# CHANNEL RESPONSE MEASUREMENTS MADE EASY

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By employing a tracking generator/receiver system, (such as an Avantek sweep system) and incorporating a local oscillator with a double-balanced mixer, you can develop a side band analyzer that greatly facilitates the requirement to measure and make adjustments to head-end equipment, including video modulators.

This technique allows the channel response measurement to be made in the presence of other carriers, thus negat- the requirement to turn the system head-end off while making these measurements. Using this technique, the head-end and system can be measured as one integral unit, thus, with the aid of a camera, providing proof of the channel response for the total system and eliminating the need to algebraically add two or more response measurements together.

## INTRODUCTION

Anyone who has tried to comply with the FCC requirements of in-channel response measurements realizes that it is a tedious job, often times producing less than satisfactory results. Typically, the "proof" pictures are of poor quality and the correction of problems found can be a slow and cumbersome process.

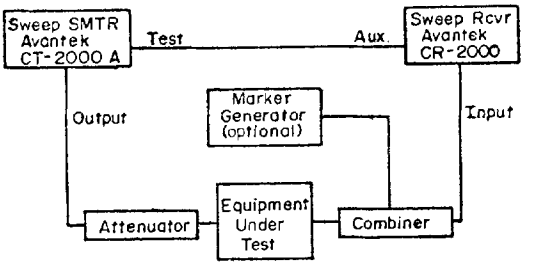
The problem has been in displaying a clean, steady and accurate response of a modulator, processor or strip amplifier with other carriers present. It is particularly difficult to prevent a modulator carrier from saturating the detector and/or masking the sideband information, either of which makes it impossible to achieve satisfactory results using the typical sweep generator/detector techniques.

The above problem can be overcome through the use of a sweep system using a tracking receiver. This paper will specifically explain the method using the Avantek CT/CR-2000A; however, the techniques will work equally well for earlier Avantek models or for tracking systems produced by other manufacturers.

## TEST EQUIPMENT REQUIRED

1. Avantek CT/CR-2000A or equivalent.
2. Marker generator (RCA-WR99 or equivalent).
3. Double-balanced mixer (Anzac Model MHF-1 or equivalent.
4. VHF amplifier (may need two).
5. Video amplifier (may not need).
6. Assortment of pads, jumpers, etc.

## SWEEPING ON-CHANNEL PROCESSORS

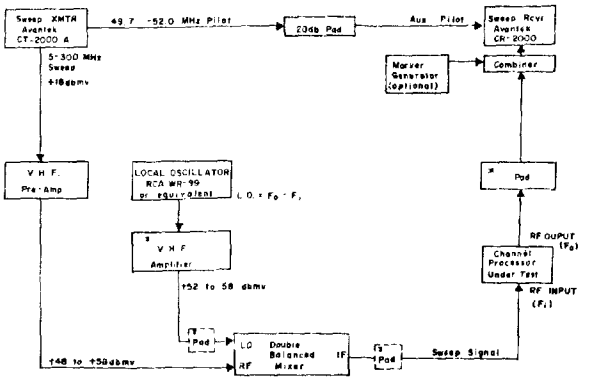



Set Up For Response Test
Of On-Channel Equipment

Figure 1

Figure 1 is the set up for sweeping on-channel equipment. This method is similar to the typical sweep generator/detector method and does not use the double-balanced mixer. The marker generator is used for marker reference only. For further details refer to the Avantek Manual, Section 12, page 30, under "Proof of Performance Measurements".

## SWEEPING OFF-CHANNEL PROCESSORS




*as required

Off-Channel Processor Sweep
Test Set Up

Figure 2

Figure 2 is the set up for sweeping off-channel processors. Note that the marker generator is used as a local oscillator. The generator is set to the difference in the channel input frequency and channel output frequency. The products of the DBM are both the sum and difference of the LO and RF frequencies and this set up will provide the proper input sweep for any channel conversion.

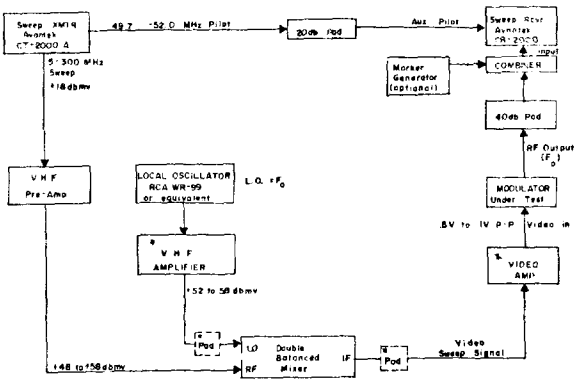
## IF INPUT SWEEPING

An IF input sweep uses the above set up as Figure 2 with the LO generator set at 45.75 MHz above the output channel frequency.

## SWEEPING MODULATORS

Figure 3 is the set up for sweeping modulators. Note that the generator is set to the same frequency as the output channel video carrier.

In Figures 2 and 3 the VHF amplifier, pads and/or the video amplifier marked with an asterisk may or may not be required, depending upon your individual equipment.




*as required

Modulator Sweep Test Set Up

Figure 3

## DOUBLE-BALANCED MIXER CAUTIONS

A word of caution regarding the use of double-balanced mixers is in order at this point. The DBM is a useful and versatile tool, and, if used properly, it will provide excellent results. The first rule to remember is that the IF port must be terminated in a resistive load such as a pad, variable attenuator or an amplifier if the amplifier has a good input match well beyond the total bandwidth in question. Unless you know exactly what you are doing, do not terminate the IF port directly into a bandpass filter. If the IF port is terminated into a reactive load, the harmonic modulation products can vary as much as ±20 dB with the conversion loss varying as much as ±3 dB.

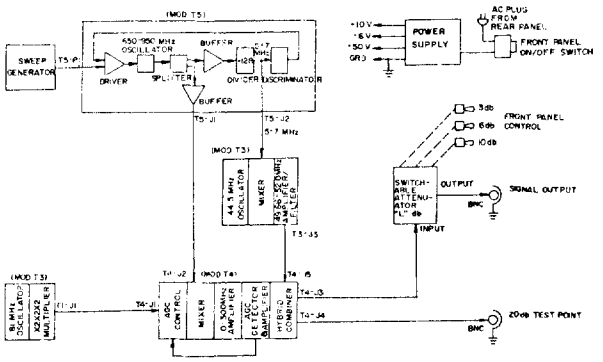
The LO port is the next most critical. The main caution here again is to use a resistive load. The RF port is not critical as the impedance that it sees.

For most DBMs used in CATV the local oscillator input level should be +52 to +58 dBmV.

A DBM with an impedance of 50 Ohms represents a return loss of 14 dB when used in a 75 Ohm test set up. If the above precautions are followed there should be no problems using a 50 OHm device.

## AVANTEK SET UP

It is necessary to modify the Avantek transmitter to remove the 49 MHz to 52 MHz pilot from the sweep in order to prevent overloading the VHF amplifier and/or the double-balanced mixer.




Avantek Block Diagram

Figure 4

Refer to Figure 4 for the Avantek block diagram and make the following modifications:

1. Remove the jumper between T3-J3 (output of pilot amplifier/filter) and T4-J5 (input to hybrid combiner).
2. Disconnect the jumper at T4-J4 (one output of hybrid combiner) and reconnect at T3-J3 (output of pilot amplifier/filter).

This now sets the transmitter up so that only the pilot is available at the test point jack and only the sweep at the sweep signal jack.

## MODULATOR SWEEP TEST PROCEDURE

The modulator sweep test procedure is typically the most difficult of the head-end units and for the sake of brevity will be the only one treated in detail in this paper.

Refer to Figure 3 and note that the sweep output of the Avantek transmitter is only +18 dBmV. This signal needs to be amplified approximately 30 to 40 dB. The higher the output of the amplifier the better, as long as the amplifier does not overload and the combined sweep and LO powers don't burn out the DBM (some DBMs can handle combined powers of 65 to 70 dBmV without burning out).

Feed this high level sweep signal into the RF port of the DBM. Then connect the local oscillator (RCA-WR99 or equivalent) to the LO port of the DBM. If either the RF sweep or the LO level is low into the DBM it may be necessary to install a video amplifier between the IF output of the DBM and the input to the modulator since 0.5 to 1.0 volt of video signal is necessary for proper modulation.

With the proper IF (video) signal level into the modulator, connect its output to the input of the Avantek receiver. Then connect the pilot tone from the Avantek transmitter (now located at the test point jack) to the auxiliary pilot input on the receiver.

The modulator is now set up for sweep testing. Note that is may be necessary to pad the modulator output and/or the pilot tone to keep from overloading the Avantek receiver.

This test set up could be expanded to include the total cable system by inserting the Avantek transmitter pilot (at the proper level) into the trunk cable and taking the Avantek receiver out into the system.

If the head-end has a multi-channel AML transmitter with transmitter monitoring, the AML transmitter can be included in the test. However, since the AML can't transmit the 49-52 MHz pilot, the test cannot be run beyond the head-end.

To perform the sweep test, set the Avantek receiver controls as follows: video filter to normal; sweep rate to remote lock; video gain to 10 dB per centimeter; and sweep width to full. Then, with the transmitter in the local control mode, tune $F_1$ approximately 30 MHz below and $F_2$ approximately 30 MHz above the output video carrier frequency as indicated by their respective dials (these controls are internal pots on the Avantek transmitter models earlier than the 2000A). The video carrier should now be displayed on the receiver CRT with the base line being approximately two centimeters long and the video carrier near the center of the base line. Now tune the center frequency control so that the tuning marker is under the video carrier. Switch the sweep width to 1 MHz per division. The video carrier should now be displayed near the center of the CRT.

With the center frequency control move the video carrier two centimeters

to the left of center and adjust $F_1$ and $F_2$ on the transmitter so that the base line just fills the full 10 centimeters of the CRT. Reduce the sweep rate on the transmitter to just above the flickering point, as viewed on the CRT. Now adjust the LO generator to the video carrier frequency. As the generator is tuned near the video carrier frequency, the response of the modulator will begin to rise up from the base line. Tune the LO generator for maximum level on the response as viewed on the CRT. The LO is now tuned to the video carrier frequency.

As the LO generator is tuned for maximum, it may be necessary to adjust the gain of the video amplifier (if used) and/or the video modulation control to prevent over-modulating the video modulator. It is best to adjust the modulation so that the sideband energy is approximately 6 dB below the video carrier.

As can be seen in the response photographs (Figures 5 through 7), the display can be quite revealing. Figure 5 shows considerable reaction in the video passband area caused by the sound trap. Although in the interest of video sharpness it is desirable to have a video bandwidth of 7 to 10 MHz, it can be a detriment in a CATV system if the upper sideband information is allowed to extend into the upper adjacent channel as indicated in the photograph. Keep in mind that the FCC channel response requirement is only from -0.5 MHz to +4 MHz with respect to the video carrier.

Figure 7 is the response of a channel processor. Although the video carrier is not present, a marker generator could be used (as shown in Figure 3) to show the location of the video and/or sound carriers if desired.

With the logarithmic display it is possible to see the rejection level of the vestigial sideband change 10 to 30 dB depending upon the proper set up of the equipment and the proper installation of modules and jumpers.

Depending upon the tuning of the Avantek receiver, the tuning marker may not be as prominent as the one in Figure 5.

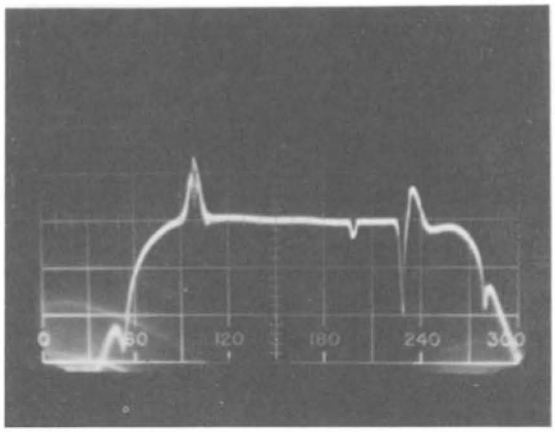



Figure 5

Vertical--10 dB/cm

Horizontal--1 MHz/cm

RCA CTM--10 modulator, bandpass filter and AML. Video carrier at the 100 MHz line. Tuning marker at the 200 MHz line. Sound trap at the 230 MHz line.

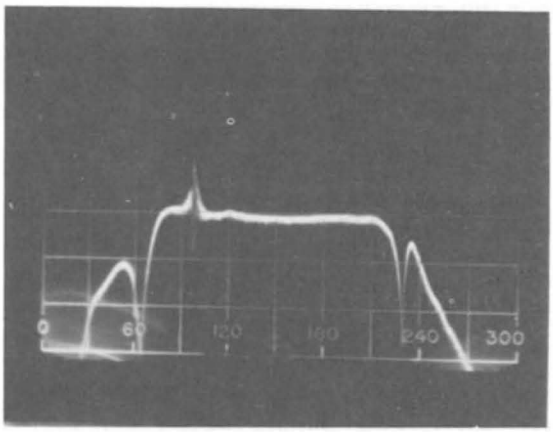



Figure 6

Vertical--10 dB/cm

Horizontal--1 MHz/cm

SA-6300--modulator, bandpass filter and AML video carrier at the 100 MHz line. Sound trap at the 230 MHz line.

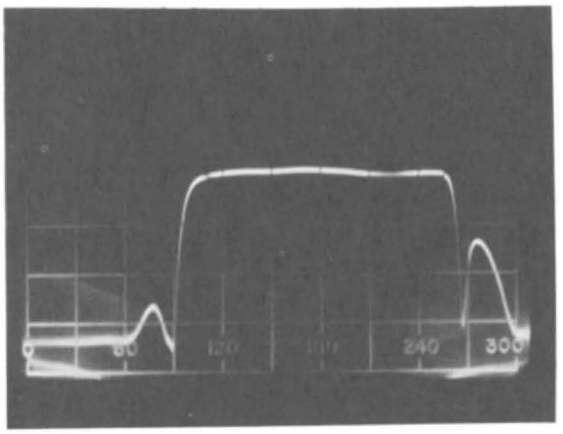



Figure 7

Vertical--10 dB/cm

Horizontal--1 MHz/cm

SA-6150--processor, bandpass filter and AML.

## CONCLUSION

The sweep generator, with its tracking receiver, provides a means for fast and accurate in-channel response measurements. With two-way communications, two technicians can make the test from antenna terminals to the end of the system as one unit.

## ACKNOWLEDGEMENTS

The double-balanced mixer that we used was the Anzac Model MHF-1, Stock No. MMN-6750. R.F. and I.F. response of 5 to 500 MHz with I.F. from D.C. to 500 MHz. Impedance 50 ohms.

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