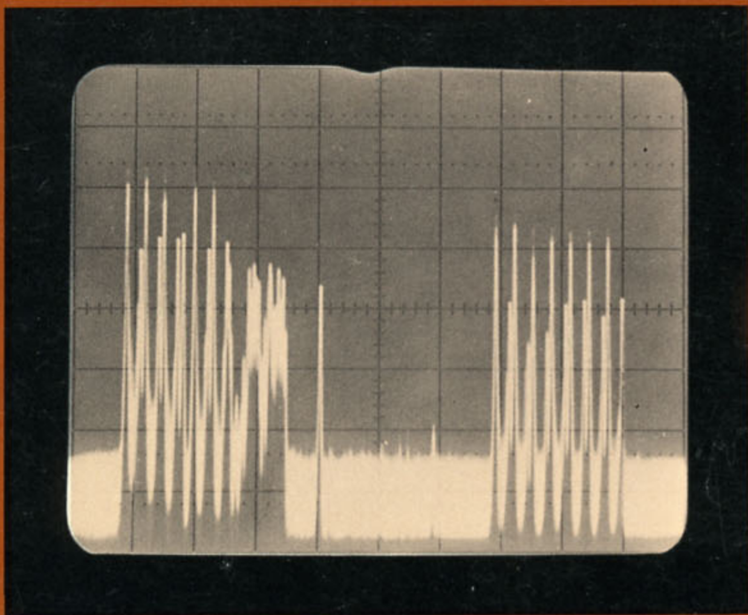

Spectrum Analyzer Series

APPLICATION NOTE 150-6

SPECTRUM ANALYSIS....
CATV Proof of Performance

HEWLETT PACKARD

April 1974

APPLICATION NOTE 150-6

SPECTRUM ANALYSIS . . .
CATV Proof of Performance

Printed April 1974

HEWLETT hp PACKARD

CONTENTS

INTRODUCTION

As the number of community antenna television (CATV) systems has increased, so has the number of rules governing the operational characteristics of such systems. The purpose of this note is to describe the use of a modern spectrum analyzer as a measurement tool in meeting these requirements.

The note is in two sections. This and the next chapter give background information and some examples of how the spectrum analyzer can be applied. The ensuing chapters give detailed information and test setups for making measurements to the U.S. FCC Rules and Regulations, Part 76.605, Canadian Broadcast Procedure 23, and Japan Ministry of Postal-Telecommunications Standard. Measurement techniques are also applicable to any other specifications which may be imposed by merely changing the actual numbers. (Note: Specifications as cited in this note are abbreviated. Consult the pertinent document for complete details.)

Suggested Equipment

The spectrum analyzers discussed in this note are broadband instruments calibrated in frequency and amplitude. Two suggested Hewlett-Packard systems are:

1. 8557A Option 002 Spectrum Analyzer or 8558B Option 002 Spectrum Analyzer
   181A Option 807 Oscilloscope Display
2. 8554B Tuning Section
   8552B Option H20 IF Section
   141T Display Section
   11694A 50-75Ω Transformer

The required characteristics are:

1. Absolute amplitude calibration in dBmV-75Ω
2. Capability to resolve signals separated by 10 kHz and 60 dB in amplitude
3. Distortion-free range $>$ 60 dB
4. Flat frequency response ($<\pm$0.5 dB, 50-350 MHz)
5. Sensitivity $<-$100 dBm / 10 kHz

The importance of these characteristics will be explained under the different measurement sections.

Additional information on operation and measurements with a spectrum analyzer can be obtained from the following application notes:

AN 150	Basic Signal Analysis
AN 150 - 1	AM & FM
AN 150 - 3	Tracking Generators
AN 150 - 4	Noise Measurements
AN 150 - 5	CRT Photography and X-Y Recording
AN 150B	8557A and 8558B Operation

A spectrum analyzer will give amplitude readings equivalent to a field intensity meter when the procedures shown are followed. Each uses a superheterodyne receiver with an envelope detector to achieve level measurements. Conversion of units of measure is covered in Chapter 8 and in the Appendix.

In addition to suggested equipment, it may be desirable to use attenuator pads at the point of connection to the CATV system to minimize reflections due to mismatch.

CHAPTER 1
SIGNAL ANALYSIS AND CATV

Before exploring the particular techniques of measurement, it is useful to look at a few applications of the spectrum analyzer on an operating system. This will help to understand the ensuing chapters.

Full System Scan

This photo shows a 35 - 235 MHz scan of an on-line system. Note that visual and aural carrier levels can be read directly. In addition, some midband spurious signals can be detected, and pilot tone levels can be measured.

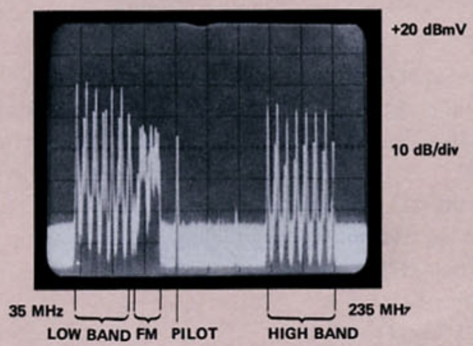

Figure 1.1

FM Band

Here, the FM band (88 - 108 MHz) is scanned. Once again, individual signal levels can be measured. These levels can be checked against TV visual carriers to determine compliance with specifications.

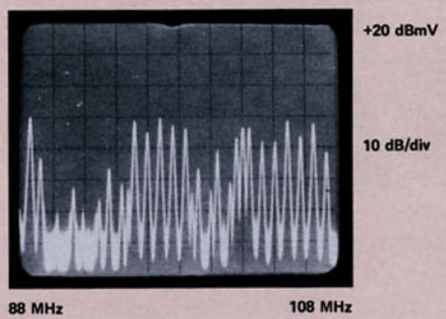

Figure 1.2

High Band

The high band (channels 7 - 13) can be scanned as a unit to get an expanded view of this portion of the spectrum. Aural carrier levels can more easily be determined, and the presence of the color burst can be verified.

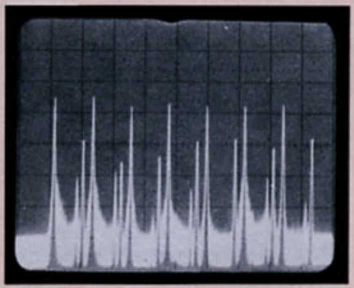

Figure 1.3

Channel 12

Further expanding to 1 MHz per division allows accurate frequency measurements to be made using techniques described later. Those spurious, single-tone signals can be measured that are relatively far from the carrier. In the next section, spurious signals close to the carrier will be measured. Also, signal-to-noise ratio can be determined.

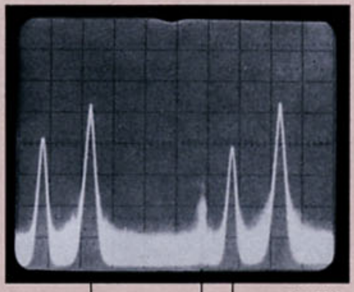

Figure 1.4

Video Carrier

With the scan at 20 kHz per division, such interference products as co-channel carriers can be measured. Here, an interference product occurs 42 dB down, 10 kHz from the video carrier.

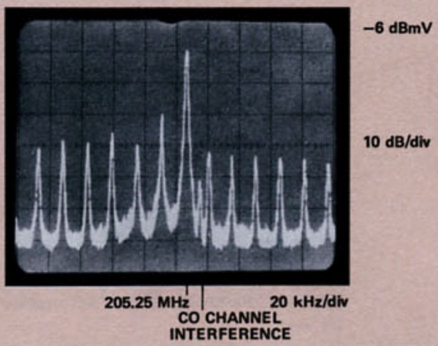

Figure 1.5

Summary

The spectrum analyzer makes rapid, precise evaluation possible. Major performance characteristics are readily determined from the display.

CHAPTER 2
SIGNAL LEVEL MEASUREMENTS

As outlined in the previous chapter, measurements of carrier levels can be made directly from the spectrum analyzer CRT.

Visual Carrier

Specifications:

U.S.:	> 0 dBmV
Canada:	4 dBmV ± 10 dB
Japan:	0 to 25 dBmV

The test setup is as shown below. The spectrum analyzer Reference Level should be set to about +30 dBmV and the Resolution Bandwidth to 100 kHz.

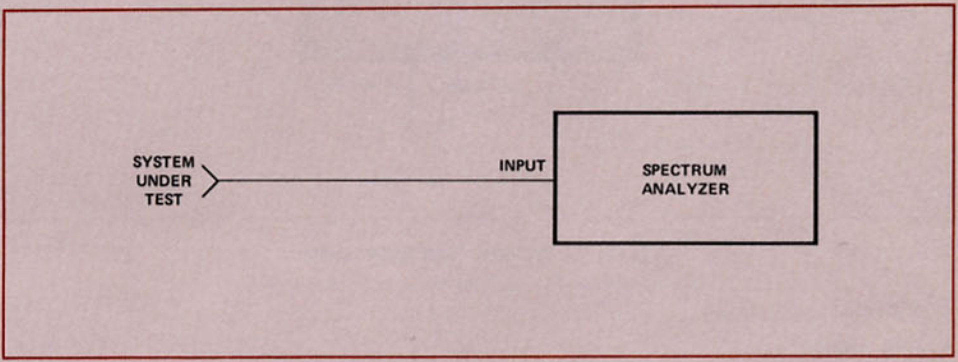

Figure 2.1 Signal Level Test Setup

The 100 kHz bandwidth is required to read the peak value of the carrier (in terms of rms volts) with the modulation on. A narrower bandwidth would show a lower than actual level[1].

Aural Carrier

Specifications:

U.S.:	− 15 dB ± 2 dB relative to associated visual carrier
Canada:	< 17 dB down relative to associated visual carrier but > 10 dB below adjacent visual carrier. (If no adjacent visual, should be > 7 dB but < 17 dB below associated visual carrier.)
Japan:	−3 to −14 dB relative to associated visual carrier, but −9 to −14 dB if there is an adjacent visual carrier.

The test setup and technique are the same as for visual carrier measurements. These tests can be performed simultaneously.

Relative Visual Levels

Specifications:

U.S.:	± 3 dB to adjacent channel
	± 12 dB to any other channel
Canada:	± 3 dB to adjacent channel
Japan:	± 3 dB to adjacent channel
	± 10 dB to any other channel

[1]TV modulation is essentially pulsed RF. It's necessary to use a wide enough bandwidth to obtain sufficient spectral components to reconstruct the actual carrier level. See HP AN 150-2 for further information.

Once again, this test can be performed in conjunction with the previous tests to simplify measurement.

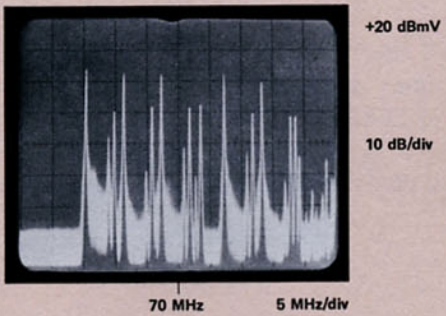

Figure 2.2 TV Signal Level Measurement

FM Broadcast Carrier

Specifications:

U.S.: None

Canada: − 20 to + 6 dBmV (88-90 MHz, > 10 dB down from channel 6 visual carrier). Adjacent levels, ± 3 dB.

Japan: None

This is the last test that can be made using the first test setup. Each carrier value should be recorded by a suitable technique, such as: CRT photography, X-Y recording, or in tabular form.

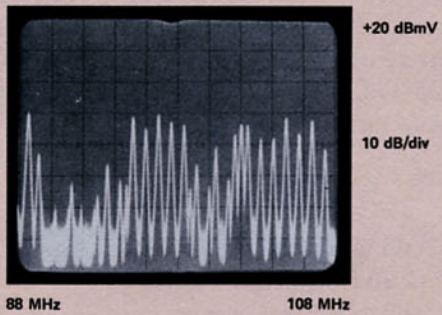

Figure 2.3 FM Signal Level Measurement

Accuracy Considerations

The accuracy of these measurements depends on several factors: the spectrum analyzer calibrator accuracy, flatness, and log display accuracy. For most systems, this accuracy will be sufficient. However, for signal levels very close to specification limits, improved accuracy may be obtained as follows:

1. Calibrate the spectrum analyzer in the 100 kHz Resolution Bandwidth position.
2. Read each signal level by using the Reference Level control and vernier to bring that signal to the top graticule line on the CRT. The Reference Level setting is the signal level.

The accuracy will then be the calibrator accuracy plus the flatness of the analyzer plus the Reference Level accuracy. For the 8554B Spectrum Analyzer this is ± 1.1 dB typically, and the 8558B Spectrum Analyzer would be typically ± 2.0 dB (for absolute voltage measurements). Relative measurements can be made to approximately ± 0.8 dB on either analyzer using the same technique. (These assume ≈ ± 0.5 dB flatness from 10-350 MHz, which is typical.) Flatness is the limiting factor in the overall accuracy, and using a calibrated signal source as a substitution device does not help measurably since typical accuracy is not much better.

CHAPTER 3
CARRIER-TO-NOISE RATIO

Specifications:

U.S.: > 36 dB
Canada: > 40 dB
Japan: > 38 dB

In this method, the noise level in each channel is measured, and appropriate corrections are applied. Then, this corrected value will be compared to the visual carrier level.

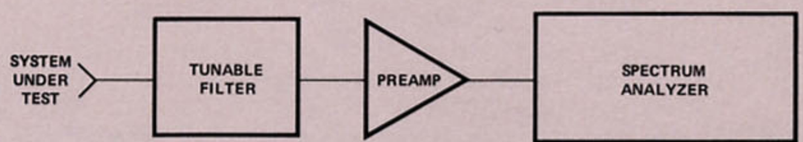

Figure 3.1 Test Setup for C/N Ratio

The tunable filter (about 6 MHz bandwidth) is tuned to the channel of interest, and the spectrum analyzer should be tuned to the same channel. The Resolution Bandwidth is set to 10 kHz, and video filtering used to smooth (average) the displayed noise.

Two corrections are added to the displayed noise level. These are described fully in Application Note 150 - 4, so only a summary will be given here.

1. 2.5 dB is added to account for log shaping and detector characteristics.
2. 25.2 dB is added to normalize to the 4 MHz bandwidth commonly used for measuring video C/N ratio. (Note: Both correction factors apply only to Gaussian shaped IF filters in the spectrum analyzer.)

The procedure is quite simple. First, tune the filter for a maximum displayed amplitude of the visual carrier with a 100 kHz Resolution Bandwidth (no video filter) on the spectrum analyzer. Then, use the Reference Level control to place this signal on the top graticule line of the CRT. (The top graticule line now represents a 0 dB carrier-to-noise ratio.)

Tune the filter slightly to insure that the noise in spectrum between the visual carrier and color burst is at a maximum and change the spectrum analyzer Resolution Bandwidth to 10 kHz. Use sufficient video filtering to smooth the noise display. (Note: Be sure no discrete video component is present where the noise measurement is made.) The noise should appear > 63.7 dB down for a 36 dB C/N ratio, and > 67.7 dB down for a 40 dB C/N ratio. Repeat the test for each channel.

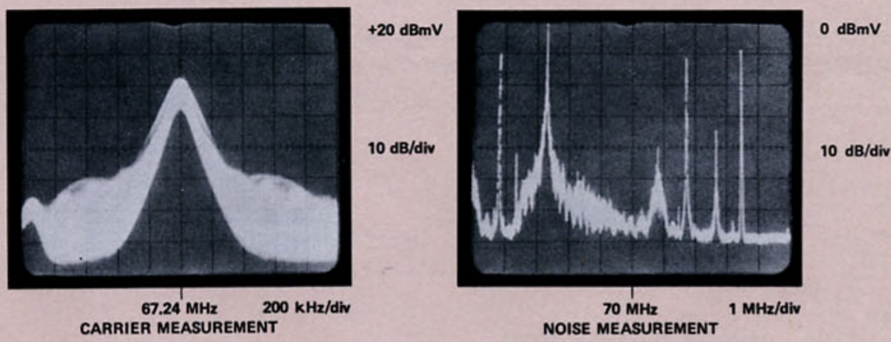

Figure 3.2 Carrier level is + 2 dBmV, and noise level is − 66 dBmV at 70 MHz. C/N Ratio (after correction) is 40 dB in 4 MHz.

Accuracy Considerations

The only factors affecting accuracy are the analyzer log display accuracy and any slight variation of the Resolution Bandwidth from its nominal 10 kHz (12 kHz noise bandwidth, see AN 150 - 4). The log display is accurate to ± 1.5 dB.

CHAPTER 4
FREQUENCY MEASUREMENTS

There are two methods of measuring carrier frequencies from the spectrum analyzer display. The method used depends only on user preference.

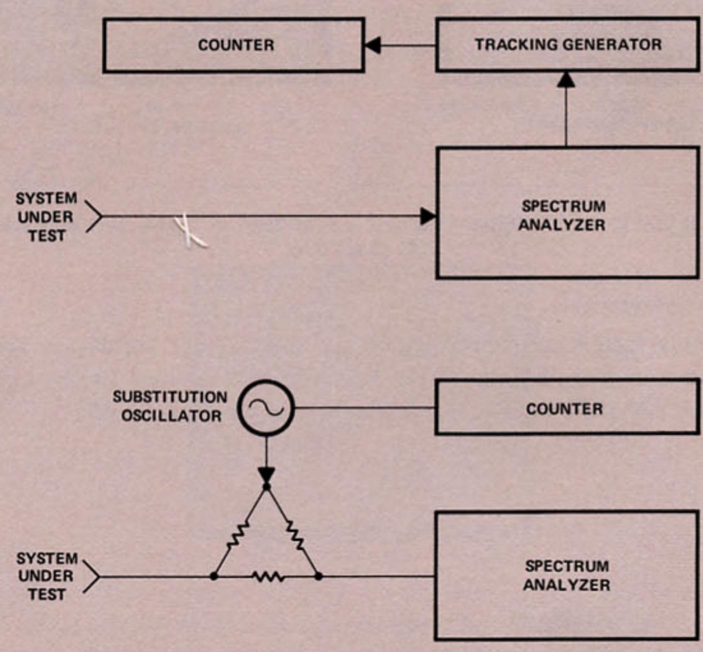

Figure 4.1 Two setups for Carrier Measurement

The first method uses a tracking generator (a device whose frequency output tracks the spectrum analyzer tuning) and a counter. The advantage of this method is simplicity. To make a frequency measurement, the analyzer is manually scanned to the signal of interest, and the counter displays the frequency.

The second method is less expensive, but slightly more difficult. The substitution oscillator is tuned until its output frequency coincides with the desired signal. The counter then displays that signal frequency.

Visual Carrier

Specifications:

U.S.: Nominal assigned frequency ± 25 kHz
Canada: Nominal assigned frequency ± 50 kHz
Japan: Nominal assigned frequency ± 20 kHz

Using either method above, narrow the scan width and Resolution Bandwidth sufficiently to assure accurate measurements. (Suggest: 1 kHz bandwidth and 5 kHz per division.)

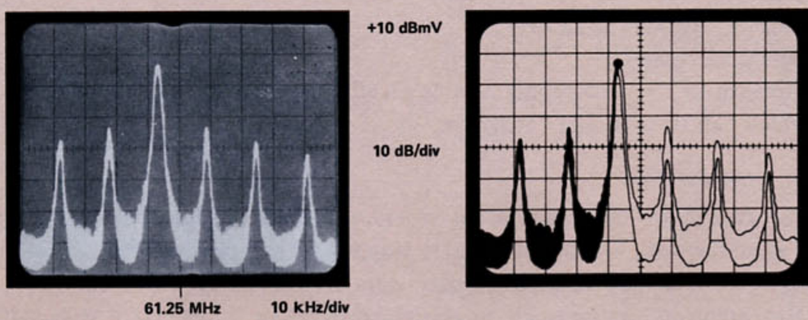

Figure 4.2 Using Tracking Generator, Manually Scan to Peak of Signal

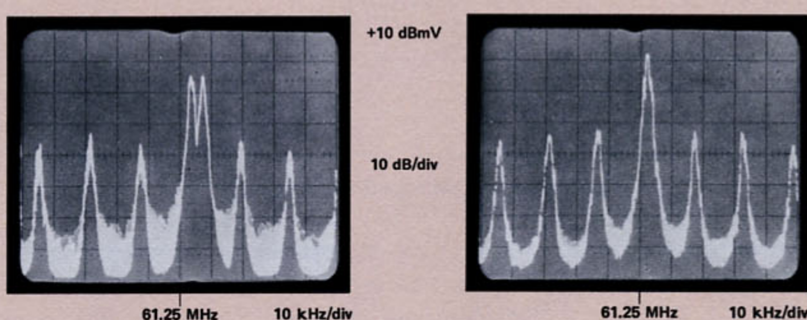

Figure 4.3 Superimpose Substitution Oscillator, and Read Frequency on Counter.

Aural Carrier

Specifications:

U.S.:	Visual + 4.5 MHz ± 1 kHz
Canada:	Visual + 4.5 MHz ± 2 kHz
Japan:	Visual + 4.5 MHz ± 2 kHz

Measure the aural carrier frequency as above. It is best to wait for a quiet period when the carrier is unmodulated to make the final reading.

FM Broadcast

Specifications:

U.S.:	None
Canada:	± 0.1%
Japan:	None

Measure as above.

Channel-to-Channel

Specifications:

U.S.: None

Canada: 6 MHz ± 22 kHz

Japan: None

Measure as above. Keeping a table of all measurements will simplify the calculations which can then be done at leisure.

Accuracy Considerations

The two major contributions to accuracy are the residual FM of the analyzer and the accuracy with which the scan is stopped at the peak of the carrier or how accurately the carrier and substitution oscillators are made to coincide.

Measurements can be made to accuracies of about ± 300 Hz if reasonable care is used.

CHAPTER 5
HUM MEASUREMENTS

The measurement of hum modulation can be performed by one of two techniques. The method most often used is to detect the unmodulated visual carrier and observe the ac hum on an oscilloscope. The other method is to use a high resolution spectrum analyzer to view the 50 or 60 Hz sidebands directly.

Hum Modulation

Specifications:

U.S.:	<5% (sidebands 32 dB down)
Canada:	−34 dB (p-p) relative to carrier (equivalent to −40 dB sidebands or 2%)
Japan:	−50 dB (50 Hz line)
	−40 dB (60 Hz line)

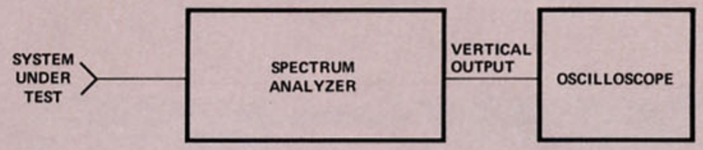

Figure 5.1 One Method for Hum Measurement

The first method is, perhaps, the easiest to use. The spectrum analyzer is used in zero scan as a filter and detector. The resolution Bandwidth should be set to 30 kHz, and the analyzer tuned to the desired carrier (unmodulated).

The oscilloscope is calibrated by dc coupling and reading the average carrier level. Then, switch to ac coupling, and expand the vertical scale to read the hum component. (The system should be checked for possible ground loops by removing the system under test from the spectrum analyzer and assuring that no hum component appears on the oscilloscope display.)

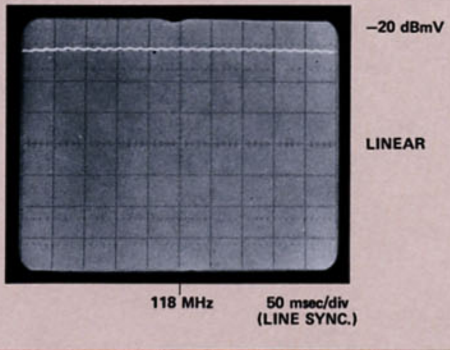

Figure 5.2 Hum on Pilot Tone — 1.5% Peak-to-Peak

The HP 8553B/8552B Spectrum Analyzer has sufficient resolution to measure the hum sidebands directly on the unmodulated carrier. However, the frequency range is limited to 110 MHz. By using a double balanced mixer and the second L.O. output (150 MHz), the range can be effectively extended to 260 MHz. Since some confusion on the display will result, this method is recommended only for this application.

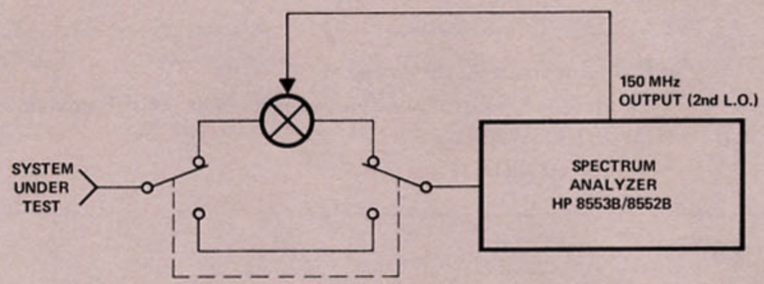

Figure 5.3 Another Method for Hum Measurement (Preferred Accuracy)

The test procedure is simple. Identify the desired carrier (above 110 MHz this is most easily accomplished by switching the modulation off and on while observing the display). Then reduce the scan width to 50 Hz per division, and use the 10 Hz resolution bandwidth. Measure the carrier-to-sideband ratio directly.

Accuracy Considerations

The accuracy of measurement in either case is well below a significant level (assuming the oscilloscope has sufficient accuracy when used in the first method). The oscilloscope should be calibrated against an external voltmeter if accuracy is insufficient.

If a spectrum analyzer other than the 8553B/8552B is used in the second method, then there are certain considerations. First the Resolution Bandwidth must be less than 100 Hz at the 60 dB points to allow sufficient resolution; and the hum sidebands produced by the analyzer must be > 10 dB below the specifications limit to avoid errors.

CHAPTER 6
INTERFERENCE MEASUREMENTS

There are three types of interference to be considered: co-channel, cross modulation, and intermodulation distortion (including any single frequency products). All of these will be measured by the same technique.

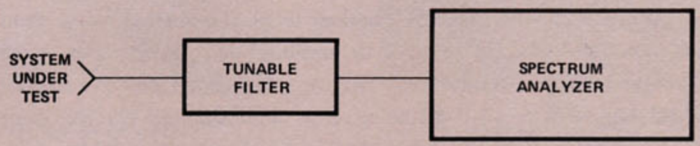

Figure 6.1 Test Setup for Interference Measurements

In each case, the tunable filter is tuned to the channel of interest, and the appropriate measurements are made. The filter is used to prevent the possibility of the analyzer contributing any distortion to the measurement. Although the analyzer performance is typically sufficient for the measurement without the filter, it is good practice to use it.

As additional assurance that the analyzer is not contributing distortion, change the input attenuator (Optimum Input) by 10 dB. If all signals change by exactly 10 dB, they are real spurious signals and not created by the spectrum analyzer.

Co-Channel

Specifications:

U.S.: −36 dB
Canada: −56 dB
Japan: None

The measurement is made by tuning to the desired visual carrier and reducing the scan to about 20 kHz/DIV with a resolution bandwidth ≤ 1 kHz. Maximum video filtering should be used to avoid the video information from obscuring the display. Modulation may be left on during this test.

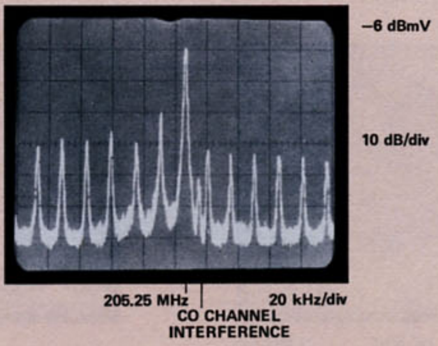

Figure 6.2 Co-channel 42 dB down at + 10 kHz Offset

Cross Modulation

Specifications:

U.S.: −46 dB
Canada: −48 dB
Japan: −40 dB
(All three measured relative to visual carrier)

The same control settings can be used as for the co-channel measurement. However, in this case, the other carriers should be modulated as usual, and the carrier under test replaced by an unmodulated carrier. Then, since video modulation sidebands are typically 24 dB down from the measured carrier level, the desired result should be 15.75 kHz sidebands −64 to −72 dB relative to unmodulated carrier. For greater accuracy modulate all channels with a white level, square wave signal (87.5% modulation), and this will give sidebands at −13.1 dB relative to unmodulated carrier. Then, make the measurement as before looking for cross modulation products −53 to −61 dB relative to unmodulated carrier.

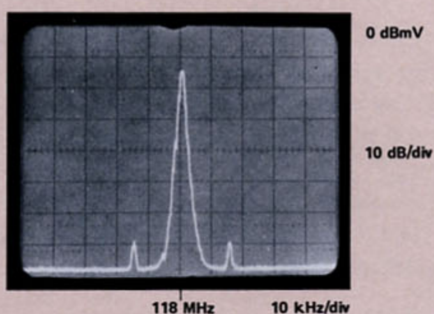

Figure 6.3 Cross Modulation on Pilot 56 dB Down From Unmodulated Carrier

Intermodulation

Specifications:

U.S.: −46 dB
Canada: −30 to −56 dB per chart in BP23
Japan: −4 to −1.25 MHz −20 dB
−0.5 to +4 MHz −50 dB (see chart in Standard)

The entire channel under test is scanned for discrete signals other than co-

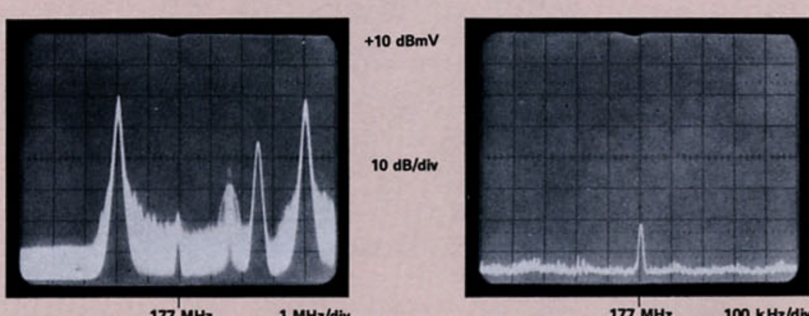

Figure 6.4 Intermodulation Component 42 dB Below Carrier

channel, and the levels measured relative to the visual carrier. This test may be performed with modulation on in the channel under test by using maximum video filtering to eliminate the video. However, since IM components may be present coincident with one of the discrete sidebands, it's best to turn the modulation off.

Accuracy Considerations

For most cases, the spectrum analyzer accuracy (±1.5 dB over 70 dB) is sufficient. For greater accuracy, the following technique can be used. Set the visual carrier level at the Reference Level on the CRT, and read the Reference Level setting. Then, use the reference level control to bring the interference product to the top of the CRT. Subtract these two reference level settings to get the ratio of the two signals. This is typically accurate to ±0.3 dB.

CHAPTER 7
TERMINAL ISOLATION

Specifications:

U.S.: 18 dB
Canada: 26 dB
Japan: −25 dB (TV-TV)
−35 dB (FM-TV)

In this test, a levelled sweep oscillator is slowly swept across the band, and the output observed at another subscriber terminal.

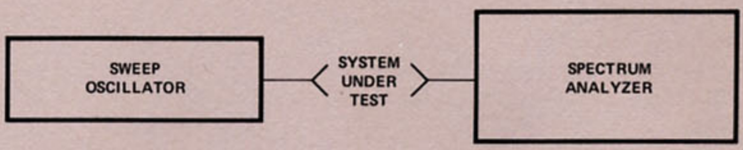

Figure 7.1 Terminal Isolation Test

The sweep oscillator is set to sweep slowly across the band with a levelled output. If the output of the sweeper is not calibrated in amplitude, measure its output level on the spectrum analyzer. Note this level.

At the adjacent subscriber terminal, set the analyzer to scan the same range of frequency using a 100 kHz or greater resolution bandwidth and a rapid sweep rate. Set the Reference Level to agree with the output level from the sweeper. Using variable persistence will allow you to "paint out" the response on the CRT. The number of dB from the top of the CRT represents the isolation.

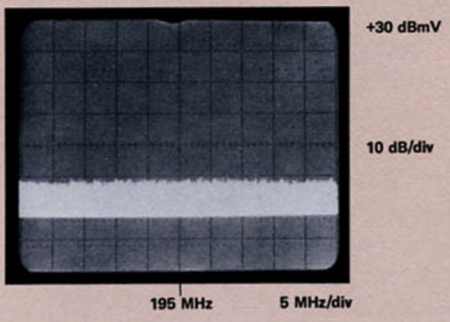

Figure 7.2 Sweeper Output was 0 dBmV. Therefore, Isolation at this Terminal is 22 dB.

Accuracy Considerations

The accuracy of this measurement is dependent on the flatness of the spectrum analyzer (typically ±0.5 dB) and the log display accuracy (<1.5 dB). This may be improved by using the Reference Level control to bring the trace to the top of the CRT, and note the setting. Then, subtract this setting from the output level of the sweeper. Using this technique will give about ±0.8 dB accuracy overall.

CHAPTER 8
RADIATION

Radiation measurements are made by setting up a calibrated antenna at a specified distance from the cable. Readings are taken on the spectrum analyzer and corrected to arrive at readings in μV/m.

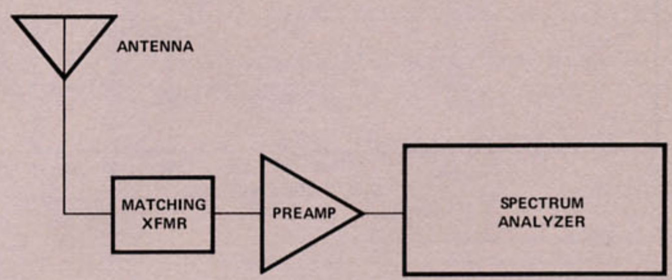

Figure 8.1 Test Setup for Radiation Measurements

Recommended antennas are:

10 kHz – 40 MHz Singer 95010-1
40 MHz – 220 MHz Singer MD-105-TI

Specifications:

U.S.:	0 - 54 MHz	15μV/m at 100′
	54 - 216 MHz	20μV/m at 10′
	>216 MHz	15μV/m at 100′
Canada:	0 - 54 MHz	20μV/m at 30′
	54 - 108 MHz	20μV/m at 10′
	108 - 174 MHz	10μV/m at 10′
	174 - 216 MHz	20μV/m at 10′
	216 - 300 MHz	20μV/m at 30′
Japan:	34 dBμV/m	per IEC method

In order to simplify measurement, all values can be taken in dBμV (0 dBμV = 1 μV) rather than μV. Then, since 0 dBμV = −60 dBmV, it's easy to correct all measurements.

10 μV = +20 dBμV
15 μV = +23.5 dBμV
20 μV = +26 dBμV

So, the measurement procedure will be to set up the spectrum analyzer to scan the range of interest using at least a 100 kHz resolution bandwidth. Measure the radiation in an unoccupied portion of the spectrum (during normal hours). Then, add 30 dB to change to dBμV. (This accounts for the 30 dB gain of the model 8447C amplifier.) Last, add the antenna correction factor. For the model 95010-1, this is 0 dB. See the following chart for the MD-105-TI antenna.

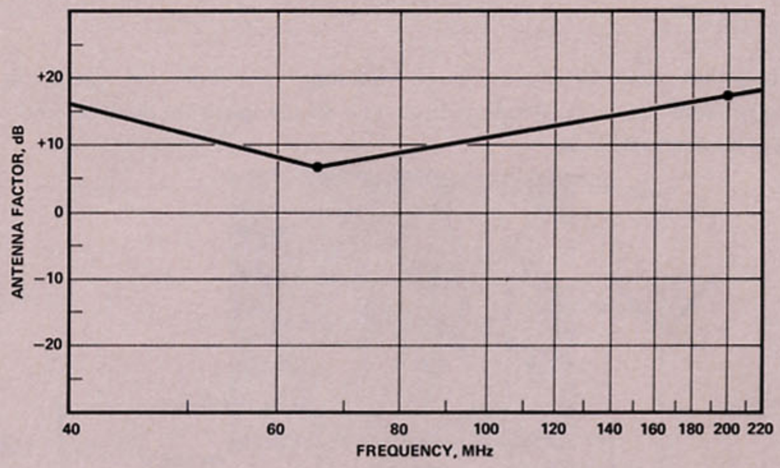

Figure 8.2 Antenna Factor, Singer MD-105-TI

Although measurements can be made during normal operating hours by restricting the frequencies observed to those which are unused by local broadcast facilities, best results will be obtained in the light usage hours. A signal generator at the headend can be used to insert a test tone at 0 dBmV (during off hours) and tuned slowly across the band while observing radiation from the cable system. This will make it possible to observe radiation in the band of any local stations. Another method is to tune to one of the AGC pilot tones. If radiation is found, further scanning is warranted.

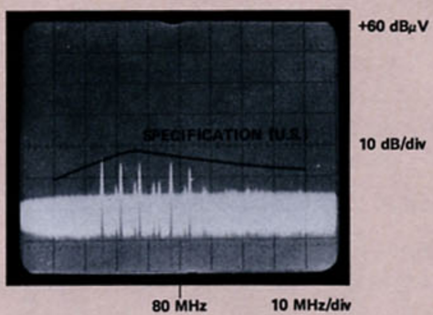

Figure 8.3 Radiation Measurement (Simulated in Shielded Room)

Accuracy Considerations

The major concern in accuracy is the great number of variables. For example, test cable length, earth conductivity, relative humidity, location of people and structures, mismatch, antenna variations, etc., can all affect the measurement. It is not meaningful to try to improve over spectrum analyzer accuracy while ignoring other factors.

CHAPTER 9
FLATNESS

Although this test is normally made periodically on an on-line system using summation sweep techniques, it can be performed using a spectrum analyzer as a detector. The disadvantage of this technique is that some subscriber interference will be introduced. However, overall accuracy is quite good.

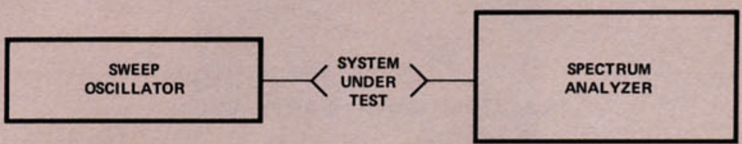

Figure 9.1 Setup for Flatness Measurements

Specifications:

U.S.: ±2 dB from −1 to +4 MHz relative to each visual carrier.

Canada: ±1 dB within each channel (headend to subscriber)
±0.5 dB from −0.75 +3.58 MHz relative to each visual carrier (headend response)
0 to −2 dB at visual carrier +4 MHz relative to visual carrier (headend response)

Japan: +3 to −4 dB from −0.5 to + MHz relative to each visual carrier.

The sweep oscillator is set to make a single, slow sweep across the band of interest. For the headend response, it's best to sweep each channel individually to get the frequency accuracy needed. For response of the distribution system, high band and low band can be swept using two sweeps. (If mid-band and super band are used, these will require additional sweeps.) The sweeper output should be set to equal the visual carrier level at the test tap chosen.

The spectrum analyzer is set to rapidly scan the band of interest, and the vertical scale set to 1 dB/DIV or 2 dB/DIV depending on the analyzer in use. The baseline clipper can be used to blank the bright baseline area, and variable persistence used to store the trace on the CRT. Upon signal from the operator of the spectrum analyzer, the sweeper is triggered, and the resultant trace stored on the analyzer.

A 100-second sweep time on the sweeper with a 50 MHz sweep width will give about 10 seconds of interruption on each TV channel. For most requirements, a 10-second sweep time can be used, which will give only a 1-second interruption of service.

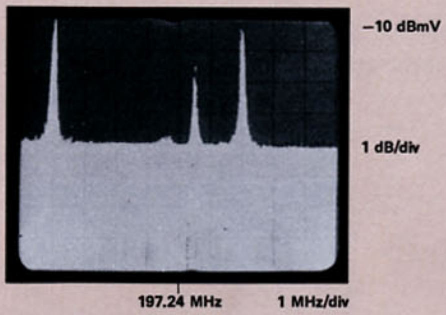

Figure 9.2 Flatness Sweep of a Single Channel

Accuracy Considerations

The flatness of the spectrum analyzer and sweeper are the main determining points. Typical flatness across any channel is sufficient for this measurement. Also to be considered is mismatch due to components which vary from 75Ω. The sweeper and spectrum analyzer must both be well matched to the line. Pads can be used wherever there is any doubt.

CHAPTER 10
SUMMARY

The spectrum analyzer is useful for almost all CATV measurements. The flexibility of the analyzer reduces the amount of test equipment needed, and the use of the analyzer is easily mastered. The only measurements which can not be made with the spectrum analyzer are differential gain and differential phase and echo rating which are required as part of Canadian Broadcast Procedure 23.

Recommended Equipment

Spectrum Analyzer System

HP 8557A Option 002 or	HP 8558B Option 002 or	HP 8554B
181T	181T	8552B Option H20
		141T
		11694A

Preamplifier

HP 8447C Option 002

Sweep Oscillator

HP 8620B
86210A

Antennas

Singer 95010-1
MD-105-TI

Frequency Counter

HP 5300A/5303B

Tracking Generator

HP 8444A (Note: With 8558B, Option H58 required)

Oscillator

HP 3200B

Matching Transformer

HP 11694A

Directional Couplers

Jerrold DC-8 (If taps are not provided)

Mixer

HP 10514A

Cable Assembly (To connect to 8553B 150 MHz LO)
HP 11592-60013

APPENDIX

Conversion Factors

dBm (50Ω) to dBμV

$0 \text{ dBm} = +107 \text{ dB}\mu\text{V}$

dBm (75Ω) to dBmV

$0 \text{ dBm} = +48.75 \text{ dBmV}$

dBmV to dBμV

$0 \text{ dBmV} = 60 \text{ dB}\mu\text{V}$

dBμV to dBμV/m

depends on antenna; see Section 9.

dBμV to μV

$$\text{dB}\mu\text{V} = 20 \log \frac{\text{V (in } \mu\text{V)}}{1\ \mu\text{V}}$$

$$\text{V (in } \mu\text{V}) = \log^{-1} \frac{\text{dB}\mu\text{V}}{20}$$

APPLICATION NOTE UPDATE

AN 150–6

SPECTRUM ANALYSIS....
CATV Proof of Performance

Since the printing of AN 150—6, Hewlett-Packard has introduced a new CATV spectrum analyzer, the 8557A Option 002, which operates from 10 kHz to 350 MHz. This new analyzer satisfies all the requirements of CATV measurements described in the proof of performance note.

Please add:

- HP 8557A Option 002 Spectrum Analyzer
- HP 181T Oscilloscope Display

to the list of recommended equipment on pages 1 and 23.

HEWLETT hp PACKARD

Supplement for 5952-1230

Printed in U.S.A.
April 1975

HEWLETT hp PACKARD

PRINTED IN U.S.A.