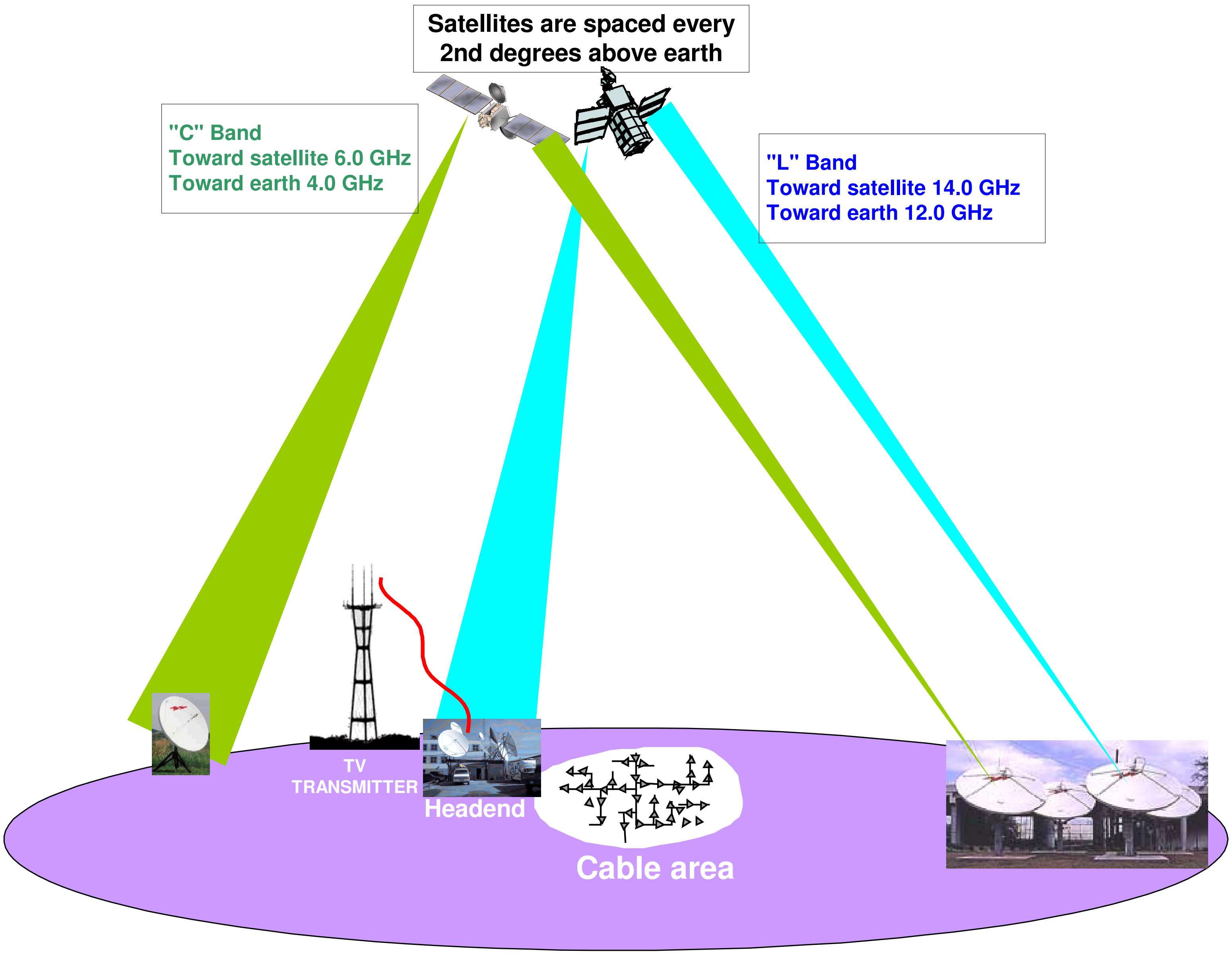
Broadband System – P



Understanding DOCSIS Operating System.

A Cable system operating with Cable Modems required,

- A bi-directional HFC or CATV system.
- A Cable Modem Termination System at the Headend or Hub site.
- A 100 BaseT or better connection to Internet or Servers.
- A 6 MHz of 64 or 256 QAM data channel operating from: 88 to 870 MHz.
- A 3.2 MHz of QPSK or 16 QAM operating between 16 to 40 MHz on the return section of the system for DOCSIS 1.0.
- At least one Cable Modem installed at a customer on the system.

Understanding DOCSIS Operating System.

One standard that will be repeated very often in the following lecture; DOCSIS(™)

Data

Over

Cable

Service

Interface

Specification.

DOCSIS specifications can be; DOCSIS 1.0, 1.1, 2.0 and 3.0

Understanding DOCSIS Operating System.

One other standard that will be repeated very often in the following lecture; CMTS.

Cable

Modem

Termination

System

The above unit is what controls all the data to and from all Cablemodem on the HFC system.

Understanding DOCSIS Operating System.

The DOCSIS services, Data Over Cable Services Interfaces Specifications was developed by CableLabs and approved by the ITU. It also defines interface requirements for cable modems involved in high speed data distribution (both MPEG and IP data) aver cable system networks. Other devices that recognize and support the DOCSIS standard include HDTV's and Web enabled set-top boxes for regular televisions.

There are two key components in the DOCSIS architecture: Cable modem (CM) which is located at the customer premise, and Cable Modem Transmission System (CMTS), which is located at the Headend of service provider s and used to aggregated traffic from multiple Cable Modems and then communicate with the backbone network.

DOCSIS specifies modulation schemes and protocol for exchanging bi-directional signals between the two components over cable.

Cable operators have the possibility of four (4) types of DOCSIS system.

- DOCSIS 1.0, DOCSIS 1.1, DOCSIS 2.0, DOCSIS 3.0

Understanding DOCSIS Operating System.

DOCSIS 1.0

High Speed Internet Access. Key features: Downstream transfert rates between 27 and 36 Mbps over a radio frequency path between 88 and 870 MHz in a 6.0 MHz spacing, and upstream traffic transfer rate between 320 Kbps and 10 Mbps over a RF path of 3.2 MHz between 5 and 42 MHz.

But, because data over cable travels on a shared loop, individuals will see transfer rates drop has more users gain access.

Understanding DOCSIS Operating System.

DOCSIS 1.1

The types of services afforded by DOCSIS 1.1 differ from DOCSIS 1.0 technology, by;

- **QoS (Quality of Service).**
- **Data fragmentation which permit voice services where latency matters more than sheer bandwidth.**
- **Security upgrade**
- **The ability to pre-equalize upstream traffic, thus doubling reverse path throughput (<u>10 Mbps per 3.2 MHz spacing, versus 5 Mbps for DOCSIS 1.0</u>)**

Understanding DOCSIS Operating System.

DOCSIS 2.0

Added capacity for symmetric services by operating at 64 QAM and having new 6.4 MHz wide channel. It increased bandwidth for IP traffic by using enhanced modulation and improved error correction. The result for upstream transmission is 30.72 Mbps using 64 QAM, which is 3 times better than DOCSIS 1.1 and 6 times than DOCSIS 1.0. DOCSIS 2.0 is interoperable and compatible with DOCSIS 1.x

The latest DOCSIS specification eDOCSIS has been published to the industry. eDOCSIS stands for embedded DOCSIS, which would provide a subordinate function at the core chip level to the host device. And, rather than leveraging a home networking protocol, an eDOCSIS device would feed directly into a cable network's DOCSIS channel. eDOCSIS is intended to solve end device (and traffic) management, configuration and security issues to significantly reduce cost in the service operation and to improve speed and quality of end customer services.

Understanding DOCSIS Operating System.

DOCSIS 3.0

The new DOCSIS 3.0 standard that features IPv6 and channel bonding which enables multiple downstream and unstraem channels to be used together at the same time by a single subscriber.

Docsis 3.0 Downstream speed is 160 Mbps and 120 Mbps Upstream.

Channel bonding in computer is an arrangement in whitch two or more NETWORK INTERFACE on a host computer are combined for redundancy or increased throughput.

Internet Protocol Version 6 (IPv6) is a network layer IP standard used by electronic devices to exchange data across a packet-switched internetwork. It follows IPv4 as the second version of the Internet Protocol to be formally adopted for general use..

Understanding DOCSIS Operating System.

In a HFC system, there are two types of modulation used for Cablemodem transportation system:

•QPSK and QAM technologies.

•The forward transport system (88 to 870 MHz) can use 64 or 256 QAM.

•The return transport system (5 to 42 MHz) can use QPSK or 16 - 64 QAM technologies for 3.2 MHz wide.

QPSK;

Quadrature

Phase

Shift

Keying

QAM;

Quadrature

Amplitude

Modulation

Understanding DOCSIS Operating System.

Nominal DOCSIS Downstream Data Rate in 6-MHz Channel

Modulation type	64 QAM	256 QAM
Symbol rate	5.057 MSs	5.360 MSs
Total data rate	30.34 Mbps	42.9 Mbps
Effective data rate	27 Mbps	38 Mbps

Nominal DOCSIS Upstream Data Rate for QPSK

Bandwidth	200 kHz	400 kHz	800 kHz	1600 kHz	3200 kHz
Symbol rate	0.16 MSs	0.32 MSs	0.64 MSs	1.28 MSs	2.56 MSs
Total data rate	0.32 Mbps	0.64 Mbps	1.28 Mbps	2.56 Mbps	5.12 Mbps
Effective data rate	0.3 Mbps	0.6mbps	1.2 Mbps	2.3 Mbps	4.6 Mbps

Nominal DOCSIS Upstream Data Rate for 16 QAM

Bandwidth	200 kHz	400 kHz	800 kHz	1600 kHz	3200 kHz
Symbol rate	0.16 MSs	0.32 MSs	0.64 MSs	1.28 MSs	2.56 MSs
Total data rate	0.64 Mbps	1.28 Mbps	2.56 Mbps	5.12 Mbps	10.24 Mbps
Effective data rate	0.6 Mbps	1.2 Mbps	2.3 Mbps	4.5 Mbps	9.0 Mbps

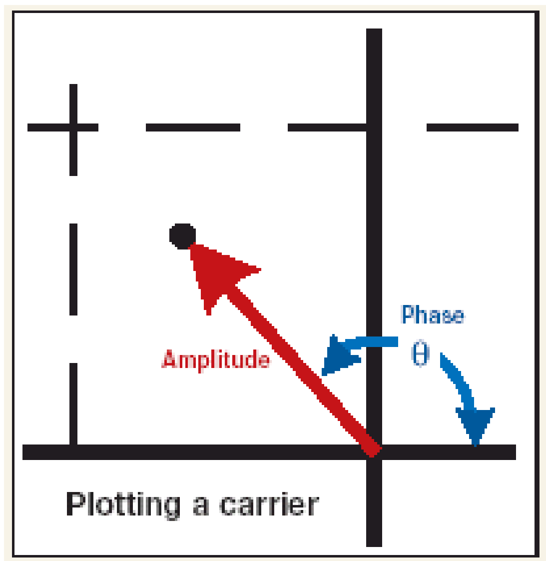
Understanding DOCSIS Operating System.

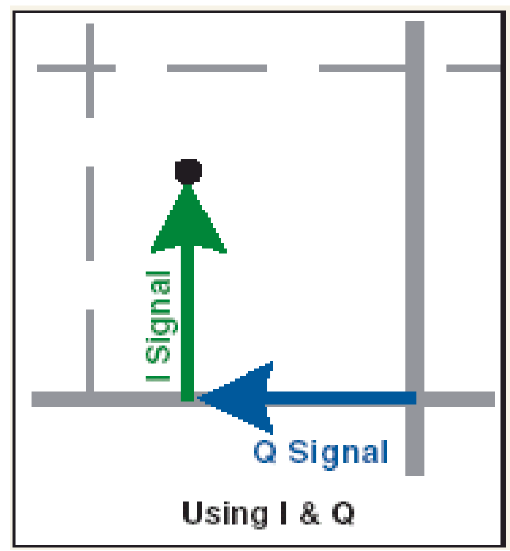
Different DOCSIS differerent SPEED

	Upload	Download
Docsis 1.1	38 mbps	10 mbps
Docsis 2.0	40 mbps	30 mbps
Docsis 3.0	160 mbps	120 mbps

QPSK and QAM Modulation

Location of the Constellation





QPSK modulation

QAM modulation

QPSK only uses <u>Phase and Amplitude Modulation</u>

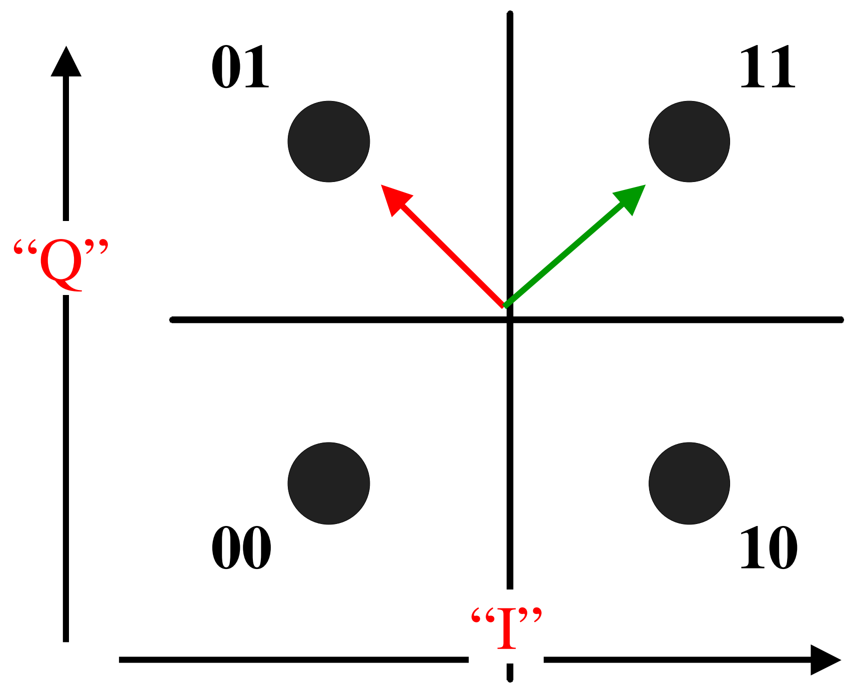
QAM <u>uses "I" and "Q" signal</u>

QPSK Constellation

•QPSK has 4 phases with a constant amplitude.

•QPSK is more resistant to INGRESS but has a lower data rate than 16 QAM

•QPSK has one level of "I" and one level of "Q", for 4 bits symbols.



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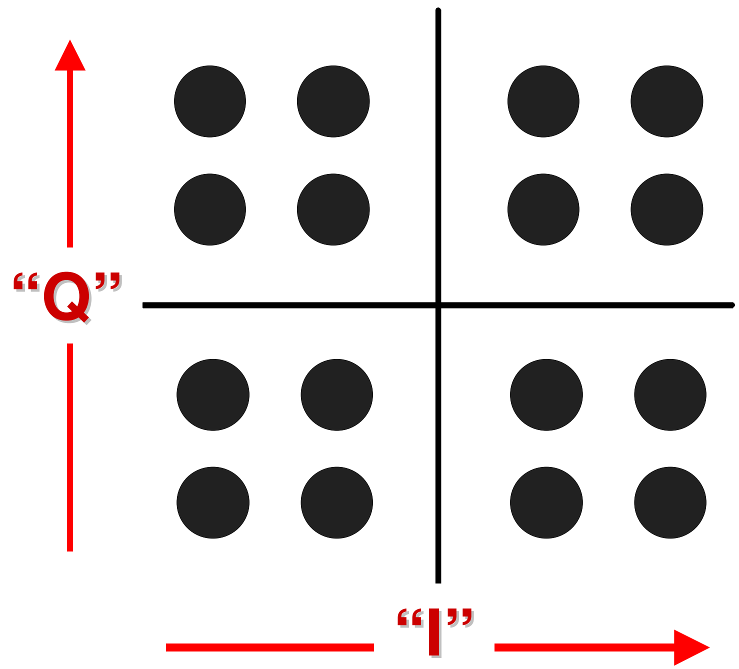
16 QAM Constellation

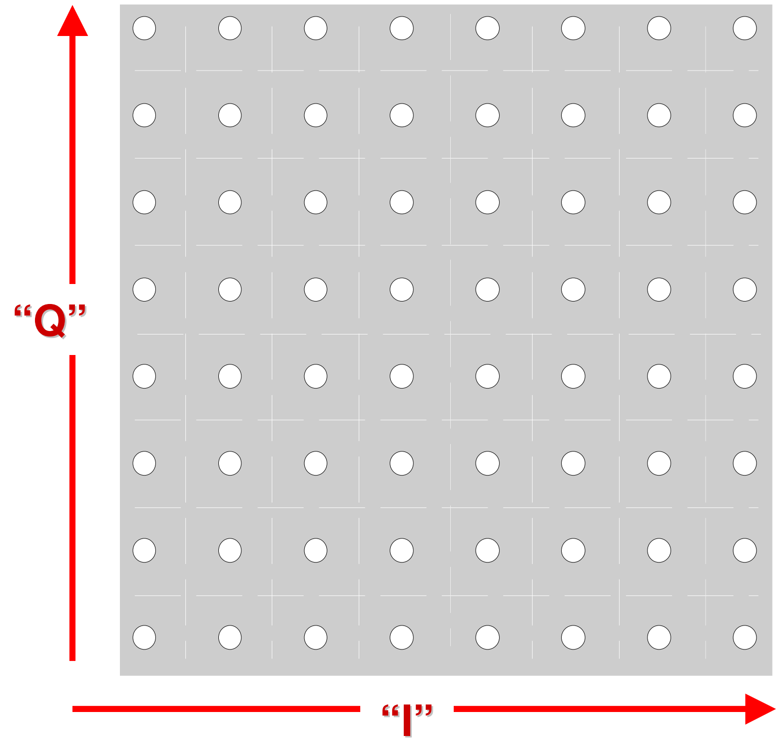
•16 QAM has a data rate is higher than QPSK, but requires a better Carrier to INGRESS ratio, because the symbols are closer together.



16 QAM has 2 levels of "I" and 2 levels of "Q" for 16 possibility.

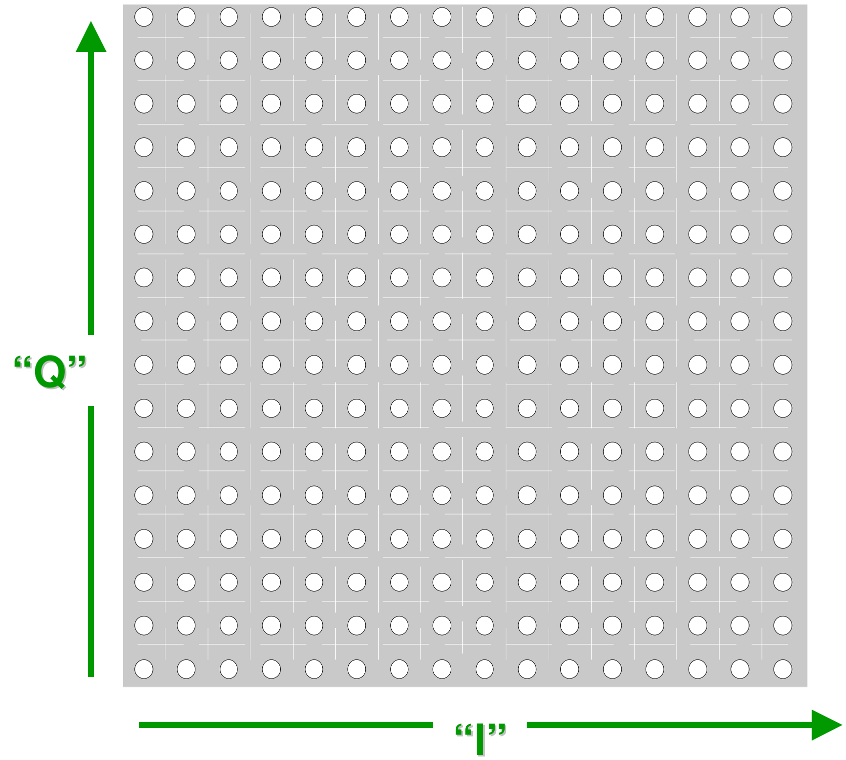
64 or 256 QAM Constellation

64 QAM Constellation



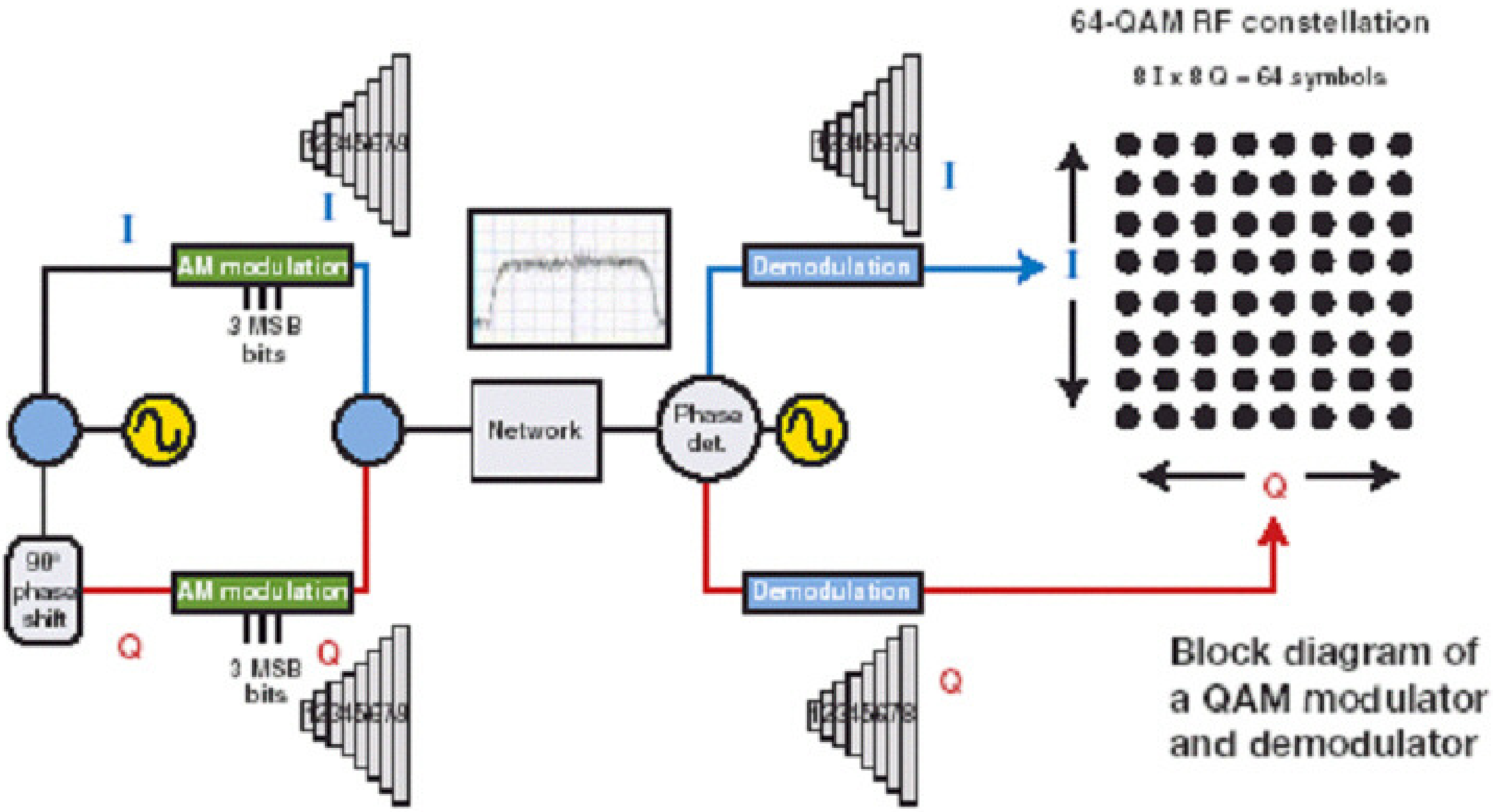
64 QAM has 8 levels of "I" and 8 levels of "Q" for 64 possibility.

256 QAM Constellation



256 QAM has 16 levels of "I" and 16 levels of "Q" for 256 possibility.

A Digital QAM Modulator.



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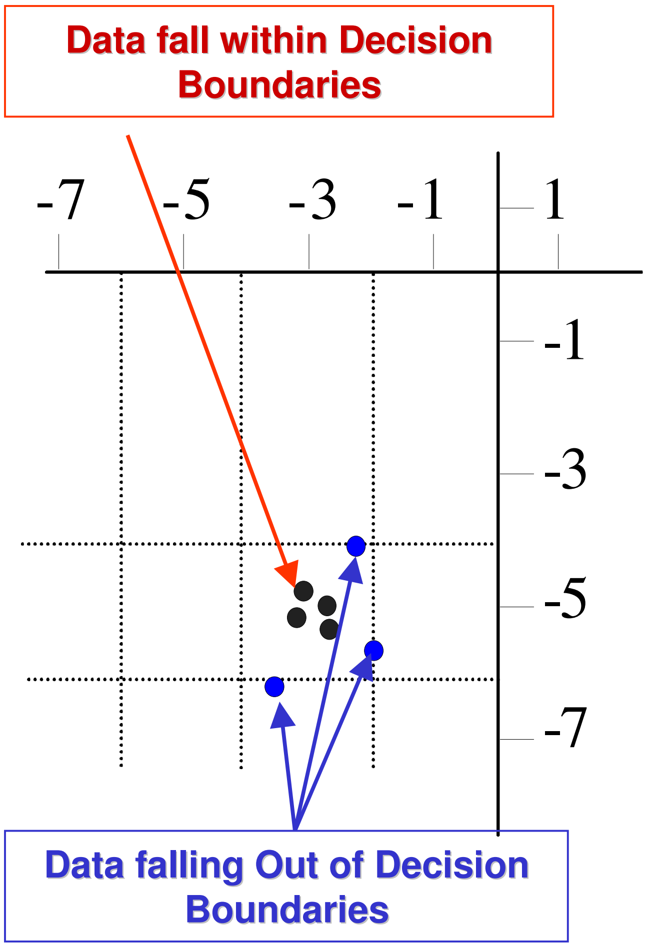
Reading the Constellation Diagrams

In a constellation diagram, all the possible combinations of "I" and Q form a kind of "grid" making them easier to interpret and making disturbances stand out. The constellation diagram can be thought of as array of "boxes" with each box representing one state or "symbol"

In a perfect data transmission conditions each received bit would land right in the centre of its "box", the "nominal" position for that particular symbol. In the real world noise, ingress and reflections push the bit away from its nominal spot, toward the boundary of the adjacent box.

The boundary is called the "Decision Threshold". If a signal disturbance pushes a symbol across the Threshold it is incorrectly interpreted as belonging in the neighbouring box, and becomes a "bit error". Symbols that are not disturbed enough to be pushed across the Threshold are always interpreted correctly. A constellation diagram is a good troubleshooting aid and can give clues concerning the source and nature of a disturbance.



DOCSIS Forward Path System

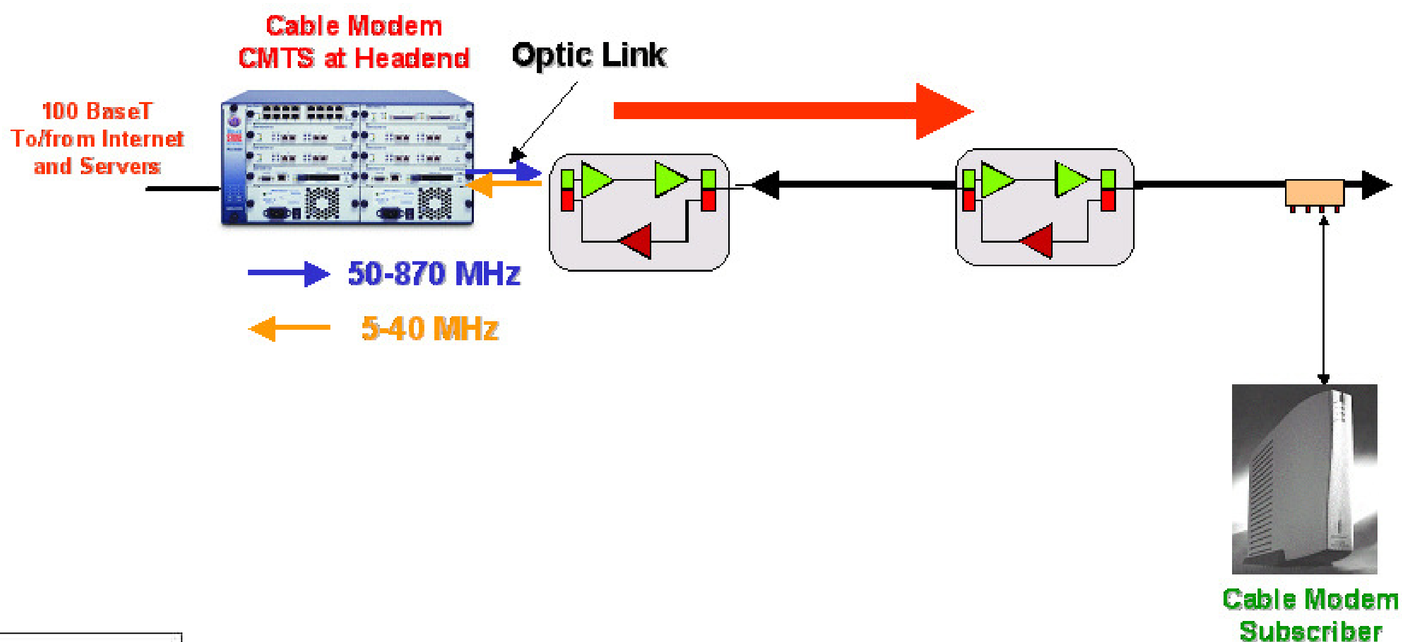
From a CMTS, located at the headend, DATA signal is transported that way.

Requires a 6 MHz TV channel, from 88 to 870 MHz, transporting;

64 QAM (30.3 MB/s)

or

256 QAM (42.9 MB/s)



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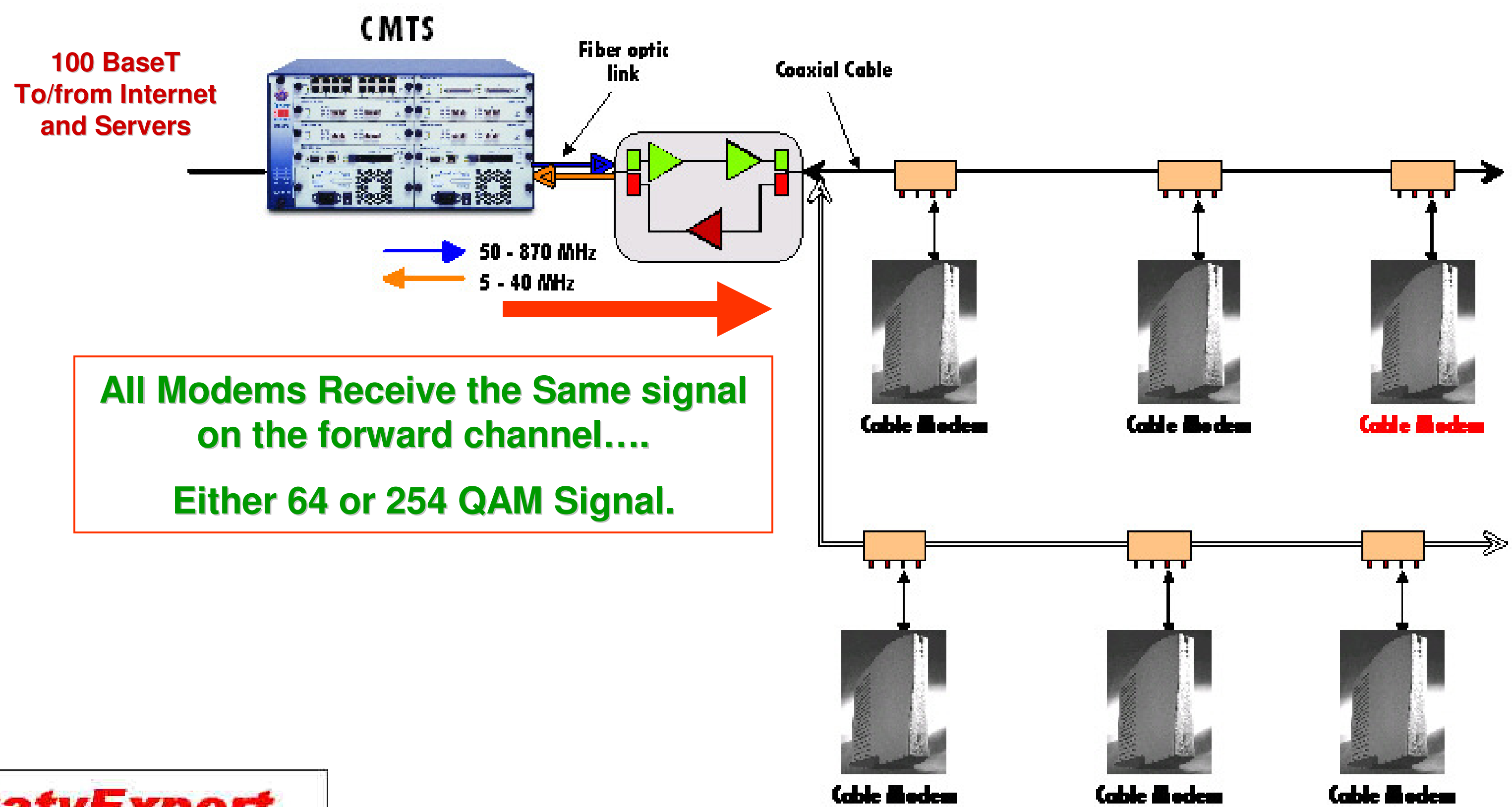
DOCSIS Forward Path System

- Data on the forward path is sent from: 88 to 870 MHz,
- Using either 64 or 256 QAM, in a 6 MHz spacing.
- Streamed data is sent to all Cable Modems connected to the CMTS



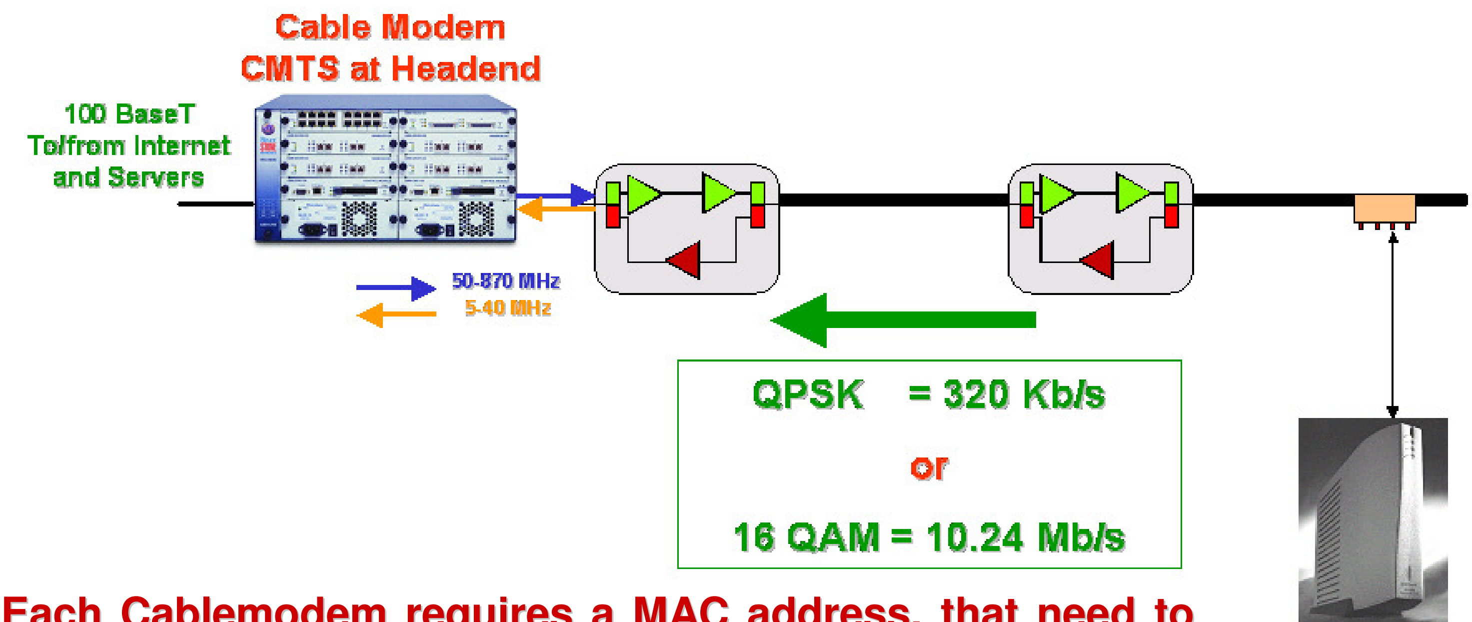
All Modems Receive the Same signal
on the forward channel….

Either 64 or 254 QAM Signal.

DOCSIS Return Path System

•In a DOCSIS 1.1 system, the Return Path transmission system can either use:

QPSK or 16 QAM, TDMA technology in a 3.2 MHz spacing.



Cable Modem Subscriber

•Each Cablemodem requires a MAC address, that need to be enter in the CMTS, before it can connect to the operating system, the CMTS .

•Then a IP address will be given to each Cablemodem, by the CMTS so it can begin receiving and transmitting data.

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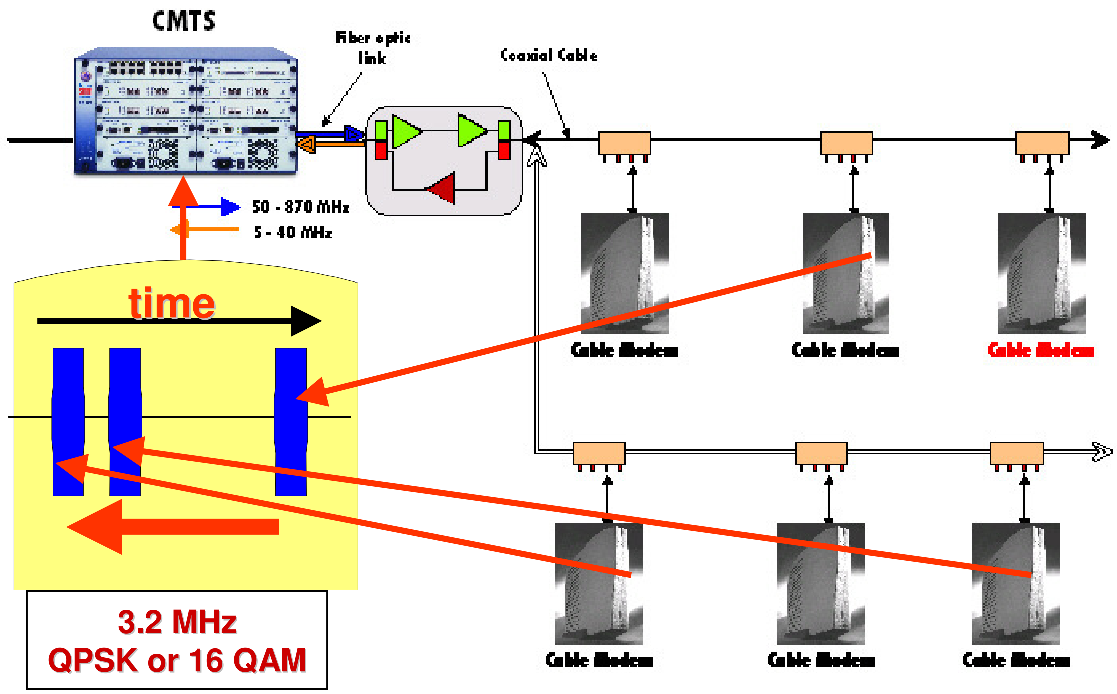
DOCSIS Return Path System

•All of the Cable Modems time share the return path signal under the control of the CMTS upstream time slot map.

•Burst Signal are QPSK or 16 QAM, depending of the CMTS set-up.



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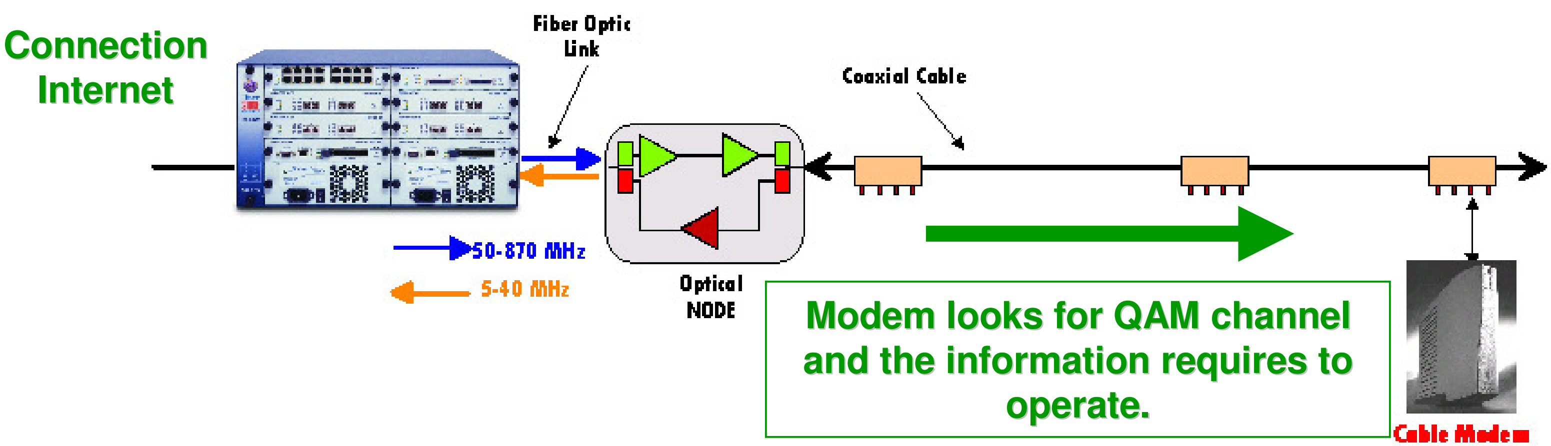
DOCSIS operating system

•When the CMTS is operating and a cable modem is first installed on the system, it first checks for a 6 MHz data channel, from 88 to 870 MHz and look for either 64 or 256 QAM signal.

•When a cablemodem find the 64 or 256 QAM signal, it look at it, and if it is a Video data, it then look for another channel.

• Once it has found the right QAM signal, the cable modem looks for upstream channel and in that data channel are included, symbol rates and the type of modulation required.

•Now that the cable modem has acquires a map of that signal, it now knows when to transmit.

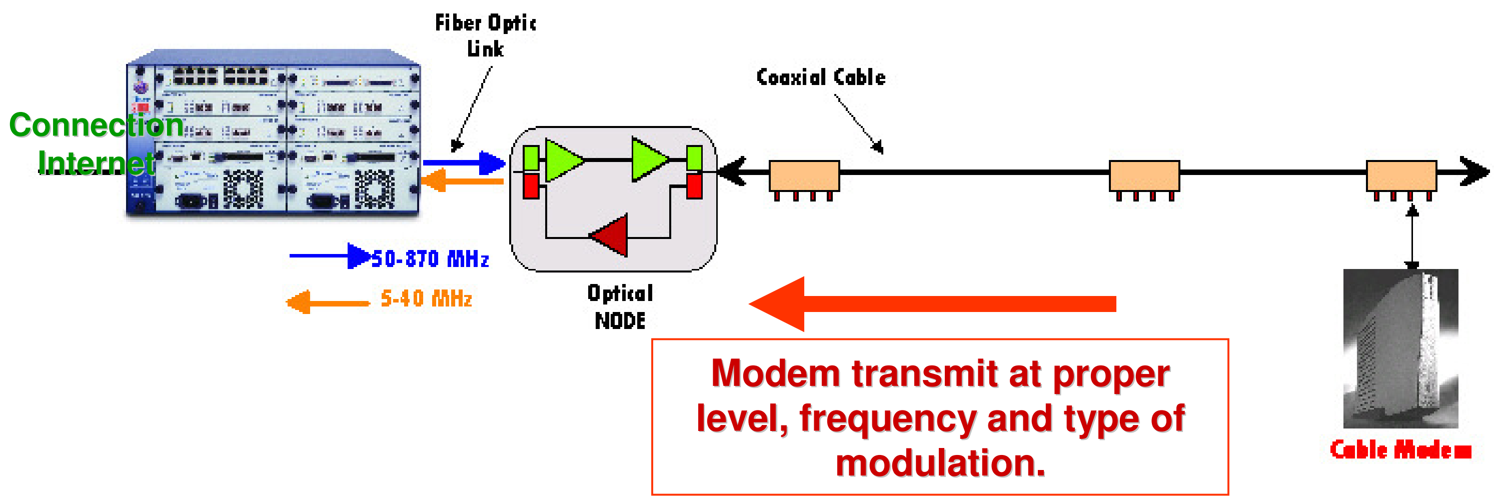


DOCSIS operating system

•When the cable modem received the right information from the CMTS, it start transmitting at low level until the CMTS discover it.

•Once discover by the CMTS, it tell the cable modem, by the forward path, at what level it should transmit, so it can operate properly.

•When the proper return level is found, 2 way communications in now established and the Cable modem is ready to receive and transmits DATA.



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DOCSIS operating system

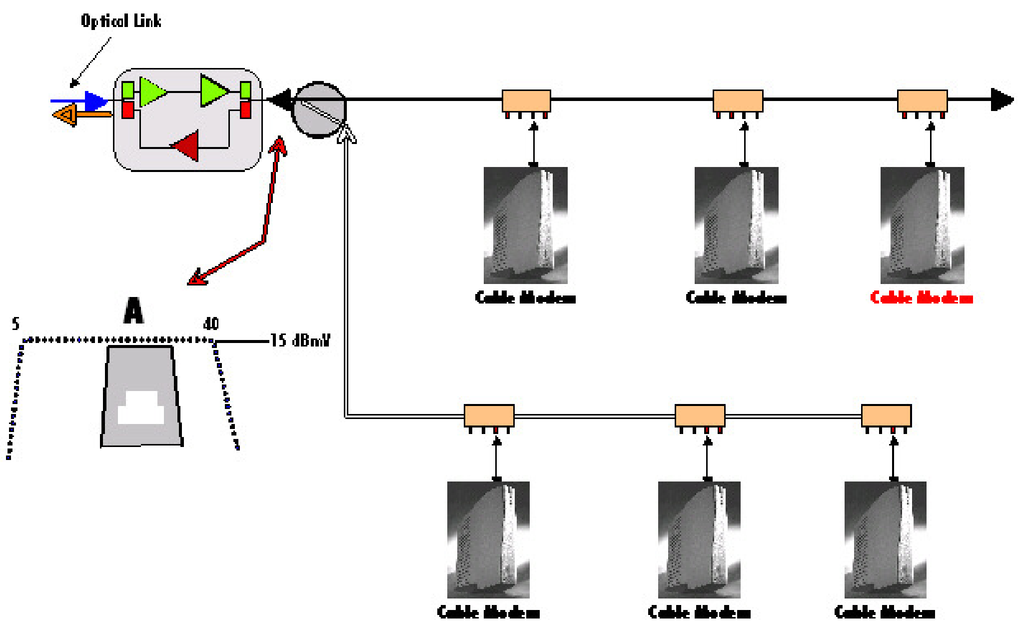
- DOCSIS cable modems have a maximum output level of + 58.0 dBmV when operating in QPSK mode and + 55.0 dBmV using 16 QAM.
- Typically the CMTS located at the Headend requires a level of 0 dBmV.
- The maximum link loss without any amplification is then 58.0 dB with QPSK and 55.0 dB with 16 QAM.
- In a perfect world, all cable modems should never operate at their maximum output, doing so, would put the system in trouble when system degradations are presents.

DOCSIS operating system

•Link loss between any cable modem on the portion of the system, should never be more than 58.0 dB for QPSK and 55 dB with 16 QAM.

•In all cases, the level of the return signal from: 5 to 40 MHz, should be around +15.0 dBmV at the input of all amplifier and NODE on the system.

•That 15.0 dBmV input signal, need be added, the signal loss of the RF coupler or RF splitter, the loss of the drop (RG-6 or RG-59), the loss of the multitap and some headroom at the output signal of the Cablemodem.



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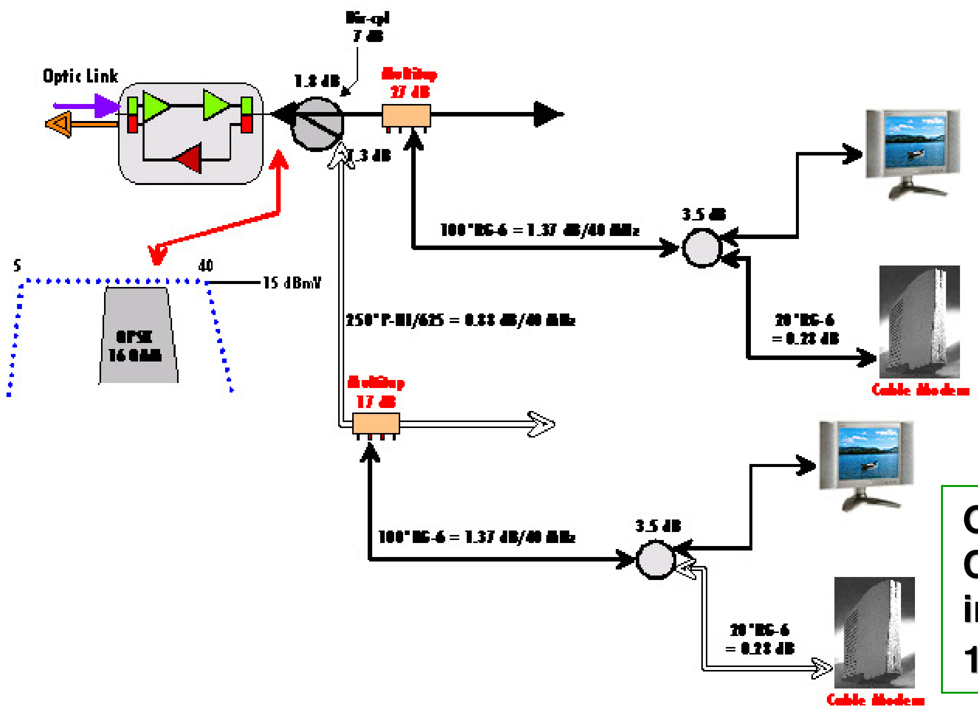
DOCSIS operating system

Actual output level required at the output of a cable modems to meet the required + 15.0 dBmV at the input of all actives equipments on the HFC system.

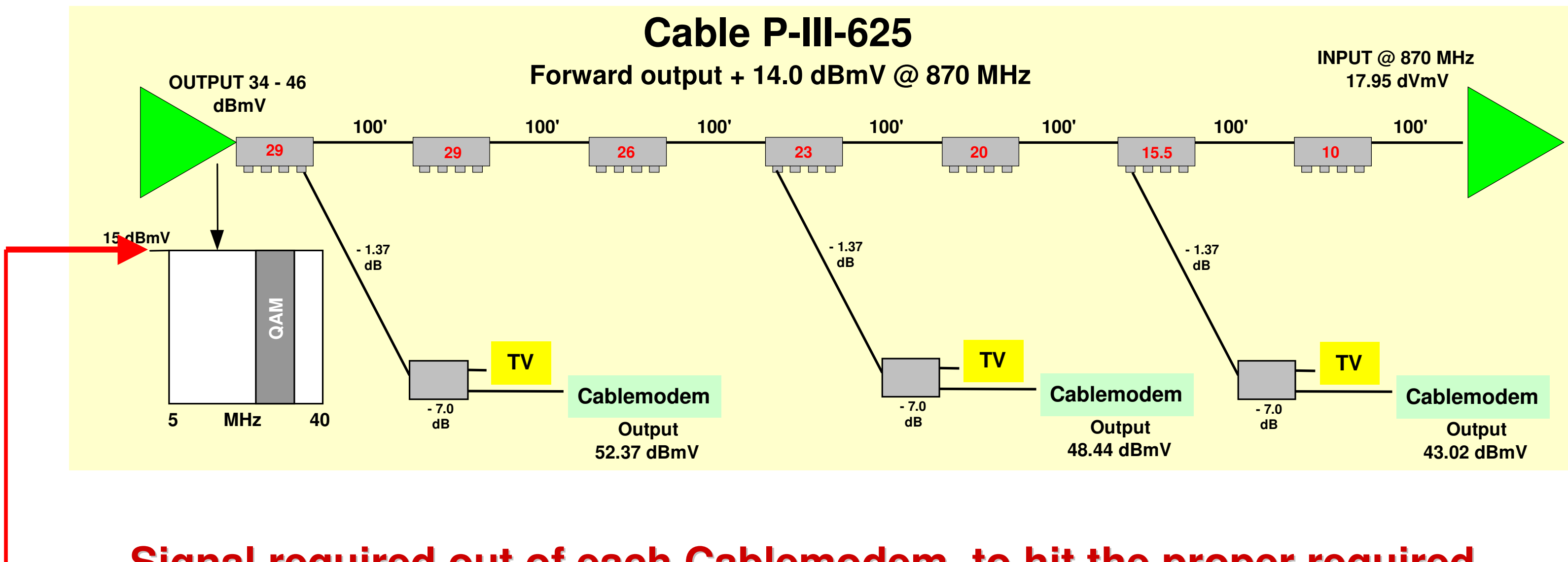


Output level required at this Cable modem for 15 dBmV input: 15 + 1.8 + 27 + 1.37 + 3.5 + 0.28 = **48.95 dBmV**

Output level required at this Cable modem for 15 dBmV input: 15 + 7.3 + 0.88 + 17 + 1.37 + 3.5 + 0.28 = **45.33 dBmV**

DOCSIS operating system

Actual output level in dBmV, required out of the Cablemodem, to hit proper input at the next return amplifier or Optical Node, where the forward signal output is @ 14.0 dBmV at 750 or 870 MHz



Signal required out of each Cablemodem, to hit the proper required 15 dBmV at the input at the housing

This actually shows why new Cablemodem are now equipped with a output level control. This output level is controlled by the CMTS or the SERVER located in the headend.

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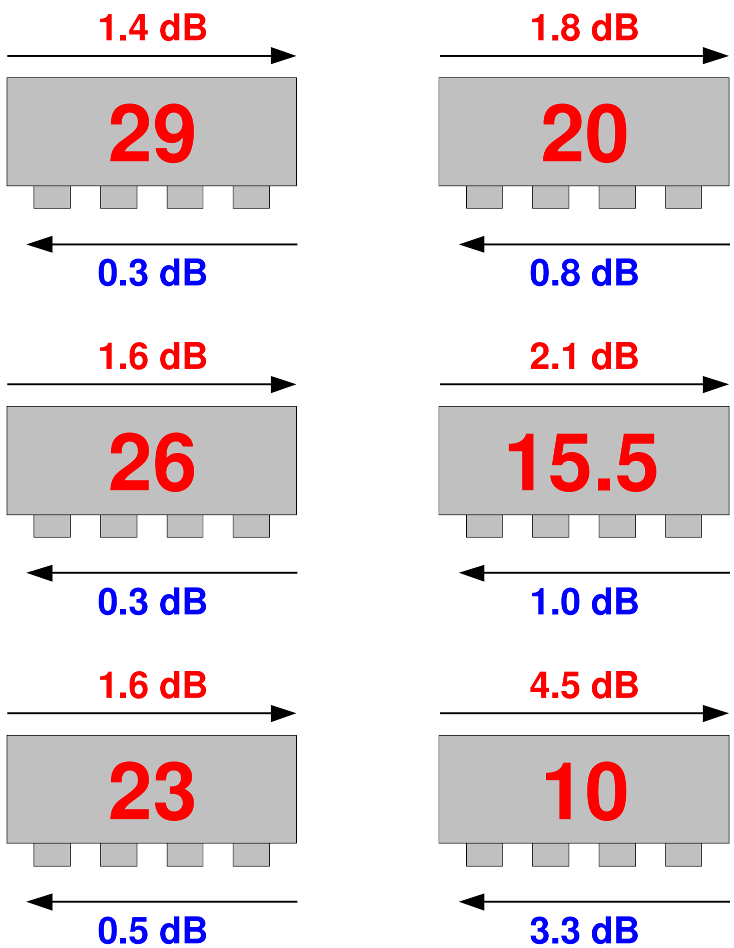
DOCSIS operating system

Loss of signal on Tap;



As the value of the multitaps lower as it installed a way from the amplifier, the forward and lower frequency value changes also. These values have to be taken in conside-ration while designing the system.

A modern HFC system requires about + 14.0 dBmV at 870 MHz at the output of each multitap.

For the return section each Cablemodem must have an different output to reach the input of the return pattern.

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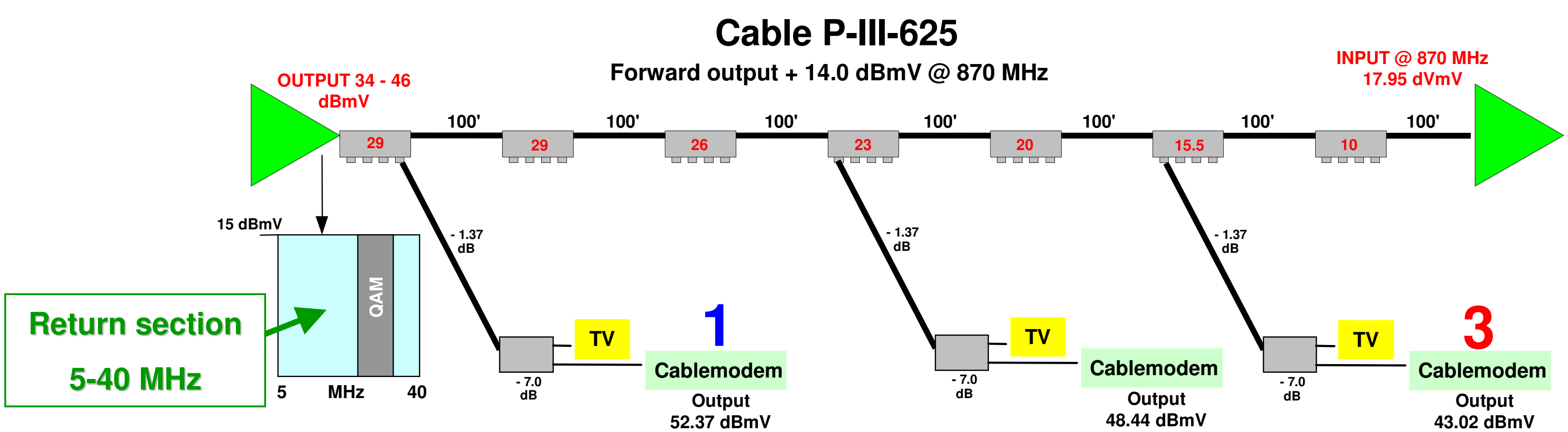
DOCSIS operating system

Loss of signal on a return system;



Signal loss at 40 MHz between Cablemodem - 1 and the Amplifier =

Cablemodem output = 52.37 dBmV.

Signal loss at 40 MHz between Cablemodem - 3 and the Amplifier =

Cablemodem output = 43.02 dBmV.

DOCSIS operating system

Signal loss on forward and return section.

Section avec BLE-87

Perte de signal: 1.95 dB @ 870 MHz par 100'
Cable PIII-625 0.36 dB @ 55 MHz par 100'
0.39 dB @ 40 MHz par 100'

Distance: 700 Pieds @ 870 MHz

Perte @ 40 MHz			0.39		0.39		0.39		0.39		0.39		0.39		0.39	
Input Multitaps				44.65		41.30		37.75		34.20		30.45		26.40		Entré
Perte M-T & Cable 870 MHz		1.4	1.95	1.4	1.95	1.6	1.95	1.6	1.95	1.8	1.95	2.1	1.95	4.5	1.95	Amp.
Perte M-T & Cable 55 MHz		0.3	0.36	0.3	0.36	0.3	0.36	0.5	0.36	0.8	0.36	1.0	0.36	3.3	0.36	
Valeur MT	48.00	29	100	26	100	26	100	23	100	20	100	15.5	100	10	100	19.95
Sortie	36.00	19.0		18.7		15.3		14.8		14.2		15.0		16.4		dBmV
Perte 40 MHz	dBmV	0.3		0.3		0.3		0.5		0.8		1.0		3.3		

Gain 26.05 870 MHz
Sortie 46.00 870 MHz

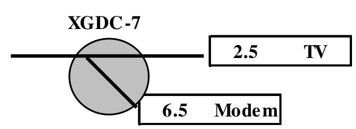
Gain 9.2 40 MHz
Entre 15.00 40 MHz

Entre 40 MHz 15.0 *dBmV*

6.2 *Perte dB par 100' @ 870 MHz*
1.55 *Perte dB par 100' @ 55 MHz*
1.37 *Perte dB par 100' @ 40 MHz*

5 MHz 40

	Cpl.	2.5	Cpl.	2.5	Cpl.	2.5	Cpl.	2.5	Cpl.	2.5	Cpl.	2.5	Cpl.	2.5
	Modem	6.5	Modem	6.5	Modem	6.5	Modem	6.5	Modem	6.5	Modem	6.5	Modem	6.5
Sortie cablemodems @ 40 MHz	51.8		49.5		50.2		47.9		45.8		42.5		38.4	dBmV
Signal 870 MHz	10.30		9.95		6.60		6.05		5.50		6.25		7.70	dBmV
Signal 55MHz	2.95		6.84		4.63		6.97		9.83		12.45		16.59	

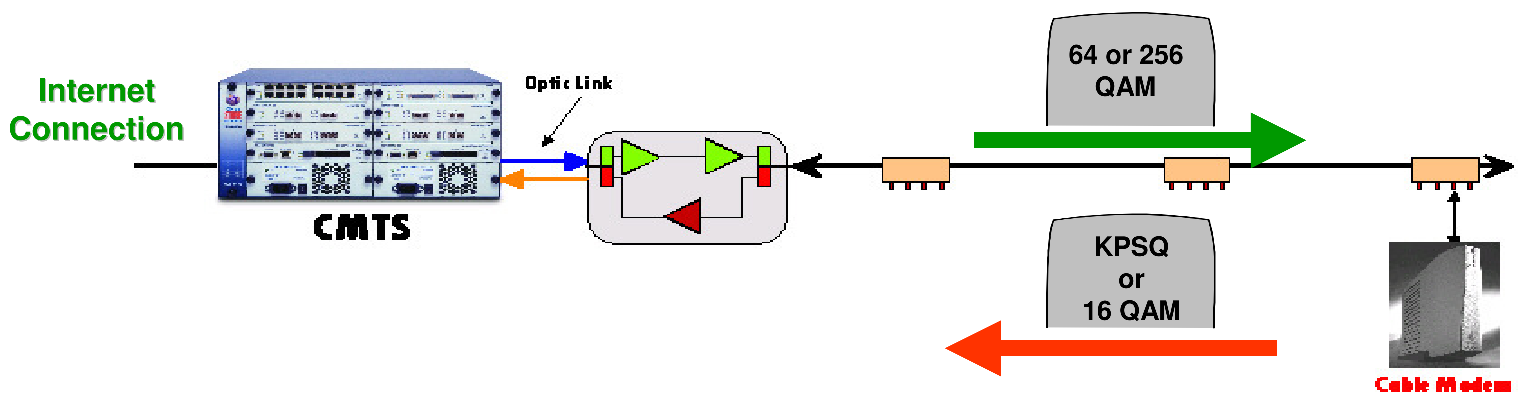


Coupleur for installation

DOCSIS operating system

•Once two way communications is established, and the proper connections are made with the following protocols; DHCP, TOD and TFTP server, a full IP connection is then established.

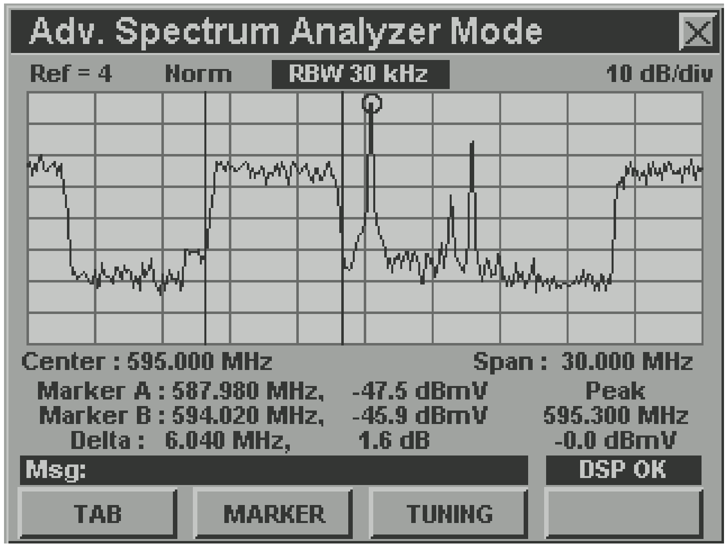
•When the registration process is completed, the modem is now in full operation and ready to surf the web at will.



DOCSIS operating system

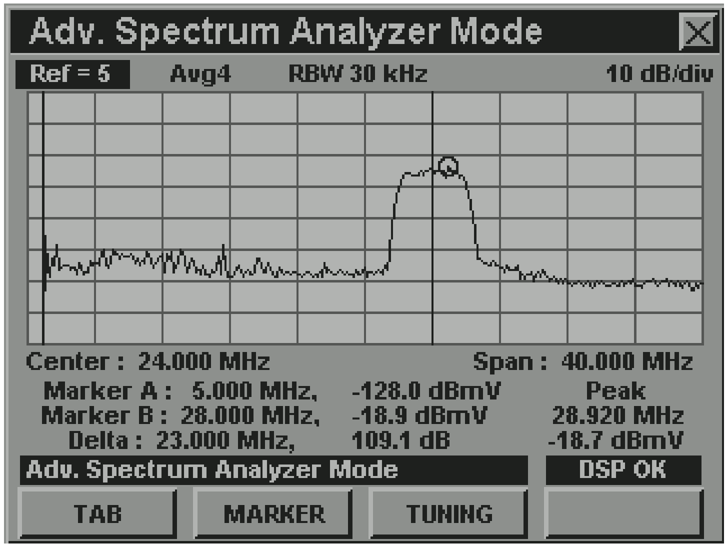
•QAM signal on a HFC system.

Forward section



64 or 256 QAM signal in the 580 to 610 MHz region.

Return section



QPSK or 16 QAM signal in 5 to 40 MHz region.

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DOCSIS Testing and Measurement

•When a Cable modem received packets with errors present, they are resent again to make sure all the data is correct.

•Resending data can be done on the forward as well as in the return path.

•Modem that are continually resending data, cause the overall data throughput for all of the modems drops.

•This problem may be not to severe with low data traffic or a small amount of cable modem on a system.

•When the traffic load increases and with a high number of resends demand get out of control, the system grinds to a halt.

•This is when testing the system for throughput become necessary, to improve the heavily loaded performance of the system.

DOCSIS Testing and Measurement

Forward path testing consist of testing for;

•MER (Modulation Error Ratio) or BER (Bit Error Ratio)

•MER is much like doing (Carrier to Noise) in a CATV system, it is also the average amount that bits are displaced from their nominal values. This is expressed as the ratio of the power of the noise causing the displacement to the power of the QAM signal. The result is expressed in dB. A larger number mean better. (36 dB MER is better that 29 dB MER).

•BER measures how often symbols are pushed into neighbouring symbols "territory", causing these symbols to be misinterpreted. BER is expressed as the ratio of eroded bits per some number of bits sent (given as a power of 10). For example, a BER measurement of "3E-7" ("3 times 10 raised to the –7th power) means that a given bit has a 3 in 10 millions chance of being misinterpreted. This ratio is extrapolated from a smaller number of real bits that were actually analyzed and the eroded bits that were counted. A lower BER means better performance.

•BER does not measure the purity or condition of the QAM signal itself, though a poor BER is an indication of poor signal quality. Because the BER measurement detects and counts every misinterpreted bit, it is sensitive indicator of problem caused by transient or "bur sty" noise interference.

DOCSIS Testing and Measurement

•For Câblemodem and Digital Televison signal to work properly, the HFC system requires a MER's better than;

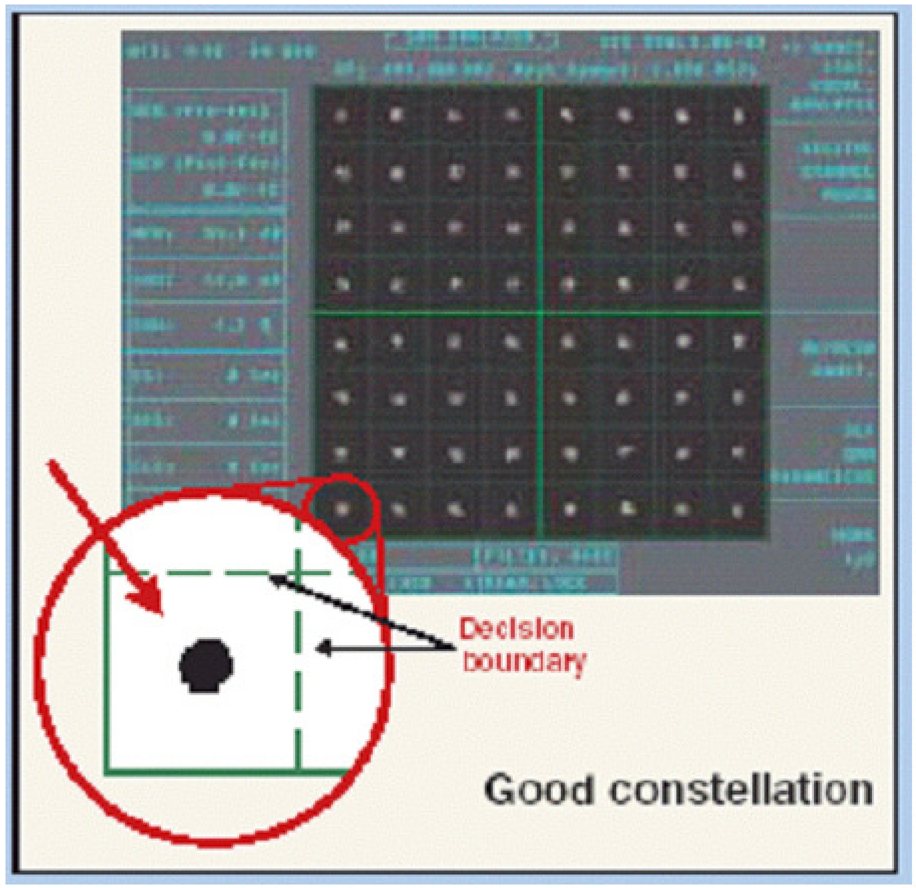
•<u>18.0 dB MER level is required for 16 QAM,</u>

• <u>27.0 dB MER level is required for 64 QAM</u>

•<u>31.0 dB MER level is required for 256 QAM,</u>

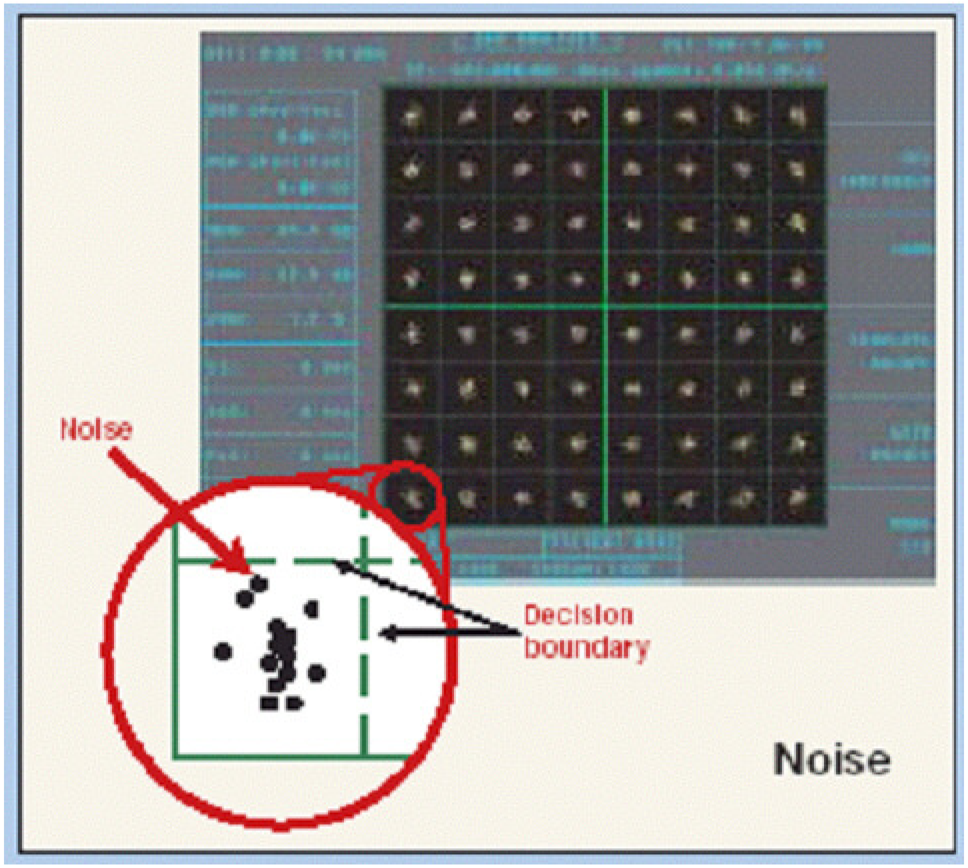
•The Constellation is then used to verify or to troubleshoot the signal quality. This quality is then check using MER or BER technology.

DOCSIS Testing and Measurement



GOOD

DOCSIS Testing and Measurement



NOISE

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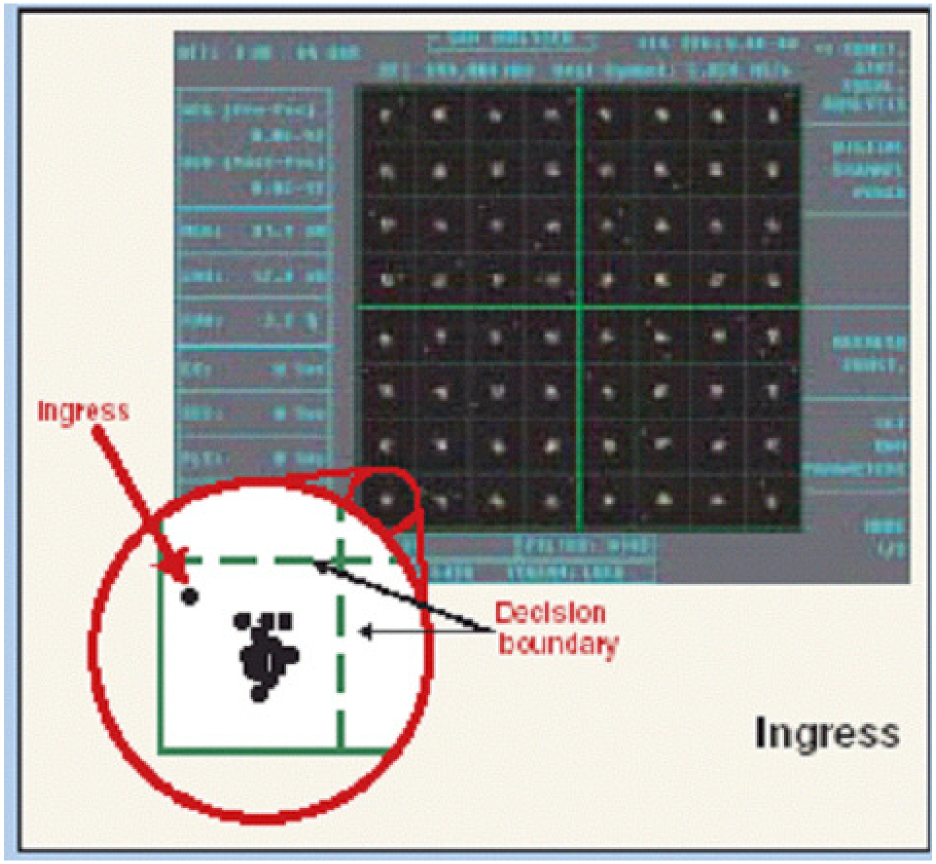
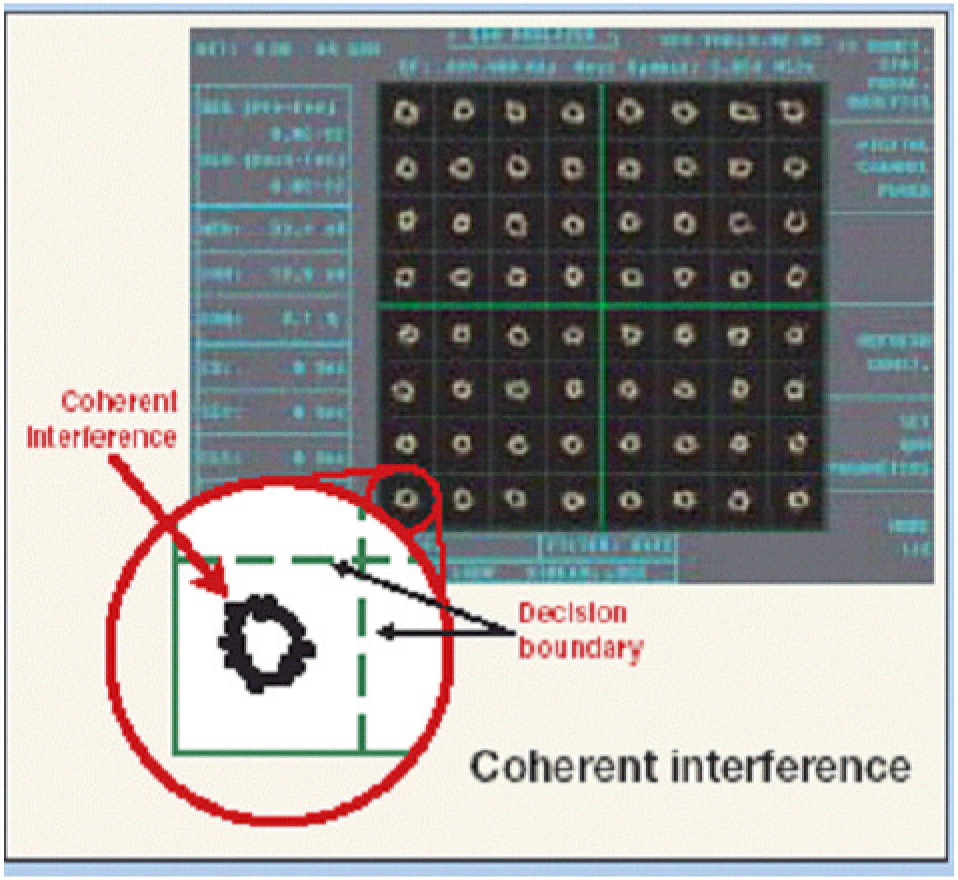
DOCSIS Testing and Measurement



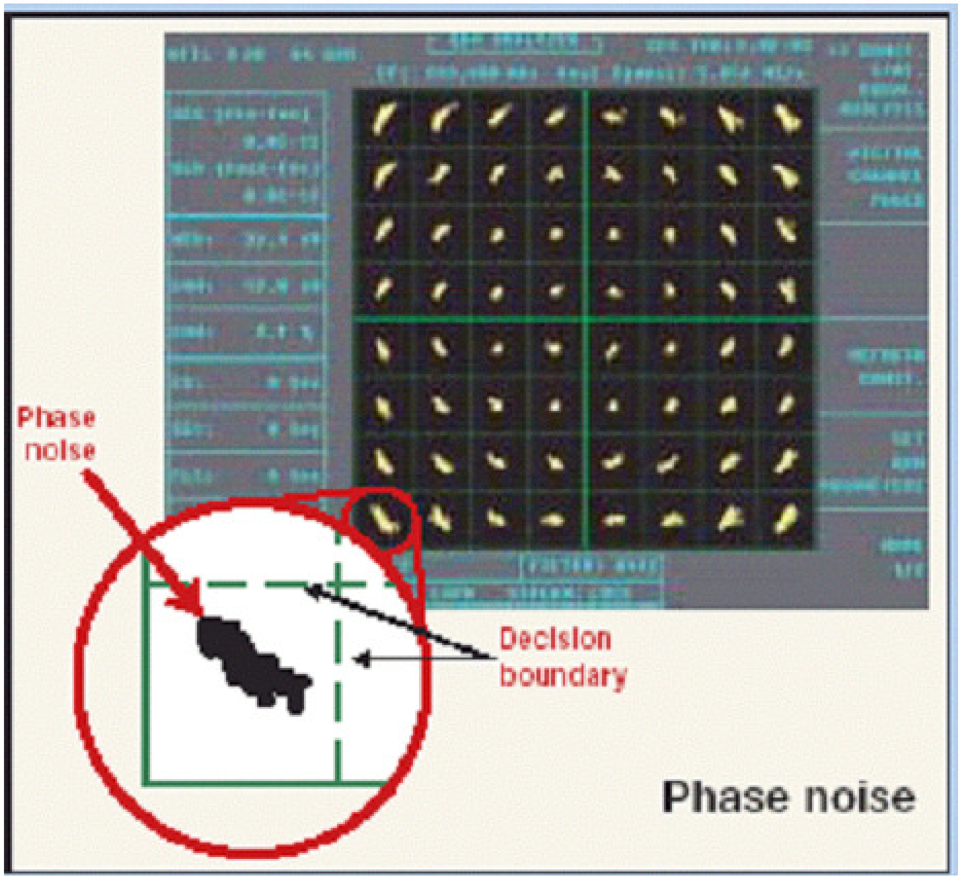
INGRESS

DOCSIS Testing and Measurement



COHERENT INTERFERENCE

DOCSIS Testing and Measurement



PHASE NOISE

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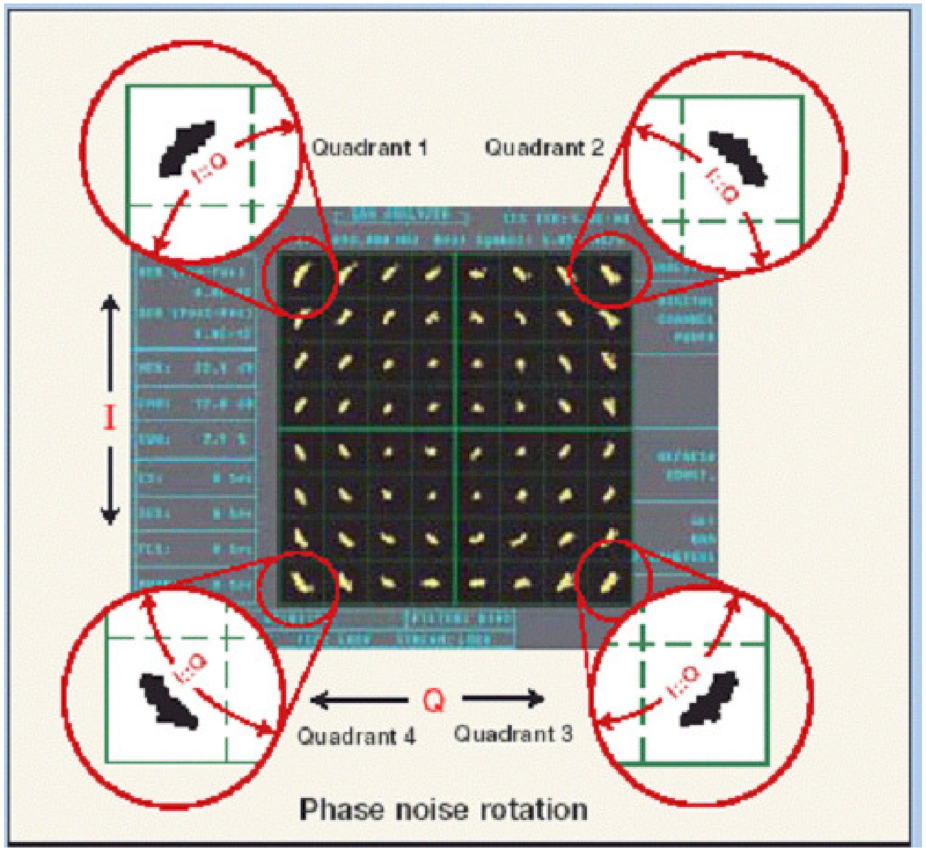
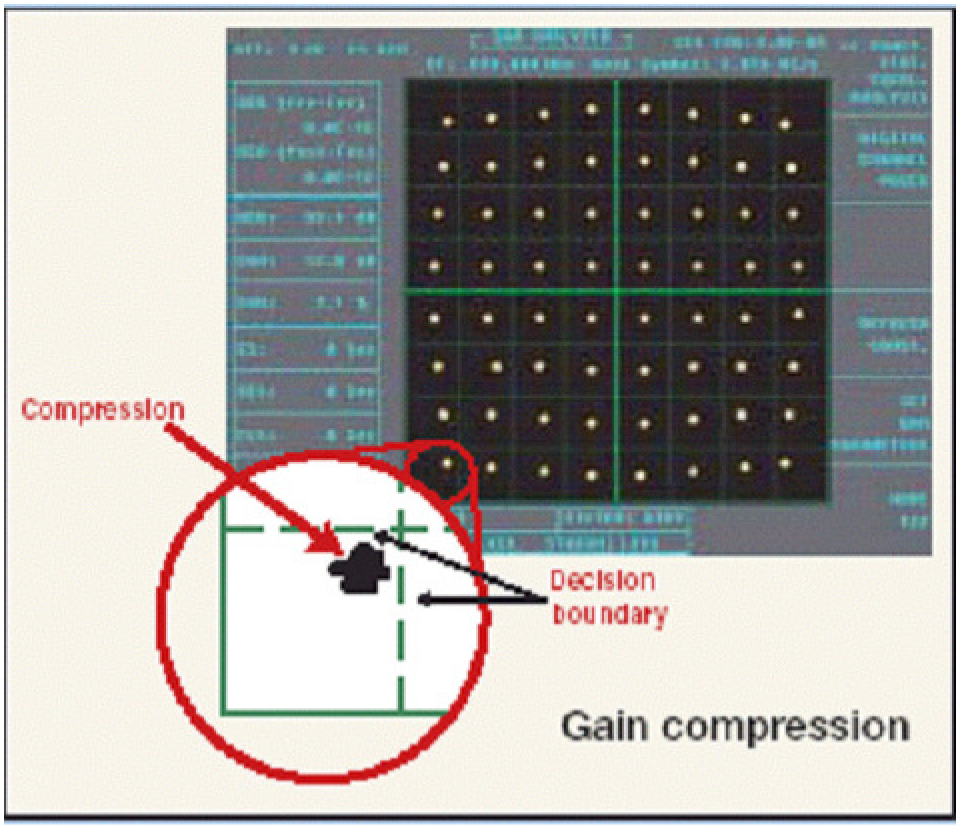
DOCSIS Testing and Measurement



PHASE NOISE ROTATION

DOCSIS Testing and Measurement



GAIN COMPRESSION

DOCSIS Testing and Measurement

HOW GOOD SHOULT IT BE?

TARGETED PERFORMANCE GUIDE

The charts shows at right outline goals for a typical network. Specific systems requirements may require tighter or less critical performance.

Expected MER & BER Results

Digital Video		MER 64 QAM	MER 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	1.0E-08	0.0E+00
	Marginal	30 dB	32 dB	1.0E-07	1.0E-08
Node	Excellent	34 dB	35 dB	0.0 E-00	0.0 E-00
	Acceptable	31 dB	34 dB	1.0E-08	0.0 E-00
	Marginal	28 dB	30 dB	1.0E-07	1.0E-08
Amp	Excellent	33 dB	35 dB	1.0E-09	0.0 E-00
	Acceptable	30 dB	32 dB	1.0E-08	1.0E-09
	Marginal	25 dB	27 dB	1.0E-07	1.0E-08
Tap	Excellent	32 dB	35 dB	1.0E-08	0.0 E-00
	Acceptable	28 dB	31 dB	1.0E-07	1.0E-09
	Marginal	24 dB	28 dB	1.0E-06	1.0E-08
Set-Top	Excellent	32 dB	35 dB	1.0E-08	0.0 E-0
	Acceptable	27 dB	31 dB	1.0E-07	1.0E-08
	Marginal	23 dB	27 dB	1.0E-06	1.0E-07

Digital Data		MER 64 QAM	MER 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	0.0E+00
	Marginal	32 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	1.0E-09	0.0 E-00
	Acceptable	31 dB	33 dB	1.0E-08	0.0 E-00
	Marginal	28 dB	30 dB	1.0E-07	1.0E-09
Tap	Excellent	33 dB	35 dB	1.0E-08	0.0 E-00
	Acceptable	29 dB	32 dB	1.0E-07	1.0E-09
	Marginal	25 dB	30 dB	1.0E-06	1.0E-08
Modem	Excellent	32 dB	35 dB	1.0E-08	0.0 E-0
	Acceptable	28 dB	32 dB	1.0E-07	1.0E-08
	Marginal	25 dB	28 dB	1.0E-06	1.0E-07

DOCSIS Testing and Measurement

SCIENTIFIC NOTATION.

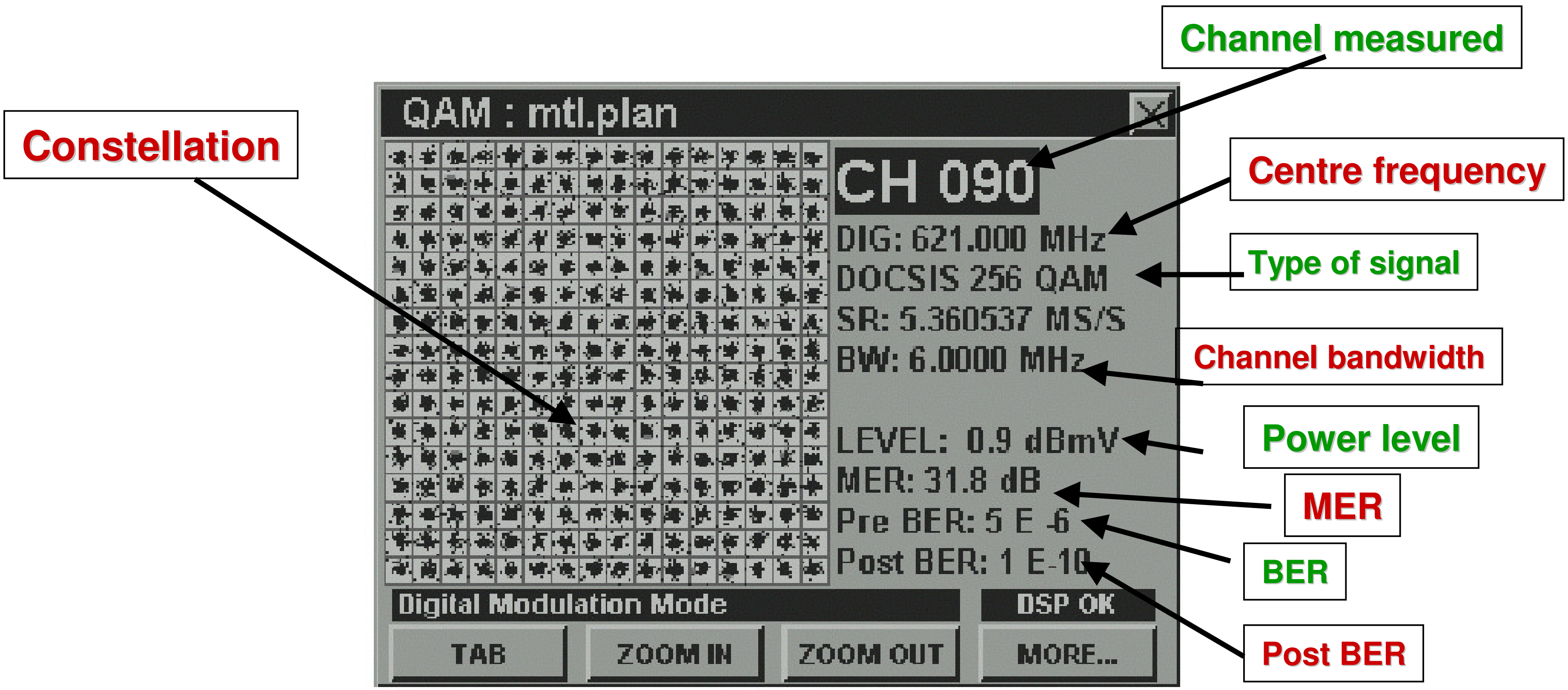
BER (Bit Error Rate) measurements are expressed in terms of errors divided by a total number of un0erroded bits transmitted or received. Since the number of errors is very small compared to the number of bits transmitted, the measurement is typically expressed in scientific notation. For example, one error out of one million bits would be expressed as 1/1,000,000 or 1.0 E-6. Confusion often arises when a second measurement is compared. Is 7.0 E-7 better or worse? 7.0 E-7 means seven errors out of 10,000,000 bits, which is better than 1 in 1,000,000. The following chart may be helpful in interpreting scientific notation.

One important note: Many instruments will read 0 (zero) errors or 0.0E-0 when no errors have been detected. E0 or E-0 is equal to 1, but the leading 0 makes the measurement equal to 0.

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
0.00E-00	0 x 1	Zero (no errors)

•For example, one error out of one millions bits would be expressed as 1/1,000,000 or 1.00E-06

DOCSIS Testing and Measurement



DOCSIS Testing and Measurement

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DOCSIS Return Path System

Return Path Testing.

•The return path of a HFC system is the section of the system that will be most affected by all kind of problems, problems like:

•INGRESS,

•NOISE,

•OPERATING LEVEL of the cable modem,

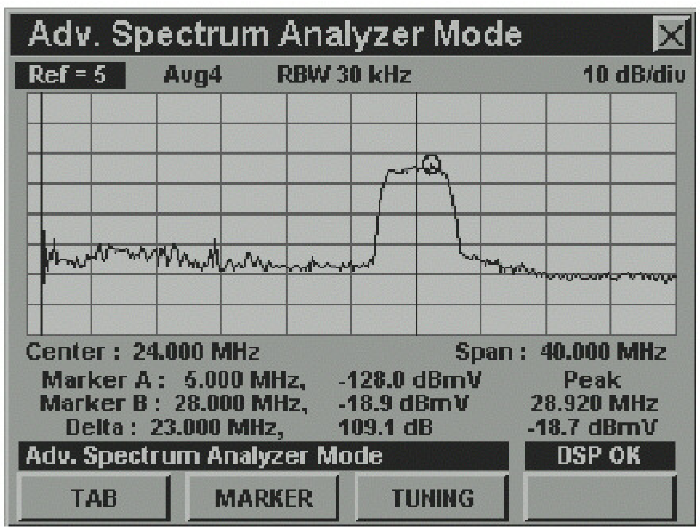
•ATTENUATION of the return signal,

All of the above capable of causing BAD return BER or MER level, that will affect lost of packets.

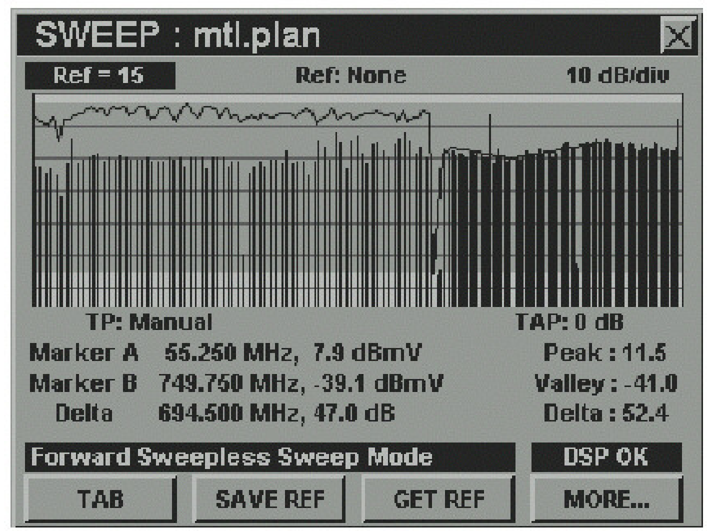
Most of the above problems usually comes from customer home and need to be repaired ASAP, to keep the Cablemodem functioning properly.

HFC system and DOCSIS

If both, the return path 5 to 40 MHz and the forward path 50 to 870 MHz operate properly, there should not be any problem with cable modem or digital television transmission performance.



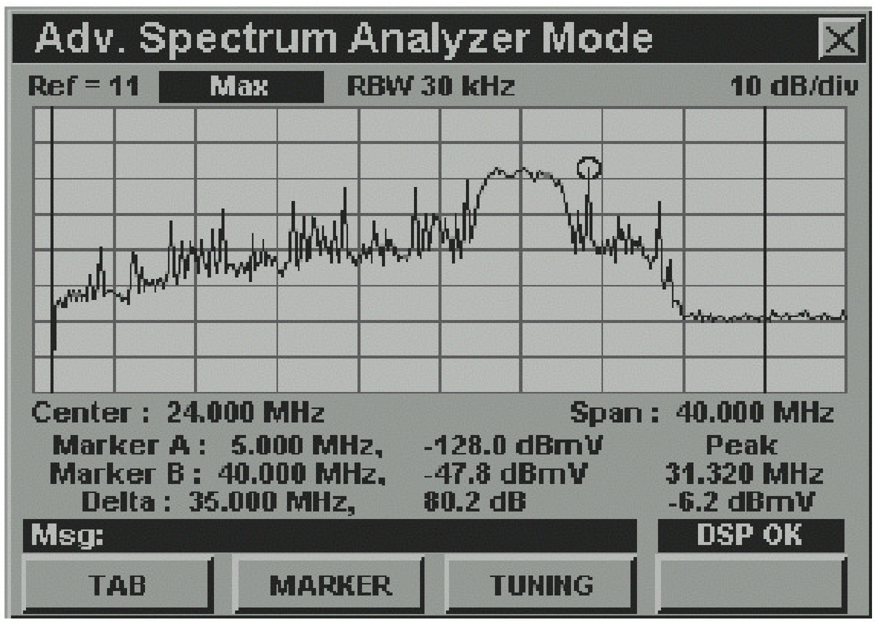
Return path free of INGRESS and NOISE.



Forward path working properly.

HFC system and DOCSIS

If the return path from: 5 to 40 MHz look something like this, you can expect big problem with cable modem transmission and you need to locate and repairs the source of the problem as soon as possible.



Return path with a high level of INGRESS.

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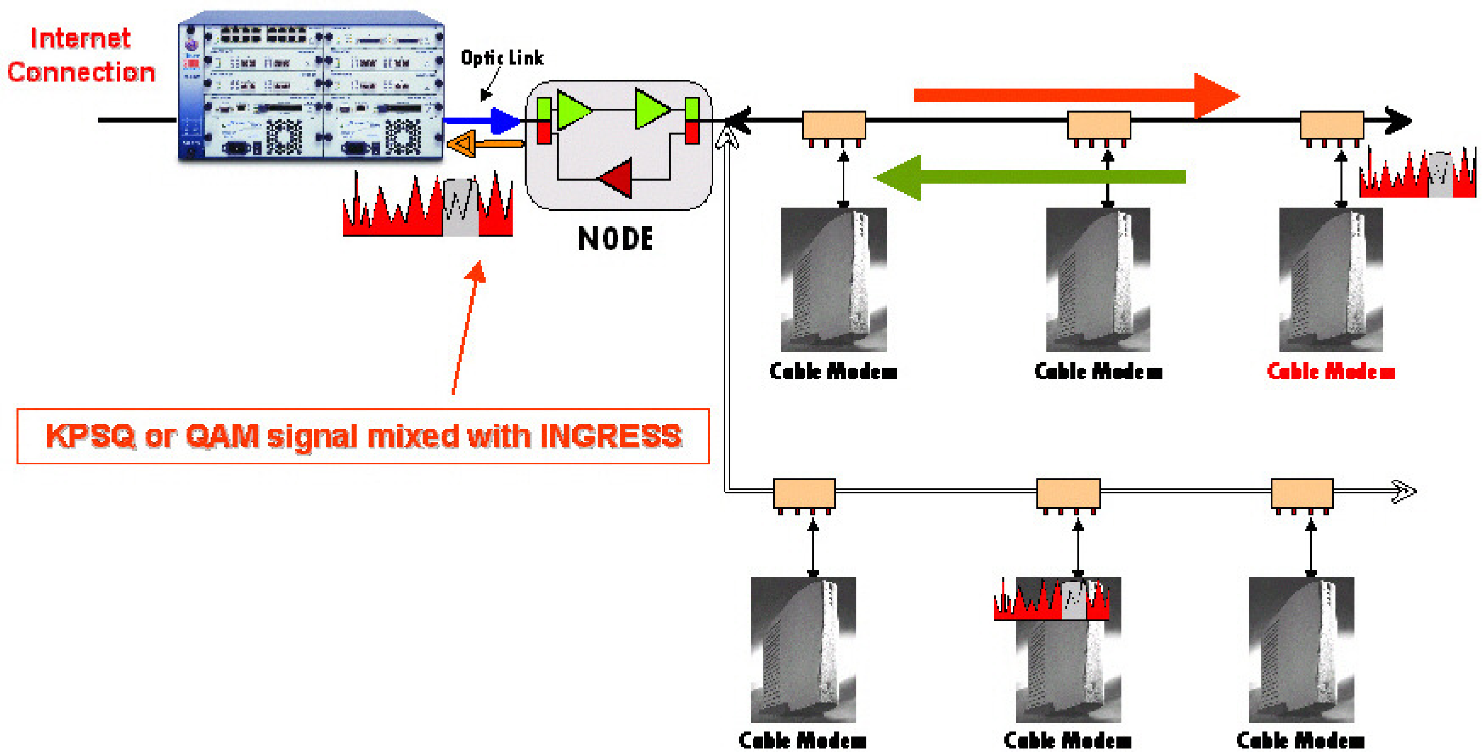
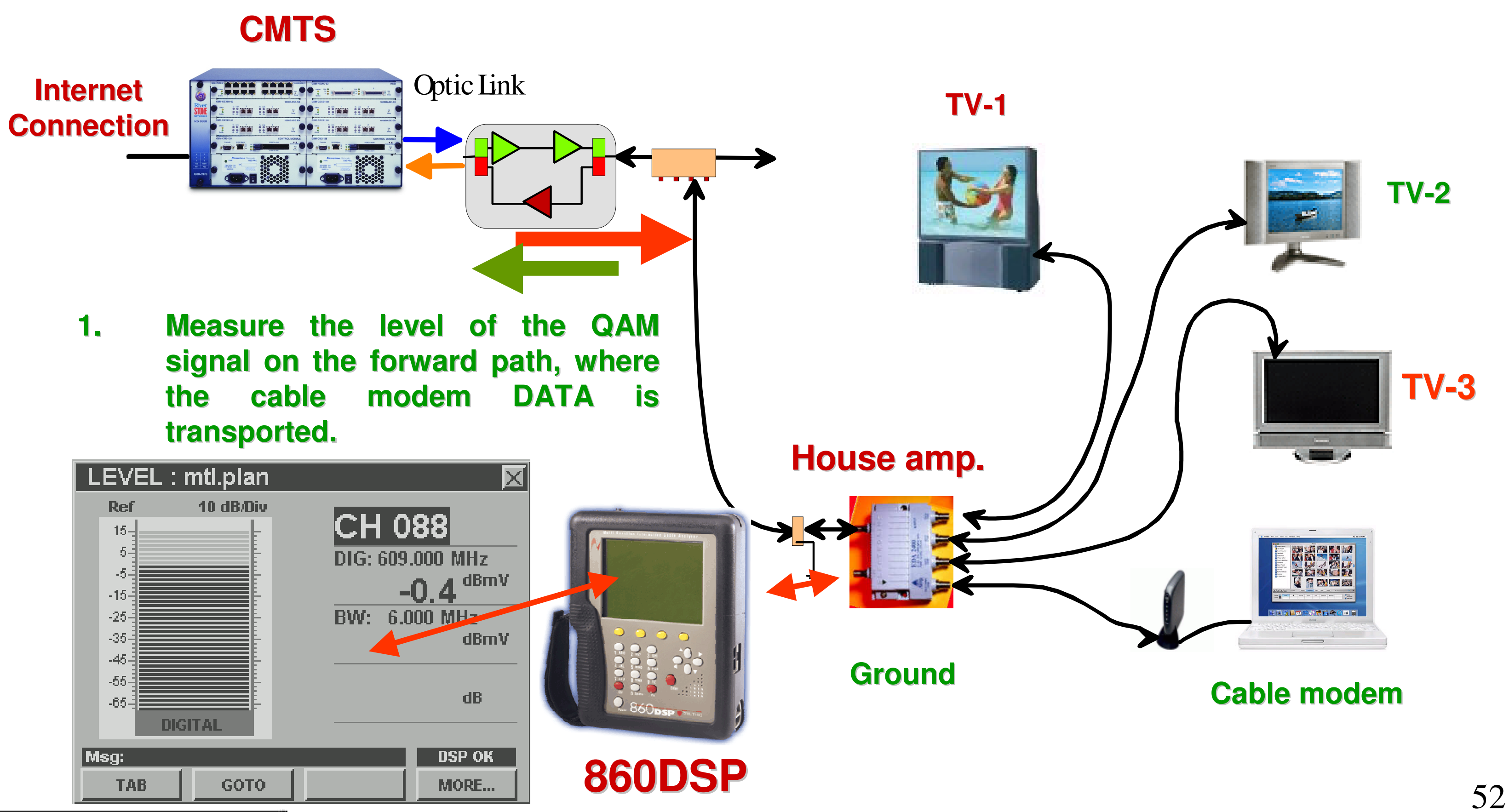
HFC system and DOCSIS

The INGRESS problem could be coming from any of these customers or other problems on the HFC system.



HFC system and DOCSIS

What to do at the customer, when you get in contact with a bad operating Cablemodem.



1. Measure the level of the QAM signal on the forward path, where the cable modem DATA is transported.

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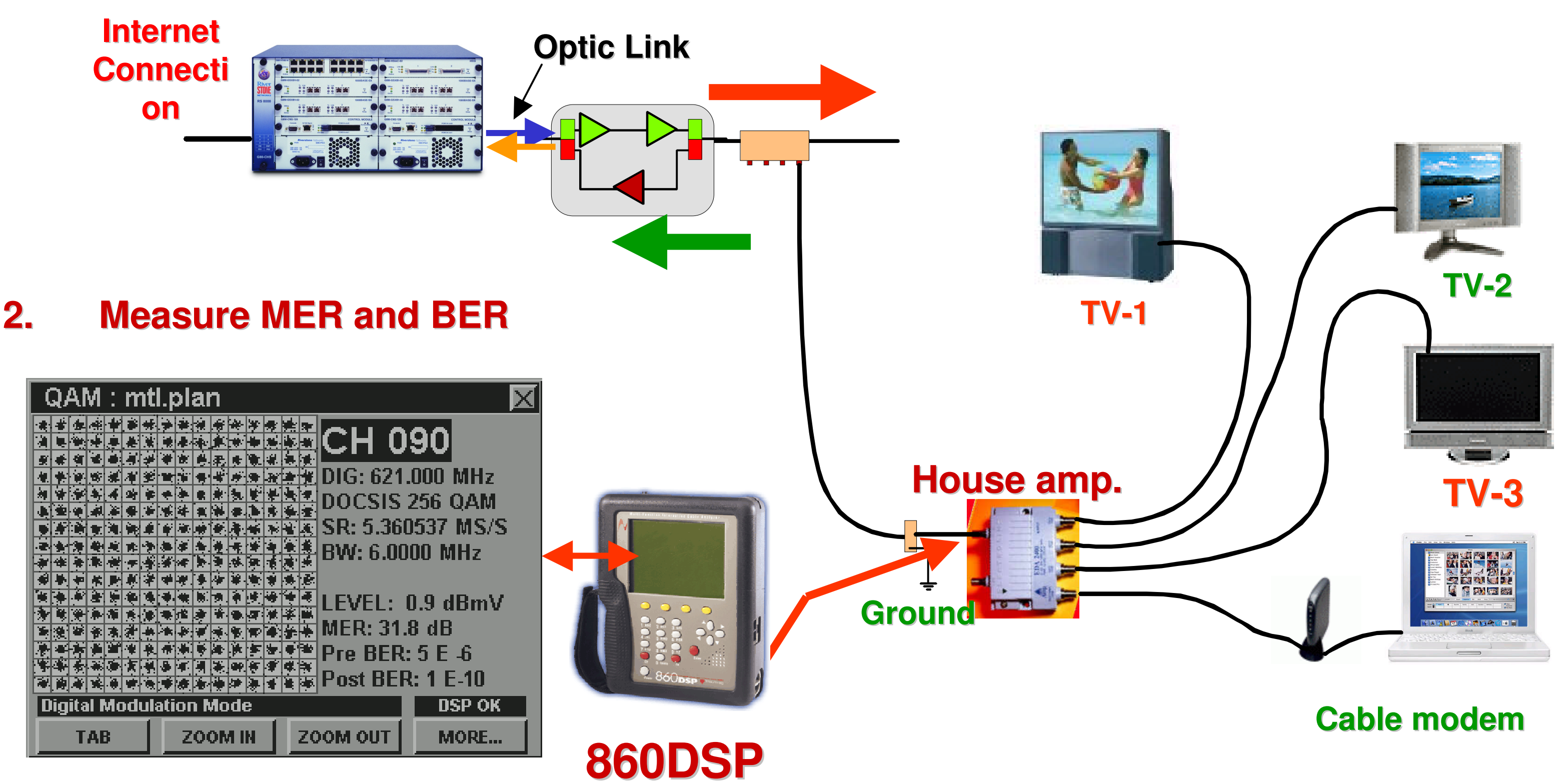
HFC system and DOCSIS

What to do at the customer, when you get in contact with a bad operating Cablemodem.

2. Measure MER and BER



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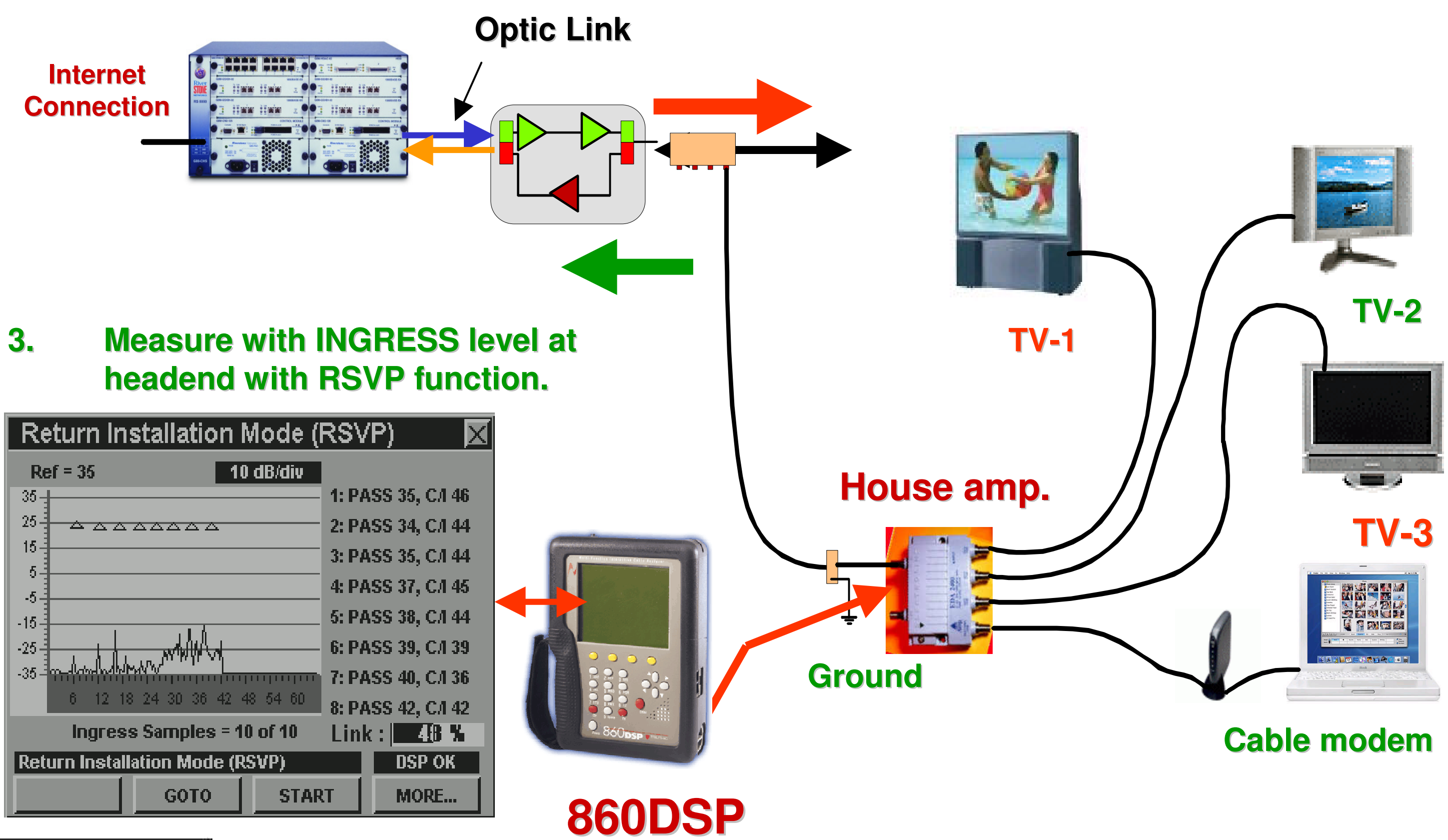
HFC system and DOCSIS

What to do at the customer, when you get in contact with a bad operating Cablemodem.

3. Measure with INGRESS level at headend with RSVP function.



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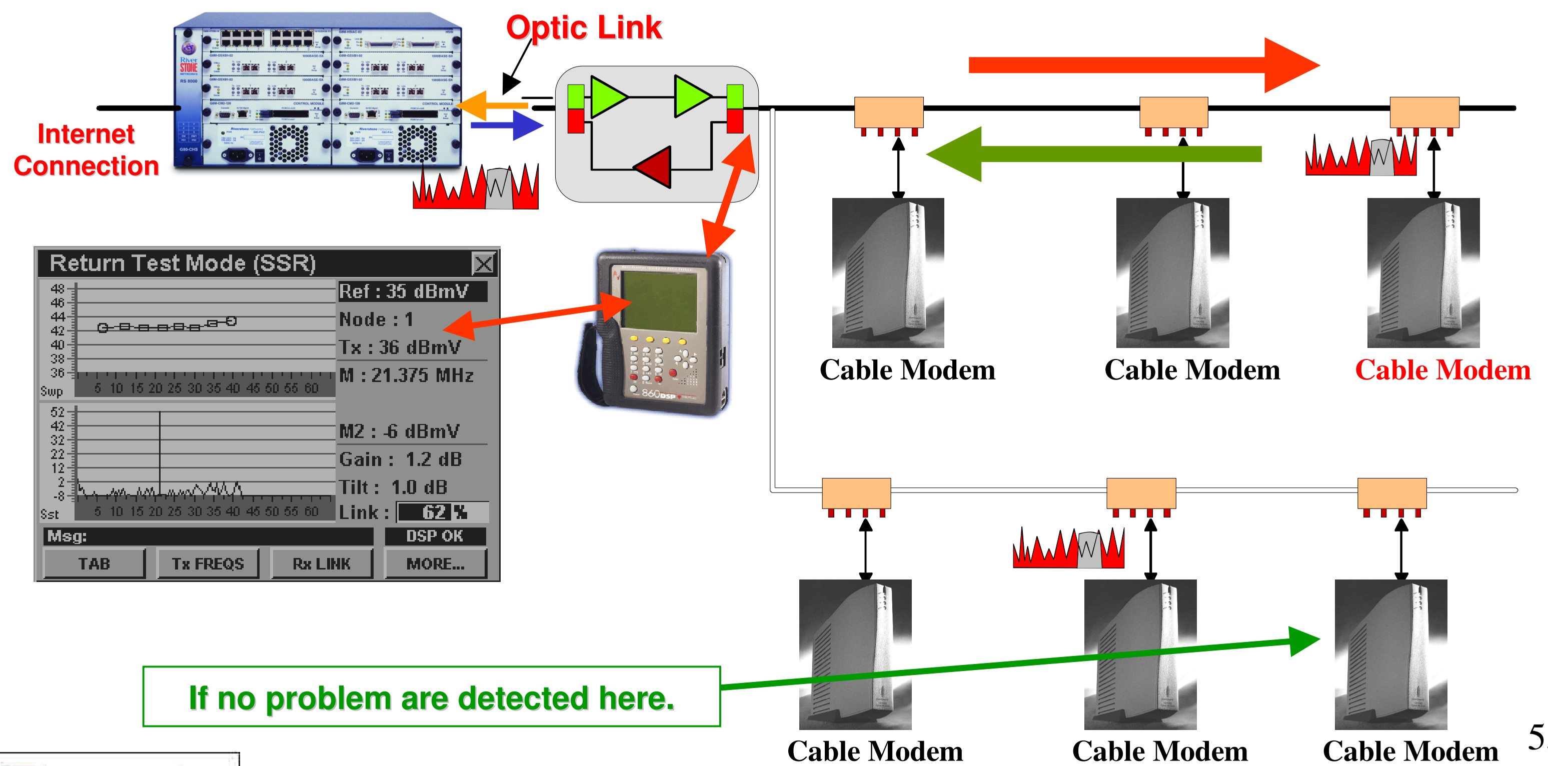
HFC system and DOCSIS

The next operation is to move the 860 DSP at the FIRST amplifier from where the customer is been feed from and use the SSR function. Check if the return system is properly adjusted and verify the INGRESS level. If the INGRESS level is high, check where it is coming from by removing the proper return jumper inside the amplifier.



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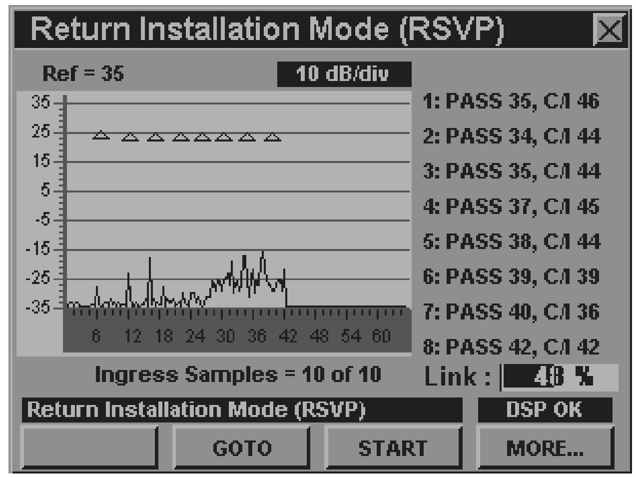
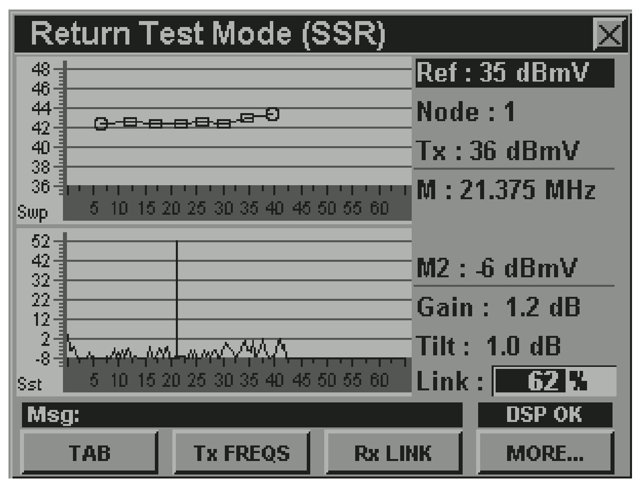
HFC system and DOCSIS

A word about reading INGRESS

•In most case, all instruments reading INGRESS, use a Spectrum Analyzer technology, where they scan the bandwidth from 5 to 40 MHz, using different Video filters. This technology can cause the transient not to be displayed, when it is happening outside the Video filter bandwidth.

•The 860-DSP, in the RSVP and SSR mode, used a “patented” DIGITIZER that look at the whole bandwidth from 5 to 40 MHZ at one time. The pictures are refreshed every 0.725 second regardless of the workload. This give the SST, 860DSP combination the possibility of reading 56 NODE per second.





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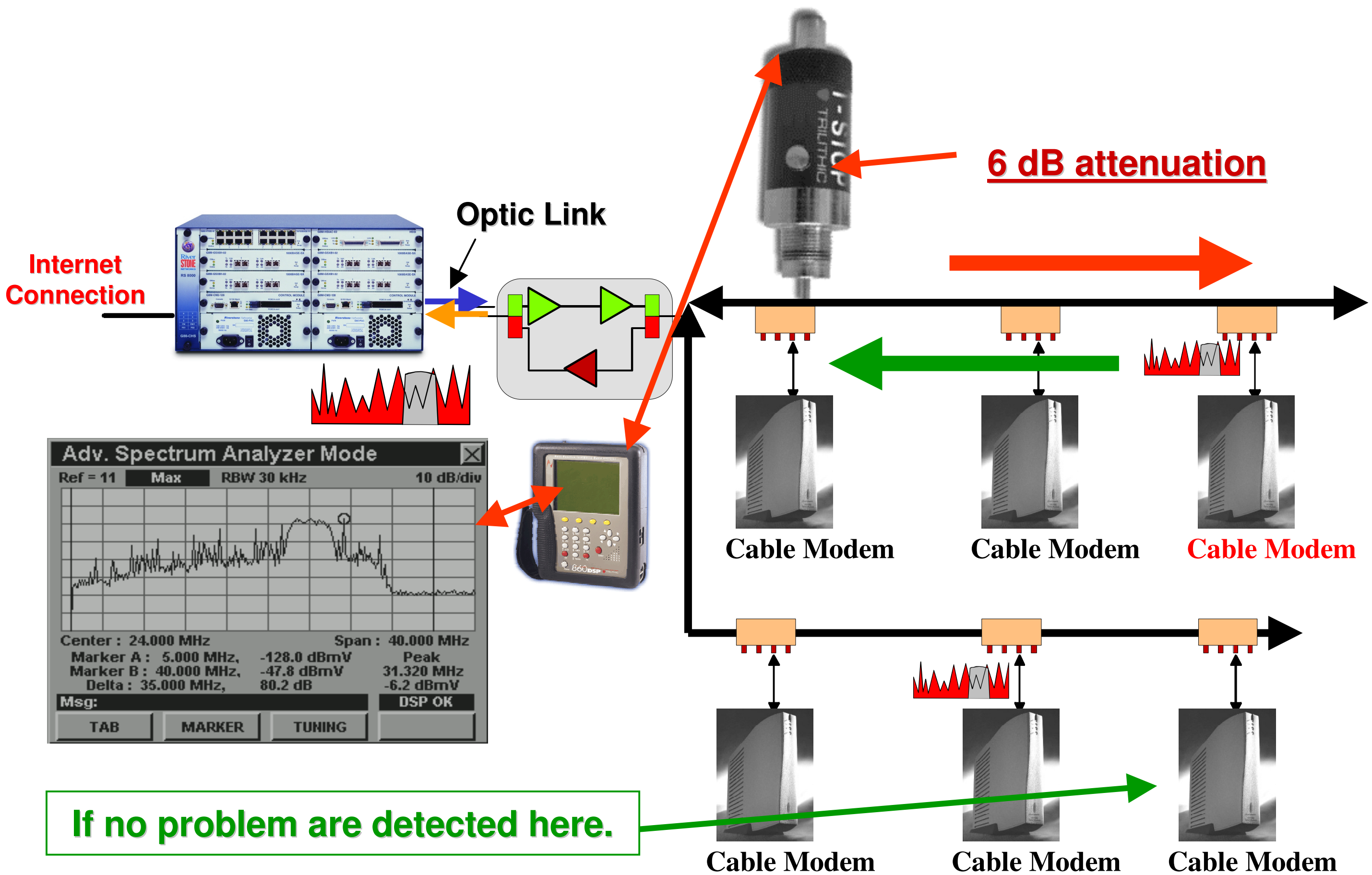
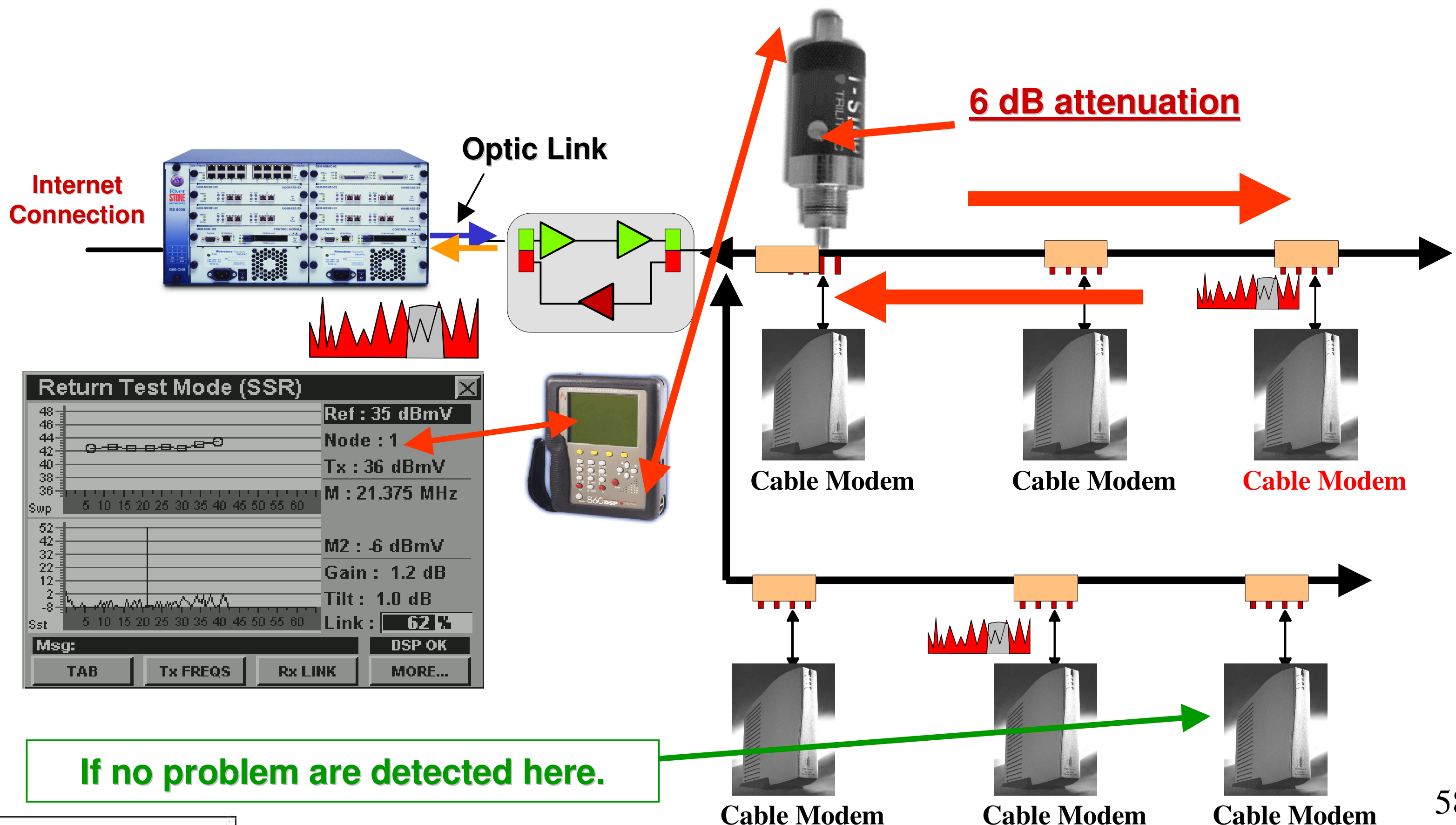
HFC system and DOCSIS

The use of SPECTRUM mode and the "I STOP" probe can help locate the problem by adding a 6 dB attenuation on the line been tested.



HFC system and DOCSIS

The use of SSR mode and the "I STOP" probe can help locate the problem by adding a 6 dB attenuation on the line been tested.



If no problem are detected here.

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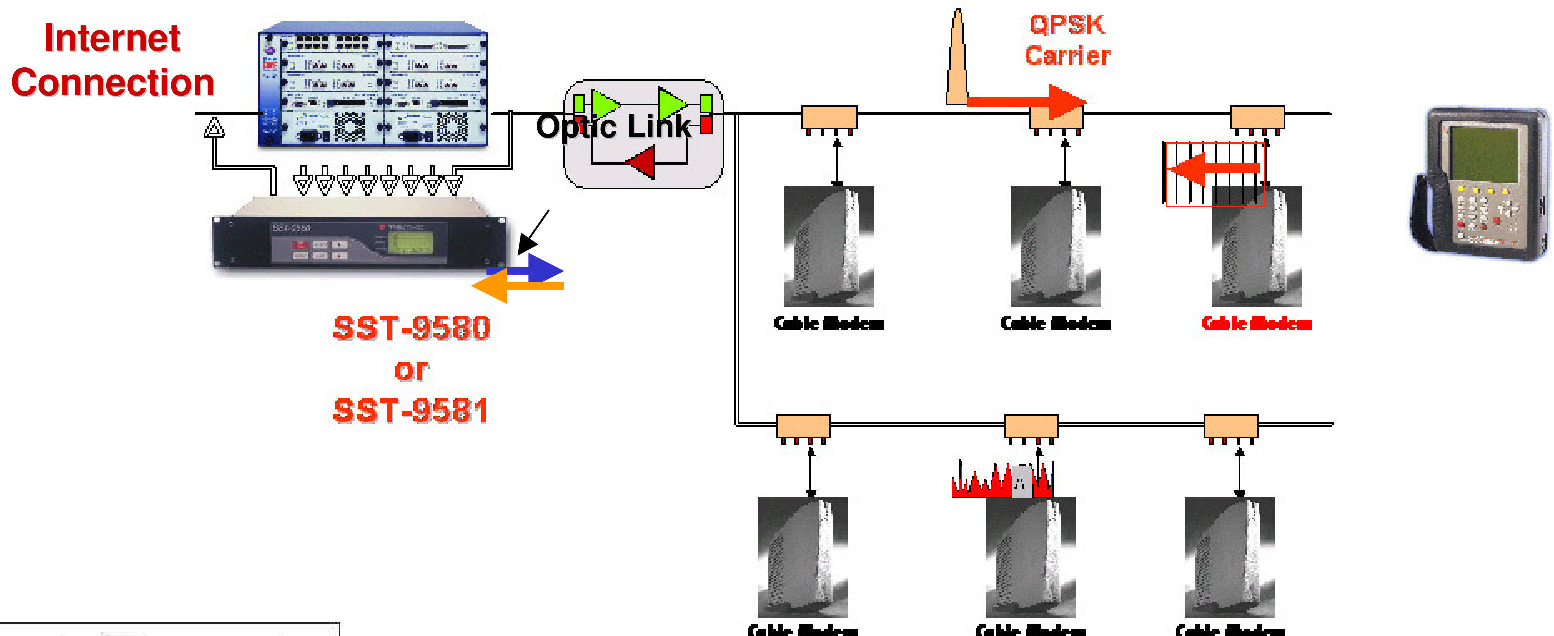
HFC system and DOCSIS

The 860DSPi, when operating in the SSR or RSVP mode, send 8 selected frequencies between 5 and 42 MHz to the SST-9580 located at the headend. The SST read the level of these 8 carriers, then send the result to the 860DSP, in a QPSK signal 300 KHz wide. This carrier can be located between 50 to 52 MHz or between 72 to 75 MHz. At the same time, the level of ENGRESS between 5 to 42 MHz is also sent from the H.E. to the 860-DSP.



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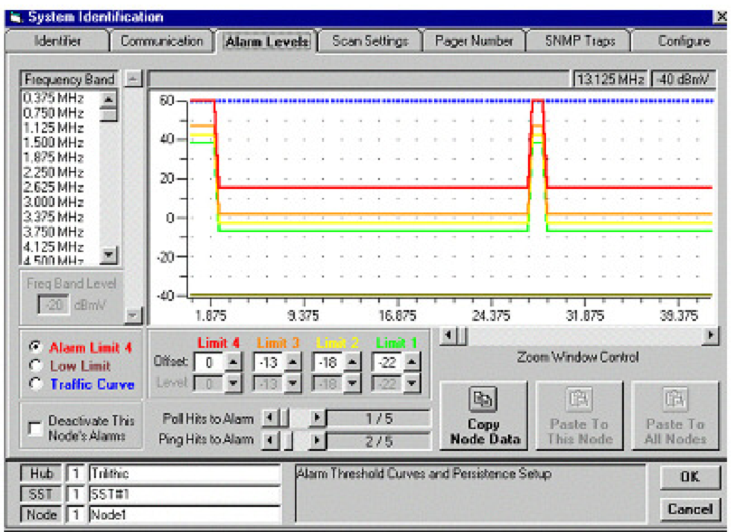
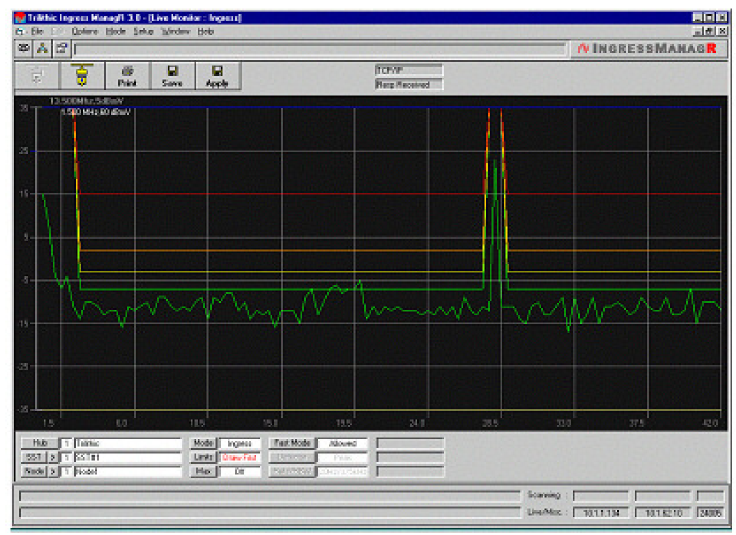
HFC system and DOCSIS

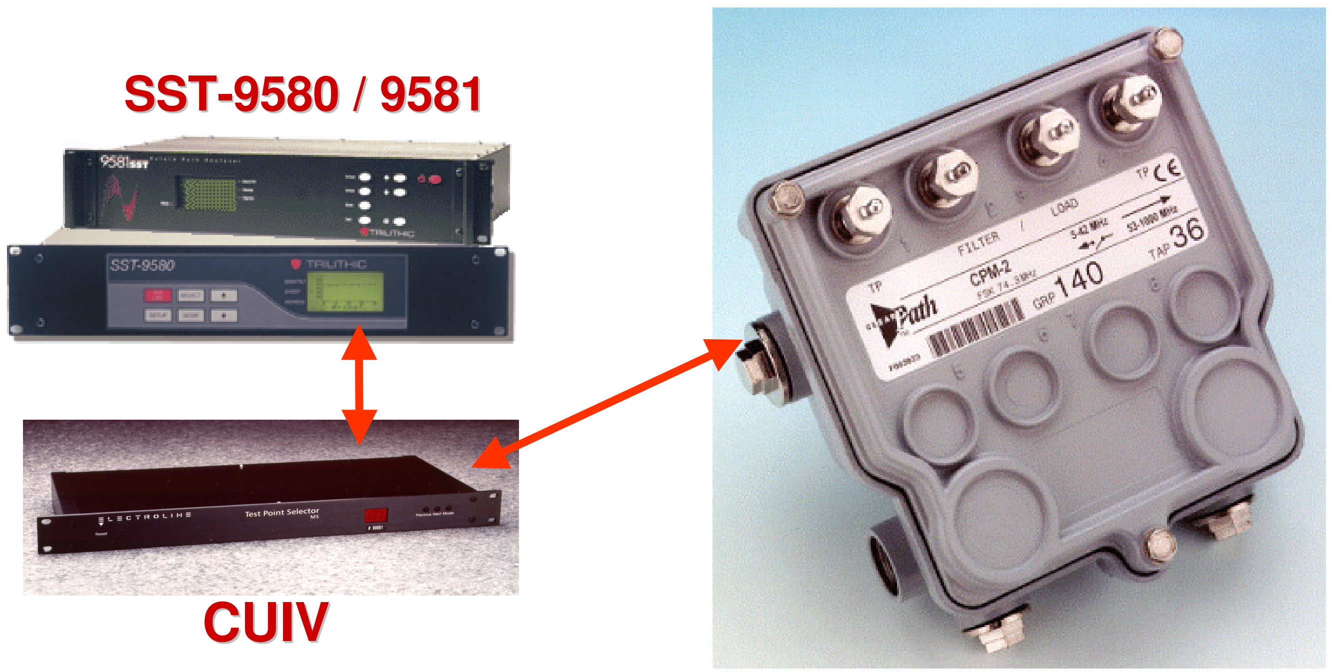
<u>Ingress Monitoring</u> is a software that operates the Guarding Return Path Monitoring System, which collect analysing INGRESS data from the 9580-SST. The software adds a wide range of capabilities to the application, Including SNMP capability, expanded viewing “TREES” and refined analysis of INGRESS severity.





HFC system and DOCSIS

The INGRESS manager software, can also communicates with all the ClearPath from Electroline installed in the HFC system, it will select the faulty one, by adding and removing a 6 dB pad, add a 40 dB pad to clear the system if required and sound an alarm and warn the personnel in standby by calling his pager.



HFC system and DOCSIS

A short movie will follows.

This movie will give you and description on how ClearPath actually operates on a HFC system.

HFC system and DOCSIS

DIA SUITE.

*Summarize Spectral Information.

*INGRESS Level over time.

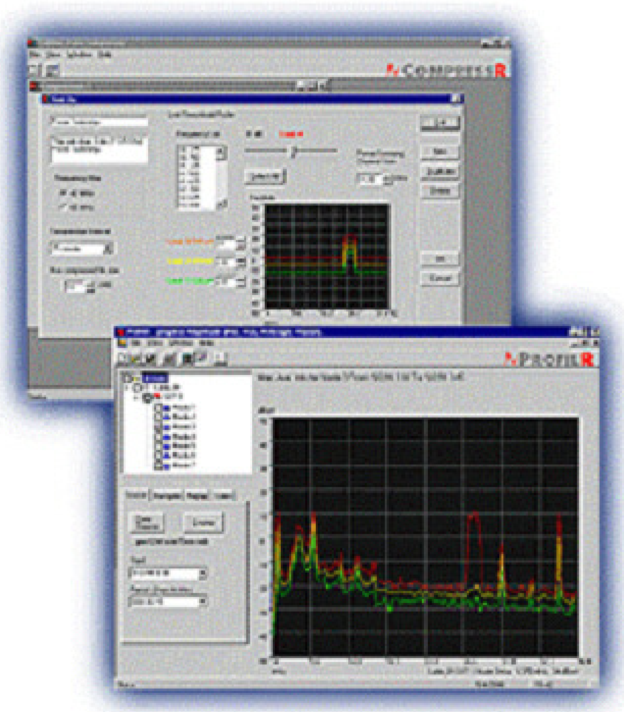
*Determines Channel Availably.

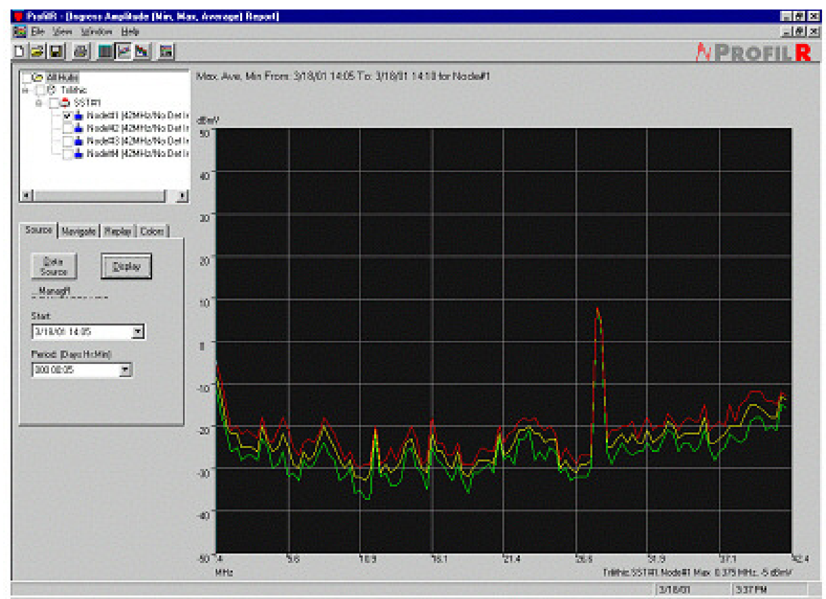
*Figures of Merit.

*Calculates Max/Min/Avg.

*Determines Percentage of Threshold

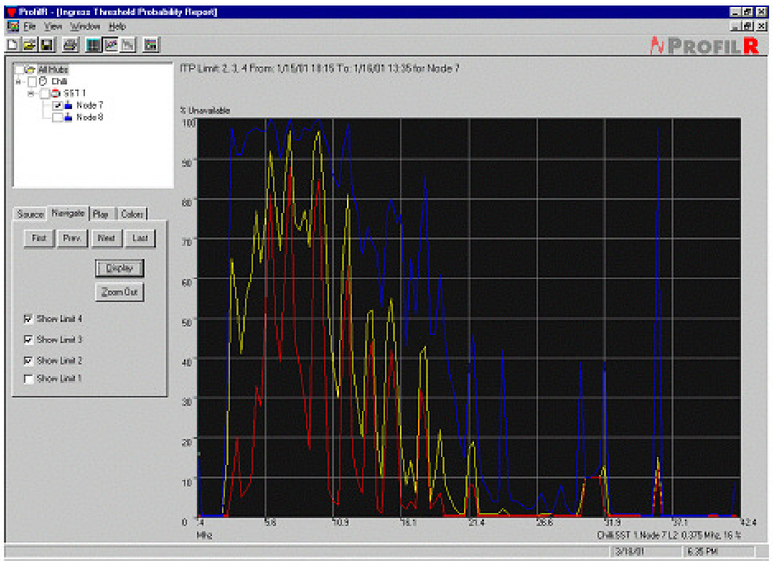
*Node Certification.

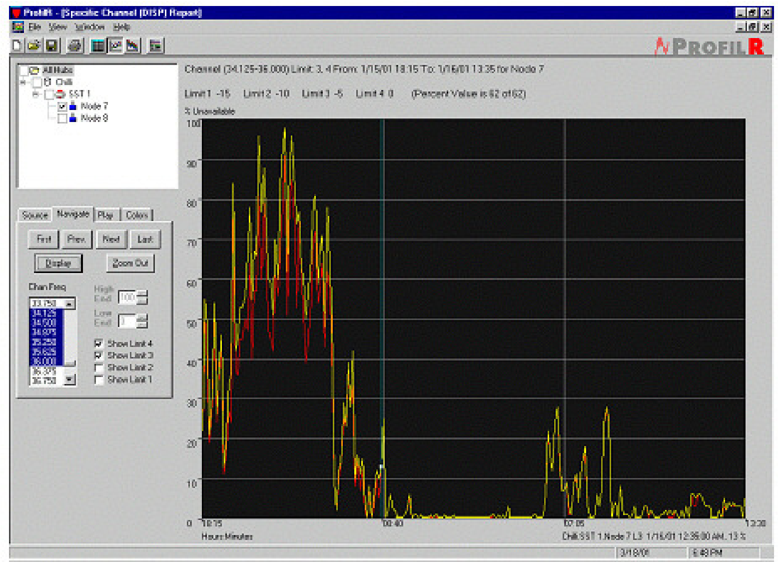




HFC system and DOCSIS

DIA SUITE.





- Displays the probability that a frequency will be unavailable for use.
- Identifies frequencies capable of carrying new services.
- Grades the severity of Ingress as a percentage of unavailability.

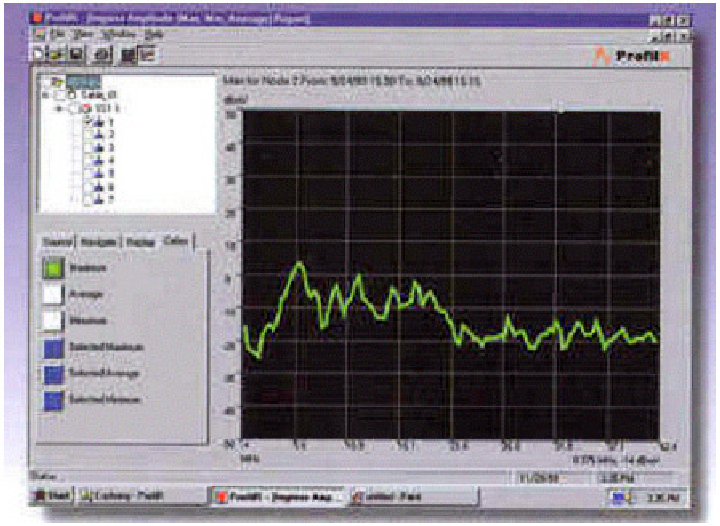
- Displays the percentage of unavailability for a selected channel or freq. over time.
- Determines system readiness to launch a new services.
- Determine Ingress Patterns, over time.

HFC system and DOCSIS

TRAFFIC CONTROL Software;

•Allows user to see INGRESS hiding under active Traffic.

PICTURE with CARRIER showen.



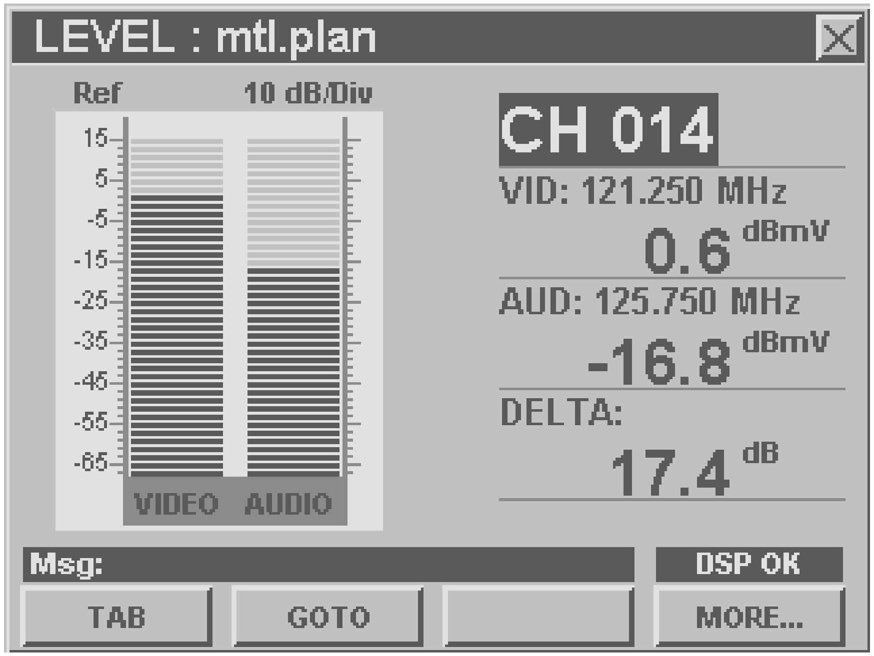
PICTURE with CARRIER Removed

Conclusions

- Testing and optimizing both, the forward and the return path, can significantly improve the HFC system throughput by eliminating the need for resending DATA.
- Forward path testing consists of checking for MER (Modulation Error Ratio) and BER (Bit Error Rate) and the CONTELLATION.
- Return path testing consist of checking the RETRUN frequency response and the INGRESS level.
- Proper testing of the HFC performance, improve technician efficiency, allows more Cablemodem installation and a constant communication between them.

860 DSPi operations.

Field Strength Meter reading level of channel 14.



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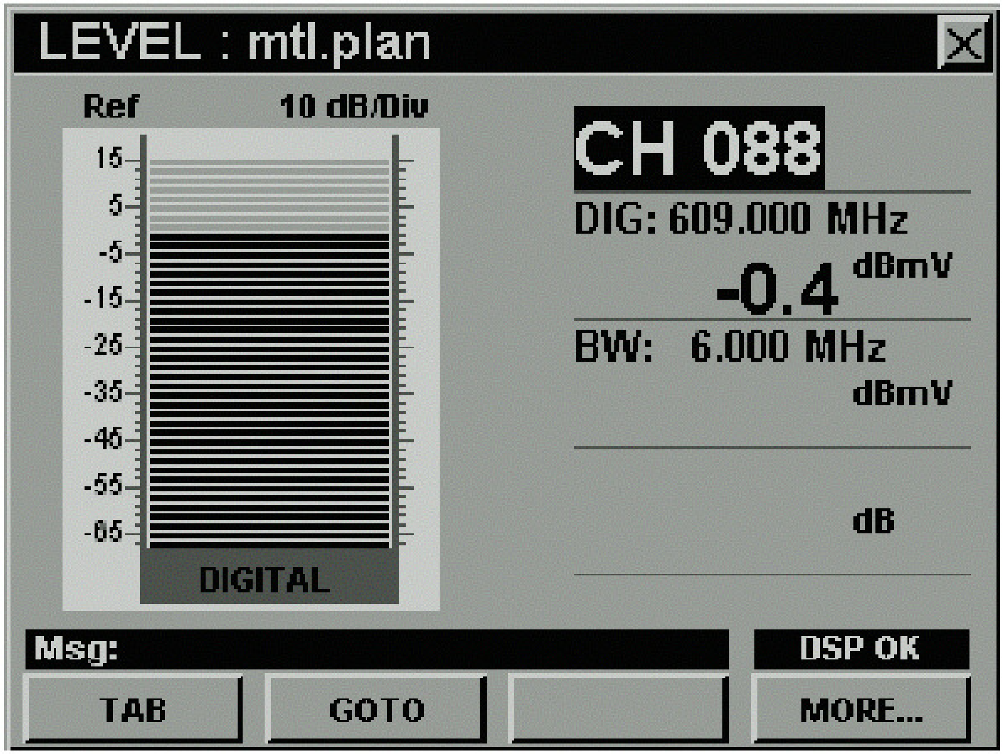
860 DSPi operations.

POWER METER reading Digital level.



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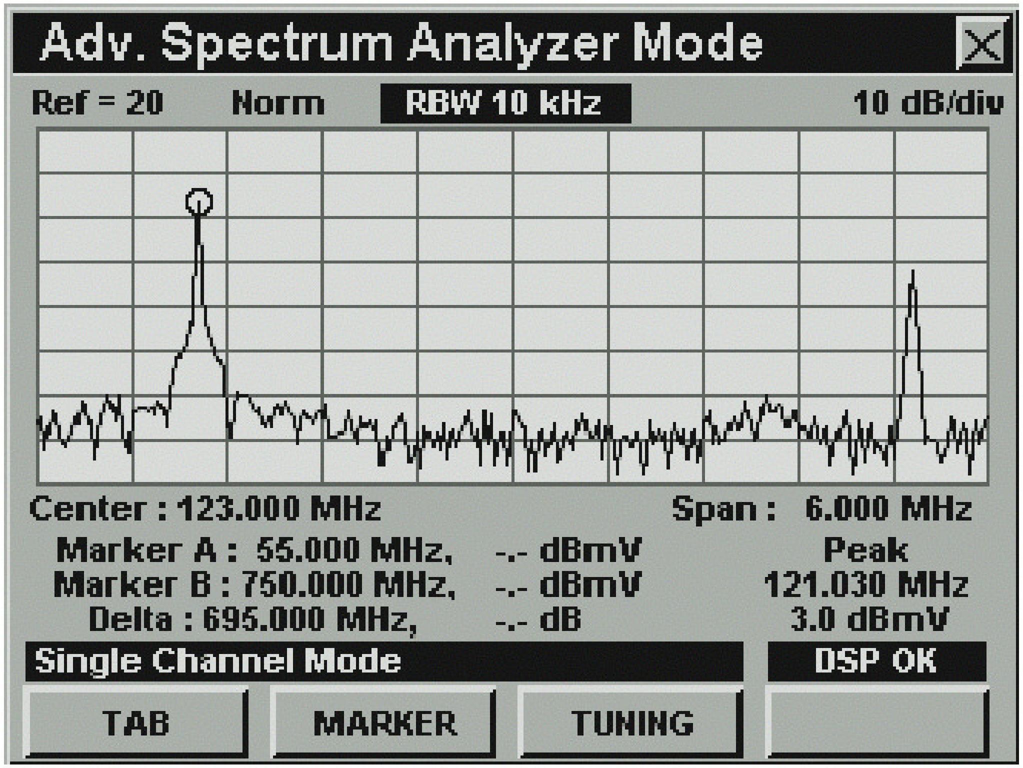
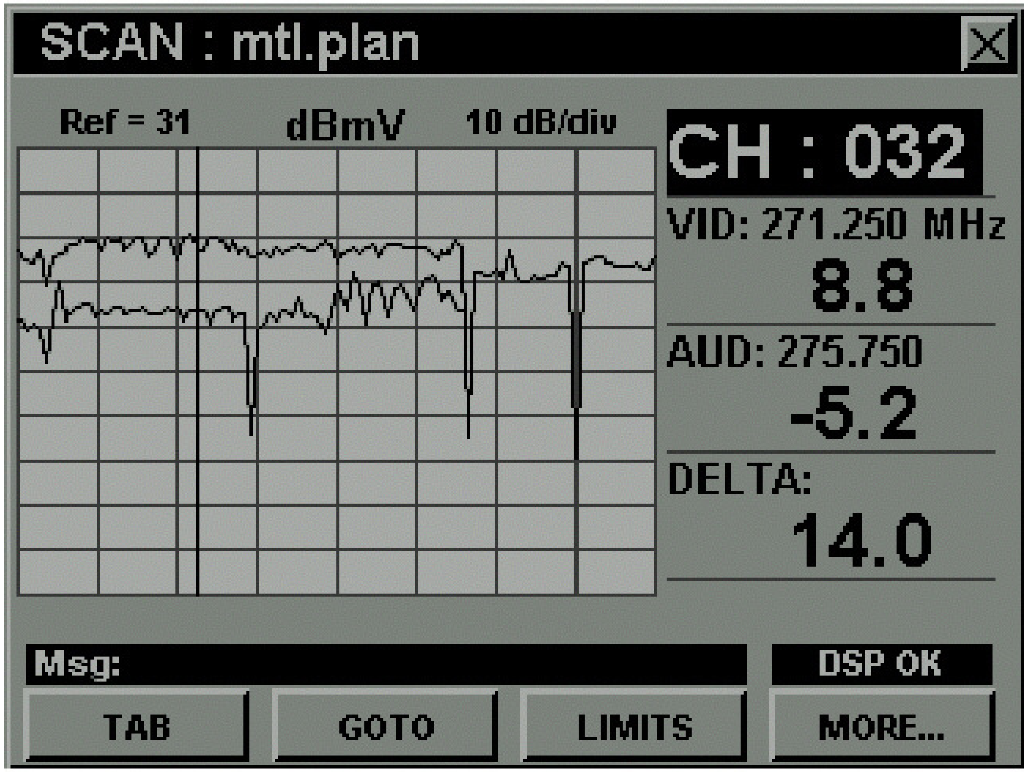
860 DSPi operations.

Spectrum Analyzer view from: 120 to 126 MHz.



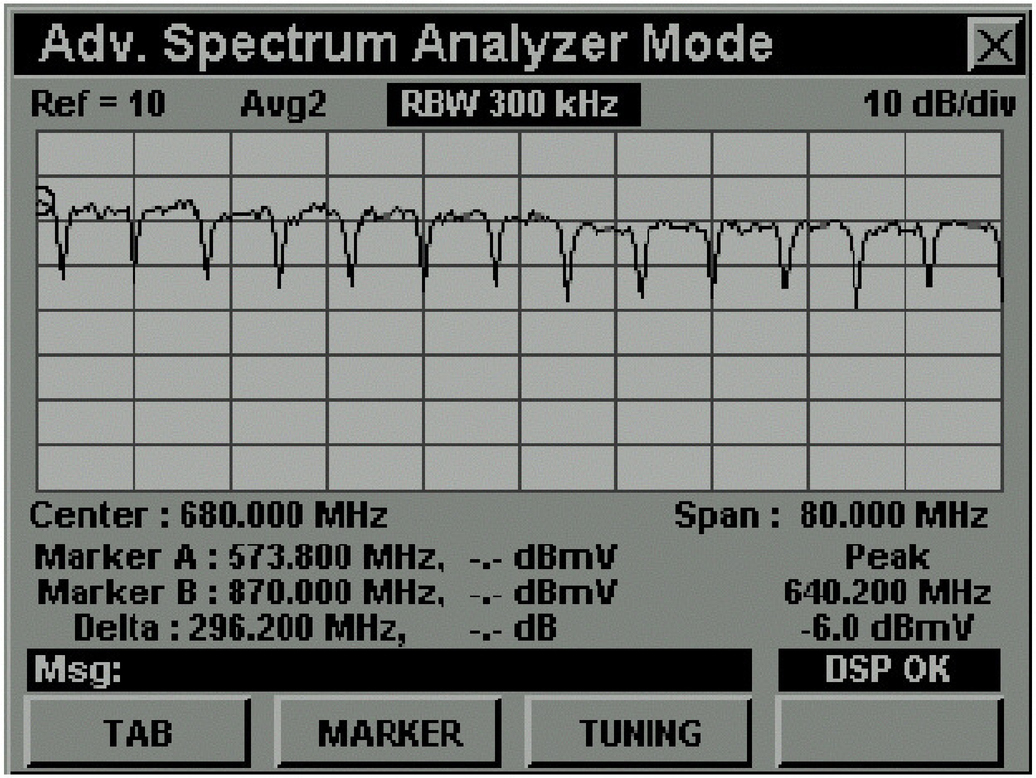
860 DSPi operations.

SCAN the system from 50 to 870 MHz.



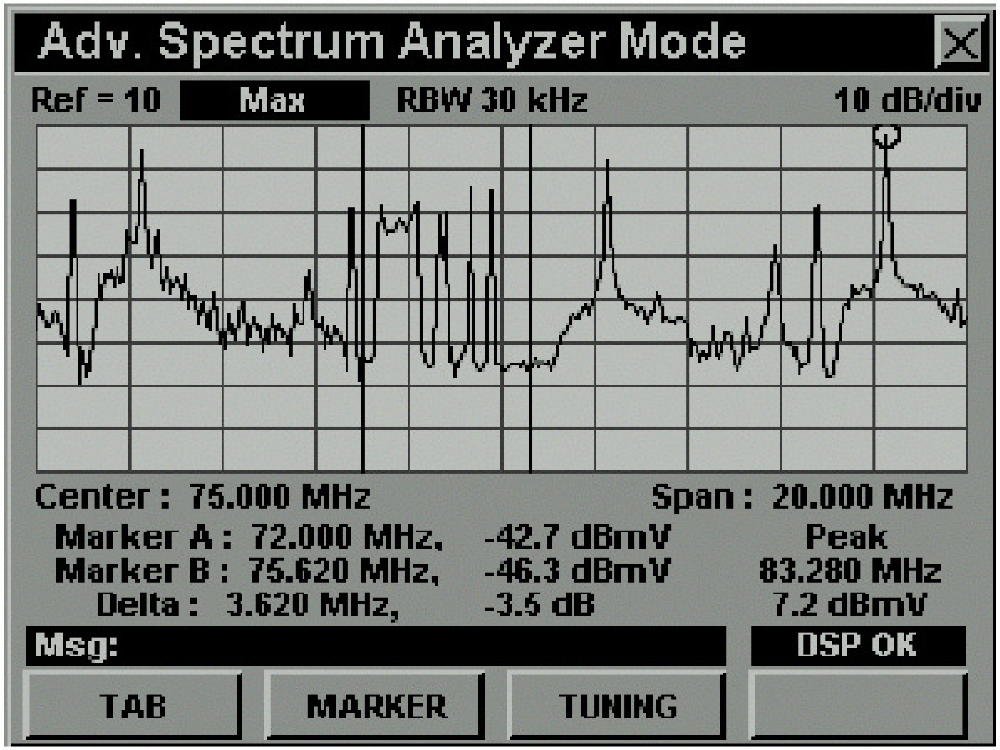
860 DSPi operations.

Spectrum view from: 640 to 720 MHz.



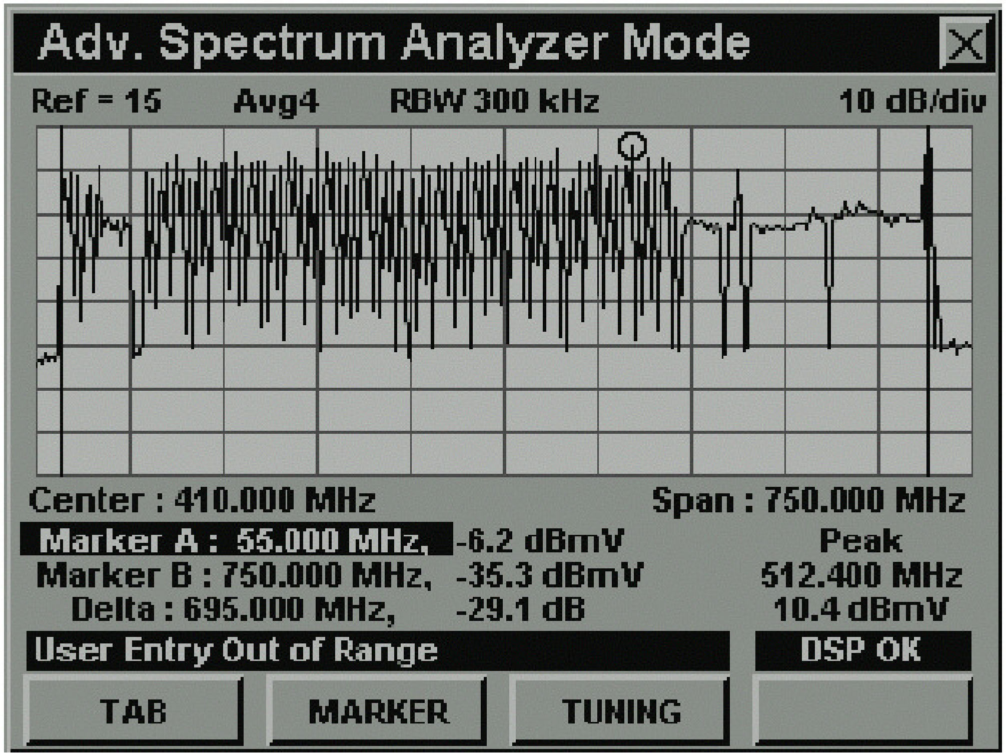
860 DSPi operations.

Spectrum view from: 65 to 85 MHz.



860 DSPi operations.

Spectrum Analyzer from 50 to 870 MHz.



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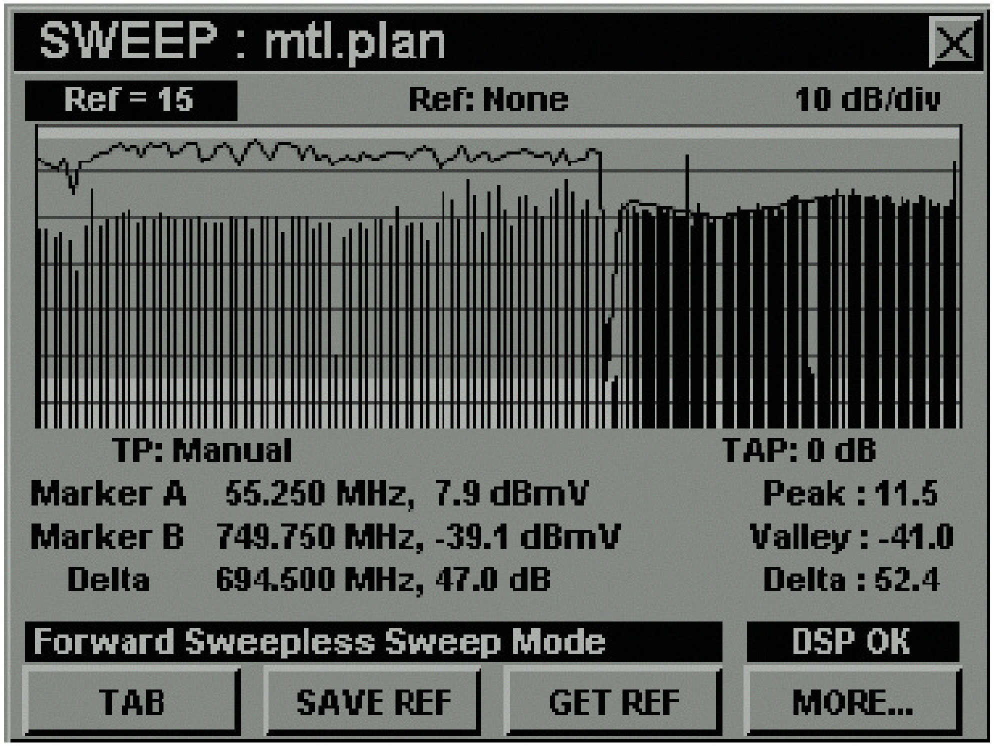
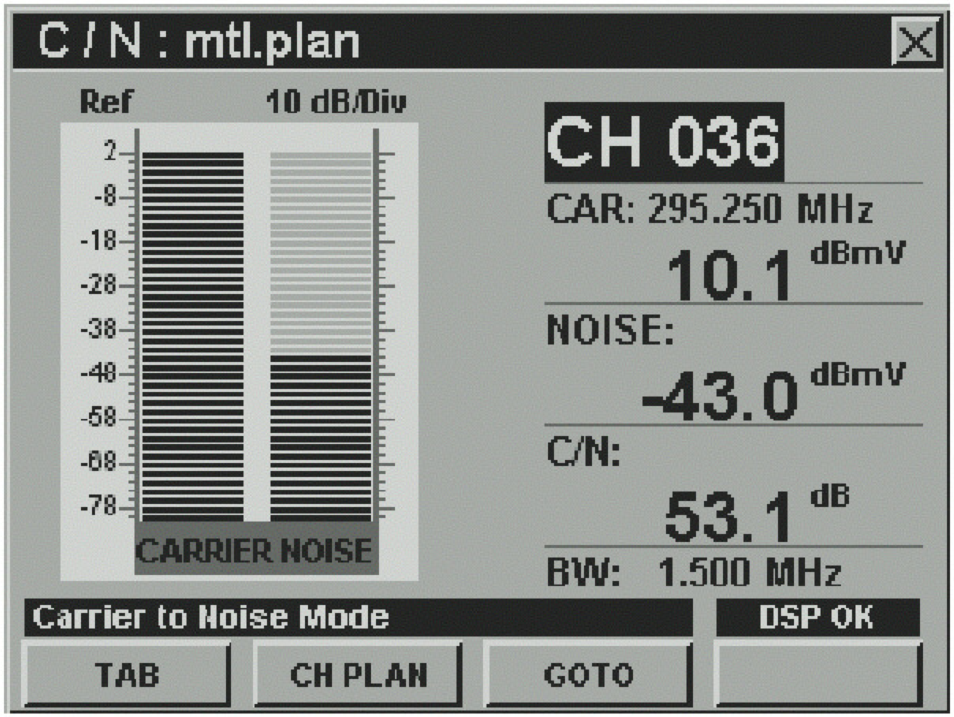
860 DSPi operations.

SWEEP the system from: 50 to 870 MHz using the channel level as reference.



860 DSPi operations.

CARRIER to NOISE measurement without removing the modulation.



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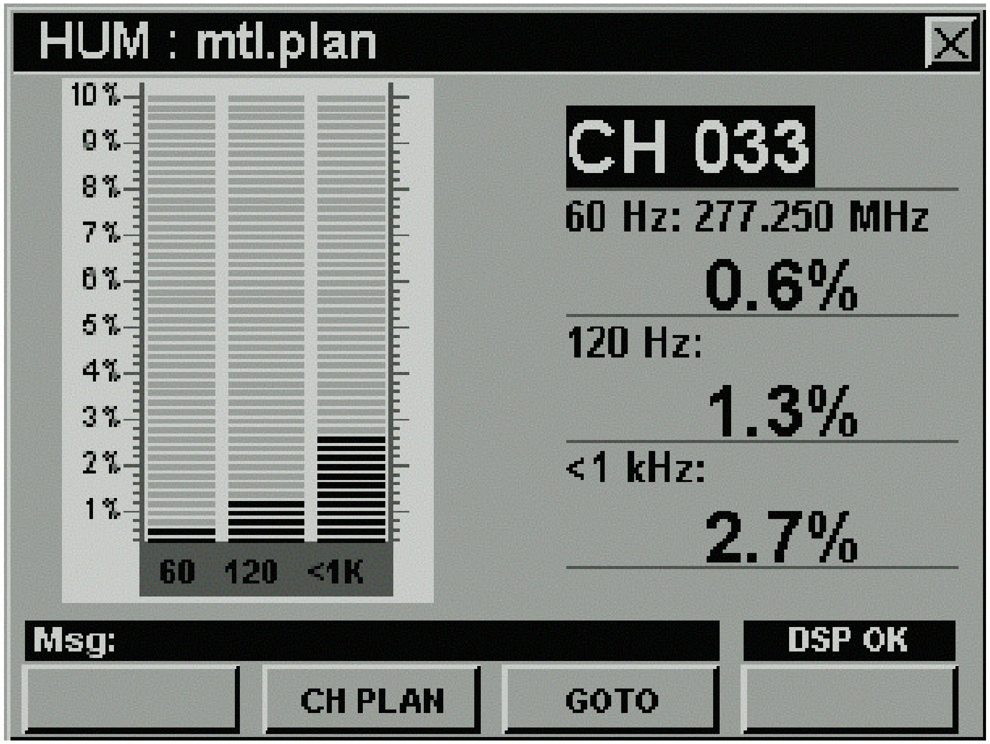
860 DSPi operations.

HUM test without removing the modulation.



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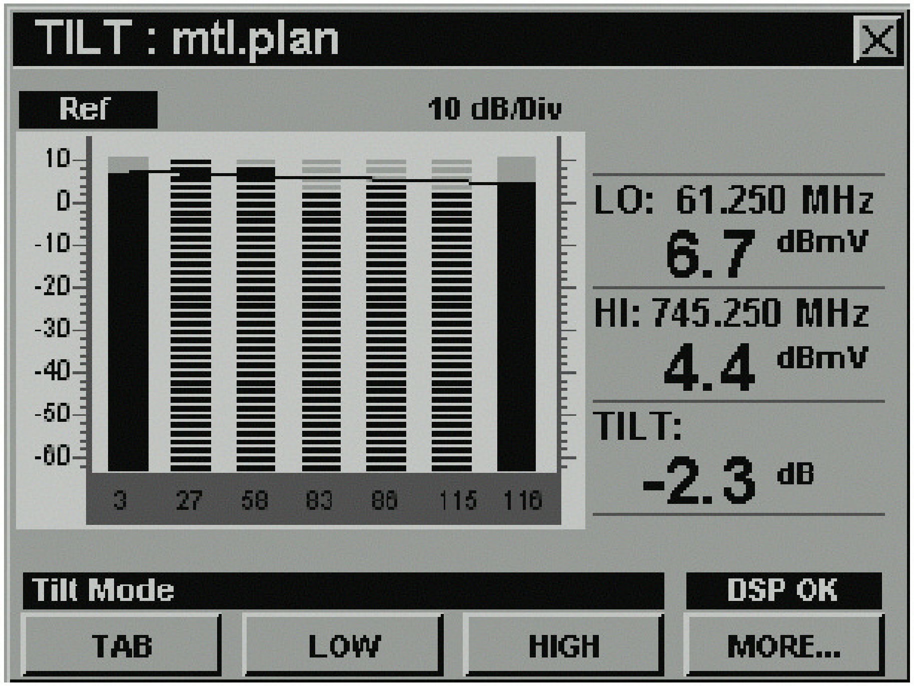
860 DSPi operations.

TILT level reading 8 channels from 50 to 870 MHz.



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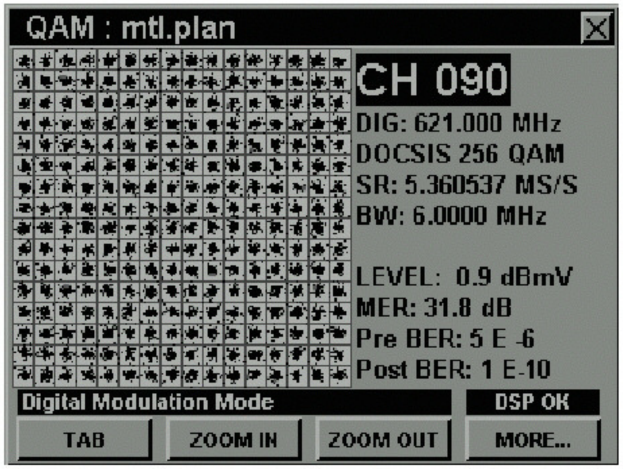
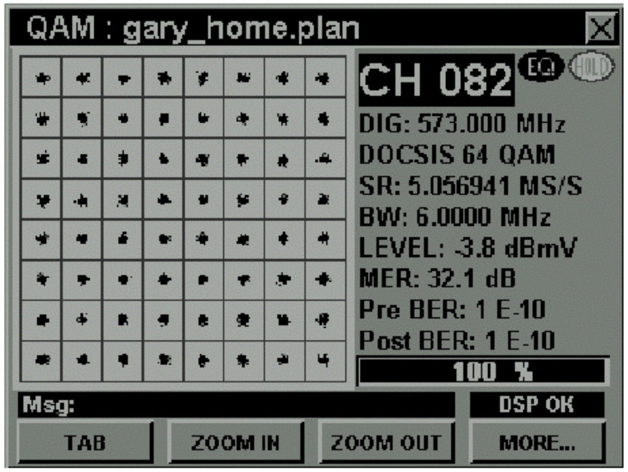
860 DSPi operations.

The following specifications should be meet on the forward path;

•27.0 dB MER for 64 QAM

•31.0 dB MER for 256 QAM





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The end of this seminar.

I am now open to answer any question.

Before we go on the system to do some alignment,
I like to thank you for your attention.