SYNERGETIC
SYN AUD CON
AUDIO CONCEPTS

newsletter

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VOLUME 11, NUMBER 2
WINTER 1984

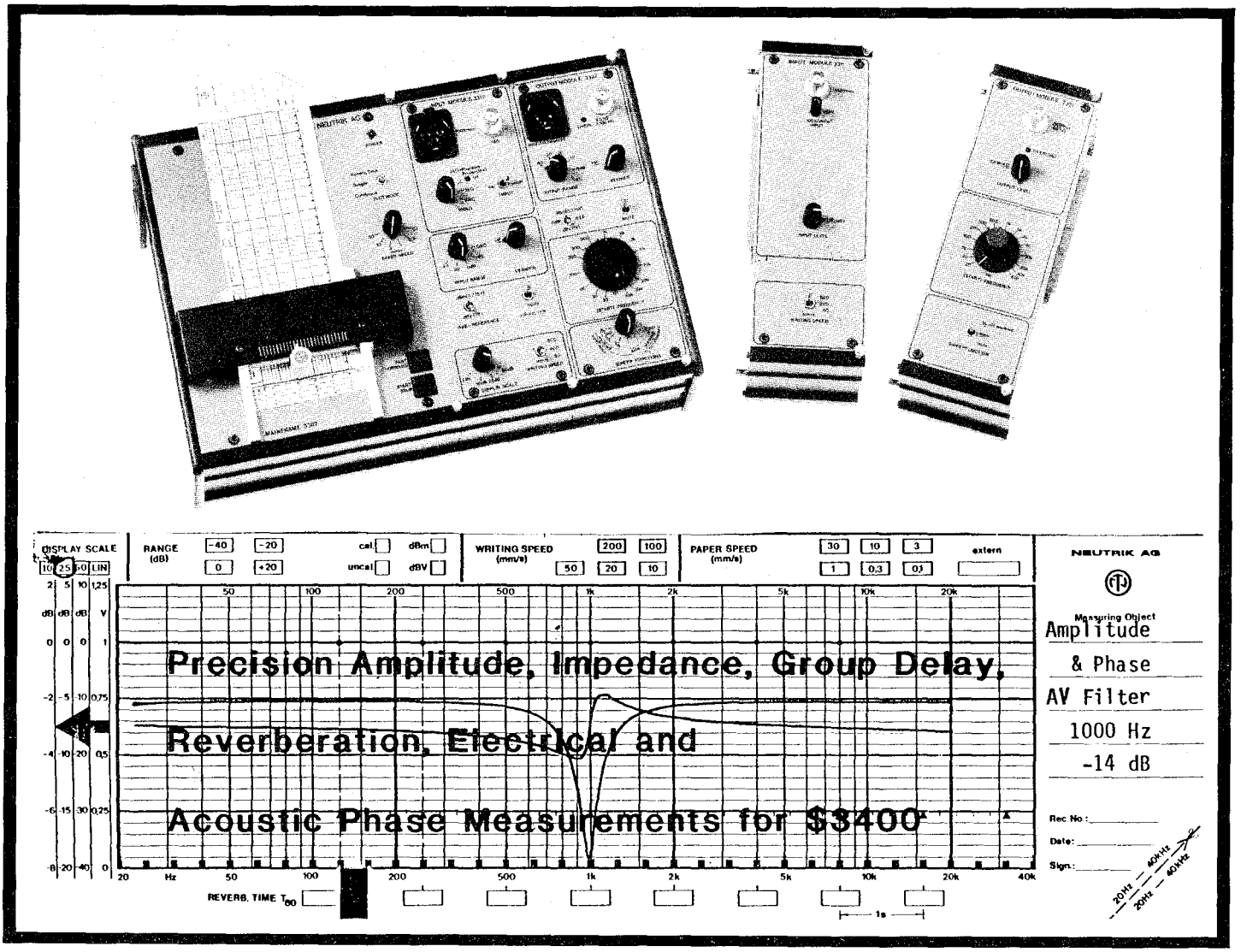
SYNERGETIC
Working together; co-operating, co-operative

SYNERGISM
Co-operative action of discrete agencies such that the total effect is greater than the sum of the two effects taken independently.

EXCHANGE OF IDEAS

I met a man with a dollar
We exchanged dollars
I still had a dollar

I met a man with an idea
We exchanged ideas
Now we each had two ideas



NEUTRIK 3300 SYSTEM

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THE HEYSER TRANSFORM

The step from Pythagoras in 600 BC to Jean Baptiste Joseph de Fourier in 1807 was a gigantic one in both mathematics and in spectrum estimation tools.

Strum and Liouville in 1836 extended Fourier's work to the case of arbitrary orthogonal functions which, in turn, led to the formulation of quantum mechanics as presented by Heisenberg and Schrödinger in 1925 and 1926.

In 1929 John Von Neumann put the spectral theory of the atom on a firm mathematical foundation in his spectral representation theorem in Hilbert space.

Wiener developed generalized harmonic analysis in 1930. The common ground of the spectral representations of von Neumann and Wiener is the Hilbert space; the von Neumann result is for a Hermitian operator, whereas the Wiener result is for a unitary operator. Thus, the relationship between these two representations is the Cayley-Möbius transformation.

J. S. Cooley and J. W. Tukey, in 1965, published the fast Fourier transform algorithm. Their work turned the transform into a tool and not just a theoretical description.

Emmanuel Parzens' development of spectral windows in the 1950s plus the veritable flood of developments in applying statistical theory to spectral analysis came to brilliant focus in the mid-1960s when Richard C. Heyser conceived what we prefer to call the Heyser transform, even though he too modestly labeled it TDS.

The publication of the B&K #1 and #2 Reviews in 1983 and the experience of all of us who have worked with both FFT and TEF® analyzers leads to only one conclusion. It is not out of order to say in the same breath - the Fourier, Hilbert, and Heyser transforms are the tools of our analytic trade (and I use the term analytic with Dennis Gabor respectfully in thought).

Syn-Aud-Con will, from this date forward, refer to TEF® analysis as that which employs the Heyser transform, in addition to the use of the Fourier and Hilbert transforms.

We are deeply indebted to Al Grundy who shared some of his collected data on spectral analysis with us and opened our eyes to an enhanced historical perspective of the uniqueness of Heyser's contribution to science.♦

EDITORIAL

January 1, 1984 marked the beginning of Syn-Aud-Con's twelfth year. Carolyn and I have felt these have been the most rewarding years of our careers. The vast network of Syn-Aud-Con graduates, now well over 5,000, has generated and is continuing to generate the new ideas capable of invigorating the entire audio industry.

The secret is a simple one--people like you and I eager and willing to share, shape, and lift up new ideas into the sunlight of early user acceptance, modification and ultimate perfection.

We are grateful to those who have found that what Syn-Aud-Con stands for is exciting, important, and fun. This is our once a year chance to say thank you to all of you and wish you a happy, productive 1984. ♦

1984 SEMINAR & WORKSHOP SCHEDULE

We have planned our schedule a full year in advance -- the first time in 12 years that we have scheduled so far in advance. We hope it helps you in your planning.

1984 SEMINAR SCHEDULE

March 14-15
San Francisco Area, California
Sheraton Inn/Sunnyvale

March 21-22
Seattle, Washington
Ramada Inn/Kirkland

April 11-12
Pasadena, California
Holiday Inn

May 9-10
Oklahoma City, Oklahoma

May 17-18
Columbus, Ohio

May 22-23
Minneapolis, Minnesota
Holiday Inn, Bloomington

June 5-6
Denver, Colorado
Boettcher Auditorium
June 7 - "On Location" Measurements

September 18-19
Chicago, Illinois
Ramada the O'Hare Inn

October 4-5
New York City Area, New York
Hilton at Harmon Meadows, Secaucus

October 16-17
Washington, D.C.
Ramada/Tysons Corner

October 30-31
Atlanta, Georgia
Capital Airport Hotel

November 7-8
Orlando, Florida
Nov. 9 - "On Location" Measurements

November 13-14
New Orleans, Louisiana

1984 WORKSHOP SCHEDULE

TEF® Instrumentation Workshop - March 6-8, 1984 - Holiday Inn, Pasadena, CA

Tentative

Loudspeaker Array & Sound System Design
(with emphasis on computer programming)
Late June - Midwest

LEDE™ Control Room Design
Mid-September - Nashville, TN

Concert Hall Design
Late November

3rd Day "On Location" Class

You will note that in Colorado and Florida we are doing something new and special. An optional third day has been added to perform on-site measurements of a sound system and concert hall. The first one will be held at Boettcher Auditorium. The first two days of the class ($395) will be held in a rehearsal room at Boettcher and the third day ($200 additional) will be held in the concert hall. In the evening of the third day there will be a concert by the Denver Symphony. You know why we were excited when David Wilson, head sound man at Boettcher, proposed this "feast."

The details of the second on-site measurements and evaluation day have not been completed, but our outstanding Syn-Aud-Con representative, Dan Bencsik, is encouraging us and helping with the details.

Cost of Workshops

We will have a full workshop schedule in the next Newsletter. We have wonderful plans. It has been a struggle to hold the price of workshops to $600 as "one-of-a-kind" classes are expensive and guest speakers and their expenses have to be paid. We consider workshops our gift to the industry because of the tremendous progress that comes from the greatest talent in audio coming together to study and share. ♦

SUMMARY OF 1983

We have been conducting our two day classes for the past six months and are pleased to report that they have led to some fascinating insights into Audio and Acoustic fundamentals.

Levels

We have been able to make real strides in the introduction to what audio levels are, are not, and their proper measurement. We were surprised at how widespread is the confusion between *signal amplitude* and *signal level*.

TEF® Analyzer

Each of these classes sees the Tecron TEF® System 10 Analyzer in action as it is used to demonstrate:

1. The difference between polarity and phase.
2. The effects of misalignment of identical devices.
3. The response of microphones and loudspeakers.
4. The signal delay and phase characteristics of basic audio devices.

Audio Amplitudes

Using 1/3 octave analysis and FFT analysis, we study the *amplitude* behavior of sine waves, random noise (Pink, white and ANSI) and other basic audio test signals. We measure:

1. Peak-to-peak amplitude
2. Peak amplitude
3. Rectified average amplitude
4. Root mean square amplitude

using frequency counters, oscilloscopes, RMS calibrated ACVTVMs and *true* RMS voltmeters.

We examine the characteristics of constant bandwidth analysis vs constant percentage bandwidth. Another surprise was how few knew that *it is not desirable* in sound system measurements to use greater than first or second order bandpass filters (i.e, 6dB/oct or 12dB/oct) and who thought that 36dB/oct filters provided greater frequency resolution than did a 6dB/oct device. (On sine waves, i.e, a test oscillator or an acoustic feedback tone, just the opposite is true.)

Those of you who have attended one of the older classes will be pleasantly surprised when you attend one of these newer, shorter ones. The time gained by not introducing how to use an H.P. 41C has allowed us to construct a fast paced intensive seminar within the hours of 8:30 A.M. to 5:30 P.M. for each of the two days. The attendees tell us that the evenings free allow for much better retention of the material presented. A combination of the 2 day class and a price of $395.00 made attendance feasible for many more than would 3 days at $600.00.

The Phase Era

1984 probably will go down in the annals of audio as the year that phase came out of the academic closet. Because acoustic phase has not normally been measured in the past (excepting special cases like Heyser) the unmeasured problems abound and those who come to correctly understand these measurements are rewarded with very audible improvements in their systems.

The "Heyser Transform"

It is just beginning to penetrate the minds of the acoustic instrumentation community that TEF® measurements incorporate a great deal more than a clever way to get around needing an anechoic chamber. The B&K reviews 1 and 2 of 1983 make clear to this observer that Richard C. Heyser's name will more than likely one day be mentioned as part of a holy trinity of measurement tools, namely, the Fourier, Hilbert and Heyser transforms.

Some Concluding Remarks

It is fascinating to us to observe that the equipment we are working with on modern sound systems didn't exist even twenty years ago: Digital processing, real time analysis, easy equalization, etc. It is equally interesting to realize that while all the apparatus has changed dramatically *the basics* of level, impedance, grounding, etc. are still best learned by using the methods of almost sixty years ago. We suspect that what we are sharing in these classes will still apply in AD 2044. ♦

AUDIO-41 CLUB

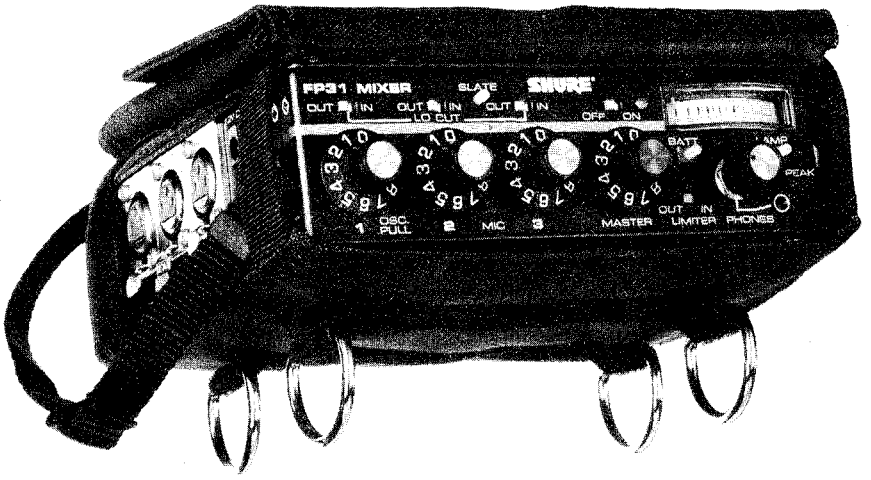
The Audio-41 Club is in full operation. Of course, Taboo Custom Designs need your membership but they also need programs. Won't you share?

The HP-41CVX and its many, many accessories is a powerful calculator/computer system. Membership is $15 per year. They have a catalog of programs ready and adding more.

Taboo Custom Designs' address is P. O. Box 37017, Tucson, AZ 85740. Ask for Peggy or Mark Laffin. ♦

NEW SHURE PRODUCTS

Two new products from Shure Brothers Inc. appear exceptionally attractive to us. Anyone who has ever attended a Syn-Aud-Con class knows we use only Shure mixers (currently the M-267). Shure has just announced a new portable microphone mixer.



The FP31 is specially designed for electronic news gathering (ENG) and electronic field production (EFP) use, including film, video, and remote broadcast applications. It seems to us to be the ideal companion to any collection of measurement analyzers also. The features of the new Shure FP31 that particularly attracted our attention are:

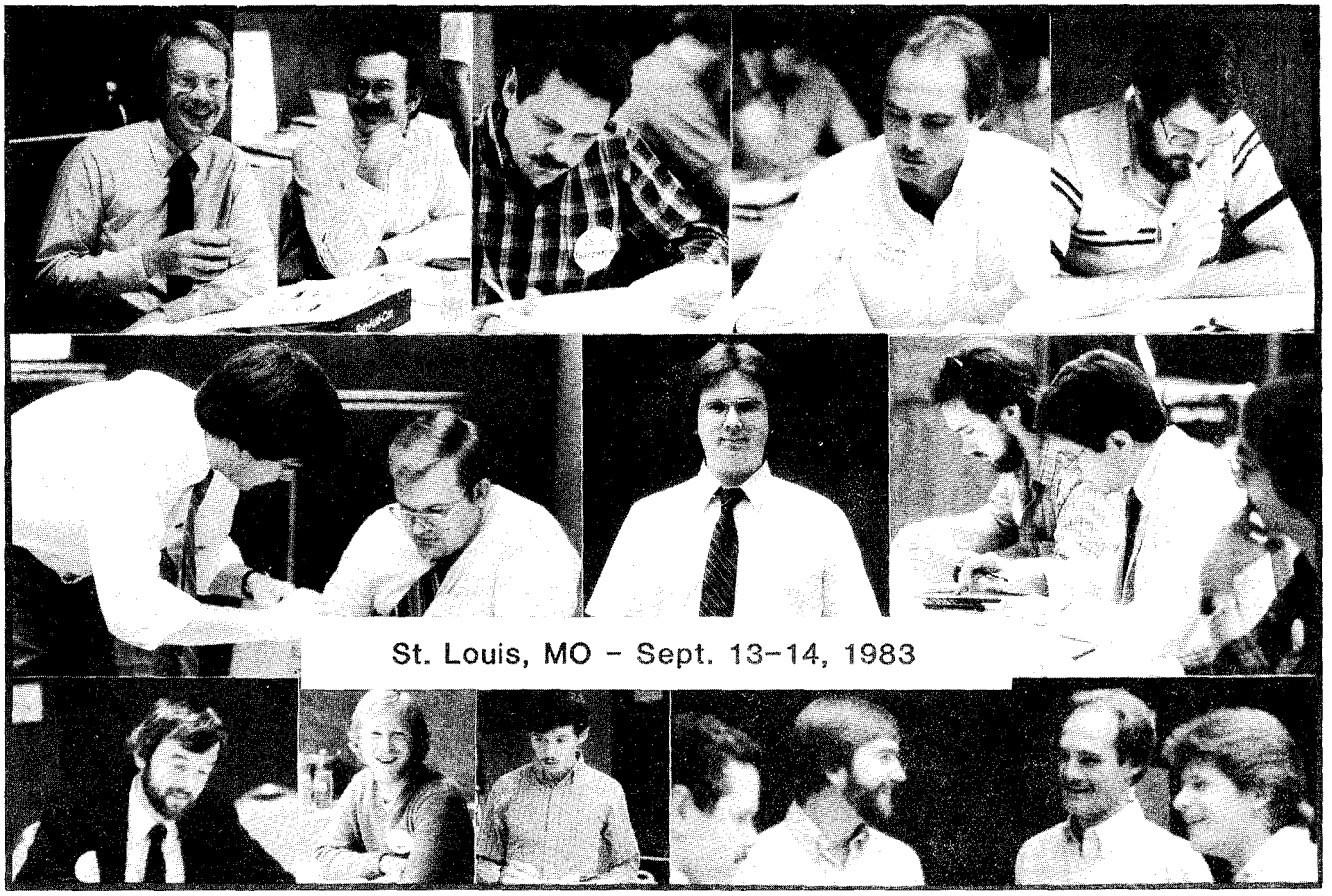
1. An indicator that lights when an overload occurs.

2. Battery operated.

3. A real VI meter set so that a "meter indication" of zero yields +4 VU as a level (i.e., on a steady state sine wave calibration signal, a zero indication on the meter would be +4 dBm available input power capability; on speech or music a zero indication would result in +14 dBm output (10 dB of "meter lag") leaving another 4 dB as "headroom" inasmuch as full output level is quoted at +18 dBm).

The instruction sheet supplied with this unit is very detailed and, other than some non-standard descriptions such as "0 VU = +4 dBm" when "0 meter indication is an apparent level of +4 VU" is what is meant, it is a very useful piece of literature.

In our opinion, this mixer would, in addition to the obvious use in ENG and EFP, be our first choice for use with a TEF® analyzer during microphone "quick difference" tests where the calibrated B&K 1/4" microphone's sensitivity varies from most of the microphones being tested. This mixer allows rapid accurate level reconciliation. ♦



ATLANTA 1983 TEF® WORKSHOP

TEF® Workshops take on quite a different aspect when a majority of the class members own their own analyzers.

The mathematics of the Heyser transform challenge the most astute mathematicians. If one looked far and wide for an illustration of the *inverse* of trivial, the Heyser transform is an outstanding choice. But when its operation is viewed on the TEF analyzer screen as 20,000 to 1 better dynamic range, increased frequency resolution, and its remarkable ability to view both time and frequency domains in its 3-D mode, the transform becomes not a mathematical abstraction but a living useful tool for exploring the unknown places of the universe called audio and acoustics.

It's becoming increasingly clear that those who have placed their bets on the FFT form of analysis are in a position similar to those who years ago made the struggle to master Heaviside operational calculus only to find that the advocates of the LaPlace transform had a more efficient technique.

The full recognition of the fundamental importance of this new transform awaits the judgment of time. Time is required not because there is any doubt as to the importance of the transform but because there is no other way to enlarge the "peer" group required before genuine breakouts become widely acclaimed.

SYNERGETIC AUDIO CONCEPTS

TEF® INSTRUMENTATION WORKSHOP
November 1-3, 1983 - Atlanta, GA

WORKSHOP CHAIRMAN:	PARTICIPATING INSTRUCTORS:	HOSTED BY:
Dr. Eugene Patronis Georgia Tech	Don Eger Crown International	Don & Carolyn Davis Syn-Aud-Con

David Andrews
Andrews Audio Consultants
347 West 39th Street
New York, NY 10018

Russell Berger
Joiner Pelton Rose
10110 Monroe St.
Dallas, TX 75229

Jim Brown
Bridgewater Custom Sound
938 W Montana
Chicago, IL 60614

Philip B. Clark
DCI Inc
3929 New Seneca Turnpike
Marcellus, NY 13108

Gary Cobb
Audio Rental Svc & Sales
268 W. Normandy Drive
Chicago Heights, IL 60411

Mike Garrison
HIS Sound
715 S.E. Grand Avenue
Portland, OR 97214

Robert C. Hagenbach
Hagenbach Labs
P O Box 22158
Indianapolis, IN 46222

C. Michael Hoover
Audio Technical Services
239 Mill Street N.E.
Vienna, VA 22180

Jon Kendall
Professional Sound Industries
2737 Dorr Ave.
Fairfax, VA 22031

Howard E. King
(Tecron Division
Crown International)
54594 Bradley, R8
Elkhart, IN 46514 *

James T. King
Audiometrics, Inc.
713 N. 4th
Longview, TX 75606

Richard Lee
Criteria Records
1755 N.E. 149th St.
Miami, FL 33181

Jon Mir
Oak Ridge Boys, Inc.
329 Rockland Road
Hendersonville, TN 37075

Joe G. Mitchell
Saint Germain Foundation
1180 Stonehedge Drive
Schaumburg, IL 60194

William E. Oates
Audio Marketing Assoc.
6903 Hyland Hill Court
Louisville, KY 40258

Bill Peterson
Professional Sound Industries
2737 Dorr Avenue
Fairfax, VA 22031

Ray Rayburn
(Broadway Video)
6408 68th Avenue
Glendale, NY 11385 *

Jerry Snellbaker
(U. S. Government)
704 Morningside Court
Herndon, VA 22070 *

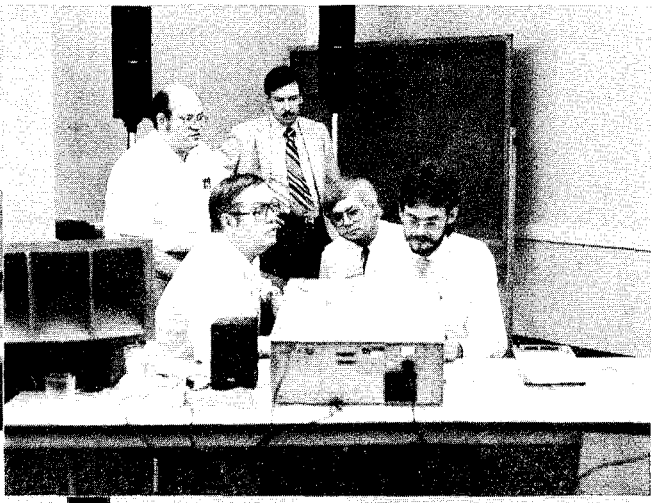
William M. Sprinkle
(TDFB)
10303 Sanbet Court
Glen Allen, VA 23060 *

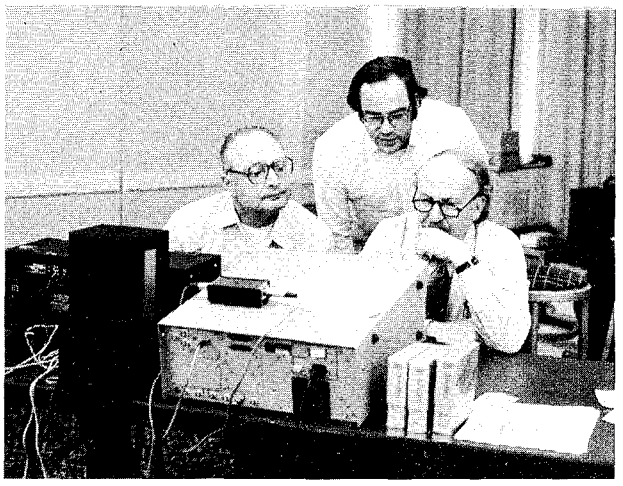
Tim Zweig
Music & Sound Recorders
706 19th Avenue South
Minneapolis, MN 55454

Albert B. Grundy
Audio Institute of Research
64 University Place
New York, New York 10003

* Home Address

The members of the November 1983 TEF® Workshop were a unique group of pioneers. Just one glance at the class list reveals those who are genuinely responsible for the present spread of TEF technology and who worked on seven different measurement problems in rotation so that each group got to measure all seven problems. The intensity of expression is merely a reflection of the chemistry created by real talent solving real problems with an analyzer that is providing "first time" mental insights into what they had formerly believed they already understood.





Because Heyser's TDS patent lay dormant for 10 years, there were people who thought it would never come to product stage. Sure, audio "Luddites" exist -- just ignore them. Its too early to tell yet but audio may divide into Before TEF (BT) and After TEF (AT).

This class had giants in it. One remarkable common trait of pioneers is their sheer energy level. Another is the intensity of their enthusiasm. TEF Workshops are the Mt. Everest of audio. ♦

LOUDSPEAKER ARRAY MOUNTING HARDWARE

One of the most popular and well received special workshops Syn-Aud-Con has sponsored has been the series of Loudspeaker Array Design Workshops with Dr. Eugene Patronis, Dave Klepper, and other contributors.

At the most recent of these, Phil Clark of Diversified Concepts, a highly respected sound contractor in upstate New York, made a presentation on how to mount arrays. Often sound contractors accuse the consultants of showing on the drawing the array mounted with chewing gum. We have had repeated requests from those who did not attend the workshop for the materials he showed.

1. Kindorf
   Midland-Ross Corp.
   Electrical Products Division
   P. O. Box 1548
   Pittsburgh, PA. 15230
   (412) 323-5400

   A. Channel and Fittings Handbook
   B. Kindorf Catalog for Structural Support, Surface Raceway and Metal Framing

2. Unistruct
   GTE Products Corp.
   35005 Michigan Ave. W.
   P. O. Box 802
   Wayne, MI. 48184
   (313) 721-4040

   A. Telespar - Telescopic Engineering Tubing
   B. General Engineering Catalog #9 (Metal Framing Systems)

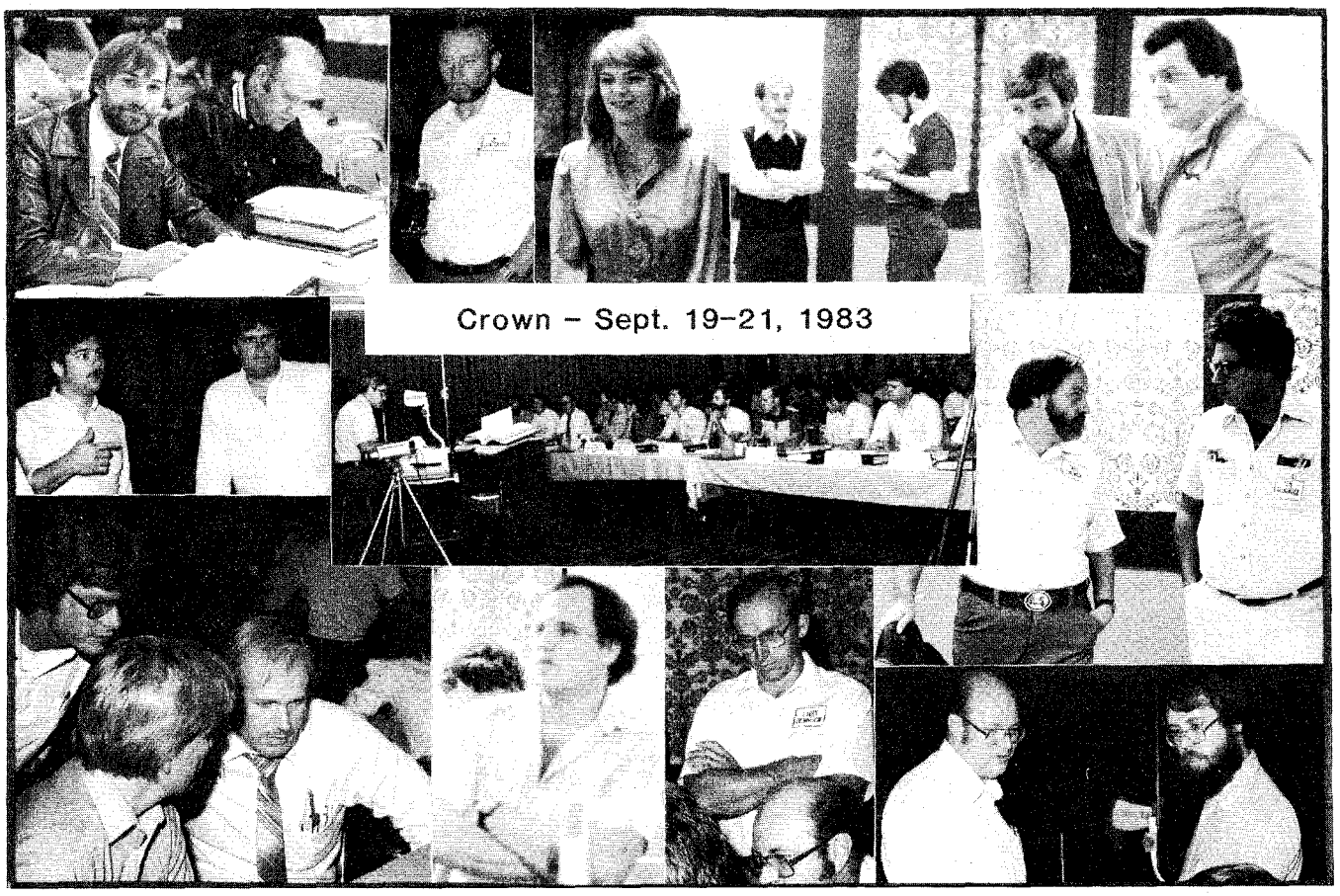
3. J. R. Clancy, Inc.
   7041 Interstate Island Road
   Syracuse, NY 13209

   A. Catalog #54 - Manufacturers for the Theatrical Industry
   A remarkable source of equipment associated with stage rigging.

4. Hollaender Manufacturing Co.
   10285 Wayne Ave.
   Cincinnati, OH 45215-1199
   (513) 772-8800

   A. Structural pipe fittings

If you have any intention of constructing any kind of array mounting, these catalogs are basic and essential. Some of the catalogs are large, so there may be a charge involved. Our thanks to Phil Clark for researching this subject so thoroughly. ♦

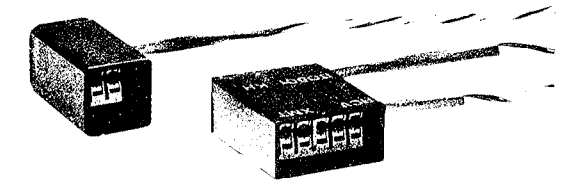


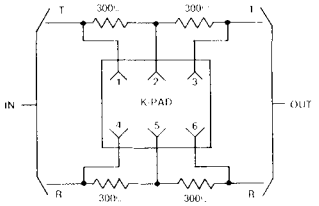
TELECONFERENCING TOOLS - KENTROX

Those audio firms that have detected the potential for explosive growth inherent in teleconferencing systems and who are doing their daily homework will find the latest Kentrox "Product Profile No. 12" a gold mine of hard-to-find items.

For many years Syn-Aud-Con has recommended the Kentrox 'K' pads (these are the small plug in "pads" we pass around in class).

Equipment Type
Digital Carrier Equipment
Usage Measuring Equipment
TSPS Bridging Repeater System
Repeat Coils
Sealing Current
Attenuators
Bridges, Passive
Bridges, Active
E&M Signaling Interfaces, Appliques. Pulse Link Rptrs, Trunk Link Rptrs
Relays
Amplifiers (Voice Frequency Repeaters)
Station Equipment
Central Office equipment mountings and adapters
Miscellaneous: Cable build-out capacitors, fuse panels, terminating resistors, equalizers, jacks





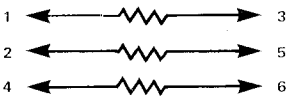
Each circuit has 6 db loss without K-Pad in socket

TYPICAL CIRCUIT
K-PAD MOUNTING
600 ohm

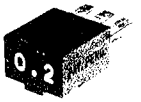
SPECIFICATIONS

Port impedance:	600 ohm ±2% balanced (900 ohm optional)
Insertion loss:	determined by K-Pad®
K-Pad® standard attenuations:	
	0 to 23 dB, 0.2 dB increments
	23 to 30 dB, 1.0 dB increments
	35 dB, infinity
Attenuation accuracy:	±0.1 dB nominal
Circuit crosstalk:	>80 dB
Longitudinal balance:	>70 dB
Amplitude response:	±0.25 dB dc to 20 kHz
Delay distortion:	negligible dc to 20 kHz
Operating temperature range:	0 to 55°C
Humidity:	up to 95% no condensation
Dimensions:	See Mechanical Outline
Weight:	approx. 1 oz.

In order to obtain your own copy of this valuable reference, write: Gil Godinez
KENTROX INDUSTRIES, INC.
14375 N.W. Science Park Drive/Portland, OR 97229
Telephone: 503/643-1681 ♦



K-PAD
WIRING



ACTUAL SIZE

TYPICAL CIRCUIT
K-PAD

SPECIFICATIONS

Port impedance:	600 ohm ±2% balanced (900 ohm available)
Insertion loss:	determined by K-Pad®
K-Pad® standard attenuations:	
	0 to 23 dB, 0.2 dB increments
	23 to 30 dB, 1.0 dB increments
	35 dB, infinity
Attenuation accuracy:	±0.1 dB nominal
Circuit crosstalk:	>80 dB
Longitudinal balance:	>70 dB
Amplitude response:	±0.25 dB dc to 20 kHz
Delay distortion:	negligible dc to 20 kHz
Operating temperature range:	0 to 55°C
Humidity:	up to 95% R.H. no condensation
Dimensions:	approx. 0.46"L x 0.38"H x 0.80"D 1.17 cm x 0.97 cm x 2.03 cm
Weight:	approx. 0.1 oz. 2.8 g.

CONVERTING "OPEN CIRCUIT" dBV RATINGS

Some manufacturers give an "open circuit" rating in the form 0.35mv (- 69 dBv) 0 dB = 1V/UBAR. This means that for an acoustic input of 1.0 UBAR (an L_p = 74 dB), the open circuit voltage is 0.35mv (0.00035V).

For all such ratings *where the rated microphone impedance is 150Ω*, the EIA power rating (i.e. the AIP in dBm for an acoustic input of L_p = 0 dB) is equal to:

EIA rating = (open circuit dBV) - (71.78 dB)

Remember this assumes a 1.0ω BAR original test input (an L_p = 74 dB). If the dBV rating was made with a one pascal (1.0PA) acoustic input, then the EIA rating becomes:

EIA rating = (open circuit dBV) - (91.78 dB)

The advantage of the EIA power rating is, of course, that you merely need to add your performer's L_p to the EIA rating in order to have the AIP at the input of your mixer. ♦

USING SIGNAL DELAY DEVICES (SDD) TO ALIGN LOUDSPEAKER ARRAYS

We have refrained from discussing the alignment of arrays until we could investigate the subject personally. The results of our research can be posed as a series of questions.

First Question

Is it necessary to provide signal alignment between a woofer and a high frequency unit? The answer: Only in a control room type environment is it likely to be necessary.

One Caution. If you're not aligned, at least avoid those misalignments that produce a null at exactly the crossover frequency. For example, if you have a 500 Hz crossover frequency, you would want to avoid

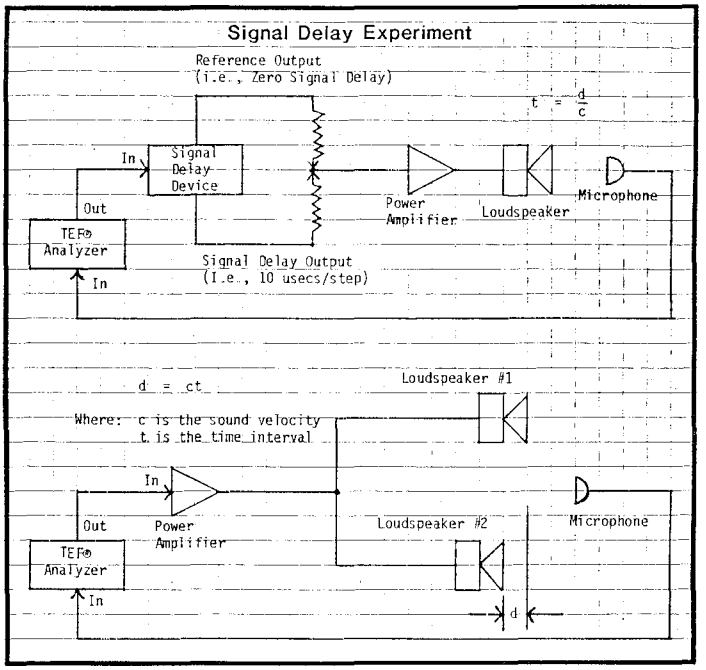
$$D = 0.5\frac{c}{f}$$

or:

$$D = 0.5\frac{1130 \text{ ft/sec}}{500 \text{ Hz}} = 1.13' \text{ or } 13.65"$$

as this spacing and/or the signal delay it represents would place the initial null frequency (INF) at exactly 500 Hz. You would also want to avoid sub-multiple spacings such that subsequent null frequency intervals (NFI) fall on the crossover frequency. The first three null frequencies are INF, (INF + NFI), (INF + NFI + NFI).

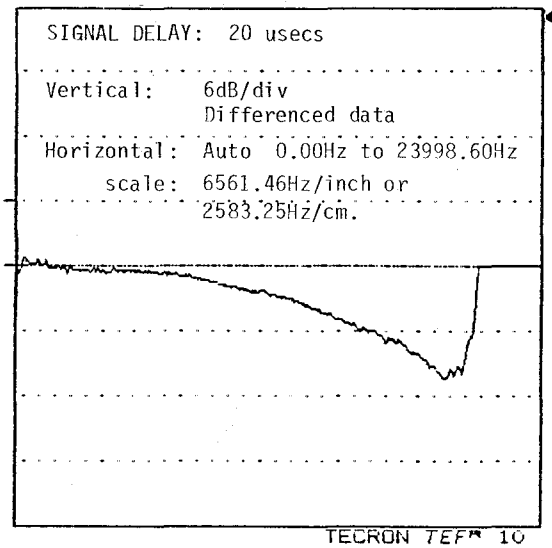
We had been demonstrating the audibility of 20 and 30 microsecond delay in each class using the Sunn Signal Delay but had never measured it. In the New York class, Lewis Feldman asked to "see" what we were hearing. Lewis (left) is shown talking to Hellmuth Kolbe of Zurich.



Second Question

When is it critical that I correct signal delay? The answer: When two devices share the same frequency range such as high frequency horns in a large array.

Two devices covering a shared audience area out of signal alignment as little as 30 usecs (that's right, microseconds or 0.41 inches) are very detrimental to speech and music. In fact, in demonstrations in Syn-Aud-Con classes, as short a signal delay as 20 usecs was audible (see illustrations). 20 usecs is a distance of 0.27".

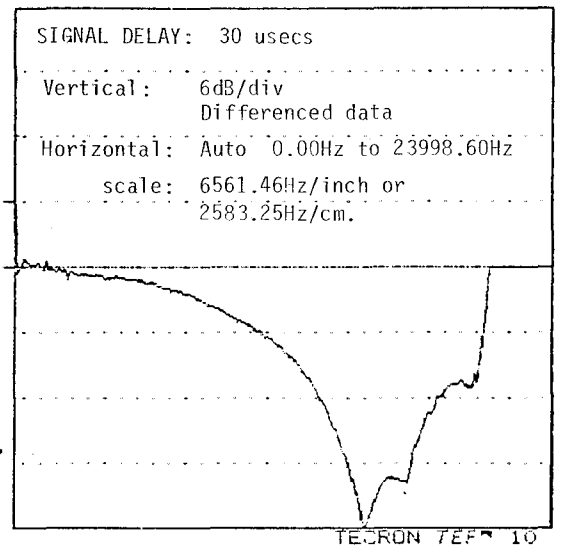


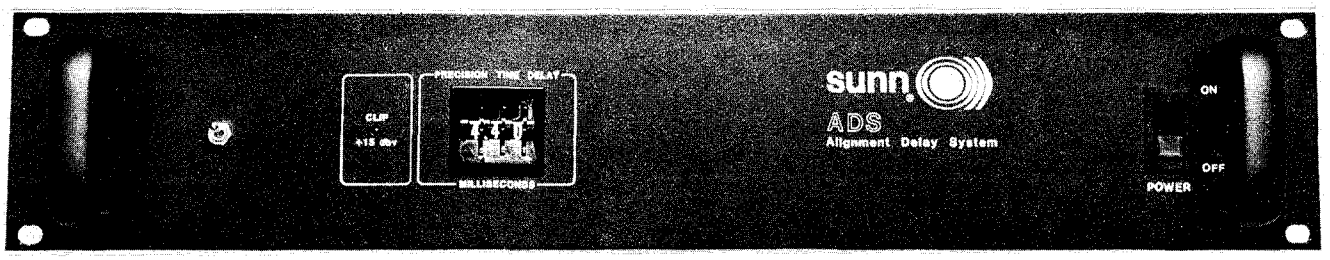
←1st Measurement:

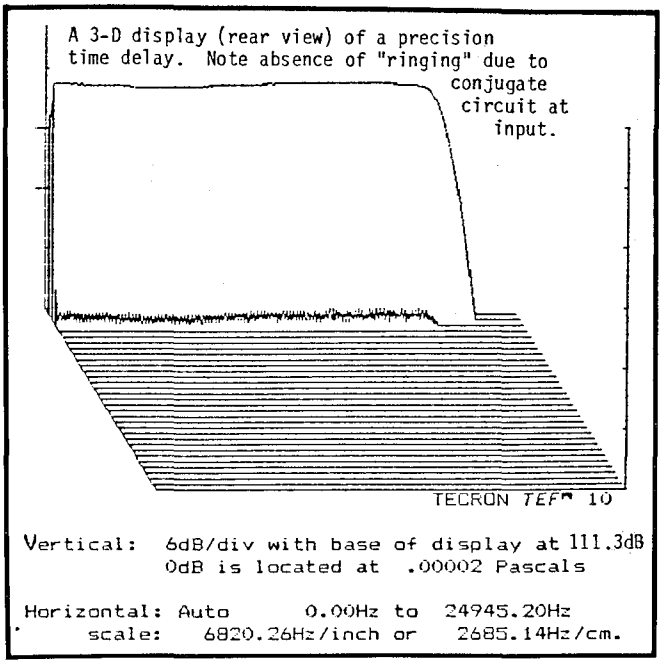
20 usecs would be more audible on music than speech (down about 3dB at 5000 Hz and about 8dB at 18,000 Hz). The "brickwall" at 18,000 Hz is the anti-aliasing filter on the Sunn Signal Delay.

2nd Measurement:→

30 usecs is 0.41 inches out of alignment.







Third Question

Okay, so small signal misalignments are devastating. Can't I just line them up carefully during installation? The answer: Unfortunately, no! Why? Because to do so usually requires that two large devices occupy the same physical space.

That's where the new breed of precision signal delay devices with their very wide frequency response, superb transient characteristics, and 10 usecs per step adjustments come into play. We can now mount the devices in the array in a physically convenient manner and signal align them with greater ease than we can adjust a system's equalizers.

At the TEF® class in Atlanta, each member of the class participated in using the Sunn ADS unit to signal align two misaligned loudspeakers. With the TEF® analyzer, it became a delight.

Final Question

What can I do? The answer: Get involved or get superceded.

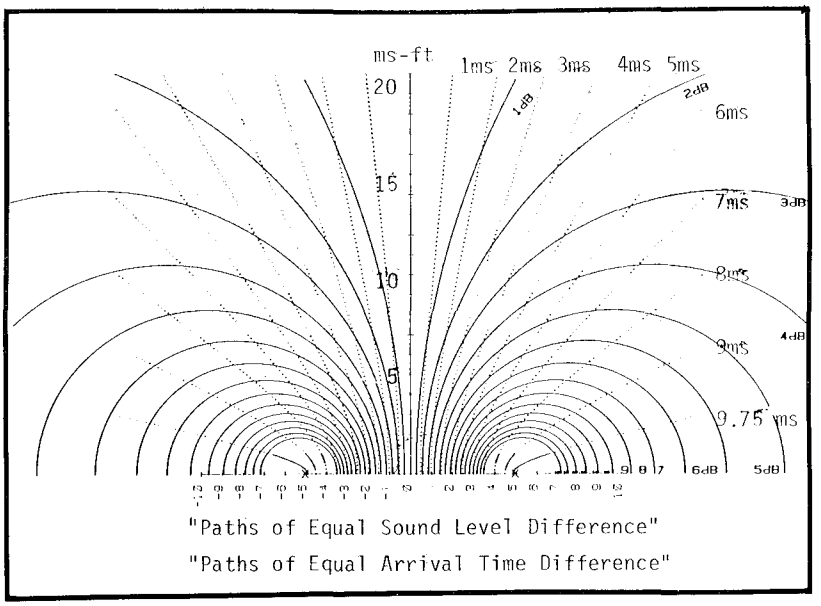
Manufacturers are discovering that their equipment is now being measured *in the field* by users of the TEF® analyzers. ♦

A SPLIT SPEAKER DESIGN CHART

Joe Mitchell, one of Syn-Aud-Con's prized graduates and a real gentleman in every sense of the word, has put his large H.P. computer to work and plotted both the level differences and signal delay differences on the chart.

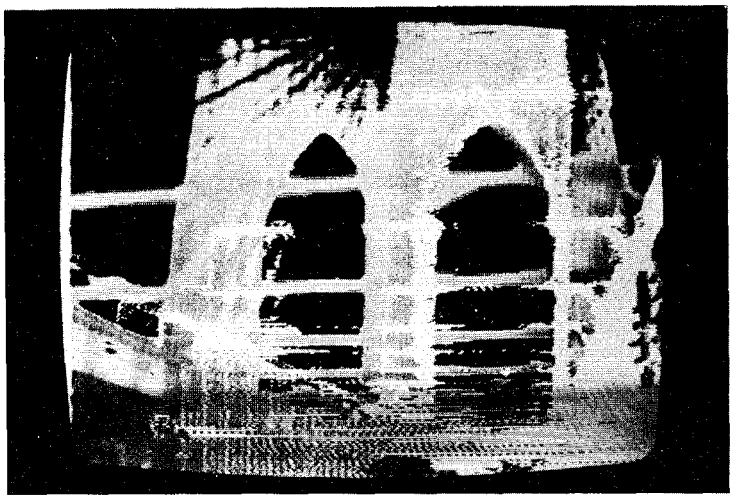
Note that if the source level in one speaker is turned down 3dB, the center balance (0 dB) line moves to the -3dB circle on that side (all others are moved likewise.

This is an extremely useful tool for evaluating the areas of most likely audible interference from the split loudspeaker. ♦

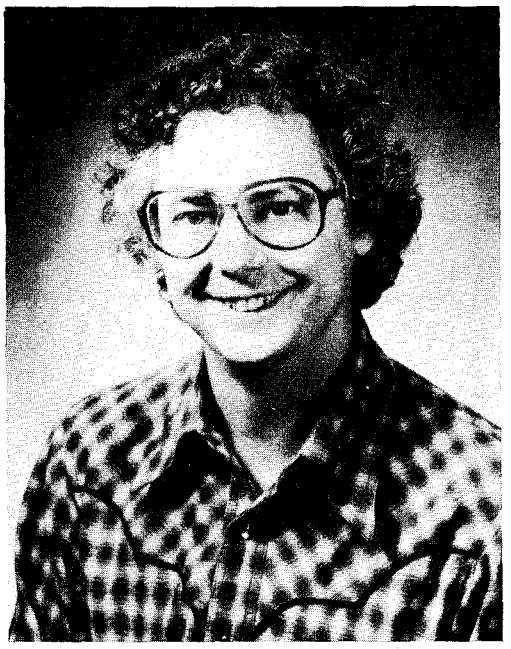


GRAND PRIX WINNER - JVC Video Festival

I was reading through the October 1983 issue of the PZMemo recently and noted in Reynold Weidenaar's comments that he was surprised that there were no entries in the PZM Challenge in the Environmental Sounds category. He stated that he had "incredibly striking recordings in this area -- pigs grunting at feeding time -- the interior of a chicken coop -- *and most amazing, the sound of traffic beneath the Brooklyn Bridge, which resembles a massive hive of monster bees!* (Italics mine) They were all made with a stereo pair of PZM's on a Nagra IV-Se at 151ps."



By computer-processing both the video image and the audio, Reynold developed a work of synthesized sounds and images. As he says, "The visual beauty of the bridge is complemented by the massive sonic resonance of its motor traffic."



Reynold Weidenaar, winner of the JVC sponsored 6th Tokyo Video Festival Video Grand Prix.

The next day, with this all fresh in mind, we received a press release from JVC announcing that Reynold had won the very prestigious Video Grand Prix, the top award from the Sixth Tokyo Video Festival sponsored by JVC, for his 10-1/2 minute program, "Love of Line, of Light and Shadow: The Brooklyn Bridge." There were 1176 entries from 18 countries.

Reynold is a freelance composer and adjunct instructor of film and television at New York University. He was one of the very early users of the Wahrenbrock PZM's, having heard them demonstrated in Syn-Aud-Con classes. ♦

2^{256}

While visiting old and dear friends, Mr. and Mrs. Floyd Cooper, in Greenville, Pa., they entertained us along with a charming couple, Dr. and Mrs. Richard Brown. It has been our privilege to spend many an invigorating evening with these couples, always to our palate's delight and our intellect's benefit.

Dr. Brown is another Ph.D. on our list of "Gee! I wish I'd had him teach me physics."

I had remarked at dinner that my book by Casper Schott, written in 1657, declared that $2^{(256)}$ was the number of virtues of the Virgin Mary. Dr. Brown soon followed up with the letter reproduced here.

Carolyn and I have the feeling that friends like this are a quick flash of what heaven may be like - harmonious, all-knowing, and full of fun. ♦

Here is the number in which you expressed an interest: 2^{256}. It came out on our Math Department's Math program to the proper number of digits (78), but otherwise I have not taken time to check it.

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Copyright (C) 1981 The SOFT WAREHOUSE
Licensed by MICROSOFT, Inc.

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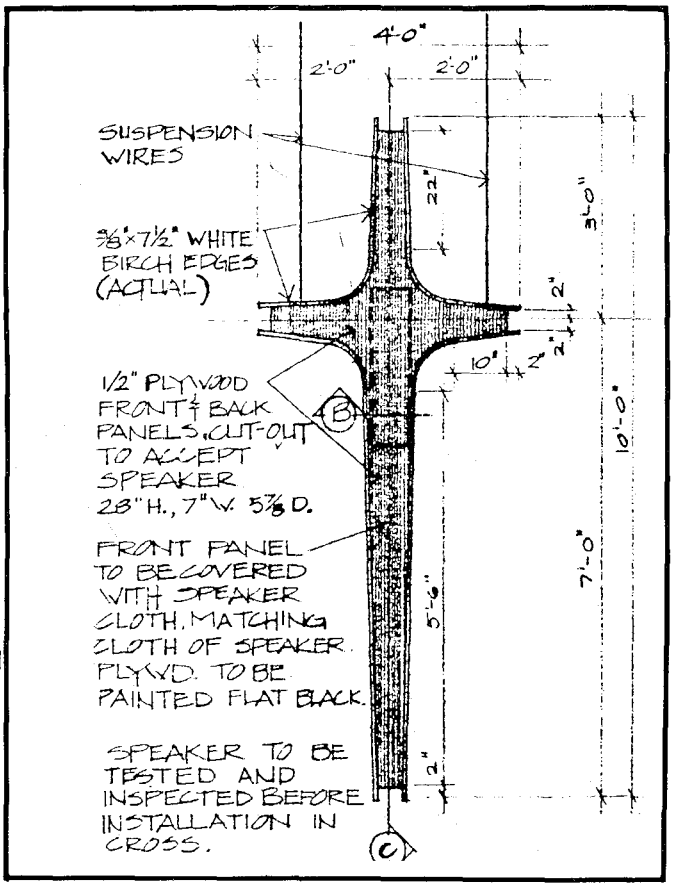
CROSSTALK

In a class for Crown reps and personnel in late September, Don discussed the need for contractors and architects to creatively house speakers and arrays. He told of Ken Patterson of Superior Sound in Kansas City housing a speaker in a cross.

When the architect told Ken, "I won't have that ugly thing in my church," Ken proposed a clever answer that the architect admired enough to re-design the cross to accept the speaker system.

Jim Stembal in the front row of the Crown class responded, "Oh, that's Crosstalk." ♦



DALLAS LEDE™ & STUDIO DESIGN WORKSHOP

We were delighted to host the Joiner-Pelton-Rose LEDE™ and Studio Design Workshop in Dallas at the Dallas Sound Lab.

The Joiner-Pelton-Rose organization is one of the highest regarded acoustical consulting firms in the United States. We were extremely fortunate to receive the wealth of material so generously shared. Much of the material is not in print except privately. (Tom Rose has spent 25 years gathering the material he gave us.)

Certain ideas have lives just like human beings do. Some of the ideas destined for the longest lives begin as fragile infants. To whom the ideas appeal and who initially rejects them tell much about the quality of the idea. The LEDE concept is such an idea. We are grateful to those who reject it because they'd be odd man out in the class of individual competence shown here. We are tremendously pleased to both see and hear the recognition coming to Chips Davis, Russ Berger, Glenn Meeks, Hellmuth Kolbe, and the other pioneers who persevered and carried the idea to a successful conclusion in the market place.

LEDE is now past its infancy and flexing its muscles like a young Atlas. The recent LEDE Workshop was a gathering of very talented engineers from the recording and broadcast industry.

JOINER-PELTON-ROSE, INC.

LEDE AND STUIO DESIGN WORKSHOP
Dallas - December 5-7, 1982
JOINER-PELTON-ROSE, INC.

Monday 5 DEC
Welcome: Don Davis
Intro: Russ Berger

* Jack Wrightson - Psychoacoustics
* Mike Fann - Environmental Noise Control
* Jim Johnson - Basic Acoustics
* Tom Rose - Transmission Loss of Partitions
* Russ Berger - Tour Dallas Sound Lab and Discuss Construction Features

Tuesday 6 DEC
Intro: Russ Berger

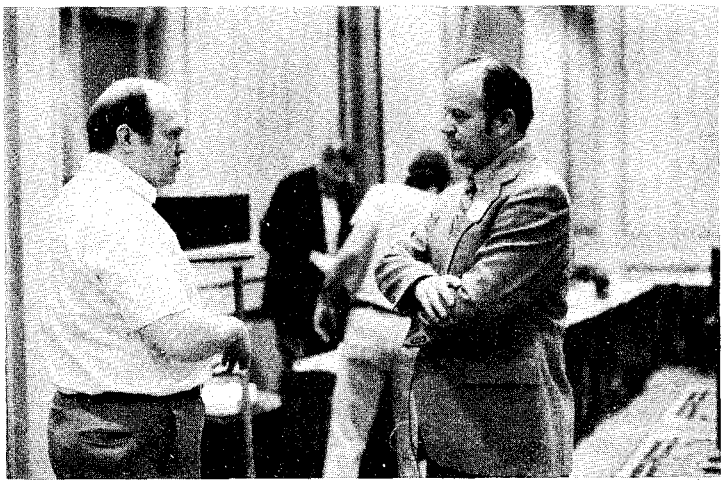
* Tom Rose - HVAC and Mechanical Noise Control
* Russ Berger - LEDE Control Room and Studio Techniques
* Topper Sowden - Grounding and Electrical Power Noise Control
* Ron Baker & Staff of JPR - Test QRD and PRD with TEF and demonstrate computer design software

Wednesday 7 DEC

* Don Eger - Basics of TEF
* Jack Wrightson - Test Dallas Sound Lab
* Don Davis, Don Eger, Russ Berger - TEF, NR, STC, TL, Modal Response
* Bruce Fogerty - Tour of the Sound Stages at Dallas Communications Complex
* Don Davis - Farewell

That Russ Berger's LEDE control room came out well is clearly evident in the expression on Russ's face as he sees the room's ETC appear on the TEF® analyzer's screen.

David Joiner, President of the acoustical firm that supplied the exemplar teaching staff for this workshop, showed his pleasure in entertaining the class with the classic "singing tubes" demonstration.



Gordon Carter, Chief Engineer of WFMT in Chicago (in our opinion, the finest FM classical music station in the world), is shown talking to Tom Rose.

Tom gave the finest presentation on the control of HVAC noise and vibration problems it has *ever* been our pleasure to witness. To label Tom as an authority is to understate the facts. We quickly came under his spell of "we all know bigger is better" when he was about to demolish another commonly accepted myth. His exhaustive preparation, in detail relevant material, and his dynamic presentation is combined with a real aptitude for *carefully listening* to a question from the floor and going straight to the heart of the solution. ➔

BELOW - Another member of the JPR team is Topper Snowden (right) who successfully tackled an audio tiger called "Signal Circuit Grounding Techniques." You'll be hearing more about Topper when we receive some of this data from him for publication. Topper is shown talking with Bob Todrank (center), who has the distinction of being the first to do a Quadratic-Residue Diffusor rear wall in an LEDE control room for the Oak Ridge boys in Nashville, and Bob Blackstone from San Antonio, Texas.

That's Don talking to Ake Eldsater and Bo Hansen who came all the way from Sweden to participate and carry the idea for replanting in their area of the world.

RIGHT - Neil Muncy (left) and Dick Trump (shown talking with Gordon Carter (right)) are two designers rapidly making their mark in the LEDE world.

BELOW - Don is shown talking with Jack Wrightson of JPR. Jack is their psychoacoustician. We were very impressed that JPR takes the time to evaluate the results of their work in an area normally restricted to academia. We expect very useful work from this young man as he couples his excellent research into the literature with the practical everyday problems really expert consulting firms tackle.

ABOVE - Members of the Dallas LEDE Workshop.

SYNERGETIC AUDIO CONCEPTS

LEDE™ & STUDIO DESIGN WORKSHOP
December 5-7, 1983 · Dallas, Texas

WORKSHOP CHAIRMAN:

Russ Berger
Joiner, Pelton, Rose

HOSTED BY:

Don & Carolyn Davis
Syn-Aud-Con

David Andrews
Andrews Audio Consultants
347 West 39th Street
New York, NY 10018

Randall S. Bauske
Baus Engineering
1684 Kalakaua Ave.
Honolulu, HI 96826

Gene E. Behrend
National Broadcasting Co.
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Burbank, CA 91523

Robert Blackstone
Sound Madness
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San Antonio, TX 78201

Gordon Carter
WFMT Radio
303 E. Wacker Drive
Chicago, IL 60601

Van R. Cook
Spectrum South, Inc.
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Greenville, SC 29607

Peter D'Antonio
RPG Diffusor Systems
12003 Wimbleton St.
Largo, MD 20772

Terry Dwyer
Sun Dwyer
26483A Base Line
Highland, CA 92346

Donald M. Eger
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Hisingsgatan 28
S-417 03 Gothenburg, SWEDEN

Max Grossbard
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Burbank, CA 91523

Mary C. Gruszka
(CBS)
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Stage & Studio AB
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Somerville, NJ 08876 *

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LD Systems, Inc.
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Brunswick, OH 44212

Thomas Mullins
Designs in Audio & Acoustics
4650 Reka Drive No. 6
Anchorage, AK 99508

Neil Muncy
Neil Muncy Associates
315C Howard Avenue
Rockville, MD 20850

Bob Pinkston
United Artists Comm.
314 S. Harwood St.
Dallas, TX 75201

Romulo Romo
(Arnold & Morgan)
4225 Normandy Ave.
Dallas, TX 75205 *

Bill Ryan
c/o KVIL Radio
5307 E. Mockingbird Lane
Suite 500
Dallas, TX 75206

Kean Sakata
Kean Media Consulting
2814 Dohr St.
Berkeley, CA 94702

Robert L. Todrank
(Valley Audio)
2101 June Drive
Nashville, TN 37214 *

Richard F. Trump
Triad Productions, Inc.
1910 Ingersoll Avenue
Des Moines, IA 50309

Tom Woodruff
Jer Com, Inc.
Box 98012
Lubbock, TX 79499

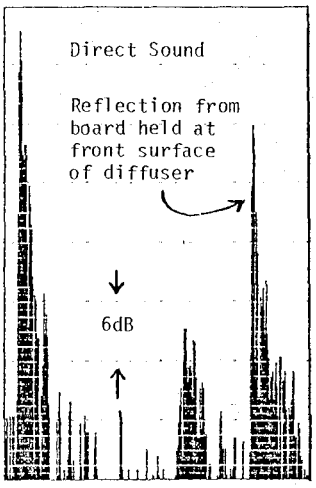
Rusty Smith
Dallas Sound Lab
Four Dallas Comm. Complex
#119
6305 N. O'Conner
Irving, TX 75039

* Home Address

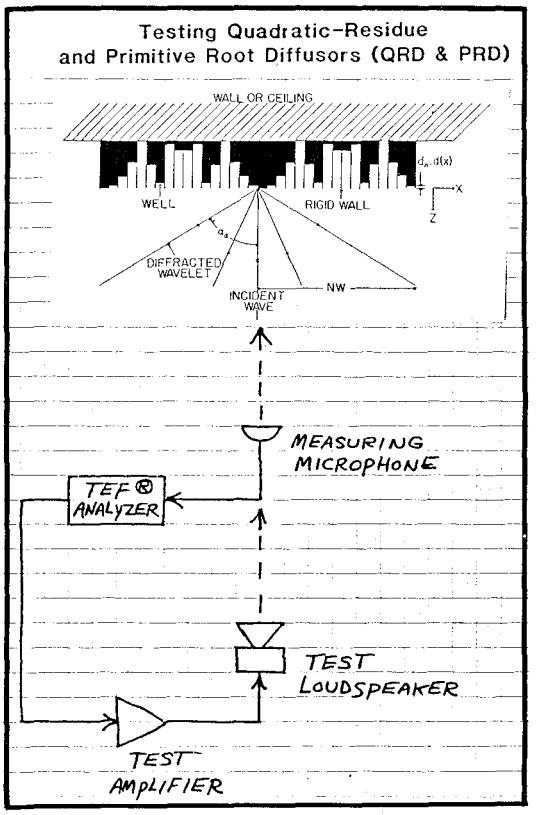
We are tentatively planning a follow-up LEDE Workshop in Nashville in the summer. If you are interested, let us hear from you. ♦

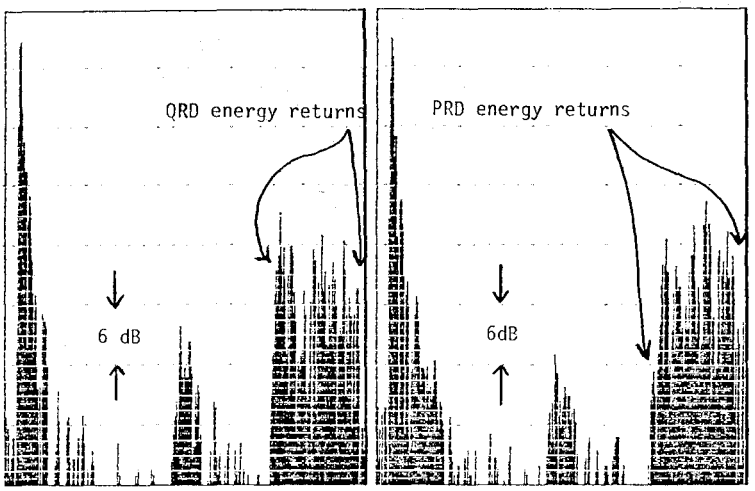
SCHROEDER'S QUADRATIC-RESIDUE DIFFUSOR

A paper of special interest to us was given at the 74th AES Convention in New York City this past fall entitled "The Schroeder Quadratic-Residue Diffusor: Design Theory and Application." The authors are Peter D'Antonio and John H. Konnert. We were pleasantly surprised to learn that Dr. D'Antonio knew of our LEDE™ work and had built some of the Quadratic-Residue Diffusors for use in his own studio.

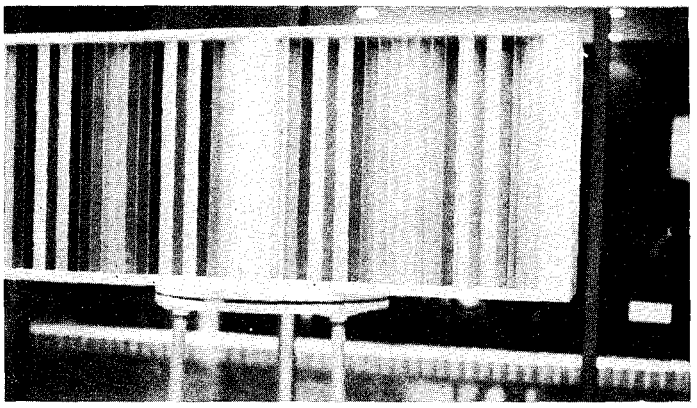


Russ Berger of Joiner-Pelton-Rose Consultants in Dallas was also fascinated with the paper and invited Peter D'Antonio to come to the special LEDE class in Dallas and bring along a sample of his work. He did indeed and they were large boxes nearly 6 feet long and weighing 250 lbs. More important, they worked. Many of us felt, after hearing them perform, that we had never heard real diffusion before.

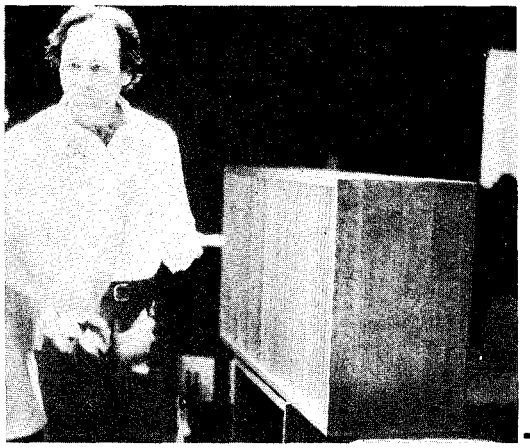




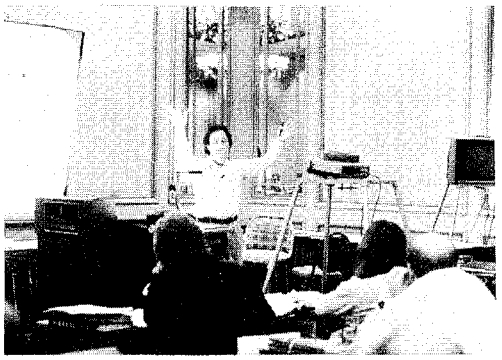
Bob Todrank (left) and Bill Ryan talking with Russ Berger. Bob is the first user of the D'Antonio diffusors in the control room he is building for the Oak Ridge Boys.



ABOVE: A QRD (note two "periods" are visible in the pattern) on our J. W. Davis turntable.



RIGHT: Here's Peter standing next to one of his diffusors. These extraordinary devices are of a size reasonable to use in control rooms without having compromised the superiority inherent in the concept.



Dr. Peter D'Antonio is an exuberant enthusiast of Manfred Schroeder's Quadratic-Residue Diffusors (QRD) and the Primitive Root Diffusors (PRD). He's shown here conjuring up the necessary magic that made the equations used an understandable series for his listeners.

Measurements confirmed our subjective judgments. We were in the presence of an idea whose time had come. Peter D'Antonio is a scientist in the chemical field and, consequently, happily at home with the mathematics of QRD (Quadratic-Residue Diffusor) and PRD (Primitive Root Diffusor). He's also a recording enthusiast with his own recording studio. Finally, he's a wild-eyed enthusiast for new and better ideas and we quickly sensed that the audio field has been blessed with a new personality from the field of chemistry. We predict you'll be hearing a great deal more both from and about Dr. D'Antonio.

We were further thrilled to hear that the first full use of his diffusors will be in the new control room being built for the Oak Ridge Boys by Bob Todrank of Nashville. Also, Russ Berger has scheduled the diffusors in several control rooms already, the first being installed at Chicago Recording.

We'll be reporting in much greater detail on this subject in the not too distant future. In the meantime, don't plan a control room rear wall until you have a chance to hear the Todrank room in Nashville, which is due to be completed early this spring, or one of Russ's rooms. ♦

GENIE LIFTS

When we first started the Altec Acousta Voicing program for Altec in 1968, we told the contractors that the only way to sell equalization was to demonstrate. Everyone was encouraged to purchase a Vermette hoist. Hundreds of sound contractors purchased the Vermette hoist.

We're told that Genie Industries makes one as good, if not better than Vermette.

Genie publishes an outstanding catalog - Genie Industries, 18340 N E 76th St. (P O Box 69) Redmond, WA 98052, and they have a Canadian office in North Vancouver, B.C. They have a toll free (800) 426-8089 in the United States and (604) 985-3600 in Canada.

Prices start around $500.00 and go from there. ♦

THESE MEN ARE STARTING A REVOLUTION

At the latest word from Tecron, there are now well over fifty TEF® analyzers in the field.

We are especially pleased to see analyzers in the hands of alert manufacturers, such as:

Shure Brothers, Inc., Evanston, IL
Electro-Voice, Buchanan, MI
Galaxy Audio, Topeka, KS
Community Light and Sound, Chester, PA
Spica, Santa Fe, NM
J. W. Davis & Co., Dallas, TX
Douglas Aircraft, Long Beach, CA
Ford Motor Co., Dearborn, MI

The National Bureau of Standards now has one as does Showco in Dallas, TX., and Clair Bros. in Lititz, PA.

The rest of the list reads like a Syn-Aud-Con "who's who", as over 90% of the list are Syn-Aud-Con graduates.

It has been remarked that men elevated to high political office often grow dramatically in order to meet the challenges. Be assured that this list of TEF® analyzer users are being "lifted up" dramatically in their understanding of audio and acoustic measurements.

Richard C. Heyser
Jet Propulsion Labs.
Pasadena, CA

Charles Bilello
West Hempstead, NY

C. Michael Hoover
Audio Technical Svcs
Vienna, VA

Mike Garrison
H I S Sound
Portland, OR

Bob Todrank
Valley Audio
Nashville, TN

Hy James, Inc.
Livonia, MI

Alan Seipman
Taft Broadcasting Co.
Houston, TX

Ray Rayburn
Broadcast Technology
New York, NY

Russell E. Berger
Joiner, Pelton, Rose
Dallas, TX

Farrel M. Becker
Audio Artistry
Kensington, MD

Bill Lipis
Sound Maintenance
El Cajon, CA

Dave Andrews
Andrews Audio
New York, NY

Bob Herrick
Production Consultants
San Antonio, TX

Niles Christenson
Nilesco Exports Inc
Monterey, CA

Philip Clark
Diversified Concepts
Marcellus, NY

Bill Gellhaus
WMRG Studios
Cheltham, PA

Dr. Eugene Patronis
GA. Tech/School-Physics
Atlanta, GA

James T. King
Audiometrics
Longview, TX

Chips Davis
LEDE Design
Las Vegas, NV

Sanford Swartzendruber
Precision Audio
Bristol, IN

J. G. Mitchell
Streamwood, IL

Bob Gaude
American Multimedia
Burlington, NC

Rob McKinley
LD Systems
Houston, TX

Mary C. Gruszka
Edgewater, NJ

Don Davis
Syn-Aud-Con
San Juan Capistrano, CA

Randy Bauske
Baus Engineering
Honolulu, HI

Bill Peterson
Professional Sounds
Fairfax, VA

Ken Wahrenbrock
Wahrenbrock Sound
Downey, CA

Timothy Purcell
San Francisco, CA

Electrocom
Seattle, WA

James W. Brown
Chicago, IL

Ludwig W. Sepmeyer
Consulting Engineers
Los Angeles, CA

Deward Timothy
Poll Sound
Salt Lake City, UT

Jeff Wimsatt
Comdial
Upland, CA

Richard Lee
Richard Lee & Assoc
Miami, FL

John Prohs
Ambassador College
Pasadena, CA

Sound Investment Enterprises
Thousand Oaks, CA

Garrott W. Elghammer
Garrett Sound
Chicago, IL

Mikal Priess
Seattle, WA

Steven Hodge
Steven M. Hodge Co.
College Station, TX

Kean Sakata
Kean Media Consulting
San Francisco, CA

Mark Doubet
WMT Music & Sound
Marion, IA

If you don't have a TEF® analyzer, yet have important measurements to be made, why don't you contact a TEF owner in your area? He may be willing to rent his analyzer and his expertise. ♦

CONVERTING APPARENT LEVELS INTO VOLTAGES

Apparent levels are obtained by using a voltmeter that has a decibel scale in place of its voltage scales and reading the "apparent" level in decibels, even though the impedance necessary to make the reading a "true level" is not present. In such a case, it is usually more desirable and useful to have the voltage.

First, ascertain what reference voltage causes a reading of zero dB on the meter (i.e., normal values are usually either 1.0 volt or 0.775 volt). The voltage (E) then is found by:

$$E = \text{ref volts} \times \left\{ 10^{\left(\frac{dB}{20}\right)} \right\}$$

Thus, voltage can then be used in the normal manner to calculate the true level. For a reference voltage of 0.775V or 1.0 volt, this becomes simplicity itself on a Syn-Aud-Con slide rule. Merely enter the apparent level on scales #10 or #16 as is required by the sign accompanying the apparent level and read on scale #7 the voltage for a ref of 0.775 opposite 600 Ω on scale #6. For a 1.0 volt reference, find the voltage on scale #7 opposite 1000 Ω on scale #6. ♦

DEFINING VOLTAGE AMPLITUDES (SINE WAVE)

I. Peak to peak amplitude (A_{p-p}) is the amplitude measured from the maximum instantaneous positive peak to the maximum instantaneous negative peak.

II. Peak amplitude (A_p) is defined as 0.5 A_{p-p}.

III. Average amplitude (A_{AVG}) is defined as:

Rectified* A_{AVG} =

$$\left\{\frac{(\text{SIN } 10^\circ) + \text{SIN } 20^\circ + \cdots\cdot \text{SIN } 180^\circ}{18}\right\} =$$

$0.636\ A_p$

IV. Root mean square amplitude (A_{RMS}) is defined as:

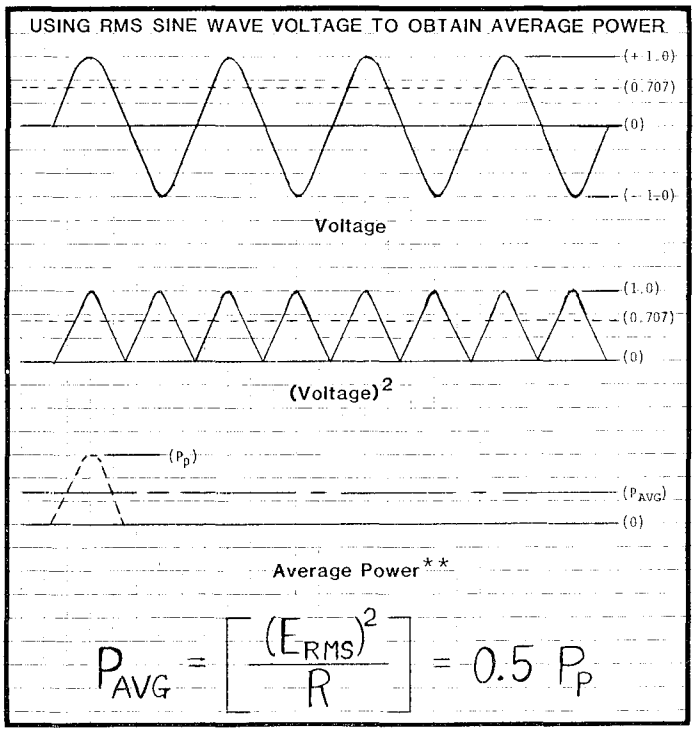
A_{RMS} =

$$\sqrt{\frac{((\text{SIN } 10^\circ)^2 + (\text{SIN } 20^\circ)^2 + \cdots\cdot (\text{SIN } 180^\circ)^2)}{18}} =$$

$0.707\ A_p$

* Unrectified A_{AVG} of a sine wave = 0.

** Average power is the continuous sine wave power rating.



ACADEMIC DEFINITIONS

Peak Value:

$e_{peak} = e_{max}(t)$ is the maximum value of e(t) within the time interval T.

Average Value:

$$e_{average} = \frac{1}{T}\int_{t_1}^{t_2} |e(t)|\,dt$$

RMS Value.

$$e_{RMS} = \sqrt{\frac{1}{T}\int_{t_1}^{t_2} [e(t)]^2\,dt}$$

From these basic definitions are derived:

The crest factor:

$$F_c = \frac{e_{peak}}{e_{RMS}} \quad \text{and}$$

the form factor:

$$F_f = \frac{e_{RMS}}{e_{average}}$$

For a sinusoidal function $e(t) = E \sin \omega t$, the different values will be:

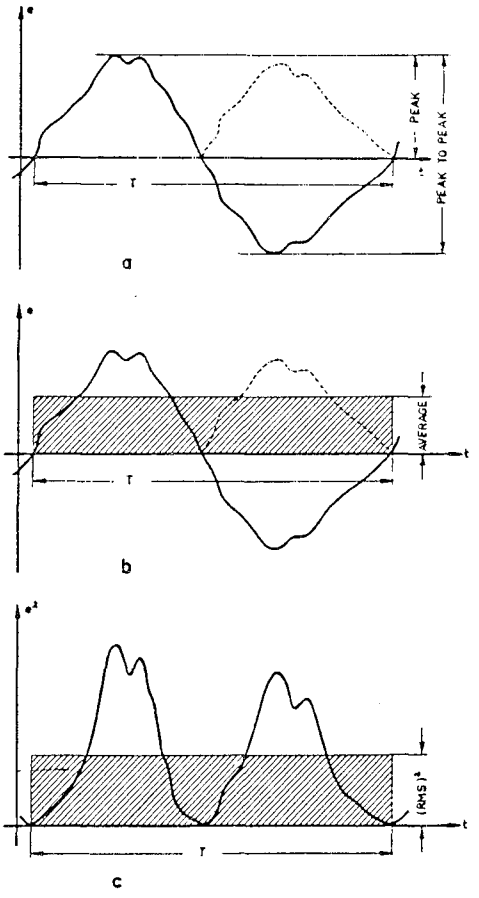
$e_{peak} = E$

$e_{average} = \frac{2E}{\pi}$

$e_{RMS} = \frac{E}{\sqrt{2}}$

$F_c = \sqrt{2}$

$F_f = 1.11$



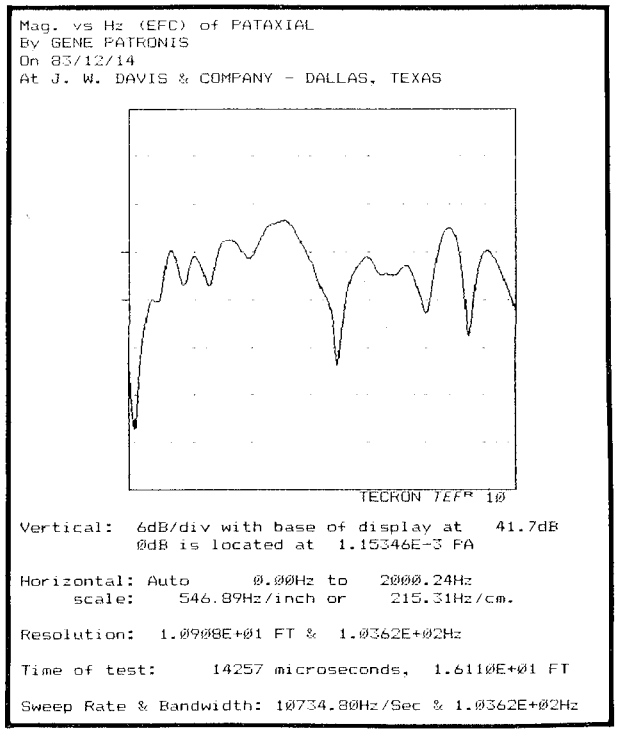
a. Peak value of a periodical signal.
b. Average value of a periodical signal.
c. Squared RMS value of a periodical signal.

THE BEST LOUDSPEAKER IN ITS CLASS

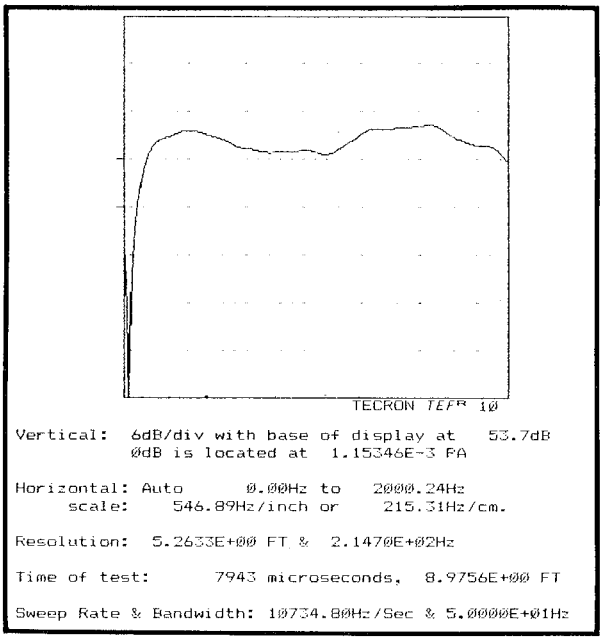
The Patronis "Pataxial" loudspeaker system is the best loudspeaker of its type (reinforcement of sound in small to medium sized auditoriums).

Dr. Eugene Patronis needs no introduction to those fortunate enough to have attended our special loudspeaker array classes,but for those of you not familiar with this unusual man we'd like to tell you something about him and why Syn-Aud-Con has such a high regard for him.

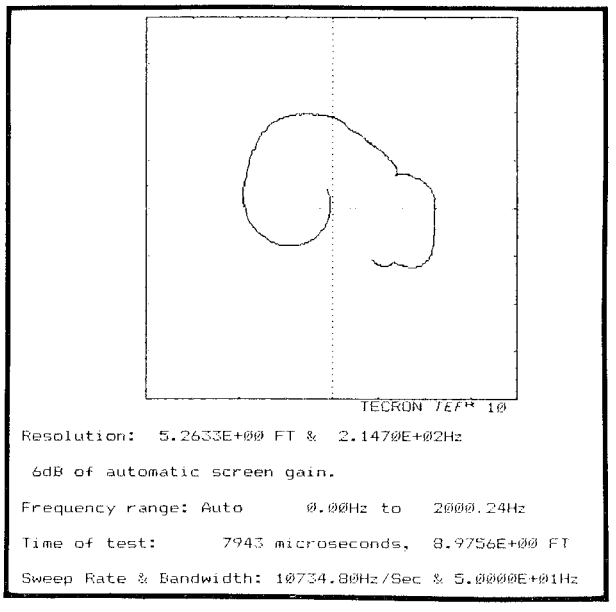
Dr. Patronis has a Ph.D. degree in Physics and is a professor at the Georgia Institute of Technology. That says he has done his academic homework. That accomplishment alone would win our sincere respect. His interest in and motivation of his students is exceptional. He not only knows what to teach them but how to teach them and is driven by a genuine love of teaching.



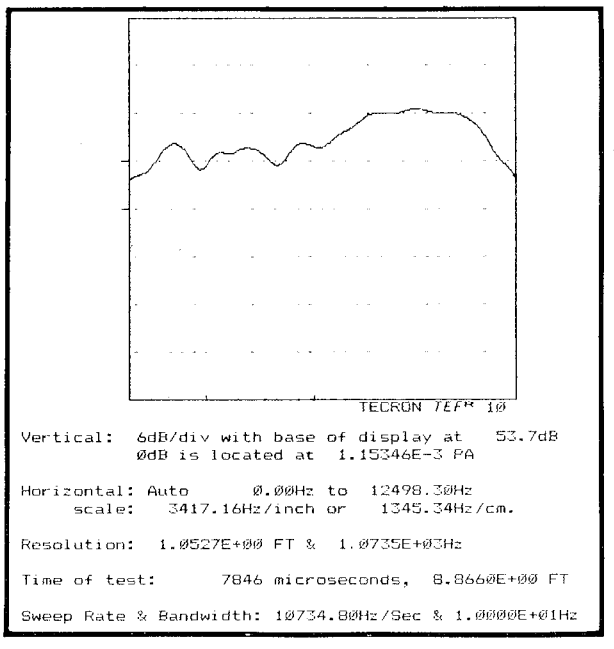
The Pataxial speaker system's *low frequency* response *before* treating low frequency horn with absorptive material.



The Pataxial speaker system's *low frequency* response *after* absorptive treatment of low frequency horn.



The Nyquist phase response *after* treatment.



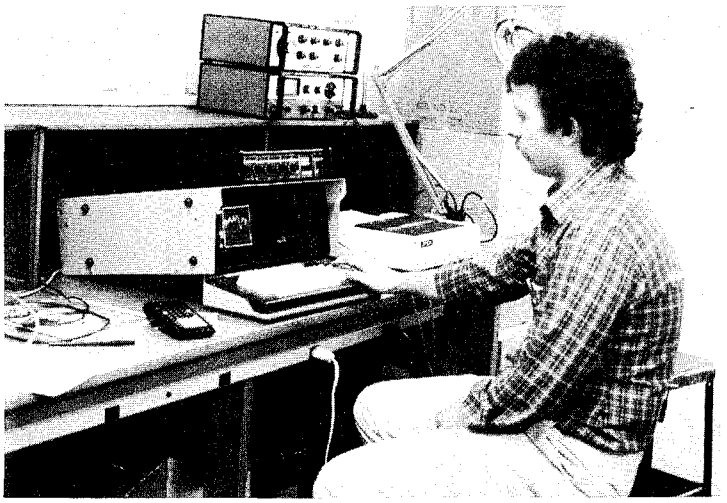
Full range response ±3 dB *after* treatment. ➔

Dr. Patronis is also a prolific inventor of both electronic devices and loudspeaker systems, including his feedback suppressor, a unique modular amplifier, and an as yet unmarketed *automatic* equalizer.

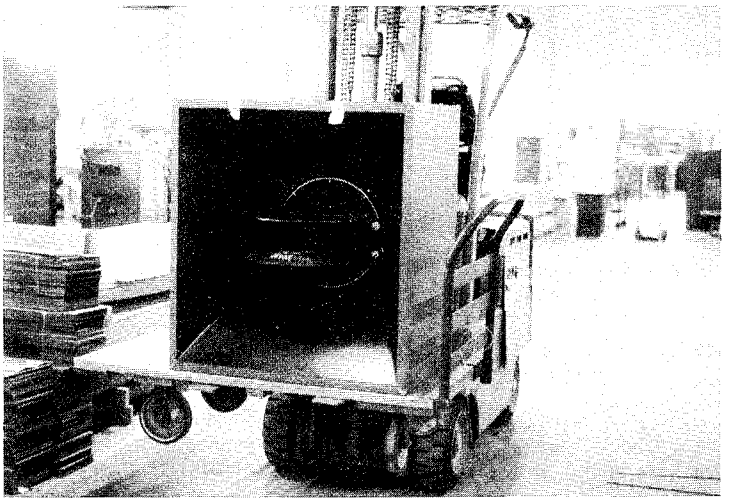
As if that weren't enough, Dr. Patronis is a thoroughly versed, practical installer of both everyday sound system setups and of major stadium, arena and auditorium setups.

The "Pataxial" is his optimized design for the sound reinforcement field.

J. W. Davis & Company in Dallas, Texas, is a small manufacturing firm headed by a Syn-Aud-Con graduate, Harvey Earp. We'd gladly attend any class on "how to successfully run an audio manufacturing business" taught by Harvey. J. W. Davis & Company is heavily involved in a series of advanced products designed by Dr. Patronis and intends to bring them to the market place in fully developed form.



J. W. Davis engineer, Gary Boyd, using their TEF® analyzer for loudspeaker measurements.



The Pataxial system being lifted by a fork lift in order to gain a wider time window for low frequency measurements.

To give you an idea of the size of the Pataxial, our very petite model is shown next to one of the early prototypes.

Is this another PZM? We think so. Try one and we think you'll agree. ♦

ONE AND TWO "PORT" MEASUREMENTS

Networks are often described as one port or two port networks, meaning an input port (portal) and an output port.

Analyzers can also be viewed from this perspective. A voltmeter oscilloscope or impedance bridge, for example, has a single input port. A TEF® analyzer, in common with other swept spectral analyzers, can be used either in a two port or a one port configuration (real TEF measurements are always two port).

There is an immense advantage in two port measurements, namely preknowledge of the source signal. This allows optimization of the analyzer's receive path for the high resolution analysis of the device under test. ♦

USING THE SUNN ADS UNIT

The first figure is the "frequency" vs magnitude of two small loudspeakers with one of their signals about 0.7" apart (i.e., the initial null frequency INF = 0.5 $\frac{c}{d}$ therefore d = 0.5 $\frac{c}{f}$). This represents a signal delay of approximately 51.6 usecs.

$t = \frac{d}{c}$ $\qquad$ $t = \frac{0.7/12}{1130} = 0.0000516....secs$

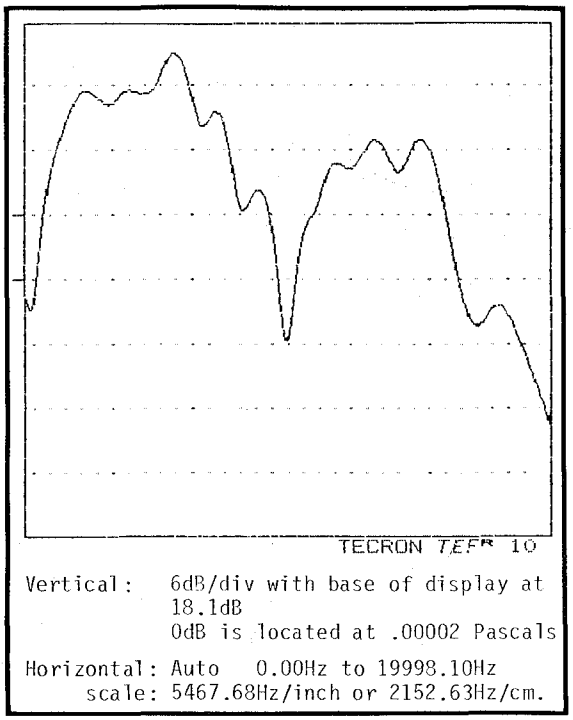


FIGURE 1: Two small loudspeakers 0.7" out of alignment.

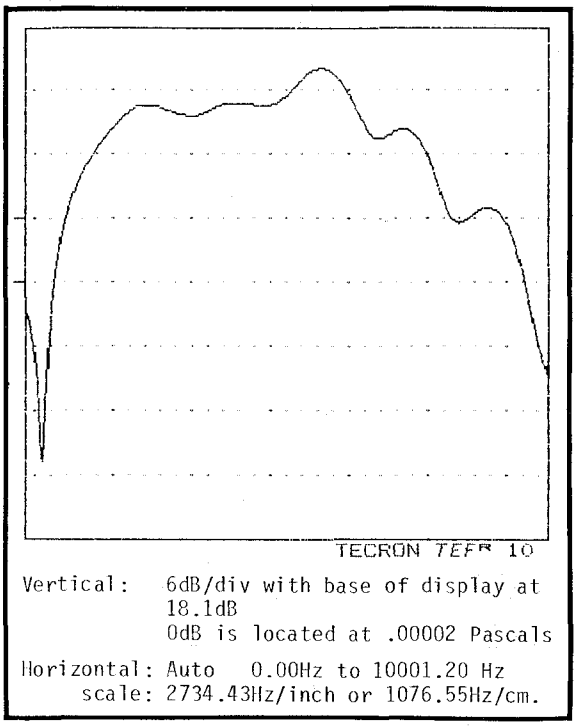


FIGURE 2: Two small loudspeakers brought into alignment using the Sunn Alignment Delay System.

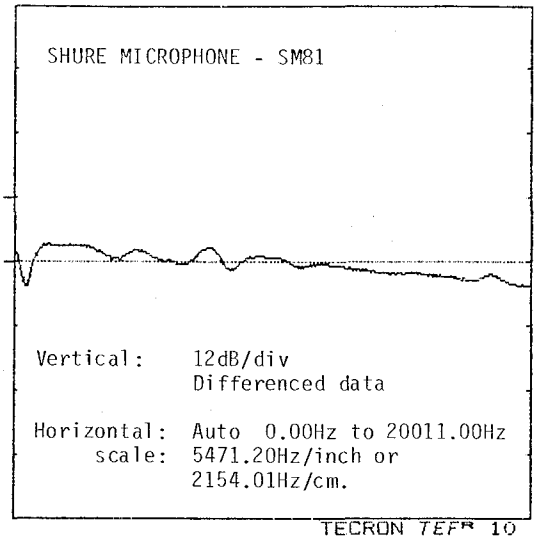
The second figure is the result obtained by delaying the signal from the nearest speaker by 50 usecs (the Sunn Alignment Delay System has 10 usec/step adjustments).

The remaining difference of 1.6 usecs represents a distance of: d = tc = 1130 x 0.0000016 = 0.0018' or 12 x 0.0018 = 0.022" ♦

A PREFERRED DIRECTIONAL MIC - SM81

The curve shown here is the *difference* between our 1/4" B&K measurement microphone and our Shure SM81. We are extremely pleased with the SM81 microphone and believe it is an optimum choice for TEF® analyzer users wanting a directional microphone for measurement work (i.e., locating echo paths, measuring acoustic absorption, etc.).

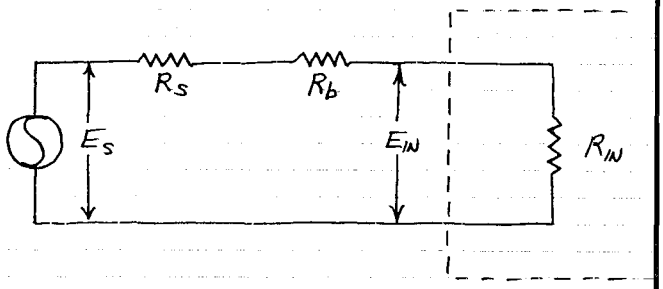
The SM81 was developed for recording. It isn't hard to see why it has been so well accepted. ♦



A CORRECTION ON THE LOFTECH REPORT

In the Spring/Summer 1983 Newsletter, Volume 10, Number 3/4, pages 32-33, we reported on a new audio test set, the Loftech TS-1. We failed, however, to test its maximum output capability *in the way we would normally use it*. Because it is a 49Ω output impedance, it occurred to us that what we really wanted was its maximum output power expressed as an available input power figure when the necessary build out resistor to make it a true 600Ω output was installed. (See diagram) Under these circumstances, the AIP = 12.48 dBm. Allen Burdick pointed out to us when we were in Dallas last December that this test unit did have a lower output when not seeing at least 2 KΩ (devices such as the TL071 or LM351 have this current limitation).

LOFTECH TS-1 AIP FOR 600Ω MEASUREMENTS



R_S = 49Ω

R_b necessary = 551Ω for testing 600Ω passive devices

Maximum voltage amplitude E_{IN} = 3.53 V

Across R_{IN} = 600 Ω

E_S = 18.5 dB re: 0.775 V (i.e., 6.52 V)

$$AIP = 10 \text{ Log}\left\{\frac{(6.52)^2}{0.001(600)}\right\} - 6.02 \text{ dB} = 12.48 \text{ dBm}$$

Loftech meter read + 12.9 dB across R_{IN}

None of this detracts from the desirability of this excellent unit but merely serves as an example of how difficult it is to remember all the pertinent details when looking at a new device.

Having shown this test set in our last 14 classes, we believe it answers the basic needs of a majority of our graduates. Our suggestions for greatly improving the unit would be as follows:

1. Make the amplitude meter read in millivolts instead of dB (forces a 4 digit read out).

2. Add a switch that allows direct meter reading of impedance (i.e., make the output constant current for that measurement).

With frequency, impedance, and voltage amplitude in a single instrument, true audio levels are easy to calculate and we'd have a very low cost, extremely effective unit available to all of us. ♦

APPLICATION OF AUTOFORMERS

The following was sent to us by Charles Townsend of T-Com Systems in Tallahassee, Florida:

The client desired stereo sound (FM radio, tapes, and phono) in 5 rooms of his new home, which was under construction at the time.

My first thoughts were the standard 70 volt line system which we had used in a previous similar job. The previous system was monophonic (L + R channels mixed) and sounded good since we had used high quality coaxial speakers and 8-watt transformers. The quality of stereo depends greatly on where the listener stands in relation to the speakers, so with the speakers overhead and the rooms used for all sorts of activities and seating arrangements, we recommended mono.

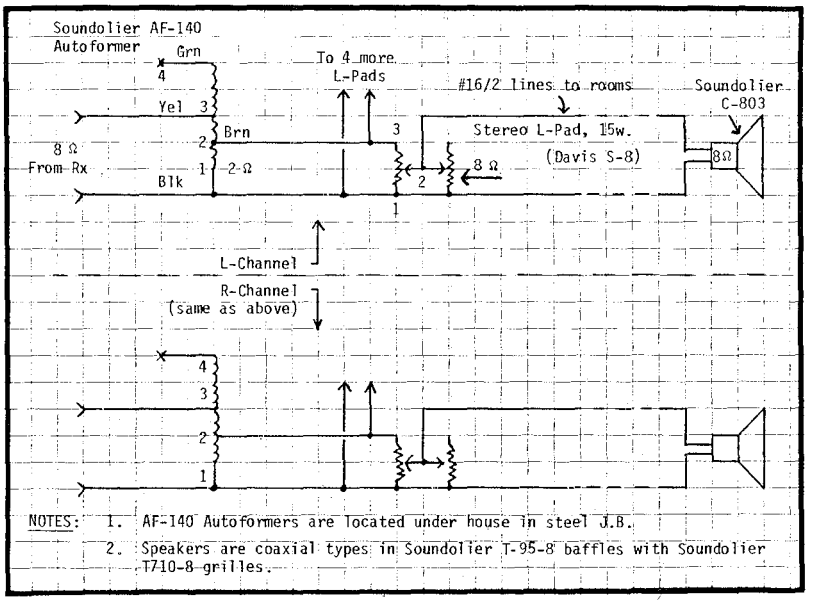
The system lent itself to stereo because the fireplaces in the rooms dictated certain seating arrangements which were unlikely to change. Also, the added spaciousness which one usually perceives with stereo would be an asset in smaller rooms (such as the library). The new house was thus equipped with 3 rooms of stereo plus the patio and front porch (terrace) for a total of 5 stereo speaker pairs.

Since FM radio was to be included, it became logical to buy a complete FM receiver with all the required features (tape in/tape out, phono preamp, tuner, and a power amplifier of 45 watts per channel). To create a 70 volt line output, two transformers (1/channel) rated at 45 watts would be required plus the transformers at each speaker, all undesirable because of the cost, loss of frequency response, and insertion losses.

The solution was to use a Soundolier AF-140 autoformer on each channel in an impedance step-down configuration. Each transformer is rated at 140 watts with an insertion loss of 0.3 dB. The 8 ohm speakers were operated through stereo L-Pads (8 ohm, 15 watt Davis S-8) to keep the line impedance more or less constant and still allow volume control action for each room. The resulting impedance reflected back to the autoformer was

$$\frac{8\ \Omega}{5\ \text{speakers}} = 1.6\ \text{ohms}$$

The autoformers were wired as shown for a 4:1 step-down ratio (confirmed with an impedance bridge), matching the amplifier output, rated 4-8 ohms, down to 2 ohms. This was judged to be sufficiently close to 1.6 ohms (plus wiring resistance) to build a test setup in the shop and try it out. The results were excellent and the load reflected to the amplifier was 6 ohms.



On the actual job, #16 wire was used throughout with the maximum run to the library being approximately 90 feet. All volume controls are on a custom brushed aluminum panel in the equipment closet, which has extra deep shelves to hold the FM/AM digital tuned receiver, turntable, and a dual transport cassette deck (which also dubs copies if desired). The speakers are Soundolier C-803 8" coaxials with 10" deep T-95-8 housings and T710-8 steel grilles. No transformers were needed at the speakers, which cut the cost to the user and labor to the installer.

The owner was very pleased and I would recommend that others try this method of distribution in similar situations. In selecting an amplifier (or receiver), try to get one reputed to be stable on speaker loads having long lines or highly reactive L_C impedances. The model used in the above system was an Onkyo TX-41. ♦

METRIC TIME

Don Creevy sent us the edict shown here. He tells us it is from the *Journal of irreproducible results*. Those of you tempted to laugh have just not read the latest Congressional output. Does the metric system come under "idle worship"? ♦

This is to advise you that Cabinet has decided that, from midnight on January 1st, 1983, the whole Country will be converting to metric time. This is, of course, another step in the Metrication Program.

From that date there will be 10 seconds to the minute, 10 minutes to the hour, 10 hours to the day, and so on, delineated according to the following table:

Old Time	New Time	
	English	French
1 second	1 milliday	1 millijour
1 minute	1 centiday	1 centijour
1 hour	1 deciday (or millimonth)	1 decijour
1 day	1 day	1 jour
1 week	1 decaday	1 decajour
1 month	1 hectoday	1 hectojour
1 year	1 kiloday	1 kilojour

The fortnight will be withdrawn

We are informed by Metric Commission Canada that further details will be forthcoming, but some preliminary guidelines are now available and steps should be instituted immediately, through the appropriate Faculty and Departmental Committees, to develop plans for the changeover.

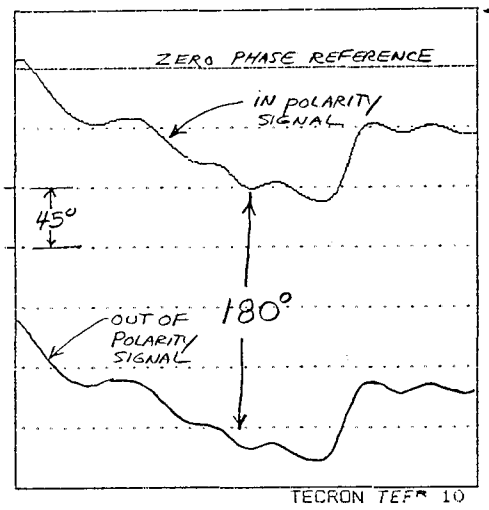
Courses which at present occupy 1 (old) hour, would by direct transposition last 24/10 of a deciday. Since this may well be confusing, they will thus be adusted to become ½ a deciday, or as they will popularly be called, a demideciday. The demideciday represents 1 2 of an old hour. Professors are thus urged to talk more slowly in order to fill the time. The office on Education Instruction will soon announce short courses on how this is to be done effectively.

J.J.R. 1982

PHASE AND POLARITY

One of the fundamental absolutely basic definitions in audio is the difference between "phase" and "polarity." The definition that is the clearest is:

Phase *is* frequency dependent. Polarity *is not* frequency dependent.

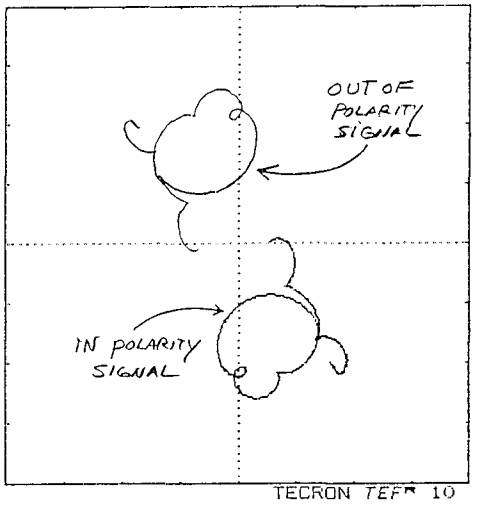


Vertical: 45 degrees/div.
0 degrees is at the dashed horizontal line.

Horizontal: Auto
0.00Hz to 10001.20Hz
scale: 2734.43Hz/inch
or 1076.55Hz/cm.

Resolution:
1.0527E+00 Feet &
1.0735E+03Hz
0dB of automatic screen gain.

Frequency range:
Auto
0.00Hz to 10001.20Hz



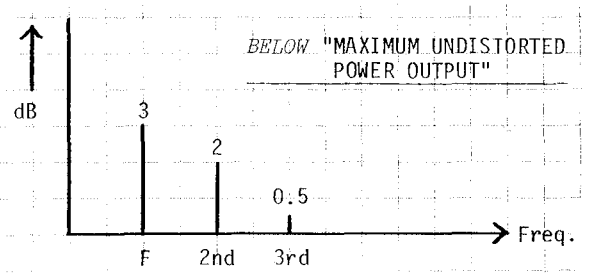
The illustrations are beautiful examples of both cases. The phase vs frequency capability of the TEF® analyzer instantly tells you when you have a polarity reversal and allows you to see the phase at every frequency. ♦

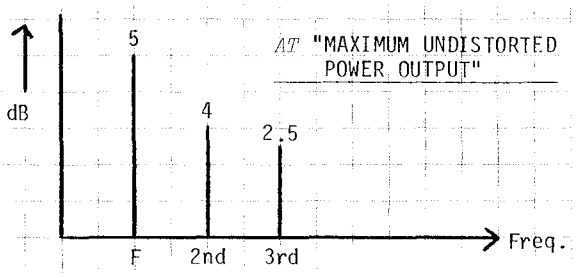
WHAT IS THE MAXIMUM UNDISTORTED POWER OUTPUT?

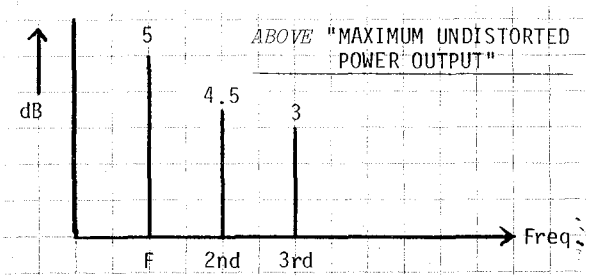
In order to view what has generally been considered to be the "maximum undistorted power output," you require a narrow band wave analyzer capable of allowing you to view the 2nd and 3rd harmonic content at the same time you view the fundamental.

As the overall level is increased, a normal system will have its harmonics rise at the same rate as its fundamental until it reaches its "maximum undistorted power output." At that point, increasing the level will cause the harmonics to rise proportionately more than the fundamental. The highest output without this change in proportionality between harmonics and the fundamental is labeled the "maximum undistorted power output." ♦

Behavior of Harmonics at Maximum Power Output







ABOVE "MAXIMUM UNDISTORTED POWER OUTPUT" HARMONICS *ARE NO LONGER PROPORTIONAL IN AMPLITUDE* TO THE FUNDAMENTAL AS THE POWER LEVEL IS RAISED.

CALCULATING THE "ELECTRICAL POWER REQUIRED" (EPR)

The proliferation of myriad sensitivity ratings (remember, a sensitivity rating *is not* an efficiency rating) can make it difficult to construct general usage equations for use in the even greater proliferation of computer programs for use in audio system design.

The equations shown here allow any reference distance at any power rating to be used and when the Q (directivity factor) is available, the following is available:

1. The EPR for a given device. (The total EPR is the sum of all EPRs of the individual device.)

Acoustic Power From Loudspeaker

$$\text{Acoustic Pwr. in Watts} = 10\ EXP\left\{\frac{L_p - 0.5}{10}\right\}\left\{\frac{4\pi\ (D_X)^2}{Q\ 10^{13*}}\right\}$$

*Use 10^{12} for S.I. D_X's

A General Case Electrical Power Required (EPR) Equation For Loudspeakers

$$EPR = 10\ EXP\left\{\frac{(L_p + 10dB) + (\Delta D_2 - \Delta REF.\ D) - (L_{SENSI}\ \text{at REF. D})}{10}\right\}\left\{\text{REF. PWR.}\right\}$$

Where: EPR is the electrical input power to the loudspeaker necessary to produce the desired L_p at the listener position (watts)

L_p is the sound pressure level desired at the D_2 distance from the loudspeaker (dB)

$\Delta REF.\ D$ is the reference distance for L_{SENSI} converted into dB

L_{SENSI} is the loudspeaker sensitivity rating for an electrical input of "REF. PWR." at "REF. D"

("REF. PWR." in watts) ("REF. D" in ft or m)

ΔD_2 is the distance from the loudspeaker to the listener (ft or m) converted into dB

$$L_{SENSI}\ \text{at REF. D} = (L_p + 10dB) + (\Delta D_2 - \Delta REF.\ D) - \left\{10\ Log\left\{\frac{EPR}{REF.PWR.}\right\}\right\}$$

$$L_{p(MAX.)} = 10\ Log\left\{\frac{(\text{Watts Avail})}{10(\text{Ref. Pwr.})}\right\} - (\Delta D_2 - \Delta REF.\ D) + (L_{SENSI}\ \text{at REF. D})$$

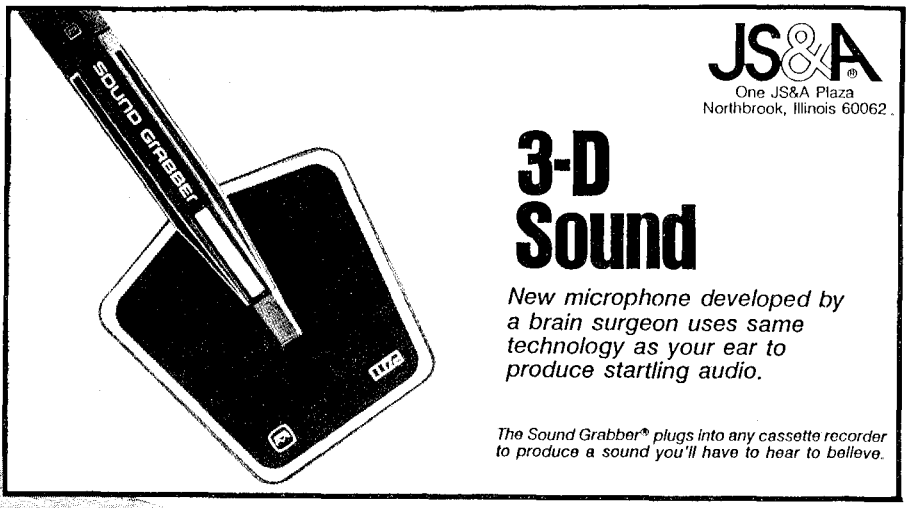
Loudspeaker Efficiency (%Effic.)

$$\%EFFIC. = 10\ EXP\left[\frac{\left\{\begin{matrix}L_{SENSI}\ \text{at}\\ \text{Ref. D and}\\ \text{Ref. Pwr.}\end{matrix}\right\} - \left\{10\ Log\ Q\right\} + \left\{20\ Log\left\{\frac{\text{Ref. D}}{0.928*\text{ft.}}\right\}\right\} - \left\{10\ Log\left\{\frac{\text{Ref. Pwr.}}{10^{-12}\ w}\right\}\right\}}{10}\right] \times 100$$

*Use 0.283 m for S.I.

2. The required sensitivity to achieve a given L_p from a given EPR and Q.
3. The maximum L_p possible from the given EPR, sensi, Q, etc.
4. The loudspeaker's *real efficiency* rating.
5. The acoustic power output of the loudspeaker. ♦

"B-S" AWARD



A totally unexpected "B-S" title was bestowed on Ed Long, Ron Wickersham and Ken Wahrenbrock, the trio responsible for the development of the PZM microphone.

A "university" named JS&A in Chicago cited these worthies as "brain surgeons" and, as everyone knows, "if it's in print, it's true." (See JS&A catalog Vol. 1, 1983, page 32 (reproduced in part here).) We're told the trio of "brain surgeons" have their first patient scheduled.

Our congratulations to all concerned who made this award possible. ♦

SMILE

How you can tell when it's going to be a rotten day.

You wake up face down on the pavement
You call Suicide Prevention and they put you on hold
You see a "60 Minutes" news team waiting in your office
Your son tells you he wishes Anita Bryant would mind her own business
You want to put on the clothes you wore home from the party and there aren't any
You turn on the news and they're showing emergency routes out of the city
Your car horn goes off accidentally and remains stuck as you follow a group of Hell's Angels
Your pet rock snaps at you

Author Unknown...But Troubled

******

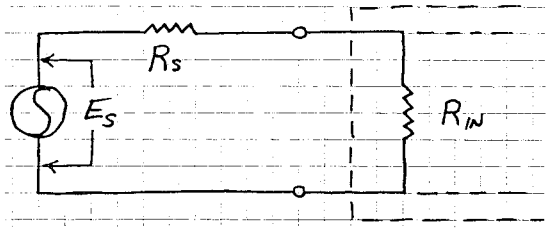
A COLLECTION OF USEFUL EQUATIONS

The following collection of equations dealing with the nomenclature associated with available input power (AIP), power across a load, gain, loss, and audio levels is well worth some study time by even the most experienced engineer.

CALCULATING AVAILABLE INPUT POWER (AIP) LEVEL IN dBm

This set of equations develops the AIP concept and illustrates in a step-by-step format where the "extra" -6.02 dB comes from.

CALCULATING AVAILABLE INPUT POWER (AIP) LEVEL IN dBm



AIP is defined as the *maximum* available power (i.e., the *matched* impedance case).

$P = I^2R$ Where: P is the power developed across R_{IN} (i.e., the R in I^2R is R_{IN})

$I = \frac{E}{R}$ Where: E is E_S (the source voltage) and the R in E/R is $(R_S + R_{IN})$

$I^2 = \frac{E^2}{R^2} = \frac{(E_S)^2}{(R_S + R_{IN})^2}$ Then: $I^2R = \left\{\frac{(E_S)^2}{(R_S + R_{IN})^2} \cdot \frac{R_{IN}}{1}\right\}$

But because this is the matched impedance case $R_S = R_{IN}$
Therefore, we can write:

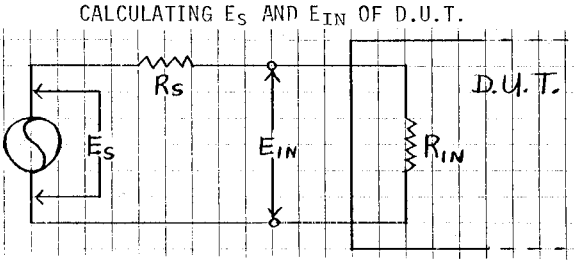
$$AIP = \left\{\frac{(E_S)^2}{(2\,R_S)^2} \cdot \frac{R_S}{1}\right\} = \frac{(E_S)^2\,R_S}{4\,(R_S)^2} = \frac{(E_S)^2}{4\,R_S}$$

$$\text{AIP in dBm} = 10\,\text{Log}\left\{\frac{\frac{(E_S)^2}{4\,R_S}}{0.001\text{w}}\right\} = 10\,\text{Log}\left\{\frac{(E_S)^2}{0.001\,R_S}\right\} - 6.02\ \text{dB}$$

CALCULATING E_S AND E_{IN} OF D.U.T.

Because E_{IN} is normally the most accessable *amplitude* parameter (and includes the result of any build out resistors on the output of the source), it is important to be able to use it to find E_S (the Thevenin source voltage) as well as the reverse (needed when you want to tell a technician what voltage amplitude to set at a given impedance point in order to obtain a desired audio *level*).

CALCULATING E_S AND E_{IN} OF D.U.T.



$$E_{IN} = \left\{\frac{E_S\,R_{IN}}{R_S + R_{IN}}\right\} \qquad E_S = E_{IN}\left\{\frac{R_S + R_{IN}}{R_{IN}}\right\}$$

When $R_S = R_{IN}$, then $E_S = 2\,E_{IN}$
When $R_S << R_{IN}$, then $E_S = E_{IN}$

ESTABLISHING A "SENDING IMPEDANCE" AND CALCULATING THE AVAILABLE INPUT POWER ASSOCIATED WITH IT

This shows the breakdown of the theoretical AIP plus any insertion loss.

ESTABLISHING A "SENDING IMPEDANCE" AND CALCULATING THE AVAILABLE INPUT POWER ASSOCIATED WITH IT

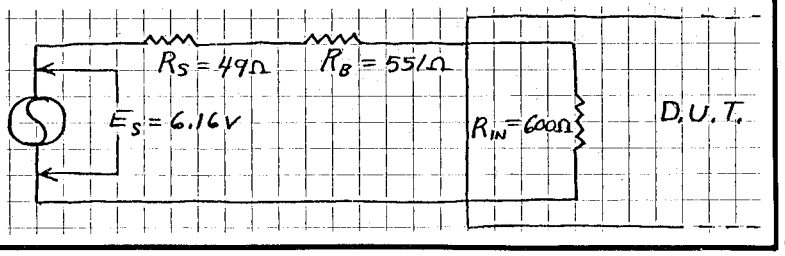
$$AIP = \text{Calculated AIP} + 20\,\text{Log}\left\{\frac{R_S + (R_B + R_S)}{R_S + R_B + R_{IN}}\right\}$$

Example

$$\text{Calculated AIP} = 10\,\text{Log}\left\{\frac{(E_S)^2}{0.001(R_S + R_B)}\right\} - 6.02\ \text{dB}$$

$$10\,\text{Log}\left\{\frac{(6.61)^2}{0.001(600)}\right\} - 6.02\ \text{dB} = 11.98\ \text{dBm}$$

$$11.98\ \text{dBm} + 20\,\text{Log}\left\{\frac{49 + 600}{49 + 551 + 600}\right\} = 6.65\ \text{dBm}$$



AIP MEASUREMENTS AND CALCULATIONS

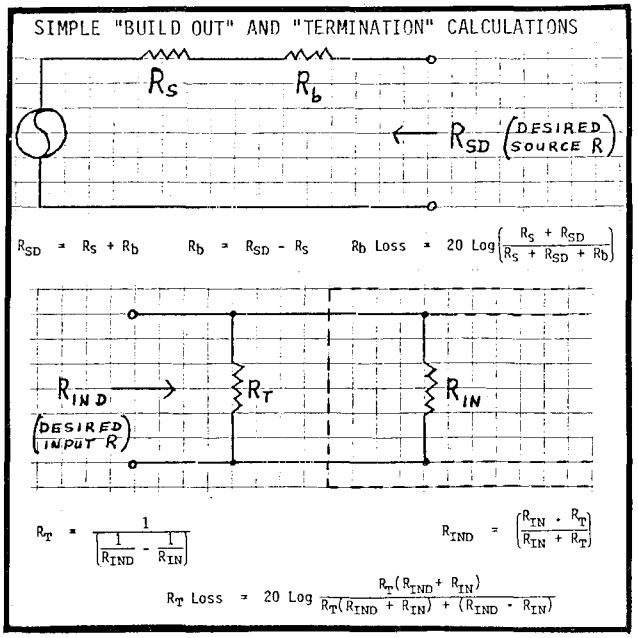
This set of equations shows the everyday practical way to measure correctly the impedance and the amplitude in an actual system in order to make an AIP calculation.

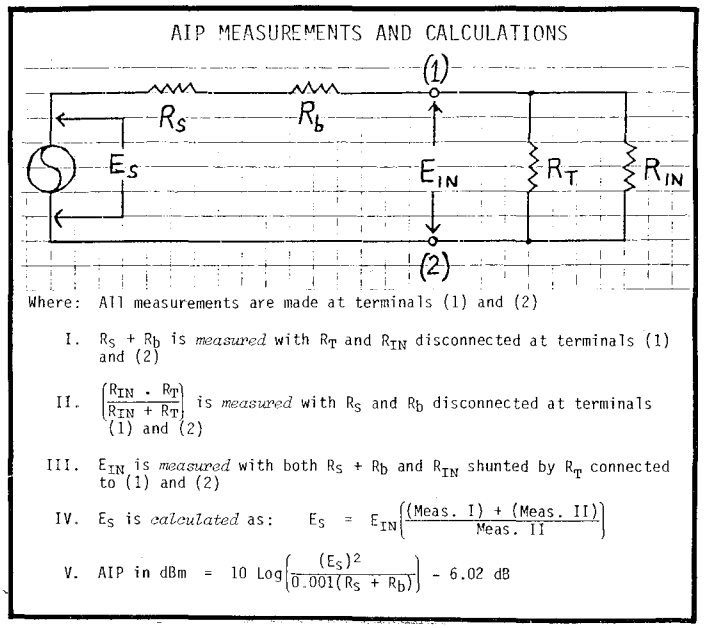
SIMPLE "BUILD OUT" AND "TERMINATION" CALCULATIONS

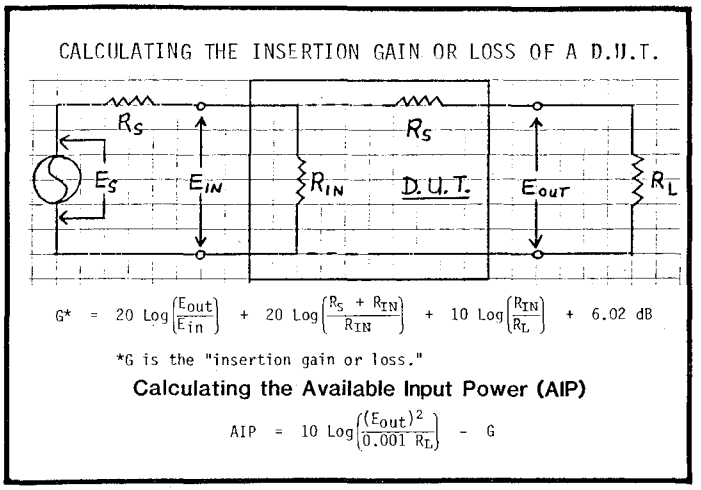
These equations illustrate how to calculate the values and insertion losses of build out and termination resistors.

CALCULATING THE INSERTION GAIN OR LOSS OF A D.U.T.

Finally, the "circuit designer's" approach to these classic terms.







♦

SIGNAL DELAY VS TIME DELAY

Careful readers of the Newsletters have probably already detected a change in our vocabulary that has been long overdue. We bridle at the misuse of the word "level" when "amplitude" is the word that should have been used. We know how those who knew better must have felt every time we used the words "time delay." We apologize to Pete Tappen and Mahlon Burkhard who set us a continuous good example without growing totally dismayed.

What we and others mean when we say "time delay" is, of course, "signal delay." "Time marches on" is more than a trite statement.

We are constantly confronted with processes that *delay* our signals. This causes us problems because *time* cannot be delayed in like manner. If it could, then signal accelerators would be possible.

What interests us in sound systems that involve delay is:

1. The signal delay time through a given component
2. The signal delay time from a loudspeaker to listener
3. The signal delay between two transducers (either microphones or loudspeakers)
4. Any other signal delays in a sound system that exceed that normally expected from a causal universe device. ♦

BOOKS OF INTEREST

The Construction And Principal Uses Of Mathematical Instruments

How often have you played the game of "If I were on an isolated island, what ten books would I choose to take with me?". We recently purchased a candidate for number one of the ten, a special reprint of M. Bions' (1650-1733) *The Construction and Principal Uses of Mathematical Instruments*, translated from the French in 1723 by Edmund Stone (1700-1768). An original edition of this book was for sale ($650.00) at our favorite old bookstore in Williamsburg, Va. and when they showed us the limited edition reprint at less than 1/10th the price, the opportunity was immediately seized upon.

Peter Brophy has written, "This is a book to be read together with the voyages of Dampier and of Anson, with Robinson Crusoe, with the letters of Lord Chesterfield to his son;... It is a book that in our apocalyptic times would be of greater use as a manual of survival than many dealing with present day technology."

Included in a special supplement is a detailed discussion of "a short account of the measure of the earth by various persons" starting with Eratosthenes.

Easily one of the most fascinating parts to us was the reduction of ancient dimensions into English feet by comparing the proportionality between:

1. The ancient stadium = 600 Alexandrian feet
2. 5 Alexandrian feet = 6 Roman feet
3. One Roman foot is in proportion to one English foot as 972 is to 1,000.

The writer then reduces all his data to show that Eratosthenes' one degree equaled 66.25 English miles or 57.53 nautical miles.

The Handbook of Chemistry and Physics states that 1^0 of latitude at the Equator equals 69.70 miles (60.53 nautical miles). In navigational systems, because the measure of 1^0 at the pole equals 69.41 miles (60.27 nautical miles), they have standardized on 1^0 of latitude = 60 nautical miles *exactly*.

The Construction and Principal Uses of Mathematical Instruments is a goldmine of thought provoking discussions especially pleasing and edifying (to twentieth century mentally atrophied minds) on the origin of things we tend to accept blindly.

Powers Of Ten

The second book we'd like to mention is called *Powers of Ten* and is available in the Scientific American Library, Philip and Phylis Morrison collaborated in this volume based upon Charles and Ray Eames' remarkable film of the same name.

Charles (now deceased) and his wife, Ray, were the designers of the American National Exhibition in Sokolniky Park in Moscow during the summer of 1959, where we served as audio consultants for the Commerce Department. Many Americans were housed in the same hotel and rode the bus to and from the park daily. We had the joy of getting acquainted with this very talented couple.

The photographs in this book change size by an order of magnitude equal to the powers of ten from a view toward the earth at one billion light years (10^{25} meters) down through a human size perspective to the inside of an atom (10^{-16} meters).

This book portrays the universe we live in as a remarkable force the human intellect can only "peep and mutter" about. The five physical senses are rapidly disenfranchised. The immensity portrayed adequately rebukes human intellectual posturing and leaves the thinker to ponder the inadequacies of intellect and the possibilities of revelation.

Subtle Is The Lord

An excellent companion book to read with *Powers of Ten* is Abraham Pais' *Subtle is the Lord - The Science and Life of Albert Einstein.*

Einstein remarked, in 1921, upon being told of a newly reported astronomical observation, "Subtle is the Lord, but malicious he is not." Later, when this remark was to be chiseled into stone at Princeton, Einstein further clarified his thought on the matter with, "Nature hides its secret because of its essential loftiness, but not by means of ruse."

Pais is a physicist. He knew Einstein personally when he (Pais) was a young student. He has the understanding necessary to delve into all the misunderstandings that accompany great work. The truly remarkable characteristic that Pais' Einstein exhibits is the ability to turn back from an incorrect theory even when his peers are acclaiming him for it.

Einstein truly observed ideas much like a genius child musician observes his elders play the piano and then one day sits down and astounds them with his playing.

My favorite quotation from Einstein is: "Science without religion is lame, religion without science is blind... A religious person is devout in the sense that he has no doubt of the significance of those superpersonal objects and goals which neither require nor are capable of rational foundation." ♦

A PTOLEMY BLUNDER

In one of the fall classes, someone took exception to a statement I made regarding Ptolemy's incorrect choice for the size of the earth and the subsequent (centuries later) effect on Columbus' thinking. This member of the class wrote his objections to my statements on his suggestion sheet at the end of the class. Just in case there are others who feel I am incorrect and, like this man, were too polite to challenge me directly, here is the source of the statement from Carl B. Boyer's *"A History of Mathematics"* published by Wiley 1968. ♦

Ptolemy's fame today is associated largely with a single book, the *Almagest*, but there are other Ptolemaic works as well. Among the more important was a *Geography*, in eight books, which was as much a bible to geographers of his day as the *Almagest* was to astronomers. The *Geography* of Ptolemy introduced the system of latitudes and longitudes as used today, described methods of cartographic projection, and catalogued some 8000 cities, rivers, and other important features of the earth. Unfortunately, there was at the time no satisfactory means of determining longitudes, hence substantial errors were inevitable. Even more significant was the fact that Ptolemy seems to have made a poor choice when it came to estimating the size of the earth. Instead of accepting the figure 252,000 stadia, given by Eratosthenes, he preferred the value 180,000 stadia proposed by Posidonius, a Stoic teacher of Pompey and Cicero. Hence Ptolemy thought that the known Eurasian world was a larger fraction of the circumference than it really is—more than 180° in longitude, instead of an actual figure of about 130°. This large error suggested to later navigators, including Columbus, that a voyage westward from Europe to India would not be nearly so far as it turned out to be. Had Columbus known how badly Ptolemy had underestimated the size of the earth, he might never have set sail.

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