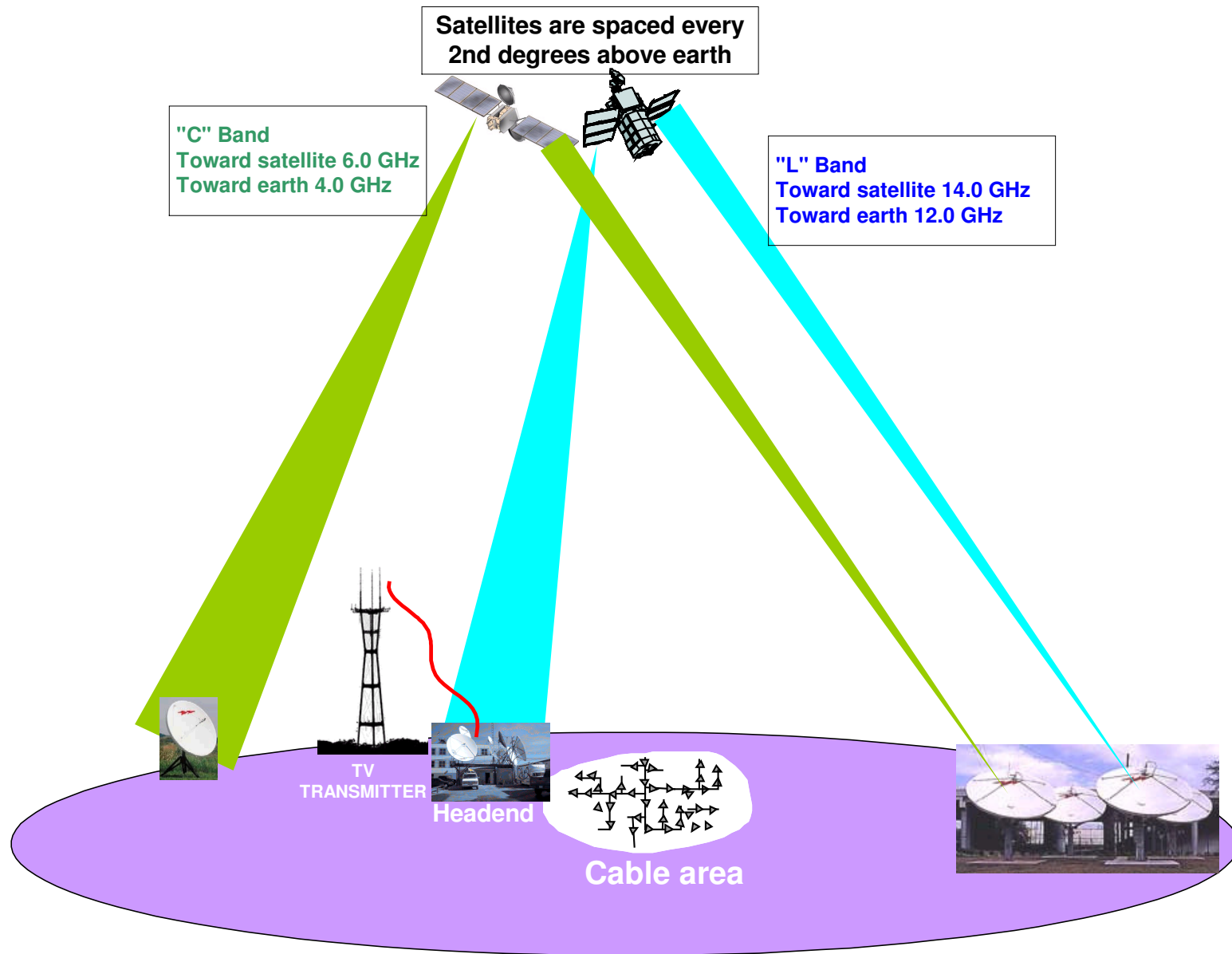


# Broadband System - K



# Understanding Bi-directional Operation on a HFC System

# Bi-Directionality on a Broadband System.

Since a HFC system is a bi-directional operating system, the frequency allocations are:

- From Headend to the Subscribers : 50 to 750, 870, or 1,000 MHz
- From the Subscribers to the Headend : 5 to 40, 42 or 65 MHz
- We now are starting to see: 5 to 65 MHz for return freq.
- And forward frequency from: 85 to 870 or 1,000 MHz

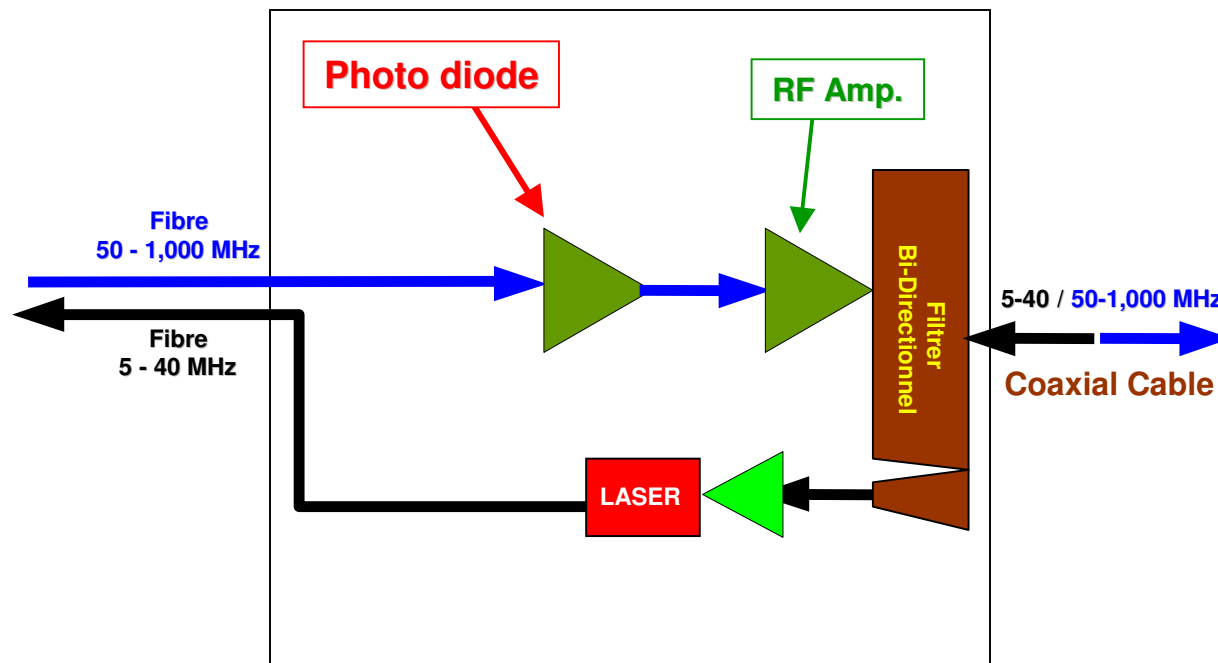
# Bi-Directionality on a Broadband System.

**A Broadband HFC Communication system utilized two types of communications technology:**

- **Fiber optic technology is used to transport signal for the long distance. Usually one fiber transmits forward signal (50-870 MHz from the Headend to a Optical Node and one more fiber transmits return signal (5 - 40 MHz) from a Node to the Headend.**
- **Coaxial cable is used from the NODE and it is transmitting in both directions (50-870 / 5-40 MHz), from the Optical Node to the each subscribers.**
- **The OPTICAL NODE, transfers Light Signal, coming from the Headend, to Electrical Signal (RF and Digital), sending these signals to each subscribers by coaxial cable.**
- **The OPTICAL NODE, also Transfers Electrical Signal (RF and Digital) from all the customers to light signal, sending them to the Headend.**

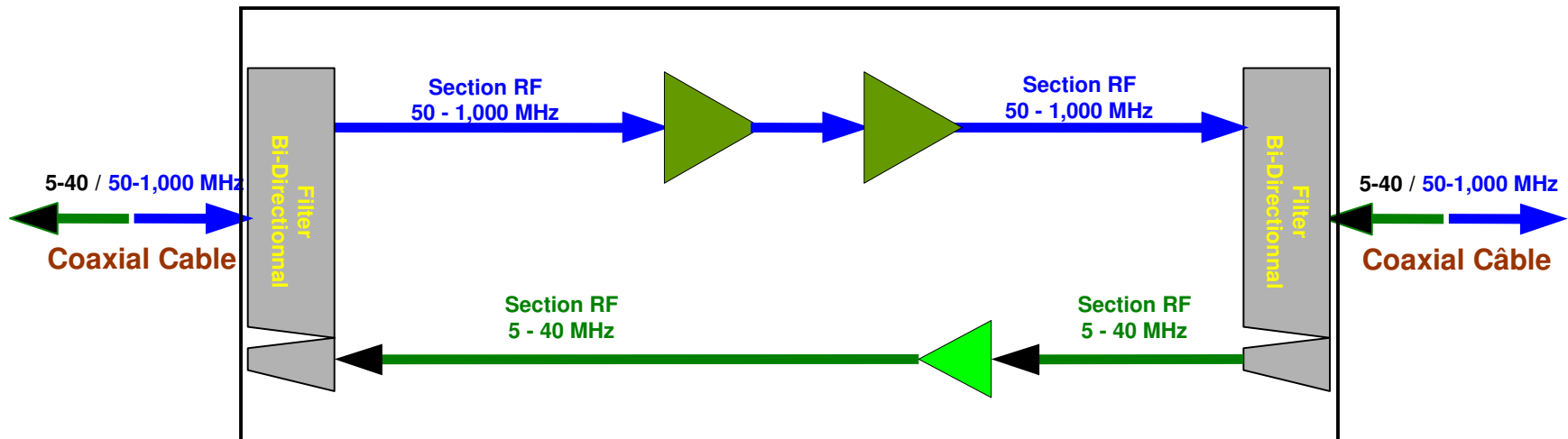
# Bi-Directionality on a Broadband System.

All optical NODE must be equipped with a Photo diode on the forward path, a bi-directional filter at each output of the coaxial system to permit an HFC system to operate in a bi-directional way and a return Laser to transmit return signal toward the headend.

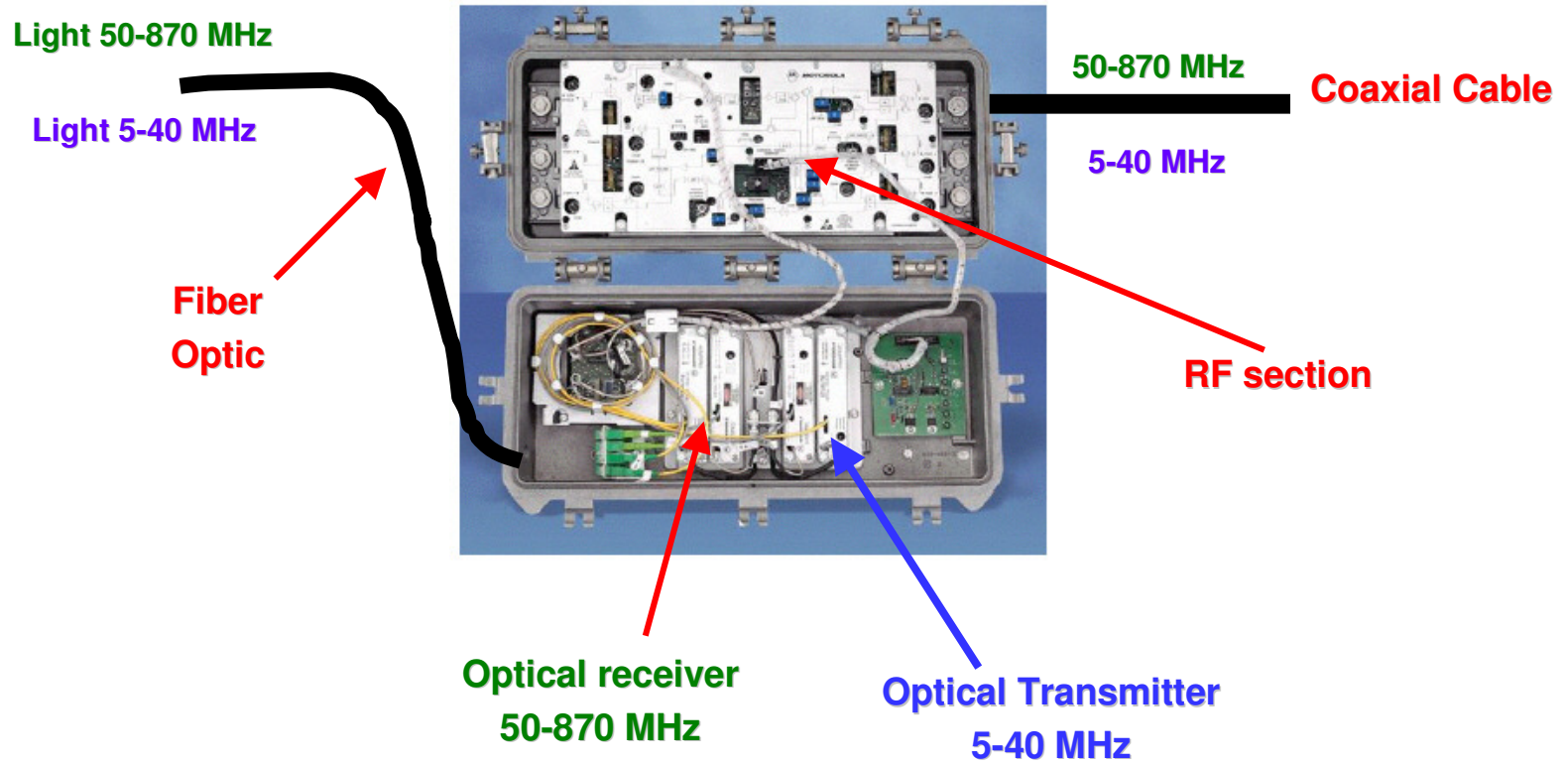


# Bi-Directionality on a Broadband System.

All RF amplifier must be equipped with a bi-directional filter at each input and outputs to permit an HFC system to operate in a bi-directional way.

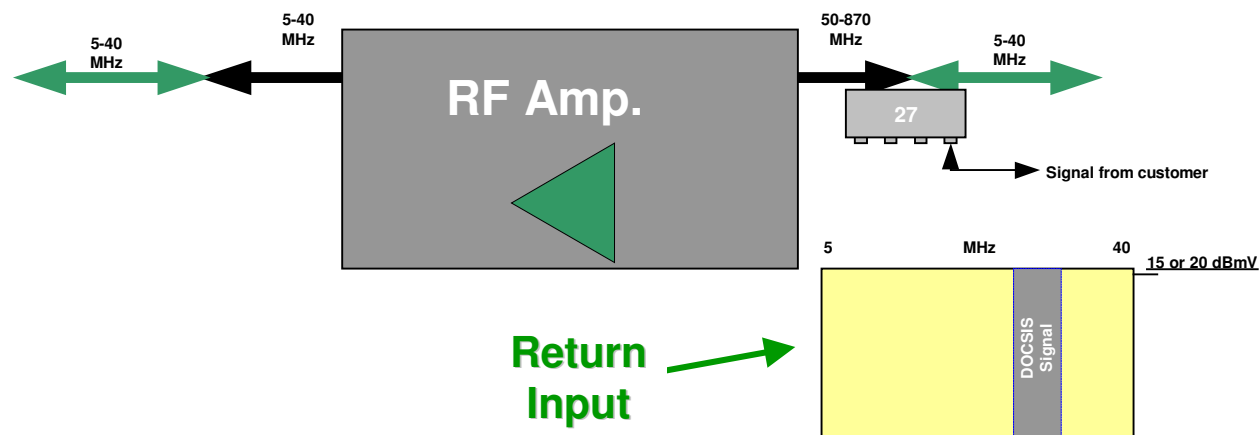


# Optical NODE.



## Determining the Required Operating Level of the Return System.

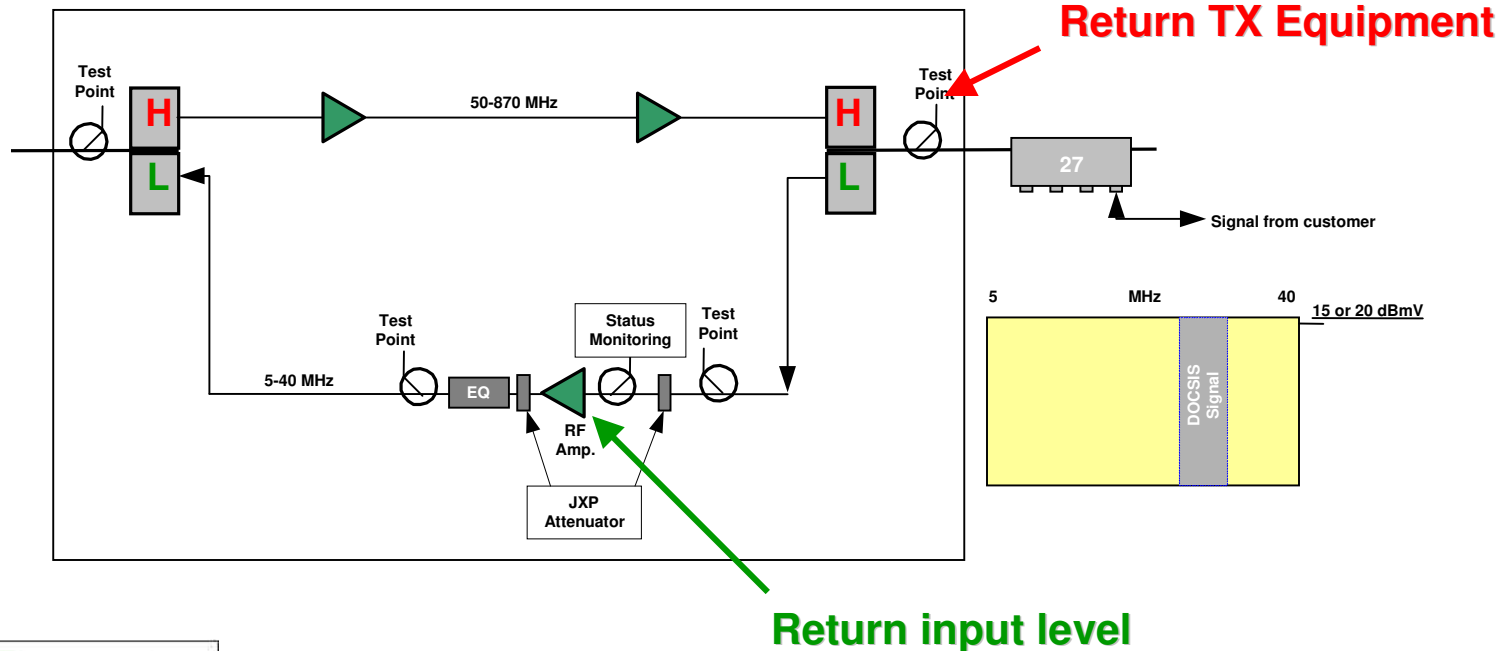
- Because the return path on a Broadband system works on a concept of UNITY GAIN, the system need to determine the required Return Input Level at each active equipment (Amplifier and Node).
- That return Input level need to be at the output of the housing.
- That Return Input LEVEL is usually between : 15 to 20 dBmV



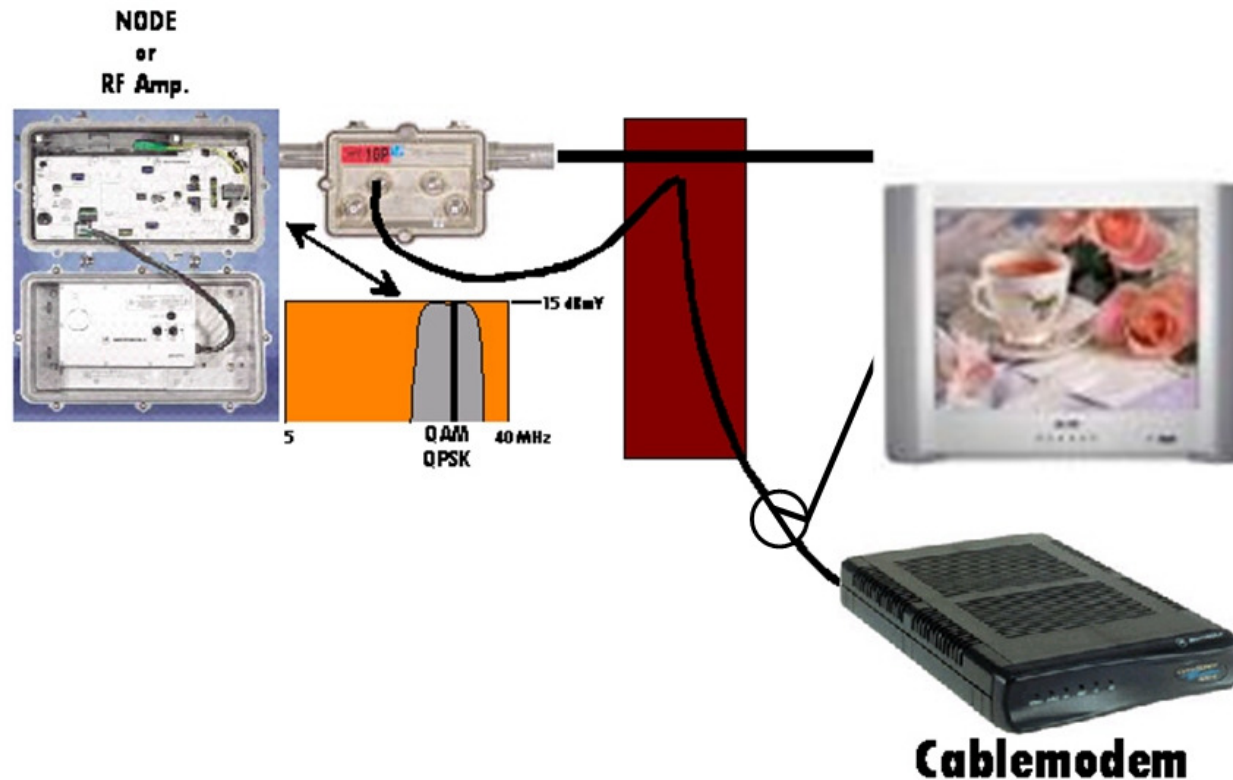


# Operating Level of the Return System.

Once the operating level is determined, it is also very important to use the output test point to introduce the signal from the **RETURN TRANSMITTING EQUIPMENT** used for this operation. The actual level at the input of the return amplifier will change depending on the type of amplifier utilised. These amplifiers can be Line Extender, Mini-Bridger and Distribution amplifiers

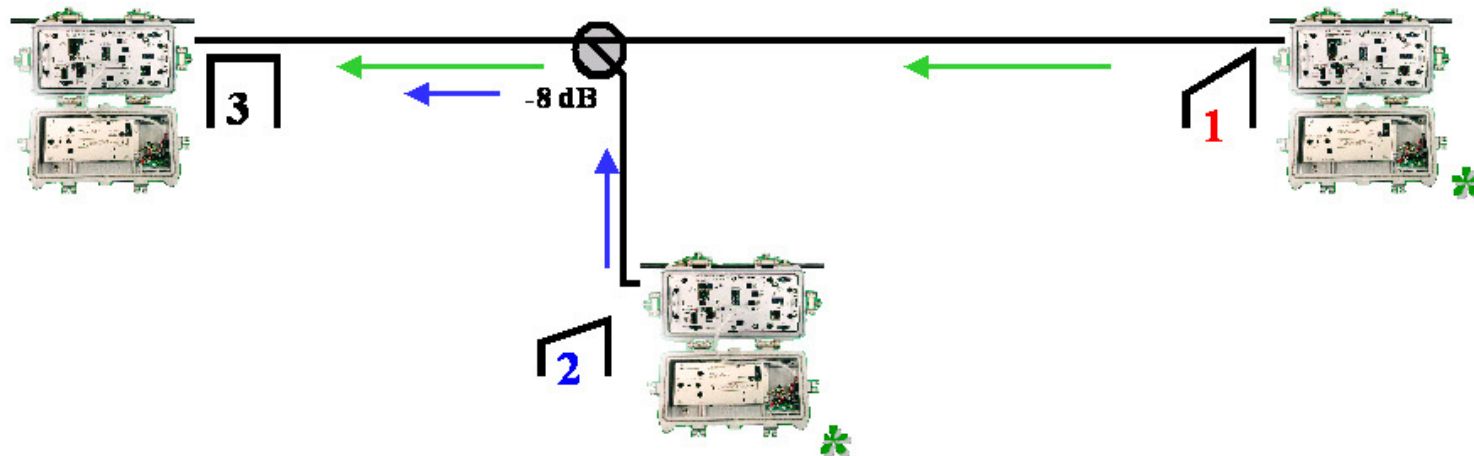


# Operating Level of the Return System.



After the HFC system has been aligned in both direction, each Cablemodem output must be adjusted, to hit a + 15.0 or + 20.0 dBmV at each input housing of all the NODE or RF Amplifiers on the HFC system. This is done automatically by DOCSIS operating system.

## Unity Gain.



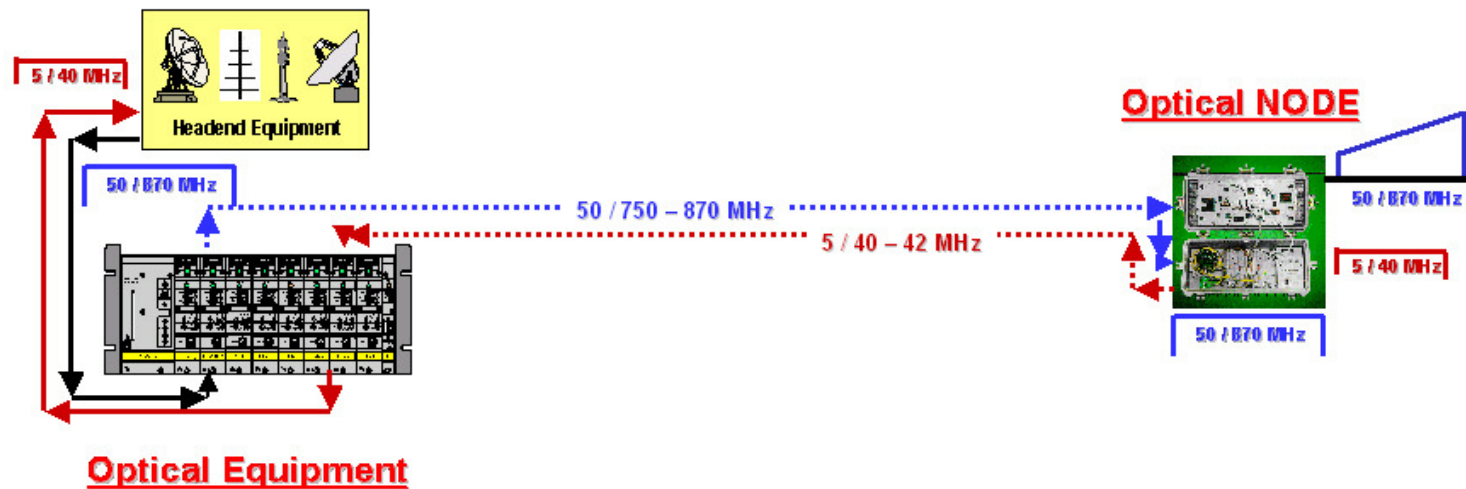
- Unity Gain, basically means output @ **1** and output @ **2** will have a different gain and slope, to fit in the required Input @ **3**

- Each amplifier need to be adjusted locally, to hit the proper level at the node or the amplifier at location @ **3**

\*  
= Where return amplifier are adjusted

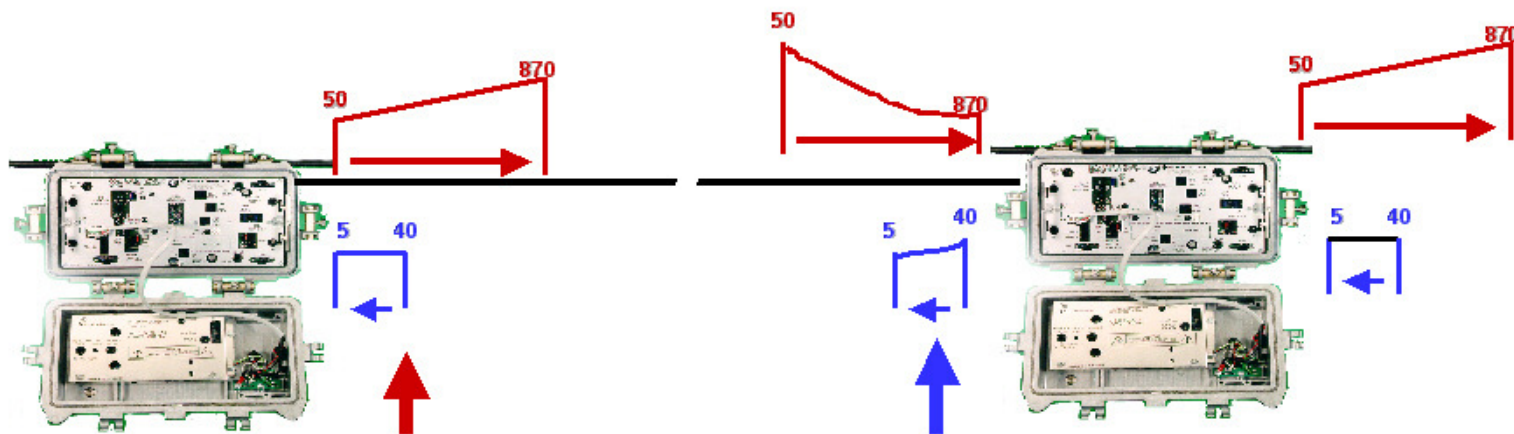
# The Fiber Optic Section.

The fiber optic section, on a HFC system, is a flat operating system, in both, the forward and the reverse section.



## The Coaxial Cable Section.

The loss of signal, in the coaxial section, works differently then fiber optic section, as frequency increase, signal loss also increase.



The slope response must be constant, on this side of all the amplifier, for the forward section (50/870 MHz) as for the return section (5/40-42 MHz)

The forward and return response slope on this side of the amplifier, depends on the length of cable and the loss of the passive equipment, placed between the previous amplifier

# Adjusting the Return Signal on a Broadband System.

Adjusting the forward section, is something, technician have been doing for year.

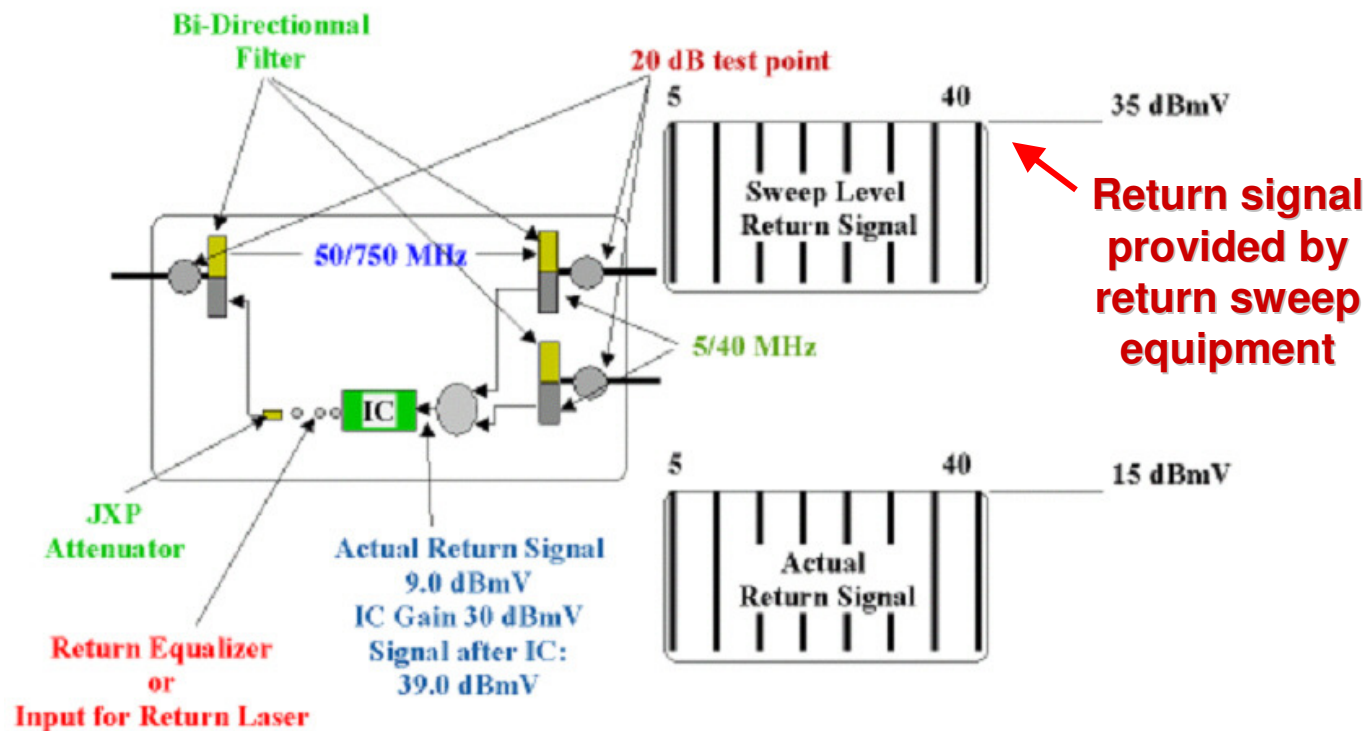
Adjusting the reverse system is quite different, it either requires:

- Two technicians communicating, to properly adjust the return amplifier.
- 2 or 4 Modulators to be transported at each amplifier, a Spectrum Analyzer at the Headend, connected to a Modulator, and a TV set at each amplifier.
- Or the use specialized equipment,



We need to adjust the Gain and Slope of the return amplifier at **1** to have the proper input signal level at: **2**

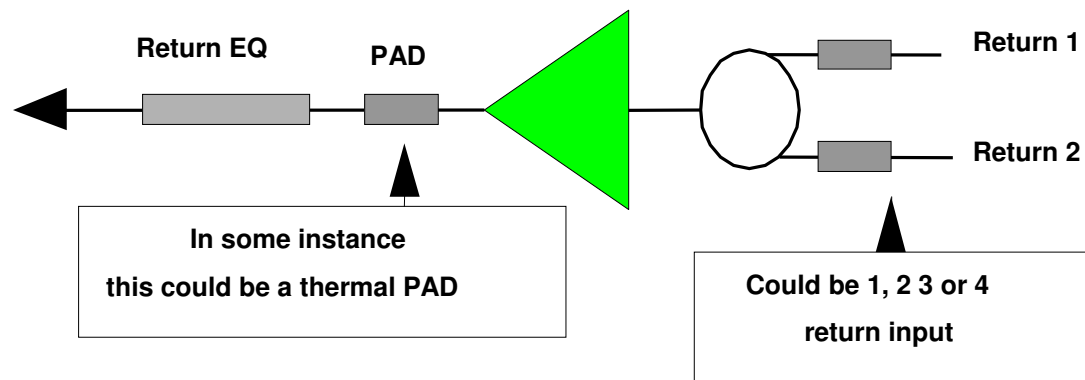
# Adjusting the Return Signal on a Broadband System.



After you have decided the right RETURN input level (15 dBmV in most cases), you need to add the test point loss and begin adjusting the return system.

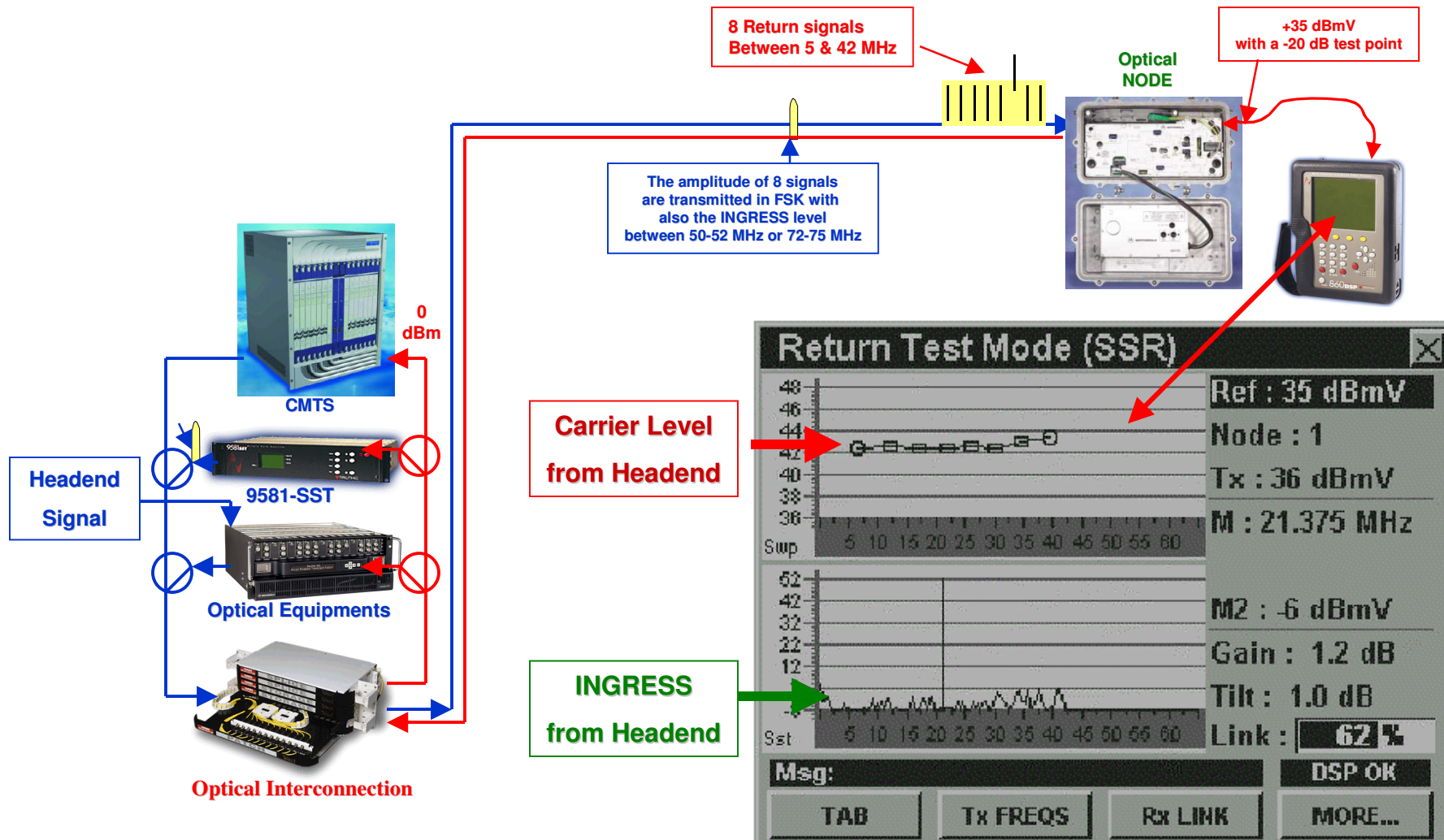
# Adjusting the Return Signal on a Broadband System.

- When we adjust the return section of a HFC system, you must remember that you need to install a RETURN EQ and RETURN PAD, so you can hit the right return level at the following amplifier or node.
- These EQ and PAD goes on the left of the return amplifier, toward the next amplifier or optical node.
- The EQ is for setting the proper slope, which should be flat at the next amplifier
- The PAD, is for setting right input level at the next amplifier.

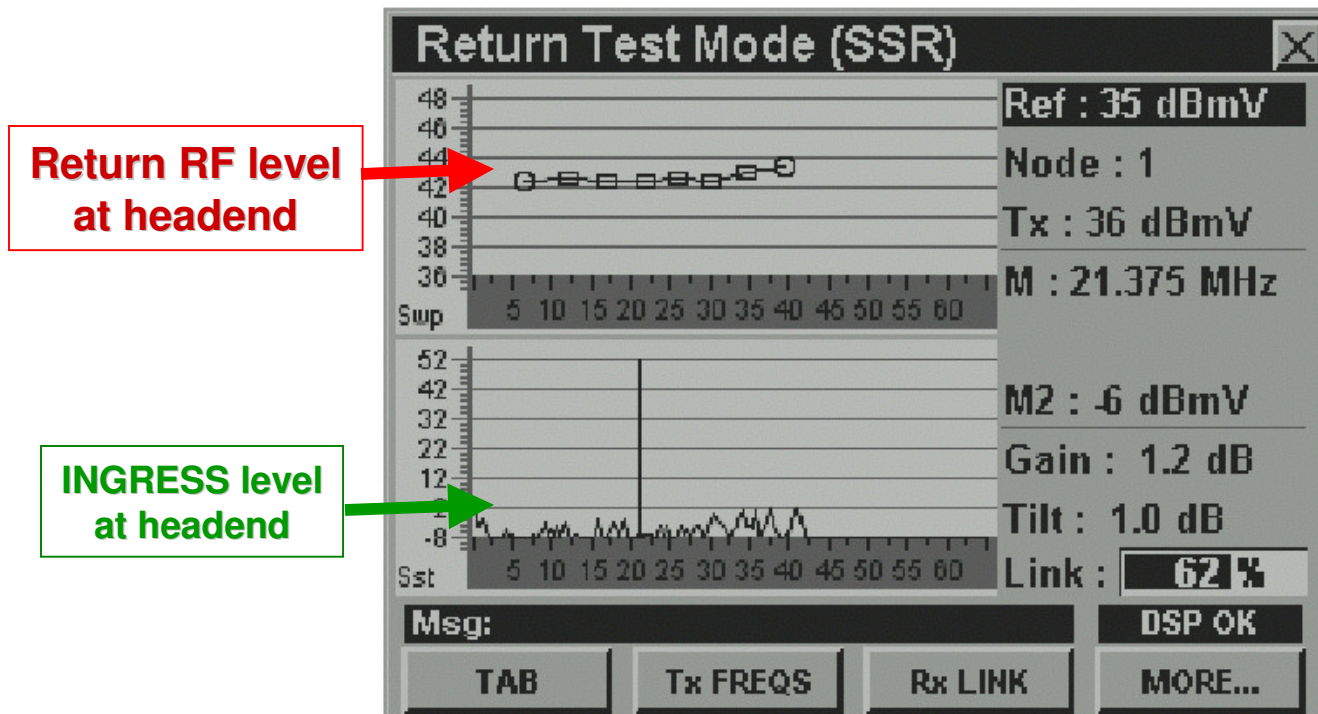




# Adjusting the Return Signal on a Broadband System.



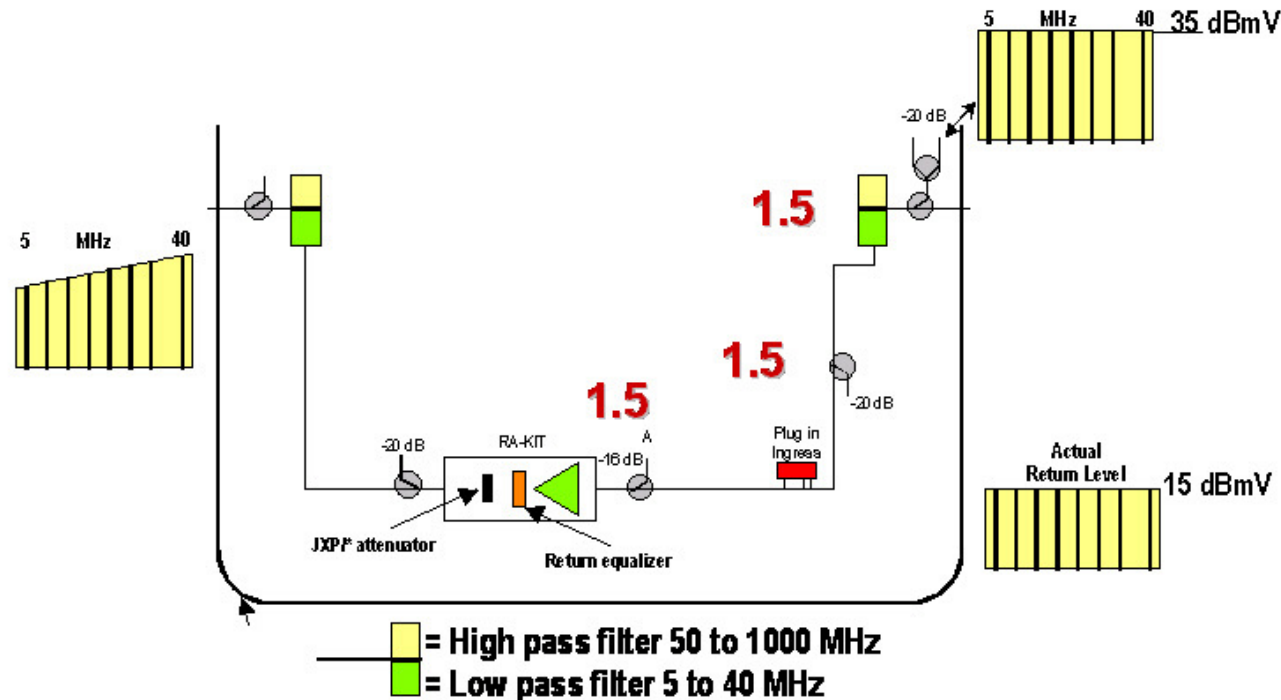
# Adjusting the Return Signal on a Broadband System.



Above is the picture of the eight (8) signals been sent from the input of the return signal. The bottom section one show the ingress on the return signal been tested.

Both of these information are read in the forward path of the HFC system.

# The Return Signal on a Line Extender.



Signal loss between the return input and the input at the Return IC :

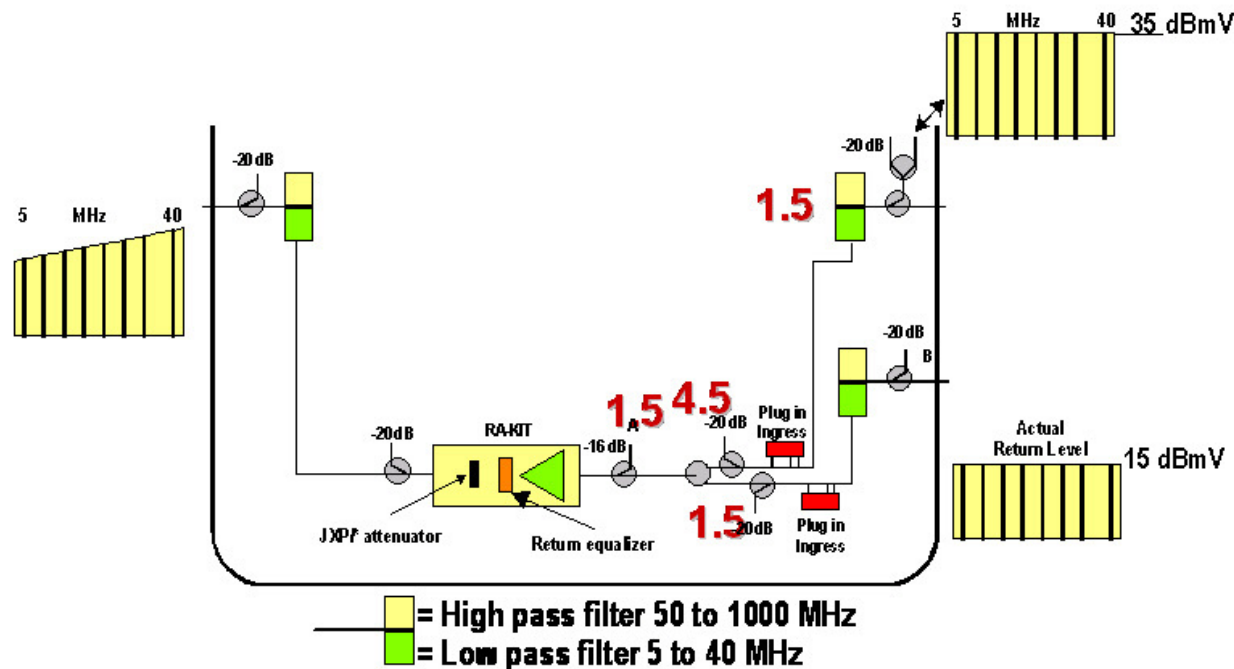
1.5 dB for H/L coupler.

1.5 dB thru 20 dB test point

1.5 dB for return input Status monitoring

Total : 4.5 dB

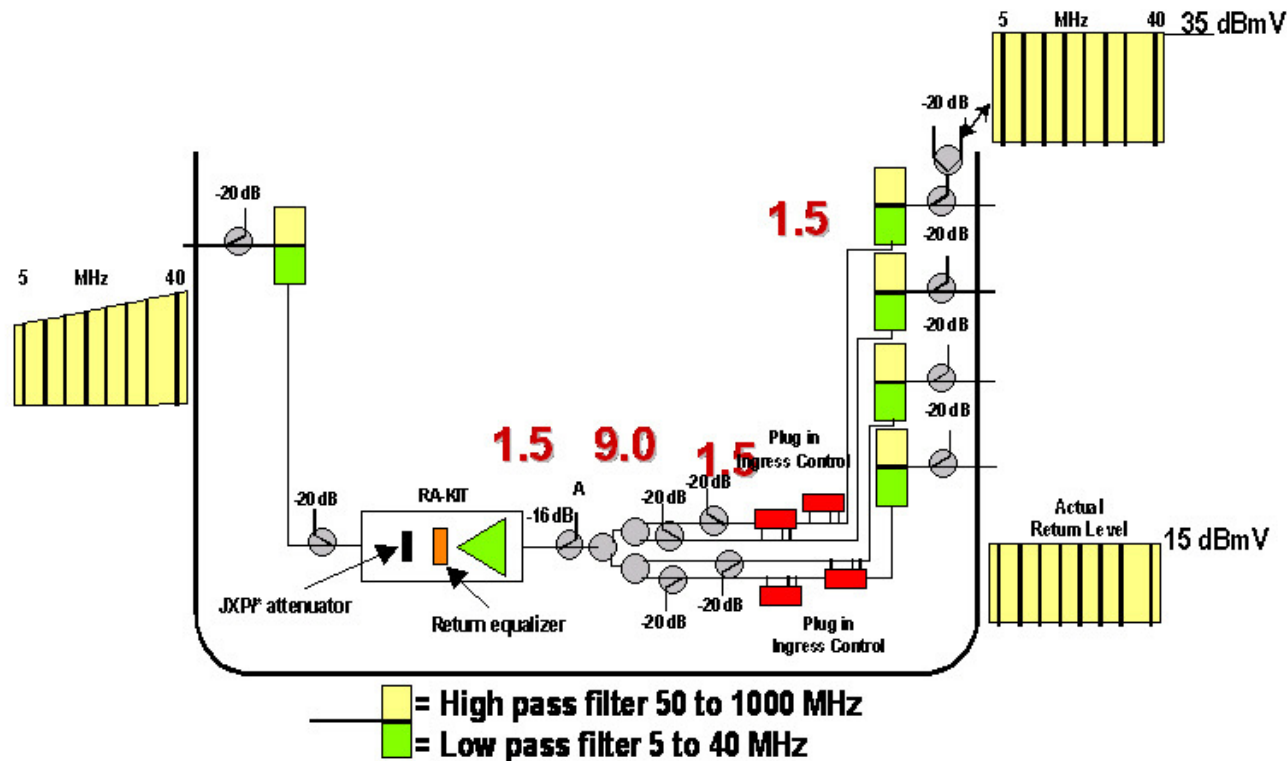
# The Return Signal on a Mini-Bridger.



Signal loss between the return input and the input at the Return IC :

1.5 dB for H/L coupler.  
1.5 dB thru 20 dB test point  
4.5 dB for splitter  
1.5 dB for return input Status monitoring  
Total : 9.0 dB

## The Return Signal on a High Gain Amplifier.



**Signal loss between the return input and the input at the Return IC :**

**1.5 dB for H/L coupler.**

## 1.5 dB thru 20 dB test point

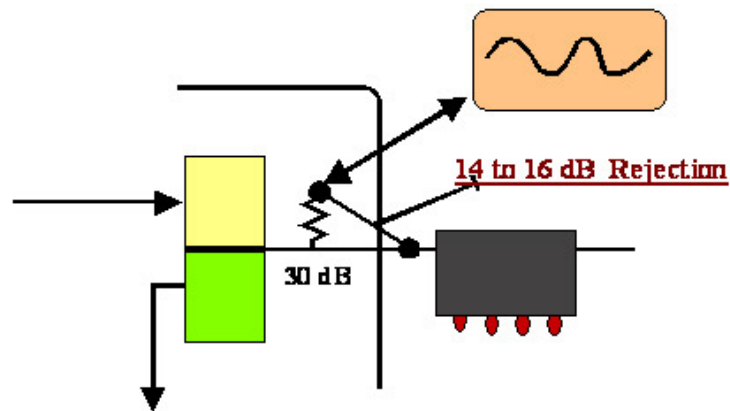
### 4.5 dB for splitter

### 4.5 dB for 2nd splitter

### 1.5 dB for return input Status monitoring

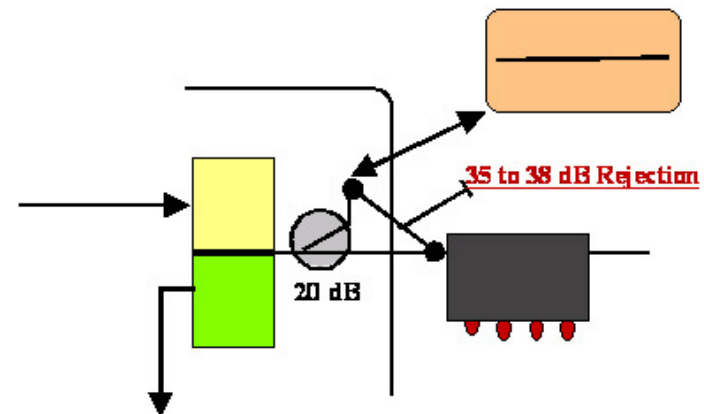
**Total : 14.5 dB**

# Difference in Response Between a 20 and 30 dB Test Point.

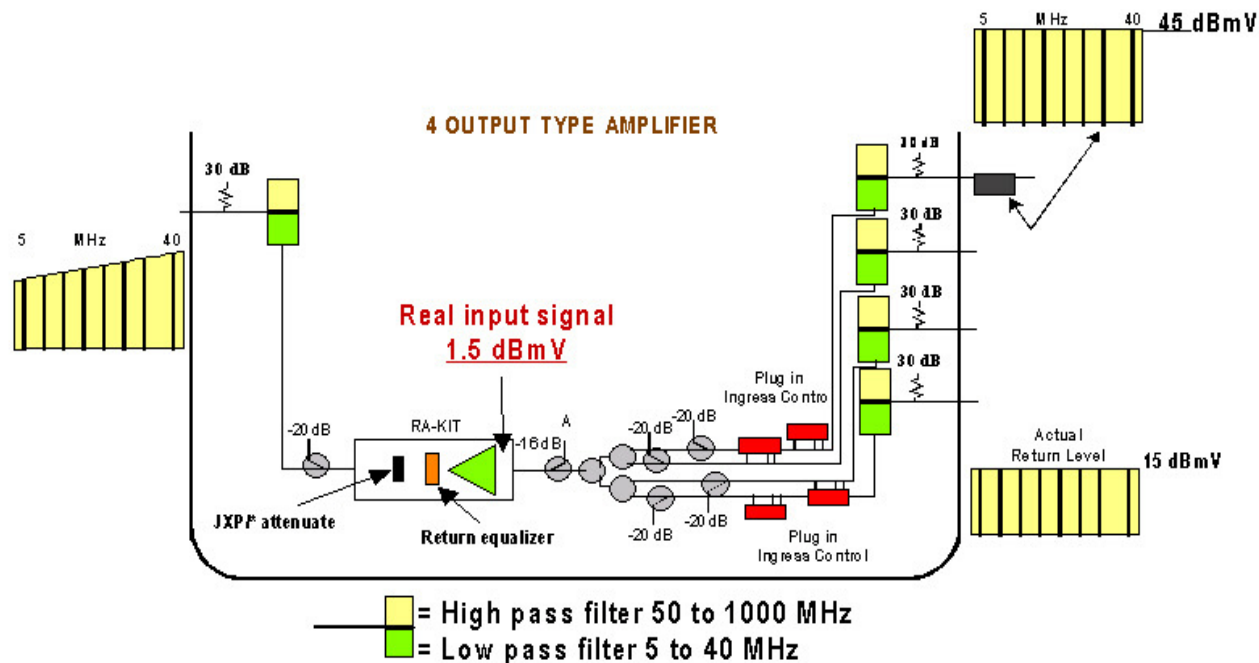


Response of a high impedance  
30 dB test point

Response of a directional  
20 dB test point



# Amplifier Equipped with 30 dB High Impedance Test Point.



With amplifiers equipped with high impedance, 30 dB test point, I strongly recommend installing a 20 dB multitap, at each output of the amplifiers, that way you will get a truer reading when adjusting the forward and the return path.

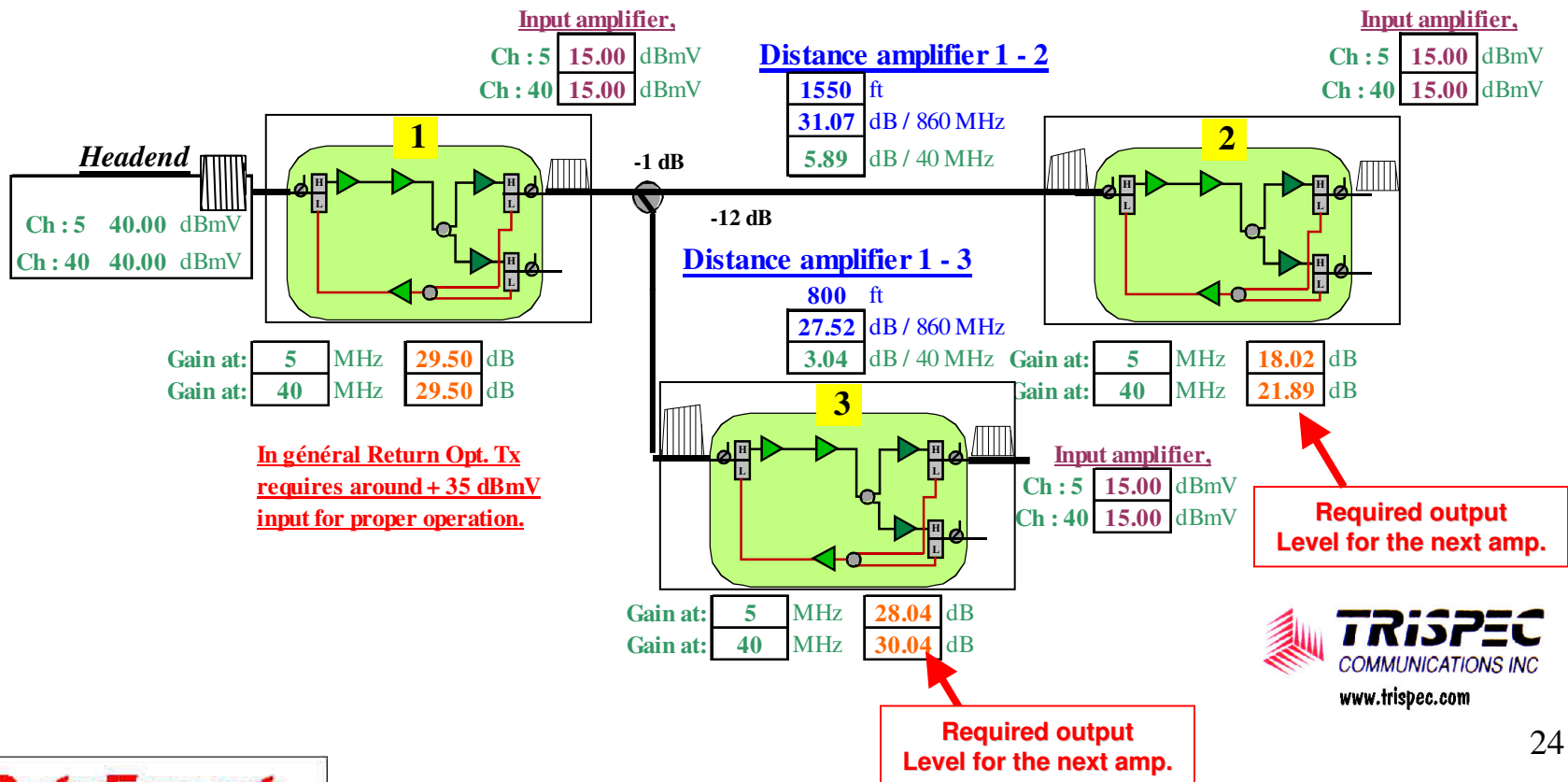


## Signal Loss Between 2 Different Return Path.

### Example of gain required for return signal

## Cable TX-625

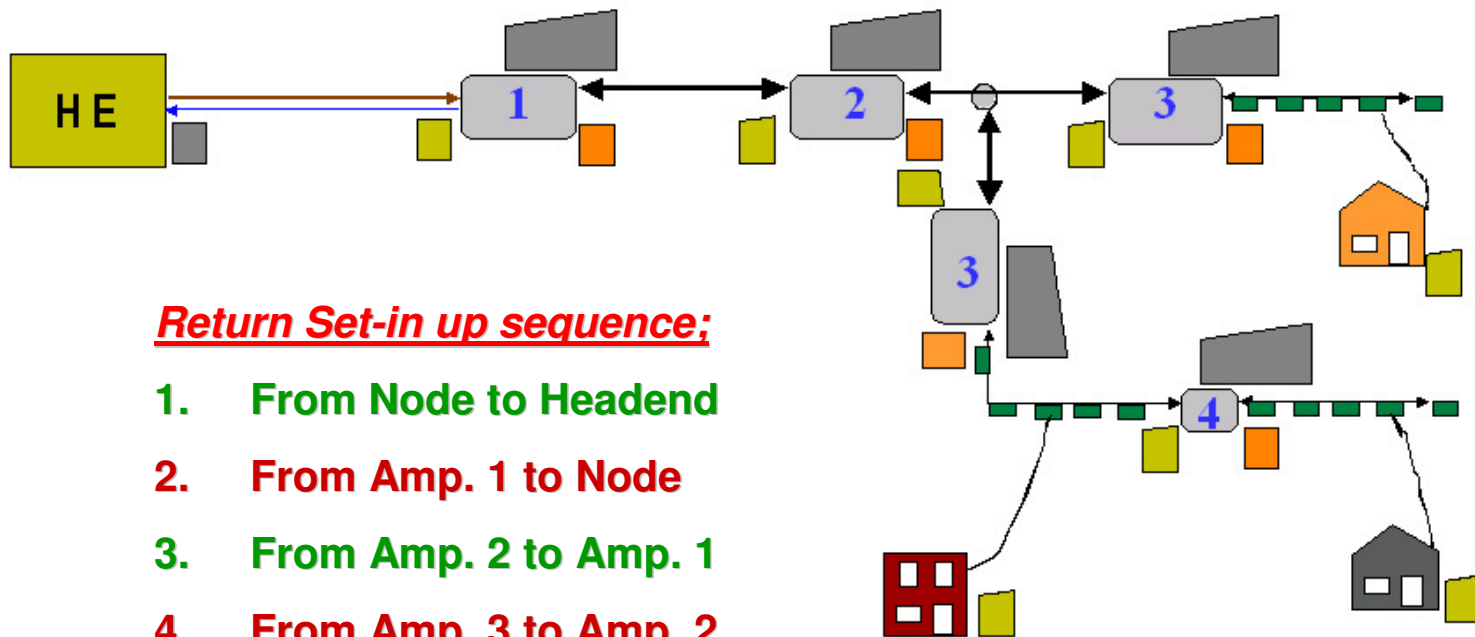
Loss at :	860	MHz	1.94	dB/100'
Loss at :	5	MHz	0.13	dB/100'
Loss at :	40	MHz	0.38	dB/100'





# Sequence for Adjusting the Return Path.

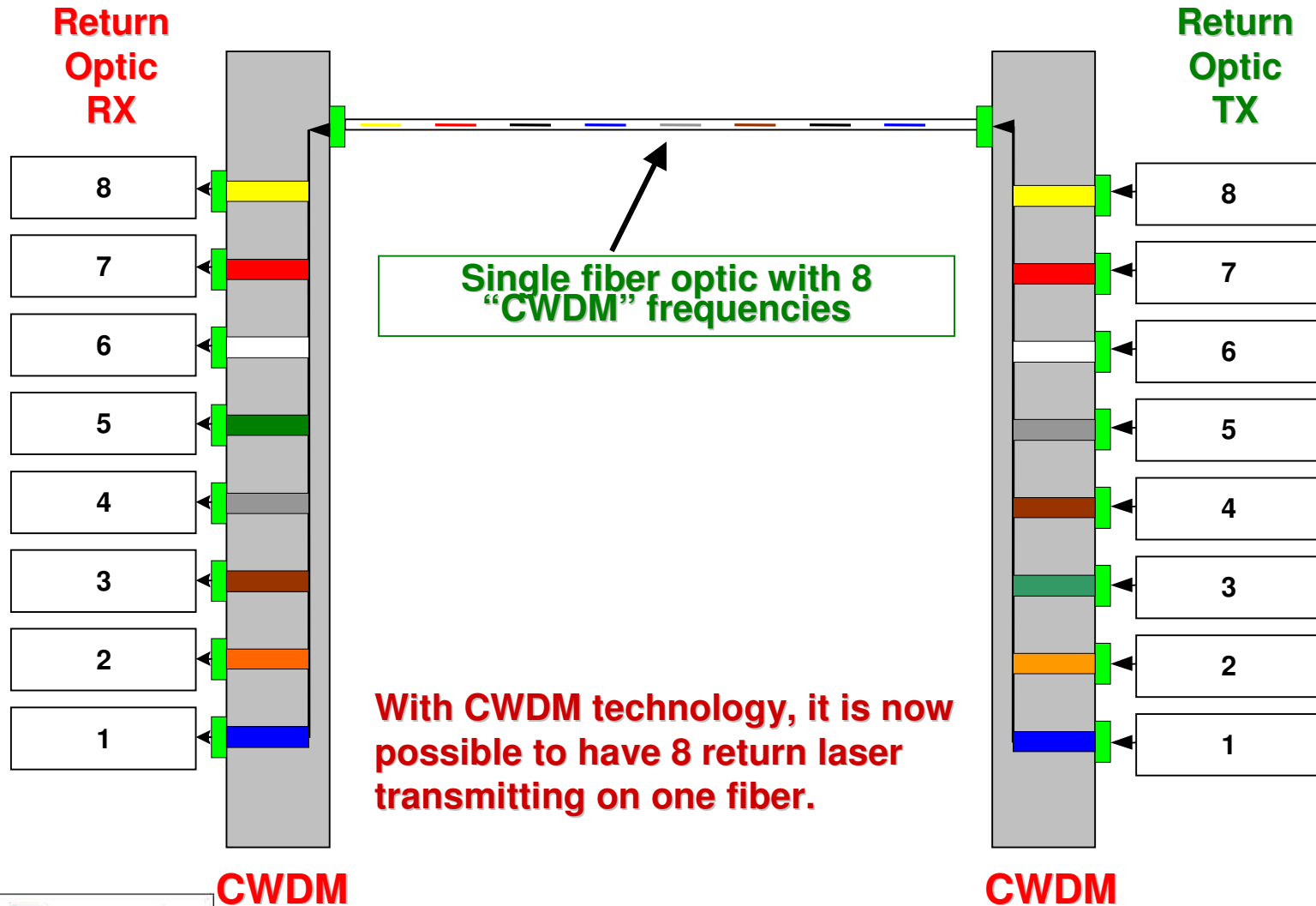
For the return path, the system should be adjusted in the following sequence.



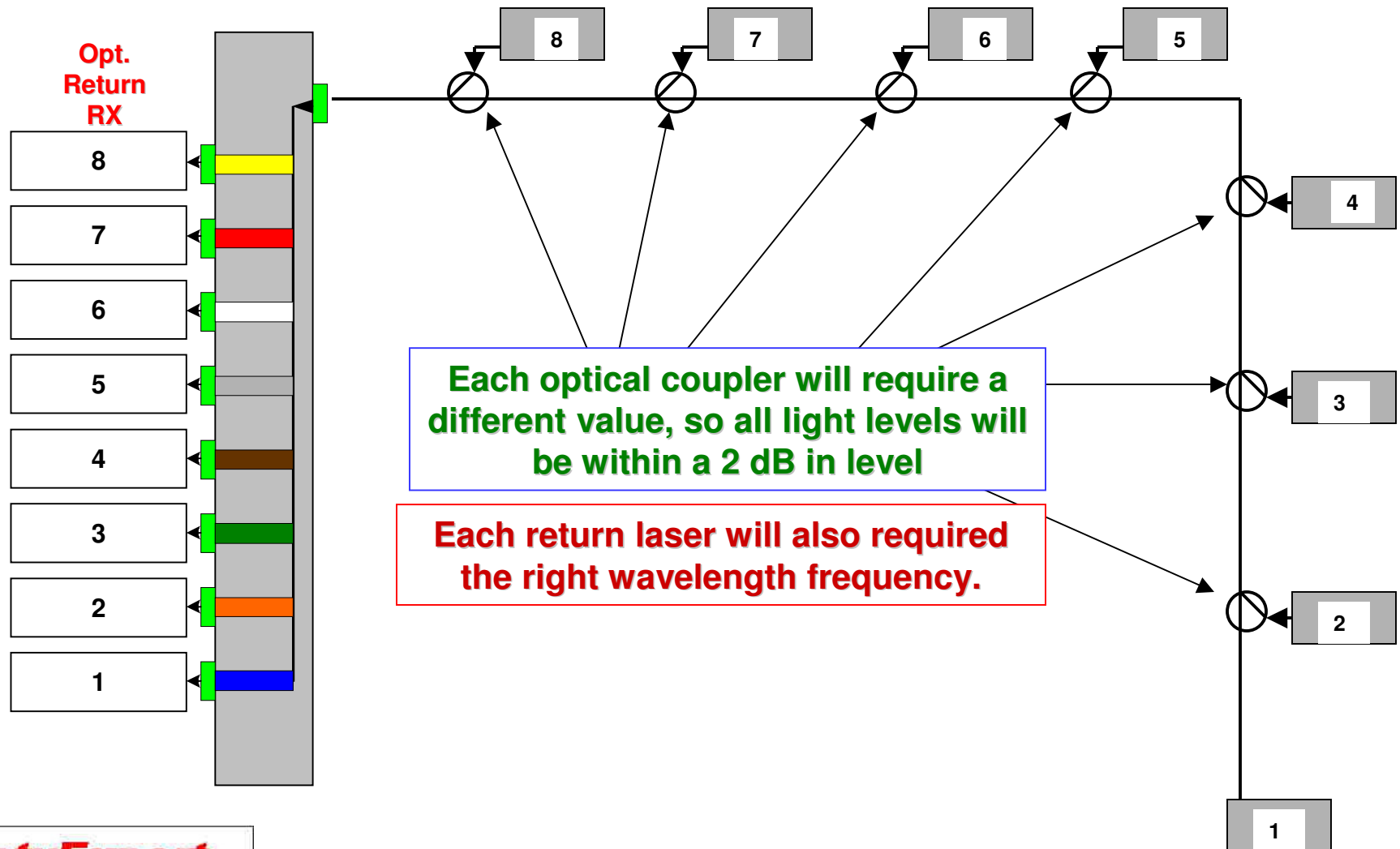
## Return Set-in up sequence;

1. From Node to Headend
2. From Amp. 1 to Node
3. From Amp. 2 to Amp. 1
4. From Amp. 3 to Amp. 2
5. From Amp.4 to Amp. 3

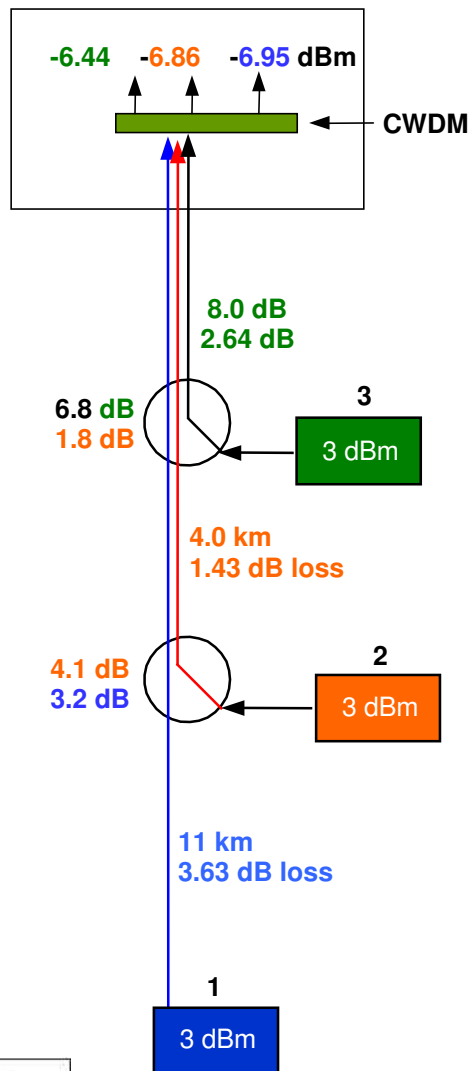
# Multi wavelength return frequencies.



# Multi wavelength return frequencies.



# Multi wavelength return frequencies.



The loss of each return TX will be:

$$1 = 3.0 - (3.63 - 3.2 - 1.43 - 1.8 - 8.0) = -6.95 \text{ dBm}$$

$$2 = 3.0 - (4.1 - 4.0 - 1.8 - 8.0) = 6.86 \text{ dBm}$$

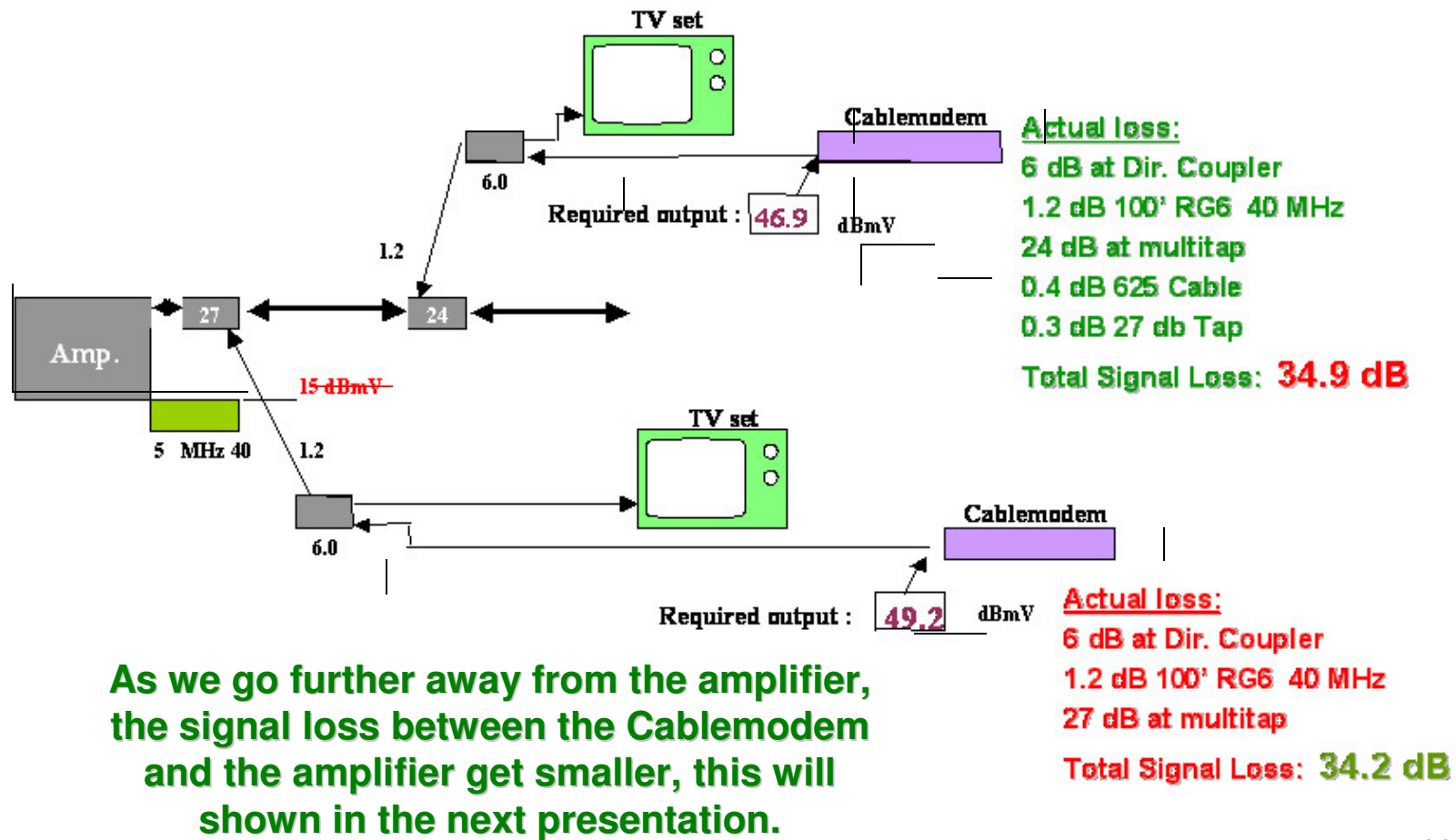
$$3 = 3.0 - (6.8 - 8.0) = 6.95$$

When using CWDM technology, we should try to keep all of the light level within 1.5 dB from each other.

The thru loss of the CWDM is not calculated

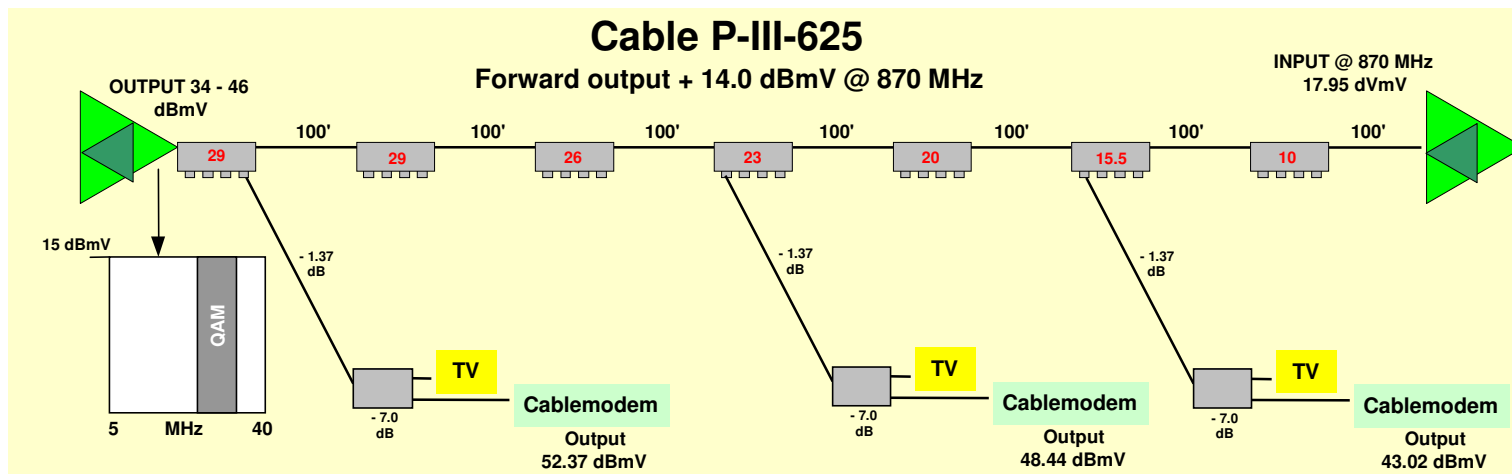
# Signal Loss Between Two Cable Modem.

Loss of signal between Cablemodem and Input of the return amplifier.



### Actual Level Required at Each Cable Modem for Proper Operation.

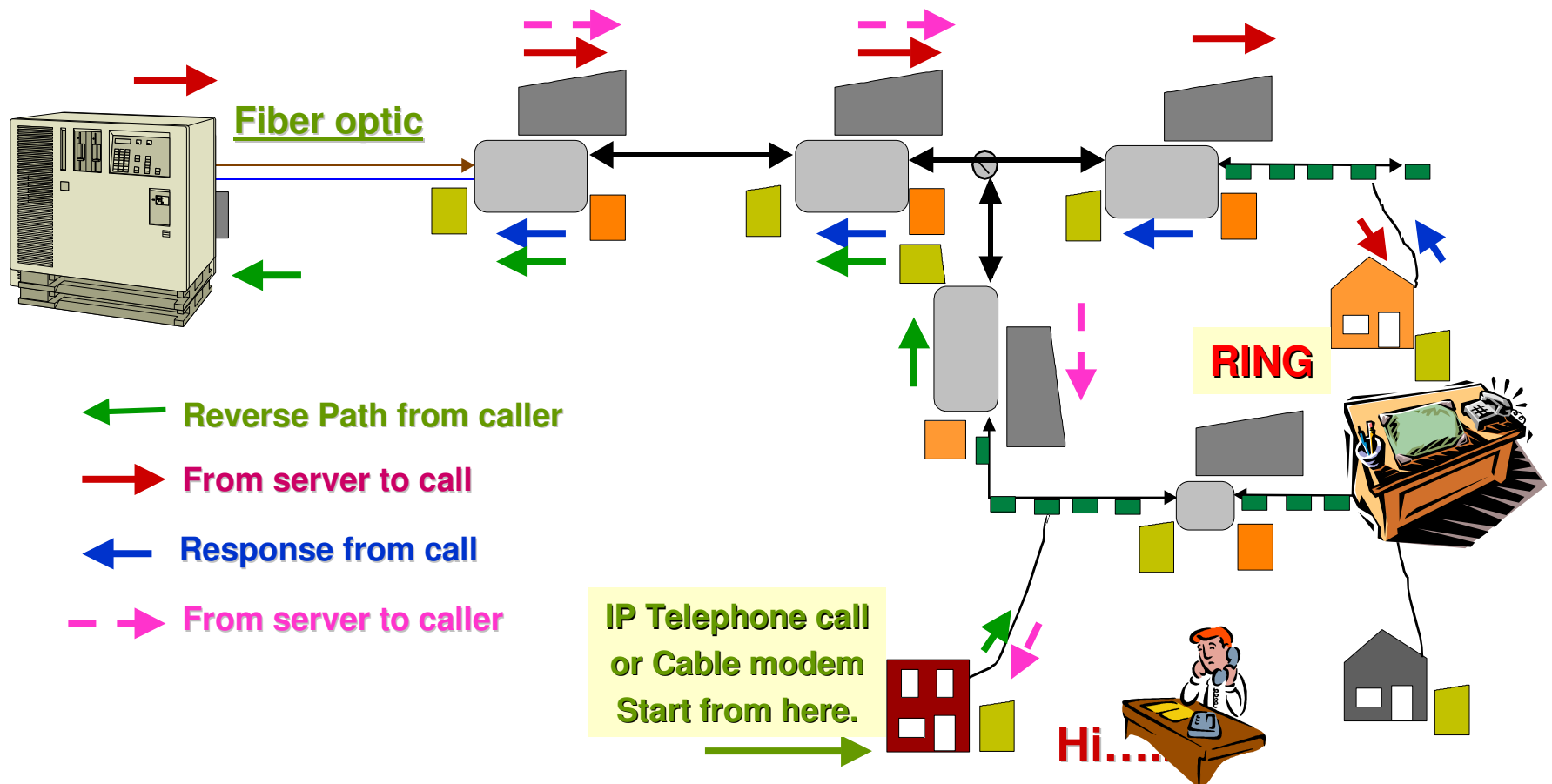
**Actual level in dBmV, required out of the Cablemodem, to hit proper input at the next amplifier or Optical Node, where the forward signal output is : 14 dBmV at 750 MHz**



**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.**

# A Bi-Directional Operating System.



# A Bi-Directional Operating System.

•You'll now see a short PC Video demonstration a HFC return signal.

## Pattern of the Video Recording of the return signal:

- 19:30:25 5 to 50 MHz upstream system.
- 19:30:25 3 active cable modem carriers (3.2 MHz DOCSIS)
- 19:31:10 Ingress appear between 5 to 18.5 MHz.
- 19:31:18 Ingress grows substantially stronger.
- 19:31:30 Ingress disappear.
- 19:31:33 Common path distortion (CPD) appears.
- 19:31:41 Common path distortion grows very severely.
- 19:31:51 Common path distortion goes away.
- 19:32:15 All traffic is now OK.
- 19:32:34 Analyzer a ZERO SPAN, centre frequency at 41 MHz
- 19:32:52 Noise floor rises to about 15 dB C/N.
- 19:32:52 Interference disappears, Noise floor back to 30 dB C/N
- 19:33:57 Analyzer is brought back to frequency domain mode.
- 19:34:27 End of recording.



# A Bi-Directional Operating System.

Controlling INGRESS is possible by utilising a device called ClearPath. A ClearPath is a return switch that locate the source of INGRESS in a HFC system. To determine where the ingress is located, the ClearPath selectively switches a 6 dB pad into the return path. In locations where the ingress is severe, the ClearPath can also switch off the entire upstream band until the ingress sources in repaired.

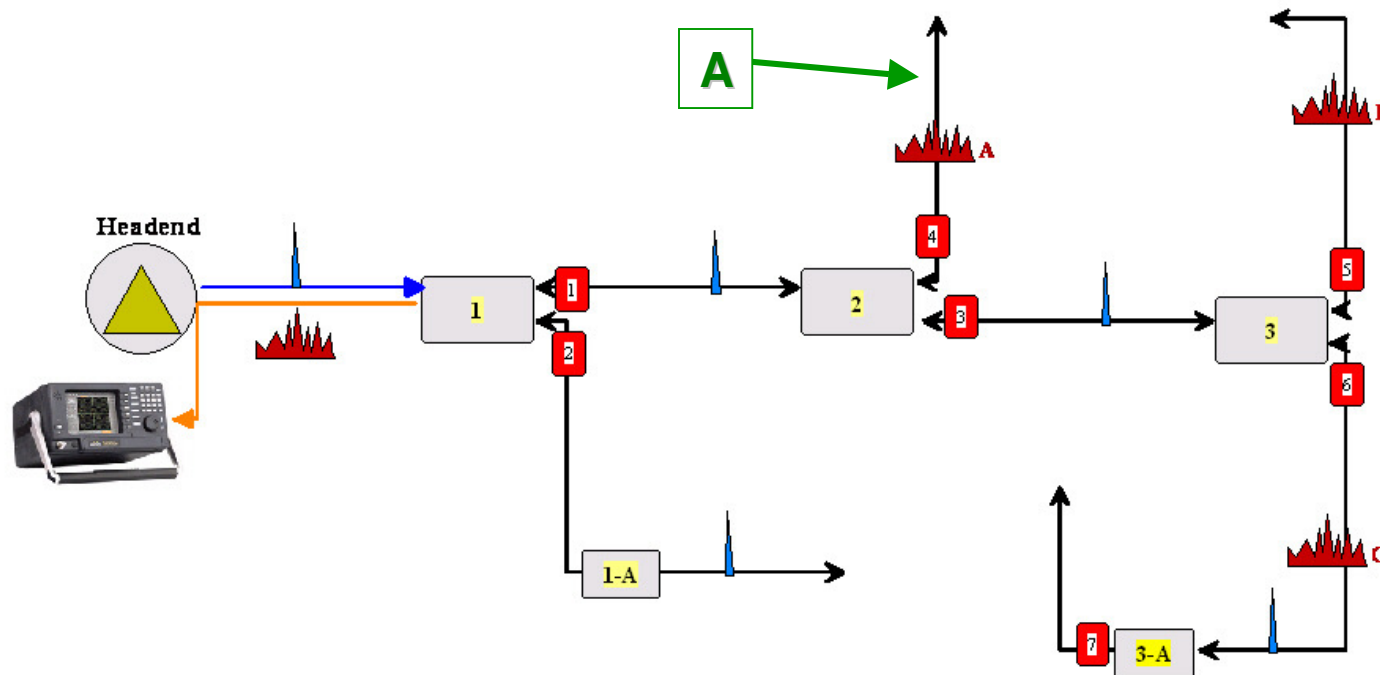
## Technical specifications:

- 90 volts, 15 amp power passing
- Smooth, non-disturbing switching
- Switching time 10 ms
- Surge protected
- Provides temporary release for severe ingress
- Single agile FSK carrier



# A Bi-Directional Operating System.

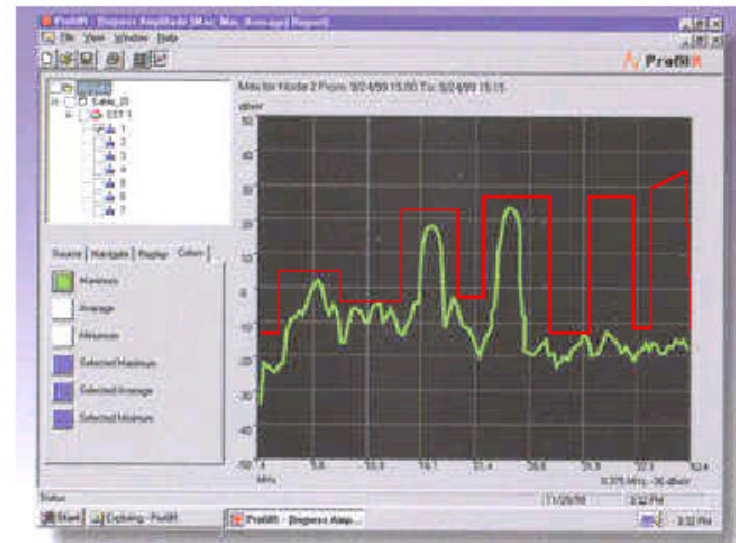
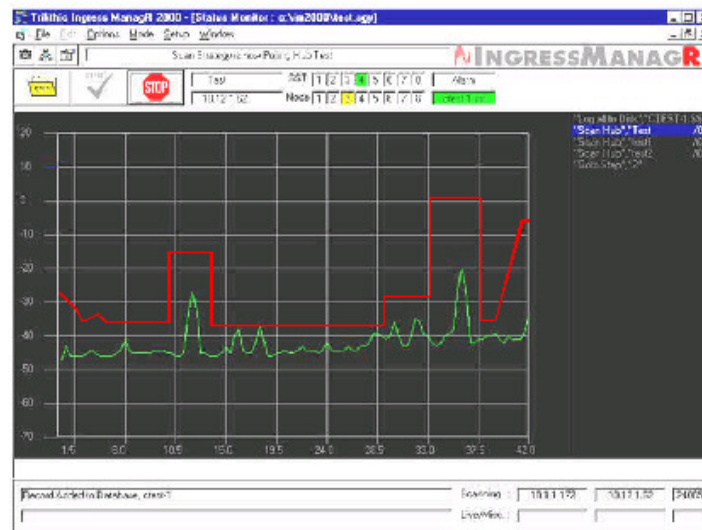
## Controlling INGRESS



1. With INGRESS coming from section A and the return path without ingress control, the return system might not been operational. If ClearPath-4 is installed, and with a ( 6 or 40 dB attenuation Pad ) operating, the rest of the return path becomes fully operational.
2. The ClearPath can be controlled by using a simple software and a spectrum analyzer or a complete software, that will activate the proper ClearPath, activate the attenuation Pad and give the proper location.

# A Bi-Directional Operating System.

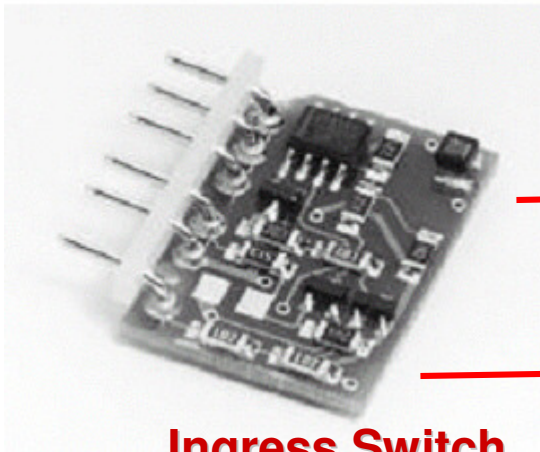
## Controlling INGRESS



- **TrafficControl** is a powerful new feature for Trilithic Reverse Path Maintenance System. This system can not only detect INGRESS hiding inside your return services, it can scan your return system and detect excessive ingress, logs the event, generates alarms and takes other programmed actions, like finding where the problem occur by opening and closing and selecting the proper ClearPath.
- **TrafficControl** can also select the operating section of the return path and forget about the none occupied section, as shown above.

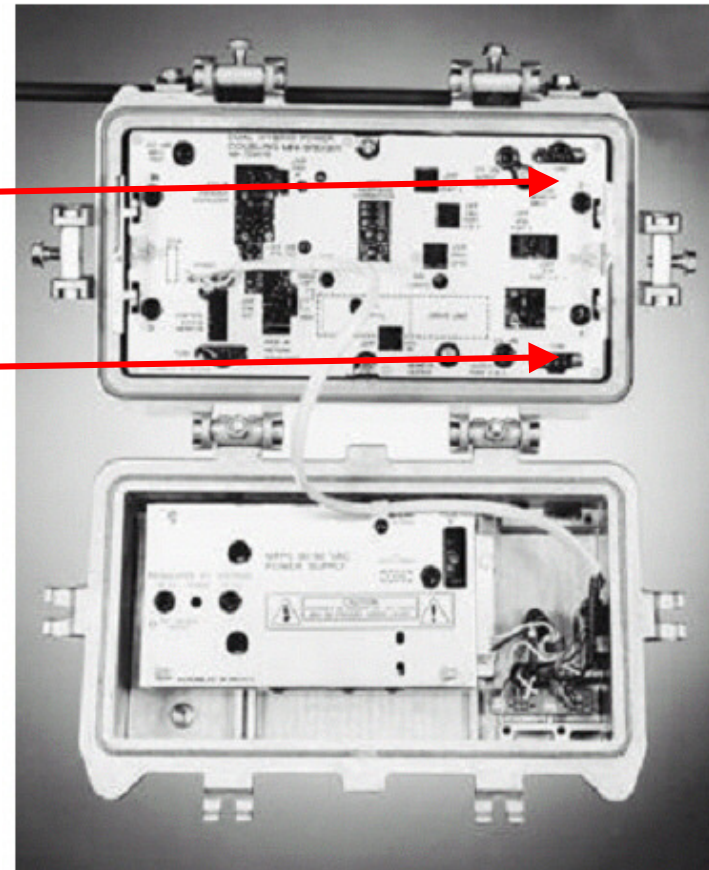
# A Bi-Directional Operating System.

## Controlling INGRESS



**Ingress Switch**

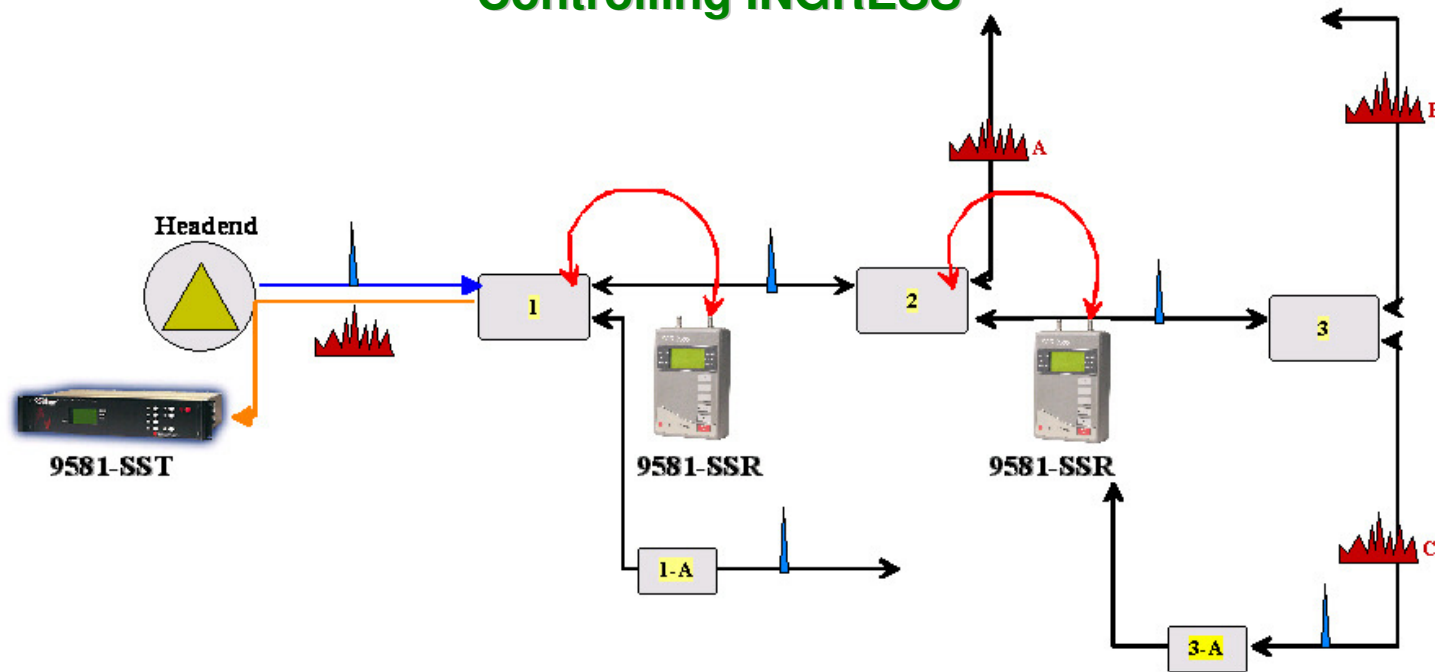
With newer optical NODE and RF amplifier, it is now possible to install INGRESS Switch inside the amplifier and controls INGRESS. This INGRESS switch is capable of inserting a 6 dB PAD or a 40 dB PAD at distance. The 6 dB PAD help us locate the problem area and the 40 dB PAD remove from the return system the problem area..





# A Bi-Directional Operating System.

## Controlling INGRESS

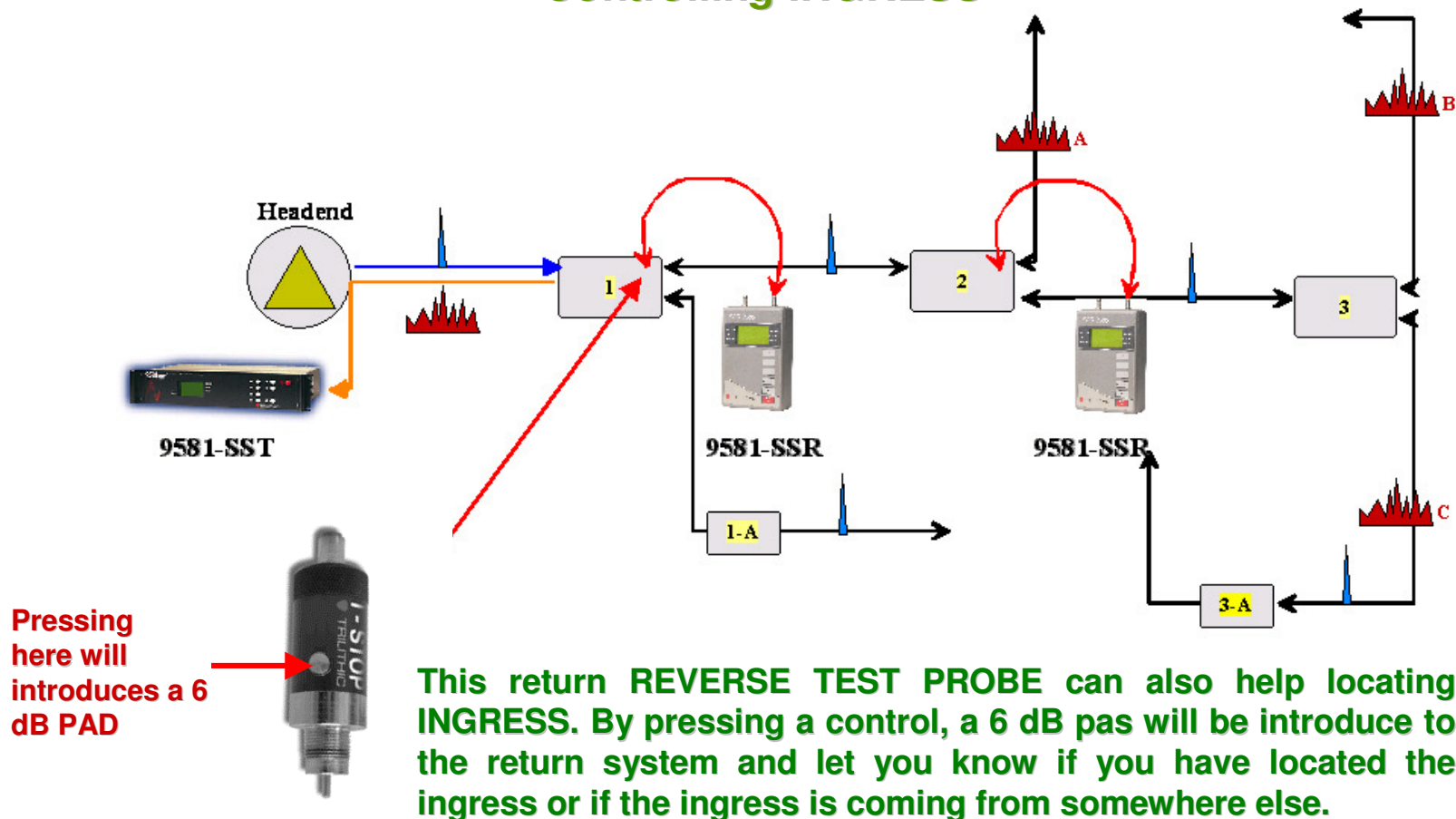


•One other way to controlled and look for INGRESS, is by using a 9581-SST and 9581-SSR. You then go to any amplifier, get the return signal from the 20 dB test point and look at the ingress at the 9581-SST at the Headend. By removing attenuator PAD before the return IC you can actually tell where the INGRESS is coming form.

•The problems with this solution, every time you remove a PAD from the return system, you actually stop the return system to operate and you will also have to move from amplifier to amplifier, before you can locate the problem area.

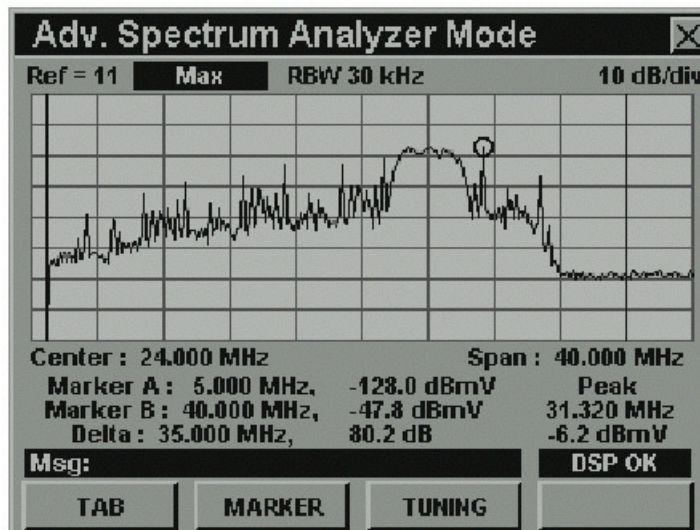
# A Bi-Directional Operating System.

## Controlling INGRESS

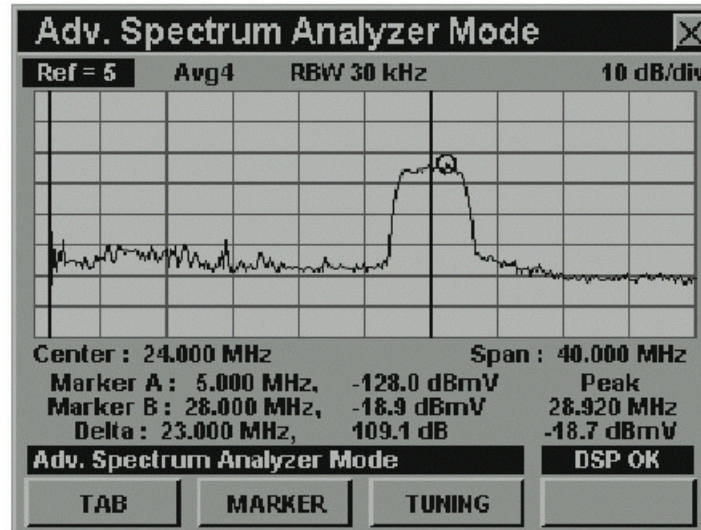


# A Bi-Directional Operating System.

It is also possible to read return INGRESS and CPD on the return system with the use of a spectrum analyzer.



Return system with INGRESS.



Return system without INGRESS.

# A Bi-Directional Operating System.

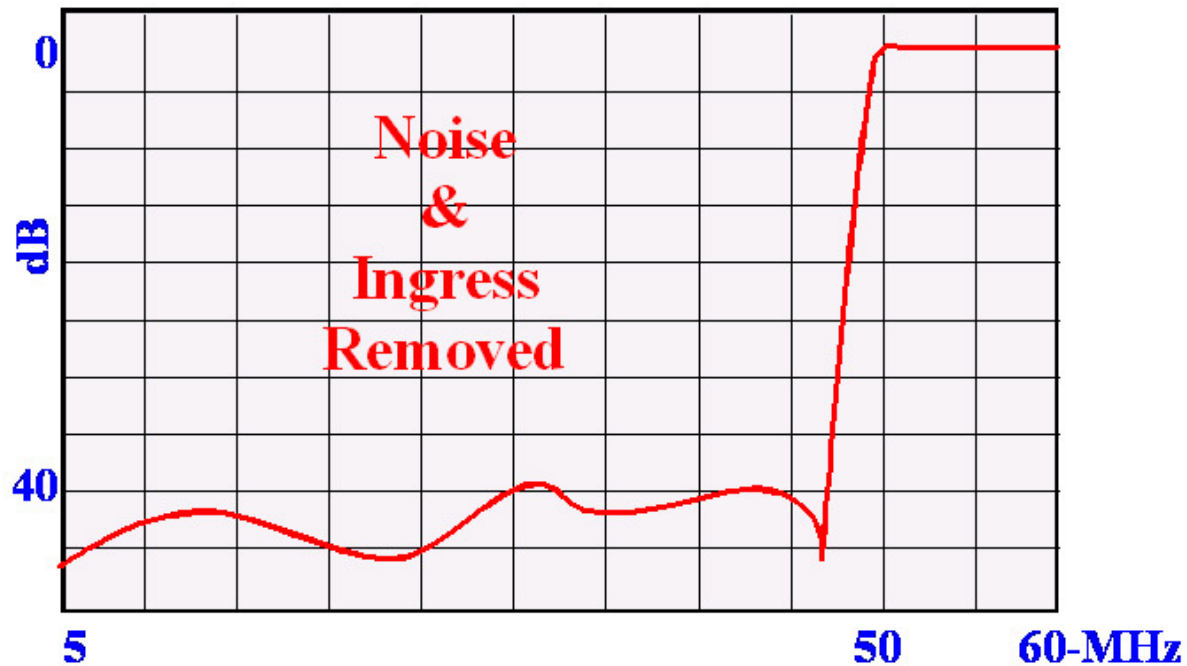
Adjusting a return system in the field.





# A Bi-Directional Operating System.

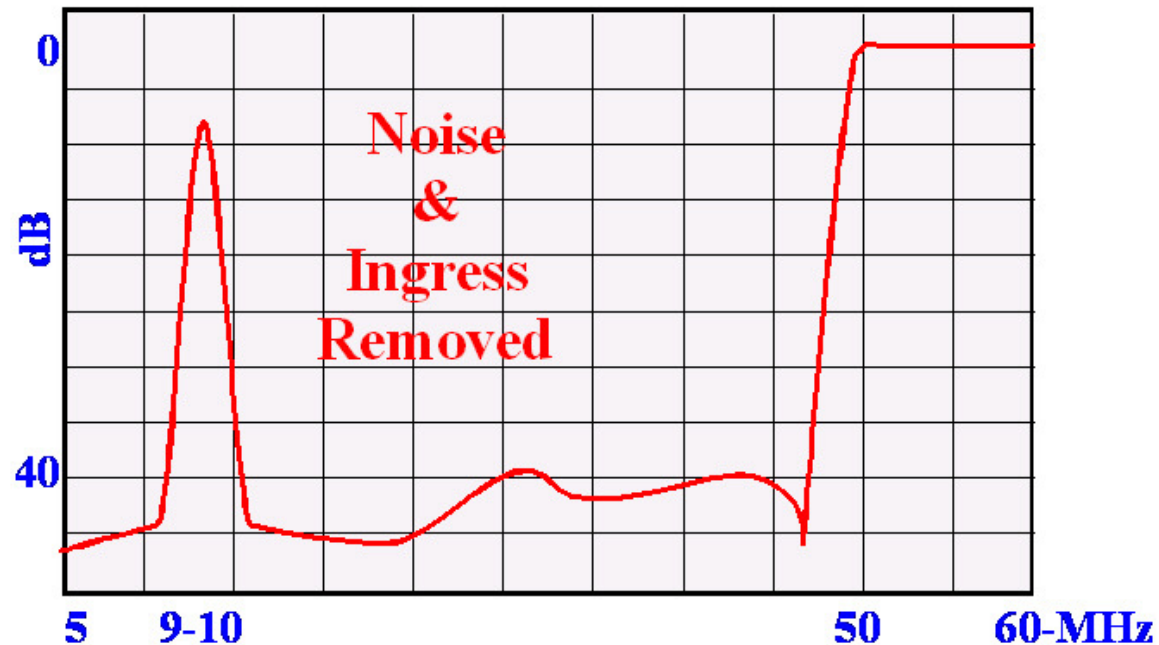
## Controlling INGRESS



One other good way to removed INGRESS on a bi-directional system, is to install a High Pass Filter at each location where bi-directional signal are not required.

# A Bi-Directional Operating System.

## Controlling INGRESS



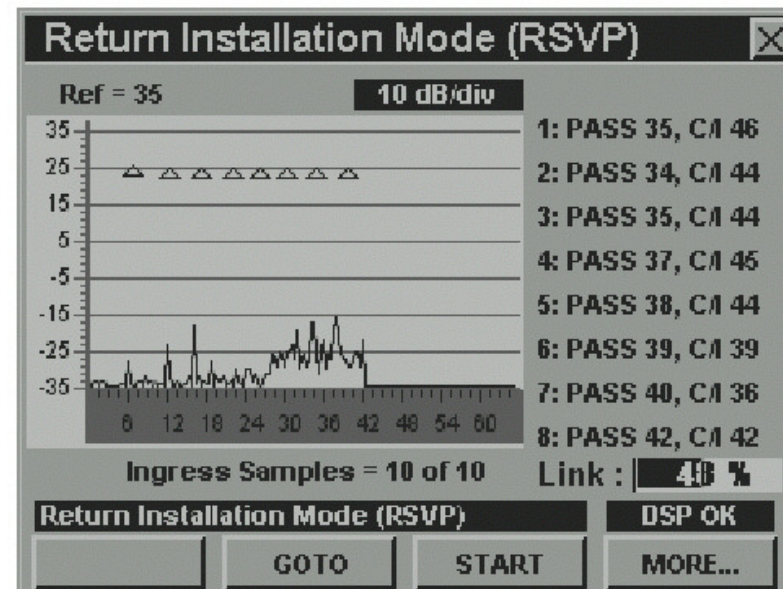
With some systems operating a VIDEO on DEMAND or a PAY TV System, you should installed a INGRESS control unit with the capacity of talking to the controls units installed at each customer with these services. These controls units are usually requiring a frequency between 9 to 10 MHz

# A Bi-Directional Operating System.

## Testing return signal, from the home to the headend.

Some equipment can test the quality of the return signal. These equipments send signal to a headend equipment, this equipment does some calculation and send you the result on the forward path.

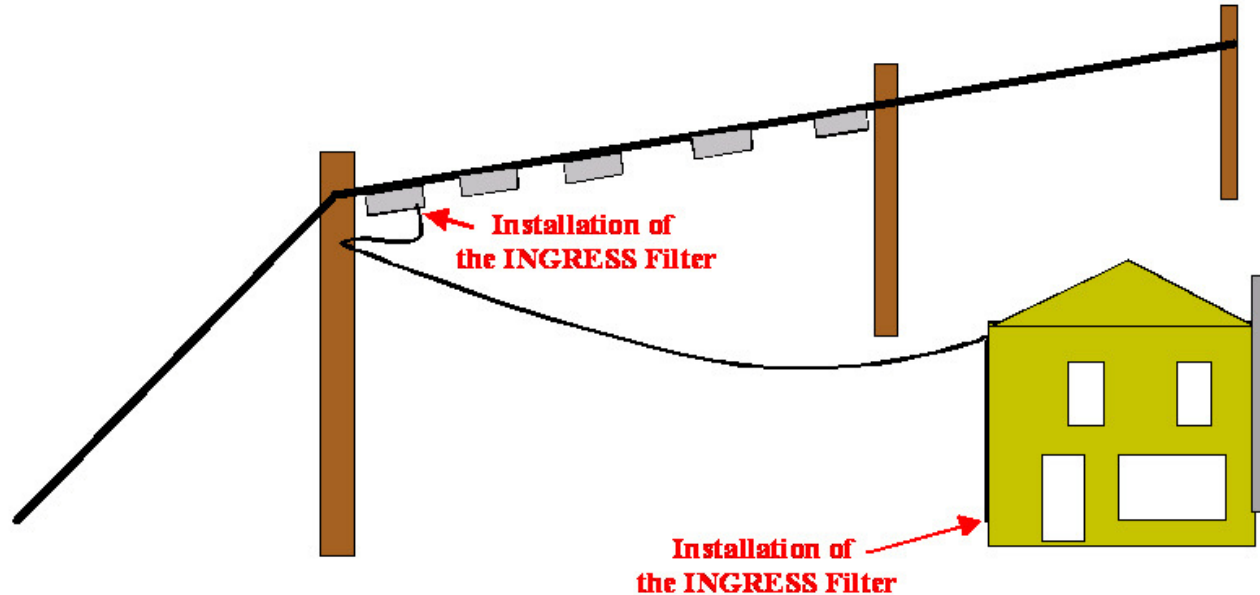
The picture show 8 frequencies from 5 to 42 MHz been sent from the home to the headend. The headend piece does some C/N calculation and let you if the system meet the return requirement.



This system send the following frequencies at the headend: 5.5, 13, 18, 24, 27, 30, 34, and 39.6 MHz. The level received at the headend is around 25 dBmV. The highest INGRESS level been around -25 dBmV, where the C/N of each of those frequencies are between; 42 to 36 dB C/N.

# A Bi-Directional Operating System.

## Controlling INGRESS



**A High Pass Filter installed at each home, not requiring by-directional communication , will help the system control his ingress problem.**

# Test!

•What is a proper return level at the input of an RF amplifier?

---

•In what direction do we line-up the return system on a HFC system?

---

•What happen to return RF signal at the NODE?

---

•How many return signal do we generally combined at the headend?

---

•Are all the cable modem adjusted at the same level at the customer?

---

•What type of modulation is generally used for cable modem?

---

•Where is the return equalizer situated on the RF section of an amplifier?

---

•What is called the none wanted signal, that can actually stop the return system to work?

---

**The end of this session.**