THE JOURNAL OF THE SOCIETY OF BROADCAST ENGINEERS

VOLUME ONE , NUMBER ONE JUNE 1964

CONTENTS

THE

SOCIETY OF BROADCAST ENGINEERS

THE SOCIETY OF BROADCAST ENGINEERS -

Steering Committee -

John H. Battison - Chairman
Box 1534, Annapolis, Maryland

Ambrose (Bill) Kramer - Vice Chairman
Box 22 2-B, Rt.1, deFuniak Springs, Florida

Charles Hallee
66 Aldrich Road, Portsmouth, N.H.

Sid Davidson
KOA-TV, Denver, Colorado

Ben Wolfe
KPIX, San Francisco, California

Howard Town
NET-TV, Ann Arbor, Michigan

Membership Standards Committee -

Ambrose Kramer - Chairman
Box 22 2-b, Rt.1, deFuniak Springs, Florida

Fred C. Hervey
WHKW, Chilton, Wisconsin

Robert Miers
P.O. Box 1051, Wewoka, Oklahoma

I. S. Posner
35 W 53rd Street, New York, N. Y.

John Reetz
KCRG-TV, Cedar Rapids, Iowa

Gordon Brown
WSAY, Rochester, New York

REGIONAL CHAPTERS -

Number One, Binghamton, N.Y.
Chairman pro tem: Charles Hallinan, Chief Engineer, WKOP-AM-FM, Binghamton,N.Y.

Number Two, Scranton, Pa.
Chairman, pro tem: Joe Risse, Director of Electronics, ICS, Scranton, Pa.

Number Three, Hutchinson, Kansas
Chairman, pro tem: Ken Cook, Chief Engineer, KTVH, Hutchinson, Kansas

Number Four, Albuquerque, N.M.
Chairman pro tem: Bill Orr, Chief Engineer KHFM, Albuquerque, N. M.

Number Five, Atlanta, Ga.
Chairman pro tem: Hugo A. Bondy, Chief Engineer, WAGA-TV, Atlanta, Ga.

NOTICES -

Articles are invited! For Issue Number Two and subsequent issues, we need material, and the more the merrier! 1500-2000 words maximum unless very important and only line drawings until further notice please.

The Society of Broadcast Engineers acknowledges with very sincere thanks the efforts of the authors who have contributed time, effort and articles for this issue and looks forward to seeing their names on future contributions.

READERS' MAILBOX -

Letters are invited and as many as possible will be printed each issue. They may be edited if necessary for reasons of length. Address to Editor.

EDITED AND PRODUCED BY - John H. Battison

THE JOURNAL OF THE SOCIETY OF BROADCAST ENGINEERS
Box 1841, Annapolis, Maryland Telephone CO 3-6860

Printed by - Palmer Press, Annapolis, Maryland

A Salutation from the Honorable E. William Henry Chairman of the Federal Communications Commission

I welcome the opportunity to address the broadcast engineering fraternity, through this, the first issue of a new Journal devoted to broadcast engineering and the interests of those specializing in this field.

Your invitation to write a guest editorial serves as a reminder that the FCC's basic operating framework is a series of interrelated engineering standards carefully developed over the last third of a century. Indeed, its predecessor organization, the Federal Radio Commission, was created primarily to bring a regulatory solution, based on engineering principles, to a chaotic situation in the standard broadcasting band.

In our daily preoccupation with political broadcasting problems, the fairness doctrine, over-commercialization, editorializing, and the broader aspects of the social and economic sides of broadcasting, we tend to take the basic engineering facts for granted. However, this is probably the best testimonial to the fundamental soundness of its engineering structure.

Although an automobile is composed of hundreds of complicated mechanical parts, its value is measured by the extent the user is able to ignore their individual existence and enjoy its attributes as a vehicle. Broadcasting itself is a vehicle for the conveyance of entertainment and enlightenment, and the excellence of this vehicle is attested to by our ability to concentrate on its course, instead of its cog wheels.

The Commission's rules and engineering standards -- which determine the frequencies on which broadcasting stations operate, under what plan stations are assigned to these frequencies, the technical characteristics of the signals radiated by these stations, and which directly or indirectly fix the basic design of nearly all broadcasting equipment -- define the structure of a broadcasting system more advanced and more completely integrated than any other in the world. These rules and standards were developed through the deliberations of technical committees, investigations, and rule making proceedings to which the engineering profession has, in every instance, made major contributions.

I cannot speak for other regulatory agencies, but I like to think there is a special relationship between the Commission and the engineers who specialize in communications. These engineers, over the years, have given unstintingly of their talents and time whenever the Commission has asked the assistance of the profession in solving some knotty technical problem. Inevitably, there are conflicting views, sometimes on the most basic technical considerations, and there are many hard fought battles preceding Commission action to amend its technical rules. However, such proceedings are conducted in the best engineering tradition, with mutual respect for the competence and integrity of Commission personnel, and the non-government participants. And, a final decision having been reached, all heave to in order to make it workable, even though the individual engineer may differ strongly from the action taken.

A recent example of such cooperation was the all-channel TV receiver legislation, and the promulgation of the rules implementing it. The broadcast receiver industry strongly opposed this legislation, and fought its enactment with every legitimate means at its disposal. However, once the bill became law, the industry engineers immediately stepped forward to work with the Commission in devising rules for its implementation. The final rules represent a sound compromise between the Commission's desire for the earliest possible effective date and a recognition of the problems of the receiver industry in gearing for the required production changes.

I salute your new organization, and look forward to our close and fruitful association in the coming years.

EDITORIAL
CUE LINE

SHAPE OF THINGS TO COME

Welcome to Volume One Number One of the JOURNAL of the Society of Broadcast Engineers! In 1961 when editor of a magazine in this field we wrote an editorial bemoaning the demise of the IRE and need for a replacement association to cater to broadcast engineers. The response was tremendous, and we looked around expecting someone to do something about it. No one did. So early this year we got together with some other engineers and formed the Institute of Broadcast Engineers with a first meeting at the NAB Convention. The meeting was a success, the name was changed to the Society of Broadcast Engineers, and we are on our way to national recognition, thanks to the activities of our members and their strong interest. So writing this editorial is a really rewarding experience.

GUEST CHAIRMAN

It is fitting, too, that in our first edition of the JOURNAL we should have a guest editorial from the Chairman of the Federal Communications Commission, the Honorable E. William Henry. It was not without some trepidation that we approached him for after all we are a brash young organization, but his prompt and gracious reply was as encouraging as 1000 new members! So it is with much pride and pleasure that we present our guest editorialist: the Honorable E. William Henry, Chairman, Federal Communications Commission.

COMMITTEES

As members know, our Steering Committee is planning our future course, and before long we hope to be able to announce long-range plans. The Memberships Standard Committee, under the Chairmanship of Bill Kramer, is hard at work establishing standards for membership. At present all who join become charter members, but once we have established standards which will be presented to members for approval or change, entrance grade and senior grades will have to be justified. We feel sure that all members will want to hold to a reasonable standard to maintain and increase the prestige value of belonging to SBE and to make it a worthwhile goal.

In this connection we should point out that SBE is not going to become a long-hair ivory tower organization, but if it is to mean something it must have standards. One or two leading broadcast industry engineers whom we approached to sit on the Steering Committee expressed the thoughts that we are not sufficiently demanding in our standards. Nor probably was IRE when it started; as the SBE grows prestige-wise so will our members.

SUSTAINING MEMBERS

Not long before this issue went to Press we invited a number of the top radio and television equipment suppliers to become sustaining (sponsor) members. So far six have replied, two of whom no longer manufacture equipment in our field, and two have joined in support of the SBE. The Society is proud to welcome Andrew Alford of Alford Manufacturing Company, Boston, and Messrs. Burke and James, Chicago, as Sustaining Members Numbers One and Two.

AM FREEZE

As we write these words rumors are spreading that the AM Freeze is almost over. Perhaps by the time this reaches our members it will be!

Whatever the new Rules do say, it is certain that the effect of ending the freeze can only be beneficial to everyone connected with the standard broadcast field. Probably the first to feel the warmth will be the consulting engineers, many of whom have found the freeze to be literally a very cold affair! Our strong hope is that the new Rules will be based on sound engineering principles but will be interpreted and applied reasonably when circumstances justify it.

THE JOURNAL

We have enjoyed this labor of love in "firing up" the SBE and the JOURNAL. Both have gotten off to a good start. Both will need your support to continue to grow. As our membership grows, so will the need for more H.Q. help. To keep the JOURNAL coming we need technical material -- it's <u>your</u> publication so let's have <u>your</u> contributions!

MEMBERSHIP

At one time we thought of listing all our members in the first issue. Fortunately this is not practical - we have too many members. So this leads to another thought - maybe soon we should publish a directory of members once our membership reaches a certain level?

JHB

MODULATION METERS FOR STEREO AND SCA TRANSMITTERS

by M. Barlow
Broadcast Engineer
CFCF-AM-FM-TV
Montreal, Canada

Presently approved modulation monitors for FM service are not well suited to the requirements of multimodulation systems such as stereo and SCA multiplex. The advantages of a peak reading instrument over the usual VU type display are discussed.

Every FM station requires some instrument to indicate depth of modulation. This may be as simple as a VU meter attached to the output of an FM receiver, or a complicated instrument costing several thousand dollars. Under commercial operating conditions, the tendency is to keep the depth of modulation as high as possible in order to produce a "loud" signal at the receiver. This is not the same thing as in AM, where a high depth of modulation helps to suppress background interference and produce a listenable signal over a larger area. With FM, of course, interference is not normally a problem, and both carrier level and depth of modulation can be reduced considerably without the listener being aware of anything except that the signal "sounds" quieter.

In spite of this, many FM stations are using limiters and compressors to maintain high modulation levels, usually at the expense of ruining the dynamic range of the Hi Fi music they are transmitting.

The question then arises, how much modulation is enough, and how can it be measured? Increasing audio amplitude increases the frequency swing, or deviation, of the carrier. If this swing exceeds the bandwidth of the transmitter tuned circuits, or the receiver IF or discriminator bandwidths, then the amplitude of the carrier will be distorted when it should be constant. Besides giving rise to a spurious AM component, harmonic distortion of the audio will occur; in the case of multi-modulation systems, severe cross-talk will result.

North American standards call for "100% modulation" to be a carrier deviation of ± 75 Kc/s. This deviation depends only on the amplitude of the modulation, and not its frequency, which may be greater or less than 75 Kc/s. The deviating carrier does produce sidebands, and the RF and IF circuit bandwidths must be wider than ± 75 Kc/s. By deliberately tuning an oscillator on one side or the other of the center IF frequency, a meter connected to the discriminator output can be calibrated in "percent modulation". This is basically the arrangement in such units as the RCA BW73 and McMartin TBM4000 monitors. Notice that the meter will read accurately only on a sine wave, and that the meter circuit must have a bandwidth better than the highest sine wave frequency to be measured. If several modulations are present at once, as in stereo, the meter will give an answer that depends on the phase and amplitude relationships of the modulations. This type of monitor is quite sufficient for routine setting up with test tones; it will give some sort of reading on stereo if the (L+R) and (L - R) channels remain reasonably in phase over all amplitudes and frequencies. The addition of a further FM signal, such as a 67 Kc/s SCA programme, causes the meter reading to vary, and it is no longer possible to read modulation depth under programme conditions. It is important to realize this because the overmodulation flashers are operated by the same type of circuit, and therefore become no longer reliable. Additionally, it is a rare monitor whose meter and flasher circuits are correct, and agree with one another, from 50 c/s to the 80 Kc/s or more required by stereo-plus-SCA operation!

VU VERSUS PEAK PROGRAM

All of this discussion has so far avoided the hoary old argument of VU meters versus peak programme meters. The VU meter is familiar to all engineers; it is a cheap, relatively simple meter that reads according to the audio power being measured. Its characteristics are standardized, as shown in Table 1. A peak programme meter is expensive because tubes or transistors are involved which require a power supply. The needle movement is slower, and it is almost impossible to read a mixture of VU and peak meters on the same audio line. Modulation meters are required to give a peak indication, since it is the peak deviation that is likely to give trouble. FCC-approved monitors therefore have a characteristic neither VU nor peak, but as reasonably "peaky" as can be obtained with a simple meter movement. Other administrations have other ideas, and 5 types of indicators are currently shown in the CCIR standards including these three.

The performance obtained from the simple modulation meter is dubious under any conditions, as it is rather difficult to correlate the reading with a standard VU-meter except on tones. Also all monitors need an amplifier to drive the meter, and these tubes or transistors would be much better employed to give a peak indication.

CHARACTERISTICS OF THREE "STANDARD" METERS

Meter	Rise Time	Fall Time
VU	99% in 0.3 seconds	99% in 0.3 seconds
PPM	80% in 4 millisecs. (2.5 millisec time constant)	80% in 1.6 seconds (1 second time constant)
FCC Mod. Meter	90% in 40 millisecs.	90% in 500 millisecs.

TABLE 1

Currently available peak programme meters do not have the bandwidth necessary to handle 50 c/s to 80 Kc/s or so. The problem then is to see how a standard monitor could be improved.

Perhaps the simplest modification is to replace the overmodulation flasher by a magic-eye indicator driven by a wideband amplifier. This gives a visual indication of modulation, is easy to install, and the meter is still available for sine wave testing. (Apart from FCC regulations, it might be better to use a true VU meter here.) Much better is to convert the meter amplifier to a peak detector and cathode follower. This will be correct under all conditions of modulation except on very short peaks, but may be difficult for the operator to interpret. The ideal would be to scrap all VU meters at the studio and go over completely to peak meters (PPMs) but this requires a change of attitude that may be difficult to obtain.

OSCILLOSCOPE USE

Finally it should be noted that an oscilloscope connected to the monitor multiplex output can be calibrated to show modulation limits. Without the benefit of the integrator circuit of the PPM the trace moves too fast for easy viewing under programme conditions. Unless the scope is required for other purposes it is an expensive luxury to tie up in this way; operations will not be familiar with it, and for this type of indication a magic-eye will do just as well.

Two final points about monitors. One, cross talk will occur if the transmitter is mistuned and is giving some AM output. The monitor should therefore include a facility for checking AM content and the transmitter should be tuned for minimum AM rather than maximum RF. Two, does anyone ever both with the positive and negative peak switch, required by the FCC? Under multiplex conditions this surely could be omitted, and the average of the positive and negative excursions used.

Editor's Note: This is a very interesting and controversial article. SBE members are invited to contribute their ideas in the form of letters and articles for publication in the JOURNAL.

Letter to the Editor:

Dear Sir:

Your suggestion that our informal group of engineers become Chapter Number One was unanimously approved at our May 14th meeting. The meeting was attended by the following:

Bruce Mackey - WKRT, Cortland, N.Y.
Wiley Bates - WCHN, Norwich, N.Y.
Charles Lissner - WDLA, Walton, N.Y.
Ronald Simpson - WPEL, Montrose, Pa.
Louveer Stantz - WBJA-TV, Binghamton, N.Y.
Gino Ricciardelli - WINR-TV, Binghamton, N.Y.
Charles Hallinan - WKOP, Binghamton, N.Y.

Four membership applications are forwarded herewith. Additional applications should be forthcoming following our June meeting.

It was decided to continue with our present informal meeting procedure with the undersigned acting as Chairman pro tem until we have more members and receive specific instructions from your office pertaining to the establishment of a slate of officers.

Sincerely yours,

Charles Hallinan, Chief Engineer
WKOP, WKOP-FM

STOP PRESS

We welcome sustaining member number three:

Electro Voice Incorporated
Buchanan, Michigan

SYSTEM PLANNING AND LAYOUT

by Thomas R. Haskett
Haskett & Volkman
Cincinnati, Ohio

This paper describes the need for, and a method of, planning an increase in physical facilities, or new construction, at a broadcast station.

When a radio or television station is being originally constructed, rebuilt, moved, enlarged, or otherwise altered, whether because of increase in power, addition of FM, stereo, or television, or change of programming mode, there arises the need for a thorough systematic planning and layout of the new or revised facilities. In many cases stations have simply tacked things on here and there a la Rube Goldberg, but this results in a costly waste of manhours, electricity, and ultimately the most important thing - money.

Although management usually makes the decision to change the status quo, the chief engineer is generally approached to handle the details. Similarly, although all staff personnel are ultimately concerned with getting a program on the air and keeping it there, the CE's principal job is to insure adequate facilities for this goal. At the larger station, he will have help; at the smaller, he will shoulder this responsibility alone. In either case, it's up to him to understand thoroughly all points.

The determining factors are electronic. The antenna must be located where it will cover the desired territory and often has to protect another station's territory. The transmitter must be placed adjacent to the antenna. Studios have been located either at the transmitter site, which is often on the edge of town and therefore inconvenient to personnel and advertisers, or near the business district, which is convenient, but which necessitates either separate transmitter engineers or remote-controlled transmitters. Within the plant, each piece of gear is placed where it will be most convenient, except where interference might be transmitted or received. Example: It's not a good idea to locate a transmitter in the same room with the announcer, unless it's very low-power, for blower noise, as well as RF, may get into the mike.

The first step in laying out a new or modified plant is to consult the people who have worked with the old plant and who will presumably work with the new. Their opinions will be invaluable in determining the human factor, which must be taken into account if operator efficiency is to be high. Poorly-designed studios or transmitter houses cause high human-error rates; such situations can be obviated by allocating enough space and a sensible working arrangement.

One technique, useful here, is to sketch a flow chart, as in Fig. 1. which will show traffic through the plant. When several equipments or rooms are associated with each other, they sh should be adjacent, if possible. Be sure to count noses when making a flow chart - there are situations where several persons must occupy the same space, and it must be large enough to contain them without crowding.

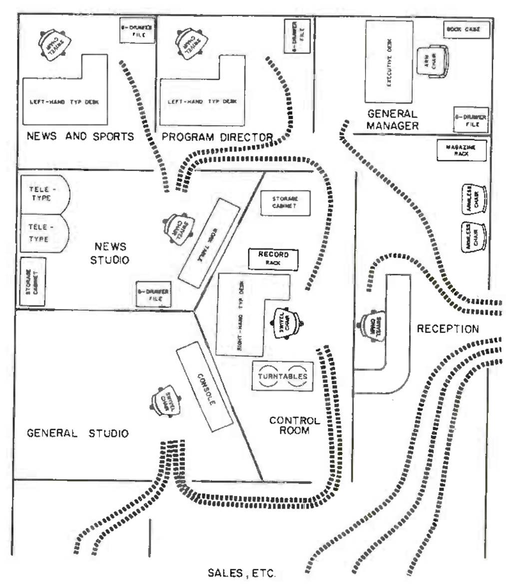


FIGURE 1: SKETCH FLOW CHART TO INDICATE TRAFFIC

HUMAN ENGINEERING

Para 3.40(d)(2) of the FCC Regulations states: "Since an operator must be on duty at the transmitter control point during operation, suitable facilities for his welfare and comfort shall be provided at the control point." This is interpreted to mean fresh drinking water, a clean toilet, protection from the elements, and heat during cold weather. It is wise to add air conditioning to this list, and to extend the coverage to studio facilities, where they aren't already covered. Operator discomfort breeds inefficiency. Rooms should be well lighted and ventilated during all seasons.

Once the needs of management and the operators have been noted, a plan should be made out. Objectives should be listed at the head of a sheet of paper, with necessary conditions below. Existing facilities should then be examined to see what changes will be necessary. Beware of interference traps. Undue heat can fatigue humans as well as equipment; moisture will cause rusting and fungus growth and it's unhealthy; audible noise will raise the microphone noise level in studios and control rooms and, moreover, will contribute to operator fatigue by causing a higher monitor-speaker volume than necessary; vibration can cause some undue audible noise, not to mention being destructive to equipment; RF fields will be extremely difficult to keep out of speech-input gear, and may cause erroneous meter readings if instruments are located nearby; AC fields can produce grounding and hum problems in low-level preamps; cable trenches must not collect water, and AC trenches should be separated from signal ducts.

Don't forget the acoustics involved in a studio. Although many small stations seldom do live broadcasts, control rooms and announce studios must be reasonably quiet and should not be "live". They should be deadened. As in padding speaker cabinets, you only need to soften one of two parallel surfaces. Don't make the mistake of putting a carpet on the floor, acoustical tile on the ceiling, and no treatment of the walls! The result is a fluttering echo. Use the tile on one or two walls; the carpet will take care of ceiling reflections - not to mention muffling footsteps. A control-room mike must not be omnidirectional, for it will pick up relay chatter, swivel chair creak, et cetera. A cardiod pattern is desirable with a rather broad response pattern, to allow the operator some freedom of movement.

BUILDING PLANS

Omit outside windows in control rooms and studios; they are bad for sound and impossible to control acoustically. Use air conditioning, heating, and remote-reading thermometers. Any ventilation must be low-velocity, to avoid noise. Be sure to plan for adequate cooling of equipment racks, transmitters, et cetera. Use quiet and absorbent furnishings, especially rubber feet and/or wheels on chairs. Drapes are also useful.

All legal questions should be checked before any work is scheduled. Depending on locality, various agencies will have jurisdiction. FCC will be involved in almost every case, especially as outlined in Para 3.40 of the Regulations. FAA will be concerned if towers are involved, and Part 17 of the Regulations outlines this. Electrical codes must be observed, and the safest course is to consult a local licensed electrician. Generally a building permit must be obtained from local authorities if a tower or building is to be erected or modified. Local codes may require plumbing, gas, fire and electrical inspection, as well as respective seals denoting approval of new facilities. Additionally some states require similar protection in rural areas. All of the above must be planned for and proper people contacted. In some cases, some or all of the job must be done by non-station union men. This brings up the next point.

When any portion of the modification must be done by non-station personnel - carpenters, plumbers, electricians, etc. - it's important for the CE to clearly specify what he wants and how he wants it done. It's also important to keep close tabs on the crew. It is not that they won't do their job properly if you don't watch them, but their job is not radio - yours is! They have no knowledge of the side effects of their routine job methods. For example, in the vicinity of a high-power transmitter, electrical conduit and ground wires must be securely bonded together, metal-to-metal, or they will cause trouble. The same is true of pipe joints in the plumbing. Much instrument error and reradiation is due to non-radio construction work which will meet the contractor's specifications, but not the radio engineer's. Be sure, too, to allow enough time for such crews to complete their work efficiently.

DEPRECIATION

Management will doubtless have consulted the staff accountant to work out an exact depreciation prorating of the new facilities over a period of years. The CE should realize that by this process it's possible to purchase reliable equipment which will outlast inferior gear, although the latter might be initially less expensive. It is poor economy to have equipment fail repeatedly before its been depreciated off the books. It will be necessary for management to set a budget or a top limit. If you cannot provide the desired services within this budget, point this out, and discuss ways to compromise. Remember to allow for still further expansion and emergency use. Don't work equipment out to the absolute limits of its capabilities all the time and expect maintenance free operation.

Since new equipment will undoubtedly be purchased, it's well to consult trade publications and catalogs, or better still, write manufacturers for their catalogs. Ask other engineers for comments on various brands. Competitive makes should be compared from an operational as well as a cost standpoint. Generally speaking, the ratio of support space (offices and storerooms) to operating space (studios and control rooms) should be about 3 or 4 to 1. If in doubt regarding engineering matters, consult the NAB Engineering Handbook and, if necessary, don't hesitate to recommend discussion with a consulting engineer.

FM STEREO, THE ENGINEER AND PUBLIC RELATIONS

by William S. Orr, Chief Engineer
Radio Station KHFM
Albuquerque, New Mexico

Although this article is not strictly of a technical nature, I hope that it will give some insight into the possibilities of the engineering staff contributing its share to the front office operations. The engineers are all too often the men behind the scene; the stagehands, as it were, of this great show business known as broadcasting. So it has been of some consolation to our engineering department to know that we have contributed a little more than our customary "taken for granted" role by helping in this public relations scheme and letting the public know we are here.

With the FCC's adoption on 20 April 1961 of the GE/Zenith system of stereo transmission, a new era in FM presented itself. This new era also produced some new public relations problems. It is an old headache to most FM broadcasters that professional musicians, hi-fi and "do-it-yourself" bugs (among others) can, and do, become a very critical audience.

This station (KHFM, Albuquerque, New Mexico) was the first FM station in New Mexico, and also the first stereo station in the State. Previous to the adoption of the GE/Zenith system, we had run some stereo in conjunction with a local TV station and at another time in conjunction with an AM station. We first transmitted multiplex stereo in the summer of 1962.

Out in this vast wasteland (not Mr. Minow's) of desert, mountains, mesas and canyons, we have our share of reception problems. All the local TV stations have their transmitters on top of Sandia Crest, rising one mile above Albuquerque, and some thirteen miles northeast of the city. With the aid of either electrical tilt, mechanical tilt, or both the TV stations put a blanketing signal down on top of the city where we are running 3250 watts ERP from a 140-foot tower in the middle of town. There, the first of our public relations problems arises. Listeners attempt to equate our FM signal with the TV signals in terms of strength. We hear time and time again, "Well, if I get good TV reception with rabbit ears on a built-in antenna then why can't I get good FM reception?" That is a fair question.

Here it should be pointed out that Albuquerque is a mass of hills and depressions. Near the middle of the city, and running north and south, is a sharp drop-off which in an ancient geological age was the east bank of the several mile wide Rio Grande. At this drop-off the land continues to slope downward toward the present river and forms what we call the valley area. That is bad enough from an FM broadcaster's point of view; but we also have segments of our audience located in Santa Fe and Los Alamos to the north, with some quite rugged country in between.

LISTENER GUIDANCE

As a service to our listeners, we began running promos inviting them to tell us of their reception problems so that our engineering department could evaluate their cases. Most of the response was very vague in terms of supplying information on which we could formulate our answers. It was like hitting a doctor cold and saying, "Doc, I'm sick, what's wrong with me?"

With the advent of multiple stereo the public relations problems have multiplied. We have always had our share of that rare, but probably well-meaning, individual in the audience who, with a three-hundred dollar hi-fi system considers himself qualified to pass judgment on the technical excellence of a station operating in strict accordance with the rules and standards of the FCC; in other words, a station whose monitoring facilities and test equipment alone probably cost more than the "expert's" new car. And then, there's the "expert" with some surplus military gear who measures our frequency and tells us we are 300 kc high, and what's more, he measures our frequency while we are modulating our carrier!

Returning to the increased public relations burden brought on by the advent of stereo, we feel that the "Audience Education Movement" could have been alleviated by more knowledgeable sales-and-service personnel. In its technical aspects, the problem as related to service is not unlike the introduction of color TV. We have worked closely with the local repair shops, and on one occasion held an open house complete with a station tour for the service people. They seemed, unhappily, on the whole, to be indifferent to stereo and regarded it as if it were just a playtoy, or a passing fancy which would not "catch on". Of course, this is far from the truth as it has turned out. We were the first FM multiplex stereo station in the State, and still the only one in Albuquerque. After two years we are still receiving occasional calls for assistance from service shops and some distributors. In addition we get calls from listeners who were not satisfied with the results of service work performed on their equipment. No reflection here is intended on local service people although I have heard and read of the 19 kc pilot carrier being compared to everything in the books as an explanation. I have had best understandings when speaking to technicians when I likened it to the 3.58 Mc color burst.

The nature of the stereo signal being approximately 40% of the total allowable modulation per channel (allowing 10% for the SCA and about 10% for the 19 kc pilot carrier) pretty well sets the minimum requirements for a receiving antenna system. Therefore, KHFM printed a two-page data sheet for distribution to our listeners. In this we set forth in layman's language the fundamental concept of the FM signal, the phenomena of multi-path and temperature-inversion, touched upon the basics of stereo, warned readers of the rules to follow and care to take in installing and maintaining antenna systems and just about gave them engineering counsel

ANTENNAS

By means of written instructions and a drawing, we showed how to construct a folded dipole from 300 ohm transmission line. We even mentioned something which, in this part of the country (and probably in others, too), is very important when using any sort of indoor antenna. Many houses here are stuccoed on the outside. The practice in applying stucco is to use chicken-wire mesh to hold the stuff. This, of course, encloses the house in a very effective shield. We tried to leave nothing to the imagination, but at the same time took care not to insult the intelligence of an audience of above average intelligence. Admittedly, the information was not a course in electronics but most of our listeners welcomed it. In our monthly program guide, we occasionally insert technical items, and in a forthcoming issue will have a feature article in the form of answers to a selection of the most common technical questions we have received in the past.

We regard each listener as a potential customer for our sponsors, and, through patience (which has sometimes worn pretty thin) our engineering department has striven to make their listening more enjoyable by going out of its way to consult them on their problems. Precautions must be taken not to set a precedent for, after all, we are not in the service business. We have, however, stocked and sold to our listeners in the backwoods FM antennae cut to our frequency.

I imagine there are comparatively few independent FM stations combining our unique problems of rough terrain and low power with a predominantly discerning class-type audience. Suffice it to say that when we are not busy with routine maintenance, running proofs, paper work and helping an announcer discover that he has thrown the wrong switch, et cetera, we have busied ourselves with the task of answering technical queries from our listeners.

The Society of Broadcast Engineers welcomes these companies to sustaining membership in the Society, and extends very sincere thanks for their confidence and support.

SUSTAINING MEMBERS

Alford Manufacturing Company
299 Atlantic Avenue
Boston 10, Massachusetts

Burke and James, Inc.
321 S. Wabash Avenue
Chicago 4, Illinois

Electro Voice Incorporated
Buchanan, Michigan

All companies engaged in the manufacture of equipment for the broadcast industry are invited to become sustaining members. Membership information can be obtained from:

The Society of Broadcast Engineers
Box 1841
Annapolis, Maryland

A SIMPLIFIED WAY TO DETERMINE TRANSISTOR OPERATING PARAMETERS

by Ben Wolfe, Chief Engineer
KPIX, Westinghouse Broadcasting Company
San Francisco, California

Conductance theory and some interesting rule-of-thumb methods combine to produce an easier way of solving transistor circuit design problems.

There has been much published data on transistors insofar as determining the overall operating parameters is concerned; however, some of these operating parameters require the application of lengthy formulas. Since most conventional equations for voltage gain, current gain, input capacity, forward transconductance, voltage gain of a degenerative amplifier, input impedance, et cetera, are cumbersome, a method employing some conventional, and some conductance theory, is used to simplify these determinations.

If the voltage gain of a common emitter stage (emitter by-passed) is desired, it is only necessary to know the forward transconductance and the load resistance. The calculation of stage gain involves a rather lengthy formula:

$$VG = \frac{(re-rm)\ RL}{(RL+re-rc-rm)(rg+re+rb)-re(re-rm)}$$

re-emitter resistance, rm-mutual resistance, RL-load resistance, rc-collector resistance, rg-internal resistance of generator and rb-base resistance. A simpler approach is to find the forward transconductance gf (similar to gm of a vacuum tube). The gf of a transistor is approximately equal to 35 millimhos per milliampere of collector current. Thus the stage gain of a transistor having a collector current of 1 MA and a load resistance of 1000 ohms, would equal .035 x 1 x 1000 = 35.

If the above stage were an emitter follower, the voltage gain could be expressed conventionally as equal to

$$\frac{RL}{RL+(1-a)Rs+RL\ Rs/rc}$$

rs-source resistance, again cumbersome because of the large number. Let's assume the emitter resistor equals 100 ohms. We have already established that gf = .035, thus using the conductance theory

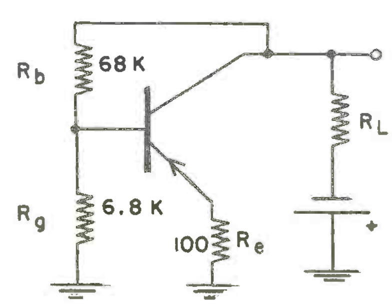
$$VG = \frac{gf\ Re}{1+(gfRe)} = \frac{.035x100}{1+(1.035x100)} = .8$$

Suppose the stage in question is a degenerative amplifier, with the 100 ohm emitter resistor unby-passed and the load resistance is still 1000 ohms. Conventional math is again cumbersome, but conductance theory provides an easy math solution.

$$VG = \frac{gfRL}{gfRe} = \frac{.035x1000}{.035x100} = 10$$

Thus with fairly simple arithmetic we have obtained approximate gain values for three complicated stage designs.

Almost any transistor has leakage and is dependent on temperature, therefore bias stabilization in the form of a stability factor must be designed into the circuit. A good rule-of-the-thumb equation for temperature stability is $Re(Rb+Rg)/RbRg =< 0.6$. Suppose our two bias resistors were 68,000 ohms and 6800 ohms respectively, and the emitter resistance equals 100 ohms, then $100(68x10^3+68x10^2)/68x10^3x68x10^2 =< .6$. Actually fairly good temperature stability can be achieved by making the ratio of the emitter resistance to the parallel combination of Rb and Rg as low as possible.



In almost every video circuit the value of input capacity is extremely important. A fairly simple approach to its determination makes use again of the conductance theory. If you have gf then the input capacity of a conventional stage without degeneration = gf/2πfa. fa=alpha cut-off frequency, 3 db down. Since in our stage Ic = 1 MA thus gf = .035, therefore

$.035/6.28 \times 7 \times 10^7 = 82$ uufd

Where gi=input conductance in millimhos, gf= effective transconductance, Re=emitter resistance, Bac=AC Beta, and rb=base spreading resistance. If the stage in question has an Ic of 3 MA, Re-emitter resistance of 380 ohms, the gf equals .035x3=.1, the input conductance equals gf/Bac or .1/30=.003 if we assume a Bac of 30. On the other hand if you are not sure of the Bac, another way to solve gi=gf/1+(gfRe). This is also a fairly approximate formula ($\pm$5%). Assume the base resistance is given by the manufacturer as 300 ohms. Thus the equation becomes

$$.003/[1+(.003+.1)380] + .003 \times 300 = .00007$$

and since this is in terms of admittance, thus the input Z equals 1/.00007=14,000 ohms.

This is rather a steep figure of input capacity for a video stage. Now let's add some degeneration by eliminating the emitter by-pass. This leaves the 100 ohm emitter resistor unby-passed. Now solve for the emitter gain which we can call Ke for this purpose. Another simple method now evolves for an easy solution to a "sticky" problem.

$$Ke = gfRe/[1+(gfRe)] = .035 \times 100/1+.035 \times 100 \cong .8$$

--and since this is really a figure of degeneration, the actual input capacity will equal (1-.8)x80=16uufd --this is a low enough figure to satisfy video conditions.

To check this quickly, the frequency response of this input circuit equals $1/2\pi CiRt$. Ci=input capacity and Rt=input terminating resistance; and if Rt is in the neighborhood of several hundred, wideband response is indeed available.

Another important parameter is the input impedance of the transistor stage. Since the actual input resistance between the base and the emitter is fairly low, 1000 ohms or so, degeneration is employed to increase the input impedance. There are several ways to arrive at the input impedance and one of the most accurate and simple methods is to solve it in terms of input admittance:

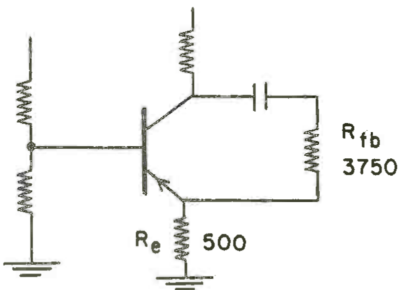
$$Y = gi/1+(gi+gf)\ Re+girb$$

The source impedance if desired, and in most video work it is necessary, becomes a simple matter in terms of conductance and is equal to 1/gf. If the output video stage has Ic of 13MA then the source Z=.035x13=.455 and 1/.455=2 ohms. Thus if we are going to match a 70 ohm line, a 68 ohm build out resistor is necessary.

Finally, if in the interest of linearity some additional feedback is desired in addition to emitter degeneration, the stage gain without loop feedback should be determined.

$$VG = gfRL/1+(gfRe).$$

Assume the gain to be 4. The voltage of the feedback loop equals $Efb \ \frac{Re}{Rfb+Re}$. If Re=500 ohms and Rfb=3750, then 500/3750+500=.12 and the gain reduction =1/[1+(VGxEfb)]. Numerically then 1/[1+(4x.12)]=.7, therefore .7x4=2.8 gain with loop feedback



A future article will deal with the overall design of a wideband amplifier using the above method of determining the operating parameters.

CUE LINE (Continued)

HAMS

At the organization meeting in April at NAB, the suggestion was made that all members who are hams should list their calls with the SBE. We thank that maybe it would serve a very useful purpose if all our ham members did list their calls. Each month, or as desirable, the JOURNAL could contain an up-to-date listing. To carry this a step further - perhaps there is a nucleus for an "SBE Net"? Comments please.

MEMBERSHIP

As of press time we had almost two hundred members. This edition of the JOURNAL is going to every member and to every engineer who wrote in for information and who may not yet have joined; also to the chief engineer of every radio/TV station in the U.S. and Canada. BUT, after this issue unless you are a paid up member you will not get a copy!!! We intend to publish quarterly until such time as we can become a monthly journal.

USING THE SINE SQUARED WAVEFORM TEST FOR TELEVISION SYSTEMS

By John H. Battison
Consulting Engineer
Washington, D. C.

The sine wave alone does not provide the most desirable test signal for checking overall performance of a television system. What is required is a more irregular or pulsed waveform. The Sine-Squared or pulse and bar signal provides a very good approximation to an actual television video signal.

Although today most of us tend to think of the United States as being the leader in television, it should not be forgotten that in Europe, and Britain particularly, a great deal of unheralded but brilliant work goes on. The subject of this paper was developed by the BBC and the British General Post Office as long ago as 1954.

Here it might be explained that the British GPO is to communication engineers in England what the FCC is to us broadcast engineers in the U.S. There is one exception, however. Because the GPO is in the operating end of the business as well (it operates <u>all</u> public communications systems with the exception of broadcast), it has developed very sizeable laboratory and development facilities. As a result a great deal of work in developing new techniques has come from the GPO. That's enough history, now for facts.

MEASURING DISTORTION

One of the problems encountered in testing TV systems is the fact that the results are subjective - that is, they are interpreted in terms of the viewers' judgment of quality, not absolute engineering quantities. Therefore, it is necessary to expose a number of viewers to the same display and grade it according to their reaction.

Based on the results of a series of tests of this nature, it was discovered that the pulse and bar method could be used as a very delicate indicator of distortion types that can be identified on a raster. A very important corollary was the fact that the amount of distortion on the test signal could be used as a measure of the amount of video degradation. Thus a new term - the "K" factor came into being to describe the amount of distortion suffered by the pulse and bar.

THE SINE-SQUARED PULSE

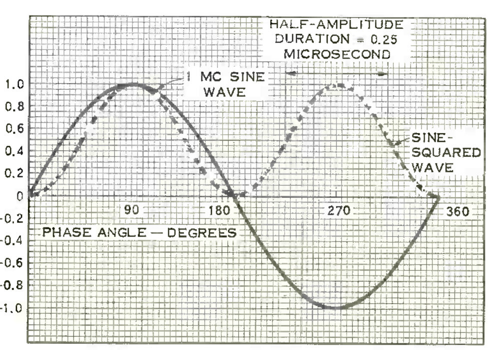
The major requirement for a television test signal that approximates the abrupt "step" change of an actual video signal is one that has the following characteristics:

1. Be easy to generate.
2. Have a simple shape for easy identification.
3. Be easy to handle mathematically to simplify essential calculations.
4. Be very easily affected by small amounts of the kind of distortion found in a TV signal.
5. Show only TV frequency distortions.
6. Be a very close approximation to an actual TV signal waveform.

At first consideration a square wave might appear to fit these requirements. However, although easy to generate, they are very rich in harmonics that seem to extend almost to infinity. Unfortunately it is not possible to predict too accurately the actual conditions because changes in test conditions and circuits cause erratic results.

On the other hand the sine-squared pulse spectrum can be simply controlled by varying the pulse width; in other words, the narrower or sharper the pulse the higher the harmonics, and <u>vice versa</u>.

To see why this pulse is called "sine squared" let us examine Figure 1. Here we see a regular sine wave and a sine-squared wave over it.



The amplitude of the sine-squared pulse varies as the square of the sine of the phase of the signal. A sine wave is defined mathematically as:

$$A = \sin \theta$$

where

θ is the phase angle.

By contract a sine-squared wave is defined as:

$$A = \sin^2 \theta$$

Referring to Figure 1 again it can be clearly seen that if the numerical relative amplitude of the sine wave is squared at a number of points and the results plotted, the sine-squared wave will result. For example, the maximum positive peak is plus 1. Squaring plus 1 gives plus 1 and the two wave peaks coincide. Squaring the minus peak of the sine wave gives us $(-1)^2$ which, of course, becomes + 1 and is so plotted. All the intermediate points can also be similarly checked or plotted.

When engineers talk about nominal pulse width it is defined as the half-amplitude duration. Thus a sine-squared pulse of $f_o/2$ has an energy content of 6 db below its peak value at the fundamental frequency f_o; and zero at $2f_o$.

PULSE AND BAR TESTS

The always useful square wave test for low frequency response can be made far more informative if the harmonics can be controlled. By modifying the window signal square wave so that the leading and trailing edges look like a sine-squared pulse, and adding a sine-squared pulse to each line of such a modified signal, a pulse and bar signal that looks like Figure 2 is obtained.

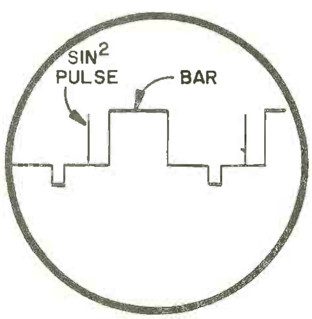


Figure 2. Pulse and bar test signal.

The pulse and bar waveform is then used to measure full bandwidth sensitivity. The bar - like the window - signal provides excellent indication of distortion up to several hundred kc. However there are no higher order harmonics to produce serious spurious distortion.

RINGING

In an effort to improve high frequency video response "ringing" circuits are sometimes employed to boost the high frequency response, in the same way that audio "treble" boosters expand hi-fi systems. Unfortunately if these video ringing circuits are too efficient, the ringing becomes apparent in the picture in the form of following lines or damped oscillations.

Another cause of ringing is a frequency response discontinuity in the video band. Such a condition shows up as damped oscillation following abrupt changes in the pulse and bar signal. The frequency at which the response is down is the same as the frequency of the ringing. Figure 3 shows ringing - or overshoot - on a conventional square wave, and the same condition displayed on a pulse and bar. The latter gives a far better indication of the condition.

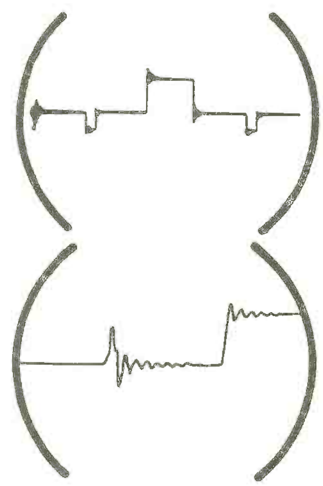


Figure 3. Comparison of ringing shown on square wave and pulse and bar signal.

The sine-squared pulse is used to test the higher frequency response. For frequencies between 0.5 and 2 Mc a pulse of duration 0.25 microseconds is used because there are no significant harmonics above 4 Mc. For the upper end of the video range to 4 Mc, a narrower pulse with a half amplitude T equal to the reciprocal of twice the upper limit (in Mc) is used. For 4 Mc then this would be 0.125 microseconds; power is 6 db below peak at 4 Mc, and zero at 8 Mc.

The sine-squared pulse's extreme suitability for demonstrating ringing and similar phase distortions is due to the fact that the pulse is extremely symmetrical about its axis and any

Continued

CANDY PROFITS BRING TELEVISION AT SEA

PIO Office
USS Kitty Hawk (CVA-63)
c/o Fleet Post Office
San Francisco, California

The value of closed circuit television on aircraft carriers, as a means of providing training and entertainment, has been recognized since the commissioning of USS Forrestal (CVA-59) in 1955. With this new class of "flattops" came a new era of communications. The new super-carriers were no longer considered "large" ships but were looked upon as "small" cities in which television systems would play an important part.

The 80,000 ton USS Kitty Hawk (CVA-63), the world's first guided missile attack aircraft carrier, is as long as three footbal fields and wide enough to sit both the SS United States and the USS America side-by-side on her deck. She has 1,500 compartments and cruises with a full complement of 4,000 men. About 85 interior communication circuits are installed within her massive framework, including three separate TV networks: a closed circuit in Combat Information Center (CIC), a Pilot Landing Aid Television (PLAT), and KTTY-TV Channel 4.

While at sea or in a foreign port, KTTY-TV is operational. The studio does not compete with commercial television. During Stateside inport periods, an outside antenna is rigged from the mast to receive local channels.

During the Kitty Hawk's seven month long first tour of duty with the Seventh Fleet in the Far East, Channel 4 demonstrated its versatility and usefulness. In the early stages of the cruise, telecasting began in the evening with the latest world news. Then came a short film or training program followed by a feature movie. Every afternoon at sea, the news was picked up from Main Communications off a teletype. The TV newscaster edited his own show. He presented the up-to-date world, sports and business news. Also in the interest of keeping the crew informed, important speeches by the President and other dignitaries, which are broadcast over radio, were taped and used on the news program.

As a training aid television is invaluable. Briefing and refresher courses on atomic, biological, and chemical defense, emergency drills and first aid have kept the ship prepared to meet any challenge at any time. Officer Candidate programs and education opportunities are brought to the attention of the crew.

Television aboard supercarriers is an important feature of the new Navy. The morale factor itself outweighs the other benefits. The men get a variety of entertaining and educational programs as well as the daily news. They can relax in their own little groups in their compartments. The sailor of today is wiser and better trained through closed circuit television.

KTTY-TV is growing. A new slide projector was recently added into the network complex. Newer props for better productions are being bought. Another camera is on the planning board. Tape equipment is being discussed. Eventually television will be broadcast from carriers to other ships in the task group. (Editors Note: Perhaps even to shore TV stations in the U.S.?)

TV as an Aid to Foreign Relations: Before entering a port, the crew is given a Port-of-Call brief. The customs of the people are shown, places of interest are pointed out, the better restaurants are emphasized, and modes of transportation are discussed. The men are told what to look for in each port and what to do in an emergency. The estimated prices of products are thoroughly discussed to aid shopping.

As experience was gained, new ideas were tried. A forty-five minute morning show was introduced. In the style of Dave Garroway's "Today" program, the KITTY-TV "EYE OPENER" brings the early morning news and pertinent shipboard information that might be helpful to the crew during the day. This is followed by a short film, usually a playback of sports events.

Since Kitty Hawk's commissioning in April of 1961, Channel 4 has been operational. While cruising from Philadelphia around Cape Horn to San Diego in 1961, the studio had a temporary location. During the six month post shakedown yard period in San Francisco, seven men, working in their spare time, combined two staterooms into a permanent studio. Sound proofing and tile left from other jobs were used in the overhead and deck. To keep the studio from becoming an echo chamber, perforated sheet metal which had been scrapped was used in the bulkheads. The welding and labor of converting the staterooms were handled by men from "R" Division aboard Kitty Hawk.
The money to pay for the cameras, control panels and receivers comes from the men through Special Services. Each time a man makes a purchase from any of the ship's stores, he knows that part of that money will go towards improving Kitty Hawk's TV system.

LETTERS TO THE EDITOR

Enclosed you will find applications from three of us here at WETV. There are an additional six broadcast engineers on the staff whom I feel will send applications in the near future. We think the idea of this Society is great and any way we can help we will be more than happy to. We are looking forward to the day we can have a local chapter in this area. I trust the applications are in order and that we will hear from you in the very near future.

Sincerely,

Thomas W. Cowan, Jr.
Chief Broadcast Engineer
WETV

The day you are waiting for is here! See list of Regional Chapters on Page 2...Editor.

Dear Editor:

I appreciate very much your letter of May 25th concerning the Society of Broadcast Engineers. I agree with you completely that the IEEE is not an ideal home for the broadcast engineers. I feel that the Society of Broadcast Engineers can probably fill this void.

I would appreciate knowing the number of people in the Nashville area that you have contacted concerning the Society. I would like to volunteer my efforts in furthering the membership drive but do not want to contact those already queried by you. I have in mind particularly other qualified members on our staff here at WSM, Inc.

The newly designated name for the organization gives me a few qualms, remembering President Truman's reference to Drew Pearson. I fear we all may end up being "S.O.B. Engineers." However, we should be able to bear up under this I suppose.

Yours very truly,

Aaron Shelton
Chief Engineer
WSM-TV

STOP PRESS NEWS!

Just as we were going to press, we were very happy to welcome to sustaining membership The Andrew Corporation of Chicago, Illinois.

The acceptance arrived too late for inclusion in our list of sustaining members for this issue.

ENGINEERING NOTES -

Your cooperation is sought in sharing operating and engineering ideas with fellow members. Please keep them short and include small sketch or sketches if necessary.

Emergency Telephone

An acceptable emergency telephone can be made by connecting a telephone earphone and carbon microphone in parallel, and connecting the combination to the red and green telephone wires. Breaking the circuit rapidly ten times (by hand if you have no dial) will summon the operator. A regular telephone handset has one side of the earphone commoned to the microphone. Merely twist the other two wires together and connect the pair across the phone lines.

Scott McCann
Former Chief Engineer, WETT
Ocean City, Maryland

Sine Squared - Continued from Page 14

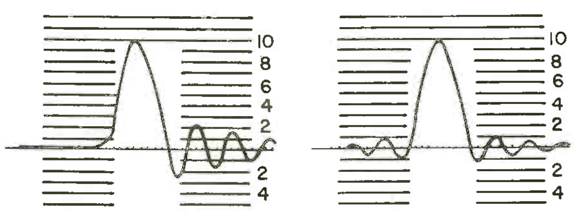


Figure 4. (a) Phase distortion causes asymmetry and low pass filter causes ringing.(b) Equalization improves symmetry and balances most of ringing.

phase distortion skews this waveform producing asymmetrical A following (ringing) ripple indicates greater high frequency delay than low frequency, and *vice versa*.

SUPPORT YOUR PROFESSIONAL SOCIETY

We have made it easy for non-members to join the Society of Broadcast Engineers. You can detach this application form and mail it back to the Membership Committee with your dues.

THE INSTITUTE OF BROADCAST ENGINEERS
P.O. BOX 1841, Annapolis, Md.

APPLICATION FOR MEMBERSHIP

Application is hereby made for membership in the Institute of Broadcast Engineers with the grade of *................. The following information is supplied to assist the admissions committee in assessing my qualifications.

Name ....

** Address ....

Position ....

Employer ....

** Address ....

Engineering Qualifications ....Degree?........University...........Year.....

FCC Licenses.............
Years of Responsible Engineering Experience......
Brief Professional History.......

Fields of Engineering Activity...Radio....Television....Transmission......

Studio....Other.........

Two References who are Familiar with my Work

Name and Address......

....

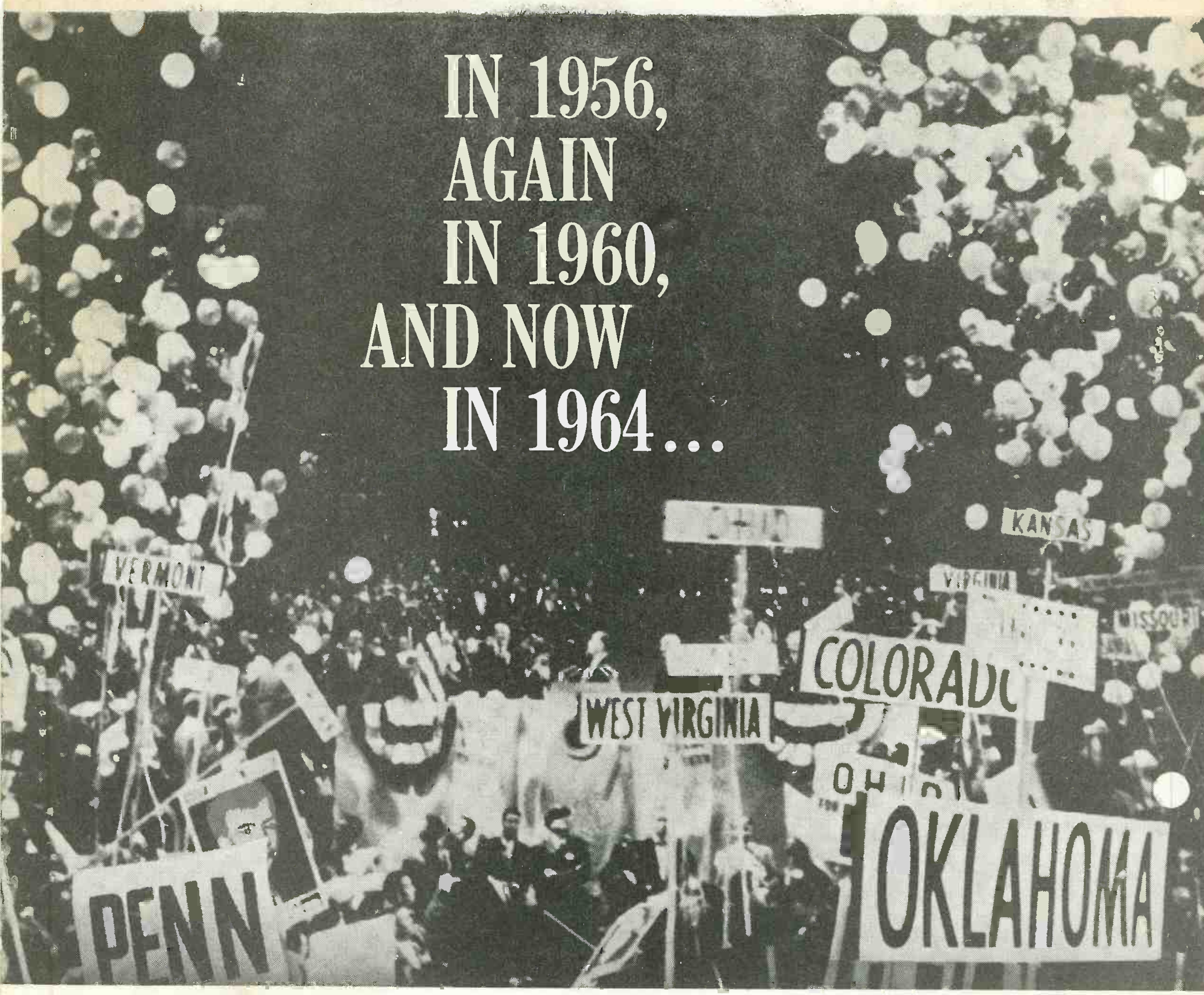
Name and Address......

....

Annual Dues of $10 are enclosed herewith (no action can be taken if dues do not accompany application). I agree to follow the Constitution and By-Laws of the Institute if admitted. Signed......................Date.......

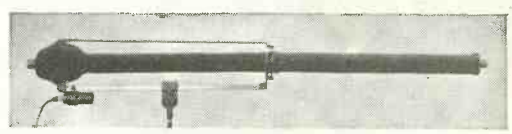
Admissions Committee Action. Date........Approved for Grade....Approved for Grade indicated....... Action deferred for more information.......
Canditate Notified........Chairman's Signature........ Entered in Records.....

* Until By-Laws are adopted all members enter as Charter Members.
** Indicate Mailing Address Preferred.



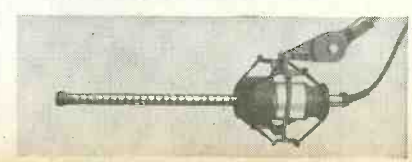
every microphone in the "pool" radio-TV coverage of both Republican and Democratic National Conventions is Electro-Voice. Performance—not politics—determined the choice, and for the third term, it's E-V by a landslide. Performance is the main plank on which every E-V microphone and speaker is built.

May we have your vote?

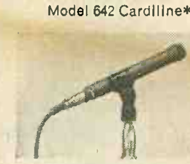


Model 643 Cardiline* Unidirectional Microphone

Model 668 Dynamic Cardioid Boom Microphone



Model 642 Cardline* Unidirectional Microphone



Model 654 Dynamic Omnidirectional Microphone

Model 666 Variable-D® Dynamic Cardioid Microphone

*T. M.

ELECTRO-VOICE, INC. Dept. 741BE, Buchanan, Michigan 49107

Electro-Voice®
SETTING NEW STANDARDS IN SOUND