



Measurements to Characterize & Qualify the Return Path for the Services of Tomorrow

By: Jerry Green
Product Manager
Spectrum Analyzers



- Limited bandwidth
 - 5 to 45 MHz
 - 5 to 65 MHz
- Susceptible to interference
- Signal vary in....
 - Modulation types
 - Bandwidths
 - Power Levels
 - Duration
- Many sources feed one receiver (Funneling effect)
- Device input is the common reference point

☞ Response (Linearity measurements)

- Levels
- Sweep
- In-Channel response
- Group Delay

☞ Performance

- CNR
- CSO/CTB
- MER, BER
- Spectrum Analysis

☞ Monitoring

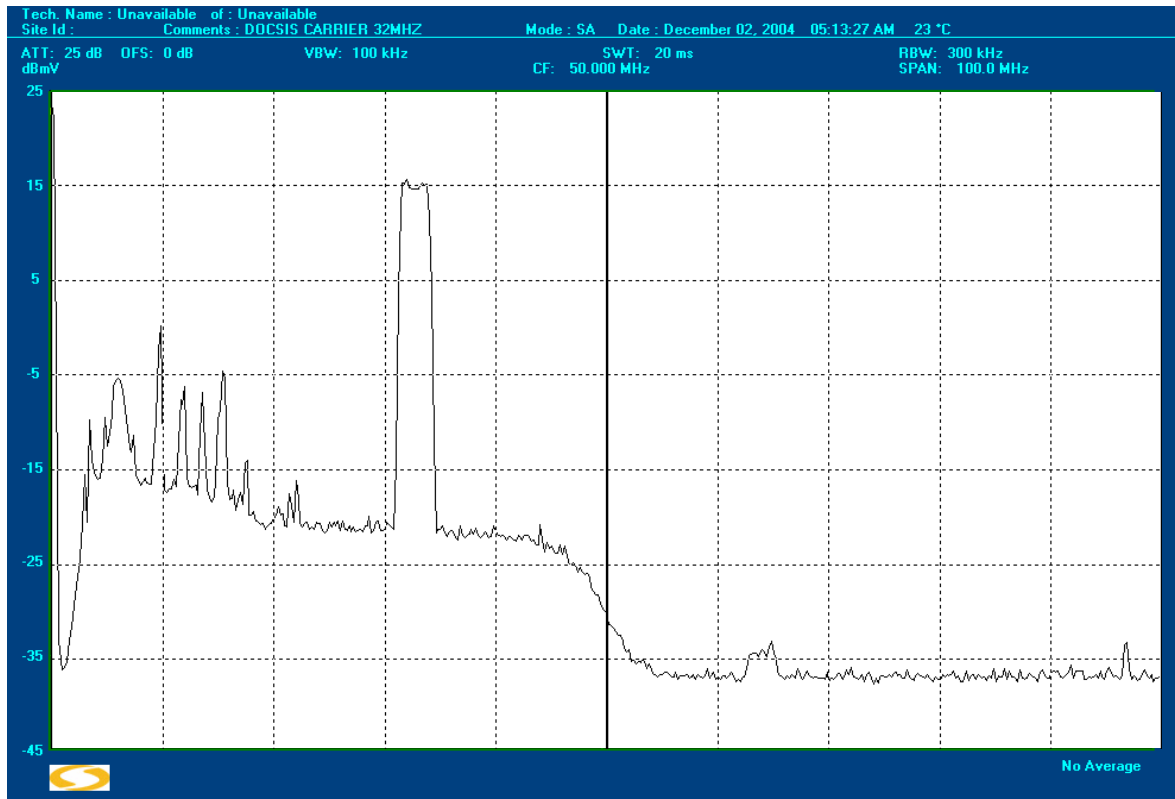
- ☞ Distortions increase
- ☞ CNR decreases
- ☞ Performance decreases
 - Increased retransmissions
 - Decreased throughput
 - Slow downloads
 - Increase latency
 - Increase Jitter
 - Lost packets
 - Dropped calls

INGRESS

- The word 'INGRESS' means the act of entering
- Ingress is any un-wanted signal found in the return path.
- Measured with a spectrum analyzer or monitoring system
- Interferes with desired channel
- Can cause other problems, such as Laser Clipping



Measuring Ingress



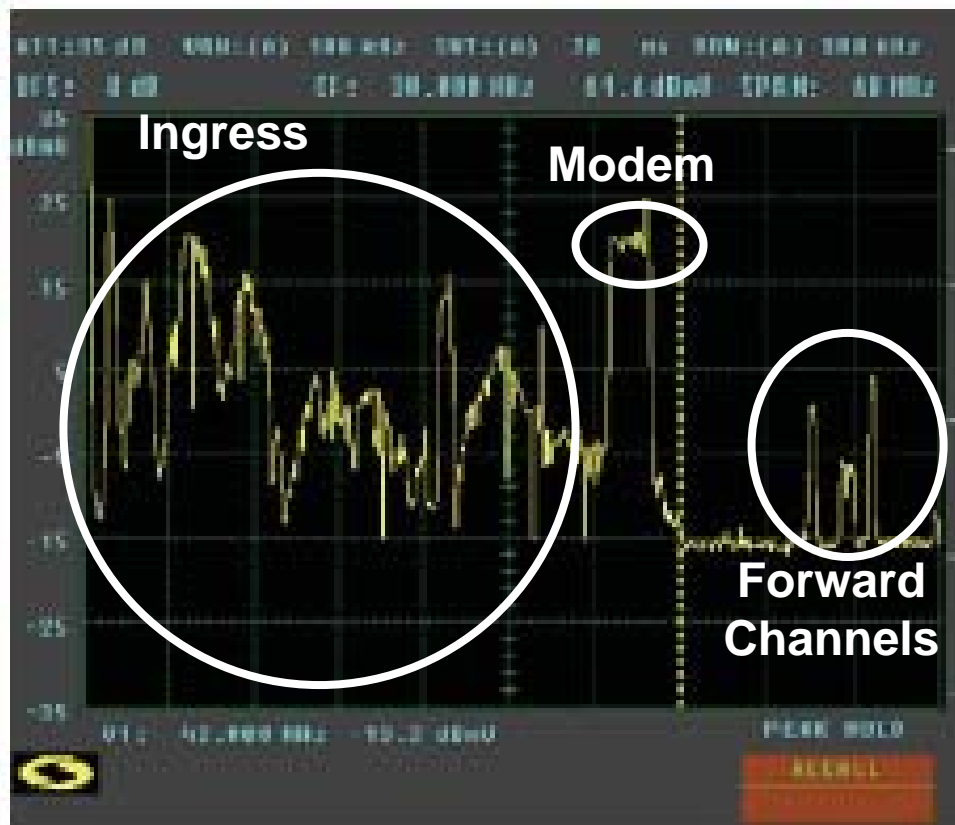
- Spectrum analyzer mode used to measure ingress
- Look above upper duplex filter limit (Return Laser pass band is 200MHz)
- Ingress can be intermittent. Trigger setting can indicate timing of interferer
- Ensure the network is not producing CPD.
- CNR indication



- Electrical interference
 - Things in customer premise (appliances, heaters, bad equipment, etc...
 - Open shields
 - Poor grounding

- Poor Alignment
 - Laser Clipping

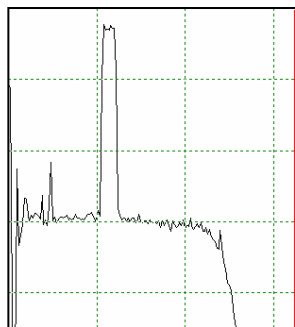
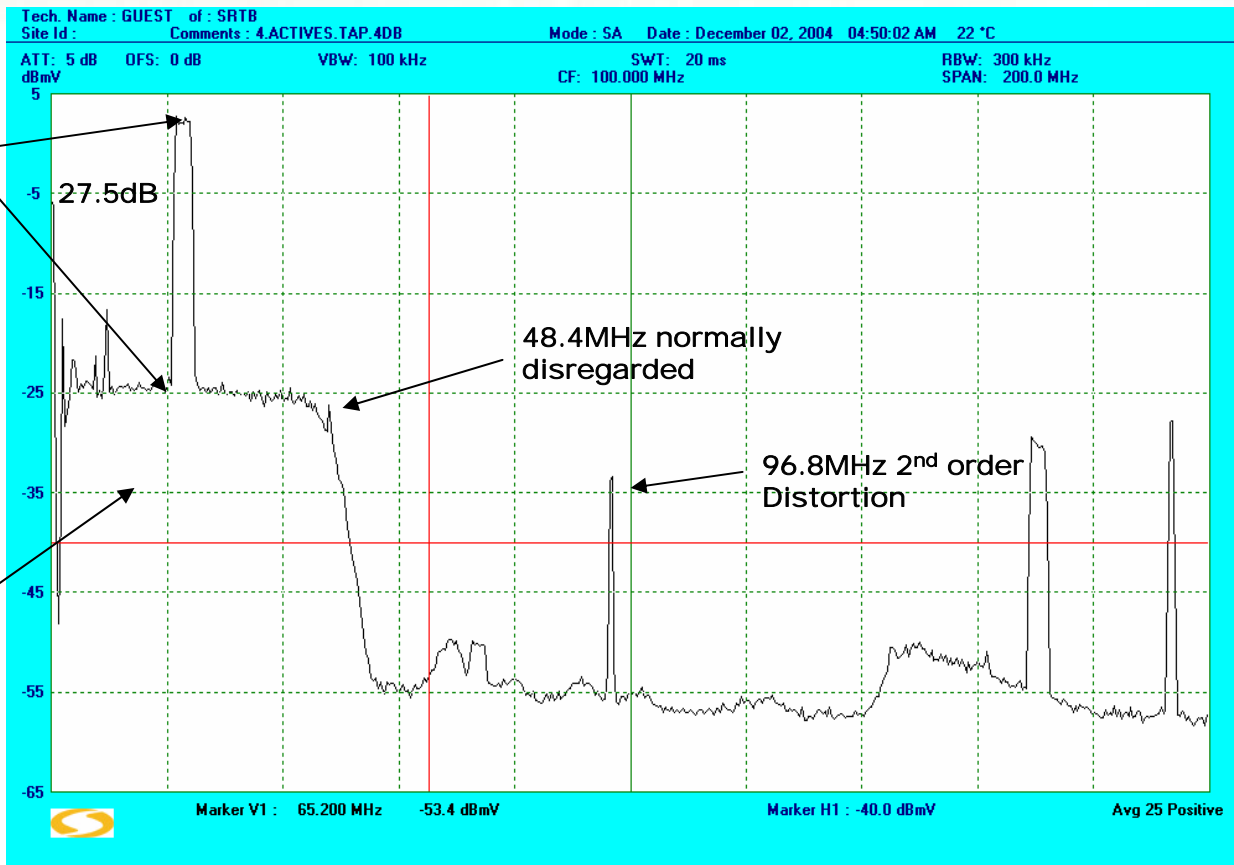
- Common Path Distortion



Non Clipping Return Laser



Proper C/N doesn't mean
Everything works fine!!!



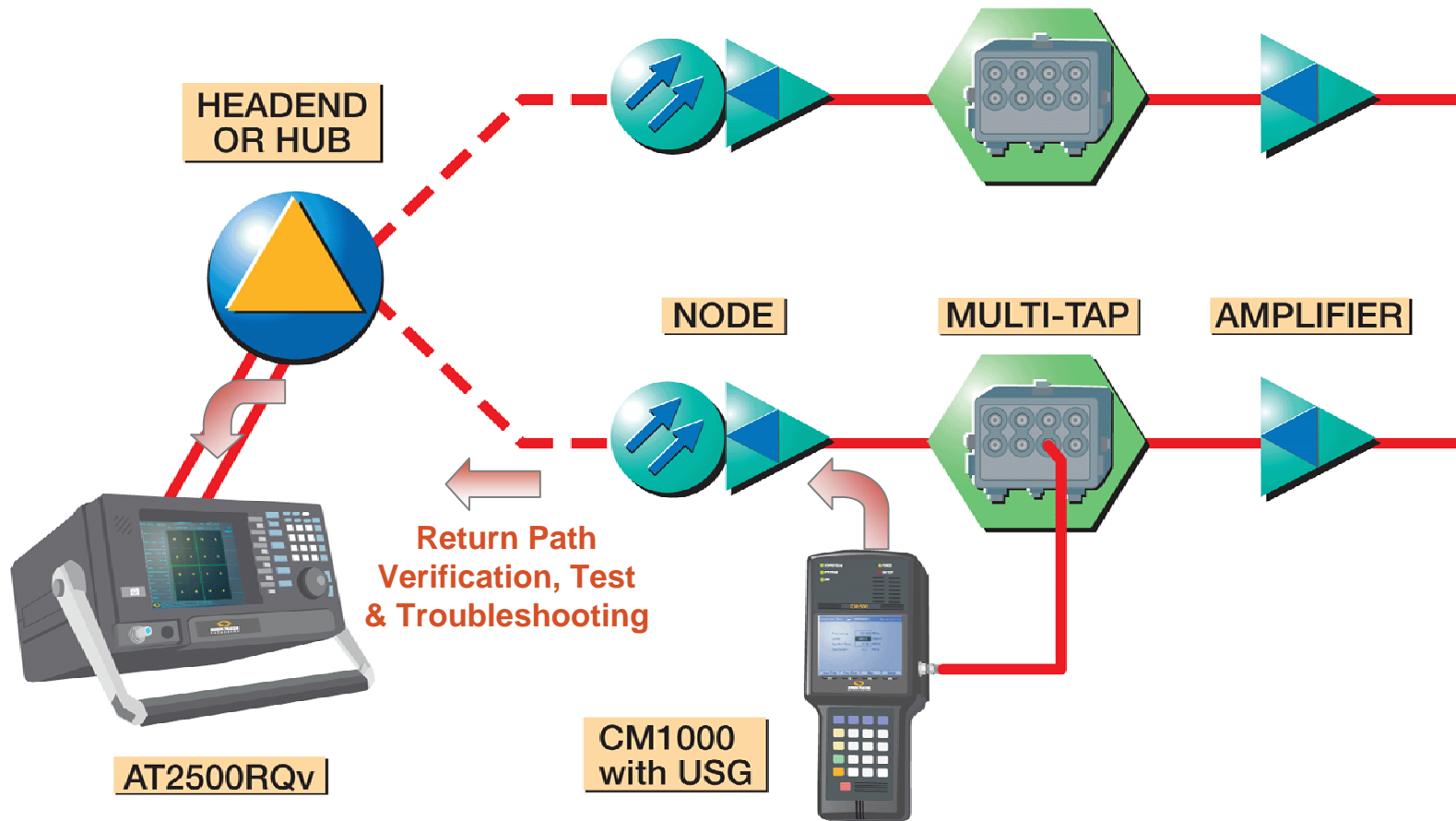
Typical view



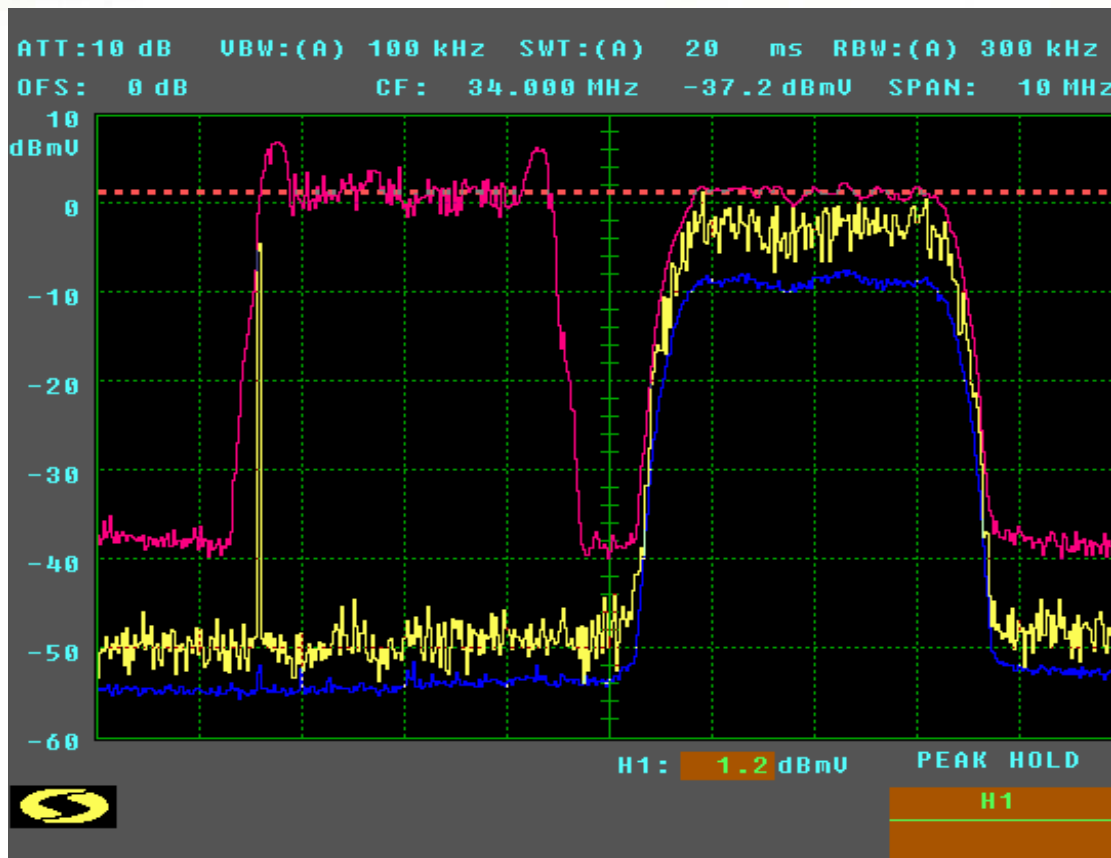
- Check for Network Headroom
 - How much can signal vary without causing problems
 - Laser Clipping
- Check for new Channel Spectrum
 - Flatness
 - Group Delay

- Insert signal in field & measure at Headend or Hub

TYPICAL APPLICATION



Inject signal in field & measure in Headend



- Insert channel at same level as current channel
- Set one trace to Peak Hold (Shown in Red)
- Set one trace to No Average (Shown in Yellow)



Good 16QAM Constellation

- Unequalized MER should be 6 dB above cliff
- 10~13 dB for QPSK
 - 17~20 dB for 16 QAM

ATT: 25 dB Modulation: QAM16 SES Threshold: 5.0e-003
Upstream QAM16 CF : 16.500 MHz Real Symbol : 2.560 MS/s

BER (Pre-Fec)

0.0e-12

BER (Post-Fec)

0.0e-12

MER: 38.3 dB

ENM: 10.1 dB

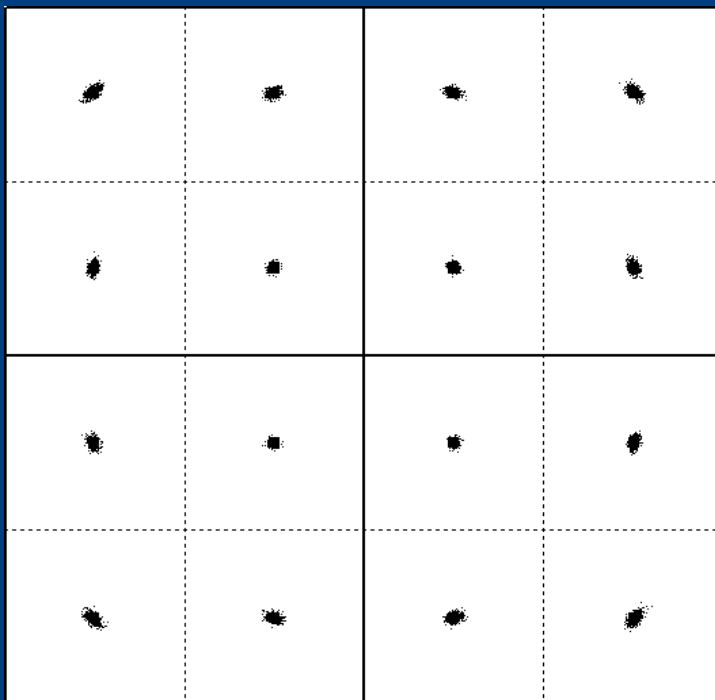
EVM: 0.7 %

ES: 1 Sec

SES: 0 Sec

FLS: 0 Sec

UNAV: 0 Sec



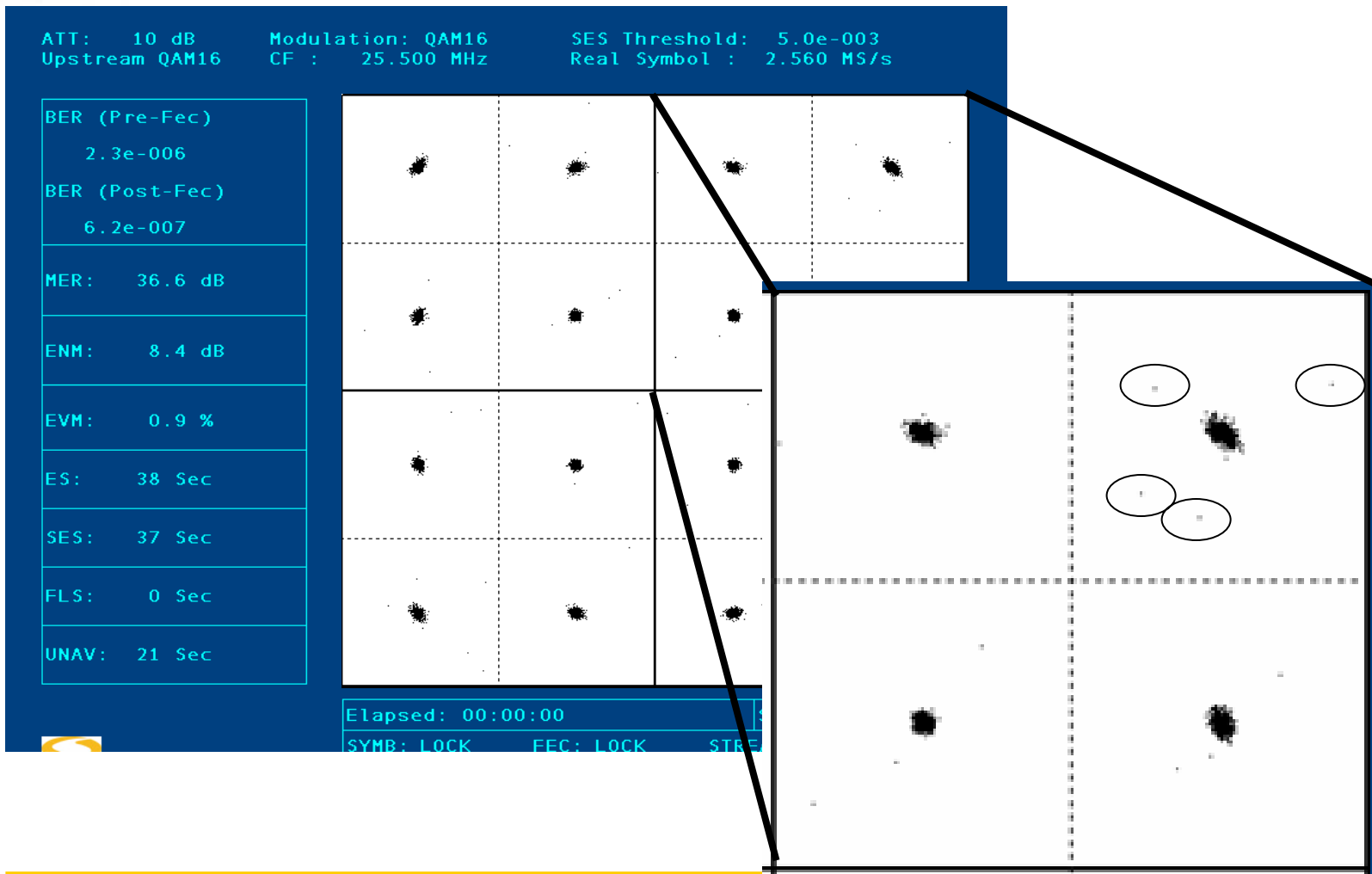
Elapsed: 00:00:00

SAMPLE: 8192

SYMB: LOCK

FEC: LOCK

STREAM: LOCK





ATT: 10 dB Upstream QAM16	Modulation: QAM16 CF : 25.500 MHz	SES Threshold: 5.0e-003 Real Symbol : 2.560 MS/s
------------------------------	--------------------------------------	---

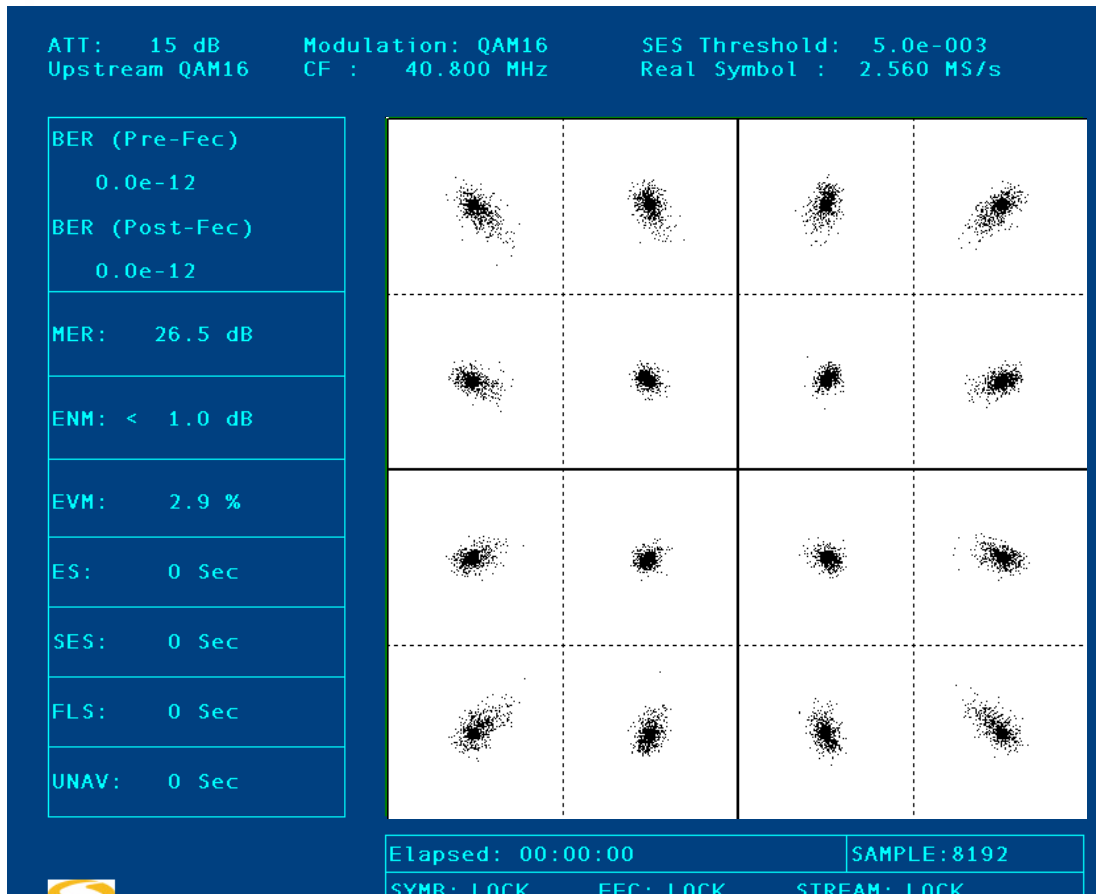
BER (Pre-Fec) 2.3e-006	BER (Post-Fec) 6.2e-007
MER: 36.6 dB	ENM: 8.4 dB
EVM: 0.9 %	ES: 38 Sec
SES: 37 Sec	FLS: 0 Sec
UNAV: 21 Sec	

ATT: 30 dB Upstream QAM16	Modulation: QAM16 CF : 23.000 MHz	SES Threshold: 5.0e-003 Real Symbol : 2.560 MS/s
------------------------------	--------------------------------------	---

BER (Pre-Fec) AVG 1.8e-007	BER (Post-Fec) AVG 6.5e-009
MER: 32.2 dB	ENM: 4.0 dB
EVM: 1.8 %	ES: 5 Sec
SES: 3 Sec	FLS: 0 Sec
UNAV: 0 Sec	

ES :	■	■	■	■
SES:		■	■	■
FLS:				
UNA:				

Elapsed: 00:02:00 of 2 (Min)
SYMB: LOCK FEC: LOCK STREAM: LOCK

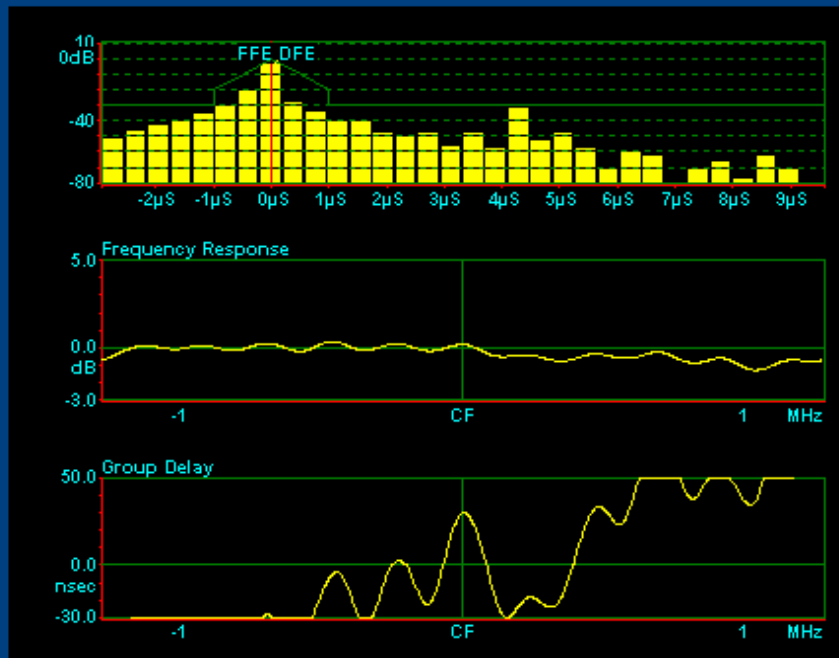


- Extreme Upstream Laser Clipping
 - Intermittent Amplitude (level) Compression

Adaptive Equalizer Screen

ATT: 15 dB Modulation: QAM16 SES Threshold: 5.0e-003
Upstream QAM16 CF : 37.500 MHz Real Symbol : 2.560 MS/s

BER (Pre-Fec)	3.1e-007
BER (Post-Fec)	0.0e-12
MER: 37.9 dB	
ENM: 9.7 dB	
EVM: 0.7 %	
ES: 1 Sec	
SES: 0 Sec	
FLS: 1 Sec	
UNAV: 0 Sec	



Elapsed: 00:00:00

- View Equalizer Taps
- View Frequency Response
- View Group Delay

Frequency Response

- Within 16-QAM Bandwidth
- +/- Symbol rate
- +/- 5 dB range
- Markers with Measurement & Delta
- < 0.5 dB / MHz typical goal

ATT: 15 dB Modulation: QAM16 SES Threshold: 5.0e-003
Upstream QAM16 CF : 37.500 MHz Real Symbol : 2.560 MS/s

BER (Pre-Fec)
3.1e-007

BER (Post-Fec)
0.0e-12

MER: 37.9 dB

ENM: 9.7 dB

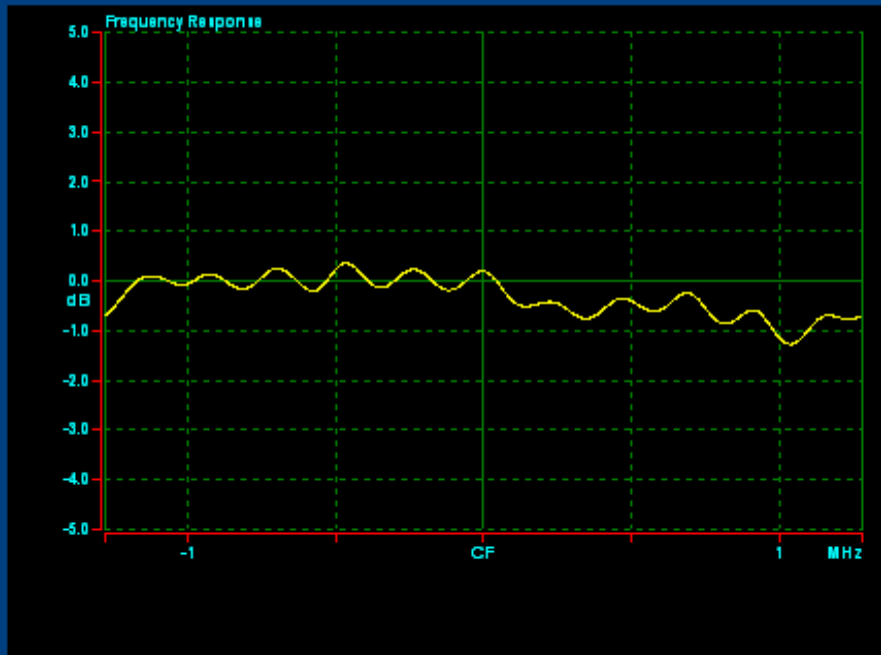
EVM: 0.7 %

ES: 1 Sec

SES: 0 Sec

FLS: 1 Sec

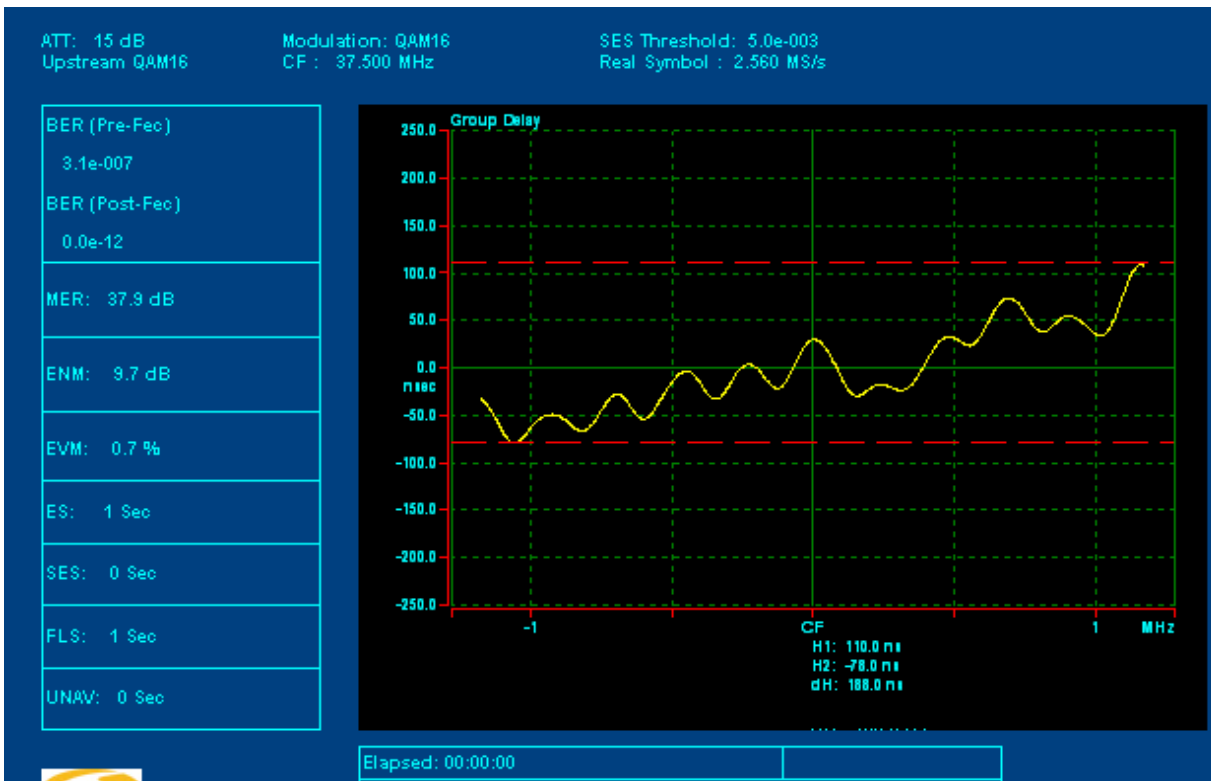
UNAV: 0 Sec

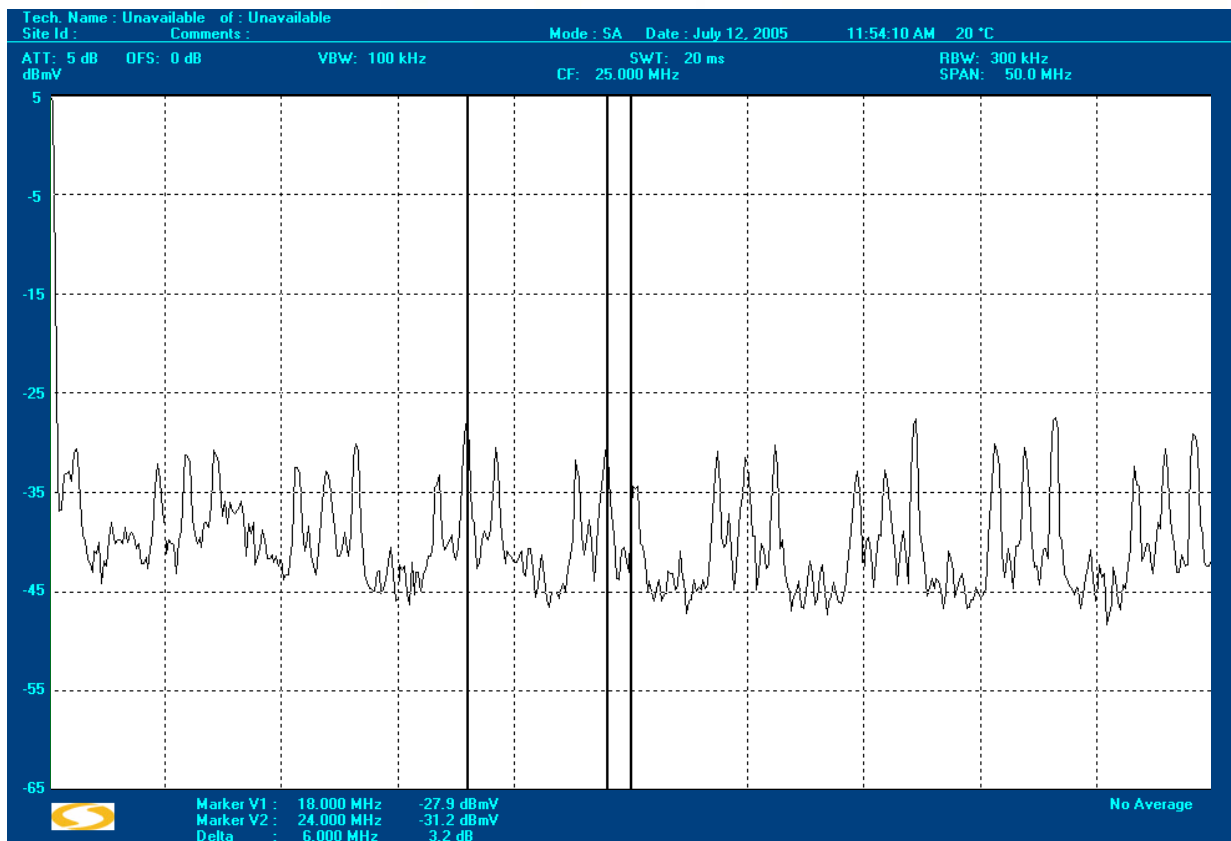


Elapsed: 00:00:00

Group Delay

- +/- 50, 250 & 1000 nSec Ranges
- Vertical (delay) & Horizontal (frequency) Markers with Measurement & Delta
- DOCSIS spec is 200nSec/MHz but <60 nSec/ MHz is recommended by many VoIP users





Typically caused by corroded connectors
Look for 6 MHz spacing on carriers

- Series of beats spaced 6 MHz apart

- Usual cause
 - Dissimilar metals interface acting as a diode
 - Forward carriers mixing together produce beats

- Usually very intermittent

- ☉ Bad line terminators
- ☉ Loose or over-tightened seizure screws
- ☉ Loose hold down screws on modules and circuit boards
- ☉ Feed through connectors
- ☉ Loose and corroded terminators on taps
- ☉ Anything that allows moisture to enter a device

☞ Alarms

- Points in Time where a limit is past
- Potential system failures
- Actual system failures

☞ Trending Data

- Collection of measurements over time



Dashboard Filter

Ingress Alarm Summary

- [Ingress Alarm](#)
- [Performance Alarm](#)

Time Range

Over All Time

Site	Active	Inactive	Total	Most Recent
Ingress//25	<u>0</u>	<u>2</u>	<u>2</u>	2008-02-19 21:49:26
Ingress//27	<u>0</u>	<u>2</u>	<u>2</u>	2008-02-19 21:49:24
Ingress//12	<u>0</u>	<u>2</u>	<u>2</u>	2008-02-19 21:43:34
Ingress//29	<u>0</u>	<u>2</u>	<u>2</u>	2008-02-19 21:49:26
Ingress//8	<u>0</u>	<u>2</u>	<u>2</u>	2008-02-19 21:48:52
Ingress//32	<u>0</u>	<u>2</u>	<u>2</u>	2008-02-20 15:25:44
Ingress//6	<u>0</u>	<u>1</u>	<u>1</u>	2008-02-19 21:43:32
Ingress//9	<u>0</u>	<u>1</u>	<u>1</u>	2008-02-19 21:43:33
Ingress//5	<u>0</u>	<u>1</u>	<u>1</u>	2008-02-19 21:43:32
Ingress//28	<u>0</u>	<u>1</u>	<u>1</u>	2008-02-19 21:43:32
Ingress//7	<u>0</u>	<u>1</u>	<u>1</u>	2008-02-19 21:43:32
Ingress//13	<u>0</u>	<u>1</u>	<u>1</u>	2008-02-19 21:43:34
Ingress//4	<u>0</u>	<u>1</u>	<u>1</u>	2008-02-19 21:43:32
Ingress//30	<u>0</u>	<u>1</u>	<u>1</u>	2008-02-19 21:43:32
Ingress//14	<u>0</u>	<u>1</u>	<u>1</u>	2008-02-19 21:43:35

RealWORX® WEB

- Dashboard
- Alarm Summary
- Alarms
- Historical Ingress
- Measurement
- Setup

Alarm List

Ingress Alarms

Number of alarms found: 29

- [Ingress Alarms](#)
- [Performance Alarms](#)

Start Date

Year

Month

Day

End Date

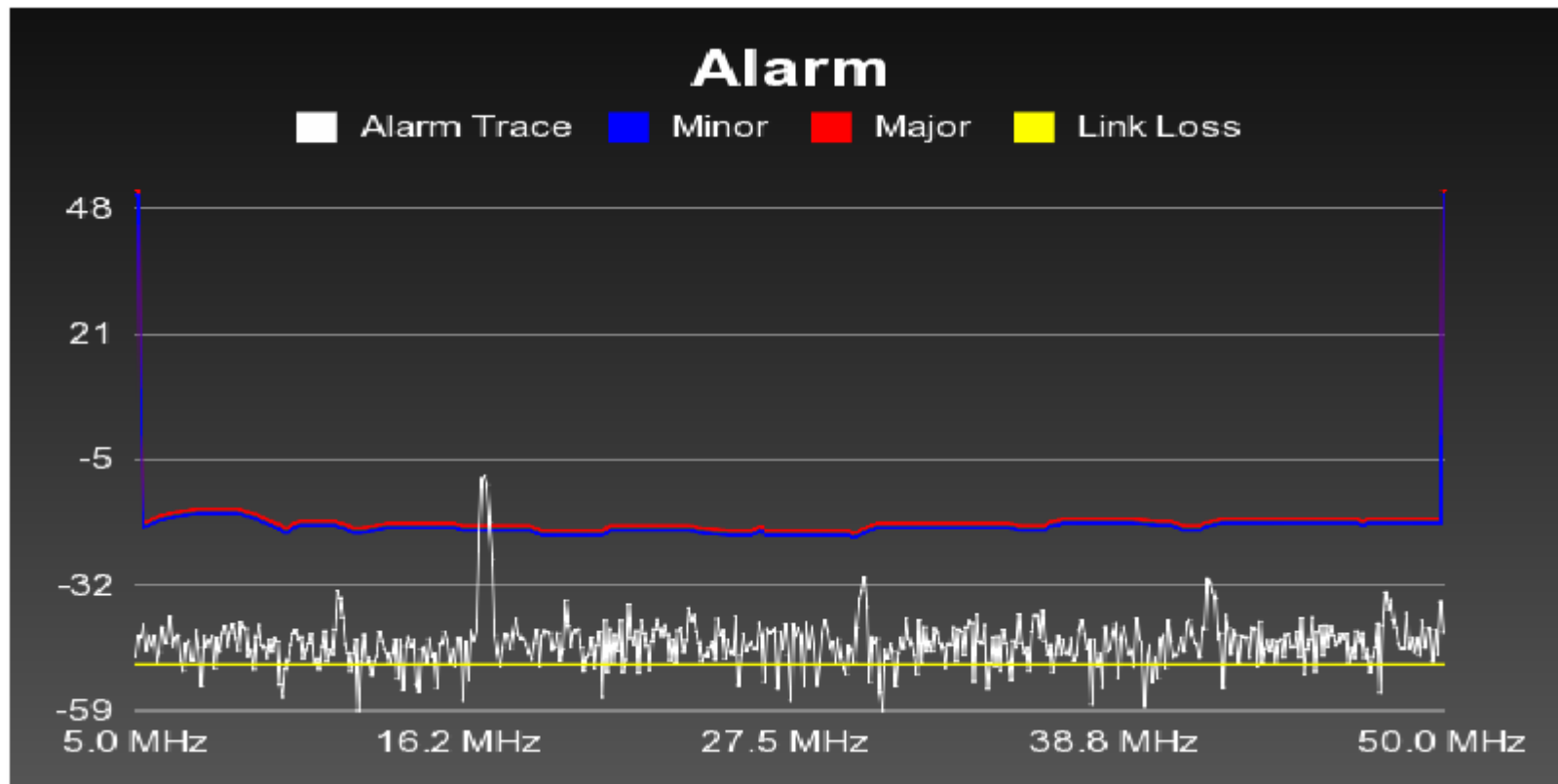
Year

Month

Day

Ack State

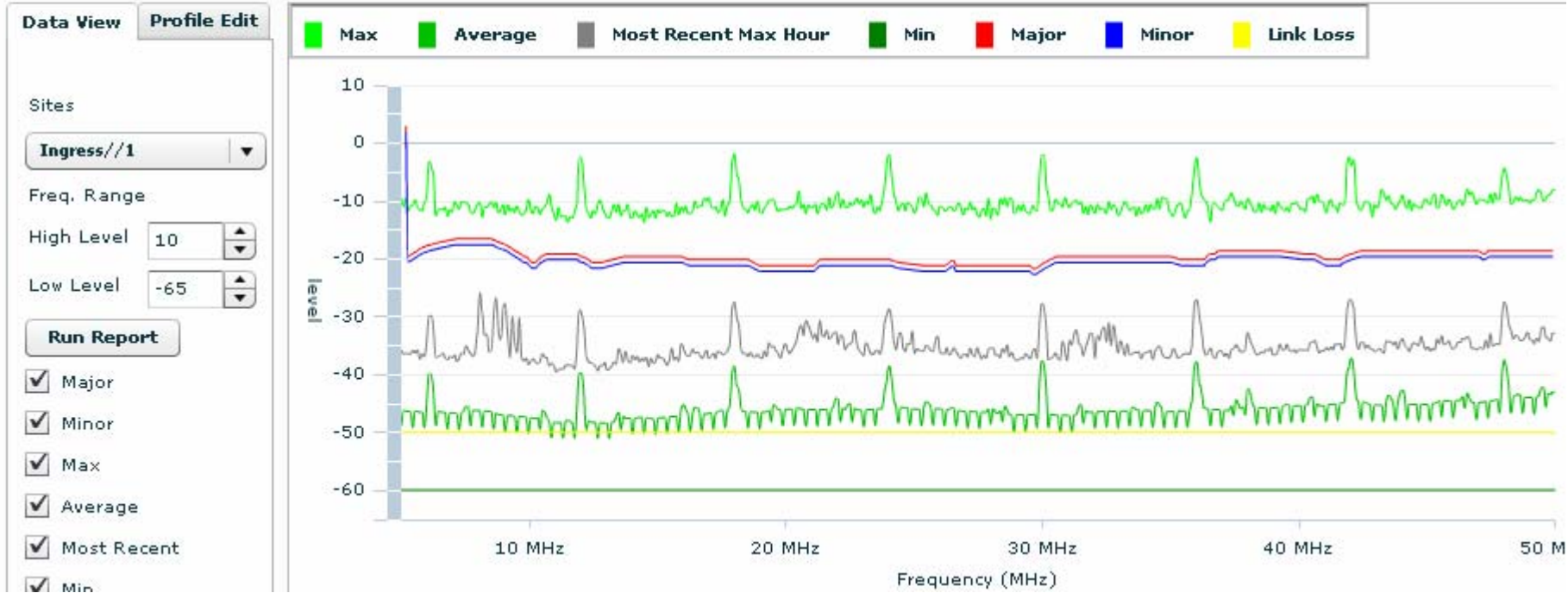
<u>Site</u>	<u>Alarm Level</u>	<u>Alarm Date</u>	<u>Alarm End Date</u>	<u>Trace</u>	<u>Alarm State</u>
Ingress//32	MAJOR	Wed Feb 20 15:25:44 -0500 2008	Wed Feb 20 15:27:34 -0500 2008		Ack
Ingress//29	MAJOR	Tue Feb 19 21:49:26 -0500 2008	Wed Feb 20 15:27:35 -0500 2008		Ack
Ingress//25	MAJOR	Tue Feb 19 21:49:26 -0500 2008	Wed Feb 20 15:27:34 -0500 2008		Ack
Ingress//27	MAJOR	Tue Feb 19 21:49:24 -0500 2008	Wed Feb 20 15:27:34 -0500 2008		UnAck
Ingress//8	MAJOR	Tue Feb 19 21:48:52 -0500 2008	Wed Feb 20 15:27:34 -0500 2008		UnAck
Ingress//14	MAJOR	Tue Feb 19 21:43:35 -0500 2008	Wed Feb 20 15:27:34 -0500 2008		Ack
Ingress//32	MAJOR	Tue Feb 19 21:43:35 -0500 2008	Tue Feb 19 21:49:26 -0500 2008		Ack
Ingress//31	MAJOR	Tue Feb 19 21:43:35 -0500 2008	Wed Feb 20 15:27:34 -0500 2008		UnAck





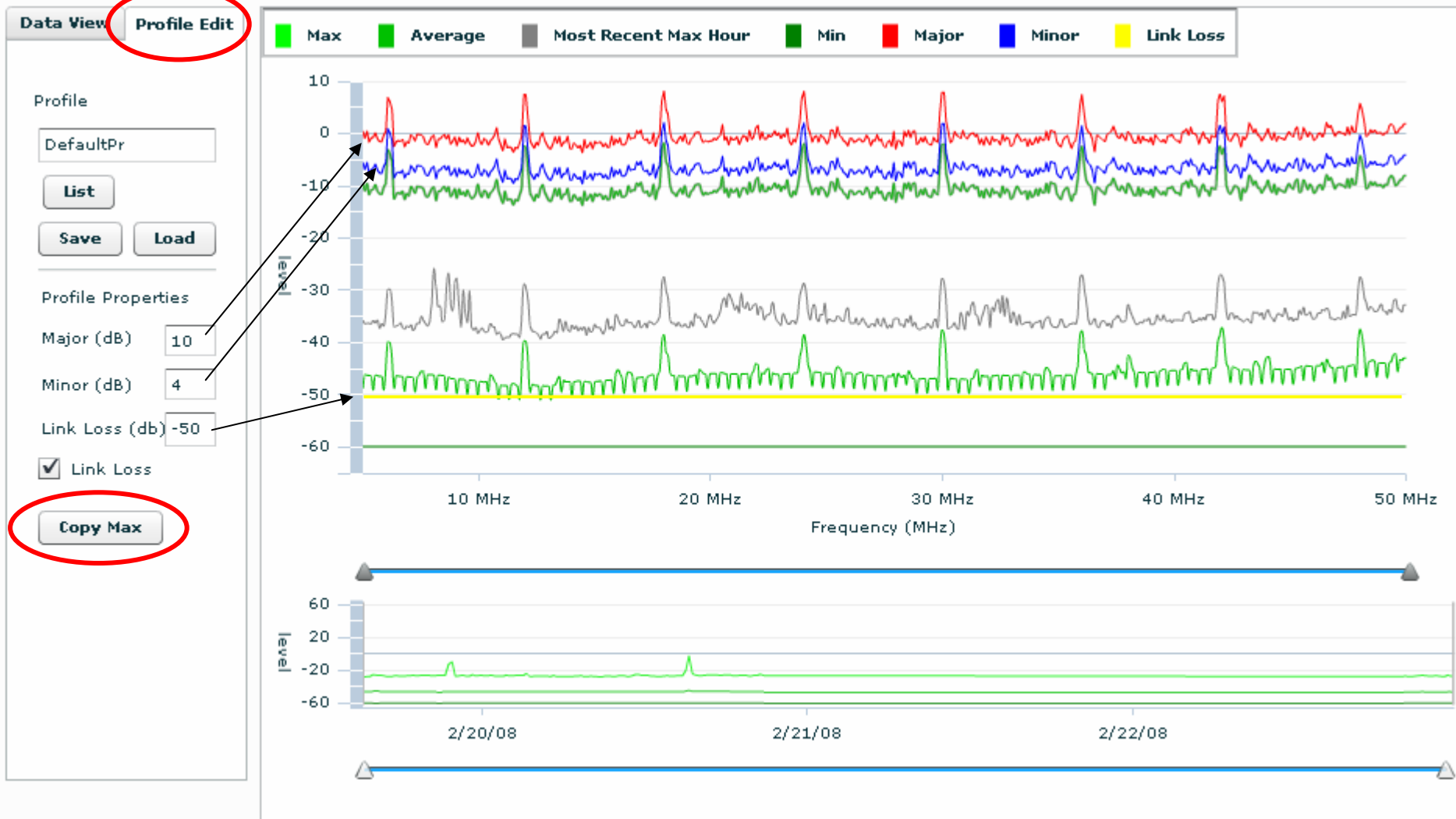
RealWORX® WEB

Dashboard Alarm Summary Alarm **Historical Ingress** Measurement Setup





Creating a new profile



- Proper setup
 - Sweep
 - Characterize the system before you add channels
- Monitoring
- Preventative Maintenance Program

- Return Path Characteristics
- Return Path Measurements
- Ingress
 - What it is
 - How to measure it
- Characterizing the Return Path
 - Constellation
 - Adaptive Equalizer Measurements
- CPD
- Monitoring the Return Path



??? QUESTIONS ???