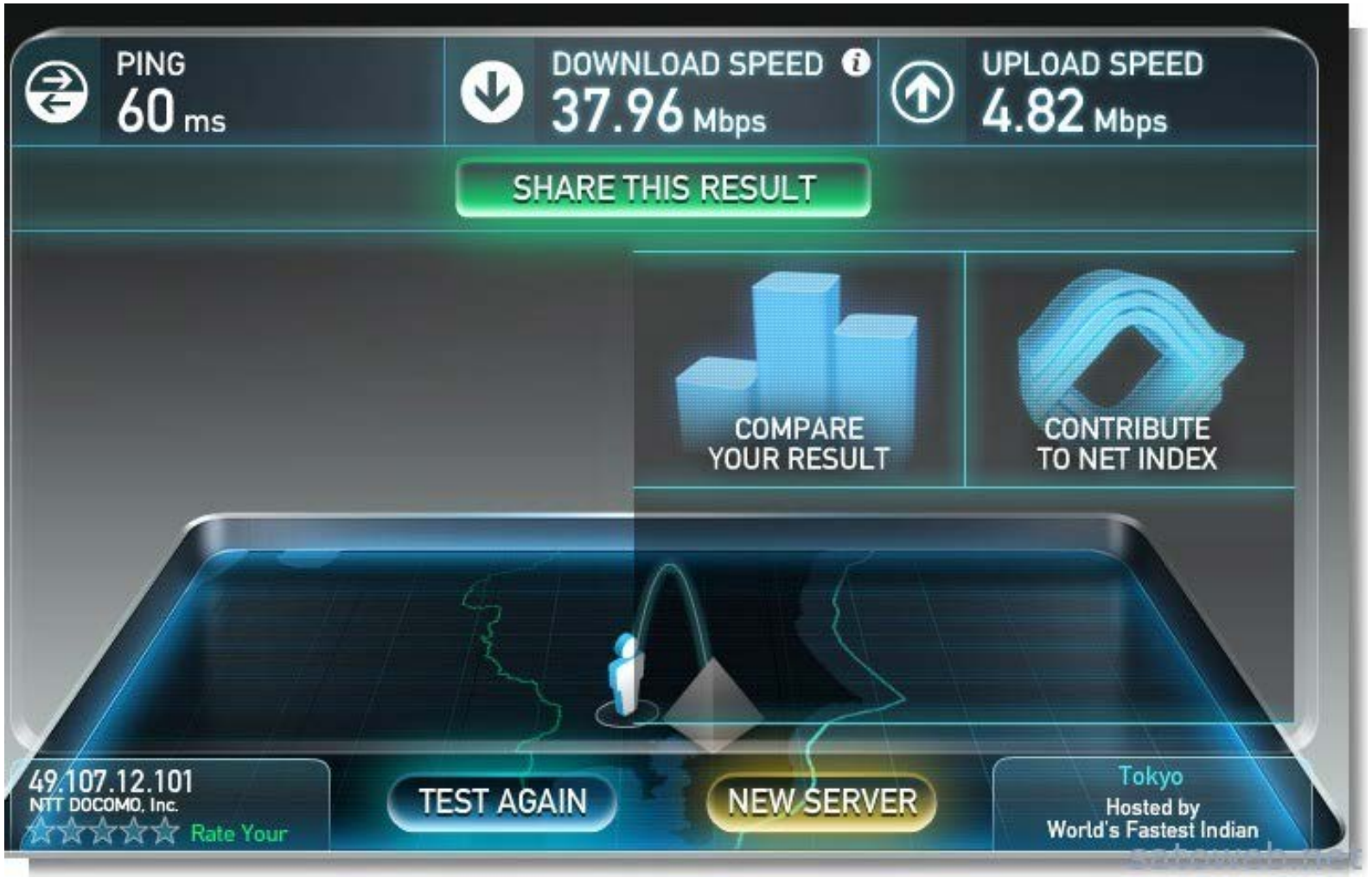
Speed Test


>Home/Cable Modem
Cable Modem
Web/FTP
Ping
Trace Route
VoIP
Setup
Result
Mode
VeTest
Provider
CableVision
VeTest Server
Parsippany1
List file version
16
Start
Update List
Ethernet Tools
Tbl:Wingdale
Loc:Outlet
TP:Splitter
26-03-2013
21:46:40


>Home/Cable Modem
Cable Modem
Web/FTP
Ping
Trace Route
VoIP
Setup
Result
CableVision | Bethpage1 | bethpage1.speedtest.optimumlightpath.com | 65.51.228.155
Status
PASS
Connection Time
10 ms
Total Data Transfer Time
5496 ms
PING Test
Ping Response
PASS
7.300 ms
Throughput
Download
Upload
Current
90.490 Mbps
14.205 Mbps
Min
87.749 Mbps
13.882 Mbps
Max
90.490 Mbps
14.205 Mbps
Average
89.325 Mbps
13.976 Mbps
Start
Update List
Ethernet Tools
Tbl:Standard
Loc:Tap
TP:Off
19-04-2013
17:02:19

Speed test from the PC

Example - http://www.speedtest.net/



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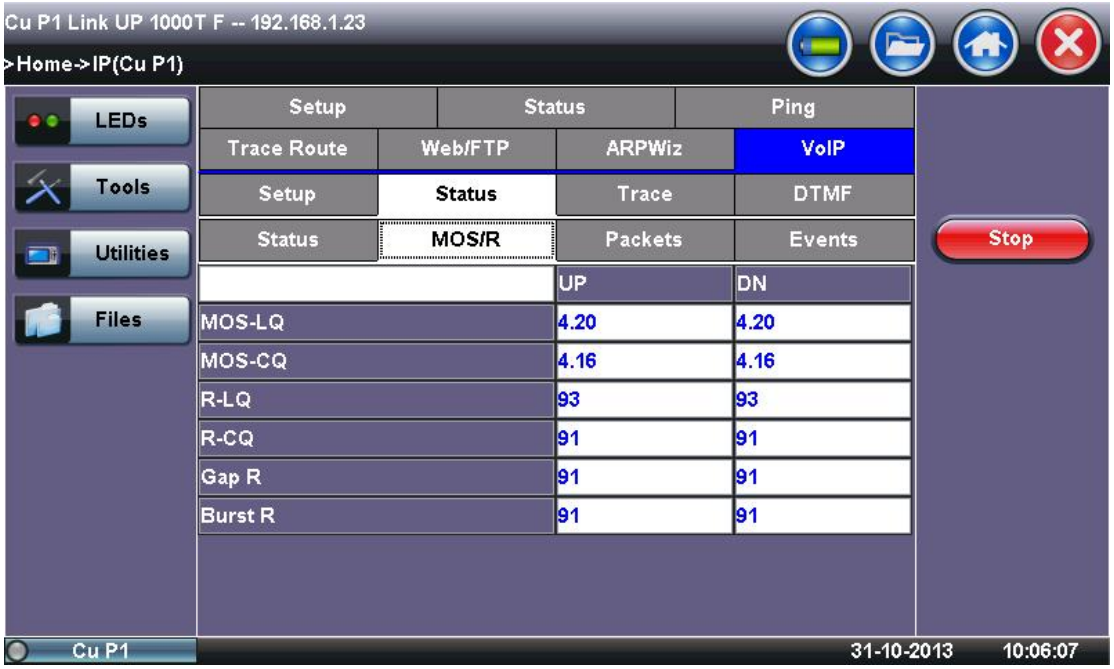
VoIP Troubleshooting

How Testing Helps

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

Mean Opinion Score (MOS)

- Subjective voice quality score based on the perception of a random group of people listening to speech over a communication system.
- Group of males and females rate the quality of test sentences read
- Each person rates from 1 to 5
- MOS is average: 1 (worst), 5 (best)



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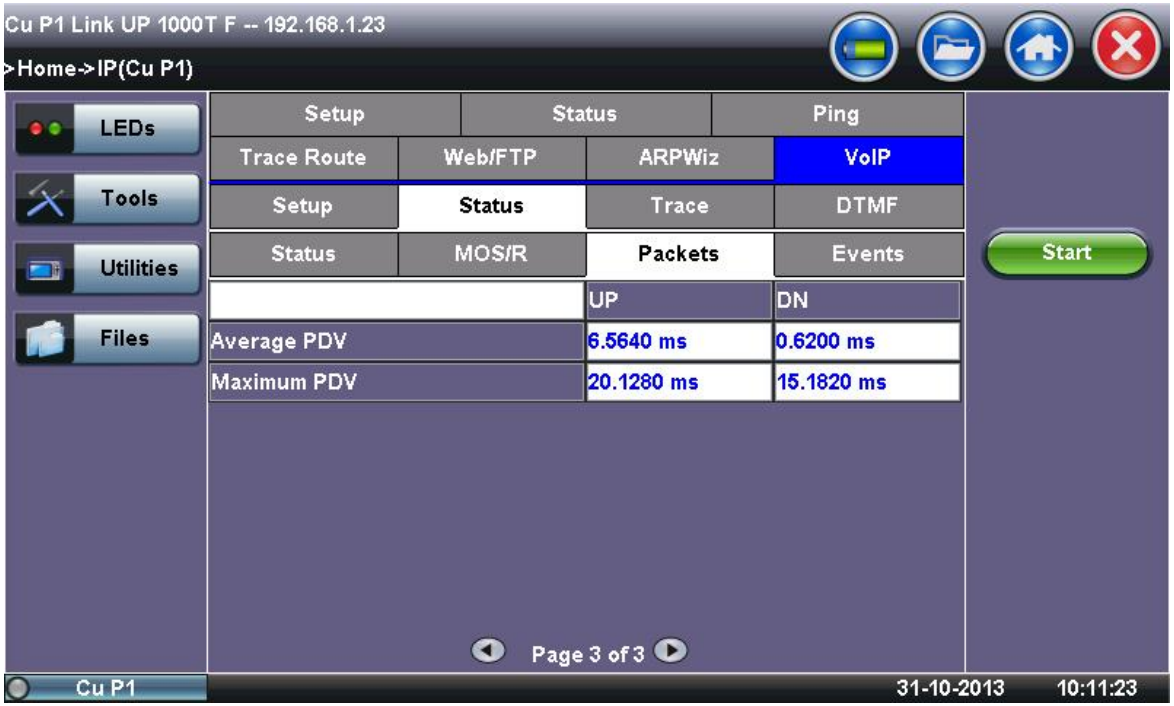
Mean Opinion Score (MOS)

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

Latency (Delay)

- Causes Echo and Talker Overlap
- When delay is > 50 msec, echo becomes a problem; echo cancellation is required
- Talker overlap is significant when one-way delay is > 250 msec

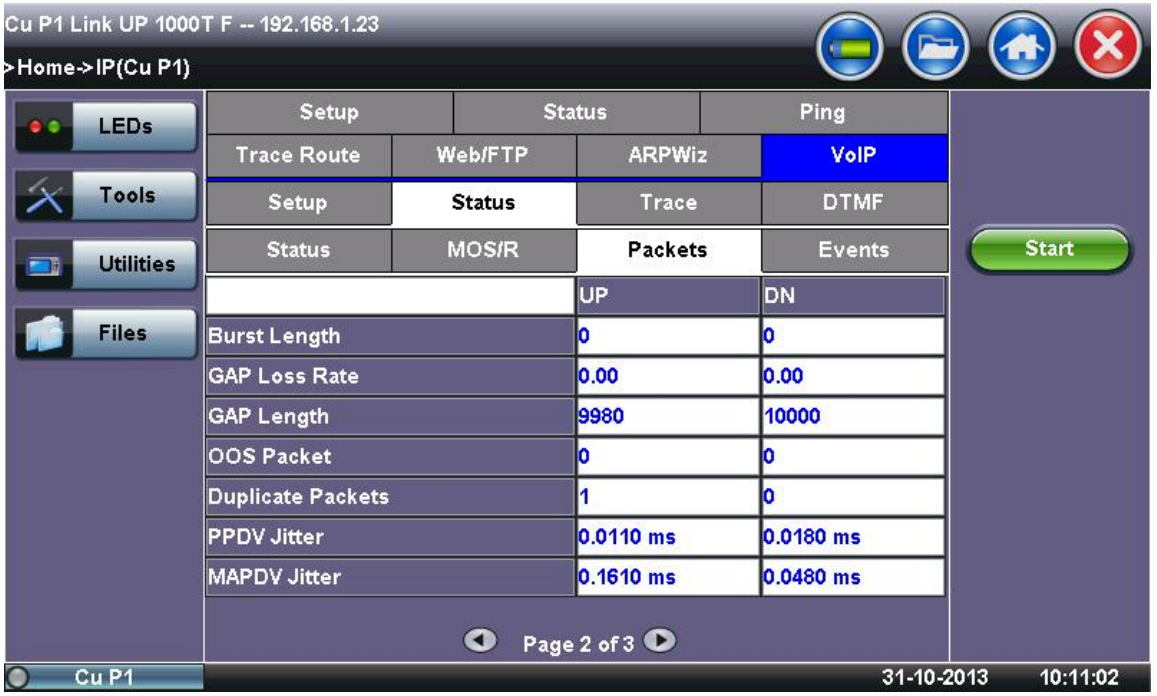


Latency (Delay)

- Can seriously impair communication
- Usually a by-product of switching and routing
- Must be less than 300 msec. round trip

Jitter

- Packets arrive at destination out of timing or sequence
- Jitter buffer is used to enable re-ordering of packets
- Increasing size of jitter buffer threatens delay
- Should be less than twice packetization rate
- Jitter buffer overflow causes packet loss



Packet Loss

- Can be caused by network congestion, jitter buffer overflow, or ingress
- Random packet loss is less noticeable than “bursty” packet loss
- Target <1%, which is less noticeable when loss is random; >4% renders service unusable

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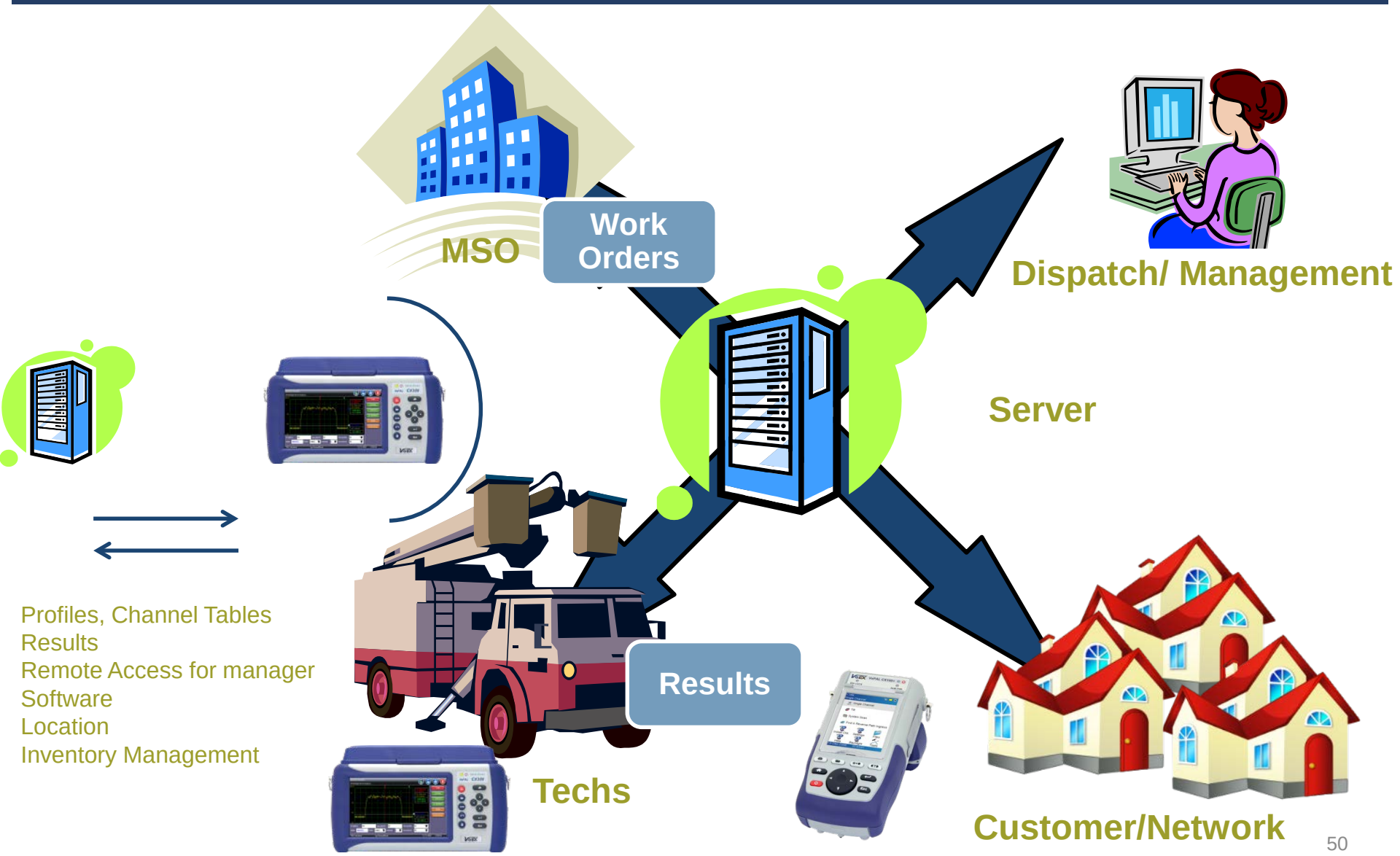
How To Automate the Home Certification

Home Certification Program



Create Work Orders

- New Installations
- Re-Connections
- Upgrades
- Trouble calls

Home Certification Process is the completion of a work order for a job professionally done, properly documented and easy accessible

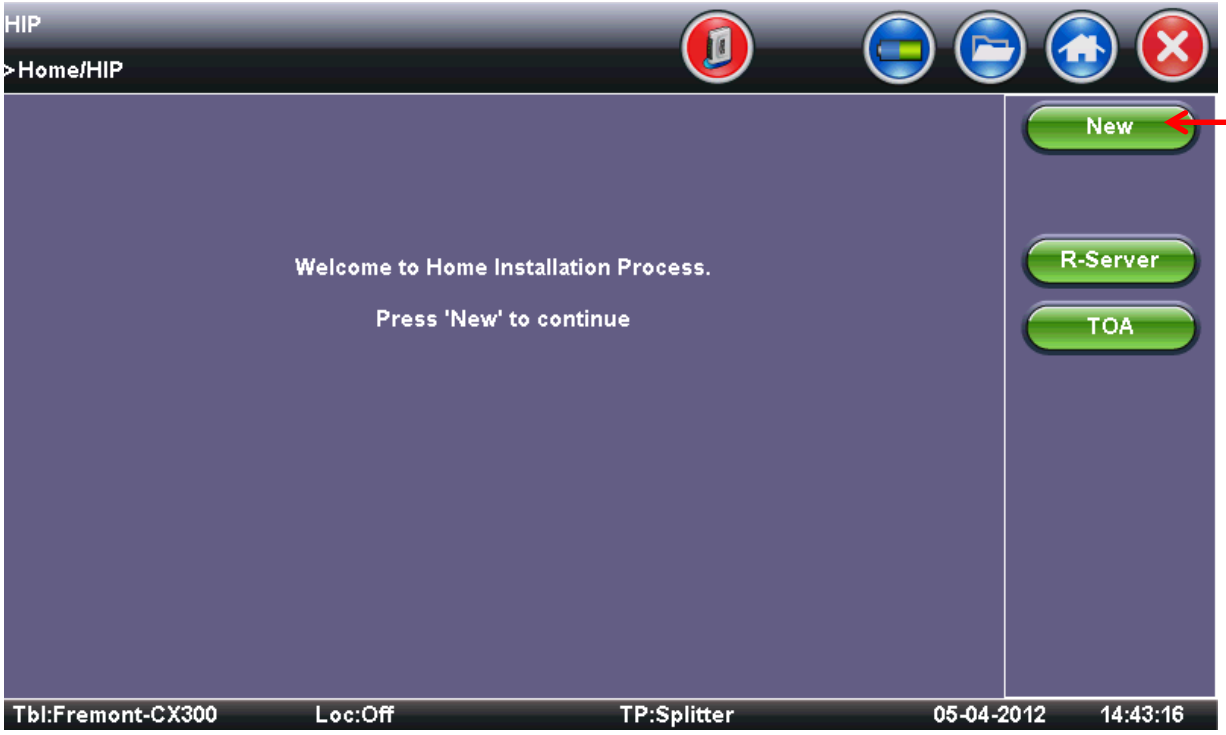
- Auto test Macro functions

- Uploading test results to server
  a) Passed/failed or failed only
  b) Referencing work order
  c) Technician ID
  d) Date and time of saved tests
  e) Current location
  f) Other pertinent information

- Access to test results
  a) Supervisors
  b) System Managers
  c) Regional directors
  d) Corporate operations

Home Certification / HIP Test Setup

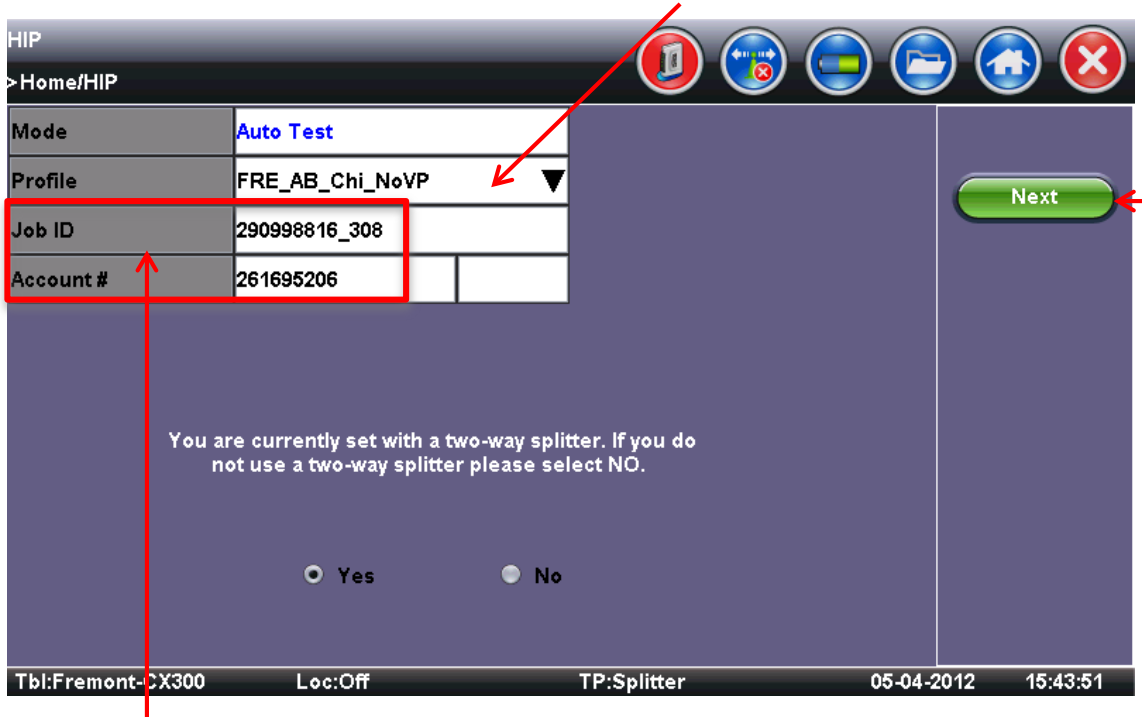
Step 1: Go to the Home Menu and press the '**HIP**' Shortcut key.



Step 2: Press the '**New**' key.

Home Certification / HIP Test Setup

Step 3: Select your Home Certification '**Profile**'.



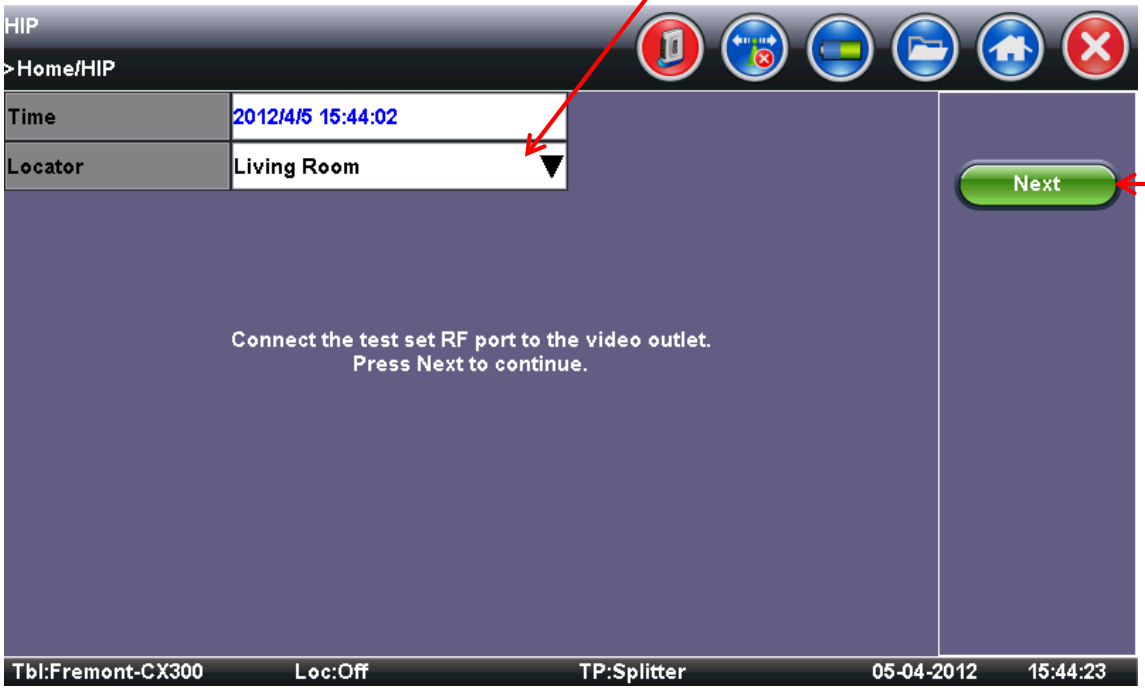
Step 4: Press '**Next**'.

Note: The Job ID and Account # are already populated based on your TOA work order.

Caution! If the Job ID or Account # does not match the current work order (or are blank), then go back to TOA to properly SAVE the latest work order.

Home Certification / HIP Test Setup

Step 5: Select your '**Locator**'. This is the location of where you are taking your measurements.



Step 6: Press '**Next**'.

The HIP / Home Certification Auto Test will begin.

Home Certification / HIP Test In Progress

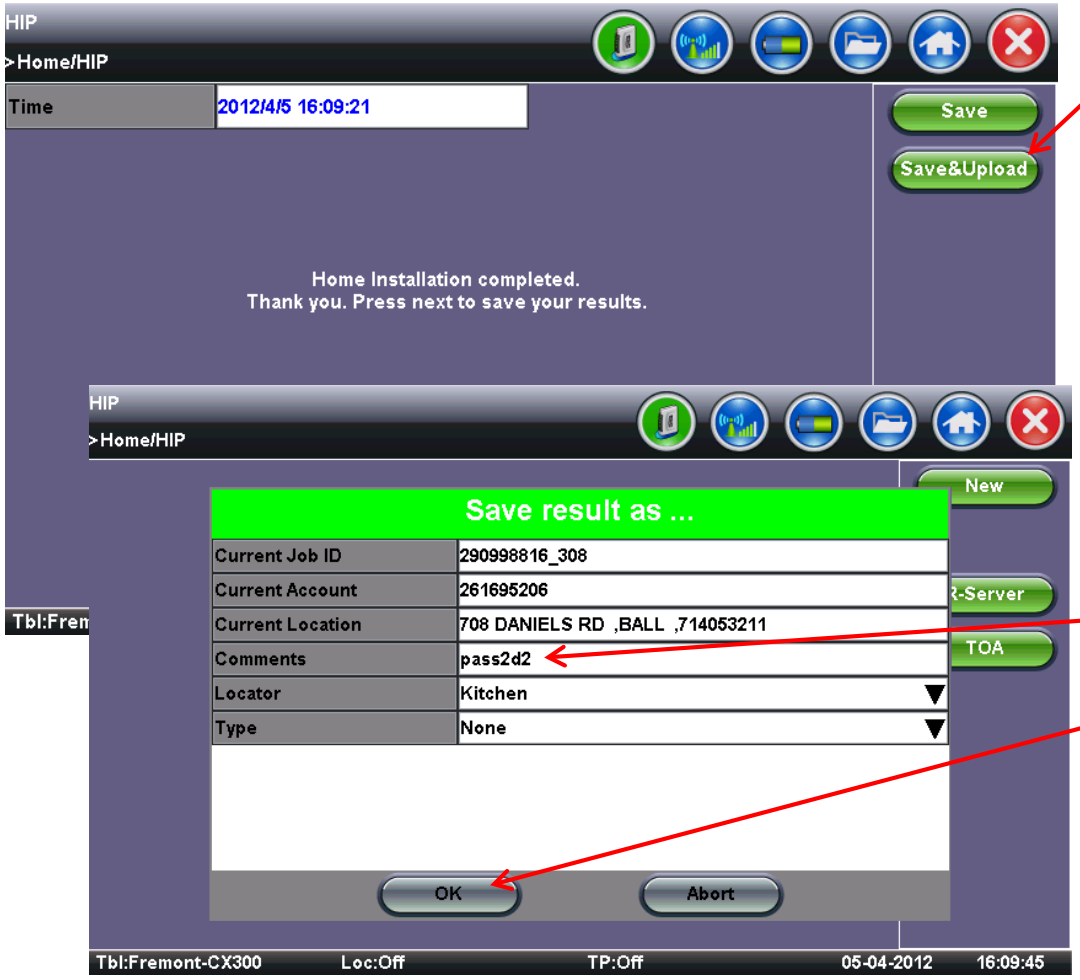
- Each major test portion will report status as the HIP test proceeds.

- You can press the '**Detail**' key next to each test portion to see the test results.

Step 7: When all tests are complete, press '**Next**'.

Home Certification / HIP Test Complete

- The Home Cert / HIP Test is Complete



Step 8: Press '**Save&Upload**' to immediately upload your test results to the R-Server.

Or, Press '**Save**' to upload at a later time.

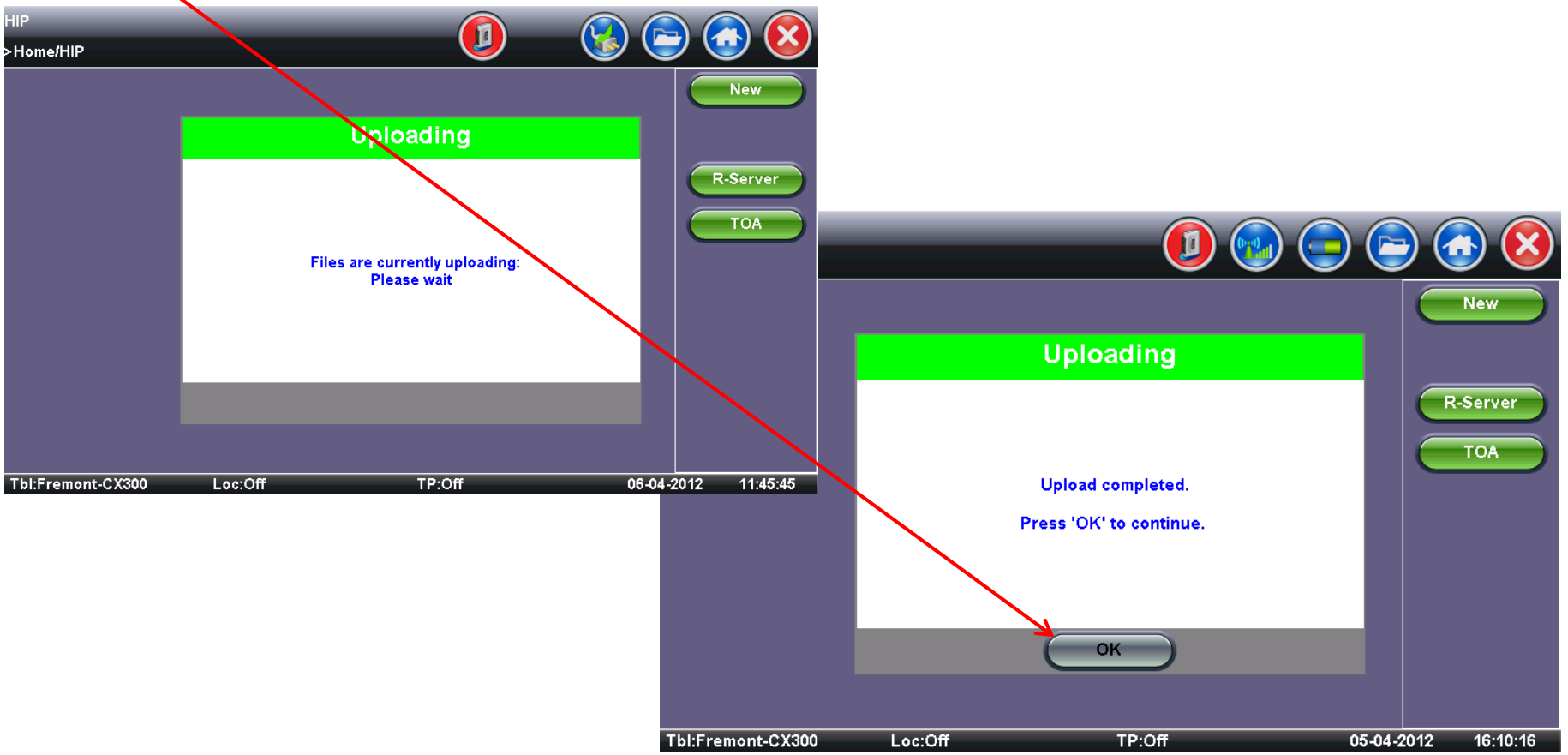
Step 9: Final chance to add some comments before you save.

Press '**OK**'

Upload Confirmation Message

Step 10: The final step is the '*Upload completed*' confirmation message.

Press '**OK**' and the job is done.



Signature Capture in TOA Work Order

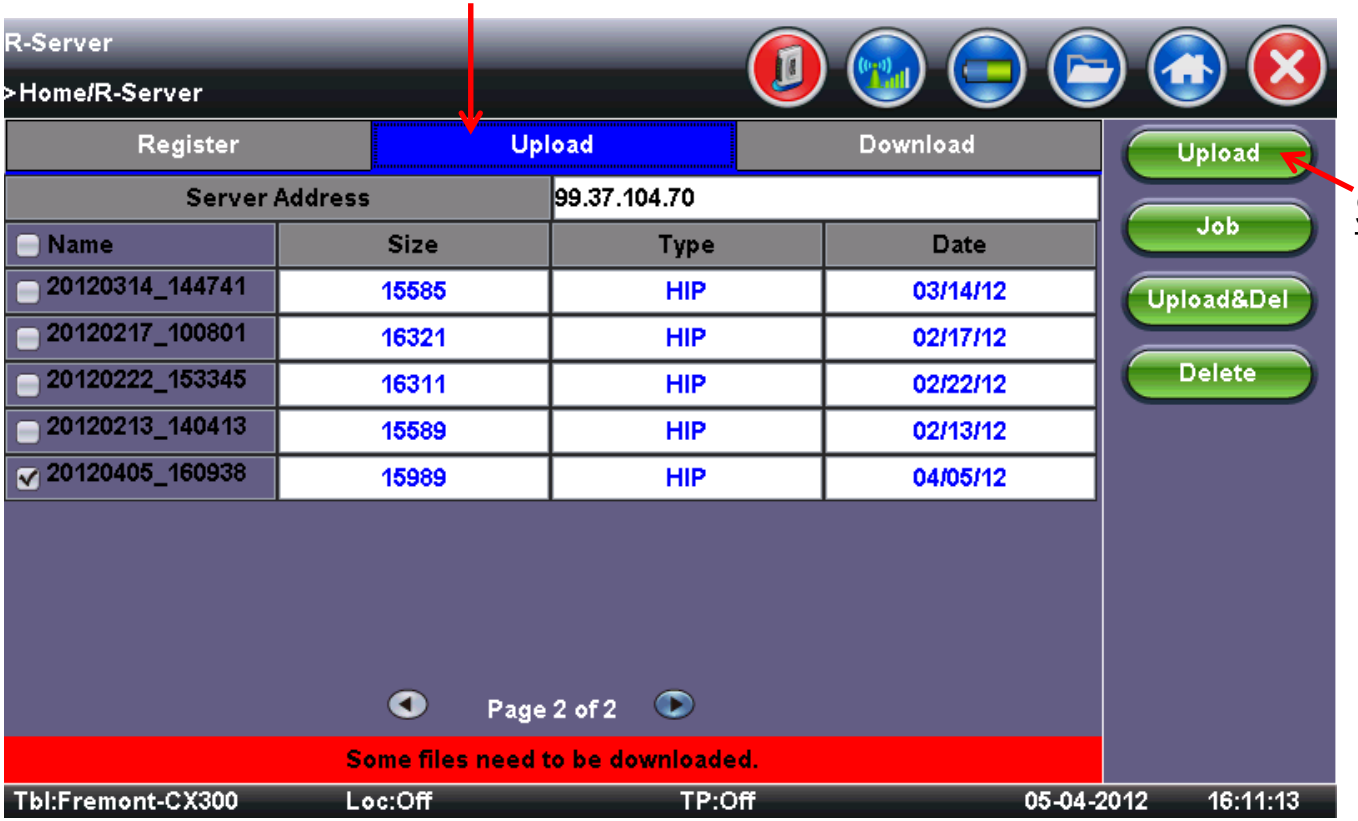
- Once the job is completed, go back to TOA and access the existing work order. Capture the customer's signature.

Uploading Test Results At A Later Time

- If you were not able to upload results right after your test, you can upload at later time by:

Step 1: Accessing '**R-Server**' from the Home Menu

Step 2: Press the '**Upload Tab**', select your results



Step 3: Press '**Upload**'

Perpetual Install

Benefits of a Perpetual Install

- Maintain High Performance of Signals
- Provide High Level of Signals Reliability
- Preserve the Integrity of Drop & Cabling
- Reduce Repeated Truck Rolls
- Reduce Service Calls
- Creating Workforce Database
- Enhancing Customer Satisfaction

Subjective & Objective Procedures

- Drop must be properly bonded
- Proper identification tagging on the drop near tap
- All open ports must be terminated
- Tap pedestal must be locked
- Routing and attachments follow industry installation guidelines
- SDU's with triple play services must use RG-6 or greater for drop
- Outside lines must use weather-sealed compression fittings

Subjective & Objective Procedures

- Drops must be free of splices between pole hooks
- All digital STB must be checked to make sure they are responding
- Inspect the in home network wiring, tighten connectors
- All external drop splitters must be sheltered with a SDU house box
- Egress & Ingress must be conducted on the line and in the home
- Home Certification measurements must be in compliance with company's procedures and standards

Example of Home Certification Parameters

Location (Tap)	Pass/Fail Minimum	Maximum
Video RF level	+12dBmv	+28dBmv
Delta Video/Audio	10.0dB	22.0dB
Digital level (256 QAM)	+6dBmv	+22dBmv
Digital level (64 QAM)	+2dBmv	+18dBmv
MER (256 QAM)	34dB	
MER (64QAM)	29dB	
Pre BER		1.0E-8
Post BER		1.0E-9
CM transmit level	+40dBmv	+50dBmv
Leakage		25µv/m
Ingress	Depending on US modulation type	

Example of Home Certification Parameters

Location (Ground Block)	Pass/Fail Minimum	Maximum
Video RF level	+6dBmv	+22dBmv
Delta Video/Audio	10.0dB	22.0dB
Digital level (256 QAM)	0dBmv	+16dBmv
Digital level (64 QAM)	-4dBmv	+12dBmv
MER (256 QAM)	33dB	
MER (64QAM)	28dB	
Pre BER		1.0E-8
Post BER		1.0E-9
CM transmit level	+38dBmv	+52dBmv
Leakage		25µv/m
Ingress	Depending on US modulation type	

Example of Home Certification Parameters

Location (Outlet)	Pass/Fail Minimum	Maximum
Video RF level	-2dBmv	+14dBmv
Delta Video/Audio	10.0dB	22.0dB
Digital level (256 QAM)	-8dBmv	+8dBmv
Digital level (64 QAM)	-12dBmv	+4dBmv
MER (256 QAM)	33dB	
MER (64QAM)	28dB	
Pre BER		1.0E-8
Post BER		1.0E-9
CM transmit level	+35dBmv	+50dBmv
Leakage		25µv/m
Ingress	depending on US modulation type	

Thank you.

Any questions?

Tel: 1.510.651.0500
www.veexinc.com