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THE SOUND ENGINEERING MAGAZINE

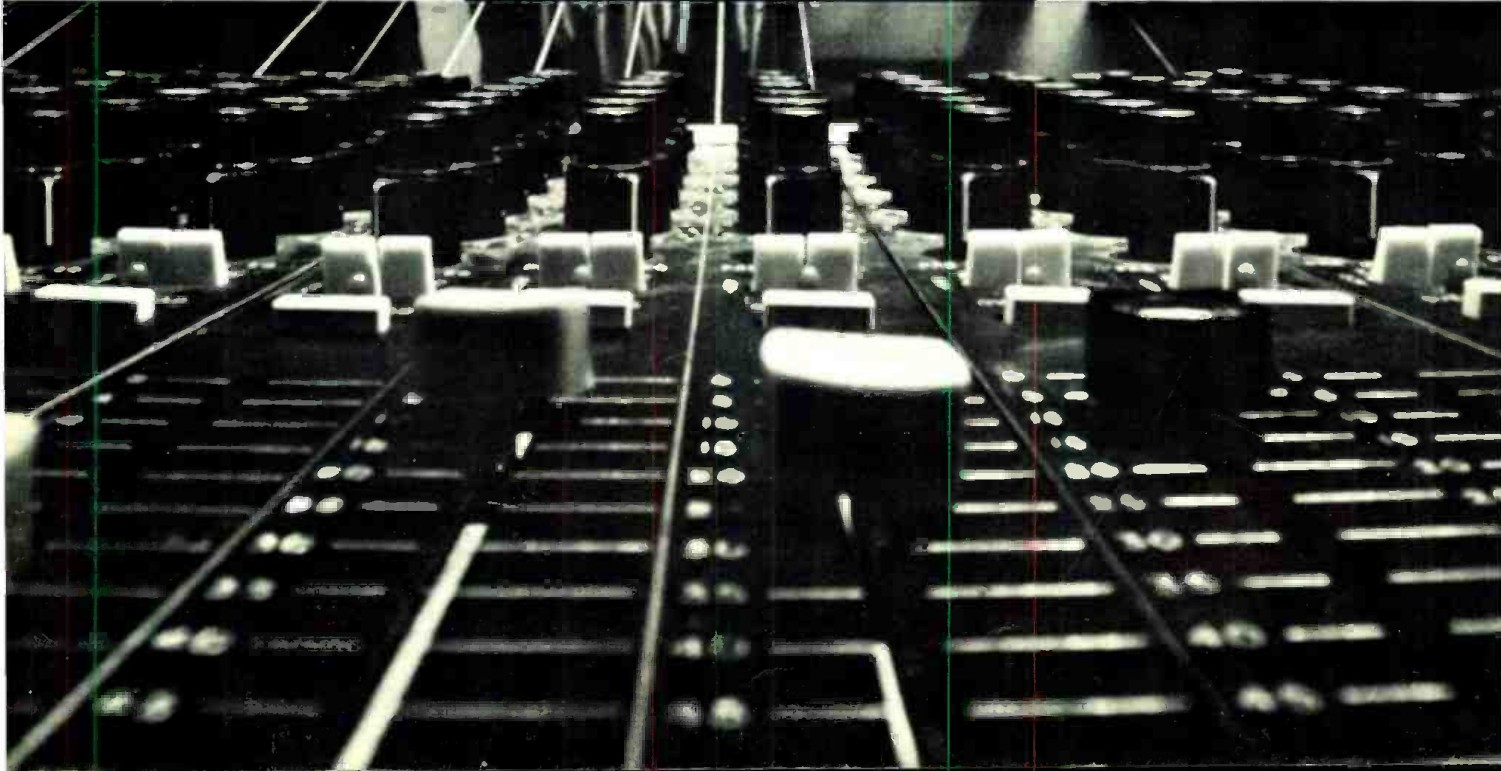
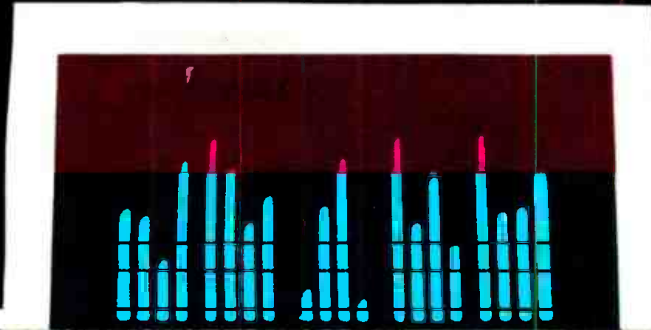
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- Better Ways to Cope With Stereo Phasing
- How to Convert A 92C Resolver
- Broadcasting in the United Kingdom



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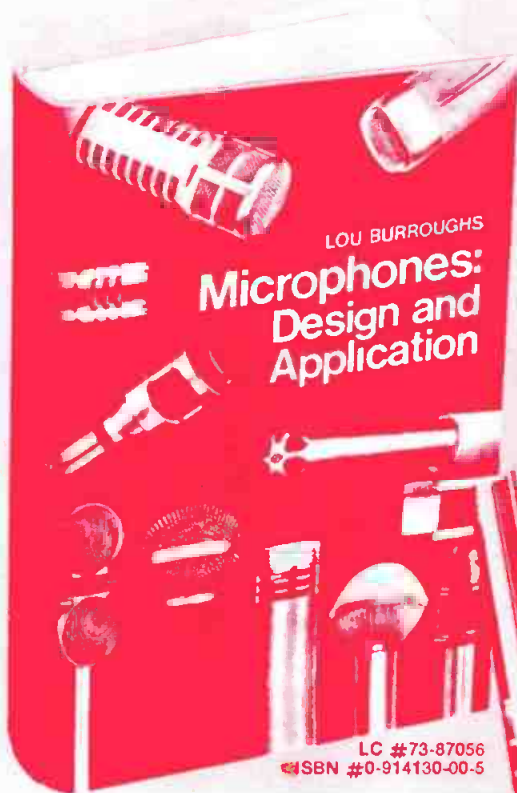
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THE AUTHOR

Holder of twenty-three patents on electro-acoustic products, Lou Burroughs has been responsible for extensive contributions in the development of the microphone. During World War II, he developed the first noise cancelling (differential) microphone, known as the model T-45. Used by the Army Signal Corps, this achievement was cited by the Secretary of War. Burroughs was the creator of *acoustalloy*, a non-metallic sheet from which dynamic diaphragms are molded. This material made it possible to produce the first wide-range uniform-response dynamic microphone. Burroughs participated in the design and development of a number of the microphones which have made modern broadcasting possible — the first one-inch diameter wide-range dynamic for tv use; the first lavalier; the first cardiline microphone (which ultimately won a Motion Picture Academy award) and the first variable-D dynamic cardioid microphone. He also developed the first wind screens to use polyester foam. Burroughs was one of the two original founders of Electro-Voice, Inc. He is a charter member of the Society of Broadcast Engineers and a Fellow member of the Audio Engineering Society.

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**about
the
cover**

● A unique view of Audio Designs' console which is installed in Dimension Sound, Boston, Mass. In the background is the Vue-Scan monitor.



THE SOUND ENGINEERING MAGAZINE

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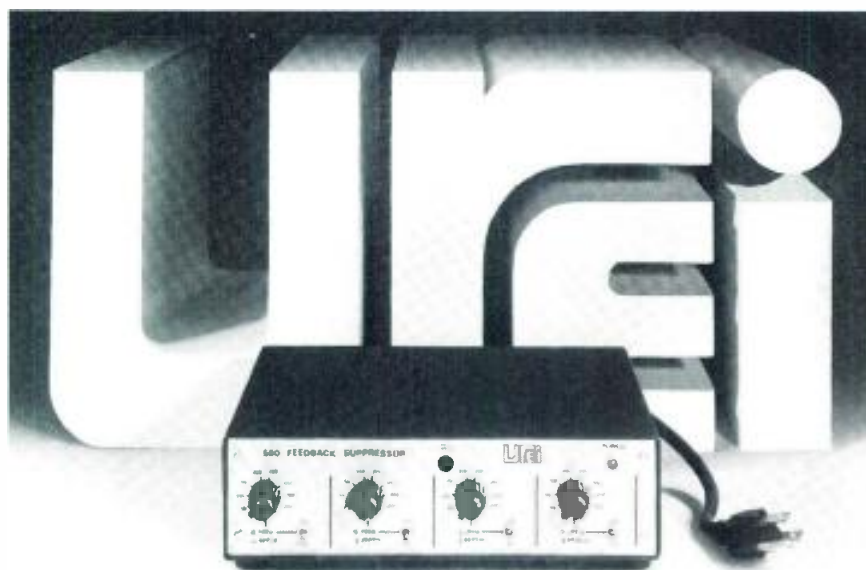
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THE EDITOR:

I have been a subscriber to db for a couple of years and in the business of broadcasting for three years. I have never written a letter to db before. The time has come. Norman Crowhurst's column is an experience in reading. I make it a rule to read it every month. He appeals to my "crazyness." Most specifically, I refer to the article in the July issue. The aspect of the I.Q., which is questionable in my case since it seemingly floats from 106 to 130, brings up the matter of dependability of these tests. In most cases it would, as he says, be reciprocal of whomever designed it. A green tree is only green in the eye of the beholder. I must commend him for the observation of the fact.

The main reason for this letter is an inquiry into his book, *Taking the Mysticism from Mathematics*. It is obvious to me that it would be a good book on math; he's a good teacher. I have always had a bit of trouble with math for two basic reasons: poor teachers who bored me with theory that to me did not have any basis, simply, I think, because the teachers were not sure of it either and secondly, my own frustration because I thought my lack of understanding was due to my own stupidity, a naive fallacy. Please let me know how to obtain the book.

Most of the things I have learned since school, I have learned on my own, which has proved fruitful in most cases. Anyone who believes it is not possible to learn by teaching himself, with a bit of help when needed, should realize that he is constantly doing that anyway in the many things that come up each day.

HANK G. LANGLINAIS
 KNET Radio
 Palestine, Texas

Ed. Note. *Taking the Mysticism from Mathematics* is out of print. However, Norman Crowhurst has a number of copies available, which he will send upon receipt of \$5.50. His address is 1183 S.E. Godsey Rd., Dallas, Oregon 97338.

Copies of all issues of db—The Sound Engineering Magazine starting with the November 1967 issue are now available on 35 mm. microfilm. For further information or to place your order please write directly to: **University Microfilm, Inc.**
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12-17 **Audio-Visual Institute for Effective Communications.** Audio-visual seminars. Contact: Dr. E. L. Richardson, Audio-Visual Center, Indiana University, Bloomington, Ind. 47401.

17 **Society of Broadcast Engineers,** Regional convention and equipment exhibition. Northway Inn, Syracuse, N.Y. Contact: Paul Barron, WCNY-TV/FM, Syracuse.

Fall Conferences. National Association of Broadcasters, Contact: NAB, 1771 N St., N.W., Washington, D.C. 20036 (202) 293-3500.

12-14 Atlanta
15-17 Boston

21-26 **International Audio Festival Fair.** London, England. Contact: British Information Service, 845 Third Ave., New York, N.Y. 10022. (212) 752-8400.

31- Nov. 3 **Audio Engineering Society 52nd Convention,** Waldorf-Astoria Hotel, New York, N.Y. Contact: AES, Room 929, 60 E. 52nd St., New York, N.Y. 10017. (212) 661-8528.

NOVEMBER

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4-7 **Meeting of the Acoustical Society of America,** San Francisco, Ca.

NAB Fall Conferences. Contact: NAB, 1771 N St., N.W., Washington, D.C. 20036. (202) 293-3500.

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12-14 Chicago
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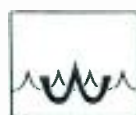
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Detailed information on a line of precision short-form potentiometers, trimming potentiometers, concentric and digital turns-counting-dials, and miniature switches is contained in this 8-page catalog. Mfr: Spectrol Electronics Corp.

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AUDIO HEAD DESIGN DIGEST

A handsome 96-page book answers frequently asked questions about magnetic head design, head applications, and circuit considerations. Includes extensive diagrams. Mfr: Nortronics.

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DIGITAL MULTIMETER

Information and specs on the model 334 digital multimeter are contained in this brochure. Mfr: Hickok Electrical Instrument Co.

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HOW TO CUSTOM DESIGN A CONSOLE

The modules and submodules that are combined to form a monaural or stereo audio system are described in this 20-page book. Complete functional diagrams are included. Mfr: RCA.

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Two bulletins from this manufacturer describe, respectively, a new adapter for making connections between two different size audio phone plugs, and seven long run audio cables. Mfr: Switchcraft.

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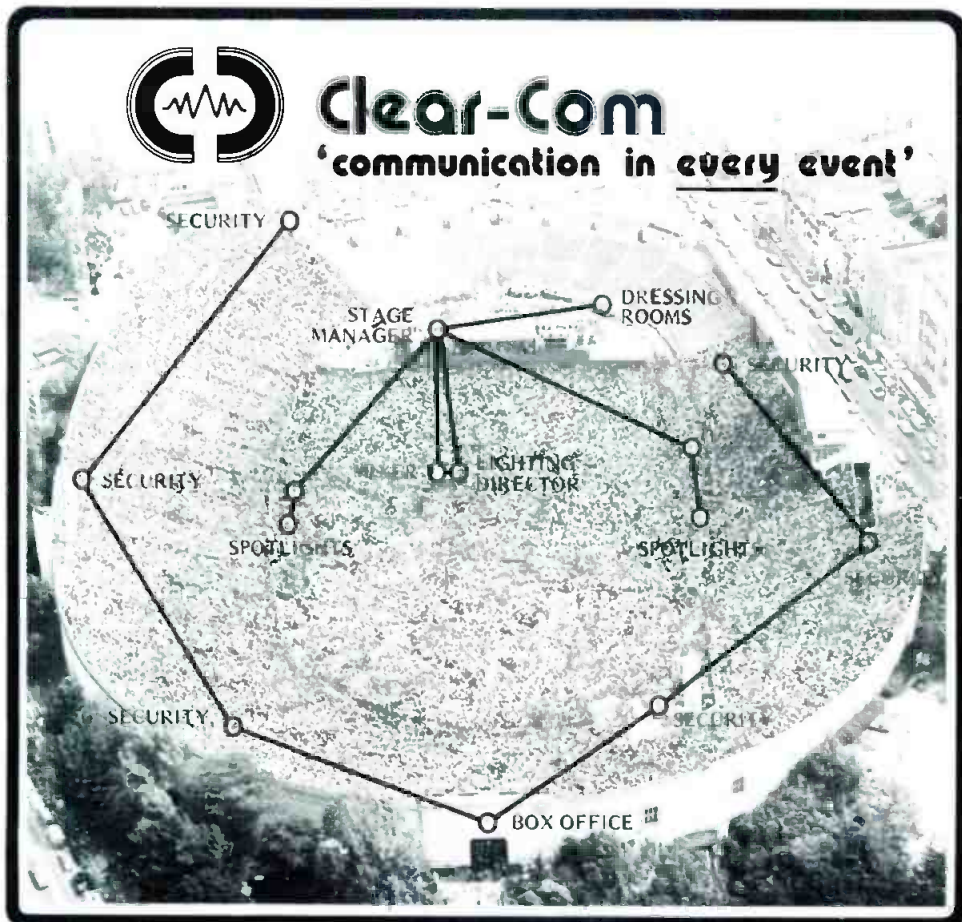
Over 300 devices by competitive part number are listed, with the suggested replacement by this manufacturer. The updated application note lists recent additions to the line as well as several new ratings. Mfr: International Rectifier.

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PULSE-GROUP ENCODER-DECODER

I.C. pulse-group encoder TMX 2141 for pulse-width code systems and 2151 decoder are described in this bulletin, with specifications and diagrams. Mfr: TMX, Inc.

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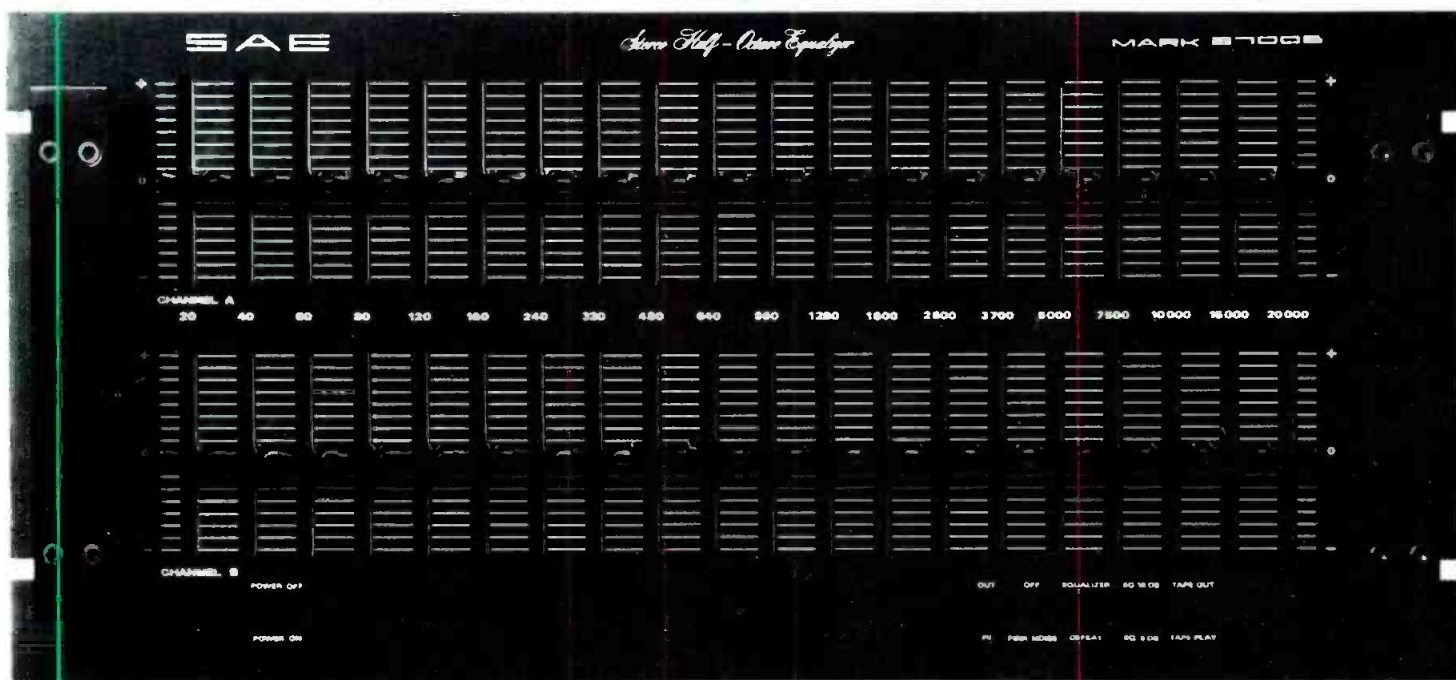


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● This marks the 90th *Theory and Practice* column I have written for **db** magazine. Projecting forward, this means I will reach my first "century" during our nation's bicentennial. But reviewing what the column has done is interesting, too.

For more than a year, this column was strictly technical, based directly on the concept with which it started, of reconciling theory with practice. The first issue that departed from that was in August 1969. And for three more years, the departures from strictly technical discussion were rare, about one a year.

Making the analysis is a little difficult, if one tries to give numbers to it, because some months the column might be partly technical, partly something else, such as educational, but with something that seemed to make a bridge from one to the other.

In 1972, the content of this column was approximately 75 percent technical, in 1973 it departed from technical the most, leaving about 54 percent, and last year the technical content was up to about 67 percent again. This

year, so far, it's running about the same proportion.

Correspondence from readers runs a little differently. Sometimes more than 80 percent of my letters are on educational questions, or else supporting what I have had to say on that subject. Recently, because of what I have been saying about audio people involving themselves in educational media, people have been writing to ask about that. Perhaps there were not quite enough to suggest that it's time to write a book on the subject, but enough to show there is growing interest in the subject.

AUDIO VISUAL QUESTIONS

How do you put audio with visual material, to help learning? That is one question. Well, one thing you don't do—just mediate existing material, such as bad textbooks! I must say that because, of the mediated material I look at, at least 90 percent is just that. Finding something that really uses media in a way that enables the properties of the media to help the learning process, is still a rarity.

Somewhere near 80 percent of the stuff I look at must consist of some form of visual material in which the audio reads to the student the visual text he should be looking at, as if the poor guy couldn't read. If he can't read, then we should do something about that. If he can, then why should we insult his intelligence by reading to him?

The thing I emphasize to media people is that the audio and visual materials should be complementary, not identical. Each should help the other. For example, if you are dealing with math, show the student the relevant formulas, and tell him (with the audio) what to do with them. To me that seems so logical it should not require saying, but it very definitely does need saying, judging by what is more often done.

Using that illustration reminds me of a discussion about use of formulas that came up at Brigham Young this year, but I'll come to that later. Staying with the audio visual questions, many people seem to think that the more sophisticated the system, the better its chances of resulting in better learning. Definitely not so!

This needs to be related to the kind of material to be conveyed, or learned. For the moment, I'll stay with the media aspects of this, or we'll never get to some other things I want to say. Educators use two words here that are useful, in describing the properties of media: transient and persistent. What they mean is that some media forms keep going, while others stay put so the student can study them.

As opposed to that, we can distinguish two parts to the material to be conveyed that broadly correspond to audio and visual in media, but which don't always have to be identified as such across the boundary: words and content. In that example just now, the formula might be the content, or expresses it in one way, while descriptive words explain it to the student.

You are reading words now. That is one vehicle for words. Or you could listen to them on the audio of a program. As you read, the medium of this page is persistent. It stays there for as long as you want to take to read it. But if this column were put on tape, you'd listen to it on a transient medium; it would go by at a speed that I would determine as I dictated the tape, or at the speed set on the machine.

Do you see that both forms of expression in words can have their advantages? You can study the printed word as long as you like. From the oral word you can get nuances of expression that the printed word cannot convey. If you miss something pre-

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sented orally or fail to understand it the first time, you must run back and replay it.

Here we must mention an administrative distinction between whole class use of mediated instruction, and individualized use. When material is used by an individual, he is able to replay only those pieces he needs. Often in whole class use, none of it gets replayed, even when the whole class may need it.

Film, film strips and slides provide various degrees of persistent vision. Video tape provides an inherently transient visual element. Similar considerations in use apply here, best considered in relation to the subject matter to be taught, or better yet—learned! There is a difference, you know.

STRUCTURE OF CONTENT

Now let us revert to that question about formulas. The first day at BYU this year, one or two of the students asked me to put up the formulas I was using, instead of merely stressing the relationships. They argued with me that, if they could not grasp the relationships, they could always plug in the formulas.

In my mind, as they afterwards admitted, this reflected the way they had learned thus far—just how to do

things without understanding why they should be done that way. But suggesting this to the students at that point would be presenting something that seemed incomprehensible, at least to those who were asking for formulas.

So I modified my approach. The good teacher should always be ready to do this. For almost two days, they had more than enough formulas sprouting from the chalkboard. I still filled in all the explanations necessary, but never without providing a formula. They soon got the point; when you had too many formulas, you never knew which one to use! It is much better to know what you are doing and why. From then on, they all preferred my way.

But that illustration raises a serious question that should always be in mind in constructing educational material: what is the natural way to learn? Let us take an example from geometrical theorems that I referred to a column or two back, about isosceles triangles.

Whether you learn the Euclidean proof or some other modern version of it, you have two theorems to learn: (1) given that two sides of a triangle, say AB and AC, are equal, then the angles opposite them will also be equal, in this case angles B and C; (2) vice versa, if the angles are

equal, then the corresponding sides are equal.

Apart from the literal problem I mentioned before, that having learned this with the angles B and C, if someone lettered the angles A and B, let's say, even the teacher would be lost—what is this theorem really about? A mathematician might answer that it's a good exercise in logic. It will help the student learn good practice in reasoning things through. Not if the student can't do it if someone reletters the triangle, it won't!

A better reason is the more practical one. Suppose you are a carpenter and get into the work of building roof trusses. What you would want to know, had you never done it before, is, if you make the two sloping pieces equal, will the two parts of the roof have the same angular run-off? Or perhaps you plan to use plywood reinforcements for the angles at the eaves. If you make them the same angle, will the length of 4 by 2 (or 6 by 2 or whatever) used for the trusses, need to be the same?

That is really the kind of way in which the geometrical theorem got started. Is it reliably true? Will it always work out that way? First it may have been an observation, that it was true in some constructions. But now is it always true? Can I rely on it as

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theory & practice (cont.)

a way to figure things out?

Let us take another instance in a totally different subject, verb tenses. We generally learn language by memorizing tense structure and other conjugations. It would be far more practical—relevant—if we would learn why all such things are needed.

When a person learns a language informally, he usually learns the root form of the verbs first, just present tense: I go, I do, I walk, I sit, I speak, etc. But in everyday use, if we use only present tense, we shall soon have difficulty communicating. If the only

form of the verb "to walk" that I use is present tense, and I say, "I walk home," what do I mean? That I always walk home? That I did walk home, or will walk home (according to where I am at the moment) today? That at some time in the past I did walk home? Or that after I have done whatever it is I have to do, I will walk home? Which is it?

Often, if I were limited like that in my language, I could be misunderstood. I might mean that I always walk home, and the person I told might get upset because he saw me taking the bus the next day. We need various tenses and other conjugations

to be able to communicate explicitly. That is their only justification. They are not added, as many school kids seem to think, to make language complicated. And if we taught them correctly, they would never think that.

MEASURES OF LEARNING

This is something about which we are going to have much more to say, because educators know too little about it. But there is little space left this month. It is appropriate to point out, before leaving you this month, that changing the orientation in the way suggested in the last two examples, makes for better measurement methods.

With conventional teaching, as practiced to most schools today, the main objective is to qualify to achieve passing grades in a test. For this purpose a student might struggle to memorize the formal proof of the isosceles triangle theorems. But given the problem of laying out a roof truss, he would see no connection with his geometry class. And having gotten the appropriate letter grade for geometry, he would forget that proof.

The important thing is for him to establish for himself the truth of that theorem and from that, to learn how to go about establishing the truth of things in general. That is what teachers should measure, to determine that the student is benefiting from his studies. When they do that, the present habit of swatting up for the test will disappear, because it will no longer be relevant, possible, or of any use.

I have readers who write to tell me that I don't know English, because I write such words as "don't" or "it's," which are known as colloquialisms. These readers will explain to me that the apostrophe is used only for the possessive case, and thus "it's" means something belonging to "it!" Strange, but I learned that "it's" is a colloquialism, or contraction, for "it is," while if I want to say a cat washed its paws, there would be no apostrophe.

Seems this reader's teacher must have been mixed up, or else mine was. I point this out as something that comes of learning by rules, formulas, or whatever, instead of understanding why such practices are necessary. If we learn things the more sensible way, and promote teaching that helps students to learn that way, it makes the measurement of learning much easier, without running into the kinds of inversion we have complained about in earlier columns, where the wrong people get the wrong grades, because they have the wrong motivations.

We'll have to deal some more with this, to show how it can be tied in with good use of media. ■

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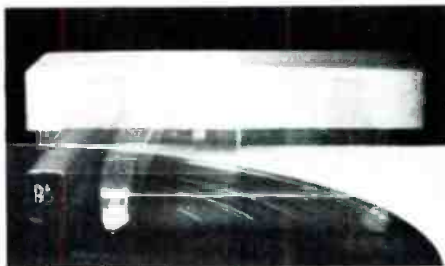
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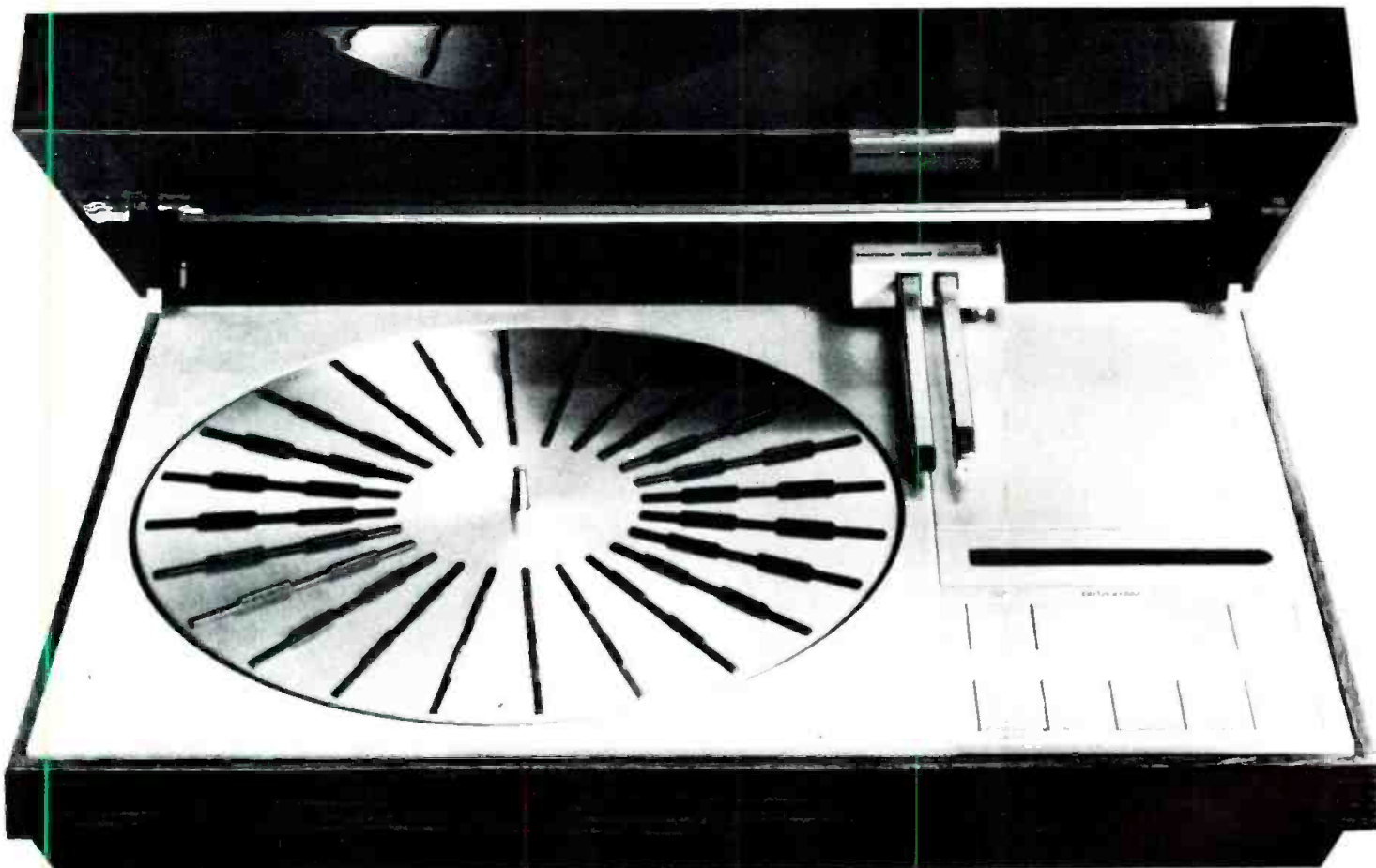
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db the sync track

JOHN M. WORAM

• A lot of time has passed since I did a column on grounds and shielding, and I was going to continue the discussion a lot sooner than this, but somehow or other, time flies, and here it is August. (For me it's August—for you it's probably October already.)

I had mentioned Ralph Morrison's book, *Grounding and Shielding Techniques in Instrumentation* (Wiley-Interscience 1967). In response, Jan Chadwell, Group Technical Director at KLAK, Denver wrote, . . . *Frankly, I am quite amazed that the general audio industry has such a lack of knowledge in grounding methods. Many articles published in your magazine as well as others over the years show a general absence of knowledge that has been known for years in other areas of the electronics industry.*

Mr. Morrison's book is one of the best handbooks anyone in any field of electronics can purchase. It has been part of my library almost from the first day it was available. In fact, mine is now so marked up and underlined I have been thinking of getting a new copy . . . Please . . . suggest that your readers get a copy the first chance they get.

I had mixed feelings about the book's value to the working studio man. It seems to be a specialist's book, and doesn't say too much about the nitty-gritties of wiring a couple of gadgets together in such a way that they will neither explode, nor hum, buzz or whistle. The information is there of course, but it must be translated out of technicalese. Depending on the reader's technical prowess, this may or may not be possible. The studio engineer with a light background may find the text a little tough going. But the book will certainly be a valuable reference to the man with a good technical background.

Another reader is planning a new studio installation that will include two (!!) new 24-input consoles, one for the control room, the other for the house p.a. system. He would like . . . *to include some sort of splitting network that would allow using one set of microphones to feed [both consoles] with proper isolation, impedance matching, and immunity to hums, buzzes, etc. I have considered both passive transformer coupled designs and active designs, but am still undecided as to what the best all round, most economical solution would be.*

Well, generally it's a good idea not to fool around with microphone lines. If both consoles have input transformers, some sort of resistive combining

network could be used, but this would deteriorate the signal/noise ratio, and interfere with phantom powering (if any). The phantom powering would have to be removed from the console(s) and applied to the mic lines before the dividing network.

I'd say a practical approach would be to use the microphone preamplifiers in one console only, which we'll call console A. Then bridge the console A preamp outputs to feed console B's line inputs. In fact, if console B hasn't been purchased yet, it could be specified without microphone level inputs, possibly saving some \$\$\$.

Any variable sensitivity controls on console A's preamps would affect both consoles, so the console A operator would have to keep that in mind during recording/p.a. sessions. However, the other console functions (balancing, echo, equalization, etc.) would be completely independent.

If the feed to console B was via patch cords, these could be moved around when and if necessary. For example, if a compressor was needed for both feeds, the patching would be: pre-amp out-to-compressor in, compressor out-to-consoles A and B in.

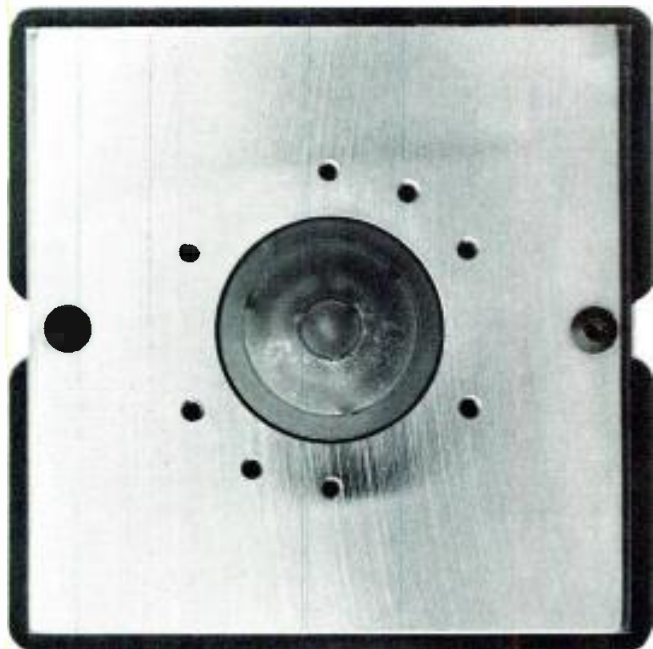
A couple of alternatives come to mind. If console A has a decent echo (or cue) send facility, this could be used as a p.a. feed. With the echo sends in the pre-fader position, the p.a. balance would be independent of the record balance. This is not quite so elegant as two consoles, but also not quite so expensive. Or, what about one "super board" with 32 (or more) inputs? When necessary, each microphone could be fed to two inputs—1 & 17, 2 & 18, etc. Inputs 1-16 would be used for recording, 17-32 for p.a. If the house p.a. system is only used occasionally, input 17-32 would be available for heavy sessions when there is no audience to please.

As for grounding/shielding, if two consoles are used, both should be chassis-grounded to the central grounding point, and the audio cables running between the consoles should have their shields connected at one end only, as was discussed in the February, 1975 column.

WHAT ABOUT GUITAR AMPS?

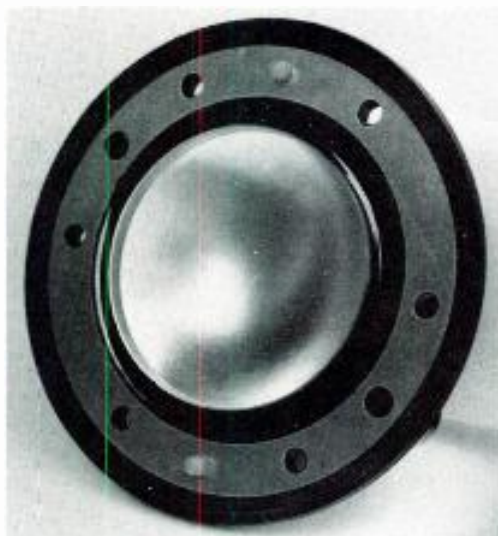
From the same letter, *Nothing is more frustrating than to finally get your entire system de-bugged, clean and quiet, especially with today's low noise tape and noise reduction systems, and then have a guitar player plug in his favorite funky axe with the original 1958 pick-ups, complete*

INSIDE 22



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the sync track (cont.)

with about a -10dB hum. I seem to be endlessly going around the cut-and-solder circle of shielding and grounding, trying to fight this one. Any comments or suggestions?"

What about using an acoustic guitar? I've seen some guitar (or other instrument) amplifiers that should be classified as war crimes. In fact, some of them look (and sound) as if they have been through a war. But even the good ones can give trouble if you're not careful. If the amplifier's chassis is grounded out in the studio, and you plug in your home built direct box, which manages to ground the amplifier to the microphone line's shield, you wind up with a great big ground loop. And maybe your phantom powered mics start acting a little strangely too. You can probably clean things up by disconnecting the shield in the mic plug that gets connected to the transformer. Or you can buy a matching transformer that has been properly wired in the first place. Or like I said, use an acoustic guitar.

The latter may be your only choice when someone shows up with "the original 1958 pick-ups." If the guitar itself is clean, but the amplifier is a sonic disaster area, you can bridge the transformer across the guitar output, rather than across the amplifier output. This will bypass troubles within the amplifier, but will also bypass the amplifier's tone controls. But it may be the only alternative with really wretched amplifiers.

WHAT ABOUT CONSOLE JACK BAYS?

At the Institute of Audio Research, we've been subjecting students to the joys of the patch bay in our Control Room Workshop. The patch bay is a wonderful tool for creative signal routing and emergency repair work. It's also a great place to short out inputs, introduce ground loops, and otherwise get into trouble.

Although most people seem to agree that pin 1 in a Switchcraft (or equivalent) plug is shield, there isn't much that can be said about pins 2 and 3. The convention that we follow is:

Pin 2 = low side = tip (of a PJ-051 tip/ring/sleeve jack)

Pin 3 = high side = ring (of a PJ-051 tip/ring/sleeve jack)

By making the tip of the jack the low side of the line, the high side is physically protected against momentary shorts when patching in and out of the jackfield. The jack bay in our cutting room is wired this way, as are various inter-connecting cables.

Now, in our control room, we've

been using various Neve consoles. All the patch points are balanced lines, and their convention is;

Pin 2 = high = tip

Pin 3 = low = ring

Because of the balanced lines, about the worst you can do is get a phase reversal if you mis-connect some external piece of equipment. Very convenient for a recording studio, but not much fun if you're trying to confuse a student.

But the plot thickens. We've recently purchased a 24-in/16-out console that was originally custom built for the RCA recording studios. It's got about 700 patch points, built into three jackfields. Some are balanced, some aren't, and as you might expect by now, their wiring convention is:

Pin 2 = low = ring.

(=Ground, in the unbalanced circuits)

Pin 3 = high = tip.

You can see where this is leading, I suppose. If a student puts an inter-connecting cable (wired according to our convention) between an unbalanced console patch point and an unbalanced signal generator, he's got to be careful. If the signal generator ground gets connected to pin 2 of our patch cord (= low = tip) the insertion shorts out the line when the other end is plugged into the RCA console where the tip is the high side of the line. Therefore, the student must reverse the polarity of the plug at the signal generator so that the signal generator ground goes to the ring of the jack.

This built-in confusion factor works out very well indeed. The student must understand what he's doing, or his laboratory procedures won't work. Just like in a real studio—if you don't get it right, it either hums, buzzes, or just dies on you. You've got to know how your console is wired: balanced?—unbalanced?—high = 2 or 3?—low = 3 or 2? Once you've got that all figured out, what about your cables? And all those little extras in the roll-around cart? If everything isn't wired according to one convention, you can go right up the wall trying to figure out why your expanders will work in some lines and not in others. The fun really begins when you borrow something from the studio down the block and try to get it to work in your control room.

The moral of all this rambling is that nine out of ten problems probably have something to do with a misplaced wire somewhere in the system. If the hum/buzz gremlins are getting the best of you, get your cable tester, an ohmmeter, and a bottle of Exedrin ready. Come in some long weekend, and if you're lucky you might get it all straightened out by Monday morning.

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● Back in July, the subject of discussion in this corner was the “talking” head which can be created by either front or rear projection. The technique, you may recall, is to project onto a face with no specific features a film of a speaking person which matches the size of the sculptured head. The effect can be startling when presented in a thoroughly darkened room. Since that story, two pieces of information have come in related to that subject which we would like to pass on to you.

The first was in the form of a letter from Mr. Arnold Grubin, President of Dimensional Communications, Inc. of Northvale, N.J.

The exhibit that you saw in the Pan Am Building in New York City featuring a “live” Columbus was conceived, and produced, by Dimensional Communications, Inc. The head in that exhibit was produced for us by personnel who we understand are now associated with Ron Chedister. That specific exhibit (there are two of them) has traveled widely in the USA, Canada, and Europe, and we are told has been a big success. We are still preparing “talking” heads in-house, both for front and rear projection.

As with most projection techniques, this one goes back many years. I've been told that Popular Science or was it Popular Mechanics, had a feature on the system several years ago giving full particulars on filming, actor harness, pitfalls, etc. I also recall reading, years ago (where I don't remember) of the technique being used in Europe during the 20's.

Many thanks, Mr. Grubin, for the letter and the information. Perhaps some of our readers may remember the original sources for both the “talking” head ancestors of several years ago and back in the 20's. Incidentally, the tour of the Pan American Organization, which had set up the exhibit in the Pan Am Building, also covered South America and Mexico. Maybe some of you got to see the showings. If you did, please let us know your reactions.

Our second bit of information was that there was a company in the middle west which made full size (or any size) figures with full costume and a featureless face for front or rear projection. We found the company to be Empire Films of Lake

Bluff, Illinois. The figure is called Audio Visual Mannequin and can be made to almost any specifications. It would seem that since the full figure is seen, this application would most likely be best used in dim lighting or even in full display, rather in a room in which the other projections (film or slides) would require an almost totally darkened room. Any other information on this subject would be greatly appreciated.

ON LOCATION A/V PRESENTATION

Last month, we discussed some of the problems with setting up a presentation at an office or conference room away from the home base. Included was mention of a bag of tricks which might be taken along to avoid some of the problems and much of the heartache and embarrassment which results from assuming that all required equipment will be made available at the meeting location. A very strong recommendation is that, if at all possible, the presentation site should be surveyed prior to the meeting time with enough leeway to prepare whatever will be required for a successful showing. Whether it be special connectors, cables, extensions—whatever—there should be time available to get everything ready to be taken to the site. There are also other things that should be observed and taken into consideration, whether the meeting takes place at a remote location, in one's own facility, or should there be an occasion to help in the design of an a/v setup for someone else.

First, let's take a look at the screen. This is what every person in the audience will be looking at during much of the presentation. If the screen is already hung on a wall or ready to be pulled down from the ceiling, someone must have taken time to figure out the size and location, and the seating will probably work out satisfactorily. If the screen (or screens) have to be set up on tripods, there might be more severe problems with the seating arrangement. In either case, don't just assume that all will be well. Get involved with the size of the screen or the location, or the seating arrangement so that heads do not appear on the screen during the slide show. It is better to ask someone to move a few chairs in the front row or

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to leave a slightly wider aisle down the middle before starting in order to prevent obstruction later, than to ask the tall person whose head is in the light to move once the show has begun.

Check out the seating by having someone sit in the questionable locations and projecting a full image at the proper size onto the screen with the light in the room at the level that will be used during the meeting. All of this worry can be avoided in most cases if tall projection tables are brought to the meeting to raise the projectors high enough so that the image will be from slightly above the heads of the audience.

As a part of this same subject of interference with the image, it might be well for the a/v specialist setting up the screen and projectors to find out if there will be vertical slides. As is well known, screens generally are set up for horizontal presentation. Film and slide format ratios demand a wider-than-tall configuration. When a vertical slide is shown, it can be very distressing to find that the top and bottom of the image are either off the screen or the top is hitting the head of someone in the front seats. In most cases where the screen is set up manually on a tripod, the length and width may be positioned the same to allow for vertical as well as horizontal images, but the setup of the seats and the projectors may have to be changed to permit the full image size to be shown. It may be possible to get to the producers before it's too late to get all slides made in the horizontal format. If not, you can at least prepare them for the possibly disconcerting effect if the presentation arrangements can not be changed to accommodate verticals.

Projectors should always be set up to face squarely on the screen, and straight at the center, if possible. Usually this is not possible in the older, more austere board rooms where it was never thought projection would ever be used. A large table in the center of the room with big chairs all around can sometimes leave very little space for setting up a screen with a wide-spread tripod and projection tables with spread legs. Then an off-center setup is called for, either to one side of the room, or diagonally. This can cause all sorts of keystone unless care is taken with the setup. (If the projection system is from the rear of the screen, and a keystone problem comes up, you may wish you had arrived an hour earlier than you did.) However, with the screen and projectors all set, and the proper lenses inserted, the images are fine. Next comes the sound.

SETTING UP THE SOUND

Usually, it will prove worthwhile to have an auxiliary speaker which can be set up at the front of the room, near the screen, hopefully, and connected with a long cable to the projector. It is most advisable to run the cable around the room rather than up the middle aisle or through the legs of the chairs. Connectors, wherever used for extending the length of the cable, should be solidly connected and taped to prevent an accidental separation by being kicked or walked over. If the cable does have to be run down the middle, use good strong tape to hold it down on the floor or carpeting. The same is true of the cable for operating the slide projector. At the connector, use a half-twist knot to hold the cable together.

With the speaker set up, the screen and projectors checked out, the cables tied and taped, new lamps put into the projectors, the sound level adjusted for approximately good listening anywhere in the room, you might now consider the other essentials for a good show, such as the lectern, the tape recorder to play tapes during the presentation, the light switches and who is going to handle them when it's time for charts between slide trays, the mechanics of changing slide drums—does the interruption come during a film or is there a long enough break

for charts? Does the person speaking just ad lib while you make the change or does he forget that it's time to change drums and continue to click his remote button while wondering how you loused up again? Then there's the problem of feeding the sound from the tape unit to the speaker in the front of the room, and so on. These are just a few of the items on the long check list to make a complex presentation run as smooth as silk. And don't forget the video cassette or tape that has to be seen on a t.v. set at the front. Is this tape to be played from the rear of the room near the projectors, or by someone at the front near the presenter?

All of this may be old hat, but it might surprise you to know how many of these little details which can make for a clean, professional presentation are not thought of before the show and not until an emergency arises does anyone think of what might have been done. One parting thought—it might be well, even for the real pro at this presentation business, to think in terms of all that is going on, all that might happen, what is needed quickly just-in-case, and how each failure or problem will be solved quickly, easily, with least embarrassment, and with the lowest down-time possible. ■

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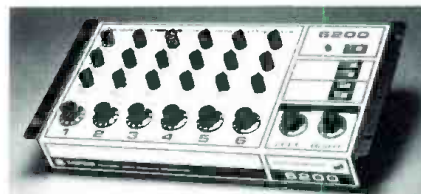
● Known as the Versa Console and designated model 4BEV-50, this compact single-channel mixer can be used for CATV, CCTV, film studios, etc. The unit has four mixers and accepts two inputs, seven inputs being externally switchable for mic or line level sources. All inputs are transformer-coupled to i.c. pre-amplifiers. The mixers are sealed pots with cue detents. The console provides both a balanced 600 ohm line output and high impedance PA output. An internal 1 kHz test oscillator supplies tone directly to the mixing bus. Monitoring facilities include a switchable vu meter, a separate f.e.t. muted cue amplifier, and a speaker. A front panel headphone jack is switchable to either the program or cue circuits.
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Mfr: TAPCO
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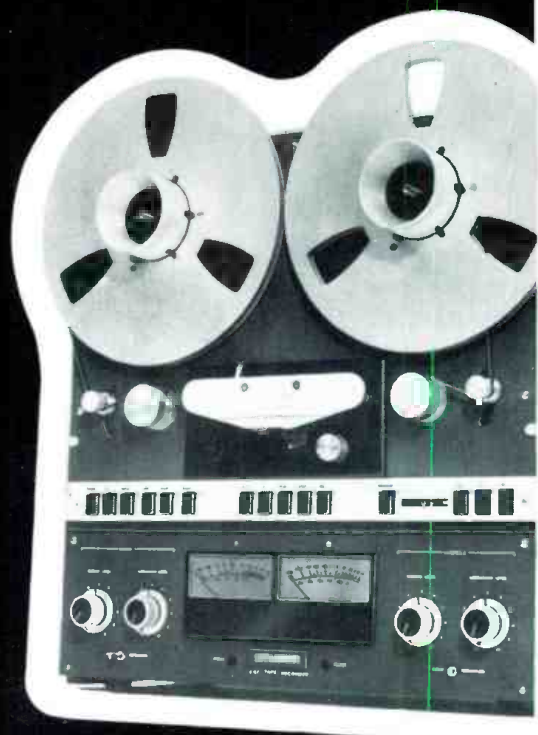
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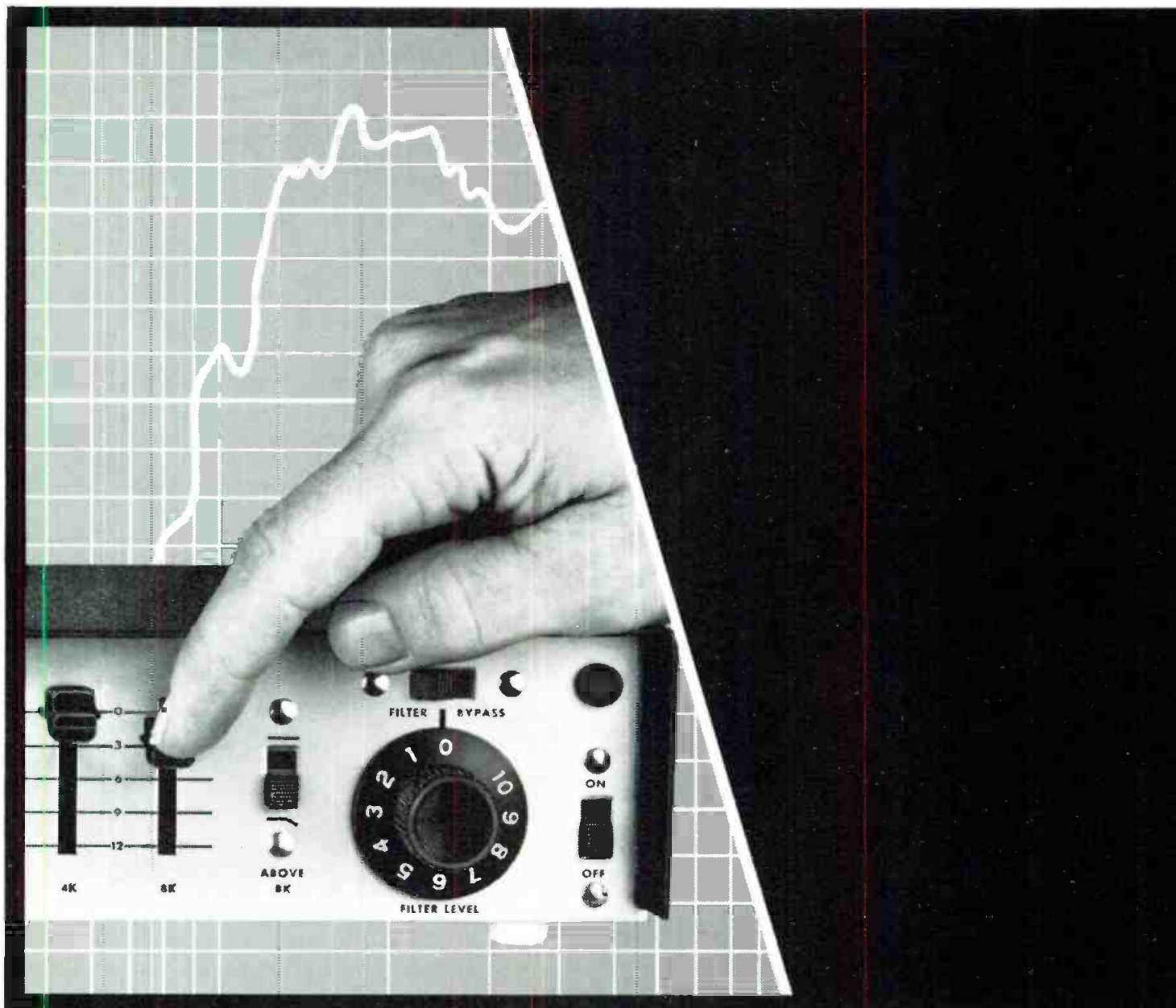
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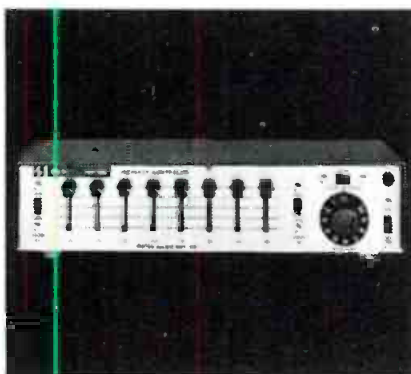
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The Gain Mutiny.



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products & services (cont.)

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isolated from each other. The units may be operated from a battery source, as well as from 120V a.c. May be wall-mounted or in standard racks.

Mfr: *Bogen/Lear Siegler, Inc.*
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FREQUENCY COUNTER



• Computing frequency counter SM-109A is particularly useful for high resolution low frequency measurements. The device measures the elapsed time for a number of periods of the input waveform, then computes the frequency for the relationship of the frequency to the time/period. A resolution of 0.00001 Hz can be obtained for a 1 Hz input frequency in one second. Range is 0.1 Hz to 10 MHz with sensitivity as low as 20 mV. The display provides 6-digit resolution with automatic decimal point placement and range indication. Front panel trigger control adjusts the input amplifier trigger level above the zero-crossing point. A rear panel switch changes the time base for a choice of one second or 0.1 second gate time. The 1-meg ohm input impedance allows use of a standard scope probe as a 10-to-1 voltage divider.

Mfr: *Heath/Schlumberger Instruments*
Price: \$640.00
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UP/DOWN COUNTERS



• Two 4-digit, 100-minute timers, ES-301 and ES-302, feature four 0.55 in. planar gas discharge displays, up to 99:59. Six separate controls—single pole, momentary push-button switches—count up, count down, stop, minutes advance, seconds advance and reset. The timers may be preset for a specific point and activated from that point, up or down. ES-301 is 8 in. wide and ES-302 10 in.

Mfr: *ESE*
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• A combination of LC tuned circuits and integrated circuit operational amplifiers are the basis of series 4000 active equalizers. The circuit utilizes all negative feedback, providing equal Q in both cut and boost conditions. There are 27 channels on ISO 1/3 octave centers from 40 Hz to 16 kHz. 10 dB or boost or cut is provided on continuously variable controls. Low end rolloff control can also be varied from 20 Hz to 160 Hz with a 12 dB/octave slope. Dual independent outputs, each driving a 600 ohm or greater load, are provided. An accessory socket prior to the buffered outputs may be inserted for a low level crossover network for bi-amped systems. The unit uses Mil-spec rotary potentiometers. Two models are available, model 4001 for sound reinforcement and model 4002 for music reproduction.

Mfr: *White Instruments, Inc.*
Price: \$635.00.
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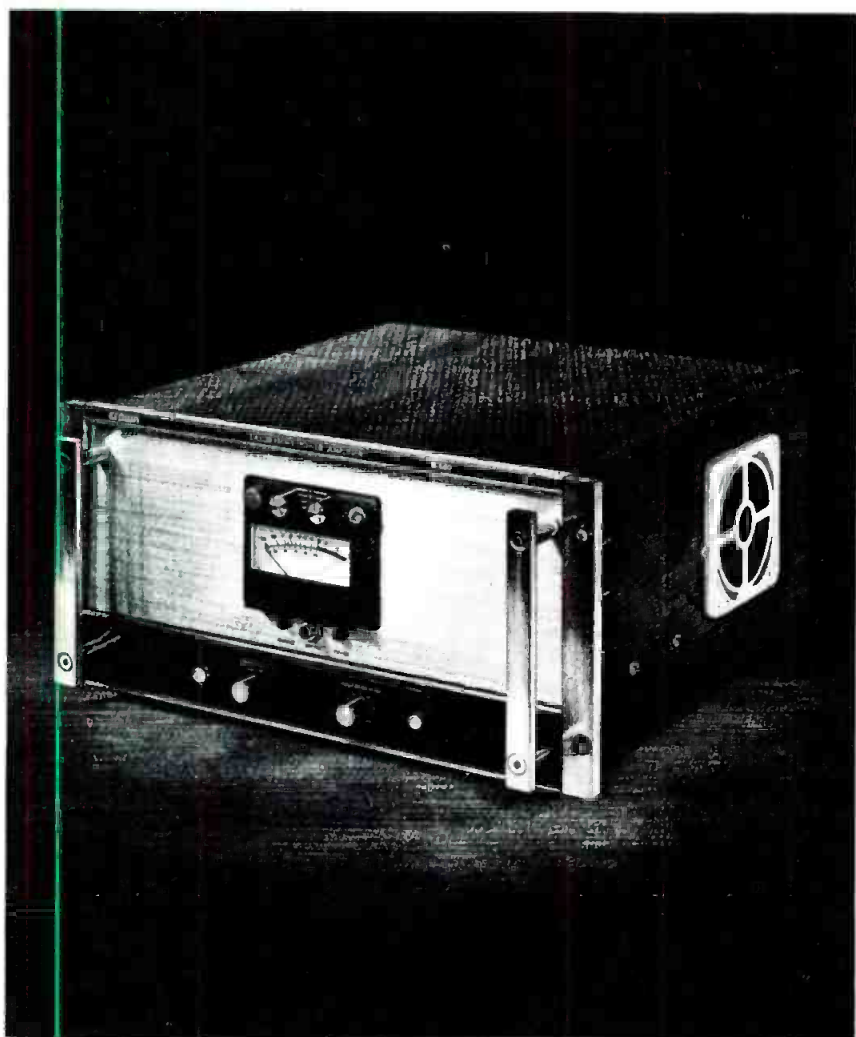
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Better Ways to Cope With Stereo Phasing

A simpler, more accurate, method than the X-Y scope plot indicates L-R phase differences.

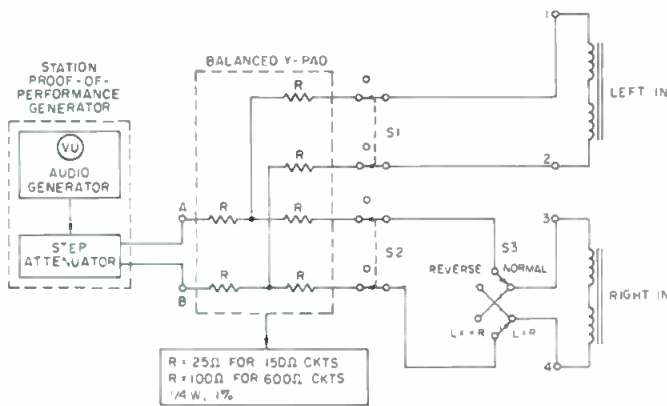


Figure 1. Convenient arrangement for stereo measurements.

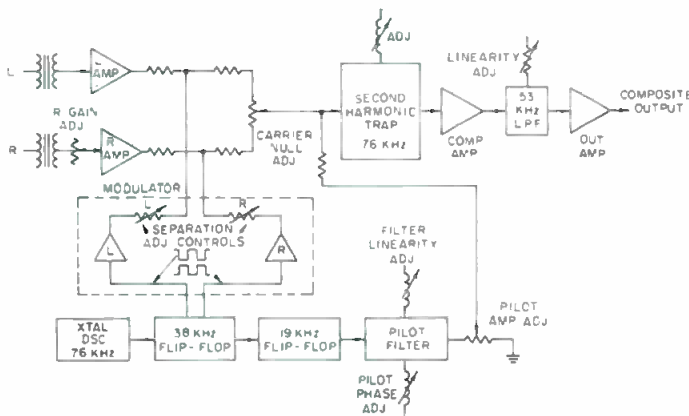


Figure 2. Simplified schematic, stereo generator, showing areas of control.

STEREO HAS BEEN WITH US since 1961. So have the phasing problems which play the villain role in both "compatibility" and stereo fidelity.

Sine waves are not broadcast. Continuously varying polyphased program signals of complex construction are carried in the L and R channels. But without the use of a sine wave signal for verifying the phase characteristics, (internal and external to the encoder), overall performance for both monophonic and stereophonic listeners will deteriorate.

Here I emphasize stereo phase measurements and problem solutions. Included is a much simpler and more accurate indication of phase differences than the cumbersome X-Y scope plot. The $L = -R$ signal as a sensitive first step in phase-difference indication is used.

THE CULPRIT: PHASE

The monophonic reproduction of stereo, stereo identity, and FCC tolerance of crosstalk specifications all depend upon phase linearity. In reality, even with the allowable 3 degree phase difference between L and R, $L + R$ and $L - R$, crosstalk specifications will be hard to meet. In general, these specifications cannot be held within limits with more than 1 degree phase difference.

Phase linearity simply means that phase shift is propor-

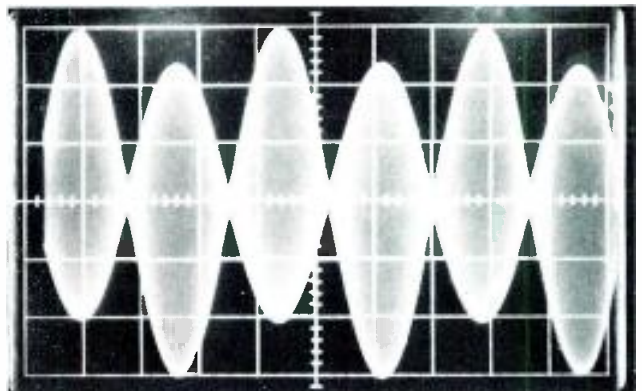


Figure 3. Waveform for $L = -R$ when R gain is not the same as L gain.

Harold E. Ennes is a consulting electronics writer from Beech Grove, Indiana.

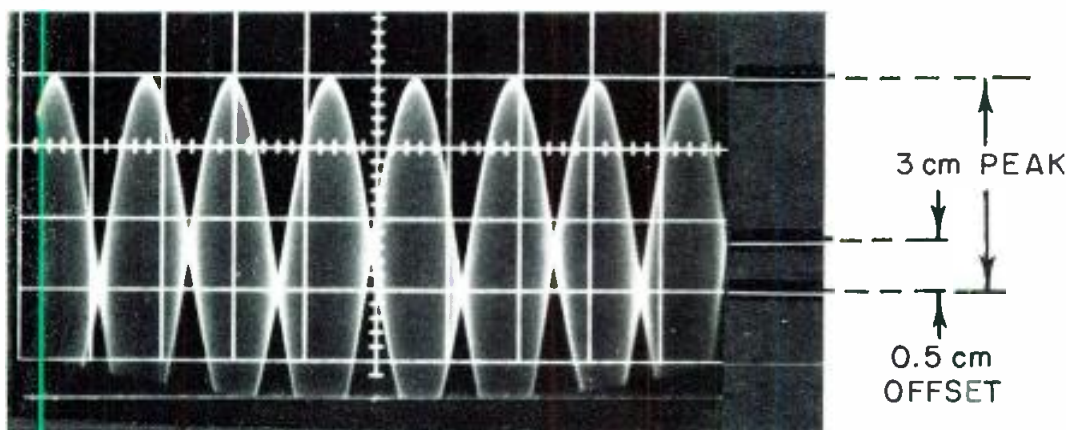


Figure 4. $L = -R$ when gains are equal, but phase shift occurs between L and R .

tional to frequency, so that all signals across the spectrum of 50 Hz to 15 kHz travel in time coincidence. The trick is to maintain this linear increase of phase angle with frequency, particularly from stereo disc and tape sources.

THE FIRST THING TO DO

Certain indications on the composite signal output show abnormal performance. It is necessary to know whether the fault is internal or external to the encoder. That is why the stereo generator itself must first be set up as a standard. Then the external effects are easily distinguished when connecting to external paths for L and R . (Mic inputs, stereo disc and tape sources).

If you don't already have it, and your stereo generator does not incorporate it, work up the arrangement of FIGURE 1. That avoids time-consuming changes of actual input wiring, and eliminates the possibility of leaving the wiring in the wrong place. Output terminals 1 and 2 feed the left-channel input, and 3-4 feed the right-channel input. In practice, this can be conveniently done by feeding the patch panel for the input desired, such as microphone, or the patch directly to the stereo generator inputs.

The audio generator, step attenuator, and vu meter are usually incorporated in one unit which serves as the generating section of the station proof-of-performance gear. The balanced Y pad splits the common audio signal into two paths for simultaneous left- and right-channel feeds.

Switches $S1$ and $S2$ permit either left-only, right-only, or left plus right feed. Switch $S3$ allows either normal, or reverse polarity feed to the right channel input. In the normal position, the A output of the signal generator feeds terminals 1 and 3 of the input, while the B output feeds terminals 2 and 4. In this case, the two inputs are being fed with a common in-phase signal, where $L = R$. With $S3$ in the reverse position, the polarity of the right channel input is 180 degrees out of phase with L input, or $L = -R$. Be certain you know which terminals of the in-

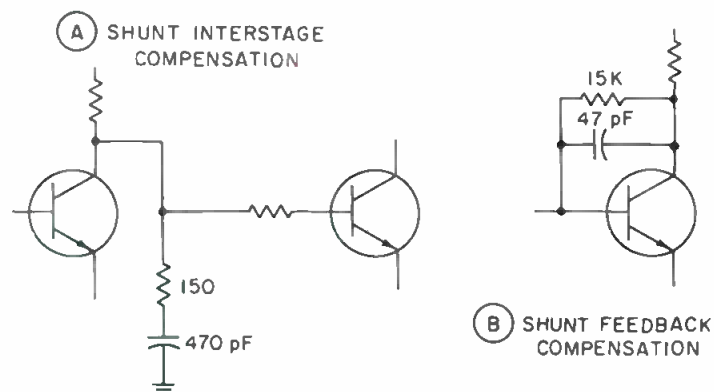


Figure 6. Typical frequency-phase compensation networks. Not only must these values be maintained well within 5% in each channel, but also well within 5% of the combination of identical networks in the opposite channel.

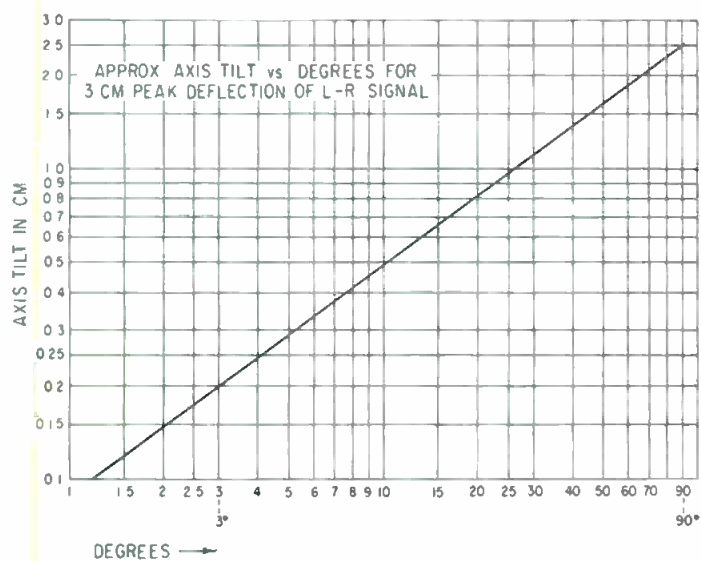


Figure 5. Approx. axis tilt vs. degrees for 3 cm. peak deflection of $L-R$ signal.

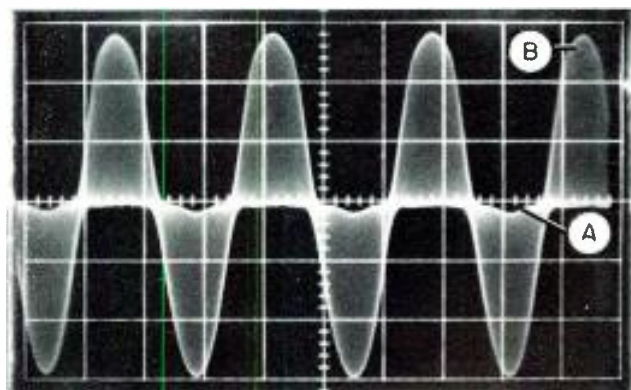


Figure 7. Notch (A) and distorted peaks (B) resulting from overload in stereo generator. Note difference of this waveform from that of Figure 8A.

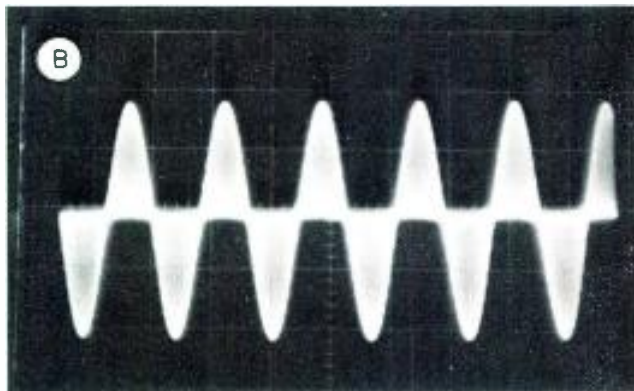
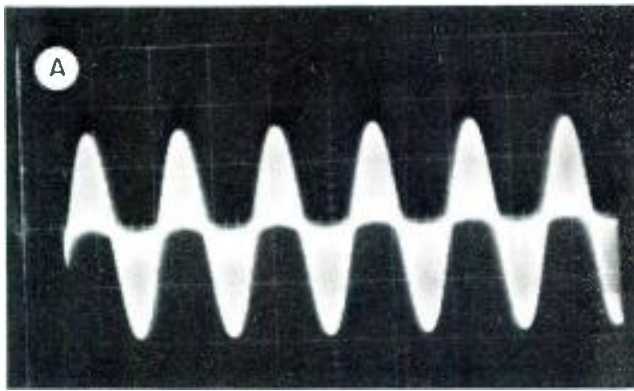


Figure 8. Setting $L + R$ and $L - R$ gains (A not equal, B equal.) Pilot turned off. L-only or R-only input.

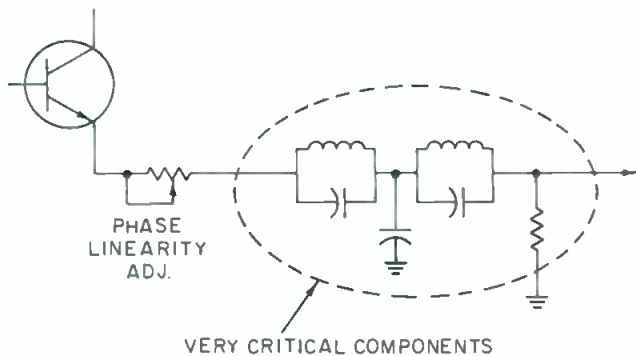


Figure 9. Simplified schematic, 53 kHz low-pass filter.

put device you are feeding constitute the in-phase connection.

THE STEREO GENERATOR ALONE

FIGURE 2 presents a simplified schematic of a typical stereo generator employing the sampling type modulator, showing the general areas of control adjustments that can affect performance. Essentially the same controls are provided on the older-type balanced modulator generators.

We will depart slightly from the conventional first step in checking the encoder by placing switch S3 (FIG. 1) in the reverse position ($L = -R$). Use 400 Hz at reference input level, and externally trigger the scope with this signal. FIGURE 3 shows the composite output (with pilot level turned off) when L and R levels are not equal. Note that a difference in gain (audio level) does not affect the straightline zero axis display as long as the phase of L and R are identical. Normally the left channel is taken as reference, and the right channel gain control is adjusted

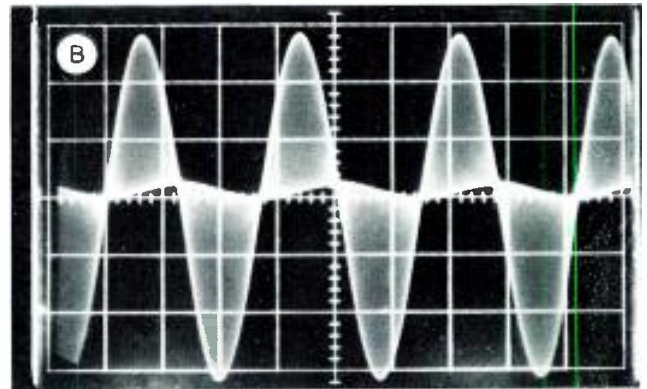
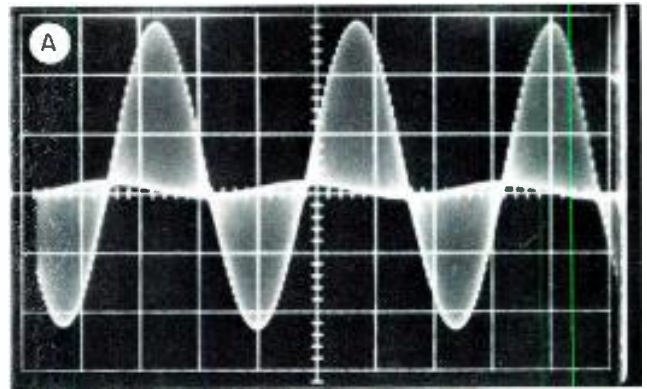


Figure 10. Phase non-linearity of subcarrier sidebands during or after modulation. (A) $L - R$ lags $L + R$. (B) $L - R$ leads $L + R$.

to obtain equal peaks on the $L = -R$ display. This is shown as R Gain Adj. on FIGURE 2.

FIGURE 4 shows the display when gains are equal, but phase difference occurs between L and R (explained by FIG. 13B). Note the decided difference in zero axis crossings on alternate sine waves. In this particular case, the "tilt" is 0.5 cm.

FIGURE 5 is a graph of approximate axis tilt vs. degrees when the scope gain is adjusted to allow 3 cm. deflection for half of the waveform. Note that a 0.5 cm. difference in zero axis crossings (as in FIG. 4) indicates slightly greater than 10 degrees phase difference. The same indication will occur when feeding through studio paths that differ in phase. At this time, we are feeding the stereo generator directly, and this display indicates internal fault usually in amplifier stages prior to the modulator. Remember that phase linearity must be retained at all frequencies between 50 Hz and 15 kHz.

Phase differences between L and R amplifiers (particularly at higher frequencies of 5 to 15 kHz) can occur from slight errors in frequency-phase compensation circuits. FIGURE 6 illustrates two typical circuits found in encoders, and in audio amplifiers external to the generator. Identical circuits exist in L and R channels. The components normally must remain within 5 percent in each channel, and well within 5 percent match to the opposite channel. Otherwise, a different phase shift will occur between channels as the frequency increases.

Caution: To avoid overload when feeding the stereo generator, remember to reduce the input level as frequency is increased to fit under whatever pre-emphasis curve is used. FIGURE 7 reveals an overload condition in the encoder. Note the distorted peaks and the "notch" which indicate overload. Also note the difference in waveform from that of FIGURE 8A which indicates $L + R$ and $L - R$ gain differences.

Next, set the separation controls (FIG. 2). Place S3 (FIG. 1) in Normal position. Feed a left-only signal of

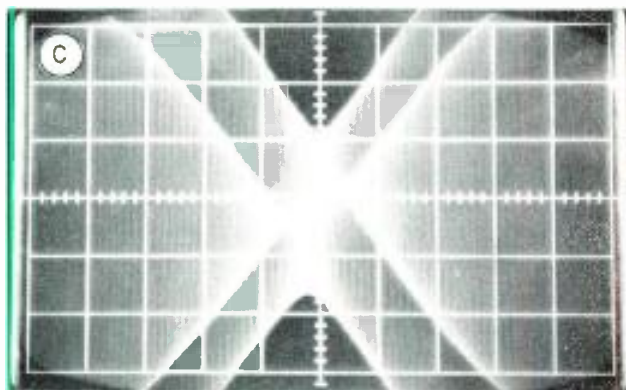
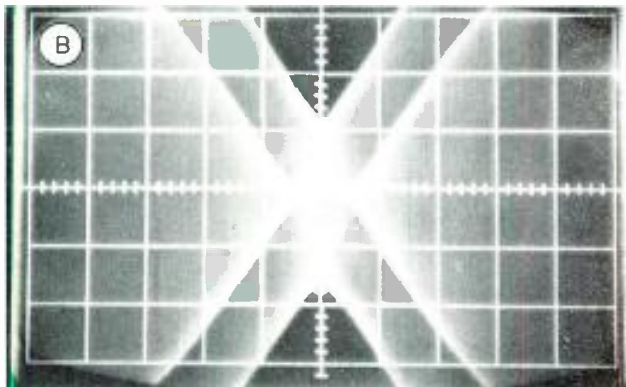
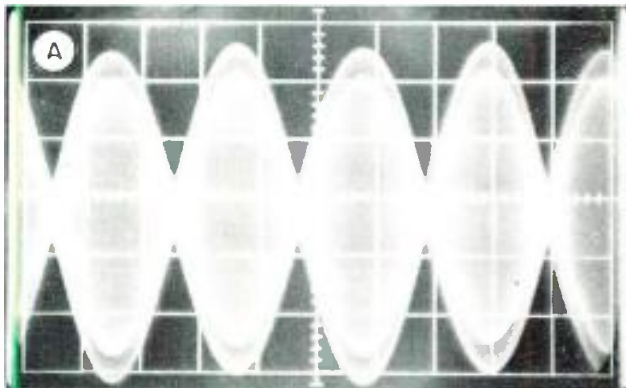


Figure 11. (A) $L = -R$ pattern with pilot on. (B) Proper pilot phase. (C) Improper pilot phase.

400 Hz (pilot control still at minimum) and observe the composite output as before. If the base line is not flat (FIG. 8A), adjust L control (sometimes termed L + R control) for a flat base line as in FIGURE 8B. There can be a "hump" in the baseline instead of a "dip," depending upon relative L + R and L - R gains.

Then apply a right-only signal, and adjust L - R control for flat base line. Sometimes both controls are used; at other times (particularly in the balanced modulator type) only an L + R gain is incorporated. The important point is that when the two gains are equal, the base line should be flat.

But what if you can't get a flat base line? The 50-Hz to 53-kHz output filter sometimes includes a phase-linearity control (FIG. 2 and FIG. 9) to set the driving impedance of the filter for maximum phase-shift linearity over this range of frequencies. Misadjustment of this control will cause a left-only or right-only signal to appear very similar to the waveform of FIG. 8A. Whether adjustment is provided or not, the same problem can occur with a component change or failure within the filtering network.

A phasing problem which can show up on left-only or right-only signals is illustrated by FIGURE 10. This condition usually indicates a fault in the modulator or following

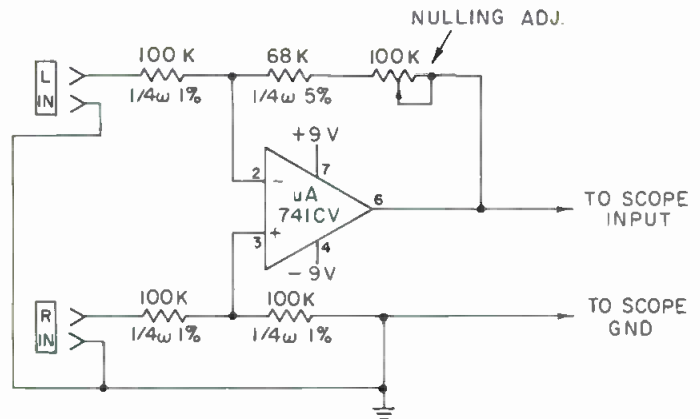


Figure 12. Simple external differential input for scope.

stages. FIGURE 10A indicates that L - R sidebands lag L + R sidebands. FIGURE 10B indicates that L - R sidebands lead L + R sidebands. This occurs when the phase of the 38 kHz subcarrier sidebands is not correct in both channels.

Check the oppositely phased switching-pulse outputs of the 38 kHz flip-flop for proper risetimes and amplitudes in a sampling type modulator (FIG. 2), and all components in a balanced modulator. Also check any frequency-phase compensation networks (FIG. 6) following the modulator. Defective coupling and bypass capacitors are always suspect. Large value electrolytic decoupling capacitors can sometimes develop an inductive component. Obviously you cannot overlook faulty tubes, transistors, and diodes.

PILOT PHASE

The setting of pilot phase is conventional, but will be reviewed briefly here. Again, reverse the polarity of the right channel signal and trigger the scope externally from the input signal. Turn the pilot amplitude control to normal level. With the scope time base around 200 $\mu\text{s}/\text{cm}$, the pattern of FIGURE 11A should be obtained.

Now expand the scope time base to around 50 $\mu\text{s}/\text{cm}$. If the pilot phase is correct, a perfect diamond pattern as in FIGURE 11B is displayed. (Expand the vertical gain for accuracy.) This indicates proper zero crossings of the pilot and subcarrier sine waves. With incorrect phasing, the four crossings do not form a diamond pattern as illustrated by FIGURE 11C. Adjust the pilot phase control so that the pattern of FIGURE 11B is obtained. Always recheck the pilot gain after pilot phase adjustment. Be certain that the 38 kHz subcarrier null is within limits by removing signal inputs, terminating the inputs, and checking the composite signal output for minimum carrier (pilot off) as the null adjustment is made. This must be less than 1 percent modulation compared to normal output level for 100 percent modulation. Use maximum scope gain for this adjustment.

CHECKING EXTERNAL PATHS

When you are satisfied with the stereo generator check-out, it's time to check the external paths. Again, the phase linearity in L and R must hold over the range of 50 Hz to 15 kHz, from microphone, stereo disc, and tape sources.

You can get a sensitive indication of external phase problems by feeding from a studio source, and using the $L = -R$ method of FIGURES 3 and 4. This is a good Step No. 1 in checking external phase linearity. If any phase problems exist between L and R, you have an axis offset,

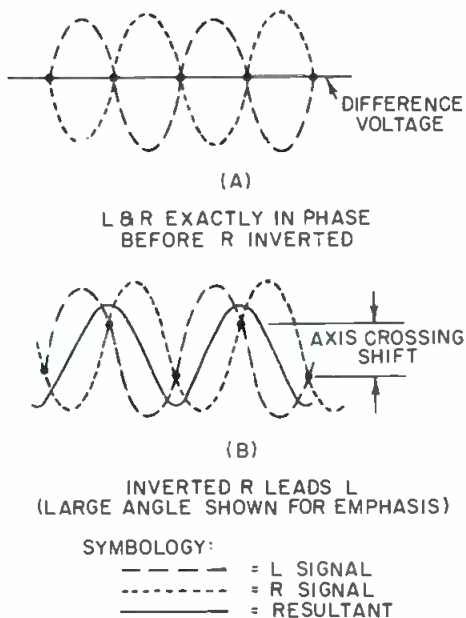


Figure 13. Basic principle of differential amplifier operation.

as in FIGURE 4. Remember to reduce the level as frequency is increased to fit under the pre-emphasis curve. When zero axis offset occurs from an external source, assuming your stereo generator has passed specifications, you know it is necessary to concentrate on the external path or source problem.

Most of you, unless you own an expensive phase meter, have probably been using the X-Y scope plot to measure any difference in phase from a common input signal between L and R. This method, as you have discovered, is cumbersome, time consuming, and inaccurate at small angles.

The simple and inexpensive circuit of FIGURE 12 provides a convenient and accurate method of measuring phase differences by converting to a voltage difference. A voltage reading is much easier to read than the X-Y scope pilot requiring H and V amplifier gain adjustments and critical centering. The simple integrated circuit of FIGURE 12 uses the very inexpensive type $\mu A741CV$, a miniature 8-pin version selling for about one dollar.

The theory of operation of the differential amplifier is briefly that two inputs are used; one is inverting (-) and the other is non-inverting (+). Any difference in amplitude or phase results in a voltage output, whereas identical amplitudes and phases result in zero output. This is explained by FIGURE 13.

In FIGURE 13, it is assumed that the two signals are of identical amplitudes. FIGURE 13A shows the resultant output (0V) when L and R are exactly in phase before one or the other is inverted in the differential amplifier. FIGURE 13B illustrates the difference voltage caused by an R-leads-L phase condition. A large phase difference is used for emphasis. Note the resultant zero axis crossing shift of L and R signals which explains FIGURE 4.

For the circuit of FIGURE 12, use two ordinary 9-volt transistor batteries for the plus and minus power. The "nulling" potentiometer allows compensation for any slight difference in level between L and R when their respective vu meters are indicating as closely as possible. This difference can actually be well up in the millivolt range. The same is true when reading p-p voltages on the scope.

When you are ready to check this device after construction, simply apply the same signal to L and R inputs (about 2V p-p) and adjust the nulling pot for zero output

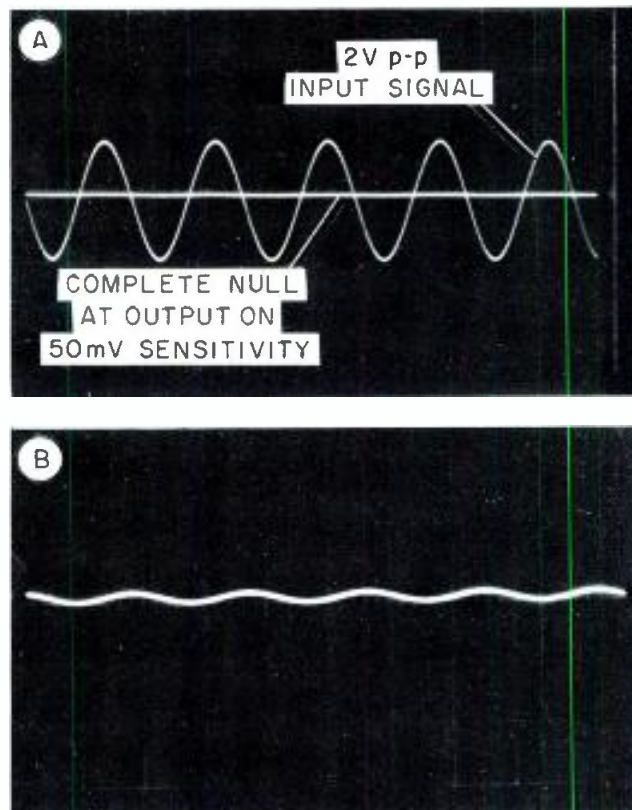


Figure 14. (A) 2 volt p-p input with null on output. (B) Imperfect null.

on maximum scope gain. In practice, a 50-mV/cm sensitivity is the maximum required. You will note that as you go through the null adjustment, you get the non-inverted signal on one side of null and the inverted signal on the other side. FIGURE 14A shows the complete null of a 2V p-p input, and FIGURE 14B indicates incomplete null on a single-trace scope.

In system use, it is convenient to provide the inputs from jack panels. Be sure to use the tip of the patch cord in each case for the "hot" side, and tie ring and sleeve to the ground connection. Although this temporarily unbalances a balanced line, such tests are normally carried out in off-air intervals and have no bearing on the accuracy of relative phase differences. Use the normals on the jack panel if possible. If it is necessary to use a direct patch which lifts the terminating load, be sure to terminate the L and R inputs with the proper resistor, usually 150 or 600 ohms. Your most important checks will, of course, be made with the differential amplifier and scope looking at the main program line output, or stereo generator input if situated at the same location.

SYSTEM PROCEDURE

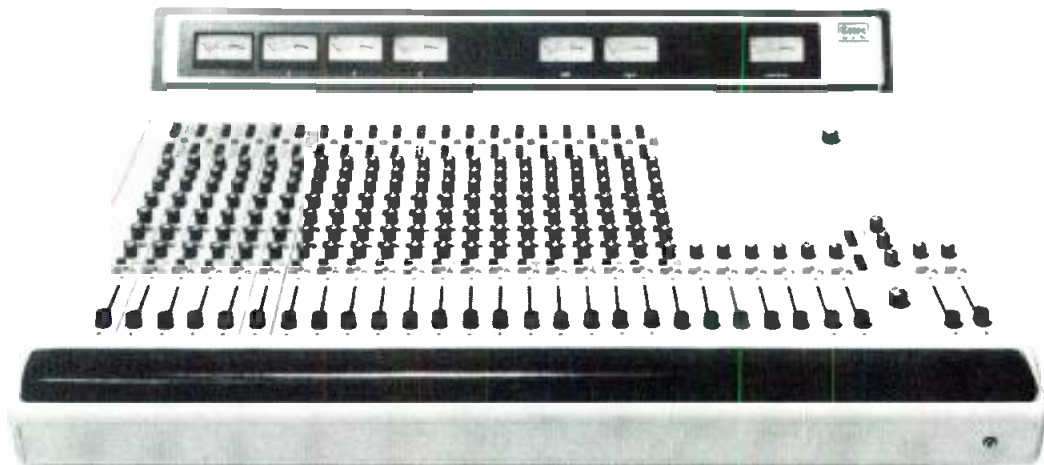
Step 1. Using the network of FIGURE 1 with S3 in the normal position, feed an input signal of 1.000 Hz to L and R microphone inputs, of such level as to result in 2 volts peak-to-peak in each line. This is a convenient level in either 150 or 600 ohm lines, and will be somewhat under zero vu deflection.

For a single trace scope, it is most convenient to use a three-position selector switch for the vertical amplifier input; one position for L, one for R, and one for the output of the differential amplifier. In this case, of course, it is necessary to switch the input sensitivity when going to position 3 (differential amplifier).

With the scope looking at the differential amplifier output, adjust the nulling pot for a straight line. If not possible to get zero voltage, you have a phase difference. In

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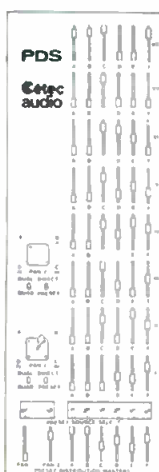
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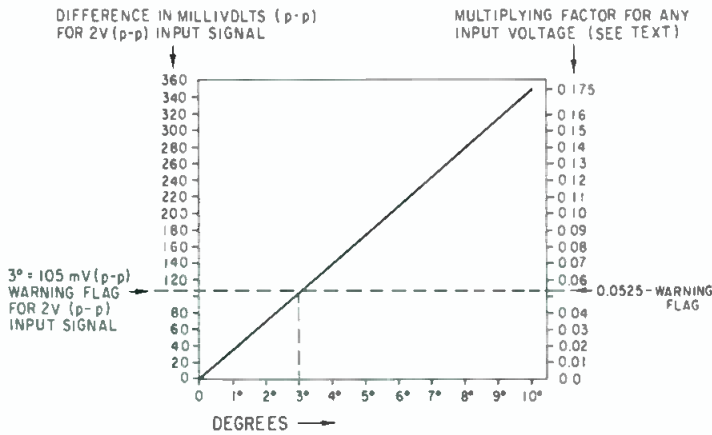


Figure 15. Difference millivolts for up to 10°.

this case, you simply adjust the nulling pot to “go through” *minimum amplitude*, then leave at minimum. The remaining resultant is a direct measurement of phase difference in millivolts.

FIGURE 15 shows the relationship of degrees to millivolts up to 10 degrees. On the left of the graph, you see that 105 mV is your warning flag for 3 degrees. That assumes the input levels are 2V p-p. If your difference voltage is well under 105 mV, you’re okay. Ideally, this difference should be no more than 40 mV p-p with a 2 volt p-p input.

If you want to use a different p-p level, see the right edge of FIGURE 15. For a 1V p-p level, your warning flag is 52.5 mV. If you use a 3V p-p input, your warning flag is $3 \times 0.0525 = 157.5$ mV, etc.

Caution: since we will use a fixed input level at all frequencies in this procedure, *do not* feed the stereo genera-

tor for these tests due to overload from pre-emphasis.

If you have a phase difference of around 15 degrees or more, you will find that you can no longer obtain any semblance of a minimum amplitude indication by means of the null pot. The display simply increases or decreases in amplitude without being able to go through a minimum amplitude. In this case, simply adjust the null pot for a straight line when feeding the same signal directly to both inputs; then leave it alone. Connect back to the L and R external lines, and read the voltage difference. With this much phase difference, you are reading in volts or large fractions of a volt, and any difference in millivolts is of no concern.

FIGURE 16 shows the multiplying factor on the left, and the actual voltage difference for a 2V p-p input signal on the right, for 10 degrees to 180 degrees. If there is a complete 180-degree phase reversal, the differential output is twice the input voltage. For 90 degrees, the output is 1.41 times the input voltage, etc.

At angles less than 90 degrees, the voltage difference becomes the square-root of the sum of the squares of the *difference* between the angles measured. Thus:

$$E_{mt} = \sqrt{(E_{m1} \cos \theta_1 - E_{m2} \cos \theta_2)^2 + (E_{m1} \sin \theta_1 - E_{m2} \sin \theta_2)^2}$$

where:

E_{mt} = maximum total difference voltage

E_{m1} = maximum voltage of L channel 2V for 2V p-p signal)

E_{m2} = maximum voltage of right channel (same as E_{m1})

θ_1 = angle of E_{m1} , taken as 0° reference)

θ_2 = angle of E_{m2} with E_{m1}

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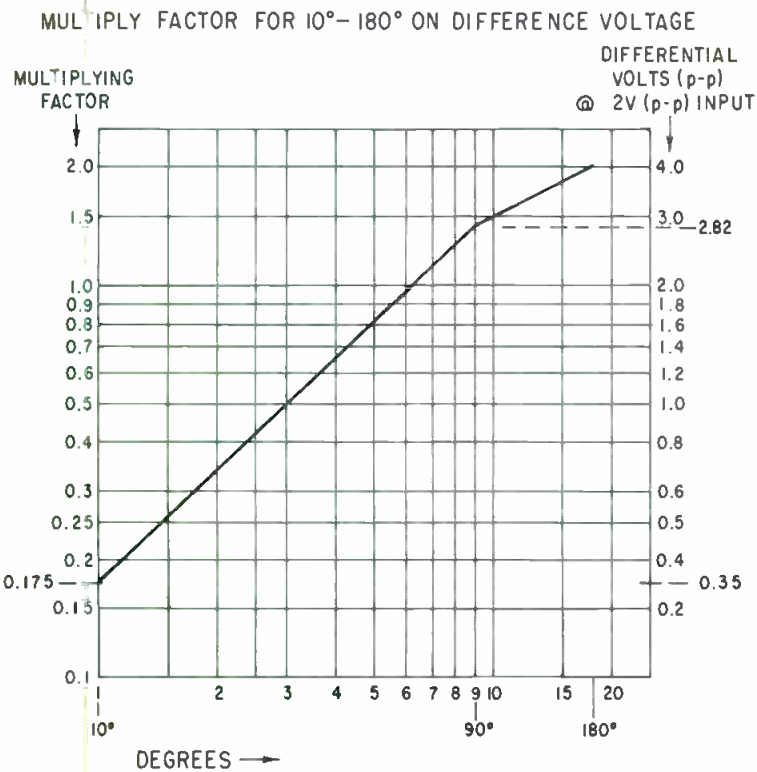


Figure 16. Multiplying factor for 10°-180° difference voltage.

Mathematically, the difference voltage at an angle of 3 degrees is 104.6369 mV. This is plotted as 105 mV on FIGURE 15. The difference voltage at an angle of 10 degrees is 348.528 mV. This is plotted as 350 mV on FIGURE 15 and 16.

Repeat the above tests for all stereo mic inputs, from 50 Hz to 15 kHz.

Step 2. Feed the stereo outputs of disc and tape systems to the lines in the normal manner. Use a monophonic lateral test record for checking discs, and full track monophonic alignment tape for tapes. Again, it is convenient to use a level corresponding to 2V p-p in L and R channels.

Fixed equalizers for RIAA and NAB specifications are most often used for discs. If you have variable equalizers for each channel, watch out!

PROPER HEAD ALIGNMENT

Proper head alignment is extremely critical in stereo tape decks. A very precise azimuth adjustment is required to avoid phase shifts between channels. Also, different skewing of the tape between record and playback functions (interchanged basis) will have disastrous results on phase linearity between L and R. You can precisely align the azimuth for the two-head stereo assembly to obtain phase linearity from the two tracks by the method outlined above. Check any skewing characteristics at the same time by deliberately skewing the tape to see if phase angle increases or decreases.

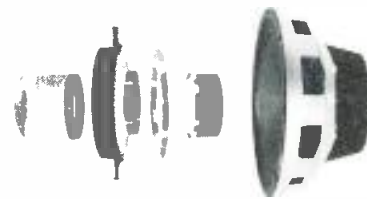
When phase problems occur, it is convenient to "patch back" along the route to see if it occurs in a particular amplifier or distribution branch. Plug-in spare amps are a godsend here! When mic inputs check okay, you will normally find that problems from disc and/or tape will be traced to the source itself. ■

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A simple alteration converts the Magnatech 92C resolver to compatibility with d.c.-controlled servo systems.

THE GUYS IN FILM WORK have a new problem to handle now that synchronous capstan motors in tape transports are being replaced by d.c.-controlled servo systems. Their auxiliary equipment may not be compatible!

However, all is not lost. The reliable Magnatech 92C resolver, designed for use with synchronous motors, need not be retired yet but given a new lease on life. With a simple addition, it will work with the servo machines and still be happy resolving your older transports.

For our purpose here, I use the resolver with an Ampex 351 and a Studer A80, but you can adopt the principle to operate with almost any machine or combination of machines.

THE RELAY

Within the 92C resolver is a variable potentiometer driven by a servo motor. This pot controls the internal $60\text{Hz} \pm 20$ percent oscillator, the output of which feeds the current amplifier, thereby supplying the drive to a synchronous motor. The leads to the pot are rerouted via a relay (FIGURE 1) and additional leads added between the relay and three of the spare pins on the rear panel connector. The relay is a standard P&B KHY17D16-12 volt, but may be any type having a minimum of three C contacts and voltage rating matching the potential across the machine's voltage busses which are being tapped. In the Studer, we tap the plus and minus 5.8 volt rails, which are available at the capstan control socket. The current consumption of the relay and pot is no problem.

When a synchronous motor machine is in use, the spare pins have no signal and, therefore, the relay remains de-

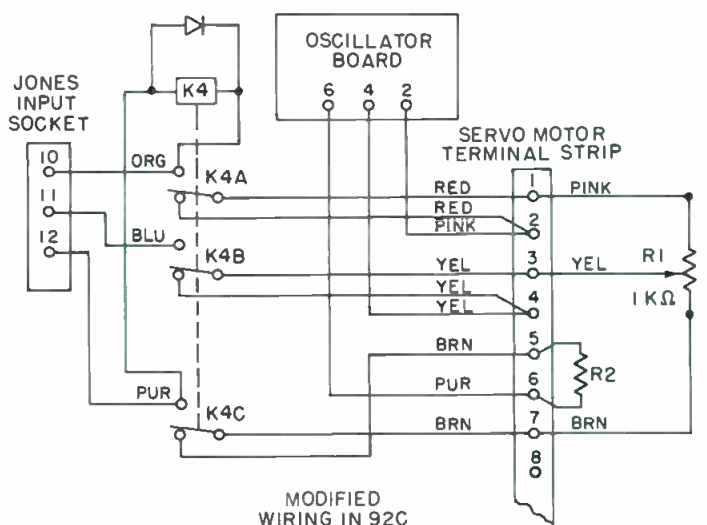
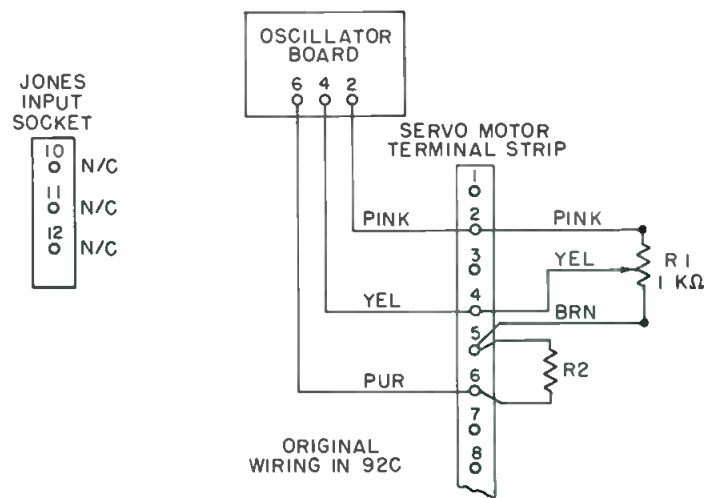


Figure 1. Rerouting leads to the pot via a relay.

Brian C. Lowe is Technical Manager of Manta Sound Company, Toronto, Canada.

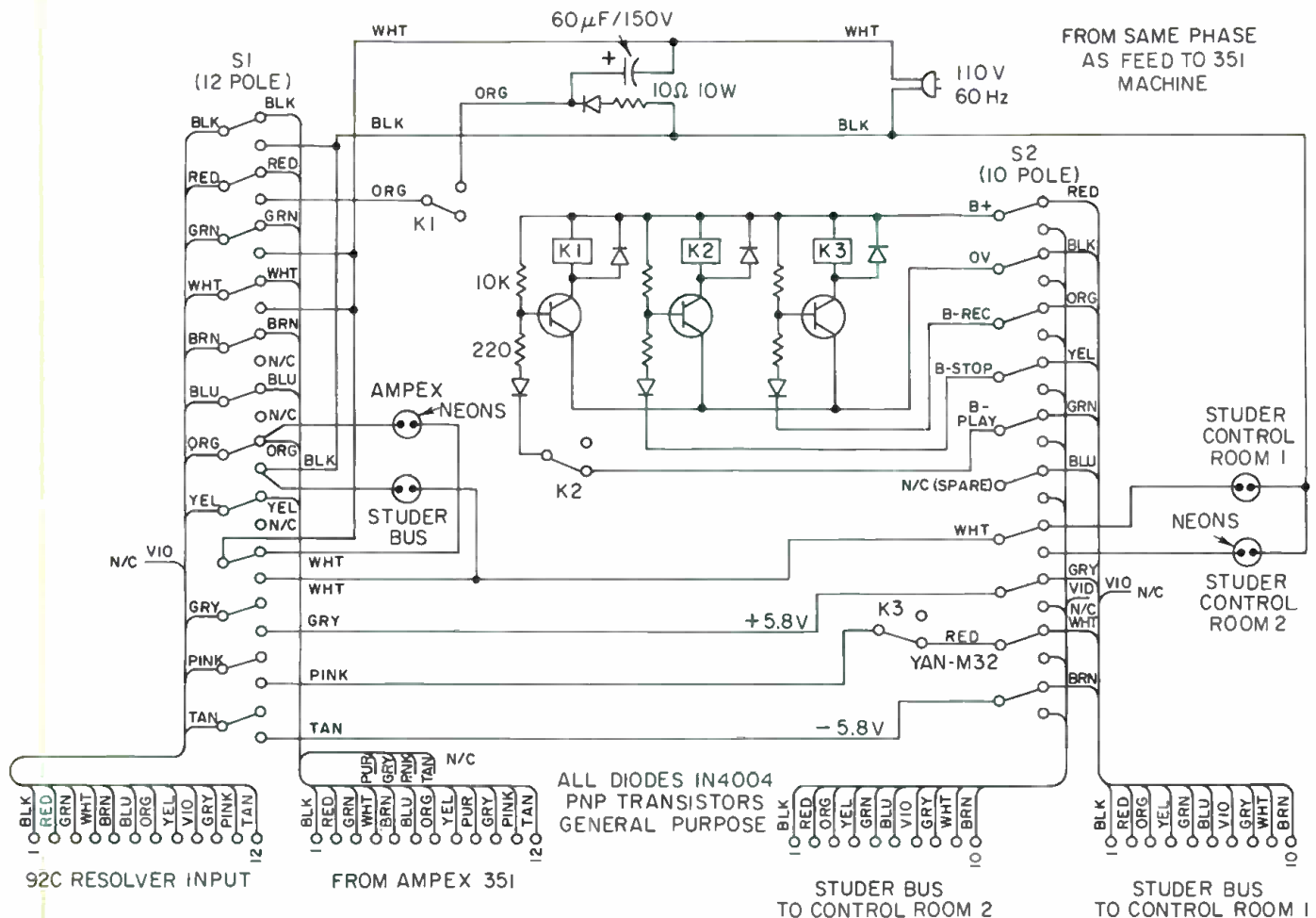


Figure 3. Complete interface schematic.

energized. The circuit is the same as in the original unit. If a servo machine is plugged in, the relay energizes and redirects the pot to the servo machine. This causes no ill effects in the resolver; it simply shuts off the oscillator and current drive circuit.

Naturally it's not just that simple. The 92C must know what mode the transport is in so that it will not try to operate in the record or wind modes. Therefore, an interface was required for the Studer to convert its low voltage d.c. logic to the high-voltage control used in the 351 in order to maintain compatibility.

But don't be scared away. A simple package will solve the problem.

MODE INDICATION

All that is required for the resolver to function correctly is an indication of play and record modes. In the Studer, a readily accessible mode indication is available on a rear socket, the lamp-feeds to the remote buttons. I use these feeds to fire relays for the isolation I need.

As in many machines, the motion sense allows Play to be selected before coming to a stop. When Play is selected during a wind mode, the Stop lamp is lit along with the Play lamp until the transport actually stops—then Play is activated. In the interface, the Play feed is inhibited if a Stop feed is present. The Record logic of the resolver is inoperative when driving a servo motor. However, the resolver must be prevented from controlling the servo tape motor when in the Record mode. That is simply accomplished by switching off the variable speed control voltage

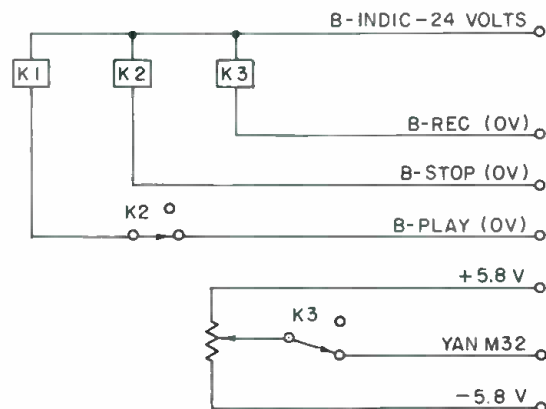


Figure 2. Relay block diagram.

by a relay which is activated by the record signal from the machine. The relay block diagram is shown in FIGURE 2.

Normally, the end of tape switch on the 351 transport, held on by the tape, activates the feed to the resolver power supply, thereby generating the variable 60Hz motor feed. The Studer has no such switch. This feature is not required; the interface provides a shorting link across these switch terminals. As we have access to various machines, a selection switching panel was included with the interface. This may be omitted if you prefer simply to plug in the machine to be used.

(continued)

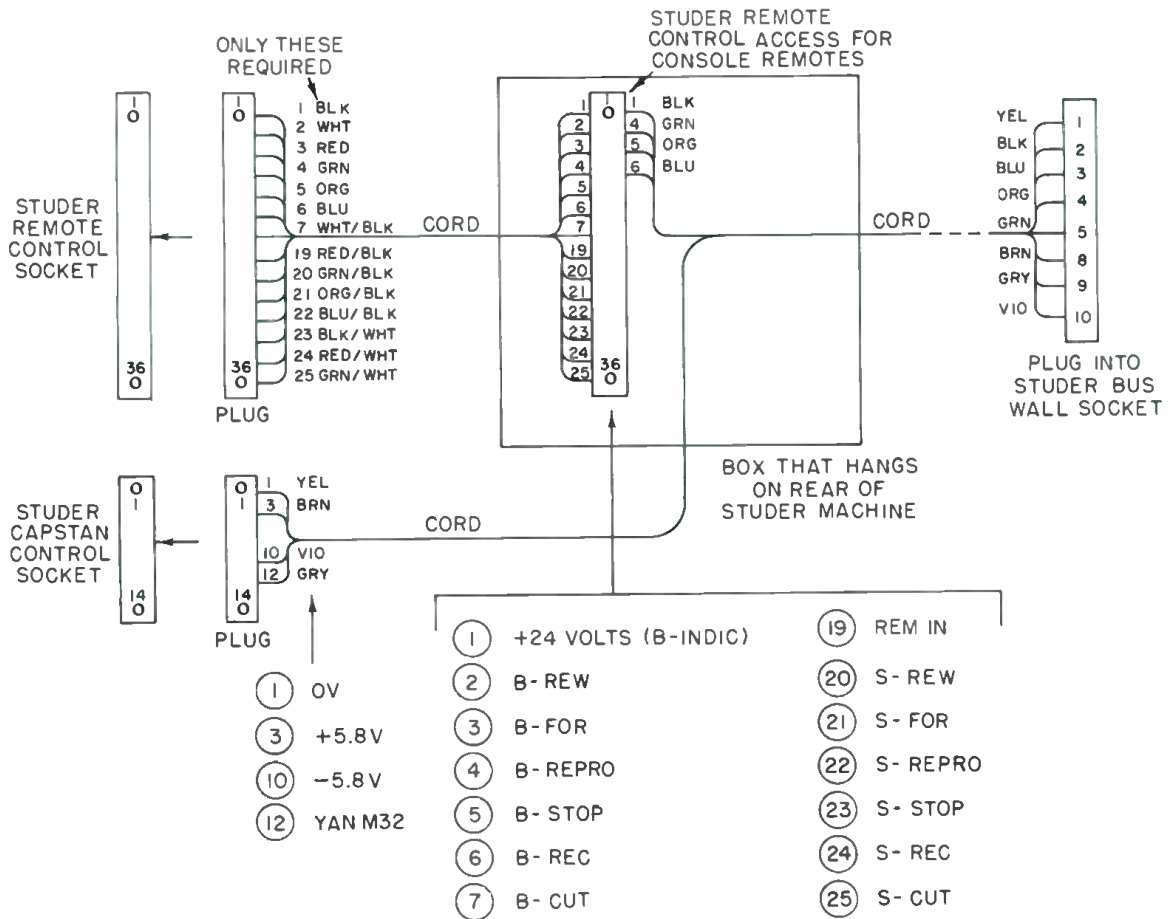


Figure 4. Adapter box.

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REMOTE CONTROL

The transistors controlling the relays in the complete interface schematic, FIGURE 3, are used to minimize the current drawn through the indicator transistors in the Studer, as they may already be supplying power to the machine mode indicators, the console remotes, and a set of remotes in the projection room.

To allow regular use of the Studer from remote locations and still have access to the same socket for these relay drive signals, it was necessary to make an adapter box as shown in FIGURE 4.

Because the vari-speed on the servo systems are pure d.c. voltage controlled, the connecting lines may be quite long. In fact, our Studers remain in the control rooms while the resolver and magnetic film recorders are up in the projection room. Also, any Studer may be plugged into the control line, including multi tracks, so a mix directly from 16-track to magnetic stock is possible, thereby saving a generation of tape.

COMPENSATING FOR SLOWNESS

The system has been in use now for over a year with no problems. It does have one drawback, however. This form of control, with an A80, provides only ± 3 percent of vari speed. This is sufficient for correcting any error in tapes, but it replaces the ± 20 percent with the original system. Obviously, the ± 3 percent over the same range of the pot is far more accurate, but it is also much slower to lock into correct sync.

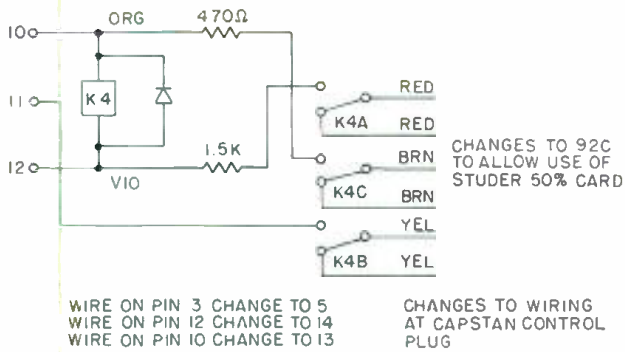


Figure 5. Wiring in the resolver.

It is necessary to start from the Edit mode of the Studer, thus providing a faster start and therefore faster lock into sync.

That has been no serious problem and will not exist with other manufacturers' systems where the vari-speed range is greater. The new vari-speed card from Studer, #1.080.374, has a range close to ± 50 percent. FIGURE 5 shows the wiring in the resolver for use with this card. The only other changes in the wiring are at the machine capstan control plug where three wires are moved, also shown in FIGURE 5. One further change will be required—this is an addition to the vari-speed card as shown in FIGURE 6. A 10k pot is recommended to control this card, but the 92C has only a 1k pot so that this addition provides for the extra current requirement of the low value pot.

Optional switching may be added to allow use with the

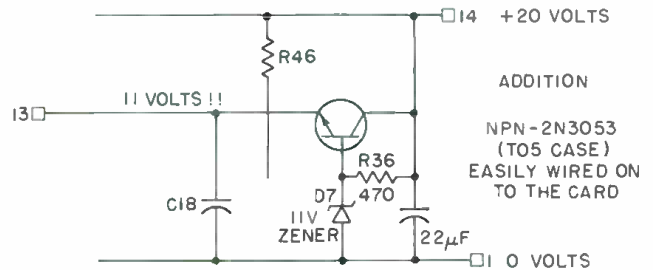
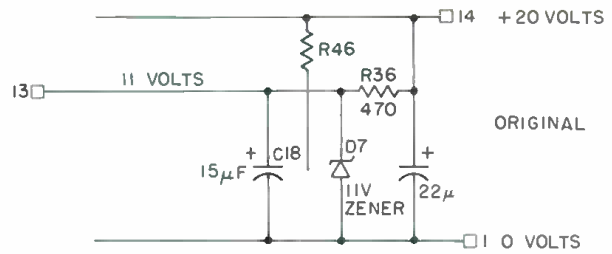


Figure 6. Addition to the vari-speed card.

2 percent or 50 percent system, depending on the availability of the vari-speed card and the nature of the product being resolved.

Now for the good news. The total parts cost of the modification, excluding the purchase of the 50 percent vari-speed card, which is optional, is less than \$50—a considerable saving when compared to purchasing a totally new system for your servo machines. Obviously this is a small cost for a compatible system to run any machine. ■

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Circle 41 on Reader Service Card



Figure 1. Medium sized BBC transmitter facility. Sandale, Northern England. BBC photo.

ANGUS MCKENZIE

Broadcasting in the United Kingdom

A commitment to excellence in programming and equipment, fueled by public support, creates Britain's superb broadcasting fare.

THE MOST MARKED DIFFERENCE between radio broadcasting in the United Kingdom and the United States is that the largest proportion of U.K. broadcasts are non-commercial, run by the British Broadcasting Corporation, which operates four national networks. Radio 1 is entirely pop-oriented; Radio 2 transmits light music and general entertainment programs; Radio 3 is entirely classical music, poetry, drama, documentaries, and other programs of general interest. Radio 4's programming sometimes duplicates the type offered by

other networks. At times, regional areas will elect to broadcast programs of local interest instead of picking up the regular BBC schedule. BBC also runs a chain of twenty non-commercial autonomous local radio stations.

Radios 2, 3, and 4 are available in stereo to approximately 85 percent of the population, while radio 1 is available on a.m. only except for the occasions on which it combines with Radio 2. Each BBC local radio station transmits only on mono, simultaneously on f.m. and also in parallel on a.m.

The Independent Broadcasting Authority maintains nineteen commercial radio stations. These are licensed to various commercial organizations under a very strict charter and responsible to the IBA for their output content and

Angus McKenzie is a well known British journalist and audio engineer.

operating standards. The commercial radio stations all transmit in stereo on f.m. and also in parallel on a.m.

Programs offered on commercial radio, while supported by advertisers, are not specifically sponsored by them. The content is controlled by the stations themselves, indirectly through IBA. This results in balanced schedules, for example, alternating heavy rock music with classical music to appeal to a wider spectrum of the public. Commercial radio station, the London Broadcasting Company, specializes in news and phone-ins; another commercial station, Capital Radio, offers mainly pop music, with occasional minority interest musical programs.

The BBC commenced a regular VHF service about 20 years ago, including the Home Service (now equivalent to Radio 4), the Light Programme (now Radio 2) and the Third Programme (now Radio 3). The Home and Light Programmes ran from early morning until late night and the Third Programme was transmitted only in the evenings. Experimental stereophonic transmissions used the Third Programme for one channel and BBC television sound relayed the other.

In 1962 the BBC transmitted some experimental stereo multiplex broadcasts; the system was finally adopted permanently in 1965 for Radio 3 only, just in time for the famous Henry Wood Royal Albert Hall promenade concerts. In 1972 the BBC commenced transmitting stereo on Radios 2 and 4, covering South East England from their Wrotham transmitter and using the transmitter at Sutton Coldfield, which had been transmitting stereo on Radio 3 since 1968, to cover the Midlands.

Whereas almost all BBC stereo distribution up to 1972 was by land lines, as supplied by the Post Office, now the majority of circuits use a type of link known as microwave pulse-code modulation which allows listeners a distance away from the main transmitting center in London to hear virtually identical quality as those close by.

TRANSMITTERS AND DISTRIBUTION

While in the States, transmitters, usually covering relatively small areas, area of intermediate power, in the U.K. the major transmitters have to cover areas in excess of 3,500 sq. miles and are thus very powerful; an e.r.p. of 100 kW is not unusual. F.m. radio antennas are almost always horizontally polarized, although some have a degree of slant polarization to improve the signal received in automobile f.m. systems. The antennas are installed on carefully chosen sites, usually at a height of between 750 ft. and 1500 ft. above the terrain. That frequently necessitates masts of up to 1000 ft. towering above an already relatively high ground level.

Transmitter sites are almost always situated away from the cities; London's Wrotham transmitter is 25 miles southeast of the metropolis. Kirk O'Shotts is another powerful BBC regional f.m. transmitter, midway between Glasgow and Edinburgh, Scotland, serving both cities. BBC's approximately 80 transmitter sites, covering a total of 250 f.m. transmissions, are mostly linked to London by a microwave pulse code modulation (pcm) system or they rebroadcast the outputs of pcm-linked stations (FIGURE 1). The transmitters are built to very high specifications.

The pcm system was put into regular service on the Wrotham link in 1972, solving an effort of many years to establish a distribution system that would cause no degradation of signals transmitted from stations more than 400 miles from London. A few months later, this remarkable system was extended to the central and north Midlands, operated entirely by BBC. Further links with the same system are operated by the British Post Office, carrying the signal to Scotland and Wales and shortly, to Northern Ireland.

The pcm link system employs an analog-to-digital con-



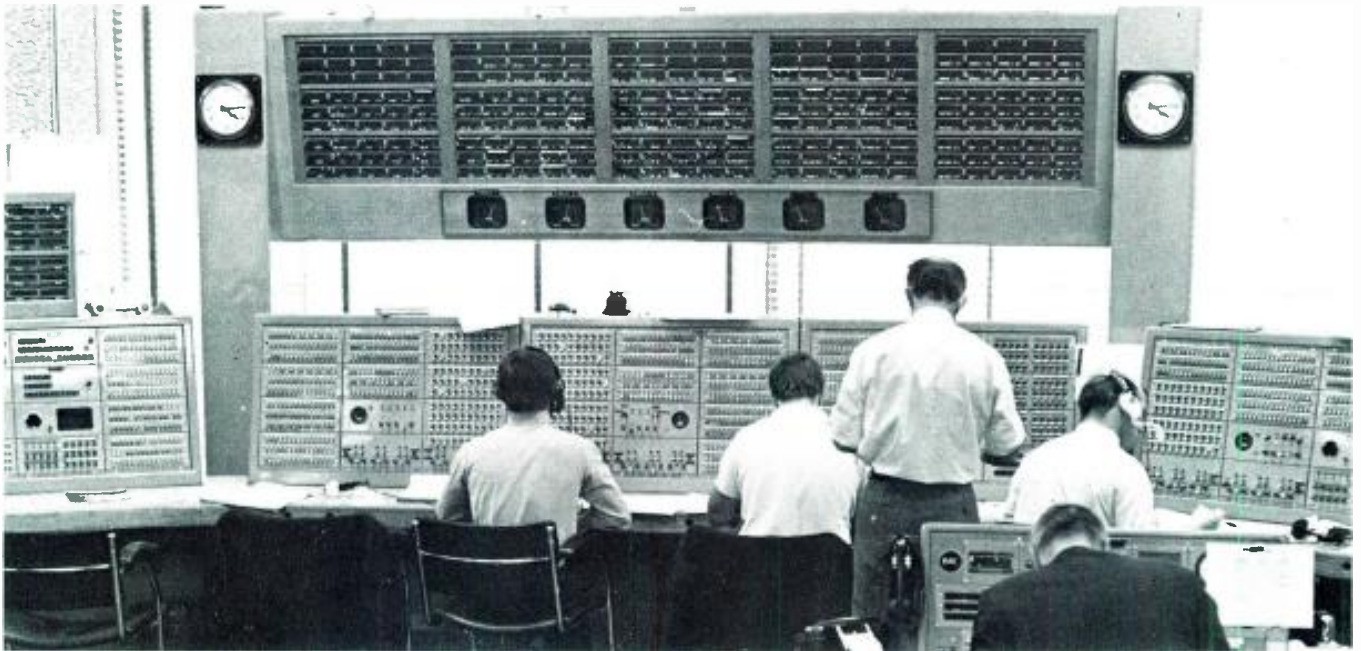
Fig. 2. Stereo AKG C24 mic being used to pick up choir in Brompton Oratory, London. Photo: Antony Askew.

version, each converter sampling the incoming waveform 32,000 times per second, transforming the information to a 13-bit code having an additional error check bit. The system includes 13 channels, adequate to distribute all the main stereo networks with reserve facilities. Since the system is a go-no-go one, a relatively poor signal-to-noise ratio is acceptable; approximately 20 dB s/n is adequate. The band width required is fairly wide, no problem since the entire system uses a microwave link chain. This distribution system is theoretically capable of achieving inherently a 70 dB s/n ratio, employing a linear transfer characteristic, including an error correction circuit to repeat a previous bit or bits if a dropout occurs.

Whereas in the U.S. 75 μ s pre-emphasis is used, all European broadcasts employ 50 μ s, thus allowing a higher average modulation level at middle frequencies. Unweighted signal-to-noise ratios of 65 dB can be achieved in stereo—this includes all the noise introduced from the continuity desks at Broadcasting House onwards. An exceptionally complicated network for live incoming programs exists. All the concert halls in London are permanently tied through to Broadcasting house. When necessary, halls outside London are connected by the Post Office with stereo land lines or by using television video circuits for multiplex audio. In certain cases, Dolby A noise reduction units are used on incoming circuits. BBC relays stereo concerts from all over Europe, using the Siemens Halskie multiplexing equipment. In probably a world's



Fig. 3. BBC continuity studio at Broadcasting House, London. BBC photo.



Busy main control room at Broadcasting House, London. BBC photo.

first such demonstration, BBC recently relayed a concert from Tokyo in stereo, via geostationary satellites.

PROGRAM ORIGINATION

In and around London, BBC has several dozen studios, mostly located in Broadcasting House. These include superb stereo drama studios and the BBC Concert Hall, designed for chamber and instrumental music and small orchestras. At Maida Vale in northwest London, is a major complex of three music studios, one of which accommodates a full-size symphony orchestra with chorus. For light and pop music, quiz and entertainment programs, the BBC has taken over small theaters and cinemas, including the recently acquired Golders Green Hippodrome, now the official home of the BBC concert orchestra. In addition to previously recorded broadcasts, many are live. Live concerts and operas are relayed from actual concert halls, including many live performances relayed from other parts of the country.

As a member of the European Broadcasting Union, the BBC frequently transmits stereo tapes obtained from other countries, such as the music from festivals at Bayreuth, Salzburg, and Vienna. EBU stereo tapes are all at 15 in./sec., of very high quality. The BBC makes its live relays available on a reciprocal basis. Recently the BBC has been transmitting some stereo tapes made by the Boston Symphony Orchestra Trust. I'm sorry to report that, while some of the performances are really superb, discriminating British listeners consider the Boston tapes to be of inferior quality, particularly the general sound balance, which appears to have no real directional clarity.

PHILOSOPHY OF BRITISH BROADCAST SOUND

The BBC's philosophy is to reproduce in the home not only the sound, but the atmosphere of the performance. For example, on their consoles they use the minimum number of microphones necessary to produce realism. All BBC classical music balance is based on a main Blumlein type coincidental stereo pair, to which is added if necessary small contributions from other mics to improve balance and clarity. In London's huge Royal Albert Hall the full symphony orchestra may well be reproduced using a single stereo pair, with extra mics for soloists and for picking up choirs more clearly. BBC studio managers believe in putting out two or more stereo pairs in different positions, thus allowing them to select the output of the pair giving the best overall balance while preserving the concert hall atmosphere.

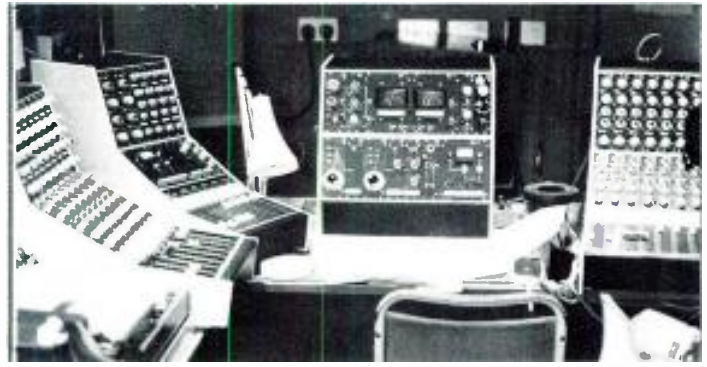
Many of the BBC's stereo microphone pairs are actually stereo mics enclosing two capsules which can have the angle between them varied at will. The pickup characteristics (directivity patterns) can be remotely varied from omnidirectional through cardioid to bi-directional. If the microphone angle is present at 90 degrees, the reverberation pickup from the back of the mic can thus be remotely varied, allowing a compensation to be made for acoustic changes in the hall. In addition, stereo widening and narrowing controls can be used in combination with the selected directivity pattern to achieve virtually any required live/reverberant ratio if the mics are placed correctly. By using stereo pairs at different heights, the or-



Temporary control room at Brompton Oratory showing Calrec mixing equipment, 2 Studer A62 recorders, BBC loudspeakers. Photo: Antony Askew.



Operations Room, Radio London. BBC photo.



Interior of a BBC mobile control van. Photo: Antony Askew.

chestral balance itself can be varied to emphasize strings or woodwind, for example.

After considerable experimentation, any form of basic spaced microphone technique was ruled out as just not realistic—stereo definition was poor and mono compatibility suffered audibly. Choirs are usually picked up by panpotting the outputs of many mics into their relative positions from left to right, suspending the mics in front of the choir and angling them to pick up a minimum sound from the orchestra. Employing many types of microphones for light and pop music, BBC frequently uses stereo pairs throughout a setup to give an acceptable spread of sound.

Most chamber and instrumental music is balanced on single stereo pairs (FIGURE 2), but sometimes artificial stereo reverberation devices are used to improve the ambience characteristic in locations which tend to be dead. Stereo pairs pick up audience reaction at quiz shows and single cardioids are used for individual panel members.

In stereo drama, the general action is usually based with a stereo co-incident pair. Sound effect, music, and specialized sequences are then overlaid onto the general sound. Since this technique is so specialized, virtually all stereo drama is recorded for later broadcast. Much use is made of different acoustics in drama; the studios have both live and dead ends. Permanent facilities include many forms of stereo reverberation and live sound effects.

Non-commercial BBC is able to produce some remarkable broadcasts of minority interest which would not be commercially viable in the United States, including esoteric music and plays and many discussions on specialized subjects, usually on Radio 3.

THE PERFORMERS AND PERSONNEL

The best known BBC orchestras are the BBC Symphony Orchestra, the BBC Concert Orchestra, and the Northern, Scottish, and Welsh Symphony Orchestras. A training orchestra is known as The Academy of the BBC. Full time choirs include the BBC Chorus, the BBC Singers and the BBC Choral Society, a group of enthusiastic amateurs. Contractual arrangements are made with virtually all of the London and provincial orchestras. For thirty years, the BBC has broadcast the Royal Albert Hall prom concerts, now in stereo and some simultaneously on color television. Since these are relayed live, they provide a veritable feast for tape-recording enthusiasts. Catering to this market for tapes, the BBC is constantly purchasing new stereo mixing and recording equipment to keep fully up to date.

In addition to the BBC Symphony, until recently conducted by Rudolph Kempe, foreign orchestras are invited to give concerts. This year the New York Philharmonic will be conducted at the end of the season by Pierre Boulez, who also conducts the BBC Orchestra for part of the

season. From the Royal Opera House, Covent Garden, Glyndebourne, and the Edinburgh Festival come memorable operatic performances. Many celebrity solo recitals are broadcast. Virtually every day, the BBC transmits a live or specially recorded orchestral concert at lunch time. The BBC runs a permanent repertory company in London, and other drama groups around the country. Several live light and pop music programs are transmitted each week; the percentage of actual recorded broadcast time allowed in the U.K. is limited because of the power of the British Musicians' Union.

Each national network has its own controller, who has complete charge of the network's output. At Broadcasting House, the audio output of each network is programmed through a continuity studio (FIGURE 3), run by engineers on a shift basis. Each studio also has a shift announcer responsible to the general presentation department. The continuity studios include both a control room and a small studio in which self-operated phono decks are provided.

Each control room, provided with stereo tape machines for replaying taped programs, fades up either an external input, the tape machines, or the continuity announcer. The console's output is then routed through to the main control room through which all the main network sound broadcasts pass. The main control room technical operations manager is responsible for feeding network outputs to the complicated network of transmitter links. He also equalizes and routes incoming programs, including those from the European continent and satellites, through to the continuity studios. This amounts to a skilled staff of engineers working in an extended form of audio telephone exchange. (FIGURE 4).

The activities of the BBC are split up into many departments, such as studio planning, purchasing, research installation, outside broadcasting, audio engineering, operations, information, and programming sections. Sound balancers (studio managers) work with both producers and engineers, unfortunately under the control of different departments. Some broadcast mobile vehicles are used, but most remotes are done from permanent installations in concert halls, etc.

EQUIPMENT

Microphones mainly come from AKG, Calrec, and STC, but other makes are used. Stereo pairs of the Sennheiser rifle microphone were used to give an excellent sound effects background in a recent royal wedding, bringing out the sound of the horse-drawn carriages. These microphones are often used at sporting events, as well as in classical music to pick up distant sounds with a very narrow high-frequency directivity pattern. The control consoles are bought from Neve, Calrec, and Glensound. Tape recorders come mainly from Studer and Telefunken. Al-

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If you are thinking about a new console, Modular Audio has nine good reasons (see list below) why you should build it yourself. Not only can we supply all major system modules but we will also provide assistance in system integration. For example, our latest console input module, Model 8422, provides all the functions necessary to do Multi-track Recording, Quad Mixdown and Quad Monitoring.

The Model 8422 features a low noise microphone preamplifier with an equivalent input noise of less than -129 dBm; a Peak Level Indicator functioning in Mic and Line modes; a switchable 70 Hz High Pass Filter; Quad Panning; Direct Track Feed; Multi-track Mixing Amplifier with full range submaster level control; and Quad Monitoring with Over-Dub facilities, just to mention a few.

It utilizes only the highest quality components (such as the MAP 1731A Operational Amplifier) for low noise, low distortion, high output level and high reliability.

Additional modules are available to permit you to construct a complete professional audio console with as many inputs as desired and up to 24 Multi-track mixing busses.

CONSOLE MODULES AVAILABLE:

- MODEL 8422-1 8422 Module less mixing amplifier
- MODEL E8422 Echo/Delay—Send/Receive Module
- MODEL C8422 Control Room Monitor Module
- MODEL S8422 Studio Monitor Module
- MODEL T8422 Communications and Cue Module
- MODEL MB8422 Input Module Mother Board
- MODEL 3000 Variable Parameter Equalizer
- MODEL 3100 Graphic/Shelf Equalizer
- MODEL CL-20 Compressor-Limiter



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though monitor loudspeakers have in the past been made by the BBC themselves, recently most of the units supplied are from Spondor (BBC designed) and Tannoy, the latter being used specifically for loud pop music.

LOCAL RADIO

Autonomous BBC local radio stations run on rather small budgets; the largest, Radio London, has a budget of only \$920,000. Radio London is primarily a speech station, with only 8 hours of recorded music time out of 111 hours of weekly broadcasting. The full time staff of 60 and 25 part-timers are involved mainly in news coverage.

Commercial radio stations operate similarly, sharing a news coverage obtained from London Broadcasting. Capital Radio transmits live pop music programs. Partly because of the restrictions laid down by the Independent Broadcasting Authority, commercial radio is not really paying its way, although advertising revenues are increasing. The future of sound broadcasting is now being discussed by the government Annan Committee, unsympathetic to commercial broadcasting. It appears that the BBC will remain almost a monopoly in the fields of classical music and drama. However, commercial broadcasting has proven to be a spur, leading the BBC to introduce more pop music and light entertainment.

Worth mentioning is the national commercial firm network of University of the Air broadcasts. Open University, as it is called, has courses in science, technology, economics and the arts. It enables many adults to achieve worthwhile degrees.

RADIO THREE

Unique Radio 3 transmits an average of over 150 operas. In one week I noted some 14½ hours of live orchestral concert relays and 13 specially prerecorded orchestral concerts. In a typical week, there were 8 hours of talks on minority subjects, drama and poetry and approximately 27 hours of gramophone records. The remaining 100 hours of music in the same week included chamber and instrumental, choral and renaissance music, almost all specially recorded for later broadcast.

WHAT OF THE FUTURE

The BBC has transmitted two quadriphonic broadcasts, using two complete networks, one for the front channels and the other for the back channels, recorded onto 1-in. 4-track A Dolby processing and replayed on a Studer A80 recorder, routed through to two continuity studios. They're researching into quad matrix systems. As I see it, the battle would appear to be between a modification of the BBC's own matrix, and a slight modification of a Japanese system, or perhaps even another alternative. The system chosen will have to produce some form of reasonable electronic quadriphonic enhancement for stereo as well as good mono compatibility.

There is unlikely to be much expansion of commercial broadcasting, except for the popular Open University, calling for more f.m. channels. The f.m. receivers in cars are likely to become more popular, influencing the future of a.m. broadcasting.

For those Americans who would like to see something similar in the United States, it should be remembered that BBC broadcasting exists primarily because of public pressure. The BBC is completely independent of the government and relies on income from licenses paid by the public annually for the use of their equipment. It receives no grant whatsoever from the government for international services. Therefore, since the public is quite aware that monies come directly from their licensing dollars, it is to the credit of the British audience that these quality and innovative programs flourish. ■

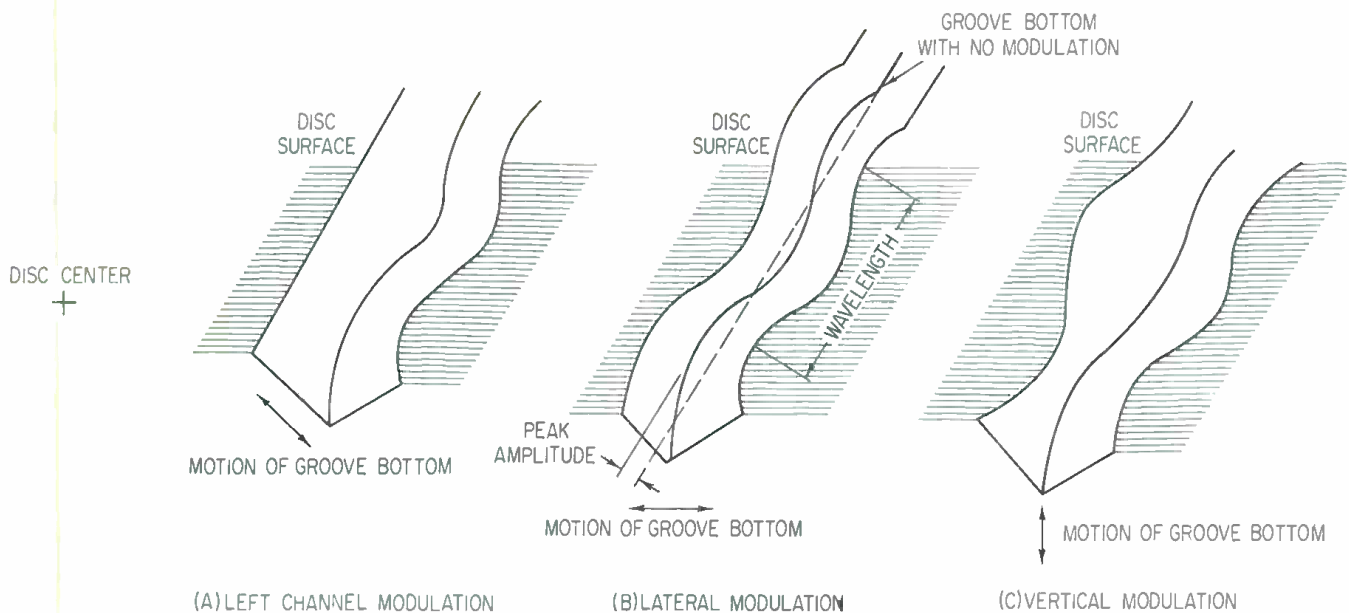


Figure 1. The static characteristics of a sinusoidal waveform in a disc groove.

Test Records—a Valuable Measurement Tool

They serve many purposes and are used by recording studio and broadcast engineers, pickup manufacturers, research-oriented professionals, and home hi-fi enthusiasts.

NOTE: Since this article appeared in April 1969, certain minor changes have occurred regarding the numbering of CBS Laboratories test records. For details, we suggest you contact: Emil Torick, CBS Technology Center, 227 High Ridge Rd., Stamford, Conn. 06905

RECORDS ARE MADE AND PLAYED primarily for a vast audience of non-technical people whose judgments of the technical excellence of the recordings are purely subjective. Nevertheless the components of this subjective evaluation can almost always be closely correlated to a set of objective measurements. The professional test record provides a rapid, accurate, and inexpensive way to make these kinds of measurements. For example, frequency response can tell us much about the coloration of a recording. By utilizing available test records, a recording or playback system can be accurately adjusted and periodically checked. In fact, the disc recording engineer can make a routine frequency response check of his entire system — from tape to disc — in minutes by using a reliable test record as the basis for his calibration. The broadcaster can set up and check his disc playback equipment quickly and accurately with the use of the available test records. Professional test records are

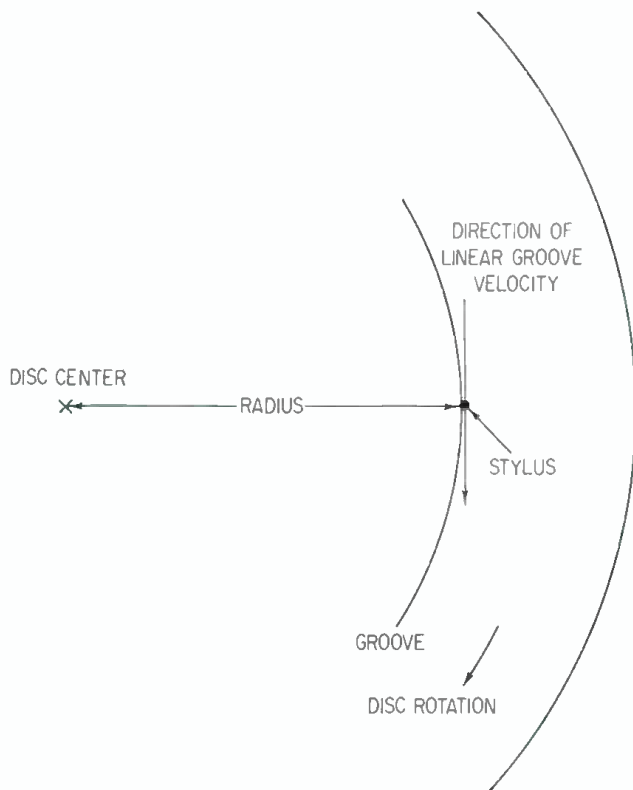


Figure 2. Linear groove velocity of a disc.

carefully calibrated so they can be relied upon when making the numerous measurements and adjustments necessary to have recording and playback equipment in top-notch condition.

Test records serve many purposes, and are used by the following groups; recording studio engineers, broadcast engineers, pickup manufacturers, research oriented professionals, and home hi-fidelity enthusiasts. This, in part explains the wide variety of test records, and the variations in technical specifications describing them. This article will deal primarily with those aspects of test records which are of immediate and practical value to the recording studio and to the broadcaster. In order to better understand test-record specifications and test-record utilization, we will start with a very brief discussion of disc recording principles.

DISC RECORDING FUNDAMENTALS

Modulation on a disc can be described by two alternate sets of characteristics; the *static* and the *dynamic*. Static characteristics are those that can be determined by direct visual observation of the recorded disc. Dynamic characteristics are those that best describe the input and output of the recording and playback process. The two sets of characteristics overlap, and are really two ways of looking at the same thing. Test record specifications can refer to either set of characteristics. Later on in this article we will demonstrate some of the relationships between them.

Static Characteristics. Three important static characteristics of a sinusoidal waveform are shown in FIGURE 1.

Modulation direction. In stereophonic recording we can have left-channel, right-channel, lateral, or vertical modulation. In monophonic recording only lateral modulation is present. In either left- or right-channel

modulation the direction of the groove bottom is 45 degrees to the surface of the record. When both channels are equal in amplitude and recorded in-phase, the resultant direction is lateral (monophonic), and the motion of the groove bottom is parallel to the record surface. When both channels are recorded out-of-phase we have vertical modulation and the direction of the groove bottom is perpendicular to the surface of the record. In this and the following discussions we can just as easily talk about the direction of a groove cross section of constant width (which supports the playback stylus) as we do about the groove bottom.

Amplitude is the displacement of the groove bottom in the modulation direction. Peak amplitude (usually called "amplitude") is the maximum distance the groove bottom is displaced in the modulation direction from its mean position (see FIGURE 1B). The groove bottom is in its mean position when no modulation is present (quiet groove).

Wavelength is the linear distance covered by one complete cycle of the wave.

Dynamic Characteristics: If we now take our recorded disc and rotate it at a constant rotational velocity we then add the ingredient which transforms the static characteristics into the dynamic. The dynamic characteristics include linear groove velocity, frequency, and modulation velocity.

The **linear velocity** of the record groove at the point of contact with the recording or playback stylus is in a direction perpendicular to the record radius drawn to that point of contact (FIGURE 2). The linear groove velocity depends upon the rotational speed, and the record diameter.

When the groove is moving at a given linear velocity the recorded wavelength will determine the number of cycles of modulation that the pickup will scan each second — which is the **playback frequency**. For example, let us say that the wavelength is 0.004 inch, and the linear groove velocity is 20 inches per second. Since there are 250 wavelengths in each one inch section of groove length the pickup would scan 20 x 250 wavelengths each second — or the frequency would be 5,000 Hz. From the point of view of the recording process, the recording stylus is vibrating at a rate of 5,000 cycles each second, and the disc is moving past the stylus at a velocity of 20-inches-per-second. The length of each recorded cycle would be $20/5,000 = 0.004$ inch.

From a playback viewpoint the **modulation velocity** — or simply **velocity** — refers to the velocity of the groove bottom away from and towards the position of the groove centerline if no modulation were present. Referring to FIGURE 3 the groove bottom of a laterally modulated groove is shown (although single channel or vertically modulated groove would serve equally well as an example). If we imagine the groove moving in the direction of the arrow due to linear groove velocity, an observer looking down at the centerline of the moving groove would see that centerline move right and left alternately. As point A passes the observer the velocity of the groove bottom is maximum to the right. As point B passes the observer the velocity of the groove bottom in the modulation direction is zero for an instant and the motion of the groove is actually parallel to the linear groove velocity. As point C passes the observer the velocity is again maximum but in the opposite direction from Point A. The maximum instan-

taneous velocity, as represented at points A and B, is called the *peak velocity*. The r.m.s. velocity is 0.707 of the peak velocity and is analogous to the relationship of r.m.s. voltage to peak voltage.

Velocity and amplitude are related by the formula:

$$v_{\text{peak}} = 2\pi f a_{\text{peak}} \quad \begin{array}{l} v_{\text{peak}} = \text{peak velocity} \\ f = \text{frequency} \\ a_{\text{peak}} = \text{peak amplitude} \end{array}$$

Another way of expressing the peak velocity is in terms of the wavelength (λ), and the linear groove velocity (V_g):

$$v_{\text{peak}} = \frac{2\pi V_g}{\lambda} a_{\text{peak}}$$

This confirms the earlier statement that static and dynamic characteristics are directly related.

TEST RECORDS

Listed below are the tests available on test records which have direct and practical application for the recording studio and the broadcaster.

1. Standard reference level
2. Frequency response
3. Crosstalk
4. Pickup tracking
5. Turntable performance
6. System phase and balance

Because of the large number of test records available, we have limited our discussion to the CBS Laboratories series, the RCA series, and the NAB test record as representative examples.

Standard Reference Level: A recorded single-channel peak velocity of 5.0 centimeters/second at 1000 Hz is the *standard reference level*. (At this velocity and frequency the peak single-channel amplitude is 0.8×10^{-3} centimeters). When both channels are modulated in phase (lateral) or out-of-phase (vertical) the resultant peak velocity is 3 dB greater or 7.0 cm./sec. Standard reference level test bands can be left channel, right channel, lateral, or vertical.

There is some confusion between the *standard reference level* and the maximum level. Standard reference level means just that: *i.e.* it is an arbitrary reference to which any given recorded level can be related. It is not the maximum level that can be recorded or played back, nor does it have any fixed relationship to these maximum levels. Maximum recorded levels are determined by the power-handling capability of the cutter head and the associated electronics, and by the geometry of the recording stylus. Maximum playback levels are determined by the pickup and tone-arm dynamic systems, and by the geometry of the playback stylus and record groove. The maximum level for a particular record playback set of conditions can, however, be related to the standard reference level.

CBS Laboratories test record series has standard reference level bands on the following records:

STR 100; left and right channel

STR 130; left, right, and lateral

BTR 150; left, right, lateral, and vertical

The NAB Test Record has a lateral standard reference band. The RCA records 12-5-49 (lateral), 12-5-50 (lateral), 11-5-51 (lateral), 12-5-75 (vertical), and 12-5-77 (left, right, lateral) refer to a "reference level" which is approximately 2.1 dB below *standard reference level*, or 3.9 cm./sec. peak single-channel velocity.

The standard reference level band is used for absolute calibration of the playback and record systems. With the pickup on the appropriate standard reference level band, the play-

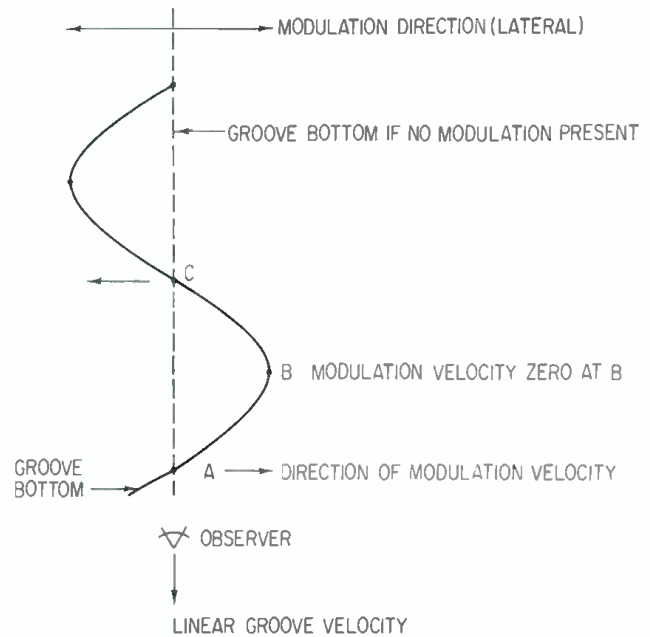


Figure 3. A diagram of the modulation velocity of a disc.

back gain is adjusted; each channel separately for stereophonic systems. The output signal level is set at, 0 vu, 1 volt, or 0 dBm — whichever level is the conventional standard signal or power reference used in your system. The calibrated playback can then be used to calibrate the recording system. The recording channel gain is adjusted; each channel separately for stereophonic systems. The gain is adjusted so that a specified signal input — 0 vu, 1 volt, or 0 dBm — to the recording channel will modulate the disc at the standard reference level as measured on the calibrated playback system. A lateral reference level band can be used to calibrate a stereophonic playback system. The lateral modulation is then considered as left and right channel modulations being present simultaneously. Unless otherwise specified, all levels will be referred to in dB relative to the standard reference level.

Frequency Response: The recorded velocity or amplitude of a frequency-response test band is related to the frequency by the recording characteristic. In a constant-velocity characteristic, the recorded velocity is constant at all frequencies. Similarly, a constant-amplitude characteristic has constant recorded amplitude at all frequencies. A combination of constant-velocity constant-amplitude characteristic is frequently used, and the RIAA or NAB is of this latter type.

Frequency response tests can be recorded as spot frequencies, or as a sweep or glide tone. Spot frequency recordings have a series of frequency bands which are spaced at uniform intervals in the frequency range covered. The sweep frequency band employs a continuously varying tone which covers the entire frequency range. Sweep frequency bands require specialized recording apparatus to be fully utilized. For the recording studio and broadcaster the frequency response test using the RIAA (NAB) recording characteristic is most useful since the standard playback electronics have the RIAA playback characteristic. The output of an ideal playback system (pickup and associated electronics) with RIAA playback characteristic will be flat when playing a frequency response test band with the RIAA recording characteristic.

CBS Laboratories test record series has frequency response test bands with the RIAA characteristic on the following records:

STR 130; left, right, and lateral spot- and sweep-frequency bands covering the range of 20-20,000 Hz at -14 dB.

BTR 150; left, right, and lateral spot frequency bands covering the range of 50-15,000 Hz at -14 dB.

RCA test record series have the following records with the RIAA characteristic:

12-5-49 (10 in.) lateral spot frequency band covering the range of 15,000 to 10,000 Hz at -20 dB, and 10,000 to 30 Hz at -16 dB.

12-5-50 (12 in.) similar to 12-5-49

12-5-51 (7 in.) similar to 12-5-49 but at 45 rpm

12-5-75 (10 in.) similar to 12-5-49 but a vertical recording

The NAB test record contains the following frequency response test bands with the RIAA characteristic:

Lateral spot frequency band 15,000 to 30 Hz at -14 dB.

A second band contains 60-second duration tones at 100, 1000, and 10,000 to facilitate system adjustment.

CBS Laboratories has a frequency-response test (STR 100) which has a constant amplitude (20-500) and constant velocity (500-20,000) characteristic. RCA has a series of frequency response tests using a constant-velocity characteristic (12-5-67, 12-5-71, 12-5-73). By using these characteristics, substantially higher recorded levels are possible. Better signal-to-noise ratios and more stable readings result. However, the output will not be flat when played with the RIAA playback characteristic. The "flat" position available in some disc recording studios should be used when making measurements with this type of characteristic.

The frequency response test bands are used to measure the response of the playback channel, whether on initial set-up or on routine check. The output level at 1000 Hz is used as the reference level (0 dB) and the relative levels at all the other frequencies are recorded in tabular or graph form. A sample of a typical response test, and the results when converted to tabular form, is shown in FIGURE 4. We call this our calibration curve.

Once the playback system frequency response has been determined, the recording system can be calibrated. We now know that the ideal recording (*i.e.* our test record) has the response characteristic, as in our typical case, shown in FIGURE 4. Therefore each recording channel should be adjusted so that the playback response of a test recording will be as close as possible to that of the calibration curve. A quick and accurate check of the entire recording/playback chain can be made by recording a test tape with the same frequencies that are on the test record. The tape is played, recorded on a disc, and then played back. Any deviations from the pickup calibration curve can then be plotted as deviations from the ideal flat response.

Lateral frequency response test bands can be used to measure the performance of stereophonic pickups. However, at frequencies below 100 Hz and above 8-10 kHz the results are not always reliable due to pickup crosstalk.

Crosstalk: Stereo standard reference level and stereo frequency-response test bands provide a means for measuring pickup crosstalk. Crosstalk is a measure of the loss of stereo-phony. When left channel only is modulated, the right-channel crosstalk signal is measured in dB below the left-channel output. The reverse procedure is used to measure the left-channel crosstalk.

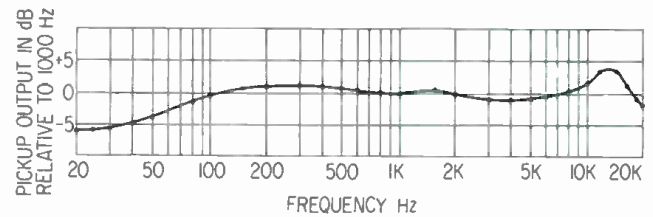


Figure 4. A typical pickup's frequency response. The test record is the CBS STR 130 in this example, only the left channel is shown. Response is plotted relative to 0 dB at 1000 Hz.

Pickup Tracking: Tracking refers to the ability of the playback stylus to maintain continuous contact with the groove walls in the presence of modulation. When, due to high modulation levels, the playback stylus is only intermittently in contact with the groove walls, audible distortion will occur. On rare occasions the pickup can be thrown completely out of the groove, although this is not likely in modern pickups. Harmonic and intermodulation measurements can be used to determine the distortion caused by mistracking. Measurements made with appropriate equipment is preferred but critical listening can provide reasonably accurate results.

The test record provides, with either single-tone or two-tone recordings, successively higher levels of modulation. The pickup output will sound normal or undistorted at low modulation levels. When the critical modulation level is exceeded, beyond which the pickup cannot track, the output becomes noticeably distorted. This then is the maximum undistorted level that can be played back by the pickup.

CBS Laboratories Test Record STR 100 and STR 111 provide single-tone tracking tests with the levels calibrated in peak amplitude. The STR 111 also contains two-tone intermodulation tests calibrated in peak amplitude. The levels on the STR 100 are from 0.001 to 0.005 centimeters in lateral and vertical modulation. The STR 111 levels are from +6 to +18 dB re 1.12×10^{-3} cm. lateral, and from +6 to +12 dB for vertical modulation.

RCA test record 12-5-37 (7 inch 45 rpm) and 12-5-39 (12 inch, 78 rpm) have two-tone intermodulation bands for pickup tracking tests. The first disc has lateral modulation from 3.5 to 18 cm./sec. The second disc has lateral modulation from 4.3 to 27.1 cm./sec.

Turntable performance: Turntable rumble can be measured by playing the pickup on a quiet groove and measuring the pickup output relative to the standard reference level. For increased accuracy a low-pass filter with a cut off around 300 Hz should be used. CBS Laboratories BTR 150 and the NAB Test Record have a quiet band for this purpose.

Wow and flutter can be measured with a Wow and Flutter meter. A 3000 Hz tone is provided on the CBS BTR 150, the NAB Test Record, and the RCA 12-5-65, for this purpose.

System Phase and Balance: A system phase and balance check is used to verify the following: channel balance, the fact that in-phase signals are present at the playback system output for lateral recordings, and the fact that out-of-phase signals are present at the playback system output for vertical recordings. RCA 12-5-77 and the NAB Test Record provide phase and balance tests. Similar tests are available on CBS records in the form of left, right, lateral, and vertical standard reference level bands.

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KNOX



JOHNS



POWELL

- An export division has been formed by the **Koss Corporation**, of Milwaukee, Wisconsin. Vice president in charge of the new division will be **Gregory Cornehl**, formerly president of Koss Ltd., Canada. Another Koss appointment is that of **Fred Forbes** to the position of marketing coordinator. Mr. Forbes will be responsible for the marketing of Model One electrostatic speaker system. A third Koss appointment is that of **Tony Satariano** as district sales manager for stereophones.

- One new face and the return of a former associate is evident at **Caedmon Records**, of New York City. **Robert D. Knox** has joined the firm as director of marketing. Mr. Knox was formerly manager of the Educational Systems Division of **Random House, Inc.** Returning to Caedmon in the capacity of production director is **Ward Botsford** who served in the same capacity from 1965-71. Prior to rejoining Caedmon, he had been an independent producer of educational radio and television programs.

- **Rupert Neve and Company, Ltd.** of London, England has received an order from the **National Broadcasting Company** for a 36-channel television console equipped for 16-track music. The huge console will be installed in NBC's Rockefeller Center studios.

- **Soundcraft Electronics**, of London, England, has moved to new headquarters at 5/8 Great Sutton St., London, EC1V 0BX. Their telephone number is 01-251-3631/2/3. The new headquarters triples the space available for the production of mixing consoles and other electronic products.

- An expansion of audio facilities in Alaska has been made possible with the establishment of **Arctic Studios** in Anchorage. The new studio is equipped with Ampex 8-track equipment and Revox for quarter-track use. Chief engineer of the company is **Dwight**

Finger, with **Linda Rhodes** acting as general manager. The address is 2427 E. 86th.

- **Raymond E. Johns** has been appointed manager of field engineering for the broadcast equipment division of **Philips Audio Video Systems Corp.**, Montvale, N.J. Mr. Johns will be in charge of customer service operations in the company's six field engineering facilities in the United States. Another appointment at Philips is the naming of **Frederick L. Bones** as northeast regional sales manager, broadcast equipment division. Mr. Bones will head sales activities in the New York metropolitan area, New York State, New England, and New Jersey.

- **Telex Communications, Inc.** of Minneapolis, Minn. has named **Richard Powell** as national sales manager for broadcast, amateur radio and citizen's band equipment. Mr. Powell comes from his own firm, **Communications Headquarters**, 2-way radio specialists.

- Two branch offices of **GBC Closed Circuit TV Corp.** of New York City have moved to new locations. The Washington, D.C. office is now located at Riggs Rd. at 1st Place. N.W. The Chicago office is now situated at 233 E. Ontario Street.

- Two new appointments in their Montreal headquarters have been announced by the **Chromacord Corp.** of Lachine, Quebec. **Peter Lymburner** will serve as general manager of both the Chromacord Corporation (U.S.) and Chromacord Corporation International Ltd. (Canada). **Chris Tansey** has been appointed customer service manager in Montreal. At the Toronto office, **Brian Steadman** is now serving as branch manager.

- The Medal of Commander of the Order of Letters and Arts has been awarded by the government of France

to **Robert W. Sarnoff**, chairman of the board of the **RCA Corporation**. The award was made in recognition of Mr. Sarnoff's contributions to French-American cultural relations in the fields of music and television. Mr. Sarnoff also received the Medal of the French National Assembly for his efforts to improve relations between France and the United States.

- **John Kearney** has been named national sales manager for high fidelity products by the **Sony Corporation**. Mr. Kearney comes to Sony from the **Plessey Consumer Products Company**. He has also been associated with **Harman-Kardon, Inc.** Sony recently contracted to build a \$16,000,000 manufacturing facility at Dothan, Alabama, financed through the Industrial Board of the city of Dothan. About 250 people will be employed initially, with the number expected to double as production increases.

- New appointments at **Ampex Corporation**, Redwood City, California include the naming of **Tom Nielson** as western area sales manager and **Ken Herring** as national sales manager, industrial products. Mr. Nielson previously served as an Ampex sales engineer for the Rocky Mountain area. Mr. Herring has been western area manager for the firm's audio-video systems division.



- **Mr. Raymond Cook**, right, managing director of Britain-based **KEF Electronics**, receives the Queen's Award to Industry for 1975 on behalf of his firm, from the Lord Lieutenant for Kent, Lord Astor of Hever at Tovil. The award, given on July 3rd of this year, is based on export business and is one of significance. KEF Electronics won the award first in 1970, making it the first audio industry so honored. The actual number of awards by the Queen varies from year to year. In 1970, KEF was one of 104 British companies so honored; this year they were one of 95.

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