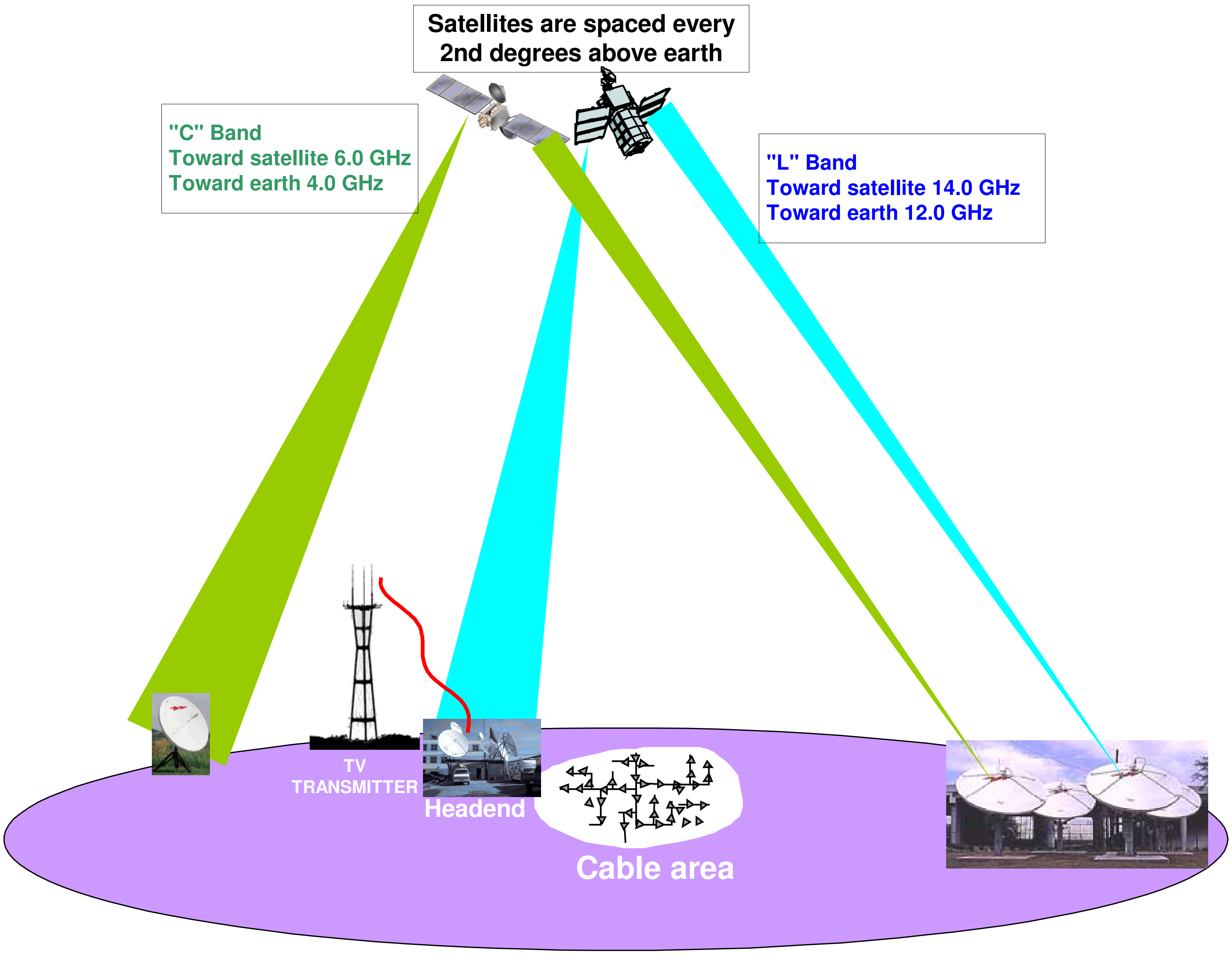
Broadband System - L



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Alignment and System Maintenance.

Broadband System Maintenance.

Since a HFC is bi-directional communications system, it needs to be aligned from the Headend toward all the customers on the system and from each customer toward the Headend.

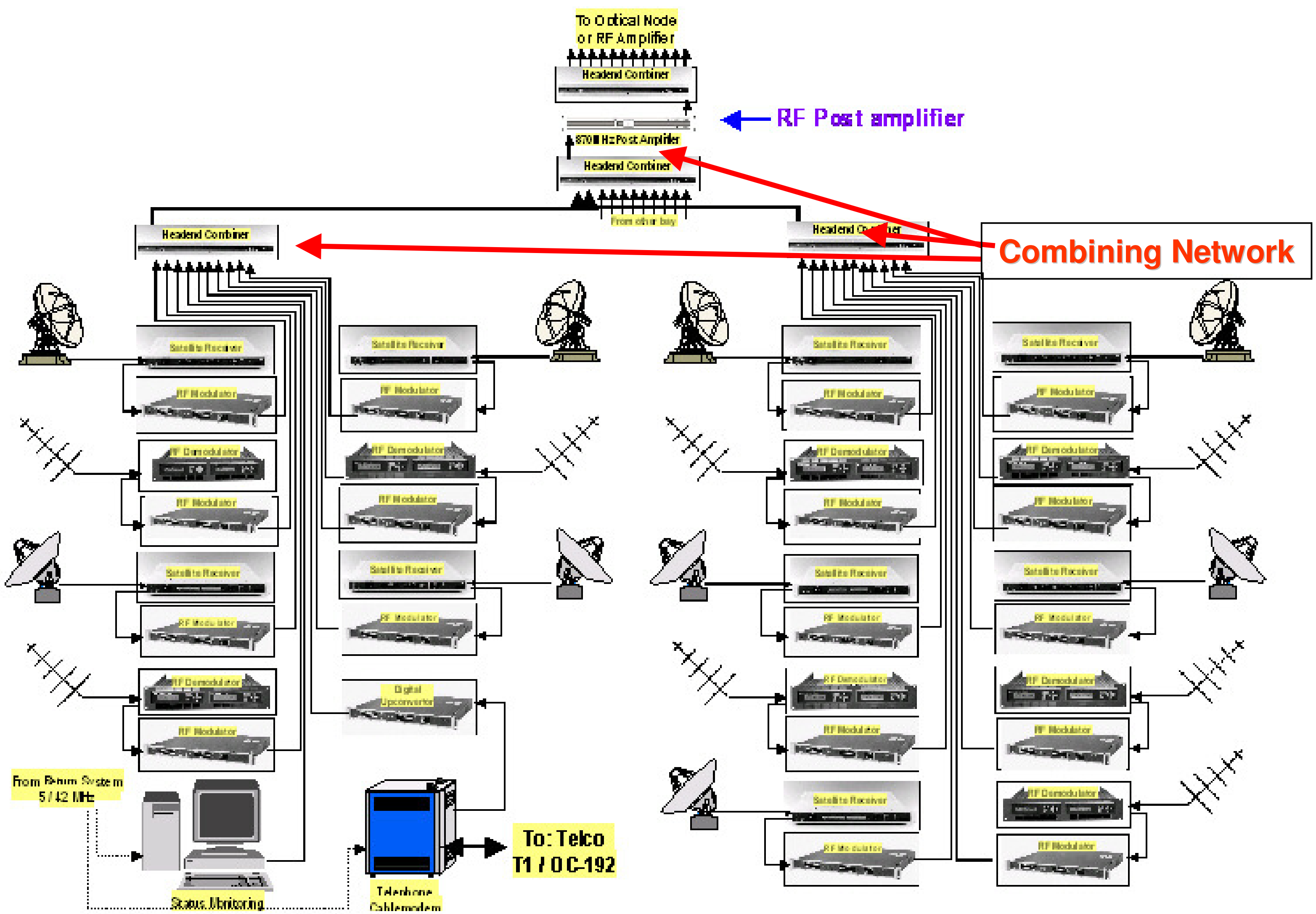
The forward direction of the system usually operates from: 50 to 750 or 870 MHz and the return path is usually from: 5 to 40 MHz.

The forward system consist of two transports medias, the first one been fiber optic, followed by coaxial cable. The fiber section of the system needs to be adjusted first. Fiber optic can operate at either 1310 or 1550 nm.

The second section, bi-directional coaxial cable, the forward section operate from 50 to 750 or 870 MHz, while the return section operate from 5 to 40 MHz.

For the reverse part, the fiber optic section need to be adjusted First, followed by the coaxial section, except this adjustment has to be done in the reverse flow, from the optical node to the Headend and from the next RF amplifier toward the node and soon, then from each customer to the next return amplifier.

Broadband Headend Combining.



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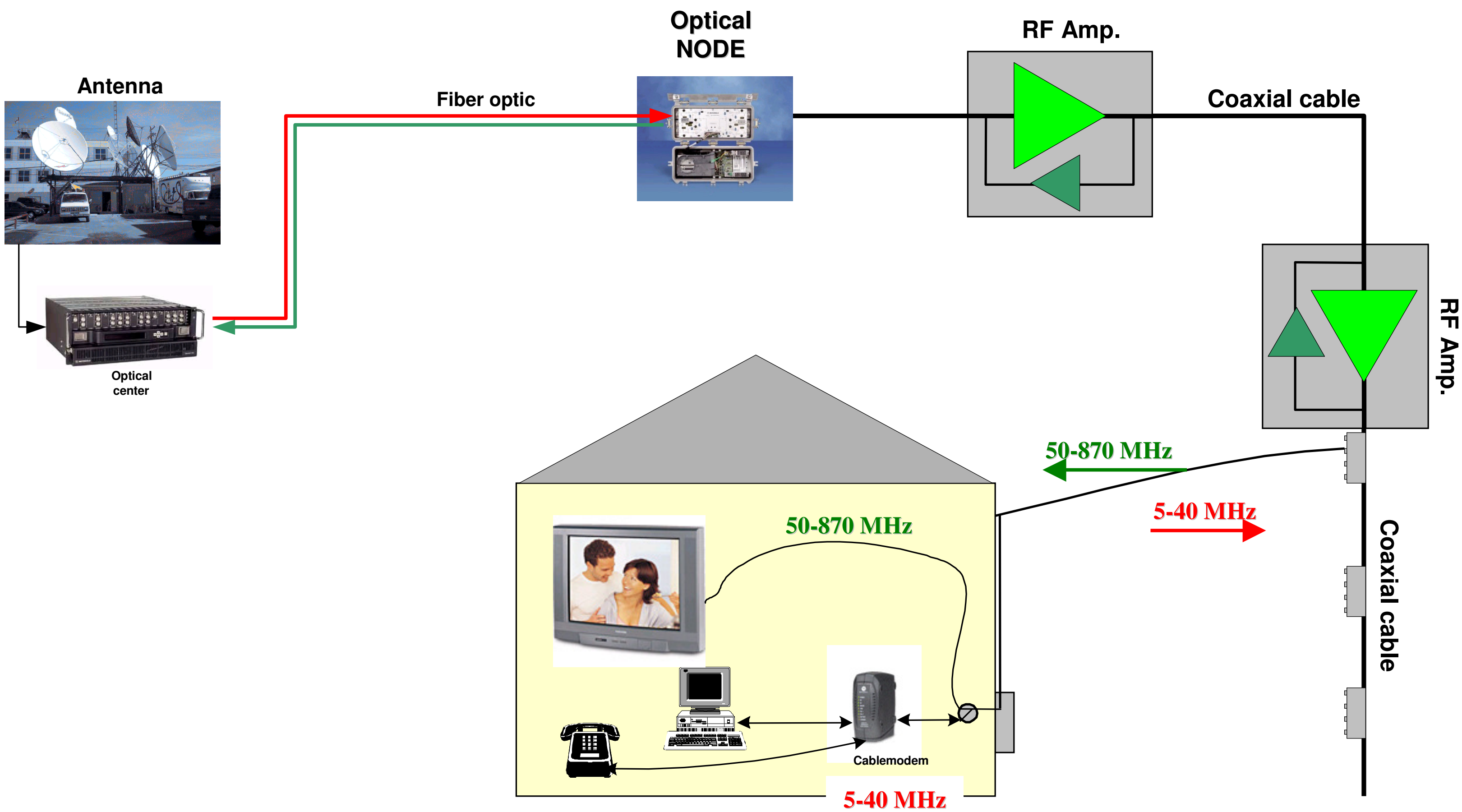
Broadband Bi-directional HFC System.



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Equipments Needed to Adjust the System.

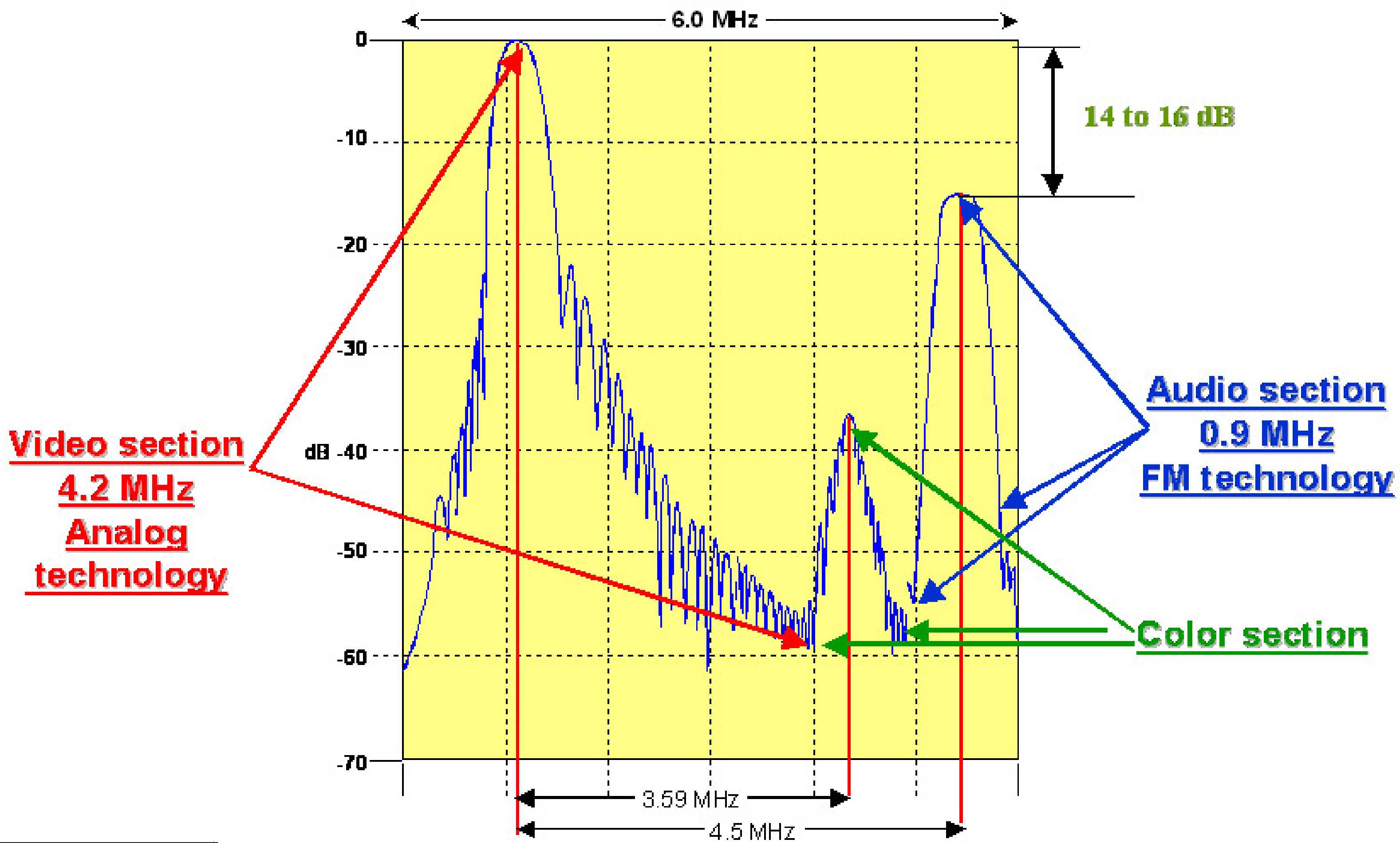
Field Strength Meter

Optical Power Meter

Spectrum Analyzer

Sweep System

Description of a NTSC Television Signal.



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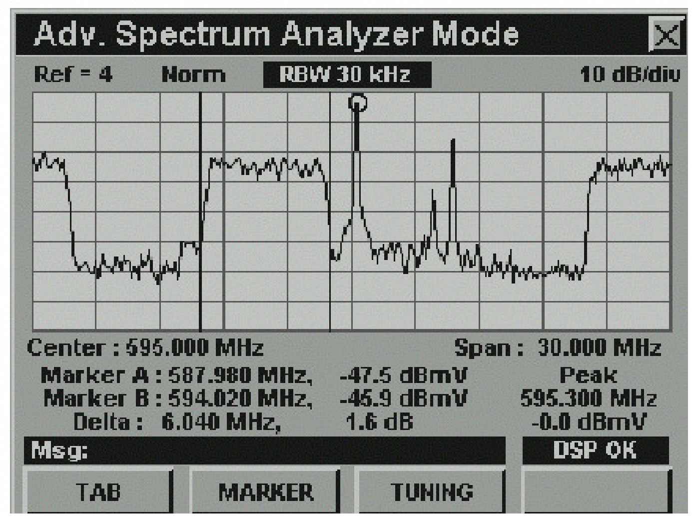
Description of a QAM Television Signal.

A QAM signal (Quadrature Amplitude Modulation) can be 8, 16, 54 or 256 QAM. Every QAM signal is 6 MHz wide and can carry up to 16 Analog channels in a digital QAM Constellation form. You can only read the exact amplitude of a QAM signal, with a Power Meter calibrated to this signal. A QAM channel can be next to a NTSC signal or following each other as in this case.



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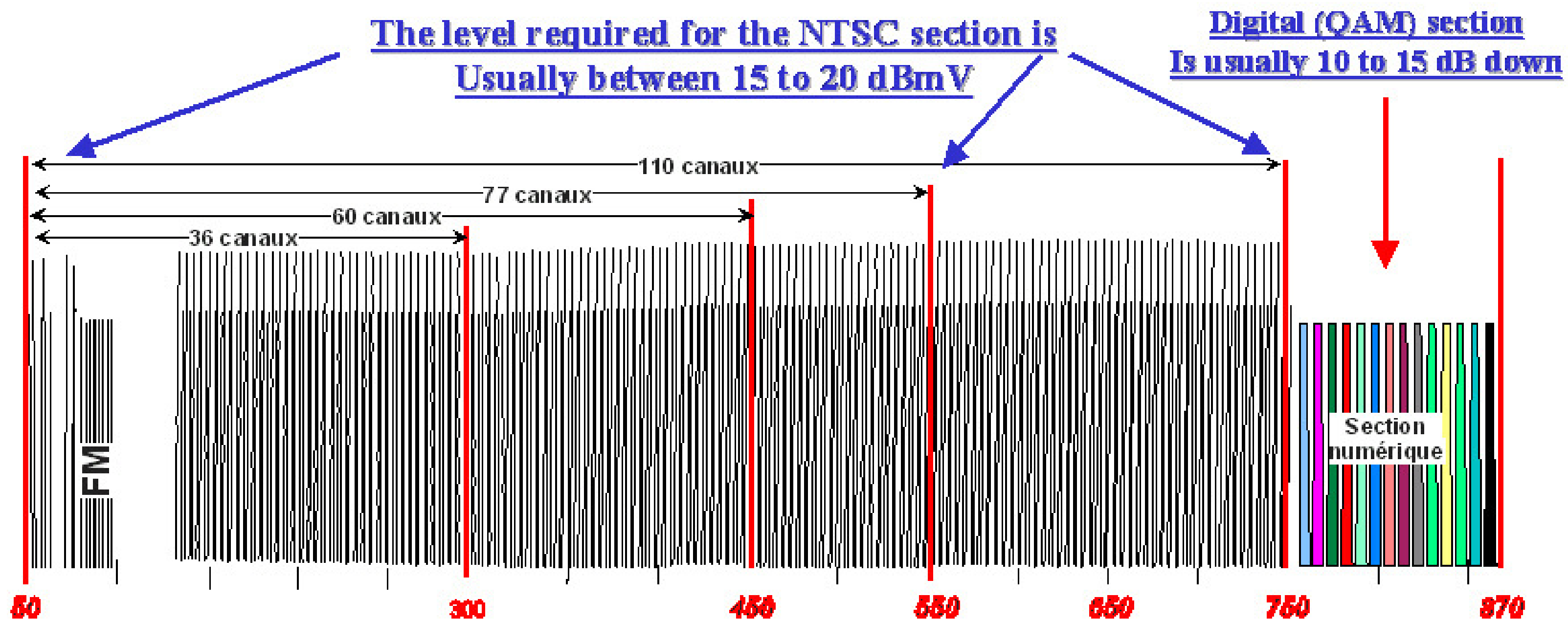
Final Adjustment of the Headend.

For the final adjustment at a Headend, you need to adjust each of the channel (NTSC, QAM and Other) at their proper level. This adjustment should provide a flat output at the final combining network. This adjustment requires a; FSM, or a Spectrum Analyzer.



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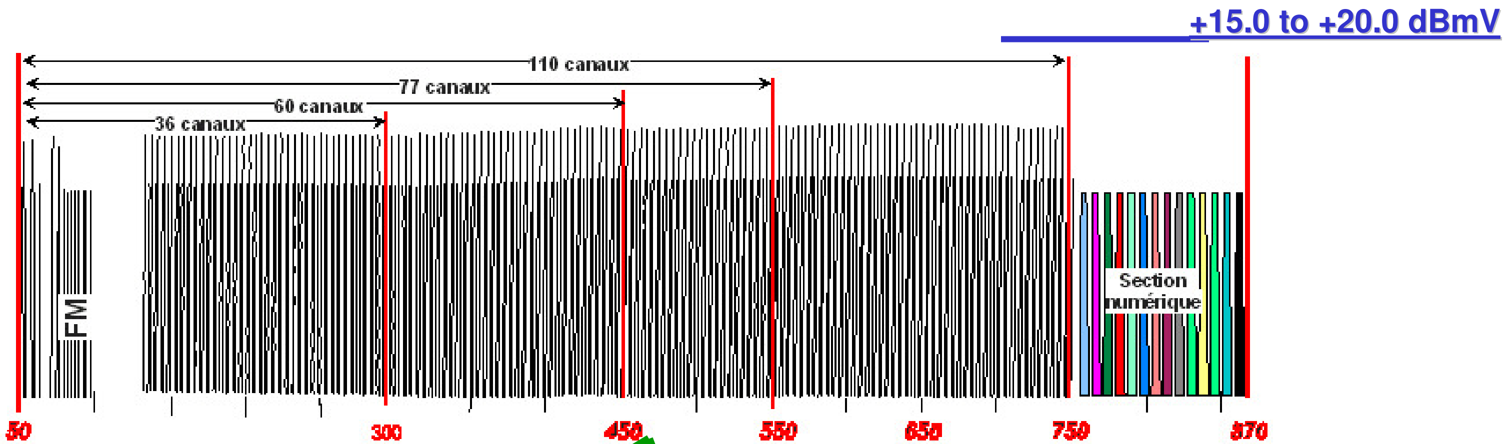
Final Adjustment of the Headend.

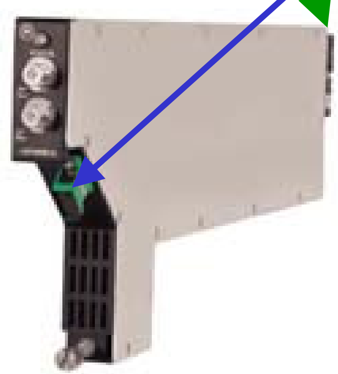
Required RF flat input for:
1310 nm optical transmitter is usually +15.0 dBmV
1550 nm optical transmitter is usually +20.0 dBmV

Output of an optical transmitter:
1310 nm TX output is from 4.0 to 14.0 dBm
1550 nm TX output is from 5.0 to 7.0 dBm
EDFA output is 13.0 or 16.0 dBm

Final Adjustment of the Headend.



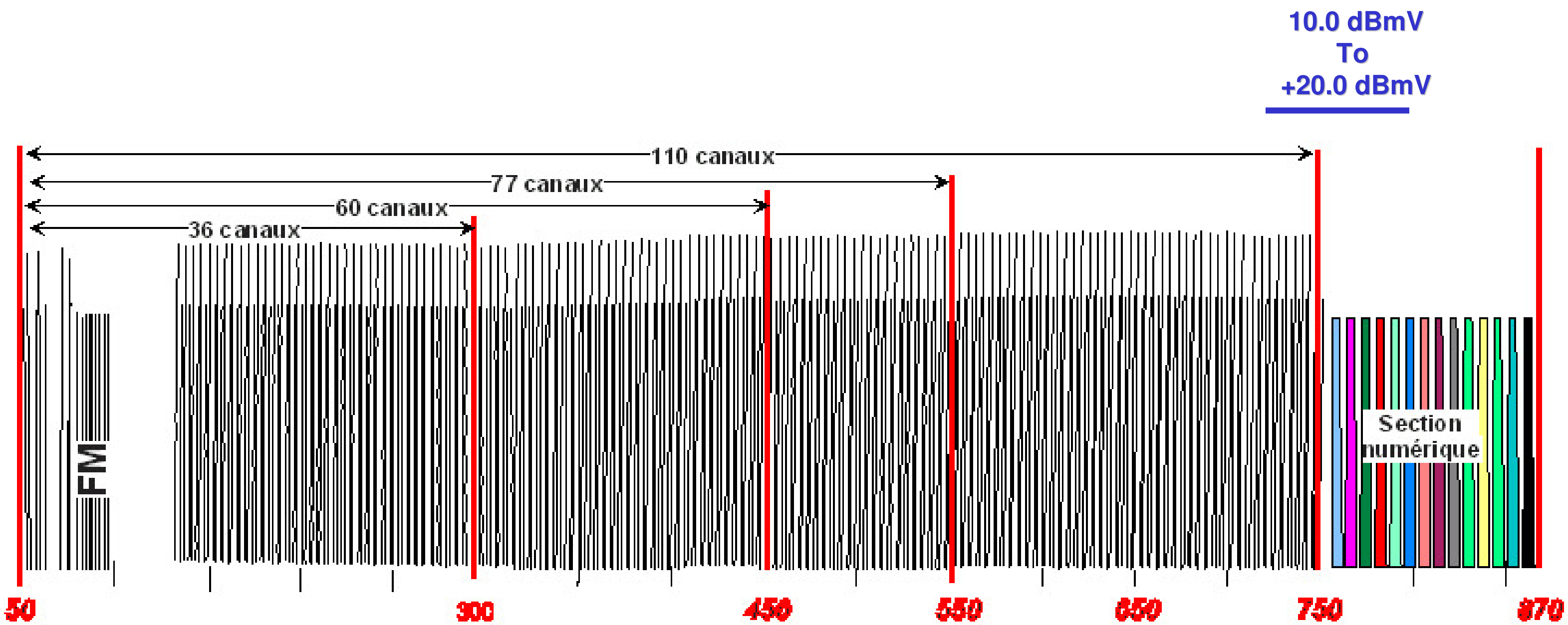
Signal required at the input of an optical transmitter. This signal can be verified by a FSM, or a Spectrum Analyzer.



At 1310 nm an optical signal can be from +4.0 to +14.0 dBm. The output level can checked by a Power meter or status monitoring.

Final Adjustment of the Headend.

All of RF amplifiers and all the Optical transmitter located at the headend require a flat input.



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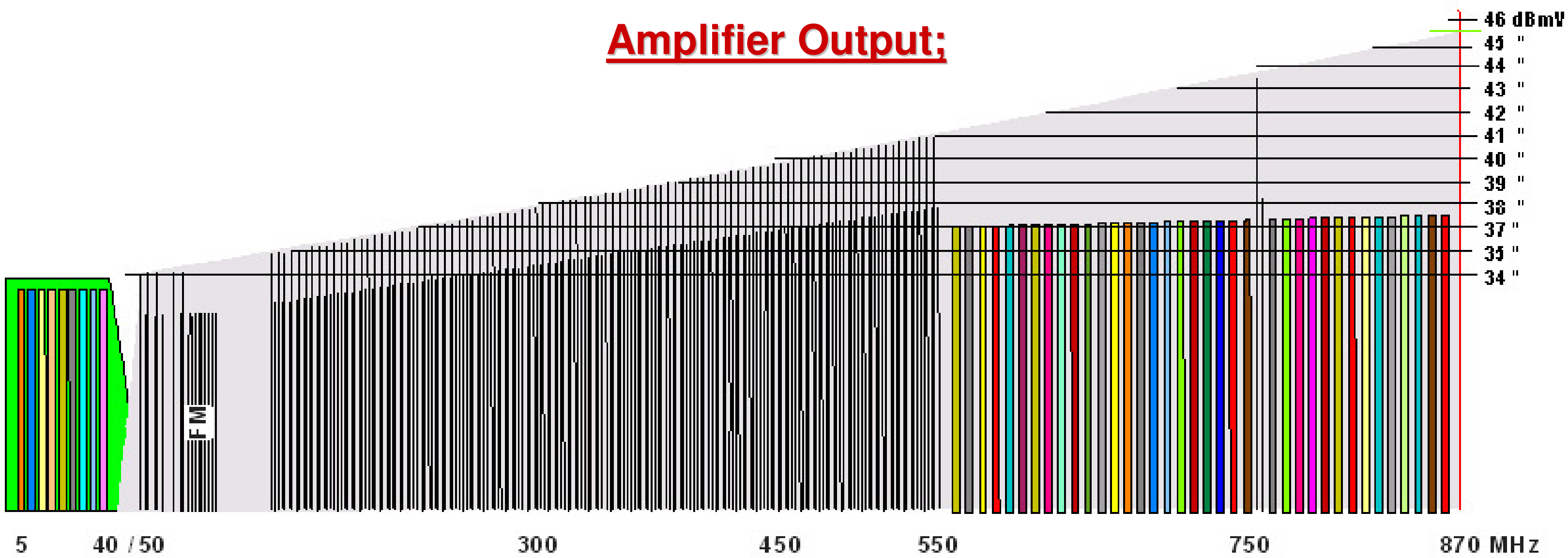
Final Adjustment of the Headend.

All RF amplifiers in the system require a sloped output. This slope is usually 10.0 dB for 750 MHz system and 12.5 dB for 870 MHz system.

Amplifier Output;



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Final Adjustment of the Headend.

There are usually two things to verify at the input of each RF amplifier and each optical transmitter;

1. Verify for the right input level, this is better done by a Spectrum analyzer, even if this can be accomplish using F.S.M. (Field Strength Meter)
2. Verify the input flatness of the broadband system (50 to 750 / 870 MHz), this can be done with a Spectrum Analyzer, a Sweep system or a FSM.

RF amplifier output;

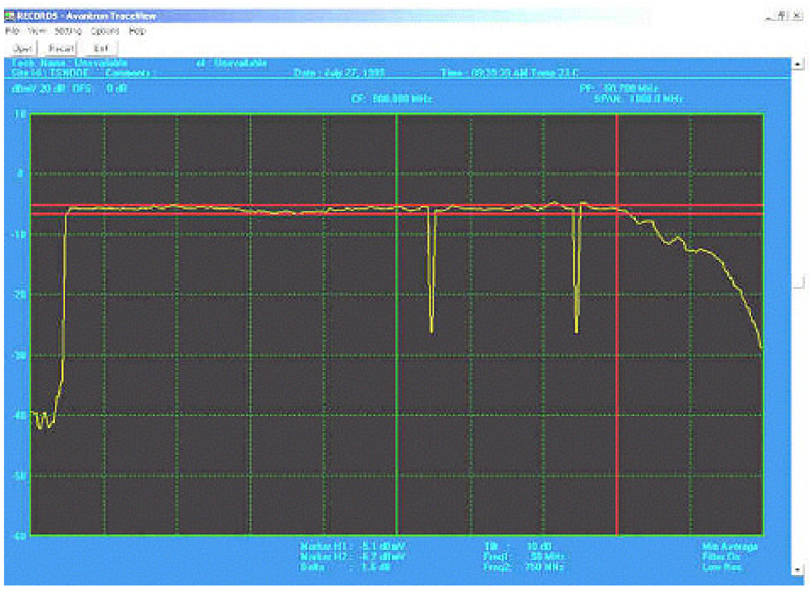
1. Verify the operating level, this is usually done at four sections of the spectrum, Low end (55 to 70 MHz), Mid Band (121 to 160 MHz, High Band (270 to 330 MHz) Super High Band (450 to 555 MHz) and finally at the last RF signal 550, 750 or 870 MHz .
2. Verify the flatness of the spectrum of all amplifiers, this can be done with a Spectrum Analyzer a Sweep System or a FSM.

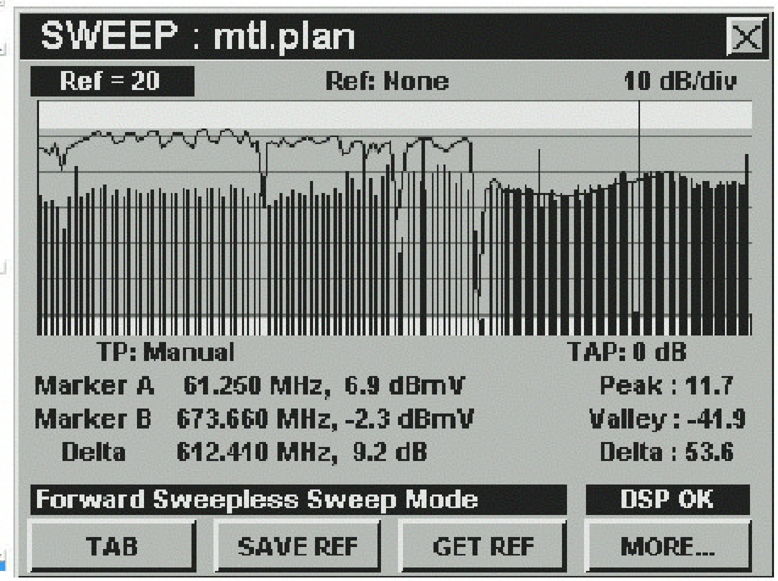
Optical Transmitter output;

1. Verify the light level, this is done with a Power Meter, you require a Power Meter capable of reading between + 4.0 to + 14 dBm or a DC Volt Meter.

Final Adjustment of the Headend.

Response of a well aligned head, using a sweep system.



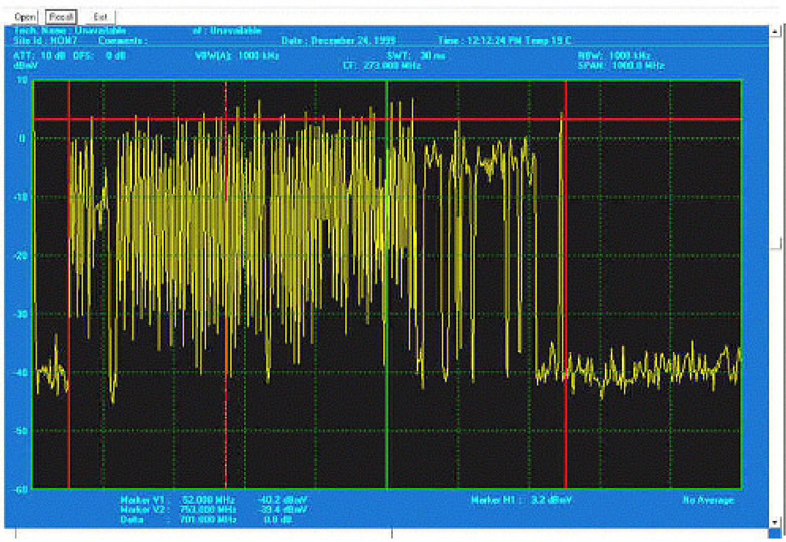


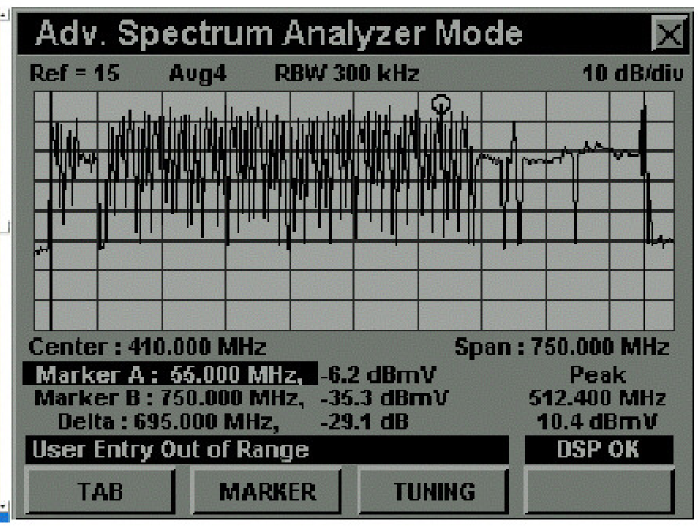
Using a sweep generator, located at the headend.

Using the actual signal of the HFC system.

Final Adjustment of the Headend.

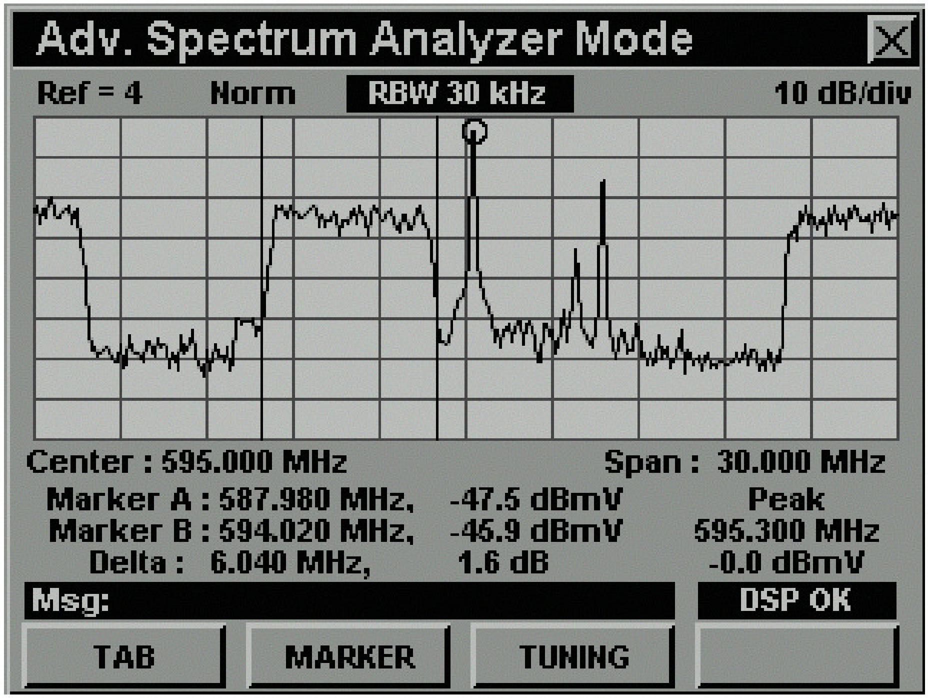
Response of a well aligned head, using a spectrum analyzer.





Final Adjustment of the Headend.

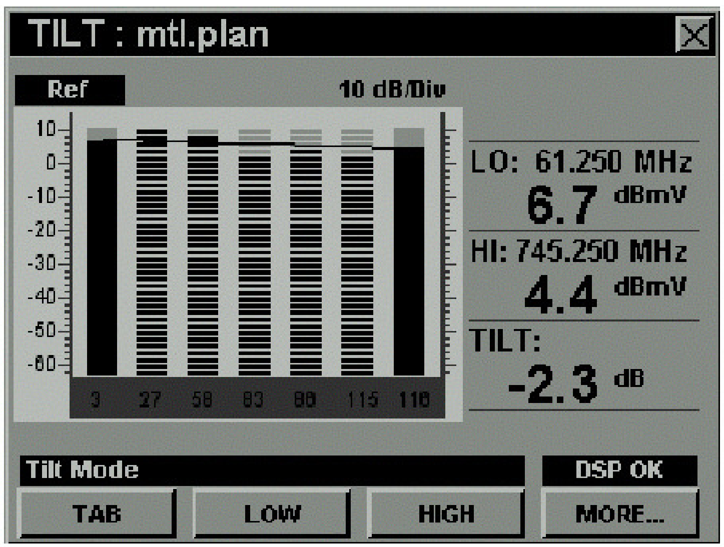
View of an other type of Spectrum Analyzer.

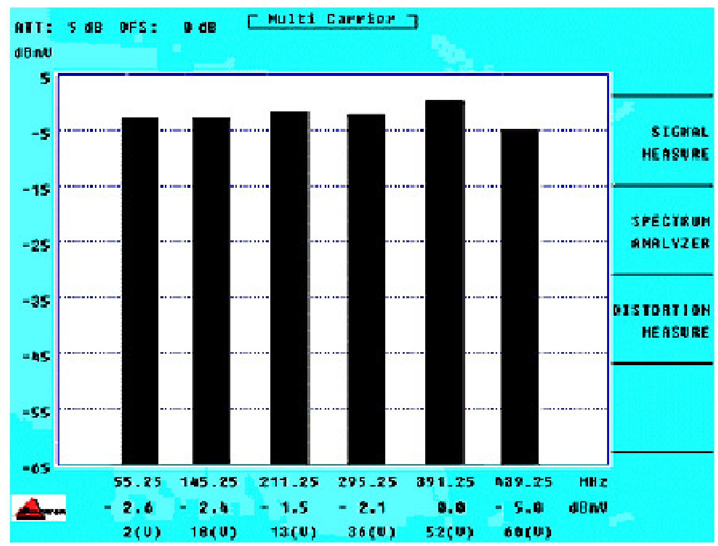


Where QAM and analog signal lives together

Final Adjustment of the Headend.

Some test equipment are able to give you a general view of the system by the selection of some of the channels in the operating spectrum.





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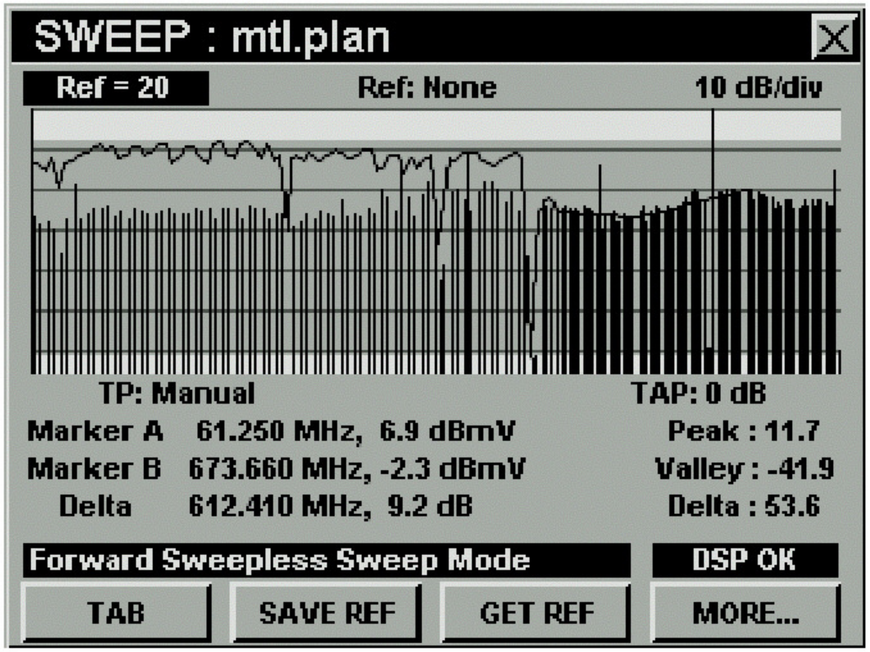
Final Adjustment of the Headend.

Another type of Sweep System. This technology is called Sweepless Sweep, where it take an average of all the signal carried by the system.



Final Adjustment of the Headend.

•You need to verify the output level of each 1310 and 1550 nm optical transmitter.

•With a system operating at 1550 nm, you'll also need to verify the output level of all EDFA

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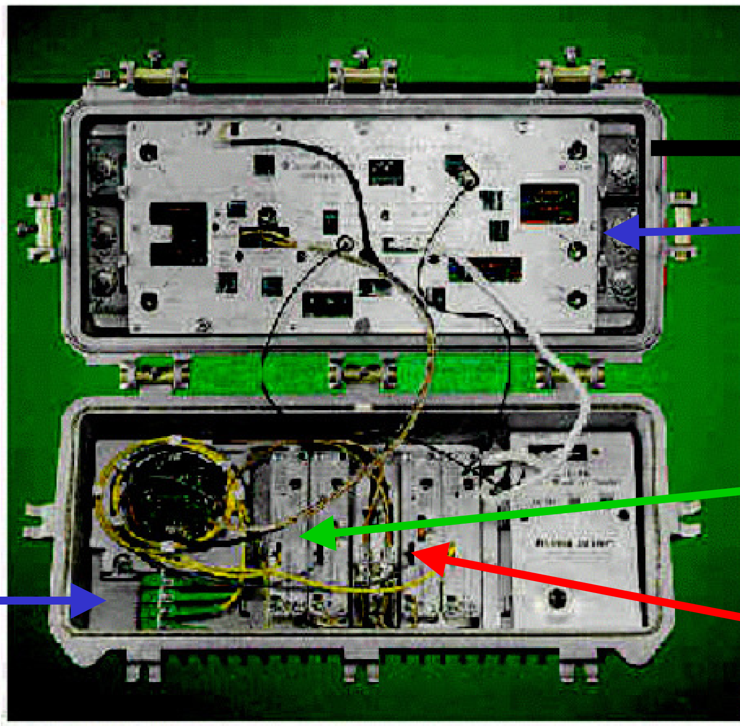
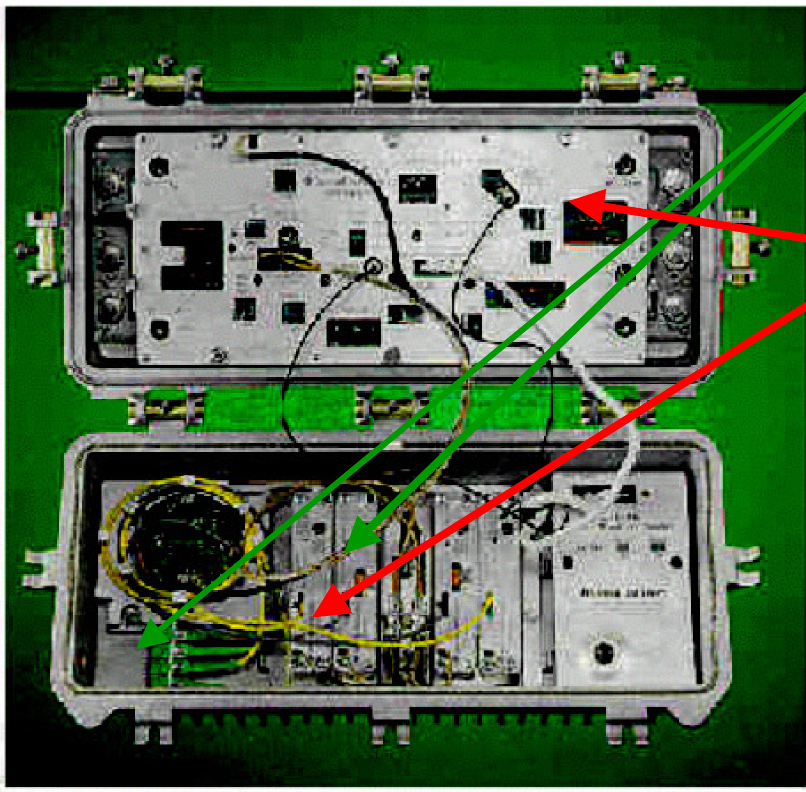
Final Adjustment in the Field.

Adjusting an Optical Node in the field.



Final Adjustment in the Field.



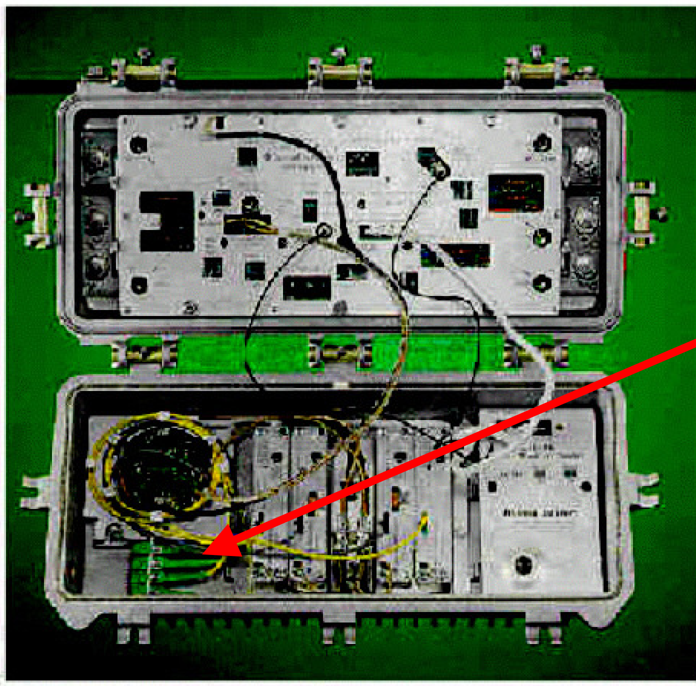
1. In general a 0.0 dBm level is required for a good optical input. This can be verified by a Power Meter or by a DC Volt Meter.

2. The flatness of the system should also be verified at these locations.

Power Meter

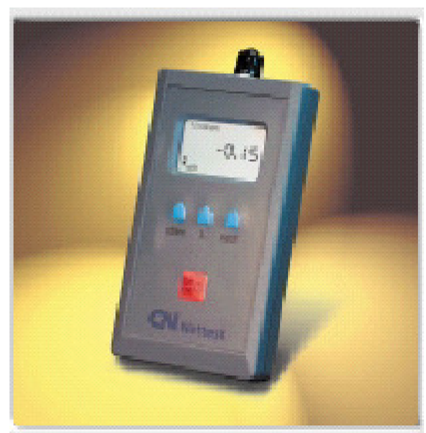
DC Volt Meter

Final Adjustment in the Field.



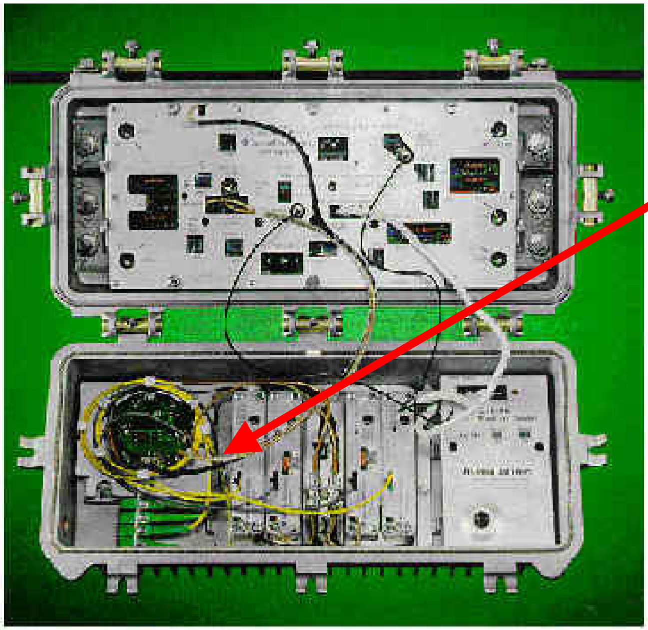
With a power meter, you need to disconnect the fiber optic at the input of the optical receiver to read the level of the light. You also need to know the operation frequency, 1310 or 1550 nm.

Normal input level for a 750 MHz system, is between –1.0 to + 2.0 dBm



Power Meter

Final Adjustment in the Field.



Most modern optical receiver have a DC test point, where you can read the actual light level.

That light level will be different, depending on the equipment you system is using.

This function will work for either the forward receiver or the return transmitter level.

DC Volt Meter

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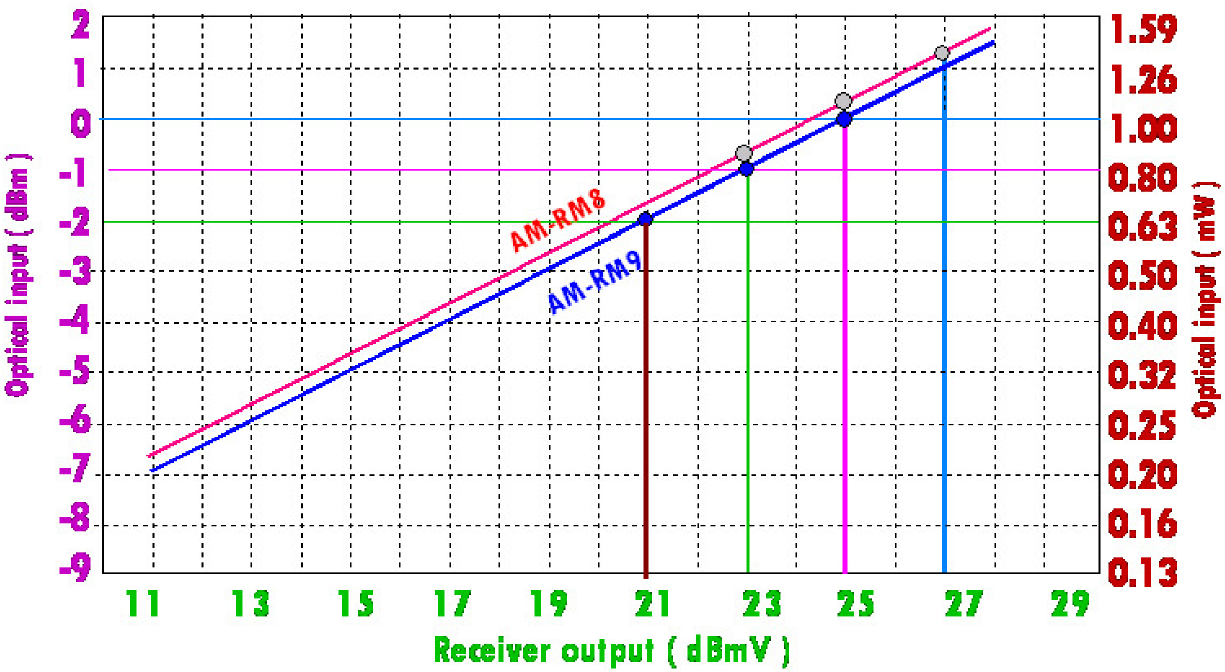
Final Adjustment in the Field.

Below are the RF level given by the optical receiver, with the dBm or mW level.



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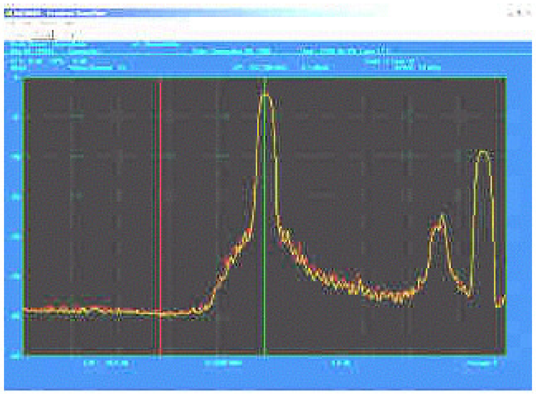
Final Adjustment in the Field.

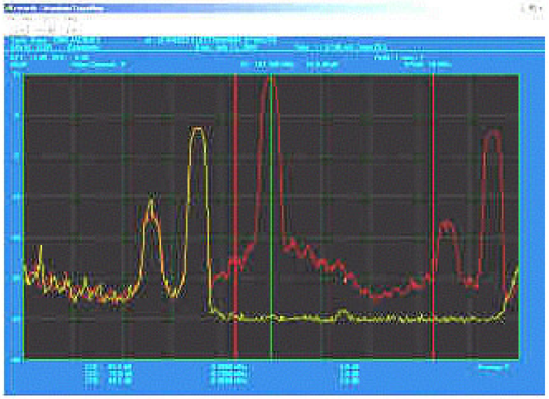
Each NODE requires an acceptance test, which are the following;

1. System flatness
2. Carrier to Noise
3. CTB and CSO



System C/ N measurement

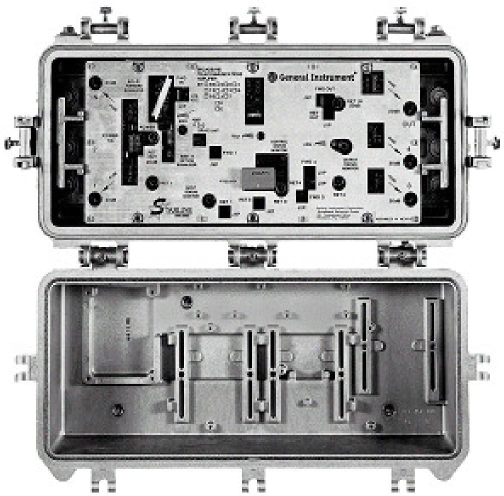
System response (flatness)



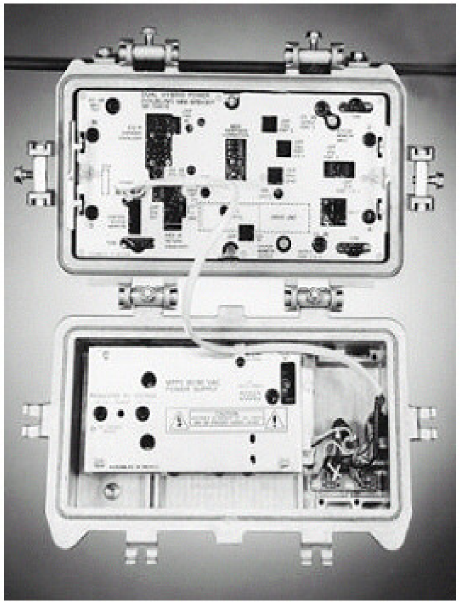
CTB / CSO measurement

RF Amplifiers.

Type of RF amplifiers used in today HFC system



High gain with 4 outputs amplifier

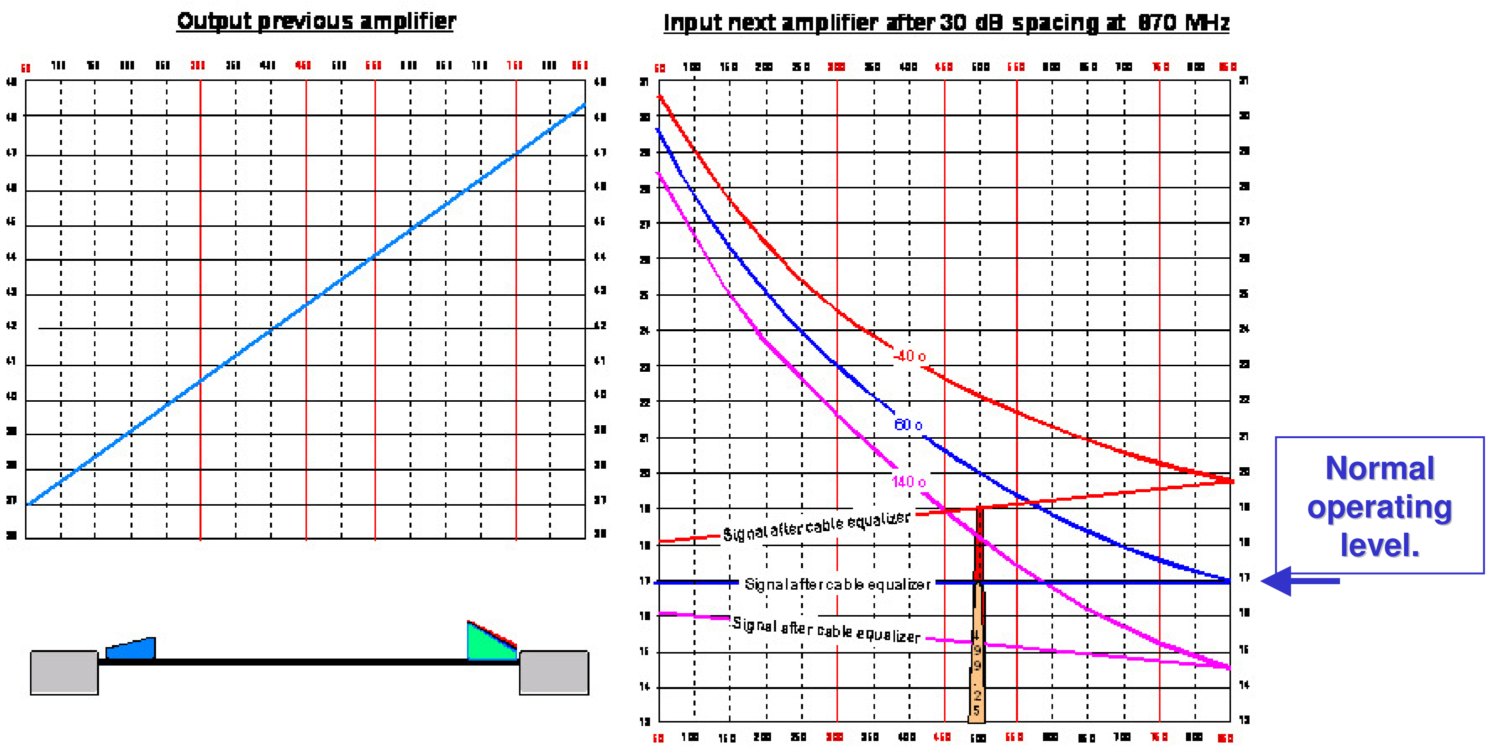


Mini-Bridger with 2 outputs amplifier

Line Extender amplifier

Coaxial Cable Behaviour with Temperature Changes.

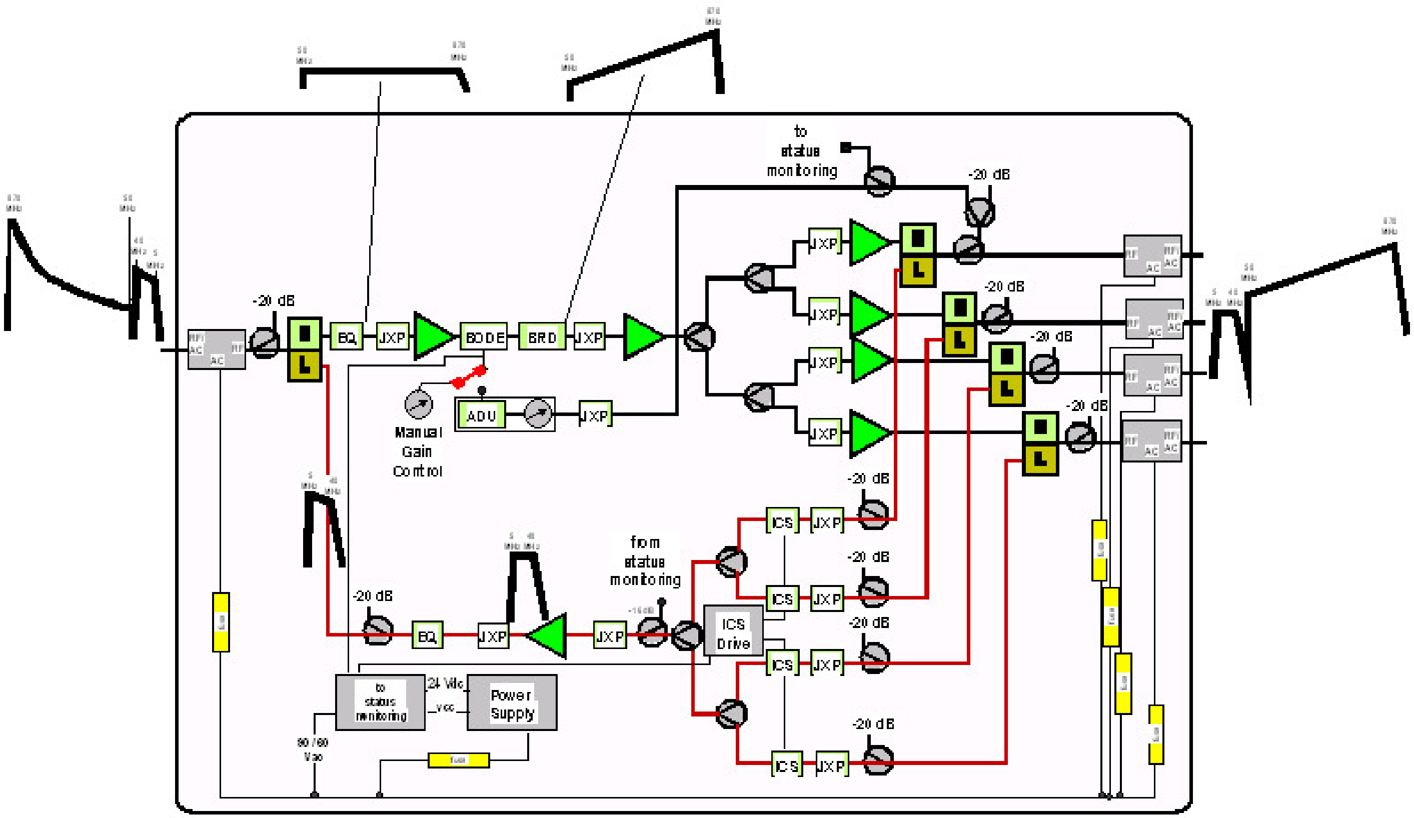
Reaction of the coaxial cable on a <u>870 MHz system</u>, due to temperature change.



As seen by the picture above, it is very important to have good automatic gain control system on your amplifiers. This system could be a AGC/ASC, BODE or TLC control system. It is also very important to have this system properly adjusted to assure good performance.

RF Amplifiers.

4 output amplifier



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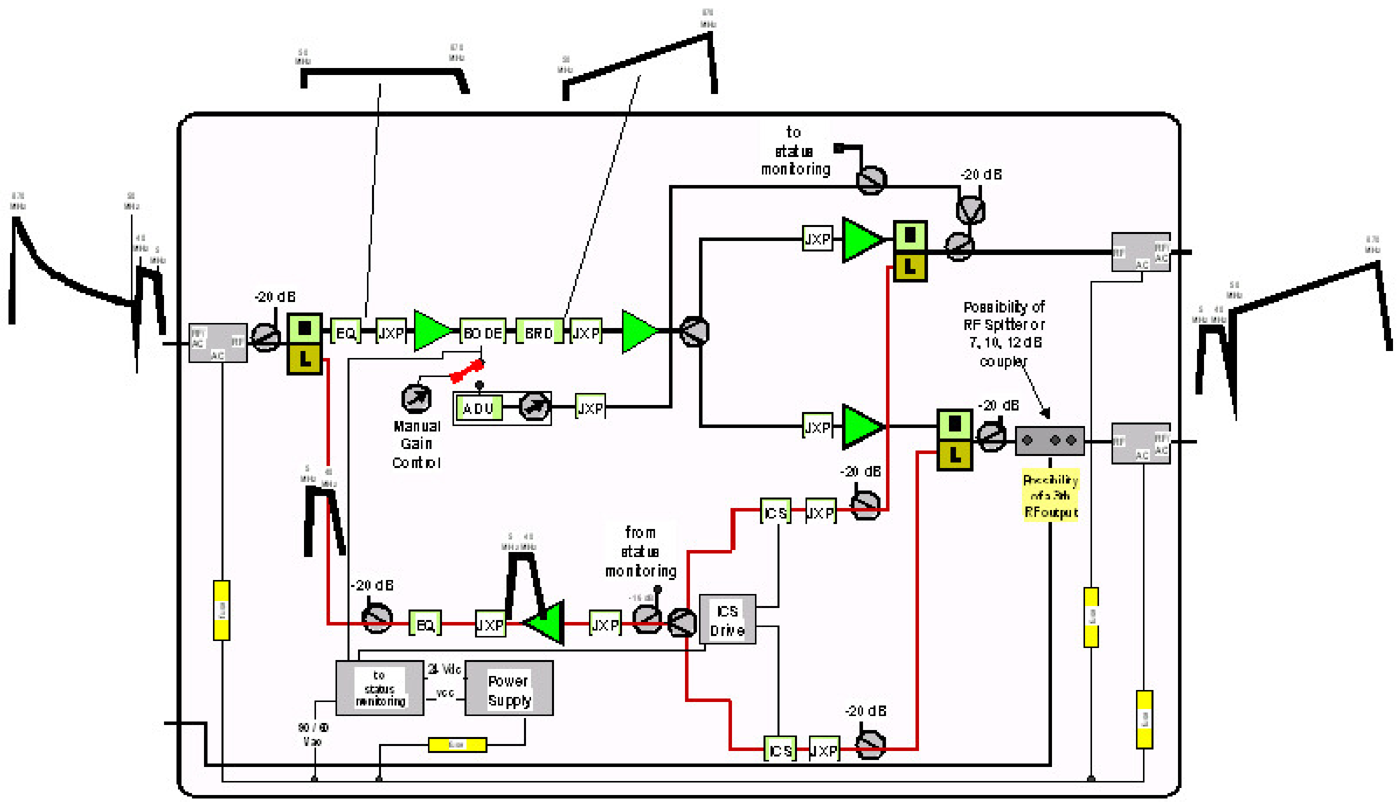
RF Amplifiers.

2 / 3 output amplifier



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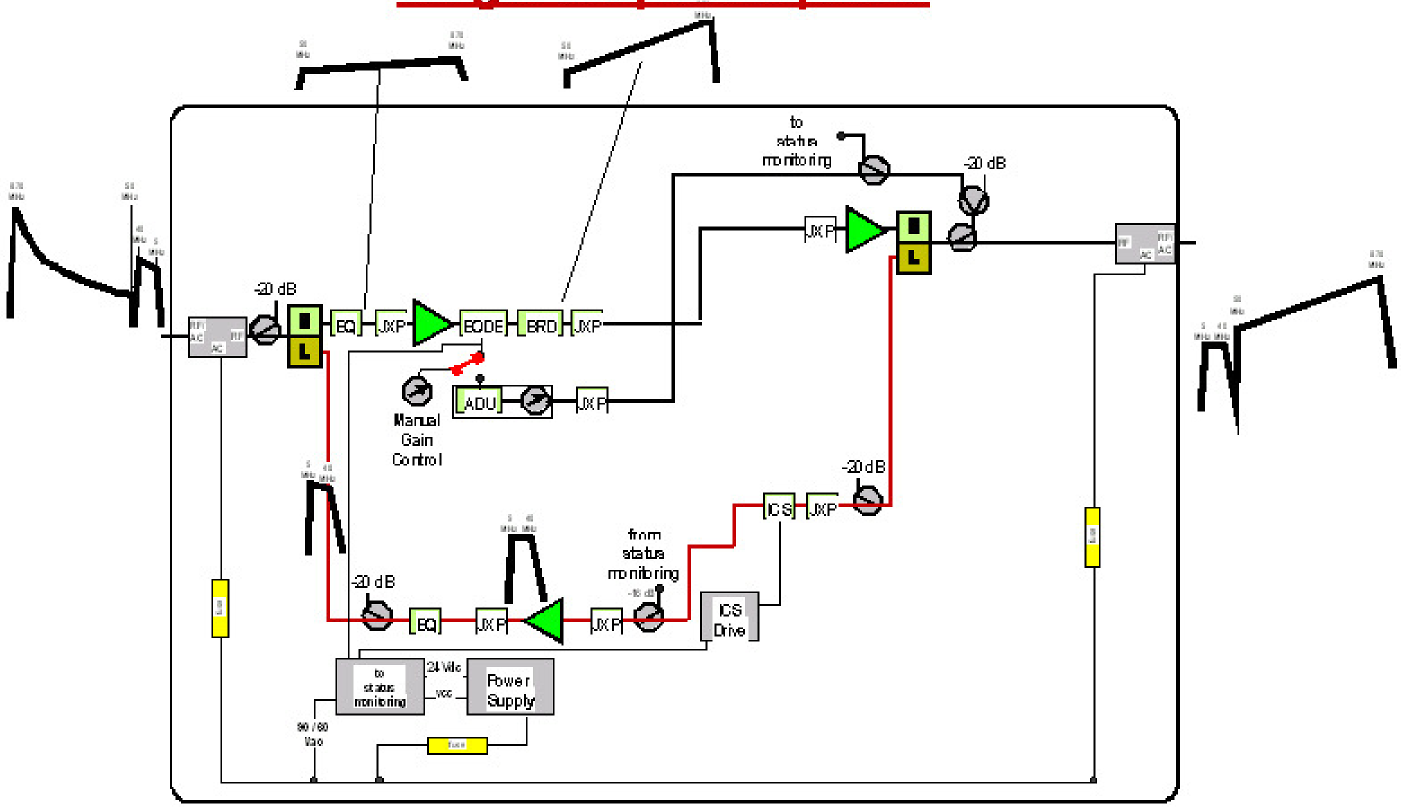
RF Amplifiers.

Single output amplifier



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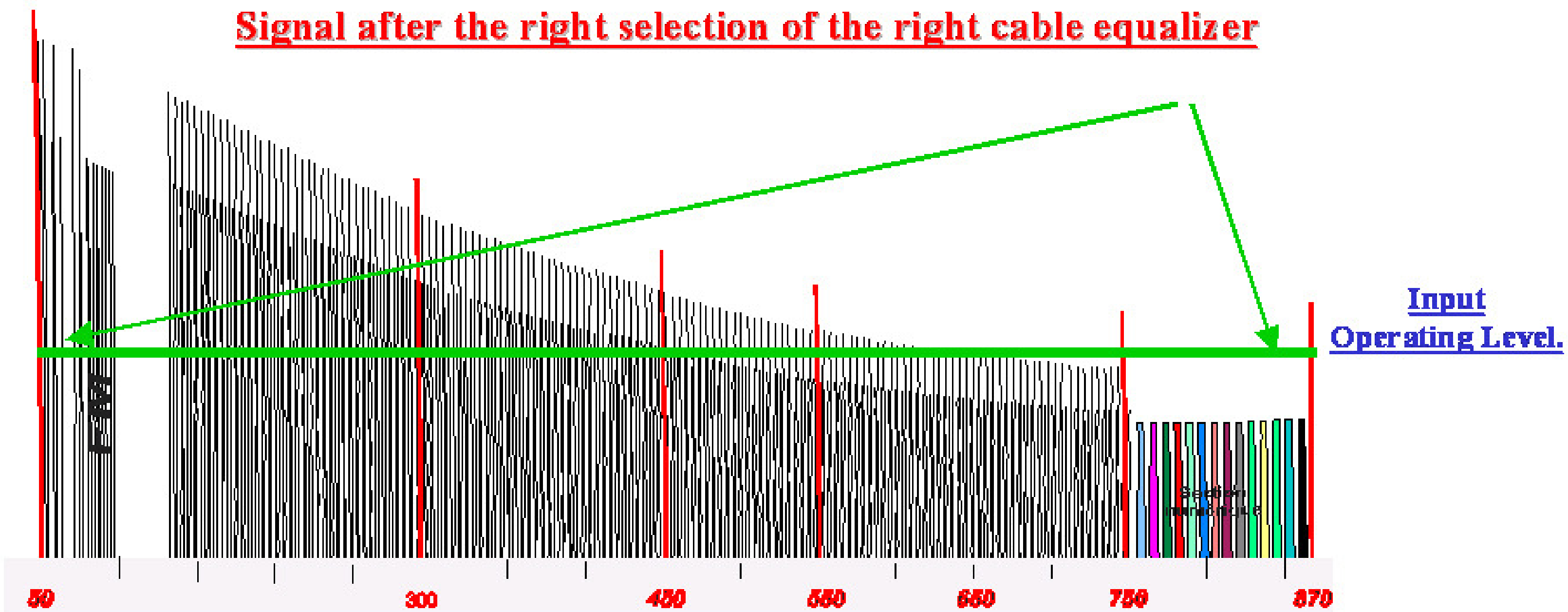
RF Amplifiers.

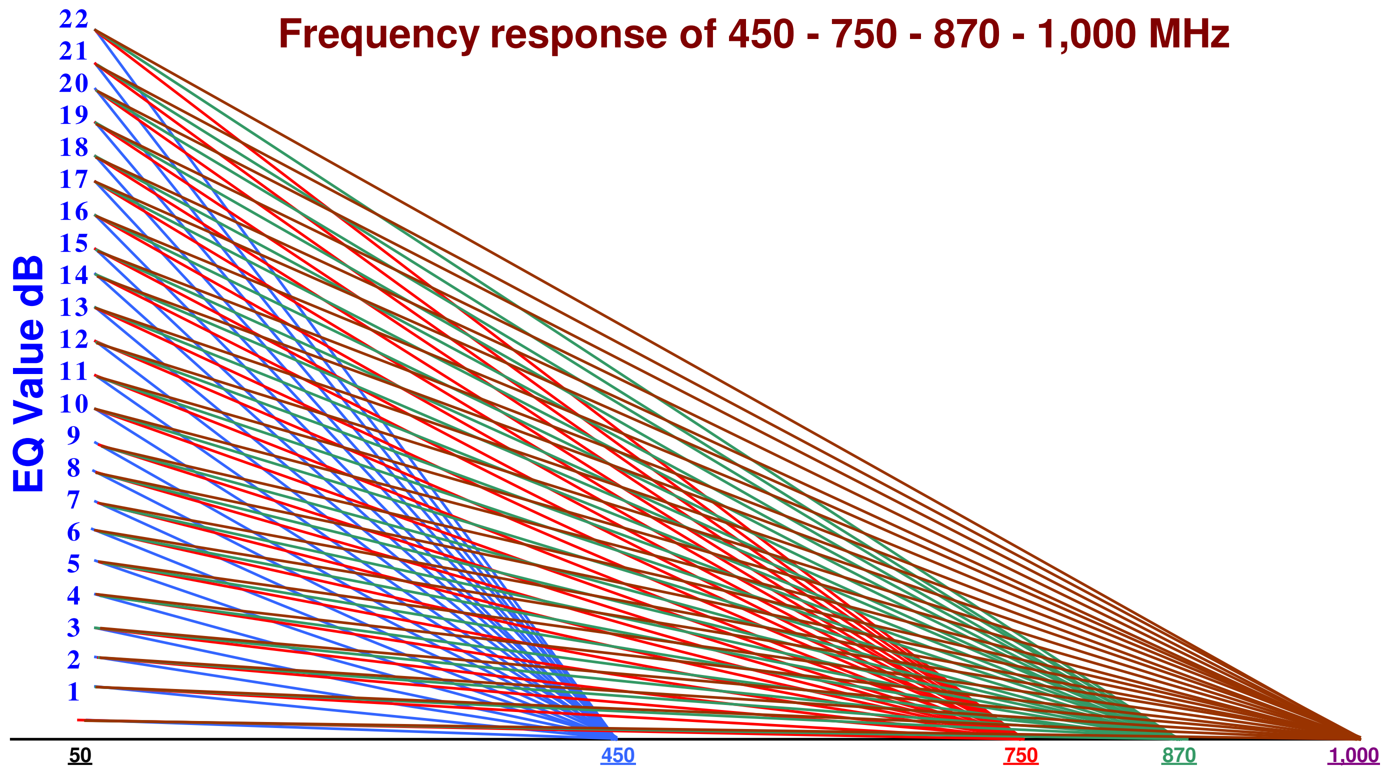
The first thing to do at the input of an RF amplifier, is to verify the proper operating input level, a fixed input attenuator can be install when the operating level is to high, followed by the selection of the right cable equalizer, that way the amplifier will get the right signal level and flatness at the first amplification circuit.



RF Amplifiers.

Selection of the proper Equalizer:

Not only it is important to select the right value equalizer at the input of each amplifier, but it is also very important to select the right operating bandwidth of the system. Selecting a 550 MHz equalizer in a 750 MHz system could cause very bad response between 550 and 750 MHz.



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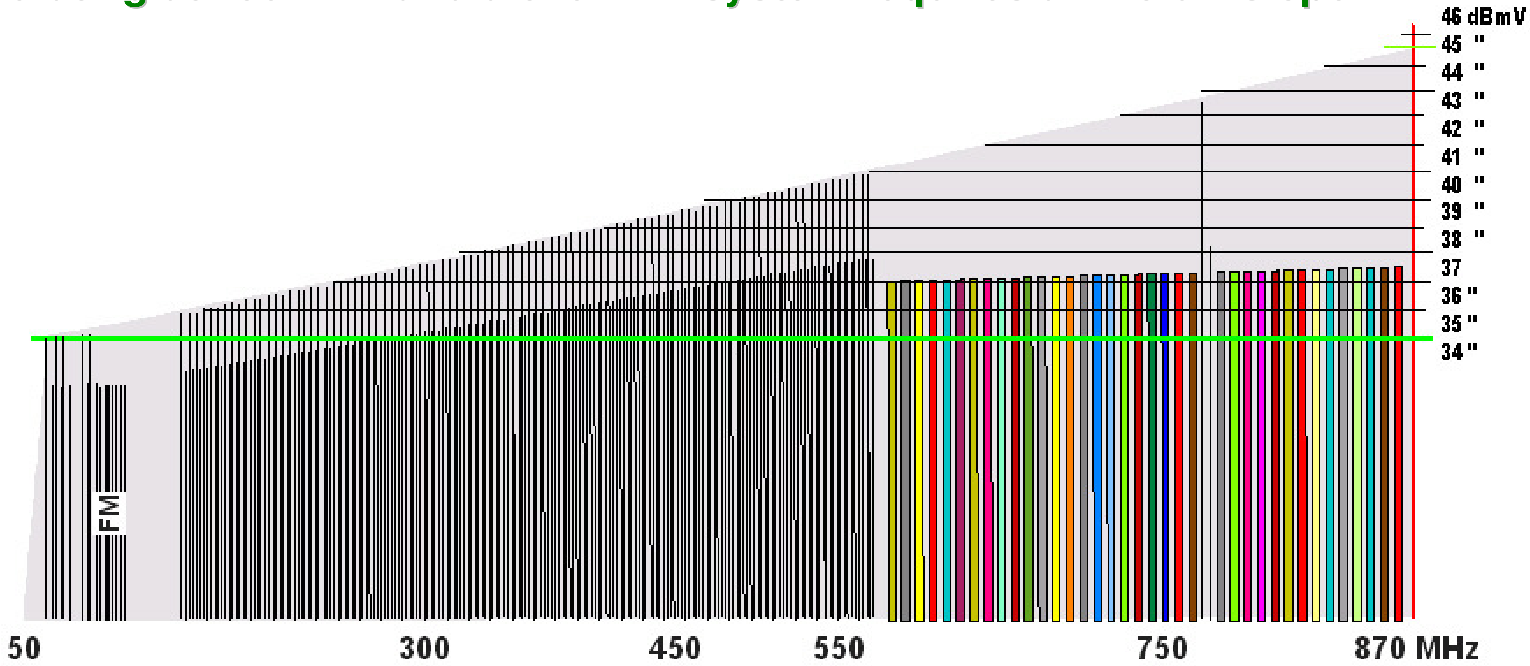
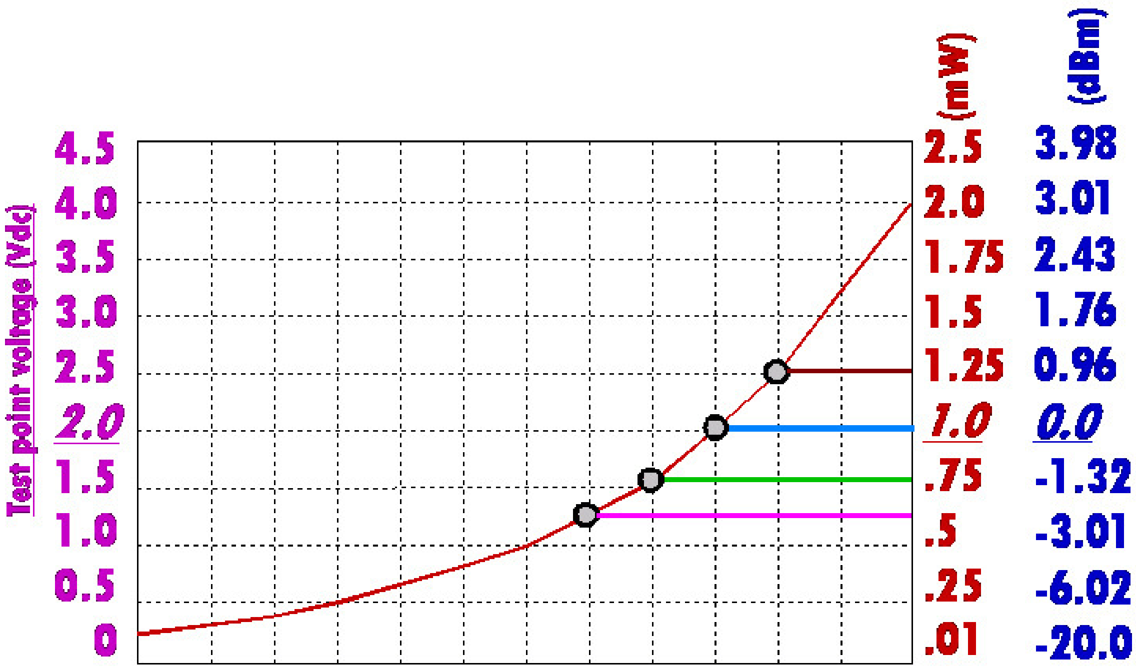
RF Amplifiers.

After verification of the right amplifier input level, you need to adjust the amplifier to his right operation level. This is done by adjusting the GAIN and the TILT control of the amplifier. Some amplifier only have a gain control, while the slope is controlled by a BODE control. In all amplifiers you also need to verify the operating SLOPE. That slope is usually 10.0 dB for a system operating at 750 MHz and a 870 MHz system requires a 12.5 dB slope.



Final Adjustment in the Field.

Below are the DC level reading at the test point of the optical receiver. A 2.0 VDC equal 1.0 mW or 0.0 dBm optical input.



Optical input power(dBm / mW) vs. test point voltage (Vdc)

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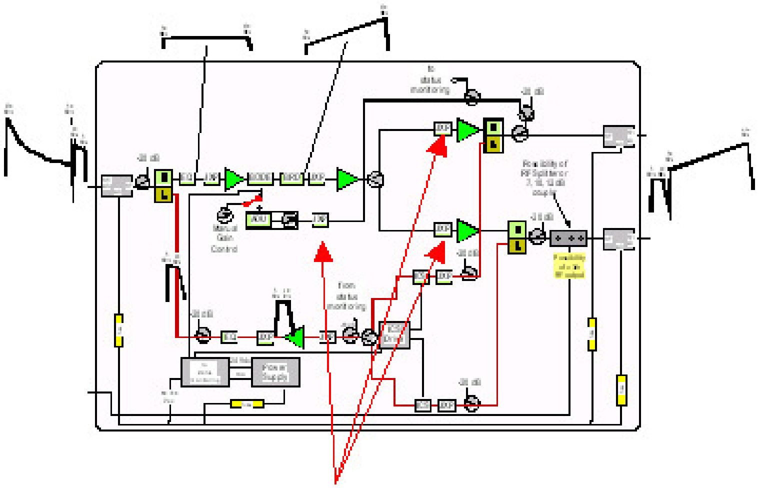
RF Amplifiers.

Because of the high gain of these two amplifier, it is often necessary to add the right value JXP attenuator at the mid stage and the final stage of amplification to these amplifiers.

•These amplifiers have 39 dB of gain at 750 MHz and let say you only want to utilise 29 dB of these 39 dB. The first thing to do is add 4 dB to the 29 dB gain for a total of 33 dB of gain.

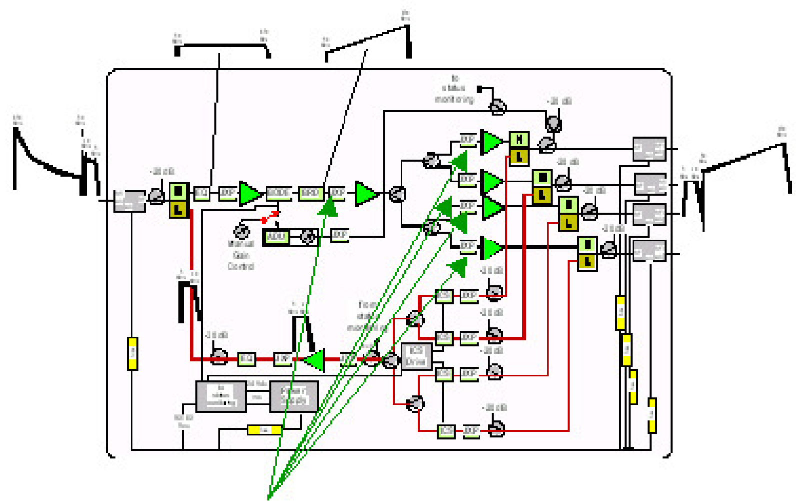
•You then now need to subtract 39 to 33, which will give you a 6 dB difference. That 6 dB should be divided in two, for a result of 3 dB, where a 3 dB JXP pad will be introduce in the mid stage and another 3 dB will have to be introduce before each output IC.

2 / 3 output amplifier



3 dB JXP

4 output amplifier



3 dB JXP

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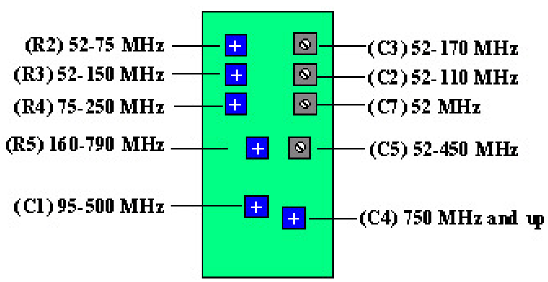
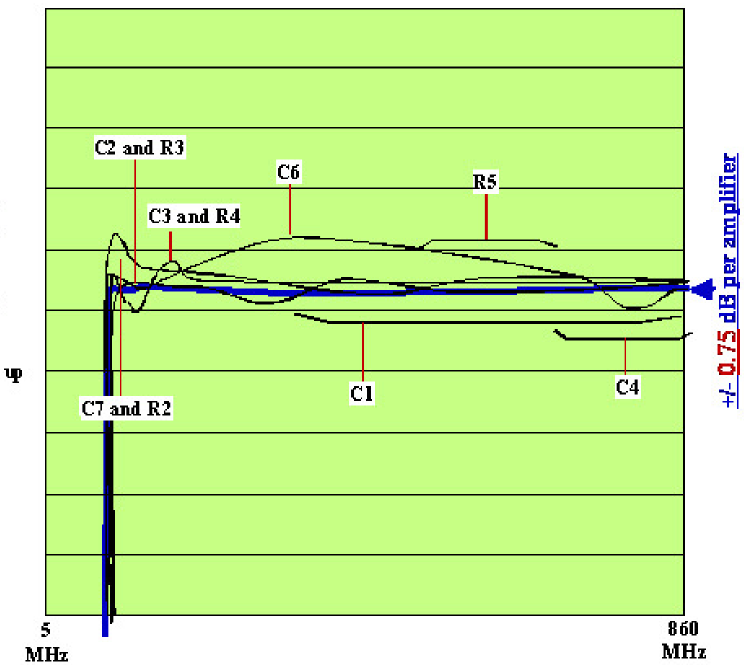
RF Amplifiers.

•After adjusting the amplifier to his right operating level, it is a good thing to verify the overall response of this amplifier. This is done by adjusting some variable controls, usually installed in the mid stage of amplification. This operating should only be done using a sweep system not a F.S.M.

•Once in the spring and once in the fall, is also a good time to verify the operating condition of all the NODE and the amplifiers in the system.





RF Amplifiers.

Why do we need to verify the response of each RF amplifier?

•The reason we need to verify each amplifier, is to make sure each section of the spectrum meets the necessary specifications, like C/N, CSO, CTB.

•To meet these technical specifications a broadband system need to meet a PEAK and VALLEY response.

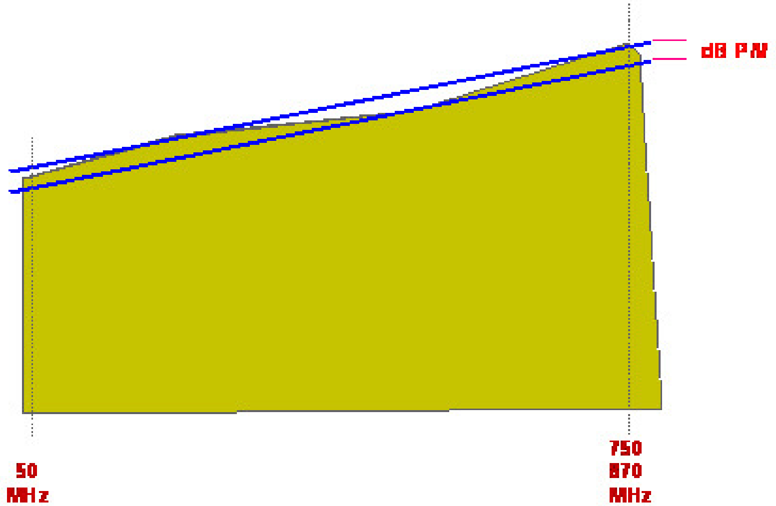
•**Formula for PEAK and VALLEY requirements:**

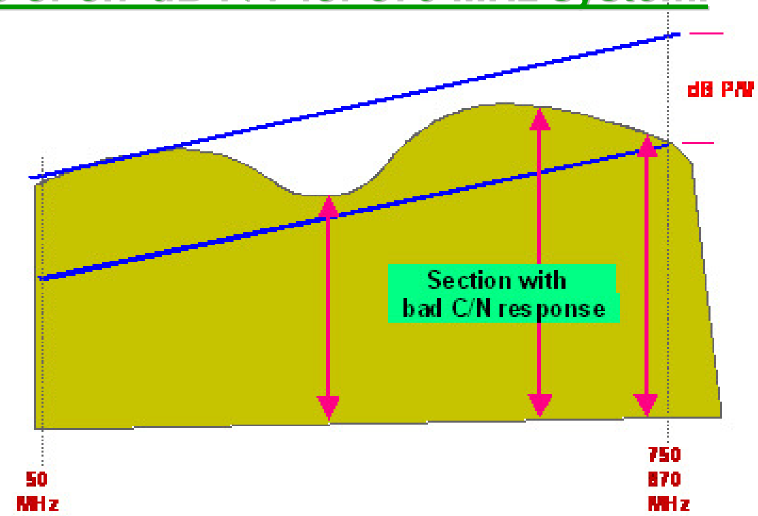
•N/10 + 1 for 450 MHz system

•N/5 + 2.5 for 870 MHz system

•Where N = the number of amplifiers in the Cascade.

•A 6 amplifiers Cascade would require : 6/5 + 2.5 or 3.7 dB P/V for 870 MHz system.





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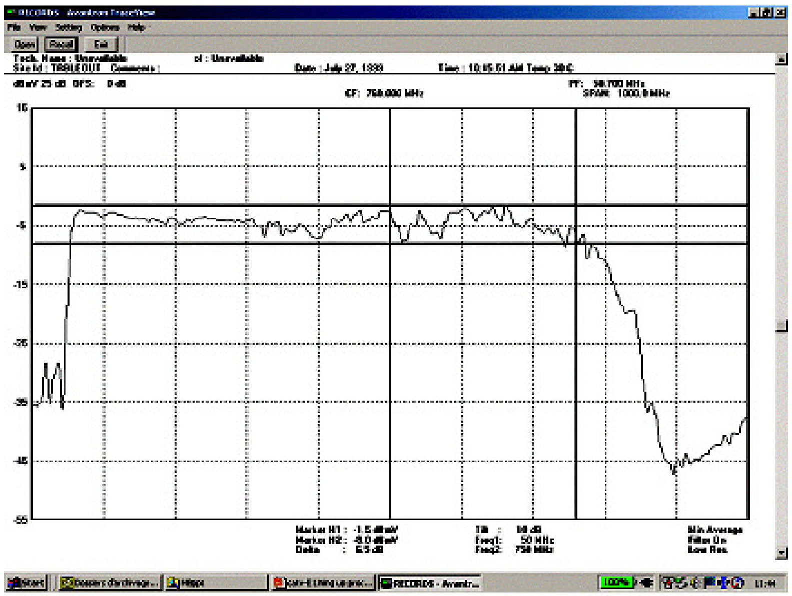
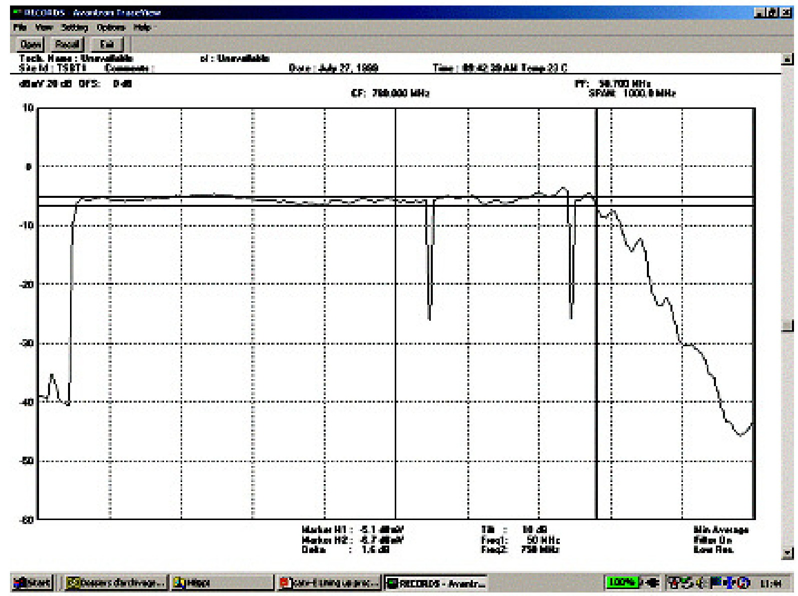
RF Amplifiers.

Below are graphs showing and RF amplifier before and after response adjustment.



Response of an amplifier before final adjustment of these variables controls.



Response of the same amplifier after final adjustment of these variables controls.

Final Testing of a Broadband System.

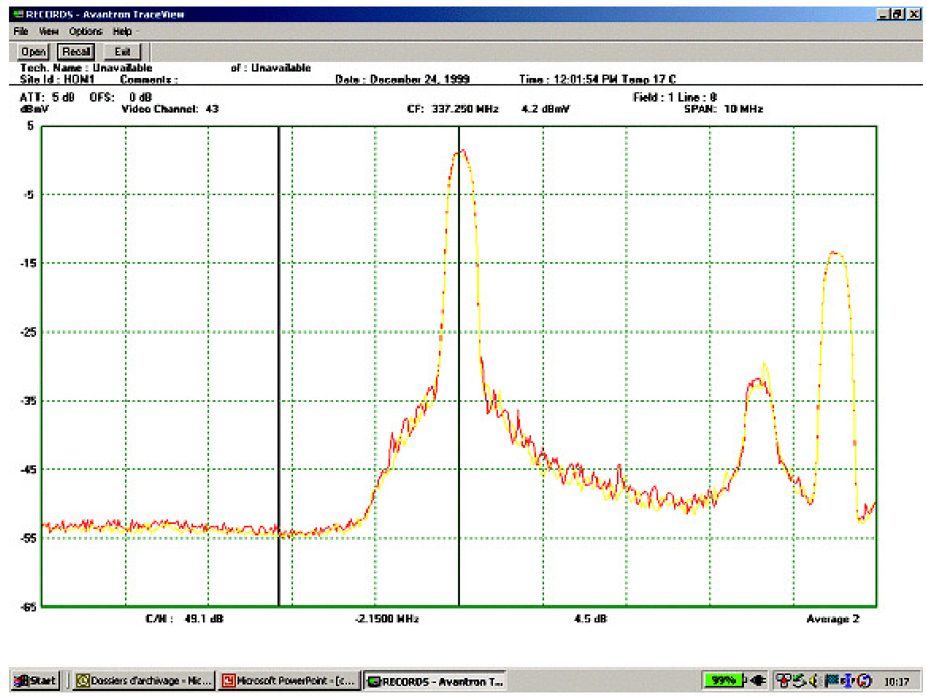
Once you have finalized the adjustment of the system, you need to make the following test at each extremity of the system. These test are;

•Carrier to Noise.

This Carrier to Noise test need to be done for a bandwidth of: 4.2 MHz. If the C/N is done with a different bandwidth, it need to be converted to a 4.2 MHz. The conversion formula is:

$$10\log\left(\frac{Bandwidth_{ref}}{Bandwidth_{new}}\right)$$

In a modern system the worst C/N specification should be better than: 48.0 dB



Above is a 49.1 dB Carrier to Noise Report. The report is done using the Picture Carrier Level and the Noise reference outside of the 6 MHz wide.

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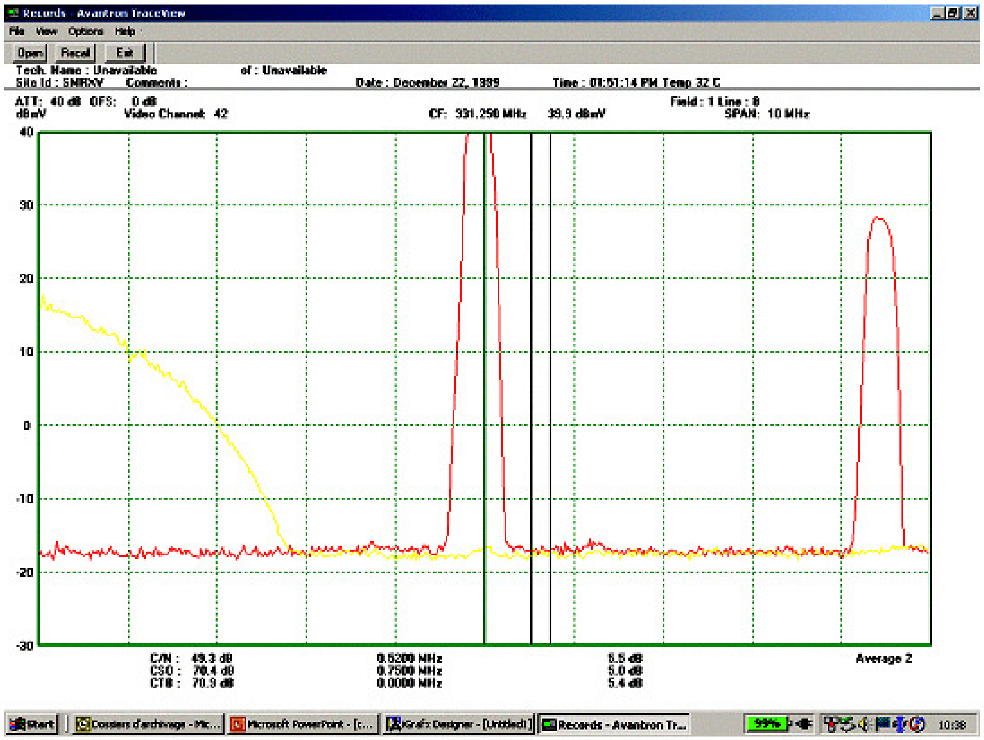
Final Testing of a Broadband System.

Once you have finalized the adjustment of the system, you need to make the following test at each extremity of the system. These test are;

- Composite 2nd Order
- Composite 3th Order.

To do these two tests, CTB and CSO, you generally require to removed the modulation on the channel the test is done on. This measurement can only be done by a Spectrum Analyzer.

In a modern system the CTB and CSO specification should be better than 51.0 dB at each extremity test.



Above is a CSO of 70.4 dB, CTB of –70.9 dB and a C/N of 49.3 dB

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Final Testing of a Broadband System.

Once you have finalized the adjustment of the system, you need to make the following test at each extremity of the system. These test are;

•Hum.

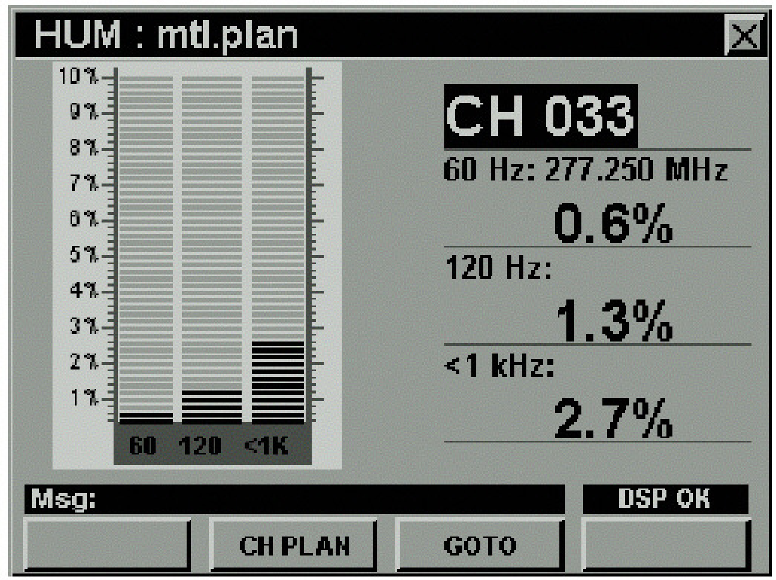
•HUM is 60 cycles coming from the AC line that is introduced in the horizontal sweep of the TV set, which occur at 59.95 Hz.

•The HUM is calculated in % or in dB.

•A good operating system should have 34 dB or 2% of HUM modulation or better.

•HUM can comes from a defective AC/DC power supply of an amplifier, to amperage draw thru a passive equipment or water in connectors.

•To measure HUM you required a battery operated Scope, FSM with this option or a Spectrum Analyzer.



Above shows a HUM report of 0.6% or 39 dB, well above the required specification for well maintained Broadband System.

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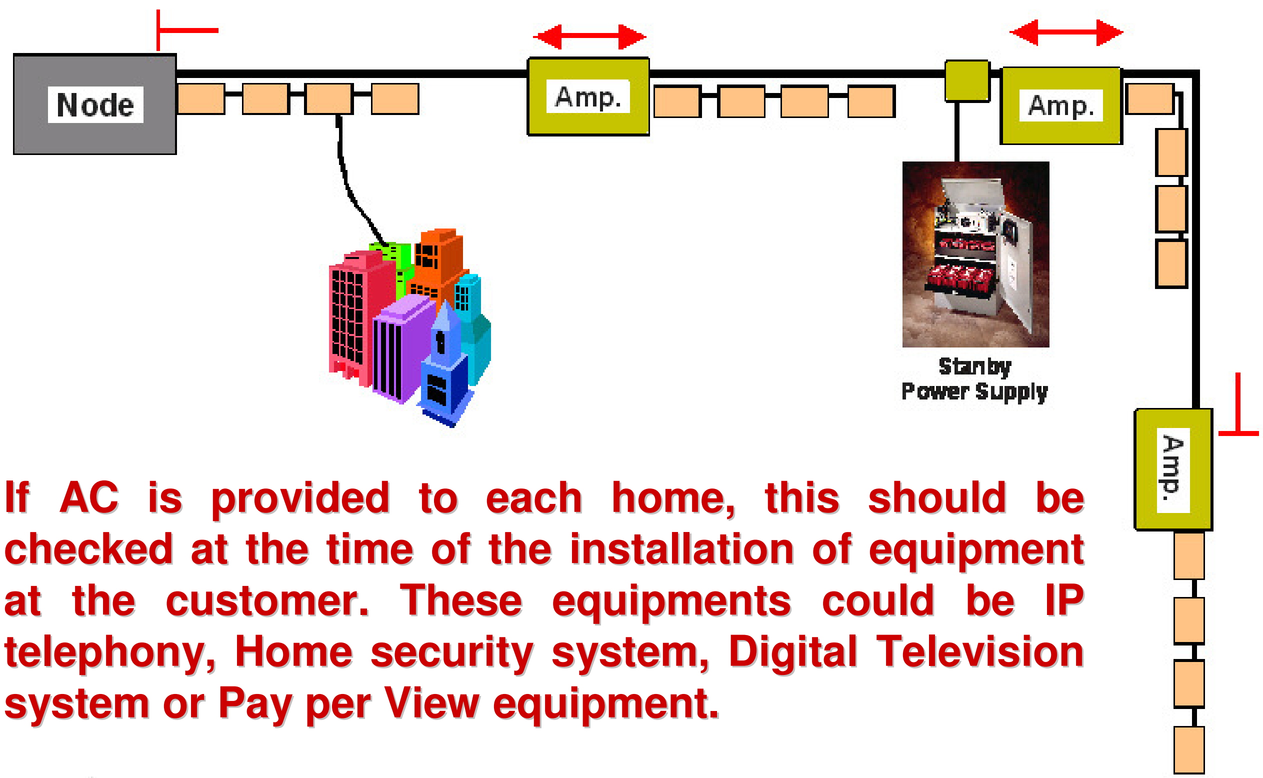
Final Testing of a Broadband System.

A Broadband system requires AC voltage from 40 to 90 Volts AC to operates properly. To-day Broadband system generally operates with a UPS (Uninterrupted Powering System) powering system. This system need to be verify twice a year to make sure the batteries and the system are in good operating order.



If AC is provided to each home, this should be checked at the time of the installation of equipment at the customer. These equipments could be IP telephony, Home security system, Digital Television system or Pay per View equipment.

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Test!

•What king of level do you read with a power meter?

•____

•Can you read RF signal with a power meter?

•____

•What are the light frequencies an OTDR operates at?

•____

•What is the normal loss at 1310 and 1550 nm on standard fiber optic?

•____

•What is the maximum RF level you can read in a HFC system?

•____

•What is call the maximum operation level of a single RF amplifier?

•____

•Why do we sweep an HFC system?

•____

•What is the general power of light input at a NODE on a HFC system?

•____

The end of this ession.

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