such people as Graybar, Westinghouse, and others. The National Electrical Safety Code is available, should any of you wish to order a copy of it, from the Superintendent of Documents, U.S. Government Printing Office, Washington. It is Handbook H-81, and it costs $1.75. It could very well be the cheapest investment you ever made; and I strongly urge that each of you secure a copy of it.

This concludes my remarks, Mr. Chairman. (Applause)

CHAIRMAN SCHATZEL: Thank you very much, Mr. Karnes; and again we say thank you, Mr. Stilwell.

I believe we all appreciate the work these two gentlemen have been doing to further the interests of the CATV industry in connection with these Codes.

Serving with Mr. Stilwell on this Committee is a gentleman who is in our audience, and I note that he wishes to make a comment.

MR. H. J. SCHLAFLY, JR.: Mr. Chairman, I did serve with Mr. Stilwell on this Committee, and I want to emphasize a point that he spoke of, and that is that the draft on the National Electrical Code has not been approved nor adopted by the NEC as yet.

I want to read a word of caution from our current print:

"The above draft has been proposed by the NCTA Standards Committee and delivered to the appropriate NEC panels for their consideration, but there has been no assurance nor indication that the draft will be adopted in this form for the 1968 publication as part of the Code."

So, if it comes out in the end with slightly different flavor than we have been able to report today, please do not be too greatly surprised; but your Standards Committee will endeavor to retain it in its present form if at all possible.

CHAIRMAN SCHATZEL: Before going to the next speaker I would like to present an announcement.

(Announcements)

We are going to change the agenda, moving past the panel which was scheduled to appear next, and going to the last of the morning items which is entitled, COMPARISON OF DEMODULATOR-MODULATOR VERSUS HETERODYNE SIGNAL PROCESSING FOR CATV HEAD ENDS.

The speaker who is going to discuss this subject, I heard a couple of years ago in Denver, when he discussed transmission distortion in CATV. At that time, as I recall it, he was discussing envelope delay distortion, and it was a most interesting paper. What he was talking about was a problem that was facing us in transmitting signals over CATV systems.

It is my hope this morning that perhaps he is going to give us some of the answers to that problem, among others.

Our speaker is Mr. Gaylord Rogeness, who holds Bachelor's and Master's Degrees in Electrical Engineering from the University of Illinois. After several years of experience with various companies in the electronics industry, he joined AMECO, where he is now the Director of Engineering, located in Phoenix.

At AMECO he developed the solid state heterodyne signal processor which AMECO has recently introduced. He has, also contributed to several other items developed by his company.

It is a privilege and a pleasure to introduce Gaylord Rogeness. (Applause)

COMPARISON OF DEMODULATOR-MODULATOR VERSUS HETERODYNE SIGNAL PROCESSING FOR CATV HEAD ENDS

by

Gaylord G. Rogeness

1. Introduction

Two techniques which have been used to receive and process television signals before they are applied to the cable system are the Demodulator-Modulator combination and the Heterodyne converter. The intent of this paper is to compare the two techniques.

With present day microwave relay equipment, at least one demodulatin-modulation is required before the television signal can be applied to the cable system. Hence it is imperative that the demodulator and modulator have characteristics which will minimize distortion of the television signal. However, when the choice between use of a heterodyne converter or a demodulator-modulator pair exists, the heterodyne converter is currently the best choice. Reasons for this choice will be given in the paper.

2. Heterodyne or Converter with IF Amplifier

The VHF converter with IF Amplifier, which will be referred to as heterodyne in the remainder of this paper, must convert any incoming VHF channel to any desired output VHF channel. The signal received from the antenna must not be degraded during the conversion process. Ideally, one requirement of the system is a flat passband from 750 khz below the picture carrier to 4.18 mhz above the picture carrier.

Figure 1 shows a block diagram of the heterodyne. The VHF signal input is amplified by an RF amplifier before it is converted to IF frequencies by the local oscillator in the input mixer. Adjacent channel trapping is accomplished in the IF amplifier. The IF sound carrier is normally separated from the

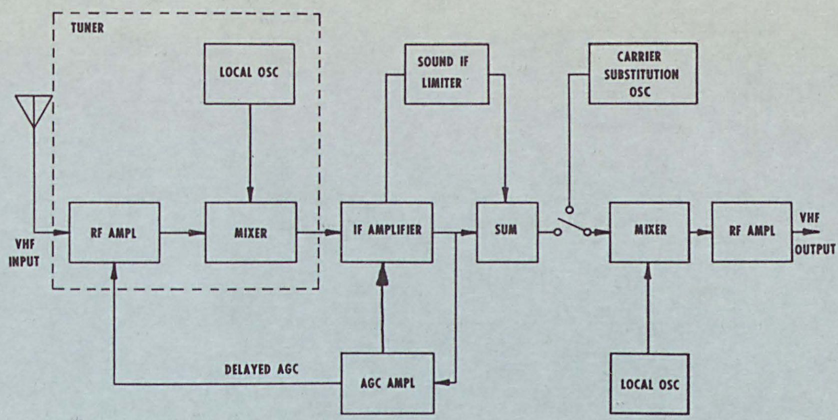


FIGURE 1 HETERODYNE BLOCK DIAGRAM

video IF carrier, amplified and limited, then summed with the output of the IF amplifier. This operation allows independent adjustment of the picture carrier to sound carrier level.

The output of the IF amplifier is held at a constant level by AGC action which controls both the RF amplifier and IF amplifier gain. The RF amplifier is normally allowed to operate at maximum gain until the input signal level reaches a point at which the signal-to-noise ratio will not suffer by a reduction in gain. This is known as delayed AGC. The combined IF output is converted to the desired VHF channel by the output local oscillator in the output mixer. If "on channel" conversion is required, the input local oscillator drives the output mixer and the output local oscillator is disabled. Differential gain and differential phase will be almost non-existant, since mixer conversion is not related to modulation percentage.

Two major advantages of the heterodyne over the demodulator-modulator are excellent low frequency phase linearity and no quadrature distortion. Referring to Figure 2a note that the heterodyne IF amplitude response is flat over the entire video modulation bandwidth. Hence, a linear phase characteristic over this bandwidth is relatively easy to realize. The demodulator IF amplitude response however, is down 6 db at the carrier frequency. A linear phase response is difficult to obtain with this type of amplitude response.

Quadrature distortion, which is discussed in more detail in the next section, is generated when the video signal is detected or demodulated to baseband.

Since the heterodyne does not detect the video signal, but merely translates the frequency of the video modulated RF signal, no quadrature distortion is generated.

3. Demodulator

A block diagram of a demodulator is shown in Figure 3. The demodulator receives the incoming VHF television signal, amplifies it, and converts it to an IF frequency for further amplification and filtering. Up to this point, the demodulator and heterodyne are identical. The IF amplifier provides gain before the video modulation on the IF carrier is detected, and finally amplified at baseband video in the video amplifier. The demodulator also provides the audio output either at audio frequency or on a 4.5 mhz subcarrier (or both).

The demodulator circuits which have the greatest effects on the video signal, in terms of distortion, are the IF amplifier and the detector. A typical IF amplifier response is shown in Figure 2b. The sound carrier must be trapped out to minimize cross modulation distortion in the detector. This filter operation is difficult to accomplish without introducing amplitude and phase distortion to the color subcarrier and sidebands. Note that the edge of the color subcarrier sidebands extends to 41.57 mhz, only 0.320 mhz from the sound carrier.

Filtering of the sound carrier at IF frequencies is also required in the heterodyne IF amplifier. Hence, both the demodulator and heterodyne are challenged to minimize high frequency phase distortion.

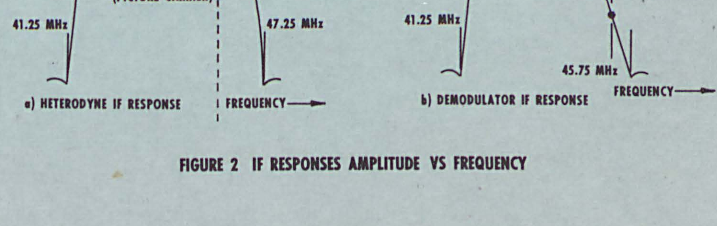


FIGURE 2 IF RESPONSES AMPLITUDE VS FREQUENCY

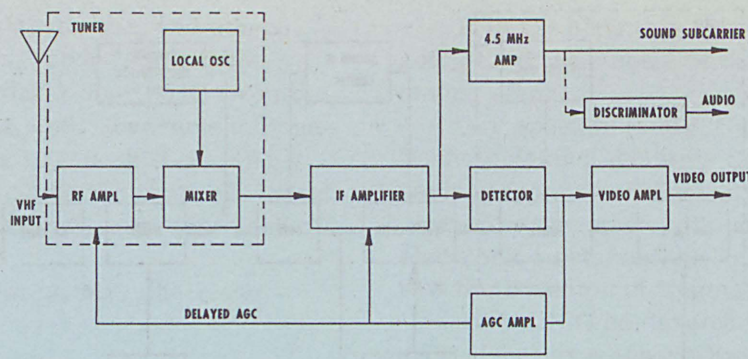


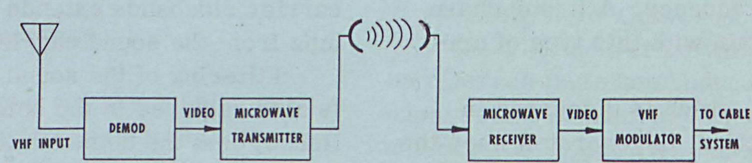
FIGURE 3 DEMODULATOR BLOCK DIAGRAM

The VHF television signal is transmitted as a vestigial sideband signal. As previously mentioned, the IF response required to produce a constant amplitude detected video signal must attenuate the frequencies near the video carrier which are double sideband. The phase response in this region must therefore be linear so that low frequency phase distortion is minimized. Low frequency phase linearity with the required IF amplitude response poses a difficult design problem.

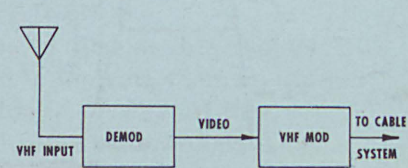
The video detector produces baseband video from the IF amplifier output. An envelope detector is a standard means of demodulating the IF signal. Differential gain and phase, which are a function of modulation percentage, will be introduced in the detector and can only be minimized. The use of an envelope detector is significant, since the signal being detected has a vestigial sideband characteristic. Vestigial sideband meaning one full sideband and a "vestige" or "part" of the other sideband is transmitted. When a vestigial sideband signal is applied to an envelope detector, an effect similar to low frequency phase distortion occurs at low modulation percentages, and quadrature distortion occurs at high modulation percentages. (Ref. 1) Quadrature distortion manifests itself as differential gain and differential phase on color signals. Quadrature distortion also affects the transient response, producing overshoots and streaking. (Ref. 1, 2, 3)

In summary, the demodulator IF amplifier must be carefully designed to minimize both high and low frequency phase and amplitude distortion. Differential gain and phase can be minimized by linearizing the detector. However, quadrature distortion is inherent in a vestigial sideband system utilizing an envelope detector and can only be minimized by utilizing nonstandard complicated video processing equipment.

Two applications of the demodulator are shown in Figure 4. In Figure 4a, the demodulator output, baseband video, is used to frequency modulate the microwave carrier of a microwave relay transmitter. The microwave receiver of the relay link then provides baseband video for the cable system. In Figure 4b, baseband video from the demodulator is applied directly to a VHF modulator which drives the cable system. A VHF modulator is therefore required in conjunction with a microwave receiver and also for direct use with a demodulator. The next section discusses VHF modulators.



a) MICROWAVE RELAY LINK



b) VHF CONVERSION

FIGURE 4 DEMODULATOR-MODULATOR APPLICATIONS

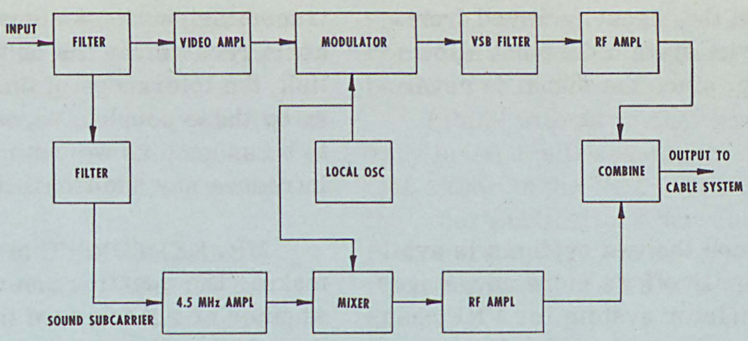


FIGURE 5 VHF MODULATOR BLOCK DIAGRAM

4. Modulator

A VHF modulator block diagram is shown in Figure 5.

Major sources of video signal distortion occur in the heavy outlined blocks in Figure 5. The modulator transfer characteristic depends upon the modulation percentage utilized. To maintain the highest signal to noise ratio, a high modulation percentage is desirable However, at high modulation percentages, differential gain and differential phase occur on the color subcarrier.

For adjacent channel operation, a vestigial sideband (VSB) filter is necessary (reference Figure 6). The VSB filter must be optimized to minimize phase distortion at frequencies near the picture carrier. This is a difficult filter design problem. The phase distortion generated in the VSB filter is usually compensated for in a video phase equalizer.

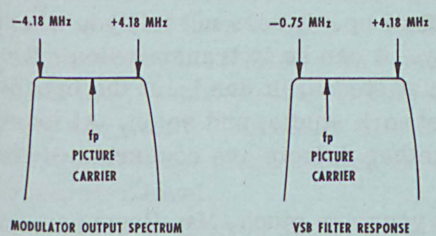


FIGURE 6 MODULATOR CIRCUIT CHARACTERISTICS

5. Comparison of Two Systems

In Table I, the demodulator-modulator system versus heterodyne system is compared on the basis of video distortion which is difficult to avoid. Item 1, phase nonlinearity near the color subcarrier and sidebands, can be minimized in both systems so as to produce a negligible effect on the picture. However, items 2 through 4 require complicated video processing equipment with the demodulator-modulator systems if pictures comparable to the heterodyne system are to be consistently provided.

Since the modulator utilizes down modulation, if the broadcast program goes off the air, a cw carrier signal to the cable system automatically results. The heterodyne system must provide a separate carrier substitution oscillator for this condition.

The heterodyne system offers the advantage of higher reliability because of the greater number of circuits and components required in the demodulator-modulator system. The probability of component failure is reduced since fewer components are required in the heterodyne.

Because of past and present day performance of these two systems, a subtle advantage for the demodulator-modulator system may be overlooked. A properly designed demodulator-modulator pair, used in conjunction with the necessary video processing equipment could conceivably produce an output with

Table I. Sources of Video Distortion

	DISTORTION	DEMODULATOR	MODULATOR	HETERODYNE
1.	Phase nonlinearity near color subcarrier and sidebands	Sound trap in IF amplifier	Video low pass filter	Sound trap in IF amplifier
2.	Low frequency phase distortion (delay distortion)	IF amplifier response	Vestigial sideband filter	
3.	Differential gain and differential phase	Video detector	Modulator	
4.	Quadrature Distortion	Video detection of vestigial sideband signal		

characteristics better than the signal received from the antenna. The heterodyne system does not allow complete video processing, since the signal is never below IF frequencies.

CONCLUSION

When the choice between the two systems is available, the heterodyne presently offers more advantages than the demodulator-modulator system for VHF channel conversion. However, microwave relay links require the use of a demodulator-modulator system. Hence, the problems associated with this system must be minimized in order to service this application.

REFERENCES

1. "Quadrature Distortion Correction for Vestigial Sideband Transmission" by Siegfred Dinsel, presented at SMPTE Technical Conference, November 1-5, 1965.
2. "Transient Response of Detectors in Symmetric and Assymetric Sideband Systems" by T. Murakami and R. W. Sonnenfeldt, RCA Review, December 1955, pp. 580-610.
3. "Improving the Transient Response of Television Receivers" by Avins, Harris and Horvath, Proc. of IRE January 1954, pp. 274-284.

CHAIRMAN SCHATZEL: We have a sufficient time for a question or two.

MR. JOHN MONROE (VUMORE Company): We all appreciate the use of the heterodyne for off-the-air equipment; but when can we expect a better type of hardware for the other use?

MR. ROGENESS: That is a different question to answer.

I would suspect that within the next year there would be equipment available if you are willing to pay the price.

MR. DONALD LEPTON (SWVA): I should like to ask in connection with the demodulator-modulator that you referred to, whether you found a great deal of difference, or whether you found the transmitting stations have this problem and are handling it 100 per cent?

MR. ROGENESS: The transmitting stations do have this problem. I believe that transmitters do use both low and high frequency phase equalization to prevent distortion of the video transmission.

I do not believe, however, they do anything to correct for the quadrature distortions, and since the transmission was designed for the broadcaster and home receiver as the only items in the transmission link, the tolerances of this system are mainly used up by these people. So, any equipment we insert has to be as good as we can make if if we do not want to introduce any additional distortion.

MR. LEPTON: That is the point I wanted you to make. The question comes up, how can we know whether or not for sure the distortion is created by them? Or, do you know of any equipment that will take and monitor an off-the-air signal with absolute credibility?

MR. ROGENESS: I cannot specify any specific equipment; but this is a definite possibility, that with the right equipment available, the CATV operator could monitor the off-the-air signal and determine what the quality of signal is that is being received, so he will know if he is inducing any additional distortion in the transmission system.

CHAIRMAN SCHATZEL: I think the vertical interval test signals, the vertical interval test signals now transmitted by the networks, provide an opportunity to the CATV operator who provides himself with the necessary additional testing equipment. It provides him an opportunity for obtaining some of the information you are talking about now, although not all of it.

It does tell you if there is a transmission defect somewhere between the network studio and where you pick the signal up. It does not tell you where it is, necessarily. It can be in transmission. It can be at the broadcast studio. It can be at the broadcast station, the network studio, and so on. At least it will tell you whether defects are occurring in transmission.

Thank you very much, Mr. Rogeness.

MR. LEPTON: Mr. Chairman, I have a question not relating to this particular schedule. When are you handling the NCTA Standards?

CHAIRMAN SCHATZEL: I am glad you asked that question, because I am about to introduce Archer Taylor, Chairman of the NCTA Standards Committee, who will conduct a brief summarization of the subject indicated on our agenda, THE NCTA STANDARD ON CATV AMPLIFIER DISTORTION.

MR. TAYLOR: About an hour ago it looked as though we had used up all of our "cushion" because of our rather late start. Some of the speakers have, I think, condensed their presentations, so that we still have a little time left.

Unfortunately, however, in the hastily-called conference I believe Jake Shekel has left. Am I correct? Is he in the room?

I am going to introduce the people who were listed on the panel in your brochure, and we will proceed very quickly into allowing questions on this general subject after an introduction.

I believe it would be helpful if the remaining panelists would come to the rostrum. Jake Shekel was to have been on the panel. He was all prepared, and I might say he is a very helpful member of the Committee. Unfortunately, when we were delayed, it was necessary for him to leave, and he is not here at the moment, but perhaps will joint us later.

Mr. Mike Rodriguez, of VIKOA, Inc.; Mr. Ken Simons, of Jerrold; Mr. Earl Hickman, of AMECO; Mr. Heinz Blum, of Entron Company, comprise our group.

I will take a few minutes to briefly describe what the Engineering Subcommittee of the NCTA Standards Committee is, and then throw the discussion open to questions from the floor. If you would like to ask a particular member of the panel a question, designate him by name; otherwise, I will channel the question to someone for reply.

Basically, the standard is a method of specifying and measuring amplifier distortion.

We changed this from the original proposal because we found in practice that it was unworkable, and in several respects meaningless.

The test, briefly, is with 12 channels, and I will oversimplify this somewhat without some of the explanations that are given in the standard itself -- the test is with 12 channels, modulated with a symmetrical square wave. In fact, generally this will be 100 per cent modulated, although the standard allows for a minimum carrier level not more than of one-eighth of the maximum carrier level.

The channel upon which you are making the measurement has modulation removed with the others all modulated synchronously, so the modulation maximum amount occurs at the same time; and the measurement is then made by measuring the sideband voltage which appears on the unmodulated carrier as a result of the modulation on other carriers.

Frequency of the modulating square wave is 15.75 kilocycles, plus or minus 20 per cent, so that a sharply-tuned voltmeter becomes the measuring device to measure the 15.75 kilocycle sideband resulting from cross-modulation.

A second important aspect of the standard is the specification of spurious frequencies. This is defined broadly to cover signals occurring within any of the test channels, at frequencies differing from the frequencies of the test carriers.

This measurement is made in a number of different ways, the most practical method being with a spectrum analyzer actually exploring the video spectrum for undesired frequencies within the video path band.

I think without further explanation, and this is very brief, I will assume that many of you have read this either in the NCTA BULLETIN, or in some of the other publications that have reprinted it. I think from here I will open the discussion to questions from the floor, and we will see where we go from there.

MR. CAMPBELL: What kind of delay do you propose between your bulk so this 15 resembles a faint pulse?

MR. TAYLOR: Do one of you want to answer that? Ken, do you want to speak to that?

MR. KEN SIMONS: I think one of the question parts of the standard that has aroused more comment than any other part had to do with the wave form of the modulation on the undesired interfering characters; and in my opinion, which I believe can be substantiated by measurement, it is that the wave form is relatively unimportant provided that it is within the vicinity of 15 kilocycles, and provides a suitable correction factor is applied to take care of whatever duty is given it by the particular modulation wave form.

There is much to be said about a pulse modulation. It would allow you to look on a receiver and see what was being created, and it would simulate real life, so to speak; but the Committee felt that a square wave is the simplest form of modulation to generate, to determine that a square wave does in fact have a 50 per cent duty factor, so that you merely have to measure the DC level. The DC level is 50 per cent of the peak; it has a 50 per cent difficulty factor.

Also, the oscillators, if you turn them off and on half the time at a 50 per cent kilocycle rate, you do not have to go through any difficult modulation standard.

We want this test to be as easy and as economical as possible so that people can do it. You can elaborate on it as much as you desire. You can take the test signal and say that the test signal should be modulated with television signals derived from the IA standard generator; but this adds cost to the test, and there is some question as to whether this is justified.

The only question is as to what the wave form on the undesired carrier should be, and has to do with the question, is there a correlation between various wave forms?

It was the consensus of the Committee that at the time we settled on this standard there was such correlation and we could use such a square wave.

If there are those who disagree with this, I think it is up to them to show there is not correlation, and it can be considered and modified.

This standard, as you understand, is a proposed standard and open to discussion, and is certainly ready to be modified in any way where this modification can be shown to be desirable.

I would again say the object of the game here is to get a simple test, as simple as possible, in a complex situation; a simple test which will correlate, in fact, with observed pictures.

Does that answer your question?

MR. CAMPBELL: Thank you; that is fine.

MR. TAYLOR: I would like to make one correction, Ken, if you do not mind.

The Board of Directors of NCTA has actually agreed with the Standards Committee's recommendation that this is a NCTA standard. I think it was proposed a year ago, and it has been subject to considerable comment and major revision. As of now, this is a standard of the NCTA industry, although any standard can, of course, be modified upon the proper showing of the need for modification.

Are there further questions?

I would like to point out that in the meantime Jake Shekel has joined us. He is with the SKL Company.

Thank you, Jake.

Does anyone have a question?

MR. BERNIE EVANS: I am curious as to whether these are a group of astrometrical 15 kilocycle oscillators, or whether all of them are on and off alike? I am a little bit unfamiliar with the detail of the standard, and perhaps my question is premature.

MR. TAYLOR: The intent is for all carriers to be on simultaneously and all off simultaneously, as precisely as possible at the same time. Then the carrier on which the measurement is to be made has the modulation removed so it is unmodulated CW, with the other modulators as described.

Does that answer your question?

MR. EVANS: Yes, thank you.

MR. TAYLOR: Are there further questions? Go ahead --

MR. CAMPBELL: I suppose I should direct this inquiry to Mr. Simons because we sell him a number of products, as do many others, and I assume we can use that CW oscillator and other heterodyne systems for the clear channel.

My question is: Is there any way to get that 15.4, or whatever it is, over to the other commanders that want to do it that way at once, without too much expense?

MR. SIMONS: I think the question is primarily one of where we are talking about the equipment being available, or being made available for making this test, and it seems to me rather evident that with an NCTA standard amplifier distortion, a standard on amplifier distortion, there are certainly people in the world who are interested in making money from selling test equipment, and I am sure that will generate the necessary enthusiasm.

To be more specific, however, if you have some form of heterodyne converter, as Mr. Rogeness has been describing, all you really need is an incorporating signal. We in the laboratory use a 608, which is rather expensive, but it does not have to be that type of signal. You can use any small oscillator and key it on and off at 15 kilocycle rate.

The circuitry involved is not very elaborate, and I hope my Instrument Division representatives are not present to hear me say it, but it should not be very expensive because it is quite simple, technically speaking.

We have purposely written the standard with that in mind. We simply need an indication. Unless we are mistaken, the exact specifications on the undesired signal are rather unimportant. It has to create a strong change at 15 kilocycles from zero to off. It could be silently modulated. It could be bulk-modulated. It could be square-wave modulated with due regulation in the final reading subtracting or adding db; and the measurement could be made on the standard set.

What you need is an IF signal. It should not be difficult.

There are, however, two areas where it is required, and with the signal you get on the desired channel, this must be very clear if you are attempting to measure 60 modulation plus. This puts it on the mixing network where the various channels are concerned, and you must have it clear so you do not have interaction between the various ones.

There is one other point, if I may just comment on it, Mr. Taylor --

MR. TAYLOR: Proceed --

MR. SIMONS: This is the specification, the proposed -- it isn't proposed any more --

MR. TAYLOR: Not proposed any more --

MR. SIMONS: The NCTA standard calls for a measurement at operating conditions, and this sounds very innocent and very essential, but the implication is not quite so simple, because the operating condition is for a line amplifier in the CATV system at levels which are 10 or 15 db below where we have been specifying, and at those levels typically plus 30 to 35 dBnV, the distortion is incredibly small. It has to be so after you cascade many amplifiers, for you do not get a reasonably sizable distortion. It is so incredibly small that it is difficult to measure. This is measuring at minus 85 to 90 db cross-mount.

It is not the intention of the standard to measure at that level. It is the intention, and it was attempted to be written so that the manufacturer guarantees that the amplifier will work at that level and will produce at that distortion.

He may arrive at that distortion by cascading 20 amplifiers and measuring the total distortion, if he is unable to measure at the operating level. There have, however, been advances in the cross-modulation technique, and I am sure the testing people will be stimulated to make the measurement at the operating level. I believe this serves the interest of the system operator because he is buying an operator the manufacturer is saying in effect that when you connect 20 of these, each will produce less than X db distortion, and the result will be good. This is more important.

We purchase sugar on a pound basis, where your pound and my pound are the same pound; and to try to end the confusion when someone says, "My amplifier will put out X dBnV under certain circumstances", this was written.

MR. TAYLOR: Are there further questions?

MR. SWITZER (Toronto): Mr. Simons, you made the statement that you were making the standard apply to a system a small degree higher than it would be if you had a stack of commanders. The simplest way to put a synchronous signal on them all is just to tune all 11 of them to the desired one good, clear, signal, and put the substitution carrier on the one you are checking, and this would be as close to home in your measurement on the distortion that you would want to come; and the instrument problem is not really at the head end. It turns on at the source to meet the standard, or come close to it.

The instrumentation, however, at the other end represents a problem in terms of money and measurement, and so on.

MR. TAYLOR: I would like to raise a question about the measurement of spurious frequencies, and something on that issue. I would like to have some comment made on spurious frequency measurement.

MR. MIKE RODRIGUEZ: One of the problems we have found VIKOA is that although we have the instrumentation, with the proper dynamic range, in order to measure cross-modulation, and incidentally, this dynamic range is somewhere in the order of about 100 db, with that we achieve in utilizing the video output which we put into a recording ray analyzer, a general radio instrument, what this really results in is a receiver with a three-cycle band width.

You can see where you would naturally achieve tremendous sensitivity. The problem, however, is that this recording regulator analyzer is designed for the audio spectrum, and it has a total AC bandwidth a 50 kilocycle measurement. On that basis, of course, if you are searching the spectrum for spuriae you will find you have a really tremendous chore because at 50 kilocycle stems it takes quite a while to check a frequency band between 50 and 220.

Our technique is based on a spectrum analyzer; a cascaded analyzer search, so that spuriae are at least within the capabilities of the spectrum analyzer.

Once we have identified the spectrum frequency within the display of the frequency spectrum analyzer, we use a 608 in connection with a controlling device similar to a synchronizer which gives crystal stability, and the purpose of this is to bring the signal or the signal generator within or close to the spuriae which we have identified.

Then what we do is we take this signal generator; use it as a local oscillator; put it into a mixing device, and then beat the spurious frequency into the 50 kilocycle range of the wave analyzer. At this point, then, of course, it is possible to make a quantitative measurement regardless of how low the spurious response may be.

MR. SWITZER: Looking at the availability of wave analyzers to cover the whole band of interest from the low to the high, and noting that it will take a whole stack of them because you get an audio from 20 to 220 megahertz, and then perhaps something up to 20 as well, there will be a spectrum analyzer that will analyze a single display, 10 megaherta to 20 megahertz, and will spot any spuriae there that should not be there.

It will simplify the search for the spurious.

We have done it by scanning the IF out of a receiver as a free collector, because most spectrum analyzers need a free collector of some kind to look for these things; and the problem that I have found in working with these is that often the best will cause the most trouble, and the one you are most accessible to is of the third order, the product from any three channels. Any two will fall back and the third will fall back as an almost co-channel. On the third one, it will either be above or below. This is a low-level spurious, and it is very close to the carrier, and in a spectrum analyzer display that has a carrier in that spurious, it will often be hiding right under the skirt.

We find it preferable to scan the video; that is, to scan the base panel in effect where the carrier is in the setup.

MR. RODRIGUEZ: This triple beat you mentioned is interesting, because we recently conducted a computer program in order to identify and get an idea of the magnitude of these various spurious responses that do occur, and how many of them there are that are involved.

Just on the basis of 24 carried, we eliminated 12 video and 12 town. The computer identified a total of 63,000 spurious responses, 40,000 of which were of the triple beat variety.

MR. SWITZER: As a practical circumstance, that triple beat that I speak of probably exists in more systems than people realize. We begin to feel that what we call a kind of "waterfall" effect, with some of our pictures, and often what looks like a co-channel, when we know really there is no reason for a co-channel, may be just that third order IM beat from three adjacent channels.

MR. TAYLOR: Other questions come to mind, I am sure, that you would like to ask, and we still have a few minutes remaining.

I would like to have some of these people who have developed test instruments to comment. Do you want to make some comment about the testing procedures?

MR. EARL HICKMAN: I was afraid you would never ask. (Laughter)

If you would like to see an integral test unit that is built following the NCTA standard, if you will drop by our booth I will be glad to demonstrate it.

MR. TAYLOR: I think there are probably some other devices, actually, and I wonder if you would like to say something about yours?

DR. JACOB SHEKEL: I believe all I can do is repeat what Mr. Hickman has said. There is one in the booth, and I will be glad to demonstrate it there.

MR. TAYLOR: Mr. Earl Hickman is with AMECO. Are there any questions? Are there any further comments that you would like to add for the good of the order?

MR. HEINZ BLUM: Just the same comment that my friend, Jake Shekel, made.

MR. TAYLOR: I have not been through the Exhibit Hall so I am not sure what is to be seen there.

MR. SIMONS: We, too, set up a computer program, and we are amazed with the result. It reminded me of an event that happened in my family when my boy, who is now bigger than I, was about 10 years old. We fell a victim to a salesman and bought a set of the ENCYCLOPEDIA BRITANNICA. When the books first came we were looking through them, and under "anatomy" there are a number of beautifully colored charts.

This has to do with the 63,000 beats, and how the CATV survived with all of these beats. There were these beautifully colored charts. You pick them up, and you can work them from the inside out, and cover the entire body. You see the intestines, the spleen, the liver, and the heart, and so on.

Our young son looked at this and he said, "You mean that is inside me, all those things? You mean all of that red thing, all that curlicue?"

We replied, "Yes."

He said, "I think I'll go lie down." (Laughter)

MR. TAYLOR: Unless there are further questions, I would like to close this by reading the information that the Committee has published on how an amplifier should be specified with regard to distortion, and it is our hope that customers will not have to have their own elaborate testing facilities; that manufacturers will specify in this form, which we hope and believe will prove to be meaningful, the necessary data.

(Mr. Taylor presented Specifications on Distortion.)

I will ask once more, are there further questions?

MR. RAY ROHRER (Kalispell, Montana): It is the intent of the Subcommittee of the Standards Committee to check on manufacturers that use this standard?

MR. TAYLOR: You ask a difficult question to answer.

The policing of this will be subject to the Board of Directors of NCTA, and on recommendation of its Standards Committee.

I might say that we have copyrighted, for example, the Able Cable Symbol, and therefore refusal of permission to use that symbol has been ordered by the Board of Directors.

I presume the Board of Directors would take such action as might be recommended by the Standards Committee in the case of abuse or misuse of the NCTA standard.

Are there other questions?

MR. ROBERT HOWARD (AMECO): I am still a little unclear as to how to correlate the new standard to a practical systems case, because of one hand you are not prepared to give me an answer for a situation which generates the worst case numberwise, but does not particularly relate to the practical case, because as was discussed yesterday by William Rheinfelder, the case of the random modulation is much more visibly detectable than the case of the synchronous modulation. Therefore, I am a little confused.

I would like an expression from the group up there as to what kind of a correction to make to the number that I now have to relate it more correctly to my system application?

MR. TAYLOR: I would comment, first, on this that there is a great need for some subjective correlations between what we are generally calling cross-modulation and subjective evaluation of picture quality. This has not been done in any extensive manner, and as you have indicated, and as Mr. Rheinfelder indicated, the parameters are complex and numerous.

The first step, however, in that process comes to the matter of how do you define the distortion that you want to correlate with subject evaluation? This is only a first step.

The next step now will be to provide the correlation with actual picture degradation.

I think that the effort of the Committee was to adopt a worst-case situation, namely, with all of the modulation in phase; how you allow it to go below that is at this moment indeterminate.

Does anybody else care to comment on that question? Apparently everyone has something to say on it.

MR. BLUM: The Standards Committee, of course, wanted to establish a standard measuring technique. It did not intend to set up a standard for the performance of an amplifier, nor for the performance of a system.

In this connection, I would like to acquaint everybody with the capability of computing systems performance in a very simple manner. The cross modulation ratio for each amplifier has been given according to the language we have set forth in the standard, and if you just total the figures for all amplifiers in cascade ahead of the location to be examined, you can determine the cross-modulation at every or any point on the system regardless of whether it is in the trunk line at the output of a bridging amplifier, or at the end of a distribution line. This added advantage is one of the fringe benefits of the particular standard.

Even though we do not attempt to say that we must have a certain minimum distortion line value, is so represented.

Some of the systems operators, as well as manufactures and turnkey constructors, have set certain standards for themselves. These vary.

A very large systems operator uses a standard of 52 db. This is nothing we have to adhere to; we can use other figures if our experience dictates otherwise.

MR. TAYLOR: I will recognize Mr. Rodriguez.

MR. RODRIGUEZ: Just as Bob indicated, Bob Howard, we VIKOA are also very much concerned about making some subjective comparisons in terms of actual performance versus the measurements.

I had intended to wait until this afternoon at which time the Engineering Subcommittee and Standards Committee are going to have a meeting. Is this correct, at two o'clock?

MR. TAYLOR: This is right.

MR. RODRIGUEZ: What we would like to do is volunteer a 60 amplifier system which we actually have working at our facility. We use it merely as an experimental system. Using this system perhaps we could organize a time at which we could actually sit down and make these measurements and make the subjective measurements and attempt to correlate these with the actual distortion measurements that one gets on the instrument.

MR. HICKMAN: I think if we get too deeply involved in this we could get caught in our own trap. I think it all goes back to the system specification.

If a system is to be built using only one amplifier, obviously that amplifier does not have as low a cross-modulation product as the system which would require a considerably larger number than one amplifier.

So, I think we should restate that the intent, as I see it, of this Committee, is merely to come up with a basis for comparison, a clarification of what we mean when we speak of cross-modulation and attach a number thereto, so that we do not have to go into a long dissertation each time we say that our cross-modulation products are down 60 db or 50 db, or whatever the figure; that it will be immediately known what we mean by such a quotation.

That is the principal purpose behind using synchronous modulation on the carriers as the test prescribes.

If we did not use synchronous modulation, we could use any other form of random modulation and it would be very difficult to describe, and we might have trouble finding the common denominator.

DR. SHEKEL: I just want to make clear what the standard does not set or specify, so there will not be any doubt about it.

The standard does not set a level of distortion which is desirable for a single amplifier. It does not say how the distortion accumulates along the line. It does not say what the picture quality should be at the end of the line. We all have our personal opinions, as well as company specs; but it is not included in the standard.

The only thing implied by the standard is a standard way of specifying individual amplifiers, so that a customer can read the specifications of different amplifiers, compare them, and draw his own conclusions.

We believe that if two amplifiers, A and B, that -- measured under the same conditions -- if amplifier A has a lower distortion than amplifier B, and if then two identical systems are built using these two types of amplifiers, then the system with amplifiers of type A will have less distortion than the system with amplifiers of type B. This is the only correlation that we do imply between the specifications of a single amplifier and the picture quality in a system. The standard does not imply any precise numerical relations between amplifier specs and systems performance.

If anyone can prove that this general assumption is not true, that means if the rating of those two amplifiers A and B, does not lead to the same rating of systems, I think we would like to hear about it, and we may then modify our standard. I think, however, that the standard does, what it was supposed to do, and I would not like anyone to assume that it does anything more.

MR. SIMONS: I just want to say that if you look behind these words "subjective testing", you will find it means people looking at pictures and deciding whether they are any good, or not. In your systems you have people. You have television receivers. If you had an amplifier that had a known rating, you could do your own testing. You can look at the pictures and determine whether they are any good. You do not have to wait for us to carry out tests.

We should, of course, do it in a scientific way. You can do it on your own if you have an amplifier.

MR. TAYLOR: Our time has been exhausted, and our panel has concluded.

I will turn the meeting back to our Chairman, Mr. Schatzel.

CHAIRMAN SCHATZEL: We have completed our agenda for the morning, and I think we can say thank you to our speakers for a very capably performance.

We likewise extend our appreciation to the audience for its attention.

This Technical Session is adjourned.

(The Technical Session adjourned at one o'clock.)
