Electronics World

JULY, 1971
60 CENTS

TELEPHONE ATTACHMENTS—What Is Available?
MEASURING COLOR-TV GENERATED X-RAYS
BE COOL—COOK WITH A MICROWAVE OVEN
LIGHT EMITTERS & DETECTORS—The Optoelectronics Revolution

TRANSISTOR TESTERS

How new Memorex Recording Tape shattered glass and why it will make your favorite music sound better.

To shatter glass with the human voice, a singer must reach and hold the pitch it takes to make a given glass vibrate. That pitch must then be projected with enough volume to vibrate the glass to its shatter point.

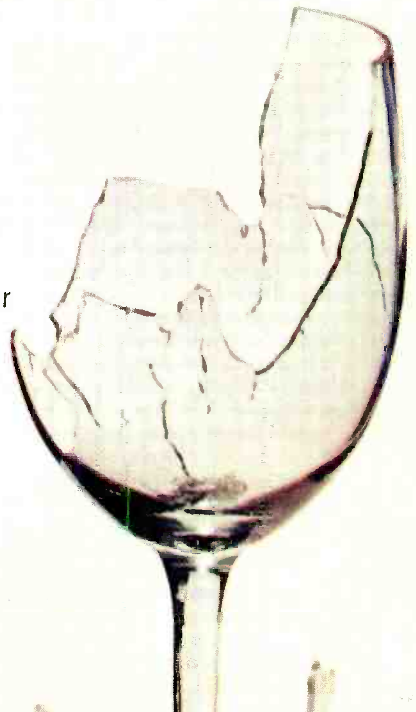
We figured if we could capture that precise pitch on our new Memorex Recording Tape and play it back at the same volume, we'd dramatically demonstrate the exactness with which our tape can reproduce music.

So that's exactly what we did.

Memorex has increased tape sensitivity, increased high-frequency response, and improved signal-to-noise ratio; so much, that now you can record your favorite music, then play it back the same way it sounded live.

You should hear us.

MEMOREX Recording Tape
Reproduction so true it can shatter glass.



Incidentally, our cassette tape also shatters glass.

CIRCLE NO. 130 ON READER SERVICE PAGE

NEW CRIME ALERT®

features greater protection range, many new options for security systems.

New CA1A CRIME ALERT®
Even 22 feet away, this new ultrasonic intrusion alarm can detect a burglar and take appropriate action. Like letting out a high-pitched scream or turning on a lamp floodlight, horn or bell. The built-in audible signal may be switched off and the accessory outlet used to give warning at some remote location without alerting the intruder.

Increased detection sensitivity isn't all that's new about the CA1A. It's got four different operating options that give it greater flexibility and allow it to make use of more accessories for a variety of security systems.

Option REMOTE RESET, lets you activate and deactivate the alarm from a remote location. Lockswitch RS1 is recommended.

Option AUTOMATIC RESET, alarm automatically stops after two minutes of operation. Accessory timer CAT 100 must be used.

Option INSTANT RESET, lets alarm trip only when intruder moves. When movement stops, the alarm stops and is instantly and automatically reset, ready to signal the next movement. Accessories like the weatherproof horn 87600, bell 60006 and rotating red light RRL1 are ideal for use with this option.

Option MANUAL RESET, after the intruder has been detected the alarm remains on until manually turned off and reset.

A variety of remote alarms which plug into any 120 VAC outlet without additional wiring are available for use with the CA1A.

New CA1DC CRIME ALERT®
This model operates on both 120 VAC and 12 to 18 VDC. Automatically switches to batteries if AC power fails. Has remote reset, automatic reset and manual reset described above. Audible alarm may be switched off. Normally open isolated relay contacts may be used for accessories such as DC bell 60007. Three Mallory M915 batteries are recommended for standby power. AC accessories not recommended for use with CA1DC.

Price for either CA1A or CA1DC $99.95.
Accessories at additional cost.

Write for bulletin 9-616 which describes the Mallory full line of security systems.

MALLORY

MALLORY DISTRIBUTOR PRODUCTS COMPANY
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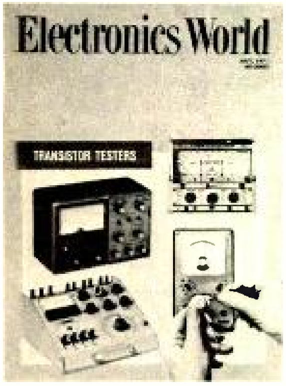
Batteries • Capacitors • Controls • CRIME ALERT® • DURATAPE® • Resistors • Semiconductors • Switches • Timers • Vibrators

Electronics World

JULY 1971 VOL. 86, NO. 1

Contents



THIS MONTH'S COVER shows a grouping of representative transistor testers used for servicing. At the top left is the Eico 685. Below it is the Heath IM-36. At the top right is the Hy-Tronix 900. At the bottom right the RCA WC-506A is being used to check a power transistor. For specs and prices on these and a number of other transistor testers, refer to our article on page 40 of this issue. Cover photo: Dirone-Denner

27 **Attachments to Your Telephone** *Walter H. Buchsbaum*
What are some of the devices that can be easily attached to the phone or to the phone lines? Here are phone-company specs and requirements, along with prices.

30 **Recent Developments in Electronics**

32 **Zener Diode Voltage-Regulator Nomograms** *Chester W. Young*

34 **Designing a Phase-Shift Oscillator** *Jon L. Turino*

36 **Technicians in Britain** *E. A. Bromfield*

37 **Measuring Color-TV Generated X-Rays** *J. G. Ello*
Descriptions of the various types of survey instruments, their comparative characteristics, and methods of checking color-TV receivers for excessive radiation.

40 **Transistor Testers for Servicing** *Forest H. Belt*
Contrary to early promises, transistors don't last forever. In order to check their performance you need a good transistor tester such as ones described. A complete directory of such service-type testers and their specs is included.

43 **Transistor Testers and Curve Tracers—Directory**

44 **Be Cool: Cook with a Microwave Oven** *William Stocklin*

46 **The Optoelectronics Revolution** *Lothar Stern & Irwin Carroll*
Solid-state devices, with their extremely long lives and low power consumption, are starting to take the place of incandescent lamps and glow-discharge display tubes. Used as light sources, light modulators, indicators, detectors, couplers, and sensing arrays, here's what is available now and prospects for the future.

52 **Advertising a Service Business** *John Frye*

61 **Miniature Wide-Range V.L.F. Tuner** *N.H. Brown*

66 **Remote U.H.F.-TV Signal-Seeking System** *Paul LeFevre*

68 **Understanding Complex Waveforms** *Lawrence S. Nickel*

6 **EW Lab Tested**
KLH Model 41 Tape Deck
Sony ST 5100 AM/Stereo-FM Tuner

15 **Reader Service Page**

MONTHLY FEATURES

4 Coming Next Month

13 News Highlights

20 Letters

60 Books

70 New Products & Literature

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Coming Next Month

Special Feature Article

PORTABLE SOUND SYSTEMS FOR PERFORMERS

Putting together such a system is a challenge because performers are usually loud, halls frequently have poor acoustics, and there is plenty of noise and feedback. In this first of a two-part series, Donald L. Patten of Shure Brothers explains how to select, locate, and hook up mikes and mixers to overcome these problems.

Computer Typesetting

Computers and TV-like scanning techniques are helping publishers keep abreast of the information explosion. David L. Heiserman explains how the RCA Videocomp works—photographing lines of type from the screen of a CRT at speeds of up to about 1000 words per second.

Do We Need 4-Channel Stereo?

Frank Krausser of Fisher Radio thinks so. He contends that stereo reproduction through four channels can improve the listening experience considerably, provided certain psychoacoustic factors are taken into consideration.

A Close Look at TV Lead-Ins

Here's some practical help in selecting the best TV lead-in for your particular installation. Low loss at u.h.f.; impedance smoothness for color; shielding against interference; freedom from aging—these are all current requirements and Forest H. Belt explains their importance.

An Improved Vehicular Intrusion Alarm

An interior-mounted "on-off" switch makes this alarm system virtually burglar-proof. Adjustable time-delay circuits sound horn a short time after the car door is opened. Component parts are readily available and inexpensive.

*All these and many more interesting and informative articles will be yours in the **August** issue of ELECTRONICS WORLD . . . . . on sale **July 20th***

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HI-FI PRODUCT REPORT

EW LAB TESTED

by Hirsch-Houck Labs

KLH Model 41 Tape Deck
Sony ST-5100 AM/Stereo-FM Tuner

KLH Model 41 Tape Deck

For copy of manufacturer's brochure, circle No. 1 on Reader Service Page.

ALTHOUGH the *Dolby* "B-type" noise-reduction system is now incorporated in several cassette recorders, we know of only one reel-to-reel tape recorder with a built-in *Dolby* system—the *KLH* Model 41. This is a compact, low-priced tape deck with a minimum of frills (barring the *Dolby* circuits, which we would hardly classify as a "frill"), but clearly designed to provide the optimum combination of quality and low operating cost when fed into a home music system.

The deck is a three-speed, single-motor stereo machine, assembled on a rigid cast plate. Its electronics portions are built on seven printed boards. One is a long master interconnection board, which carries the sockets into which the six smaller boards are plugged. The printed-circuit boards are readily accessible from the rear for servicing or adjustment.

The unit has three heads, but cannot be used as a simultaneous recording/playback machine for monitoring off the tape. It has only a single set of *Dolby* circuits, which are switched from record to playback. The transport operation is controlled by a single knob, which has an ingenious mechanical interlock to prevent accidental tape breakage or spilling when going rapidly from fast-forward or rewind to normal playing speed. Before entering normal speed from a fast speed, it is necessary to wait about 2 seconds for the tape to come to a complete stop. The knob will not move into Play until that time has elapsed. When going from Stop to Play there is also a delay of about 2 seconds, for a different reason. Power is removed from the playback amplifiers in the fast speeds, to eliminate annoying squeals from the speakers. There is a noticeable time required for the amplifiers to reach their operating condition in Play, but this can be avoided by first going into Pause for a moment. This situation does not exist during recording, as the recording amplifiers are turned on whenever the power is applied to the deck.

The deck has individual illuminated vu meters which read both recording and playback levels of the two channels. Each channel has its own recording-level control, for balancing, and a master gain control sets the over-all recording level. Playback level is adjusted by a control under the deck. Also under the deck are the two pairs of line inputs, with different sensitivities, and the outputs for an external stereo power amplifier. A pair of microphone jacks are recessed into the right side of the unit.

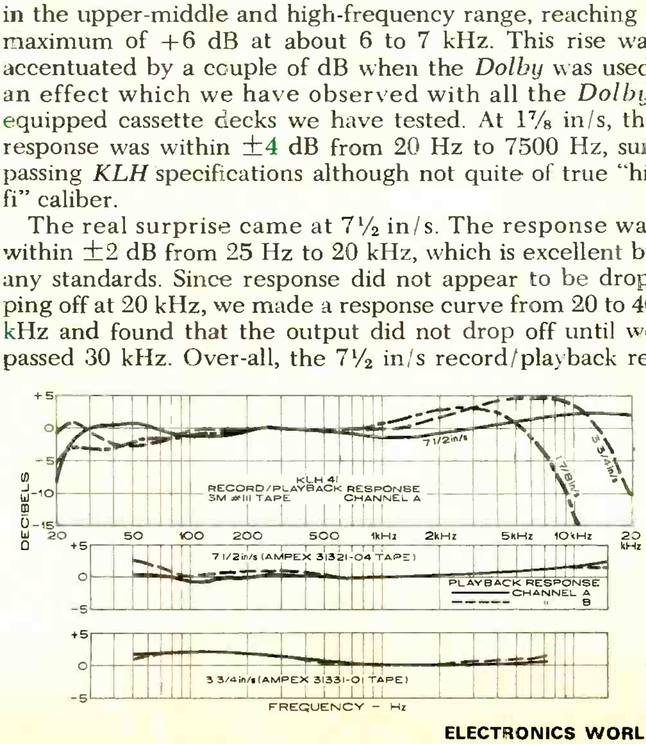
The front-panel control lineup is completed by the two record safety buttons and their signal lights, and three lever switches controlling line power, *Dolby* operation, and playback mode. The latter switch can feed either channel through both outputs for mono playback or provide normal stereo operation. A four-digit index counter and a small lever for speed changing are on the deck near the head covers.

KLH specifications are based on the use of standard tape formulations, such as *3M* #111 or #190, and the machine is normally biased and equalized for these tapes. If one chooses to use the more expensive low-noise tape, such as the *3M* #201 series, bias and equalization must be re-adjusted for the tape used. This can produce a slight extension of high-frequency response and improvement in signal-to-noise ratio, although as our tests showed this is hardly needed.

Laboratory Use Tests

In our laboratory measurements, using *3M* #111 tape, the record/playback frequency response at 3¾ in/s was within ±4 dB from 20 Hz to 16 kHz. There was a broad rise in the upper-middle and high-frequency range, reaching a maximum of +6 dB at about 6 to 7 kHz. This rise was accentuated by a couple of dB when the *Dolby* was used, an effect which we have observed with all the *Dolby*-equipped cassette decks we have tested. At 1⅞ in/s, the response was within ±4 dB from 20 Hz to 7500 Hz, surpassing *KLH* specifications although not quite of true "hi-fi" caliber.

The real surprise came at 7½ in/s. The response was within ±2 dB from 25 Hz to 20 kHz, which is excellent by any standards. Since response did not appear to be dropping off at 20 kHz, we made a response curve from 20 to 40 kHz and found that the output did not drop off until we passed 30 kHz. Over-all, the 7½ in/s record/playback re-



sponse was ±2 dB from 25 Hz to 28 kHz, far exceeding *KLH* specs.

The playback response, with *Ampex* test tapes, was excellent. At 3¾ in/s it was within ±1 dB from 50 Hz to 7500 Hz; while at 7½ in/s it measured ±1.5 dB from 50 Hz to 15 kHz.

The transport operated slightly fast (about 2.5%), which would produce a timing error of 45 seconds in 30 minutes of playing. This should not be a problem in home-recording applications. Wow and flutter were very low; with wow measuring 0.03% and less than 0.01% at 3¾ and 7½ in/s, respectively, and with flutter measuring 0.12% and 0.08%, respectively (about half the specified limits). The fast-speed operation of the deck was within specifications, but rather slow for our taste. It took 182 seconds in fast-forward and 104 seconds in rewind to pass 1200 feet of tape.

To reach a 0-dB recording level, an input of 96 or 310 millivolts (depending on one's choice of input sensitivity) was required at the line inputs, or 0.59 millivolt at the microphone inputs, which have a 1000-ohm impedance. The playback output at 0 dB was 1.85 volts, which could be adjusted downward by the control under the deck. Cross talk between channels was unmeasurable, being below the noise level. The distortion was 1.6% at 0 dB and reached the standard 3% level at about +2.5 dB.

The signal-to-noise ratio was 51 dB without the *Dolby* and 56 dB with it, referred to the 3% distortion level, at either 3¾ or 7½ in/s. These figures are from 7 to 10 dB worse than *KLH* specifications, although they would be considered quite low for any home tape recorder, at least at the lower speed. Like *KLH*, we restricted our measurement bandwidth to the audio range (actually 22 kHz) to exclude ultrasonic noise.

We recorded FM broadcasts, disc records, and interstation FM hiss on the Model 41, using 3¾ in/s. In the case of the records and the hiss, we were able to make an A-B comparison of the playback with the incoming signal. With noise, the high-frequency emphasis could be heard distinctly, together with a slight loss in extreme highs. In the case of music, it was sometimes possible to detect these response characteristics, but only by direct comparison with the original. At 7½ in/s, music emerged unaltered from the recorder, although we heard a slight accentuation of the extreme highs with noise signals.

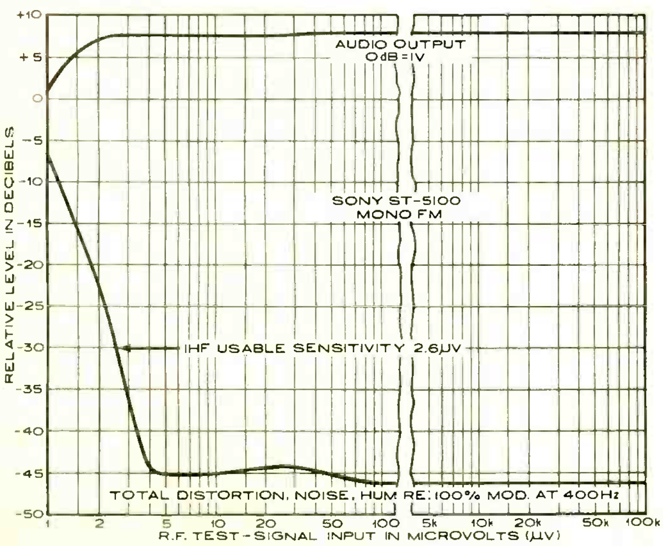
Subjectively, the *Dolby* circuit had a much more impressive effect than the mere 5 to 8 dB measured improvement would indicate. Our test instruments are not frequency sensitive, while the ear is most sensitive to high frequencies which are actually reduced about 10 dB.

In view of the excellent frequency response and low noise of the deck at 3¾ in/s, using relatively inexpensive standard tape, we must conclude that *KLH* has achieved its aim of producing a tape recorder for home use which can do essentially perfect recording of FM broadcasts and disc records at the lowest possible operating cost. Although the best cassette decks can come very close to matching this performance, cassette tapes are relatively expensive and do not offer the convenience of editing that one enjoys with open-reel tapes. Furthermore, a cassette deck which is at all comparable to the Model 41 costs at least as much and, in some cases, considerably more.

The *KLH* Model 41 is supplied complete with a wooden walnut-finished base. It measures 14¼" wide × 11⅜" deep × 5⅜" high and weighs about 19 pounds. The suggested retail price is $249.95, but the tape deck is widely offered at about $200. ▲

Sony ST-5100 AM/Stereo-FM Tuner

For copy of manufacturer's brochure, circle No. 2 on Reader Service Page.



SONY'S Model ST-5100 AM/stereo-FM tuner is a companion to the TA-1144 amplifier, which it closely resembles in styling. Like the TA-1144, it has a silver-colored, satin-finished panel, with a large black central cut-out for the dial and twin tuning meters. The FM dial scale has linear calibrations, and the tuner features both relative signal-strength and zero-center tuning meters. At the lower right of the dial opening the word Stereo lights up in red when stereo-FM broadcasts are being received by the tuner.

Dominating the center of the black dial area is the only knob on the ST-5100—the large, fluted tuning knob. The tuning is smooth and free from backlash. At the left side of the panel is a lever switch controlling the power and on the right side of the panel is a similar switch which selects FM or AM reception. The other controls on the panel are four push-buttons. The two at the right control a.f.c. and stereo/mono operation (stereo switching is automatic when the button is in the stereo position); at the left are the muting and high-blend switch. The latter function, which blends the two channels somewhat at high frequencies to reduce background hiss on weak stereo signals while retaining most of the stereo effect, is found on many tuners. However, on the ST-5100 its operation is automatic when signal strength falls below about 100 microvolts. The listener is unlikely to be consciously aware that the blending has taken place, merely that the ST-5100 sounds quieter than most tuners when receiving weak signals. The muting takes place for signals below 8 microvolts, when the switch is actuated.

In the rear of the tuner are the ferrite-rod antenna for AM, the external antenna terminals, and two pairs of audio outputs. One is at a fixed level of about 1 volt; the other can be adjusted to any level that is desired up to 2.5 volts.

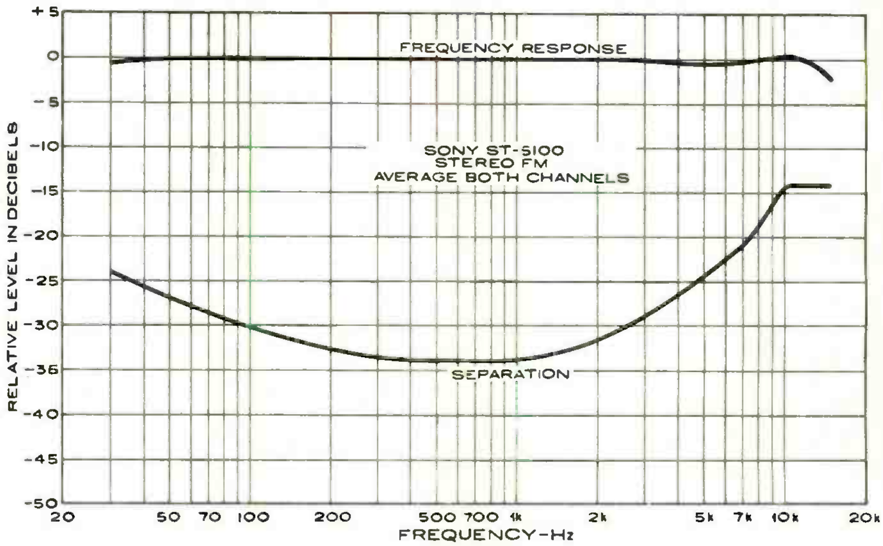
The front-end of the tuner is novel in its use of three tuned circuits ahead of the FET mixer, but there is no active r.f. amplifier. This combines excellent image and spurious-response rejection with exceptional freedom from overload in strong-signal areas. Also unusual for a new tuner design is the absence of IC's. However, the discrete-component i.f. section has seven stages, with six permanently aligned ceramic filters. The last two stages include diode limiters followed by a ratio detector. Interstation noise is sensed at the input to the sixth i.f. stage and its rectified average value controls a FET switch in the audio output of the detector for muting. A separate, similar noise-sensing circuit, one stage earlier, operates the automatic high-blend circuit.

The AM tuner has an r.f. stage, FET mixer, and two i.f. stages with two permanently aligned ceramic filters for selectivity. Although no measurements were made on it, it had good audio quality.

The power supply is electronically regulated and the power transformer is tapped for 100- or 120-volt a.c. line power. Export models (outside the U.S.A. and Canada) have a dual primary transformer for 100- to 240-volt operation. Inside the tuner is a switch to change the FM de-emphasis from the U.S. standard of 75 microseconds to the 50 microseconds used in Europe.

Laboratory & Use Tests

In our lab tests, we measured the FM IHF usable sensitivity of the ST-5100 at 2.6 microvolts, exactly as rated. The limiting action was complete at 5 microvolts and the measured distortion for that and higher input levels was the 0.5% residual level of our signal generator. The outputs of the multiplex circuit are filtered with exceptionally effective low-pass filters to remove virtually all 19-kHz and 38-kHz components, yet with negligible effect on the frequency response up to 15 kHz. We measured the response at ±1 dB from 30 Hz to 13.5 kHz, and it was down only 2.5 dB at 15 kHz. Stereo separation was between 30 dB and 35 dB from 100 Hz to 2.5 kHz and reached a minimum of about 14 dB between 10 kHz and 15 kHz. The AM rejection was 56 dB, exceeding *Sony's* specification of 50 dB. Signal-to-noise ratio was also better than rated—74 decibels *versus* the 70 decibels specified.



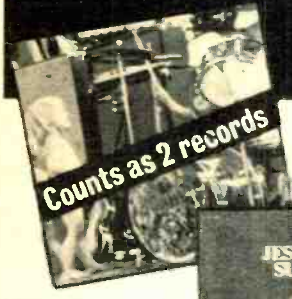
The subjective performance of the tuner leaves little to be desired. It is one of the smoothest handling units we have used, with excellent mechanical "feel." The quiet background and general freedom from hiss on almost all FM signals, weak or strong, is immediately apparent and sets the ST-5100 apart from many other tuners we have operated. The sound is clean and effortless and tuning is non-critical.

Our chief criticism is the dim illumination of the tuning meters. Otherwise, this is a delightful tuner to use, in every respect.

The price of the *Sony* ST-5100 is $219.50, including a matching dark-gray metal cabinet. ▲

FREE...Any 3 Stereo LPs or

WITH NO OBLIGATION



68023 **WOODSTOCK TWO**
(2 record set)
Cotil LP, 8TR, CASS

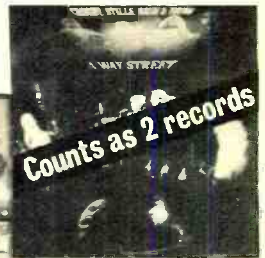
66764 **ELTON JOHN**
Tumbleweed Connection
Uni LP, 8TR, CASS

41213 **JESUS CHRIST SUPERSTAR**
(2 record set)
Decca LP, 8TR, CASS

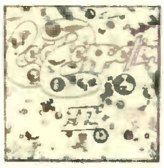
66826 **BOBBY SHERMAN** Portrait of Bobby
Metro LP, 8TR, CASS

33184 **DIONNE WARWICK**
Very Dionne
Scept LP, 8TR, CASS

67517 **THREE DOG NIGHT**
Golden Biscuits
Dunhi LP, 8TR, CASS



68030 **CROSBY STILLS NASH & YOUNG** Four Way Street
(2 record set)
Atlan LP, 8TR, CASS




65797 **GABOR SZABO**
Blowin' Some Old Smoke
Budda LP, 8TR, CASS

21597 **RIMSKY-KORSAKOV** Scheherazade
Yorks LP, 8TR, CASS

42780 **LED ZEPPELIN**
III
Atlan LP, 8TR, CASS

33093 **IAN & SYLVIA**
Greatest Hits
(2 record set)
Vangu LP, 8TR, CASS

33182 **SUSAN SINGS**
SESAME STREET SONGS
Scept LP, 8TR, CASS

39089 **5th DIMENSION**
Greatest Hits
SouCi LP, 8TR, CASS

37833 **ROD McKUEN**
In The Beginning
Sunse LP, 8TR

44765 **SHIRLEY BASSEY** Is Really Something
UniAr LP, 8TR, CASS

41217 **BERT KAEMPFERT** Orange Colored Sky
Decca LP, 8TR, CASS

38368 **VENTURES** 10th Anniversary Album
(2 record set) **Liber** LP

43871 **STATLER BROS**
Bed of Roses
Mercu LP, 8TR, CASS

21551 **BEETHOVEN**
Piano Sonatas
Yorks LP, 8TR, CASS

30618 **DIANA ROSS**
Motow LP, 8TR, CASS

37838 **FLIP WILSON**
Flipped Out
Sunse LP, 8TR

21633 **RED ARMY ENSEMBLE**
Yorks LP, 8TR, CASS

42988 **ROGER WILLIAMS** Love Story
Kapp LP, 8TR, CASS

42986 **ROGER WILLIAMS** Golden Hits
Vol. II
Kapp LP, 8TR, CASS

48800 **B. B. KING** Live At Cook County Jail
ABC LP, 8TR, CASS

38373 **IKE & TINA TURNER**
Workin' Together
Liber LP, 8TR, CASS

75002 **JACKSON 5**
Maybe Tomorrow
Motow LP, 8TR, CASS

42665 **CROSBY STILLS & NASH**
Atlan LP, 8TR, CASS

43870 **MELBA MOORE**
Look What You're Doing
Mercu LP, 8TR, CASS

33099 **PDQ BACH**
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50506 **BUFFY SAINTE-MARIE**
Wanna Be A Ballerina
Vangu LP, 8TR, CASS

32882 **JOAN BAEZ**
Joan Baez 5
Vangu LP, 8TR, CASS

68019 **EMERSON, LAKE & PALMER**
Cotil LP, 8TR, CASS

16595 **VIRGIL FOX**
Bach at the Fillmore
Decca LP, 8TR, CASS

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	Citadel Record Club (as adv. in TV Guide Oct. 3, 1970)	Columbia Stereo Tape Cartridge Service (as adv. in Esquire Nov. 1970)	Capitol Record Club (as adv. in Look Jan. 26, 1971)	Columbia Record Club (as adv. in Playboy Feb. 1971)	RCA Stereo 8 Tape Club (as adv. in Esquire Oct. 1970)	RECORD CLUB OF AMERICA
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MUST YOU BUY A "MINIMUM" NUMBER OF RECORDS OR TAPES? HOW MANY?	12	12	12	10	6	**NONE!** No obligations! No yearly quota! Take as many, as few, or nothing at all if you so decide!
HOW MUCH MUST YOU SPEND TO FULFILL YOUR LEGAL OBLIGATION?	$59.76 to $71.75	$83.76 to $95.40	$59.76 to $71.76	$49.80 to $59.80	$41.70 to $47.70	**ZERO DOLLARS** You don't have to spend a penny—because you're not "legally obligated" to buy even a single record or tape!
CAN YOU BUY ANY RECORD OR TAPE YOU WANT AT A DISCOUNT?	NO	NO	NO	NO	NO	**ALWAYS!** Your discount up to 79% OFF. Guaranteed never less than a third! No exceptions!
DO YOU EVER RECEIVE UNORDERED RECORDS OR TAPES?	YES	YES	YES	YES	YES	**NEVER!** There are no cards which you must return. Only the records and tapes you want are sent—and only when you ask us to send them.
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Savings of 63% or more from recent Club sales up to $4.42 per LP. Start these giant savings now... not after you fulfill your obligation like the other clubs.

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2001—A Space Odyssey	MGM	6.98	2.56
Mary Travers—Mary	WarBr	4.98	1.96
Creedence Clearwater Revival—Pendulum	Fanta	4.98	1.96
Miles Davis—Bitches Brew	Colum	5.98	2.25
Love Story—Soundtrack	Param	5.98	2.25
Perry Como—It's Impossible	RCA	5.98	2.25
Bloodrock—3	Capit	5.98	2.25
Santana—Abraxas	Colum	5.98	2.25
Worst of Jefferson Airplane	RCA	5.98	2.25

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That makes Sylvania tubes easier to sell.

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The way we see it, if we lay it on the line with you, you can lay it on the line with your customers.

Instead of just handing them a line.

GTE SYLVANIA

	color bright 85® XR	color bright 85® RE	color screen 85
Sylvania rare earth red phosphors	yes	yes	yes
Other manufactured rare earth phosphors	no	no	yes
All sulfide phosphors	no	no	no
X-ray inhibiting glass	yes	no	no
New glass	yes	some	some
Reused glass	no	some	some
Regunned	no	no	some
Screen blemish specs	OEM	OEM	slightly wider than OEM
White field uniformity	OEM	slightly wider than OEM	slightly wider than "RE"
Cut off; purity currents; beam shield leakage	OEM	OEM	slightly wider than OEM

NEWS HIGHLIGHTS

Money for Unemployed Engineers

A $42-million program to help unemployed engineers and scientists find new jobs has been announced by U.S. Labor Secy. Hodgson. Most of the money ($25 million) is to be used to retrain 15,000 in new fields; $5 million is to provide 20,000 with travel money to look for new jobs; $10 million is to reimburse 10,000 for moving expenses; and $2 million is for research. Right now there are between 75,000 and 100,000 unemployed engineers and scientists in the U.S., a good many of whom have been working in the depressed aerospace industry.

Consumer Electronics Sales Are Up

It's difficult for a monthly magazine to keep up to the minute on sales figures, especially when they fluctuate as widely as they do in the area of consumer electronics. However, the last quarterly figures we saw from the Electronic Industries Association show healthy increases in sales of TV's, radios, and phonos for the first quarter of 1971 compared to last year. Here are the figures: color TV's up 18%, black-and-white TV's up 6%, FM home radios up 14.7%, AM home radios down 2.8%, automobile radios up 24.4%, console phonos down 20.9%, and portable and table phonos up a whopping 51.2%.

While we're talking about the EIA, we should give you a couple of more figures they are especially proud of. The Association's electronic service technician workshops for high-school instructors will reach 15,000 young men this year, and the sale of the one-millionth EIA-sponsored textbook on consumer electronics servicing was marked recently at a ceremony in New York.

CB'ers Aid Police in California Earthquake

Everyone was pitching in to do their share to help in the violent earthquake that was centered in the San Fernando Valley some months ago. One group we have heard about are those local, CB'ers affiliated with React, which is a national public-service community program to provide 2-way radio communications in emergencies. A number of CB units were used to relay messages to and from the police and hospitals. Messages also handled dispatching authorities, equipment, and volunteers to areas where they were needed. Evacuation orders were sent out to residents below two dams that were in danger of breaking. The main communications control was at the Foothill Division Police Station, from which messages were continuously relayed from units in the area without telephone service. The Citizens Band can be employed for a worthwhile purpose; although it's sometimes hard to believe this if you've monitored some of the idle and useless chatter that you hear on the band around New York City these days.

The Video Cassette Pot is Bubbling

There is lots of activity in the video-cassette field these days. We recently attended a press conference at which Bob Brockway, president of *CBS Electronic Video Recording Div.*, announced that agreement had been reached with four Japanese manufacturers to make EVR players for sale in the U.S. and Canada. The four are *Hitachi, Matsushita, Mitsubishi,* and *Toshiba*; delivery is expected to begin early next year. The EVR players use special film cartridges which are played back through one or more TV receivers. *Motorola* has been making these players under an exclusive manufacturing license in the U.S. and Canada; the license expires at the end of this year. *Motorola* issued a statement welcoming the Japanese manufacturers to the U.S. market as a step toward popularizing and standardizing the EVR medium. Most of the company's efforts have been in the school, industrial, and institutional markets, while the Japanese companies seem to be more interested in the home market. *Motorola* has been selling its EVR color player for around $800. No prices were given for the Japanese models but it was indicated that these would be simpler and not have some of the "industrial" features found in the *Motorola* players. Our guess is that they will come into the U.S. market at least several hundred dollars cheaper than the *Motorola* units. They will have to be a lot cheaper than this, however, before we find one in every home. Remember, this system is strictly for playback and does not provide for making your own TV home movies.

At about the same time, *Sony* announced that it will begin to market its video cassette system in the U.S.

early next year. *Sony's* system uses a cartridge of video tape that is played back on its player through one or more TV receivers. The company's playback unit will sell for around $800, while a blank 60-minute tape cassette will cost approximately $30. Pre-recorded cassettes will be more expensive, though, depending on the particular program offered. *Sony* is limiting its efforts to the industrial, educational, and institutional markets, saying that the use of the units in the home will be "in the future."

In the meantime, representatives from *Avco* are talking about extensive additions to its library of pre-recorded magnetic tape cartridges for its Cartrivision system. New programs on such subjects as: the art and sport of fishing, science for young viewers, how to enjoy the arts, and world culture, are some of the offerings. Cartrivision representatives certainly seem to be emphasizing the home market, and they keep talking about home movies taken on blank tape with a separate camera, and played back through the television receiver.

Dolby System for Broadcasters

Our readers are probably quite familiar with the use of the *Dolby* noise-reduction system in mastering records and tapes, in home tape recorders, and in separate outboard adapters. *Dolby Laboratories* is now pushing the use of its system to FM broadcasters and in FM tuners and receivers. We recently attended a demonstration of the use of the simple *Dolby*-B system in a simulated FM broadcast. The normally noisy reception one gets from a distant FM station that is transmitting stereo was just about all gone. It was almost as though the station had increased its power output. This means that the stereo-FM broadcaster should have greater effective coverage and be able to transmit signals with a higher dynamic range. For best results the FM receiver should also have *Dolby* circuits built in. But even without these circuits, there is an improvement in reception. On receivers without the matching circuitry, the sound appears to be treble-boosted. By simply rolling off the treble somewhat with the treble control, the received audio is flat and noise is reduced. However, since the system is a dynamic one, best results are obtained with the matching circuitry in the receiver.

The system was later demonstrated at the National Association of Broadcasters in Chicago. The first FM tuners and receivers incorporating the *Dolby*-B system are expected to be on sale later this year.

Audio Tape Cartridge Market Expected to Reach $1 Billion

Sales of equipment and audio tape cartridges mainly for the automobile are expected to break the billion-dollar mark in 1971, according to Red Gentry of *Motorola Automotive Products*. Equipment sales will account for half this amount; cartridge sales for the remainder. Factory and dealer installations on new cars are running at about 5% of domestic new-car sales, with aftermarket sales estimated to be about 7 times the original equipment installations. The home audio tape cartridge market is also beginning to grow steadily, and this may account for one-third of the 1971 sales.

These figures were given at a recent *Motorola* press demonstration of its new Quad-8 tape players for autos. These players accommodate the increasing number of 4-channel, 8-track tape cartridges that are coming into the market. We heard a demonstration of 4-channel stereo in a car where the four separate speakers were installed in the car's four doors. The player had front-back and left-right balance controls. Talk about being surrounded with sound!

Four-Channel Stereo Adapters

There's some more excitement brewing in the 4-channel stereo field these days. *Allied Radio Shack* has announced plans to market 4-channel hi-fi equipment under the "Stereo-4" name. Using the matrix system developed by *Electro-Voice*, *Allied* will manufacture and market receivers, amplifiers, and an adapter which will make it possible for existing equipment to play back 4-channel sound.

Not to be outdone, *Lafayette* is also beginning to promote a 4-channel amplifier along with a tape-cartridge deck. The company is also offering a 4-channel adapter, called the "Dynaquad," under license from *Dynaco, Inc.*

Upcoming NEA Annual Convention

The National Electronic Associations is getting ready to hold its seventh annual convention on July 12-18 at the Portland Sheraton Hotel in Portland, Oregon. Sessions are planned on business management and association matters for the radio-TV service technicians and shop owners who will attend. Fishing trips, a dance party, and golf are also on the agenda. If you hurry, there is still time to register and attend. Write to: National Electronic Associations, 1309 West Market St., Indianapolis, Ind. 46222. ▲

Electronics World

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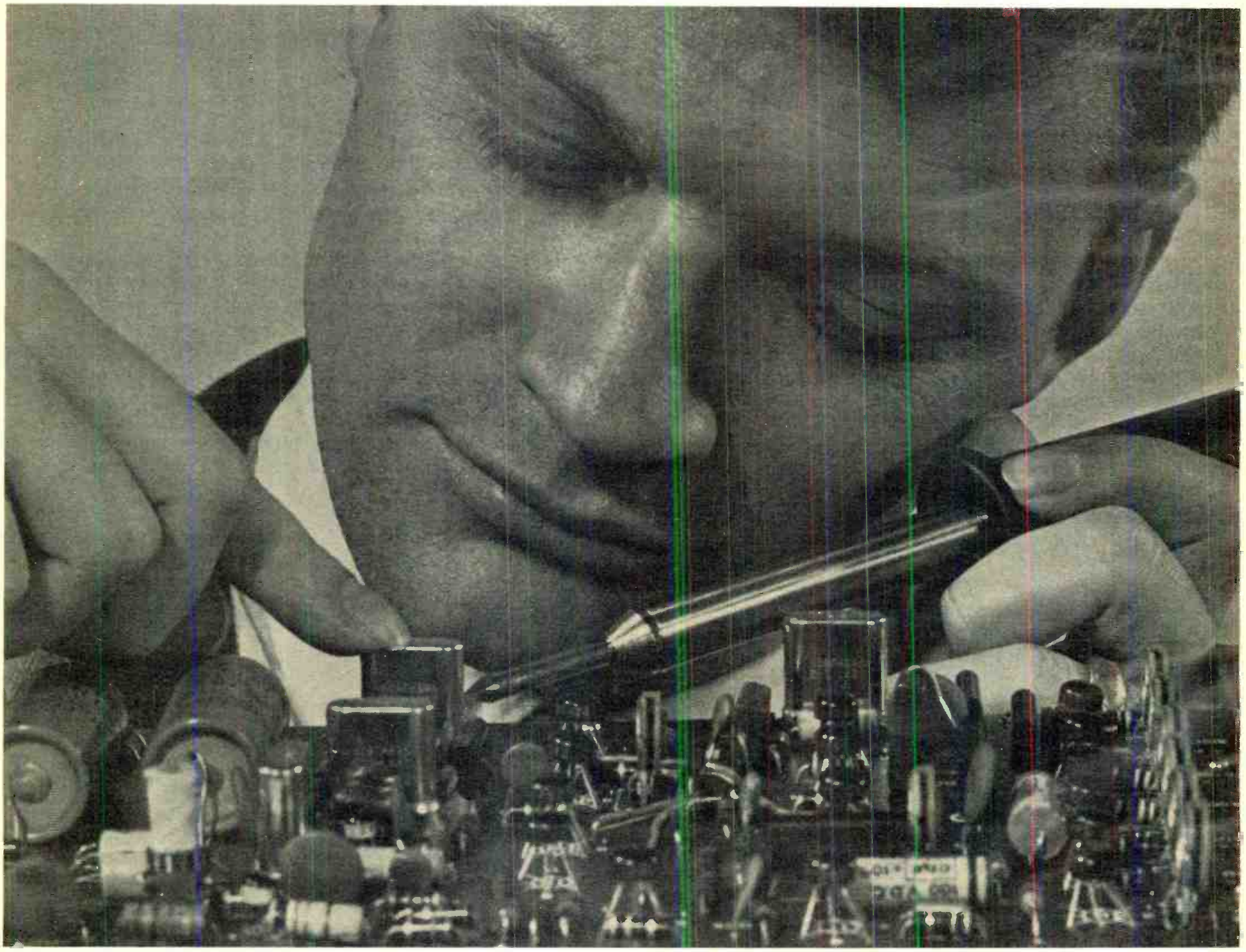

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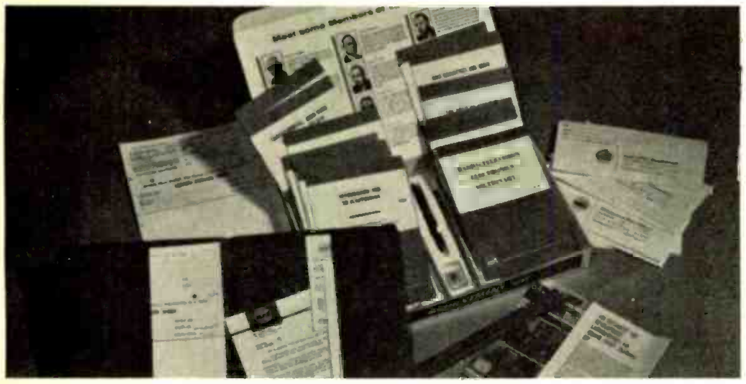

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LETTERS

IC's IN COLOR TV

To the Editor:

The article by Forest H. Belt on "Color TV for 1971" (March, 1971) is in error in the description of the IC audio circuits for the *Heath* chassis. On page 44 the author states: "The *Motorola* and *Heath* chassis use extra audio amplification before the output transistor, too. Most sound-section IC's drive the audio output transistor directly."

The *Heath* circuit also drives the output transistor by the IC directly. The circuit does have an extra transistor used as an emitter follower to drive the hi-fi output. This is between the second and third stages of the IC at the point in the circuit where the signal is brought out of the IC to the volume control.

STANLEY J. BRIGGS
Trenton, Mich.

Reader Briggs is correct as far as the Heath *set is concerned. With regard to* Motorola, *the statement in the article is correct in that two driver transistors are used between the output of the audio IC and the input to the audio output transistors.—Editor*

* * *

PHOTOFLASH NOMOGRAMS

To the Editor:

The nomograms (Fig. 3) in the two articles by Walter W. Schopp ("Electronic Photoflash Meter," June, 1970; and "Rapid-Flash," April, 1971) do not agree with each other.

According to the June, 1970 article nomogram, beam candlepower seconds (BCPS) can be converted to watt-seconds (WS) by using the factor of 35 BCPS = 1 WS. Conversion of the 2000 BCPS used in the example gives 57 WS equivalent. Using the 57 WS figure in the nomogram of the April, 1971 article coincides with approximately 1000 BCPS and not the 2000 of the first nomogram.

Reference to *Kodak* electronic-flash data and specifically pamphlet AC-37 gives a formula for determining a guide number (GN) as $\sqrt{.05} \times$ BCPS $\times$ ASA. Using the information from the June nomogram example of 100 for ASA and 2000 for BCPS produces a GN of 100. Testing this in the April, 1971 nomogram indicates a GN of about 110. Cross-checking these guide numbers against the *Kodak* AC-37 chart for a flash of 2000 BCPS shows an ASA of 100 for GN of 100 and an ASA of 125 for GN of 110.

By dividing the WS scale of the April, 1971 nomogram by two, one would get a GN of about 55 for the 2000 BCPS which corresponds to the above checks. It appears then that this WS scale should be divided by two and left positioned as it is.

KENNETH L. ANDREWS
Riverside, Calif.

Following is a copy of Author Schopp's reply to the above letter.—Editor

Dear Mr. Andrews:

Some of the problems you seem to have stem from the fact that you put too much stock in light-measurement figures that do not mean too much to the amateur photographer. Light is one of the hardest things to measure. According to what book you read, any figure can be proven. Depending on your particular flash tube and supply efficiency, your supply may provide anywhere from 10 to 50 ECPS (effective candlepower-seconds) per watt-second. (Reference to a copy of the *General Electric* "Flash-tube Data Manual" will substantiate this claim.)

As you can see, this conversion is a very flexible thing and will ultimately depend on the trial-and-error method to eventually come up with the correct figures. The nomogram just provides a starting place. The nomogram appearing in the April issue uses an approximation of 20 ECPS = 1 watt-second, which I believe to be a more meaningful figure for the lightly loaded flash-tube, such as the *Kemlite* CX2R2 used in the "Rapid-Flash."

In regard to your reference to the nomogram used in the June, 1970 issue, I believe you confused the ASA number for the GN, as this nomogram does not show any reference to GN. Using the lines as drawn on the nomogram, GN = distance in feet × "f"-stop number. Thus, GN = 10 × 11 = 110, which agrees with the nomogram in the April, 1971 issue and also agrees with the *Kodak* "Master Photo Guide" No. R-21.

The more I study this particular subject, the more I believe that everything written on the subject was designed to confuse the layman. But one thing is certain—it's hard to argue with a good exposure obtained by using the nomogram.

WALTER W. SCHOPP
Livermore, Calif.

* * *

COLOR ORGANS

To the Editor:

In the January, 1971 issue of ELECTRONICS WORLD was an article written by Fred Holder called "Color Organs & Strobe Lights Enhance Music." While the article was informative, the list of color organs available today did not begin to list all of them. Here are some more manufacturers and distributors of color organs for the author's (and your readers') information:

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Chicago, Ill. 60608

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Box 5203
Fullerton, Cal. 92633

KAS Engineering
Box 384
Beltsville, Md. 20705

Lafayette Radio Electronics
111 Jericho Turnpike
Syosset, N.Y. 11791

Lightrays
713 Pine St.
Philadelphia, Pa. 19106

Murphy Kits
204 Roslyn Ave.
Carle Place, N.Y. 11514

Olson Electronics, Inc.
260 S. Forge St.
Akron, Ohio 44308

Restivo Psychedelic Lighting
3547 Urscala St.
Seaford, N.Y. 11783

Rotch, L.
1636 Canton Ave.
Milton, Mass. 02186

Science Workshop
33 Cain Dr.
Plainview, N.Y. 11803

Southwest Technical Products
219 W. Rhapsody
San Antonio, Texas 78216

Technical Writers Group
Box 5994, State College Sta.
Raleigh, N.C. 27607

Teletronics
Box 1266
S. Lake Tahoe, Cal. 95705

ARTHUR L. STANHOPE
Cherry Hill, N. J.

As we indicated in the article, new companies are coming into the field almost daily so that a complete listing is practically impossible to obtain. We tried to pick a representative sampling, however; we thank Reader Stanhope for adding to our list of color organ manufacturers and distributors.—Editor

* * *

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For those of our readers who might be interested in the "Special Sections" we have published in the past, eight of the more recent ones (since 1967) are still available in fairly limited quantities:

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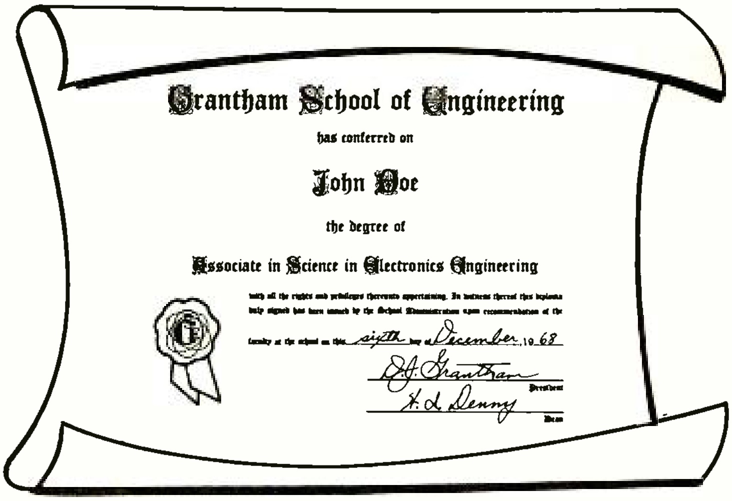

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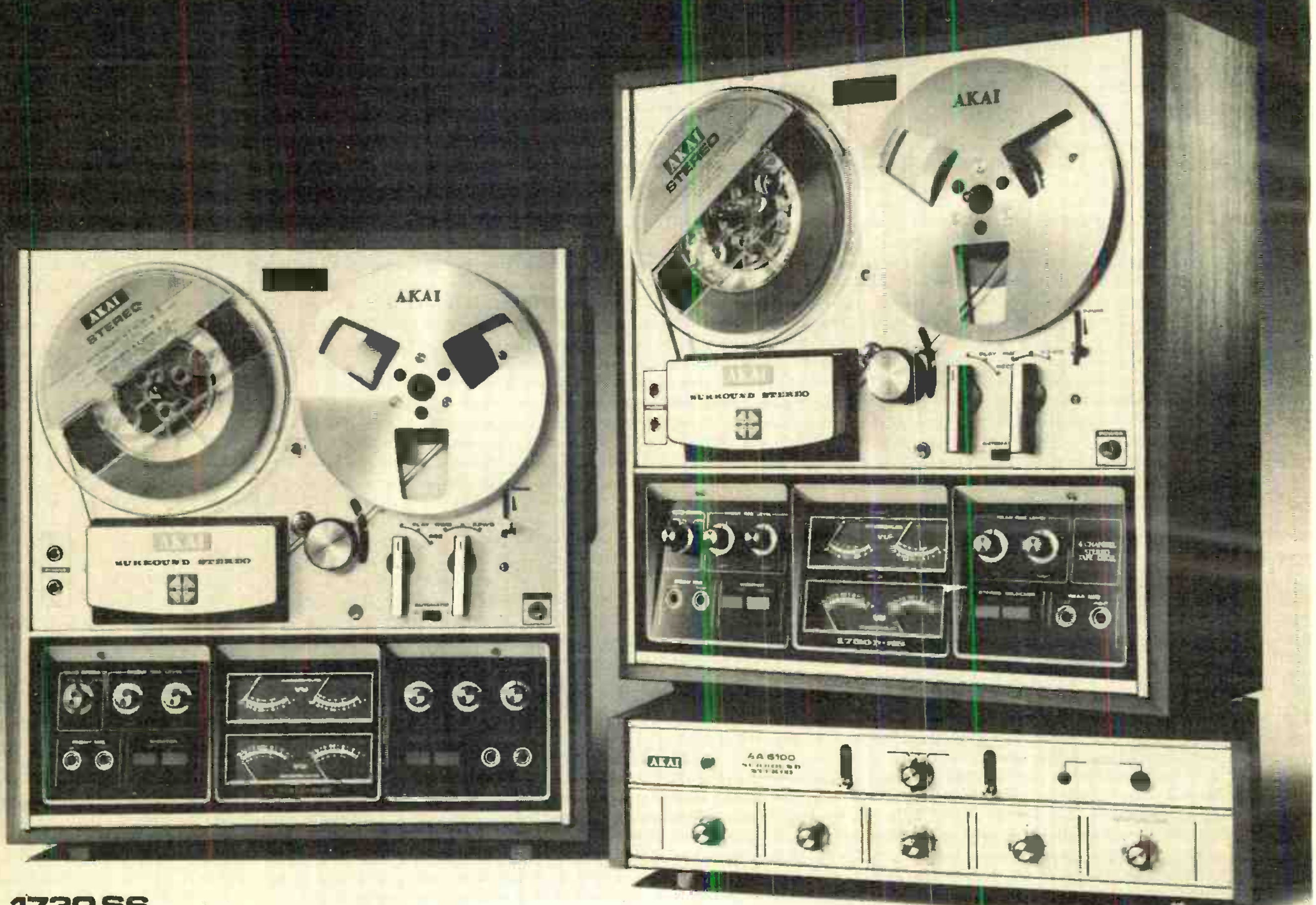

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Attachments to Your Telephone

By WALTER H. BUCHSBAUM

What kind of devices can be easily attached to the phone or the phone lines? What are phone company's specifications, requirements, and some prices?

"HAVE an extension phone without paying monthly charges" . . . suggest the ads by dealers in used and reconditioned phones. And they are right, it is now perfectly legal and permissible to connect an extension phone, or any of a host of other devices, to the regular telephone line. Ever since *Carterfone Company* won the right to connect a radiotelephone to the *AT&T* network, all sorts of devices have become available for attachment to the telephone. Some of these are simple, like a transistor amplifier driving a built-in speaker; others are complex, like a complete facsimile transceiver unit.

Many thought that the *Carterfone* case would open *AT&T's* lines to practically anyone with any sort of gadget. Newspapers wrote fanciful accounts of devices that would let you turn on home appliances by phone as you leave the office, devices that would print newspapers in your home during the night, and perform all sorts of other chores—all directed over telephone lines. Most of these things are technically feasible, but turn out to be so complex and expensive that the average subscriber would be unwilling to pay the price. There are, however, some phone attachments which are both reasonable in cost and sufficiently useful to assure their growing acceptance.

While the *Carterfone* decision makes "foreign" or subscriber-owned phone attachments legal, the phone company still has the right to insist that such attachments not interfere with normal telephone operations, deprive the phone company of its lawful revenue, or create a hazard to its equipment or personnel. It is largely for these reasons that gadgeteers are discouraged from simply connecting their own homemade devices to the phone lines.

What You Can Attach

In theory, any device that receives and transmits information in the band from 300 to 3000 Hz can somehow be connected to the telephone lines. This means human voice as well as digital data, facsimile, and slow-scan TV signals, provided they are modulated on suitable tone signals. Greater bandwidths are available in certain areas, but the average telephone lines going into homes and offices are bandwidth-limited.

The most basic attachment, that almost anyone can install, is an extension phone or bridge. This is simply another telephone set, connected in parallel with the existing phone. With this arrangement both phones will ring and either phone can be used to dial calls. If two people are using the phones, the sound levels will be reduced to approximately half. If more than two phones are connected in parallel, the loading of the line becomes too great and special circuits must be provided. There is nothing illegal or wrong in buying your own phone and connecting it across an existing phone, provided your phone meets the techni-

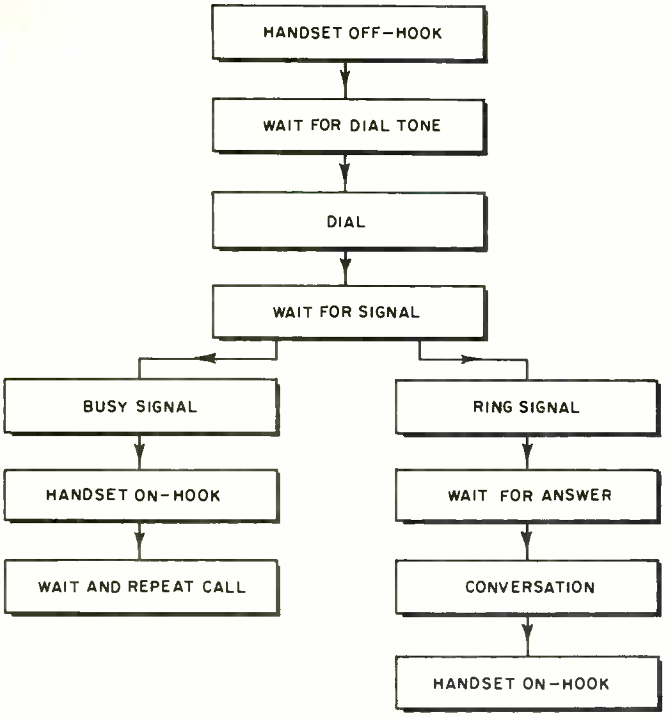


Fig. 1. Flow chart showing steps taken when making a call.

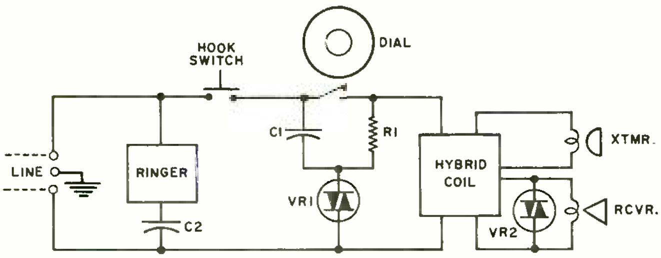


Fig. 2. Simplified circuit diagram of standard telephone set.

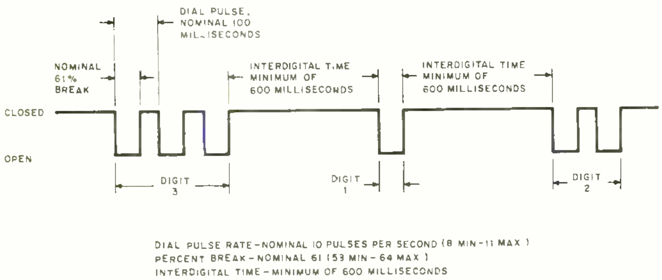


Fig. 3. Typical dial-pulse pattern when dialing "3,1,2."

cal specifications of the telephone company and does not cause interference or degrade telephone service.

Another popular attachment is a loudspeaker and amplifier system, allowing "hands-free" phone conversations and permitting several people to participate in a phone conference. In one version the telephone handset is acoustically coupled to the amplifier system, but in another version it is connected directly into the voice circuits of the handset. In this arrangement the phone can also be used as part of an intercom system. A number of such arrangements are possible, but since they require connections directly into the telephone set, the property of the phone company, you either have to know exactly what you are doing or else you have to rent a "voice coupler" from the local phone company which will install it for you.

Commercial establishments can now purchase their own internal switching equipment, such as manual switchboards, PBX's, or special-purpose equipment, and the phone company will rent suitable interface equipment—a more complex type of coupler. Some of these installations involve whole racks of equipment, power supplies, relays, dialers, ringers, and tone generators, assembled to fit specific customer requirements.

Commercial customers can also rent special couplers to connect their facsimile machines, teletypewriters, and other data terminals to the telephone network. If acoustic couplers are used, the telephone company does not get involved and can only charge regular voice-transmission rates. In many applications, however, acoustic couplers are not desirable and then direct connections, *via* phone-company couplers, are used.

Private subscribers most frequently want to connect an automatic telephone answering machine to the phone and this usually involves rental of a suitable coupler. Automatic alarm systems, which dial the police or fire departments and then transmit a tape-recorded message, are generally connected through a phone-company-furnished coupler. Radiotelephone and private-wire phone systems, which connect to the *AT&T* or other public network, also require couplers and, usually, special installations.

Aside from the legal requirement that the attachment may not disturb the telephone network, there are valid technical and economic reasons for using company-furnished and installed couplers. Initiating or receiving a phone call involves a number of simple human functions, such as waiting, dialing, listening, and recognizing different signals—functions that are not as easily implemented by automatic electronic devices. It is usually cheaper for the individual subscriber to rent the specific coupler he needs than to design, test, and maintain his own device. As we shall see, the monthly rental charges are moderate.

Principles of Telephone Operation

Consider what you do when you call someone. The flow chart of Fig. 1 illustrates the separate actions required and we can see at once that any automatic call-initiating device will have to contain timers, tone detectors, and logic circuits, in addition to the stored message. The device will have to recognize a dial tone, generate the correct dial pulses, recognize a busy signal as well as a ring signal and, depending on which it receives, either go "on-hook" and start the cycle over again or wait until the ring is answered before it can play its message.

When the device is intended only to receive calls, some of the complexity is reduced but, in many cases, other problems are added. Playing messages back on demand over the phone requires the recognition of a special code, rewinding of the tape, and resetting to the "call-receive" mode.

The basic telephone circuit for almost all phones currently in use is shown in Fig. 2. When the handset is on the cradle, the hook switch is open and only the ringer or bell is connected across the line. There is no appreciable amount of d.c. in the circuit and only the 20-Hz a.c. ringing signal from the central office can reach the subscriber. *C*2 provides the a.c. path for the ringing signal.

With the handset off the cradle, or "off-hook," the dialing contact is normally closed and a d.c. connection is made, causing the line relay at the central office to pull in and make the connection. The hybrid coil is part transformer, part balancing and isolating coil, arranged to split the 2-wire line electrically so that most of the incoming sound signal goes to the receiver (earphone) and the outgoing sound from the transmitter (microphone) goes to the line. Most transmitters are simple carbon-pile microphones, but some new ones as well as all receivers are electrodynamic devices. To prevent overloading, a varistor *VR*2 is shunted across the receiver, limiting the average audio output amplitude. Another varistor, *VR*1, limits current pulses due to the dialing contacts. Varistors change their resistance according to the amount of current flowing through them.

The dial contains a cam and sprocket which opens then closes the dial contacts when the dial returns to its stationary position. When you dial "1," you turn the dial a short distance and, as it returns, the contacts are opened once for a period of about 60 milliseconds. The pulse train for dialing the numbers "3,1,2" is shown in Fig. 3 and the different time periods, which the telephone company expects at the central office, are indicated. If the tolerance limits are exceeded, wrong numbers will be reached.

Another network, not shown in Fig. 2 but usually included in the hybrid-coil assembly, is the anti-sidetone network which limits the feedback between receiver and transmitter. A small amount of sidetone is desirable because it gives the phone a "live" sound by allowing the talker to hear himself in the receiver, but too much sidetone causes interference.

Many modern phones contain ringer loudness controls and a number of additional terminals and other variations of the basic circuit. Phones are available with selective call buttons, extension, intercom, and buzzer signaling features. Recently the telephone company has introduced "Touch-Tone" dialing in some areas. These phones have transistorized tone generators connected to a push-button-controlled matrix switch and, instead of the d.c. dial pulses, a series of tone signals is used.

What the Phone Company Can Do for You

A subscriber is not legally required to rent interface equipment for his phone attachment from the telephone company, but for most people it is the most practical and economical way. The phone company will install the coupler, but you have to connect your equipment to it, thus it is important to know something about the coupler. In some instances the coupler may be easy to figure out; in others the coupler may be quite complex, with its own power supply.

The 30-type voice coupler is used to connect voice-only from the phone to the subscriber's attachments, such as an amplifier or intercom. It is essentially an audio transformer and a phone jack. The transformer keeps d.c. out of the line and avoids unbalance of the phone line due to a grounded subscriber system. Included in the coupler is a set of varistors to limit the voice input amplitude. The attached audio amplifier or intercom system will have to have a "press-to-talk" switch, a hybrid coil, or its equivalent, to provide two-way communications over the 2-wire line. When the "exclusion key," a white button on the cradle of the telephone set, is lifted up, the coupler is connected to the phone line and only then can the attachment become active. In New York City the monthly rental for this coupler is 50 cents and the installation charge is around $20. Prices vary slightly in different parts of the country.

A much more complex coupler is offered for those who want to have an automatic alarm system notify the police or fire department of an emergency. This coupler, called type CAU, SU3, or SU6 (depending on the available optional functions), contains a one-way speech amplifier, a local power supply, relays, and a number of control logic elements. For type CAU the subscriber's equipment must maintain the "off-hook" closure for three to five seconds before starting to generate the dial pulses. In the SU6 model and in the SU3, a dial tone is sent to the subscriber's equipment and must be detected there before dialing starts.

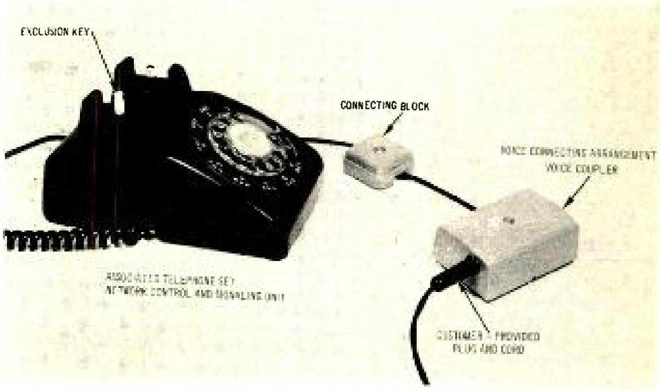
An optional feature, available in type SU3, permits the subscriber to call his home and test the alarm system. He must use a portable 1475-Hz tone generator, send that tone over the phone to his home, and this tone is then detected in the coupler. Passed on to the alarm device, an alarm condition is simulated and the coupler then sends a 2125-Hz tone back to assure the subscriber that his equipment is on the alert.

Installation cost for this coupler is about $11.00 and the monthly rental is $3.25 plus tax in New York City. A somewhat similar coupler, type RDL or RDM, used for automatic phone-answering machines and containing two-way speech amplifiers, rents for $3.50 plus tax, with an installation charge of $20.50.

In addition to these couplers, *AT&T* offers many other models for different phone attachments and subscriber connections. Other networks and local phone companies have similar couplers available. Local business offices will provide details on rental and installation costs.

If you want to design your own system to work with the phone company's coupler, you must know what signals the coupler will furnish and what it will require. Table 1 shows,

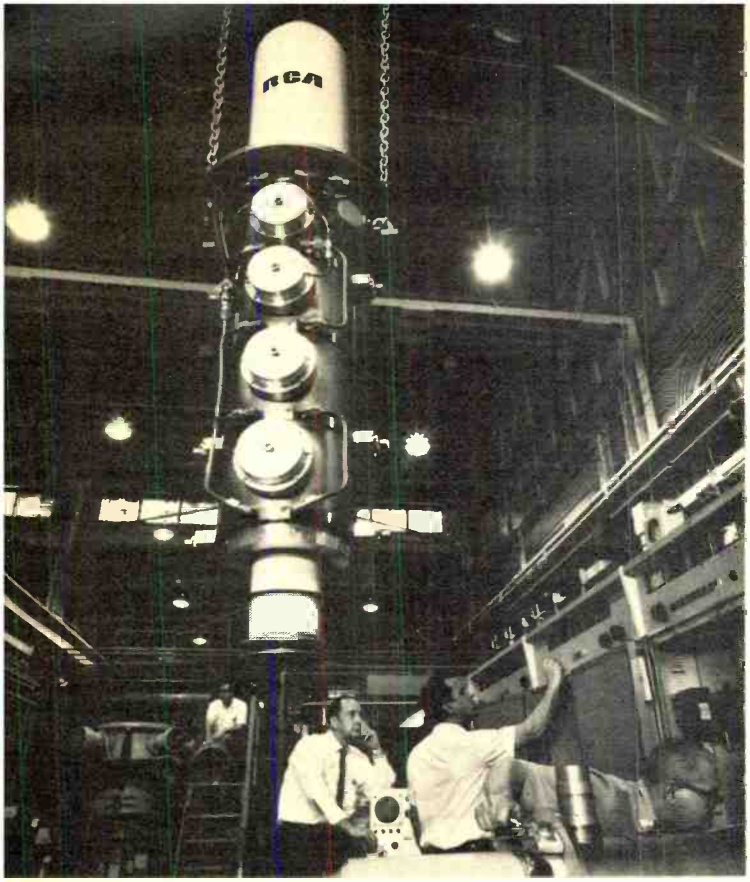
(Continued on page 54)

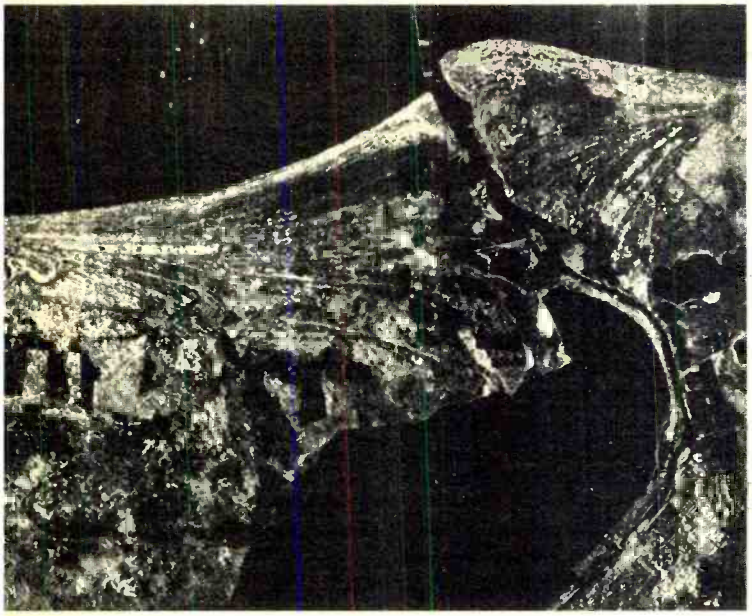


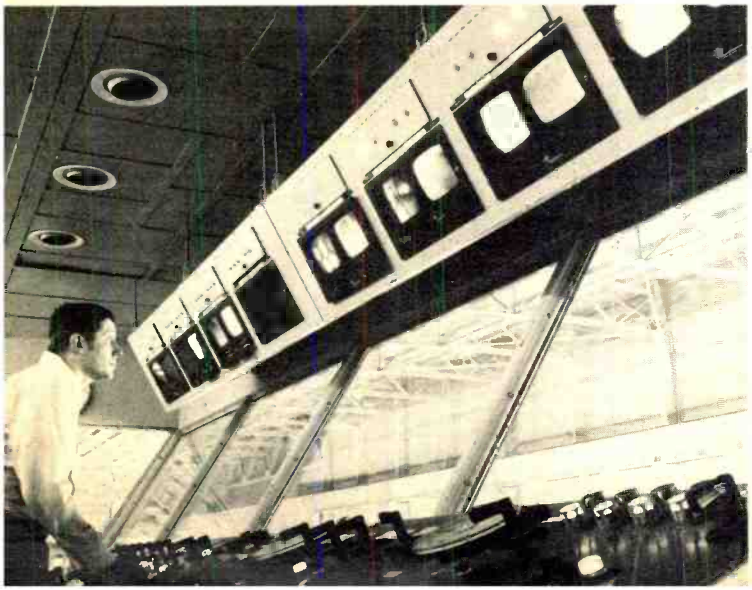
The simple 30-type voice coupler supplied by phone company.

More elaborate voice-connecting arrangements, types CAU, SU3, and SU6, are also available at increased rentals from the phone company.

A good many companies are making automatic phone-answering units which are connected directly to the phone lines, plugged into an extension jack, or coupled acoustically to the set's transmitter and receiver units. Some of these have built-in tape recorders and others require a separate recorder, such as the Tron-Tech unit shown here with an RCA cassette recorder.







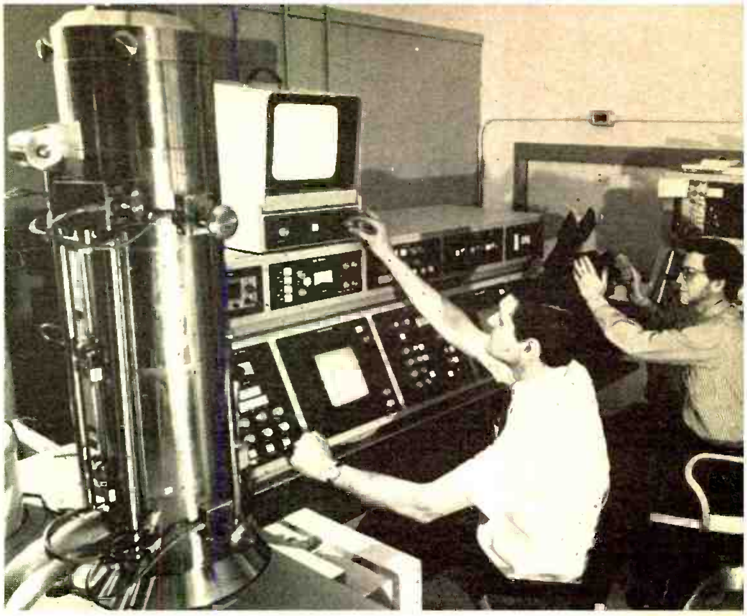
Recent Developments in Electronics

Thirty-Kilowatt U.h.f.-TV Klystron Tube. (Top left) We are always impressed with the giant transmitting tubes that are used by our broadcasters. The one shown in our photo is no exception. It is a 30-kW four-cavity klystron tube that is used for u.h.f. television broadcast transmitters. Engineers are shown adjusting the tube for the exact channel required to minimize adjustments after installation. A family of three of the new klystrons cover the low, middle, and high portions of the u.h.f. TV band. The tubes can be used in either the video or audio power-amplifier stages of the u.h.f. TV transmitter. The tubes are made in the RCA plant in Lancaster, Pa. Price of the new klystrons is $8820 each.

Side-Looking Radar Maps from the Air. (Center) You are looking at an aerial view of the low coastal area around Port Arthur, Texas. This is not an ordinary aerial photograph, however, but it is a picture made by a side-looking radar system. Unlike a photograph, it could have been made in daylight or total darkness, in sunny weather or cloudy. The black areas at the top and bottom are water, while the white specks in the water are ships and offshore oil rigs. The radar system is the same as that used for military intelligence and mapping in Vietnam since 1965. The manufacturer, Goodyear Aerospace Corp., has unveiled the system for possible civilian use in such fields as topographic mapping, geophysics, mineral exploration, oceanography, and agriculture. Transmitting and receiving equipment are carried in a plane that may be flying at extremely high altitudes and at speeds faster than the speed of sound. The radar pulses are sent out to the side. Returning pulses are recorded on data film which subsequently undergoes chemical and optical processing to produce an exact image of the territory surveyed. And because side-looking radar images a wide swath of terrain on a single flight, thousands of square miles are condensed on one strip of film. The high resolution results from the use of the Doppler frequencies of the pulse returns to improve their along-track or azimuth resolution.

Closed-Circuit TV Monitors Steel Plant. (Below left) No less than 15 closed-circuit TV monitors are being used to keep watch on the progress of steel plate in the heat-treating facilities of a new steel plant in Baytown, Texas. The new line, consisting of a hardening furnace, roller quench, and a tempering furnace, has been designed to ultimately produce heat-treated ship steels and pressure-vessel steel plates up to 12½ feet wide and up to 5 inches thick. Natural gas is used to fire the heat-treating system, which is controlled through the television monitors from the hardening furnace to the tempering furnace. Steel plate travels 186 feet through the hardening furnace at temperatures up to 1800 degrees. It is then quenched by water sprays. The quenched plates are then moved into a tempering furnace 244 feet long where they are heated to between 750 and 1350 degrees. After tempering, the plates are allowed to air cool. The new plant is U. S. Steel's Texas Works, which will serve fabricators in the Gulf-Southeast section of the country.

Scanning Electron Microscope Teamed with Computer. (Top right) A scanning electron microscope (at extreme left in photo) has been teamed with an IBM computer in an experimental configuration that provides immediate chemical analysis of the specimen under observation. The microscope can magnify an object more than 50,000 times compared to about 2000 times for the conventional optical instrument. In this setup, the computer selects the electron scanning beam locations and collects and analyzes observed signal characteristics. Since the computer requires digital information, the analog signals from the microscope must first be converted into this particular form before they are used.



Electronic Thermometer for Hospitals. (Center) The nurse is about to take the temperature of her young patient with a new electronic thermometer. The thermometer accurately records temperatures in only 20 seconds and has a sterile disposable cover. There is no washing, sterilizing, breakage, or shake-down required. The probe uses a thermistor for temperature measurement and the meter readout unit is not much larger than a king-size cigarette package. It operates on two long-life 9-volt transistor-radio batteries. Price of the unit, made by LaBarge, Inc. of St. Louis, is $140.

Low-Light TV Watches Shoppers. (Below left) The nation's first police-operated low-light-level TV system designed for round-the-clock detection was placed in operation recently in Mount Vernon's (N.Y.) main shopping area. The system consists of two all-weather TV cameras mounted on utility poles. The pickup tubes used are so light sensitive that they can easily detect a man one-half mile away in what looks like almost total darkness to the eye. A wide-range automatic brightness control protects the tubes when the scene is brightly illuminated. The cameras are connected to two monitors at police headquarters via underground cable. They can be remotely controlled from headquarters to rotate, tilt vertically, or zoom in on any suspicious person or object. Ultimately, the system will include a video tape unit that will record all incidents "seen" by the cameras over a 24-hour period. GTE Sylvania made the installation, which covers 1000 feet of the town's main business street.

Electronic Ignition Switch Foils Drunks. (Below right) When you get into your car a few years from now, a random number may flash on a small display screen. You get three chances to repeat that number. You should have no trouble doing it, provided you are not too drunk to drive. If you are successful, you can then press the Start button and start the car. At least this is the idea behind the latest configuration of Delco's Phystester ignition-interlock system. Scientific evaluation is now underway and 50 of the units have been available to the National Highway Traffic Safety Administration for evaluation in government vehicles. Now all we have to do is make sure the car starts when we press the button on a cold or damp day.

Zener Diode Voltage-Regulator Nomograms

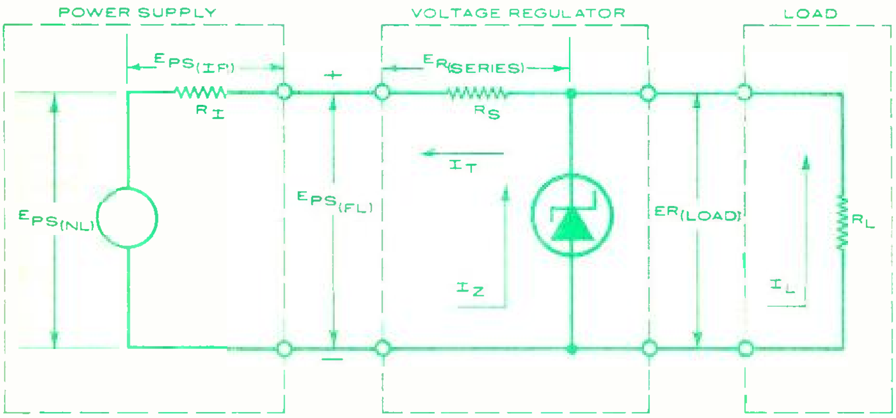


Fig. 1. Basic circuit diagram of the zener-diode regulator.

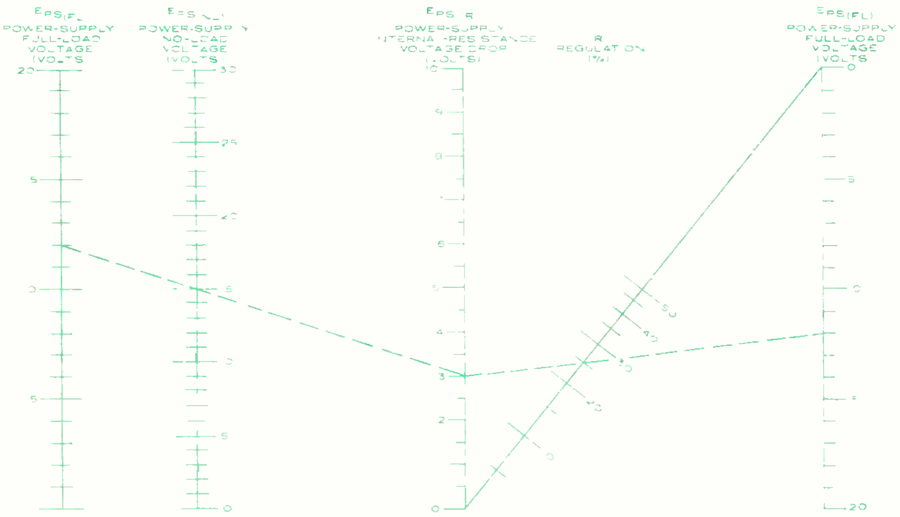
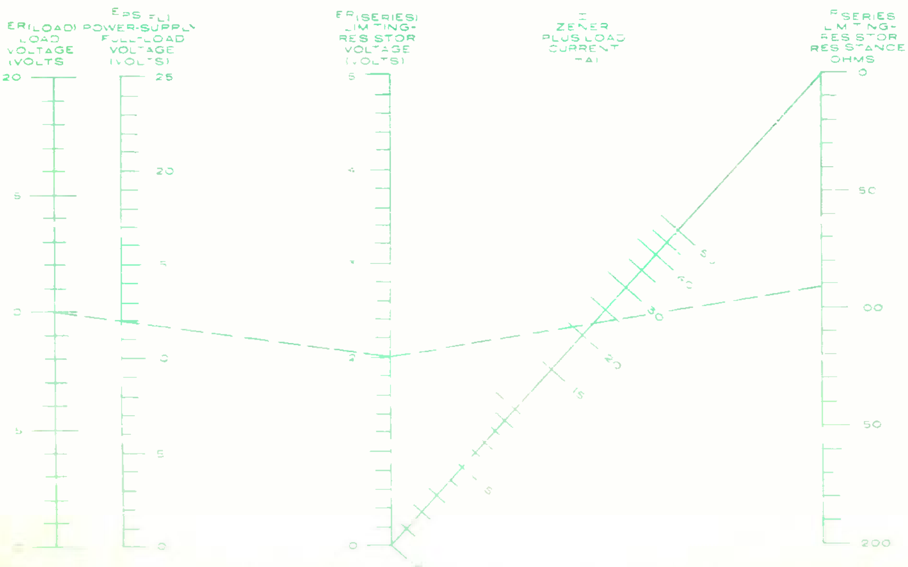


Fig. 2. This voltage-regulator design nomogram is used to determine percentage regulation of zener supply voltage.

Fig. 3. The second voltage-regulator design nomogram is used to determine the parameters of the series limiting resistor.



Editor's Note: Although some of the nomograms shown in the following article are used to solve some fairly simple calculations, they do serve to demonstrate the use of nomograms in design work. In most cases, nomograms serve to speed up tedious, time-consuming calculations simply by the user placing a straightedge over the scales of the chart.

THE silicon zener diode is the workhorse of solid-state voltage regulators and simple circuits like that of Fig. 1 are easy to design. Although the regulating action is similar to that of the VR tube, zeners are quite temperature-sensitive so additional calculations are necessary. Four design nomograms have been developed that will help make regulator design fairly routine.

Any voltage-regulator design begins with the load requirements and determination of the voltage variations to be supplied to the regulator from the basic power supply. The nomogram of Fig. 2 shows how the regulation of the supply can be determined. First the no-load voltage is determined analytically or measured. Then a dummy load can be placed across it equal to the full load and the new voltage measured. Regulation is determined by the internal resistance drop and can be expressed by the equation:

$$R = \frac{E_{PS(NL)} - E_{PS(FL)}}{E_{PS(FL)}} \times 100$$

where: R is percentage regulation, $E_{PS(NL)}$ is output voltage of power supply with no load, $E_{PS(FL)}$ is output voltage of power supply with full load, and:

$$E_{PS(NL)} - E_{PS(FL)} = E_{PS(IR)}$$

where: $E_{PS(IR)}$ is voltage drop across the internal resistance of the power supply. These three voltage are shown in Fig. 1 to the left.

The first three scales on the left of Fig. 2 determine the numerator of the first equation and the "Z" scales on the right use the numerator to calculate the regulation.

For example, if an unregulated supply furnishes 15 volts under no-load condition and 12 volts under full dummy load, we have a 3-volt internal resistance drop. If we draw a line between the 3-volt point to the right to a 12-volt point on the fifth scale, we cross the Regulation scale at 25%.

By CHESTER W. YOUNG

Four design charts that can be used to simplify selection of components for a solid-state voltage-regulator circuit.

The second nomogram (Fig. 3) takes the next step and starts with the power-supply full-load voltage. This is combined with the current requirements of the load and the zener to determine the series limiting resistor value. The three scales to the left determine the voltage drop involved and the "Z" scales on the right determine the required resistance. Two equations are:

$$E_{R(series)} = E_{PS(FL)} - E_{R\,(load)}$$

where: $E_{R(series)}$ is voltage across series-dropping resistor, $E_{PS(FL)}$ is voltage output of the power supply under full load, $E_{R(load)}$ is voltage to be maintained across the load by zener diode and:

$$R_{series} = E_{R(series)}/I$$

where: R_{series} is required resistance of the series-dropping resistor and I is the total current to be drawn under regulating conditions.

For example, if we assume that we have been designing for a load that requires 10 volts at 20 milliamperes, we enter the nomogram on the second scale at 12 volts (our power supply full-load voltage) and connect a line to the first scale at the required 10-volt point. Extending this line to the third scale on our right we determine the voltage drop across the resistor to be 2 volts. The "Z" chart on the right helps determine the resistance value if the load current (20 mA) and the zener current (usually 10% of required load current, 2 mA) are known. In this case the total would be 22 mA drawn through the dropping resistor. A line extending from the 2-volt point (3rd scale) to the far-right scale passing through the 22-mA point of the middle "Z" scale would intersect at 91 ohms. This solves the fraction 2/0.022.

The selection of the series resistor is determined by the resistance value just calculated and the maximum current to be drawn through it. The nomogram in Fig. 4 determines the power (center scale) from either of the formulas: $W = EI$ or $W = I^2R$, where W is power (in watts) dissipated in either resistor or zener diode, E is volts across resistor or zener, and I is current through resistor or zener.

For example, we have just determined the series-resistor value to be 91 ohms so we enter this on the second scale from the left. We also know the total load and zener current is 22 mA. This value is entered on the second scale from the right (I^2) at 22 mA. Joining these two points with the solid line,

(Continued on page 75)

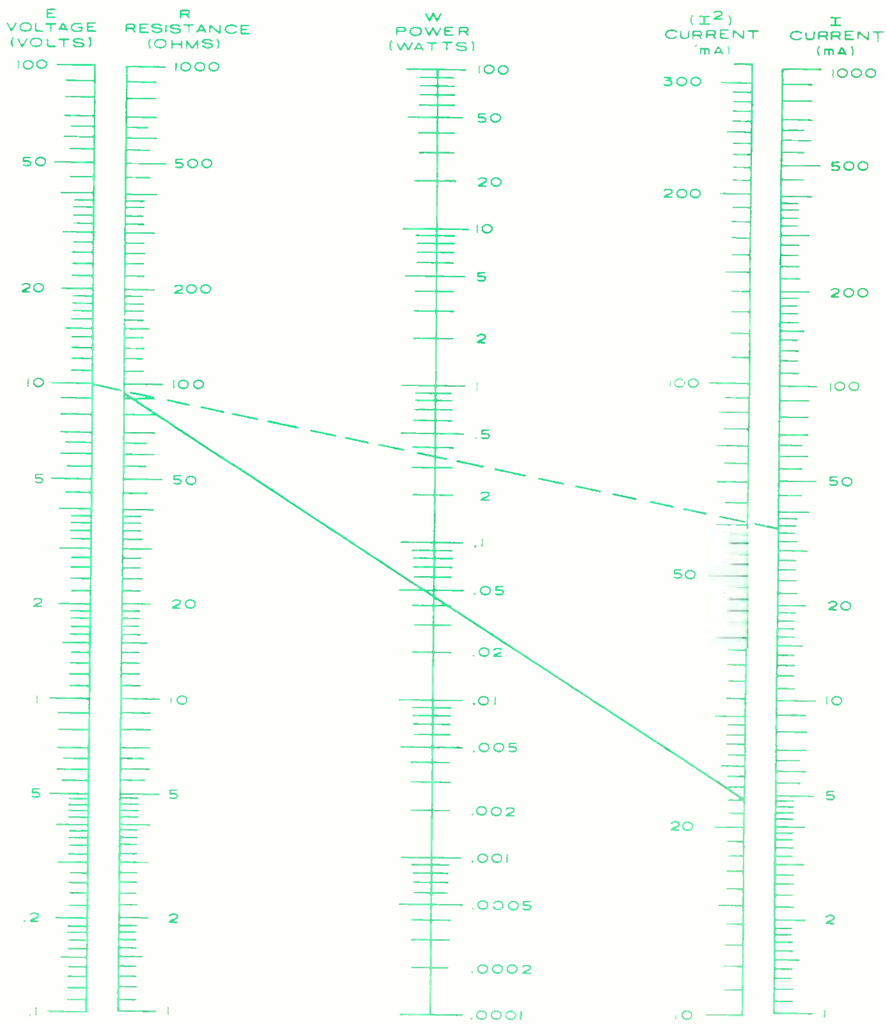
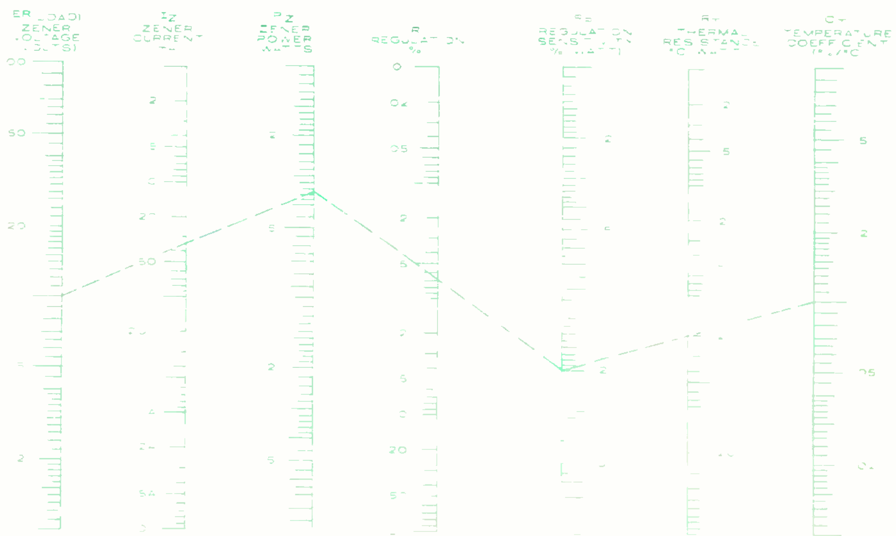


Fig.4. The third design nomogram is employed to find the power requirements of the series resistor and zener diode.

Fig.5. This fourth nomogram is used to relate the various zener-diode parameters in order to provide circuit trade-offs.



Designing a Phase-Shift Oscillator

By JON L. TURINO

Simple, step-by-step design technique that can be used to produce this versatile sine-wave audio oscillator.

THE phase-shift oscillator has been around a long time. It is a versatile circuit which has a number of applications other than its main use as a sine-wave source in the audio-frequency range.

For the experimenter, however, there is usually one drawback to incorporating the phase-shift oscillator in a project—how do you design one that will work and oscillate at the frequency you need?

Circuit designers use a long, mathematically complex procedure when they design a phase-shift oscillator; and then have the circuit built and tested to determine the actual parts values and to evaluate its performance. Many use an additional sophisticated technique unavailable to most of us—computer aided design (CAD).

The phase-shift oscillator design procedure presented here is a simple, straightforward, step-by-step method for obtaining a circuit that will work when power is applied to it. The frequency of oscillation will be within five percent of the calculated value, and the d.c. stability of the circuit is entirely adequate if a low-leakage silicon transistor is used as the active element. The approximate frequency range of this phase-shift oscillator circuit is from 20 Hz to around 50 kHz.

Fig. 1. Schematic of general type phase-shift oscillator circuit.

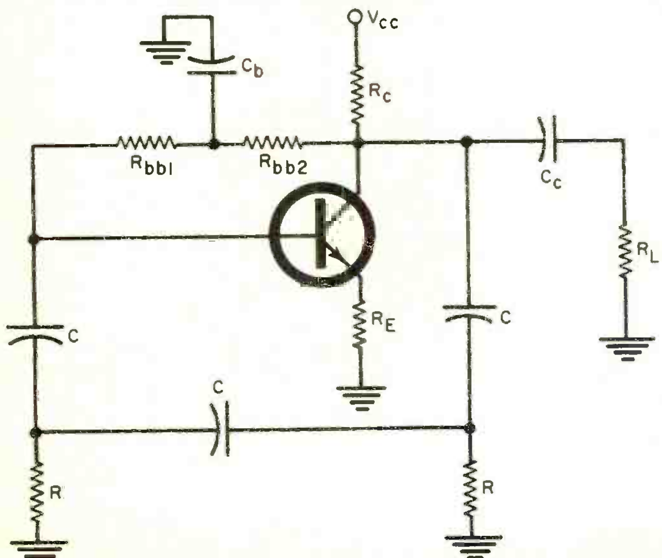


Fig. 1 is the schematic of the general circuit and the design procedure used to determine the parts values is listed in the box. Since the main stumbling block is in the first step, a little time is devoted to determining how to specify R_L if the oscillator is to drive an amplifier or emitter-follower stage, as is usually the case.

Fig. 2 shows two typical transistor stages that might be used to isolate the oscillator from the actual load so that variations in the load will not affect the frequency or output amplitude. The input impedance of the emitter-follower stage (Fig. 2A) is actually the load resistance for the oscillator. Its value can be closely approximated using the formula $R_{in}=(R_B \times \beta R_E)/(R_B+\beta R_E)$ where β (*beta*) is the forward current gain of the transistor, usually called h_{fe}. For the stage in Fig. 2A, this value is 25k ohms.

Determining the input resistance of the amplifier stage in Fig. 2B is slightly more complex. The effects of both R_{B1} and R_{B2} must be taken into account, since they are actually in parallel with the transistor input. The formula for finding R_{in} for the circuit of Fig. 2B is $R_{in}=1/(1/R_{B1}) + (1/R_{B2}) + (1/\beta R_E)$.

Once the load resistance has been determined, the rest is easy. Let's do an actual example. Suppose we need 10 volts r.m.s. at 5000 Hz and the emitter-follower of Fig 2A is used for isolation. Referring to step 1 of the design procedure, specify R_L as 25k ohms and 28 V p-p across it (p-p is 2.8 times r.m.s.). The power supply (V_{cc}) must be 1.4 times 28 V, or about 40 volts. Now set collector resistor R_c to $0.2R_L$ or 5000 ohms.

For the stage to operate properly, the collector current must allow about one-half the supply voltage to be dropped across R_c. Using the formula of step 4, I_c will equal $40/2\times 5000$ or 4 mA. Now another composite parameter is needed. The a.c. signal from this oscillator sees both R_c and R_L in parallel as a resistance, $R_{L\ a.c.}$. From the formula in step 5, $R_{L\ a.c.}$ = 4100 ohms.

In order to sustain oscillation in this circuit, the voltage gain of the circuit must equal the loss through the phase-shift network. This loss can be mathematically reduced to a constant—37. Adding an eight percent "fudge factor" to this gives us the number 40. The voltage gain in the circuit of Fig. 1 is approximately equal to the ratio of the a.c. collector resistance ($R_{L\ a.c.}$) to the emitter resistor, R_E, so this relationship can be used to calculate the value of R_E. In our example, 100 ohms is the closest standard-value resistor that will work properly.

Now a suitable transistor must be selected. First, it must be of a low-leakage silicon type. Second, it must have a *beta* (h_{fe}) of at least 50 at the frequency at which we want the circuit to oscillate. Third, it must have a power dissipation of at least 40 V × 0.004 amp or 160 mW. One other important parameter is the collector-to-emitter breakdown voltage. It must be at least equal to the supply voltage, and preferably 50% higher. For our application, the 2N930 will work. Its *beta* is typically 100 all the way to 10 MHz, its power dissipation 300 mW, and its breakdown voltage a minimum of 50 V.

Using $\beta = 100$, calculate the base current, I_B, at 0.04 mA. The formula in step 9 derives an $R_{bb\ (total)}$ of 490k ohms. The nearest standard value of R_{bb1} and R_{bb2} (from steps 10 and 11) are 100k ohms and 390k ohms, respectively. Now bypass the a.c. signal that would be fed from the collector to the base using this bias method so that it does not reduce the gain of the circuit. C_b is the bypass capacitor and its reactance should be less than or equal to 1000 ohms ($R_{bb1}/100$, step 12) at 5000 Hz. A 0.033-μF capacitor does the job effectively.

Now the R_{in} for the oscillator stage must be determined. This value is found using the same formula used for the emitter-follower input resistance, with R_{bb1} substituted for R_B (step 13): $R_{in} = (100k \times 100 \times 100)/(100k + 100 \times 100)$ or 10k ohms. The value for the two "R" resistors in the circuit are now known.

In order for the circuit to oscillate, the signal applied to the base must be 180° out-of-phase with the collector signal. Since we have three legs in our phase-shift network, each should provide 60° of phase shift. This occurs when the capacitive reactance (X_C) of the capacitors is 1.732 times the resistance of the "R" resistors. Therefore, X_C must be 17.32k ohms at 5000 Hz. Using the formula $C = 1/2\pi f X_C$, the value 0.0018 μF is derived and the design is complete. Fig. 3 shows the complete circuit, with parts values assigned. When breadboarded, it provided 30 volts p-p output at 4900 Hz, very close to what was specified.

The frequency of oscillation can be trimmed to an exact figure by adjusting the value of either "R" resistor. The phase-shift oscillator provides a signal suitable for use as a code-practice oscillator, a fixed-frequency audio-signal generator for testing amplifiers and other audio equipment, and, with minor modifications, an active bandpass filter. It can even be used to generate the sound of bongo drums by making R_E large enough so that the circuit gain is just below the point where oscillations begin. If a trigger is applied to the base of the transistor, the circuit will be shocked into oscillations which will quickly die away. (Three such circuits at low, medium, and high frequencies, will create the sounds of a bass drum, a tom-tom, and a bongo drum, respectively.)

The same gain-reducing technique (raising the value of R_E) allows the circuit to become an active bandpass filter, an application the author has incorporated into a five-channel stereo color organ. ▲

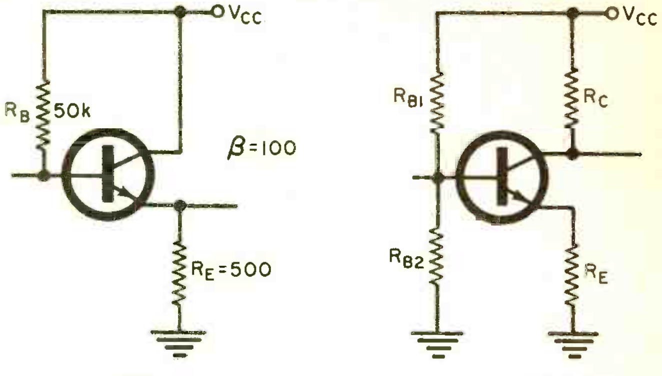


Fig. 2. Schematic diagrams of (A) simple emitter follower and (B) more complex circuit that might be used to isolate the phase-shift oscillator from actual load.

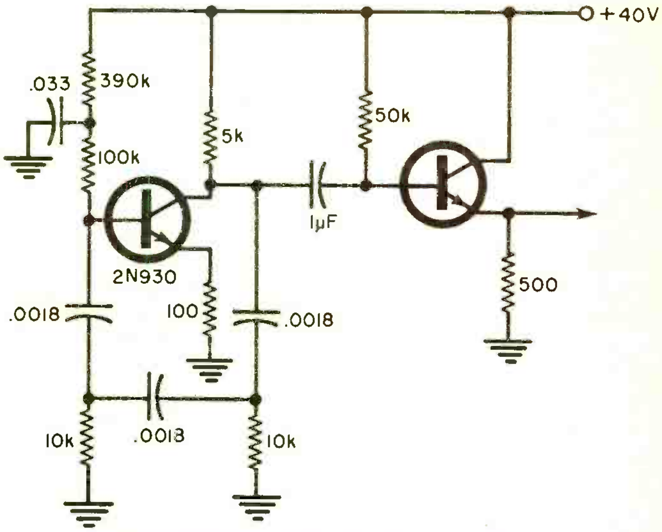


Fig. 3. The complete schematic diagram of the phase-shift oscillator circuit constructed by the author showing the values of all of the various components used.

DESIGN PROCEDURE

1. Specify R_L and p-p volts required across R_L
2. Specify V_{cc} at 1.4× p-p volts across R_L
3. Set R_c approximately equal to 0.2 R_L
4. Calculate I_c, where $I_c = V_{cc}/2R_c$
5. Calculate $R_{L\ a.c.}$, where $R_{L\ a.c.} = (R_L \times R_c)/(R_L + R_c)$
6. Set $R_E = R_{L\ a.c.}/40$
7. Select transistor with beta greater than 50 and power dissipation greater than $V_{cc} \times I_c$
8. Calculate I_B, where $I_B = I_c/\beta$
9. Calculate $R_{bb(total)}$, where $R_{bb(total)} = \frac{(V_{cc}/2) - V_{BE}}{I_B} - \beta R_E$
10. Set $R_{bb1} = 0.2\ R_{bb(total)}$
11. Set $R_{bb2} = 0.8\ R_{bb\ (total)}$
12. Set C_b so that its $X_C \leq R_{bb1}/100$
13. Set "R" $= R_{in}$, where $R_{in} = (R_{bb1} \times \beta R_E)/(R_{bb1} + \beta R_E)$
14. Set the X_C of "C" equal to 1.732R
15. Calculate the required value of "C" from its X_C at the desired frequency

Technicians in Britain

In the U.K. Technician Engineers are Tops

By E.A. BROMFIELD/Secretary
The Institution of Electrical and Electronics Technician Engineers

A recent authoritative survey has revealed that over one million technician engineers and technicians will be required by 1975. The United Kingdom is now laying the basis for their professional recognition.

IN the United Kingdom, most professional engineers of all disciplines are members of the Council of Engineering Institutions (CEI) and are referred to as "chartered." Until recently it has been possible to become a chartered engineer based on past experience but without having a professional degree. This is being changed and all chartered engineers of the future will have to be degreed engineers.

The Technician Engineer

In view of this, it has become necessary to set up a separate title for engineers without degrees whose qualifications, training, and experience nonetheless entitle them to be called engineers. In fact, these men outnumber chartered engineers by a ratio of 4:1. The generic designation "technician" would not be suitable since it is used as indiscriminately as the generic "engineer." The widespread acceptance of the title "technician engineer," however, (from the Continental concept *ingénier technicien*) shows that it has provided the long-sought compromise. This term is used by all engineering disciplines, government departments, educational establishments, industry, and by the Council of Engineering Institutions.

In all sectors of electrical and electronic engineering, technician engineers are expert in the application of specific engineering techniques—whether in manufacturing, operations, maintenance, or research and development work. These non-chartered engineers carry out a wide variety of specialized activities wherever electricity is used as a means of power, control, and communication. Technician engineers provide the detailed information from which engineering decisions are made and influence the selection of materials and apparatus. They obtain their academic qualifications—HNC (Higher National Certificate) or CGLI (Full Technological Certificate of the City and Guilds of London Institute)—by part-time day courses with technical college attendance once a week, or by block-release and evenings-only courses. (Block-release is an arrangement whereby employers send young employees to technical colleges for a period of several weeks at a time, while still paying their wages.)

With their good, near-degree academic attainment, allied to specialist training and experience, electrical and electronics technician engineers have a distinct identity and status. For them, career prospects have never been better than they are today because more and more of them are needed to occupy "kingpin" positions in every branch of industry as well as in a managerial/supervisory role.

The Technician

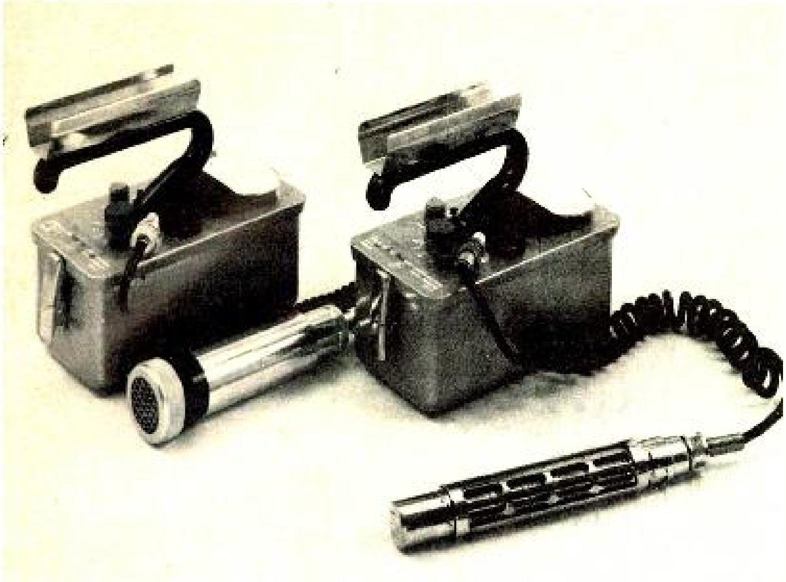
The technician, also in short supply (particularly in the electronics field) requires similar technical knowledge and skills, although not quite so high, but still substantial. Many technicians reaching the requisite technical educational and experience levels develop into good technician engineers.

A research report by the Engineering Industry Training Board published on December 8, 1970, gives added emphasis to the distinction between technicians and technician engineers. The difference "lies less in the actual activities of the two than in the technician engineer's greater breadth of knowledge and wider range of activities, backed by a higher level of attainment in further education."

In 1967, following a request by the Government, the National Advisory Council on Education and Commerce set up a committee under the chairmanship of Dr. H.L. Haslegrave (a former vice-chancellor of the Loughborough University of Technology) to review the provision of courses suitable for technicians at all levels—including corresponding grades in non-technical occupations—and to consider what changes should be made in the present structure of courses and examinations. The Haslegrave Committee, whose report appeared in December, 1969, concluded that the present complex pattern should be replaced by a simple, two-tier system of certificates and diplomas, and that national certificates and CGLI awards should be gradually phased out. They recommended that a Technician Education Council be established—along with a Business Education Council for non-technical fields—to plan and regulate the new structure, with the CGLI acting as the administering body to serve the two Councils.

There has been a widespread support within engineering circles to setting up an Engineers Registration Board and just at press time we have been advised that such a board has been set up under the aegis of the CEI (Council of Engineering Institutions). This Board will register all three categories: Chartered Engineer, Technician Engineer, and Technician. It is intended that titles and designatory initials shall be awarded under protective powers derived from the CEI's Royal Charter. It is believed that such a comprehensive, authoritative system of registration will improve the standing of the entire U.K. engineering profession and industry, will dissipate the existing confusion over qualifications and titles, and will help to encourage more young men to seek a career in engineering. ▲

(Editor's Note: Information about technician engineering careers in Britain's electrical and electronics fields can be obtained from the author, 2 Savoy Hill, London WC2R, OBS, England.)



The end-window (left) and the thin-wall Geiger-Muller (right) tube survey meters used by the author to detect the level of x-radiation emitted from TV sets.

Measuring Color-TV Generated X-Rays

By J. G. ELLO/Radiation Measurements & Instrumentation
Industrial Hygiene & Safety Div., Argonne National Lab.

Types of survey instruments, comparative characteristics, and methods of checking color-TV receivers for excessive radiation.

THE television receiver is a principal source of home entertainment and information but, like many other products, has its share of undesirable by-products. The automobile, steel mills, and power stations pollute the atmosphere with their noxious exhaust gases while television receivers emit an unwanted by-product called x-radiation. Recognized since the black-and-white television receiver came into being in 1946, x-radiation has become more of a problem since the advent of larger picture tubes requiring higher voltages.

In an effort to limit x-radiation levels, present television receivers are designed under the guidelines recommended by *Underwriters' Laboratories* and the National Council on Radiation Protection and Measurements. With the use of present-day radiation detection and measuring equipment, the author feels confident that TV-receiver manufacturers have reduced x-radiation to safe levels. Nevertheless, once the receiver leaves the factory, x-radiation levels may be altered if controls are improperly adjusted.

Color-TV receiver x-radiation, or x-rays as they are sometimes called, is only one source of radiation exposure with which the average consumer may come in contact. Other sources include: medical and dental x-rays, earthen materials used in building our homes, the sun, and in certain instances industrial equipment on the job.

The Radiation Control Act of January, 1970 was passed to provide the TV viewers with as much protection from TV-produced x-rays as possible. Standard levels set back in the 1950's, stipulating that x-ray emission from TV receivers must not exceed 0.5 milliroentgen per hour measured at about 2 inches from all outside surfaces of the TV receiver at the time of purchase, are now in effect. (A milliroentgen is sub-multiple of the roentgen and is equal to one one-thousandth of a roentgen. The roentgen is a quantity of x- or *gamma* radiation that will produce one electrostatic unit of ions in one cubic centimeter of air.)

X-rays Reviewed

TV x-rays are produced mainly by the picture tube (CRT), rectifier, and high-voltage regulator tubes. Before we go any further, a brief review of what x-rays are and how they are produced is in order.

In 1895, a German physicist, W. C. Roentgen, discovered penetrating rays, which he called x-rays, while experimenting with the luminescence produced by cathode rays (electron emission from a cathode). Unlike nuclear *alpha* and *beta* radiation, x-rays are not affected by electrical or magnetic fields. When x-rays pass through air or a gas, the air or gas has the ability to conduct electricity, that is, x-rays produce electrically charged atoms (ions). They can also stimulate or disintegrate living tissues. Opaque materials, such as cardboard, wood, or books, that block visible (light) waves are transparent to x-rays. It is the ability of x-rays to affect the sensitive emulsion of photographic film that makes it ideal for use in the medical field. We could say x-rays are of the same nature as light, but with a shorter wavelength.

A basic x-ray generating circuit, in which the x-ray tube functions as its own rectifier, is shown in Fig. 2. The secondary winding of transformer *T*1 furnishes the filament current for x-ray tube *XT* and transformer *T*2 furnishes the necessary high-voltage potential between the electrodes (cathode and anode). Once the x-ray tube is energized, its cathode will release electrons, causing the electron stream ES (cathode ray) to accelerate at very high speeds to the anode. It is the impact of the swiftly moving electron stream on the anode that produces the x-rays (secondary emission).

Similarly, x-rays of various energies (intensities) can be produced by electron tubes which are capable of accelerating electrons to energies of several thousand electron volts (eV). The higher the voltage across the electrodes of the x-ray producing tube, the higher the x-ray intensities and the greater the penetration. Potentials at, say, 100,000 volts across the tube electrodes will produce x-rays with penetrating power that would show the bones of the hand while lower potentials, about 10,000 to 40,000 volts, produce lower energy rays, referred to as soft x-rays. Soft x-rays are easily absorbed by matter and have energies below 50,000 electron volts (50 keV). Consequently, any electron tube with the potential of accelerating electrons to energies of several thousand electron volts can produce x-rays.

TV X-rays

Color-television receivers have been known to emit x-ray levels in excess of 0.5 milliroentgen per hour (0.5 mR/hr). It was also found that the amount of x-rays radiated from color-TV receivers is related to the input a.c. line voltage. For example, a five-volt increase in line voltage is capable of increasing the x-ray level by a factor of two. As mentioned earlier, the CRT is one of the main sources of x-rays from color-TV receivers. Here the primary x-rays emanate from the CRT's faceplate. In shunt-regulator tubes, x-rays are generated at the anode and in high-voltage rectifiers at the cathode (due to the reverse cycle of the sweep cycle). This occurs when the d.c. high voltage is applied across the rectifier in a reversed direction; the anode is at negative high voltage. The x-rays from the CRT's faceplate are absorbed somewhat by the picture tube's glass panel and on more recent color-TV CRT's by the steel shadow mask. X-rays from the rectifier and shunt-regulator tubes are absorbed by the glass envelope and the steel tube shields.

The x-rays that bypass the absorbers are of various energies, ranging from approximately 10,000 to 35,000 eV. Appropriate radiological survey instruments are required to detect and measure these x-rays. Some of these may cost thousands of dollars, such as the pulse-height spectrometer, or hundreds of dollars, such as battery-powered survey meters. Fortunately, the technique for identifying the TV x-ray spectrum is known and simpler radiological survey meters may be used to monitor color-TV receivers.

Since the theory behind the operation of survey meters can be found in a number of texts, we will confine our discussion to how a survey meter can be used to spot x-rays from color-TV receivers and which type is best for the job.

TV X-ray Energies

To determine what x-ray energies are emitted from color-TV receivers, studies were conducted by taking readings from specially adjusted color-TV receivers, using a pulse-height scintillation spectrometer. It was found that if a 25-inch rectangular color picture tube were operated above the recommended voltage, the over-all x-ray energy spectrum emanating from the TV receiver would be between 10 and 31 keV. The tests showed that from the face of the picture tube, x-ray energies would range from approximately 19 to 25 keV with a peak at about 24 keV. The x-ray energy range from the shunt regulator was about 10 to 25 keV with peaks at 12.7 and 24 keV and the high-voltage rectifier produced x-ray energies from about 10 to 31 keV with a peak at about 26 keV. As the high voltage increased or decreased, so did the x-rays emitted from the TV receiver. For example, when the high voltage was raised above the recommended setting the measurable amount of x-rays increased.

Measurable x-rays emanating from a color-TV set can range up to about 31 keV. Of these, the lower energy x-rays are easily absorbed by matter such as cardboard, while other energies pass through. This is similar to a light beam passing through a couple of sheets of tissue paper, which absorbs a certain portion of the light. Therefore, when measuring or detecting x-rays emanating from TV receivers, it should be kept in mind that the material from which the detector is constructed will also absorb some of the x-rays.

Since x-rays emanating from color-TV receivers are of various energy levels, an ideal detector would be one that has a flat response to the whole energy spectrum. Unfortunately, no such detector is readily available, but there are a number of detectors which are susceptive to soft x-rays and with proper calibration against a known x-ray source (which is in agreement with the National Bureau of Standards), can be used for detecting TV's soft x-rays.

Fig. 1. (Left) Eberline Instrument Corporation's scintillation type and (right) Victoreen Company's ionization chamber are two other survey meters used to detect x-rays from TV sets.

X-ray Detectors

The lead photo shows an end-window and a thin-wall Geiger-Muller (GM) tube survey meter. The end-window GM tube (at the left) consists of a very thin mica window approximately 1.4 milligrams/cm^2 thick and with an active area approximately 1$\frac{1}{8}$" in diameter. The other GM tube consists of a very thin aluminum cylinder approximately 30 milligrams/cm^2 thick and with an active area 2$\frac{3}{4}$" long. The energy response of these two types of GM tubes is poor for determining a dose rate. The data sheet on the thin-wall GM tube (1B85) shows it to be sensitive down to about 10 keV while the end-window GM tube fares a little better. One reason for a poor response is that the detection of soft x-rays (uncharged particles) requires the production of secondary electrons. Secondary electrons produced by the soft x-ray interactions are easily absorbed directly by the GM tube counting gas. The efficiency of such GM tubes depends on how many x-rays are absorbed by the GM tube and also how many secondary electrons reach the interior of the detector. Accurate calibration may be difficult because of these complications, including the energy and path of the secondary electrons. The GM-tube survey meter may be used as a "go/no-go" instrument for localizing beams that are emanating from color-TV receivers, such as those from the shunt and high-voltage rectifier tubes. They also will give an indication if excessive amounts are emanating from the picture-tube face.

Survey meters associated with the two types of GM tubes shown in the lead photo have three linear ranges, from 0 to 50 mR/hr. The readout consists of 0-50 microammeter and a phone jack for aural monitoring. The meters are powered by two carbon "D" cells with a battery life of about 300 hours.

Two other types of instruments that can be used for detecting TV x-rays are shown in Fig. 1 with the scintillation type on the left and the ionization chamber on the right. The scintillation detector has come into its own in the last decade although scintillation is not new. It is one of the oldest methods of detecting nuclear radiation through the process of scintillation in a phosphorous material. With improvements in photomultiplier tubes, the scintillator gained wide acceptance. The scintillation detector contains a photomultiplier tube and a NaI (Tl) crystal (sodium-iodide activated with thallium). Such a scintillator detector would respond to all low-energy x-rays were it not for its protective screen and opaque Mylar window, which absorbs the very-low-energy x-rays. Other limitations on low-energy sensitivity is the natural background from *gamma* and cosmic rays and from the thermionic current noise within the photomultiplier tube and its associated circuits. The energy response of the scintillator is well within the color-TV x-ray emission range. With its protective screen removed, x-rays down to 3 keV can be detected above the natural background. The small active area of the scintillator is ideal for detecting narrow x-rays beams from TV sets.

The survey meter used with the scintillator detector is a battery-powered pulse-count-rate meter with single-channel, pulse-height analyzer capability. It has three separate channels with high-voltage adjustments. The survey meter readout consists of a dual scale and pointers. The meter indicates counts per minute and, with proper calibration, the counts can be converted into mR/hr readings. Battery life is approximately 350 hours when mercury cells are used.

The other type detector, is an ionization chamber. The ionization chamber is widely used in dose-rate survey meters and is calibrated to read directly in mR/hr. Most battery-operated ionization survey meters consist of vacuum-tube electrometers. For increased sensitivity, a vibrating-reed electrometer is used as in the ionization meter shown. Ionization chambers are versatile in that all types of nuclear radiation which produces either primary or secondary ionization within the chamber may be detected. They may also be constructed in various shapes. Many chambers which have a very thin Mylar window are sensitive down to about 4 keV depending, of course, on the detector design and its counting circuit. Energies below 4 keV are easily attenuated by the chamber walls and therefore cannot penetrate it. Data that is available on the ionization survey meter shows a relatively flat response down to about 6 keV, which is well within the range of x-rays emanating from malfunctioning color-TV receivers. The ionization survey meter is battery powered utilizing 4 carbon "D" cells with a life expectancy of approximately 100 hours. It has a range from 0 to 300 mR/hr and is calibrated to read directly in mR/hr.

Radiographic X-ray Film

There are other ways of detecting x-rays. One is by means of radiographic medical x-ray film. Radiographic film is widely used for monitoring personnel working with or near ionizing radiation. This same principle has been applied to monitoring color-TV sets for x-ray emission. The film has proven useful in detecting narrow x-ray beams produced by shunt-regulator and high-voltage rectifier tubes. The film may be packaged in various sizes and the package may contain one or more types of film.

The film consists of an emulsion containing silver-iodide or silver-bromide crystals imbedded in a gelatin mix which is spread on a base support. The film is then packaged in an opaque material. Absorption of low-energy x-rays is a problem, therefore film sensitivity depends both on the packaging material and the size crystal used. The film can be made sensitive down to the 6-keV x-ray energy range. Unlike the other types of detectors mentioned previously, the film needs no electronics for its ionization process. The x-ray's interaction with the emulsion compound causes the release and trapping of electrons. The trapped electrons in the crystals cause a darkening of the film during the developing process. The film response, or darkening, is proportional to the intensity of the x-rays; that is, the greater the intensity, the darker the film will get. After developing, the film is viewed by a densitometer. Readings from the densitometer are then converted into mR/hr readings. To monitor a TV receiver, a film packet is attached to each side of the TV receiver. After a proper time exposure, the film is developed for dark clouding or images that indicate x-ray exposure.

To sum up, at present there is no all-around survey meter for TV x-ray monitoring. Calibration of the survey meter must be known. Conversion to an mR/hr reading must be certain and the accuracy of the low-level reading in the 0.5 mR/hr range must be dependable. Sensitive detectors such as the GM detectors in the lead photo and the scintillation detector which are energy-dependent, are quite capable of detecting low-energy x-rays providing the energy in question is known. They are useful in detecting small x-ray beams such as those produced by the shunt-regulator and high-voltage rectifier tubes. The ionization survey meter is not suitable for beam measurements. This is because of the large area of the ionization chamber. However, it is suitable for measuring x-rays emanating from the face of the TV picture tube. In the author's opinion, an ionization-type survey meter with interchangeable ionization chambers accurately calibrated in mR/hr would be an ideal TV-monitoring survey meter. The scintillation detector would come second only because it is very sensitive and therefore affected by natural background radiation. Monitoring with radiographic x-ray film, in the author's opinion, is too slow for home use.

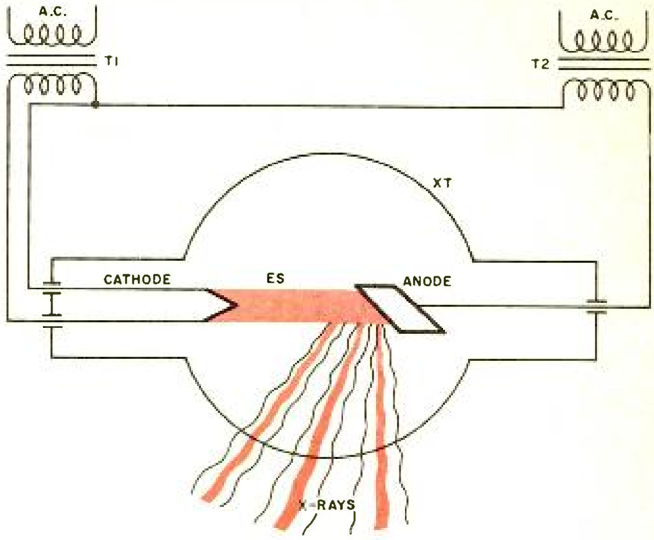


Fig. 2. Basic x-ray tube (XT) circuit showing how x-rays are produced when accelerating electron stream (ES) strikes anode.

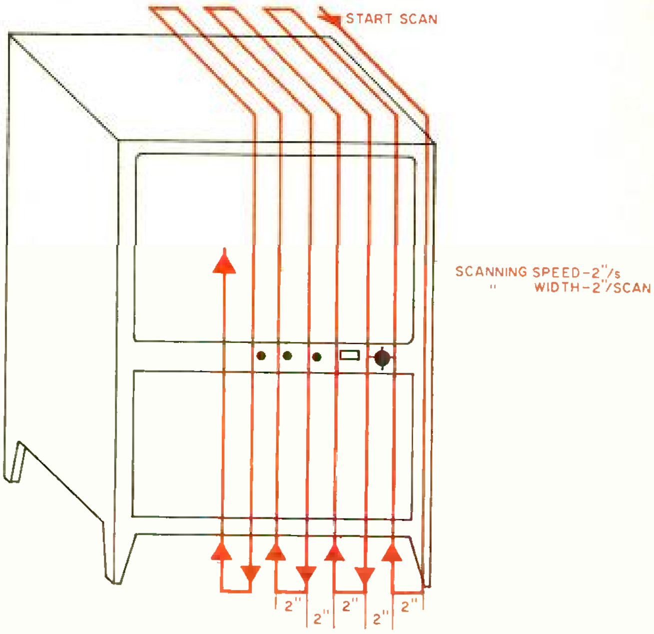


Fig. 3. Diagram showing method used by the author for scanning TV receiver for x-rays. Meter should be held no more than 2" from all cabinet surfaces while maintaining scanning width of 2"/scan and a scanning speed of approximately 2"/s.

TV X-ray Surveying

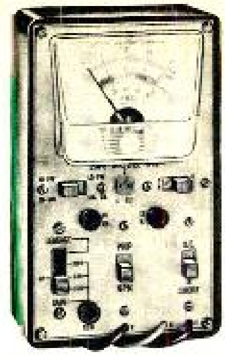
Color-television receivers are designed to limit x-radiation below the maximum value stated in the Radiation Control Act of January, 1970. If for some reason a TV receiver is suspected of emitting x-rays above the maximum level, it should be surveyed. Although as this article is being written there is no standardized procedure for TV surveys, the following technique was used by the author.

Preferably, the survey should be conducted during the daylight hours when the a.c. line voltage is highest. The choice of survey meters will depend on the surveyor's ability and knowledge of radiation-detection technology. The author has used both GM and scintillation-survey meters to survey for small x-ray beams and the ionization-type survey meter for broad area beams such as those which might be

(Continued on page 55)

Eico 443

EMC 212



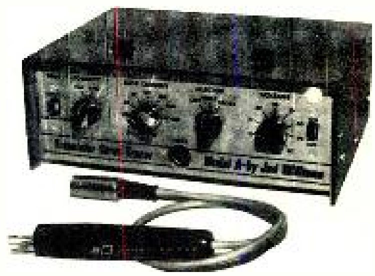
Sencore TF151

TRANSISTOR TESTERS for

B&K 162

Leader LTC-902

Williams A



THERE is certainly no mystique involved in testing transistors any more. Technicians and engineers know you can check for good or bad transistors with a simple ohmmeter, if the internal voltage or current is not too high. Lately, makers of volt-ohm-milliammeters have reduced ohmmeter voltages, and several have special low-power resistance ranges, so that they won't damage transistor or diode junctions.

But you might want to know if two transistors have the same *beta*, for use in push-pull. Or, you might want to pick one with low leakage for some critical circuit. There are a good many reasons you might need a quantitative evaluation.

That's when you need a transistor tester. There is a wide range of choices. Our recent survey for the accompanying chart turned up over twenty different models for the service technician; at least six are new this year. We know of two more that will be introduced soon.

The testers available fall into five categories: (1) inexpensive type, (2) general type, (3) automatic type, (4) lab type, and (5) curve tracer (use with scope).

Low Cost and Quick

Even within this category, instruments vary considerably. The simplest model tests only I_{CEO} (collector-to-emitter leakage current with base open) and makes a *beta* test of sorts. The diagram of Fig. 1A shows the basic test setup that is used.

For this *p-n-p* transistor, negative voltage goes to collector and positive to emitter. That reverse-biases the collector and emitter junction. Any current that flows is I_{CEO} leakage. A small-signal transistor should hardly wiggle a 0-3 mA meter at all. A power transistor could show normal I_{CEO} up to quarter-scale. More than that means the transistor is defective—with excessive leakage or shorted. No reading means the transistor may be open.

To see if the transistor amplifies, you close the Gain switch. A resistor applies negative voltage to forward-bias the base-emitter junction. If the transistor is okay, collector current jumps upward. The meter should read considerably more than it did with the base open. If not, the transistor is faulty.

This kind of evaluation is "go/no-go" testing. You make no accurate gain measurement. Also, the test voltage for leakage may be much less (or more) than what's needed by the transistor you want to test. That creates some inaccuracies. Yet, at low cost, these testers are acceptable. Two models that work this way are the *Heath* IT-27 and the *RCA* WC-506A.

The *EMC* 212 makes a simple I_{CEO} test and a check of d.c. *beta*. Then you can plug a transistor into the socket and test its performance as an oscillator. If it works, the signal generated can then be employed for signal-injection troubleshooting.

The *Simpson* 650 permits reasonably accurate d.c. *beta* readings. The 650 is an adapter that fits on the *Simpson* 260 v.o.m. Precision resistors, plus switches and adjustment pots, calibrate the tester for *beta* readings up to 250. The only leakage reading is I_{CEO}.

Testing I_{CEO} instead of I_{CBO} (collector-to-base leakage with emitter open) would be okay except that I_{CBO} usually tells more about how well most transistors will operate. Acceptable I_{CEO} and "relative gain" readings may camouflage a transistor that won't function well because of too much I_{CBO}. Some testers omit the I_{CEO} reading; their designers consider I_{CBO} the more important test.

More Time, Accuracy, Cost

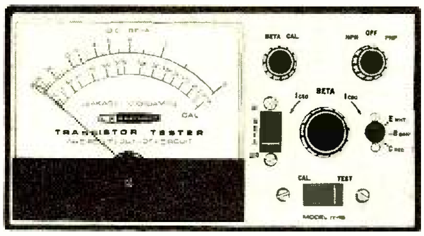
Several instruments test for both I_{CBO} *and* I_{CEO}, and measure *beta* with somewhat more accuracy. We've labeled these "general"-type models. Some do other tests, too

The *Heath* Model IT-18, for example, measures both kinds of leakage. The test for I_{CBO} of an *n-p-n* transistor is shown in Fig. 1B. (For a *p-n-p* the battery and meter are reversed.) The base-collector junction is reverse-biased. Any current that flows is leakage. A few microamps is all that's allowable. As a rule of thumb: for r.f. transistors, no more than 5 μA; low-power transistors, no more than 50 μA; power-output transistors, up to 1 mA.

The d.c. *beta* test in general-type instruments is simple, but it's calibrated so you get a better idea of how well a transistor can amplify. The test arrangement in Fig. 1C is typical, although some may have several additional ranges and scales.

Hickok 890A

Heath IT-18

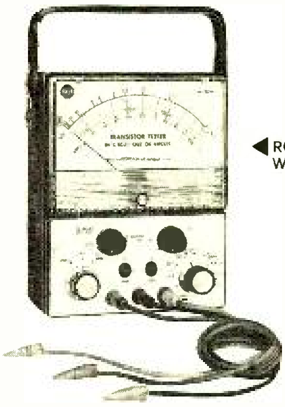


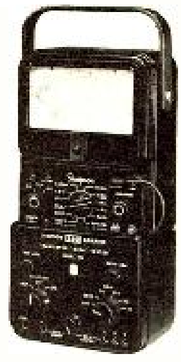
Lectrotech TT-250

SERVICING

By FOREST H. BELT

RCA WT-501A





Simpson 650

A survey of what is available to the service technician for checking leakage currents, amplification, and displaying characteristic curves of transistors, FET's, and diodes.

There are two steps. First, you push switch $S1$ to the Cal (calibrate) position. That puts the meter into the collector circuit across $R2$ and applies bias to the base through $R1$ and $R3$. You adjust bias with the knob of $R3$ until the meter reads a specific amount of collector current. For example, suppose this calibration I_C is 5 mA.

As the second step you push $S1$ back to the Read position (labeled Beta on some instruments). $R1$ becomes part of the collector circuit. The meter switches to the base circuit.

The meter measures how much base current is flowing. If the scale is marked in microamps, you can figure out *beta*. Roughly speaking, *beta* is the ratio of collector current to base current. Suppose that, with 5 mA of collector current, a particular transistor shows base current of 25 μA (0.025 mA). Collector current of 5 mA divided by base current of 0.025 mA equals *beta* of 200.

To make it easier, the meter scale is marked in *beta*. This approximation of true a.c. *beta* is dependable only if the test voltages fit the particular transistor and its operating conditions.

Some instruments provide extra test ranges. The *Heath* IT-18 has two. So does the *Lectrotech* TT-250. The *RCA* WT-501A has five different operating levels for measuring *beta*; that improves the accuracy of the reading.

The *Leader* LTC-902 tests I_{CEO} and two ranges of d.c. *beta*. It also generates a high-harmonic 1-kHz tone for signal injection. An internal amplifier, with gain of 90 dB, makes a good a.f. signal tracer. As in several instruments, metering functions are accessible separately: 0-50 mA and 0-20 volts, in this model. This and virtually all other units measure diode leakage.

Several instruments measure *beta* the a.c. way. The *Sencore* TF17 and TF151, the *B&K* 162, and the *Eico* 685 are examples in the general category. Several models in other categories also measure a.c. *beta*.

It's interesting to note that the *B&K*, *Eico*, and *Sencore* instruments also measure transconductance (G_M) of field-effect transistors (FET's). That's similar in many ways to a.c. *beta*. G_M of a FET is a ratio worked out by dividing signal current in the drain circuit by signal voltage at the gate. The result is in *mhos* (reciprocal of ohms), or more accurately in micromhos (μmhos).

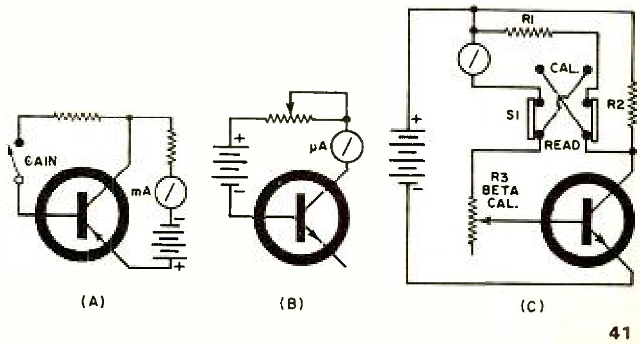
You find a.c. *beta* in bipolar transistors by dividing collector signal current by base signal current. If you did it the complicated way, you'd figure out currents from voltages across resistors in the collector and base circuits (no ordinary instrument measures *signal currents* directly). Then you'd calculate *beta*. With a tester, you set up switches and controls and the meter shows you a.c. *beta* already calculated.

These *B&K*, *Eico*, and *Sencore* models are the "upper class" of general-type transistor testers. They all check leakage in both bipolar and field-effect transistors. The *Sencore* units measure only I_{CBO} in bipolars, but measure both I_{GSS} (gate-to-source leakage with drain shorted to source) and I_{DSS} (zero-bias drain current) in FET's.

The *B&K* 162 performs a whole gamut of bipolar and FET measurements. In addition to I_{CBO} and I_{CEO} tests, it measures collector-to-emitter leakage with the base shorted to emitter (I_{CES}). This reading should be lower than the I_{CEO} reading, but not as low as the I_{CBO} reading. The 162 also checks both I_{GSS} and I_{DSS} in FET's.

The *Eico* 685 makes all three leakage tests for bipolars and both leakage tests on FET's. In addition, there is a pinchoff test for FET's. You apply 5 volts between drain and source, then turn up a control that applies pinchoff

Fig. 1. (A) Basic test circuit for I_{CEO} (collector-to-emitter leakage current with base open), and—by closing the switch—a gain evaluation. (B) Test for I_{CEO} (collector-to-base leakage current with emitter open). Reverse bias is used. Note that "n-p-n" transistor is shown here while "p-n-p" is shown in (A). (C) The simple test for d.c. beta requires two steps.



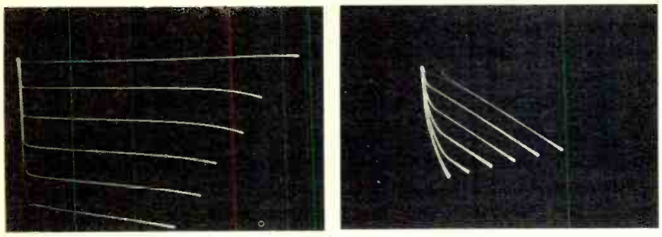


Fig. 2. Collector-voltage/current characteristics of transistor under different biases are displayed simultaneously on scope screen by curve tracer. (Left) Normal family of curves for an n-p-n transistor. (Right) A "signature pattern" of a transistor that is being checked out in a circuit.

to the gate. When current stops, the voltage control knob tells you the pinchoff value. (You use the same variable voltage to determine where a zener diode breaks over or an SCR fires.)

Another general unit is the *Sencore* FT155. It's special in that it tests only FET's. The unit makes all the FET tests the other *Sencore* units make, plus gate-2 tests on dual-gate FET's.

Automatic Testing

A couple of operations to test a transistor—or three or four, if you count leakage tests—isn't much work. But the new *Hy-Tronix* tester, made by a division of *Vanguard Tool Mfg. Co.*, takes even that chore out of in-circuit testing. There are five colored lights on the meter scale.

The in-circuit test is quick. You flip the function switch for Visual or Sound indication, Xstr test. Then you make connections to the foil side of the printed board with a special probe. If the transistor is good, the two top lights or the two bottom lights start blinking. A label between the two blinking lights tell you the polarity of the transistor.

If there's a short or excess leakage, different lights start blinking. Labels between whichever lights blink will tell you which elements in the transistor are shorted.

If you set the Function switch for Sound, and the transistor is okay, a Sonalert beeper sounds off each time the "Good NPN" or "Good PNP" lights flash. If the transistor is bad, you hear nothing. The idea is that you can go through a bunch of transistors on a printed board without looking up from your work.

Out-of-circuit tests are similar to those by other testers. You measure I_{CEO} or I_{CBO}. You can check *beta* with base current at 20 μA, 200 μA, or 2 mA, depending on whether the transistor is an r.f. type, low-power type, or a high-power type. The lights aren't involved.

"Lab" Testers

These instruments are for testing individual transistors, usually out-of-circuit. We've tagged them "lab types" because they provide operating conditions that closely approach optimum for each transistor—at least for some of the tests.

Simplest is the *Heath* IM-36. There are knobs for collector voltage, collector current, base voltage, base current, and leakage voltage. If you're testing transistors that need more voltage or current than the instrument supplies, you can connect an external voltage supply to binding posts on the panel. With the right combination of switch and control settings, you can test leakage between any two elements and measure d.c. *beta* under many different voltage and current conditions.

Similar advantages are obtained with the *Hickok* Model 890A. Test voltage and current for the collector are variable over a small range. You can test I_{CBO} and measure a.c. *beta* with a 1-kHz oscillator (more realistic than a 60-Hz a.c. *beta* test). You can test transistors in circuit or out.

The *Hickok* Model 870 is the most elaborate and versatile tester on the chart, and the most expensive. It has a roll chart with data on over 1000 transistors. If your cross-reference books are up to date, you can test new types too.

The 870 lets you test *beta* by a.c. or d.c. methods. The a.c. *beta* measurement is at 1 kHz, and transistor operating voltage and current are variable. You can test I_{CBO} with a variable test voltage. You can run operating curves to determine saturation point, and check just about any other transistor parameter you care about. The instrument has voltages to suit almost any transistor—low power or high, ordinary or switching type.

Curve Tracers

These are fairly new to the transistor-testing scene, at least insofar as inexpensive instruments for the service technician are concerned. Only two curve tracers are available as this is written, but others are expected shortly.

There is some controversy about their usefulness for servicing. True, they are more elaborate than is necessary to spot a shorted or open transistor. But, for that matter, so are most transistor testers. Detractors object because you have to use an oscilloscope with the curve tracer—two pieces of equipment instead of one.

Many technicians insist transistors don't "get weak" like tubes do; they're either good or bad. Evidence proves otherwise for some kinds of transistors in some applications. Heat changes operating curves; so does age in some instances. You can spot such variances only if you see whole operating curves.

A curve tracer and scope display a "family" of operating curves for the transistor being tested—see Fig. 2 (left). Each curve is the I_C-V_C characteristic of the transistor. It is made by "sweeping" the collector voltage while keeping a certain value of base current (bias).

The *family* of curves is developed by stairstep changes of bias. Each change of bias makes another curve. A different family can be displayed if you change the average (center) collector voltage. In an elaborate curve tracer, then, you can pick whatever collector "center" voltage and whatever set of bias stairsteps suit a particular transistor.

The *Eico* 443 lets you measure *beta*, I_{CEO}, inverse breakdown voltage, and several other parameters. You must know the calibration of your scope, but the 443 has calibration voltages built in. A collector-current switch lets you display two families of three curves each: one family for signal transistors and another for power types.

The *Williams* Model A provides for testing at eight different collector "center" voltages. The increment between stairsteps of base current is also variable. You can set the switch to make the curves 10 μA, 20 μA, 50 μA, 100 μA, 200 μA, 500 μA, or 1 mA apart. You can learn to read *beta*, spot leakage, test for breakdown levels, and so on. You must calibrate your scope, but that isn't too hard to do; most scopes have their own calibration system built right in.

Once a typical family of curves is available for every transistor type, the instrument will be more useful. It can also be used for SCR's, zener diodes, FET's, and ordinary diodes. But you must become familiar with what patterns are normal.

One TV manufacturer, *Sylvania*, has begun adding in-circuit "signature patterns" to service data for transistors in TV receivers. An example is shown in Fig. 2 (right). Once setmakers or service-lit publishers add transistor curve data to schematics, the curve tracer can be a more valuable aid. You just go through the set (with power off) touching the special three-prong probe to each transistor at the foil connections. Compare the curves you get with the pattern specified for *that* transistor in *that* circuit, and you can spot any significant variations.

The special transistor-testing probe we've mentioned is a product originated by *B&K*. The Model FP-3 probe has three tips or prods of needle-point steel. Each prod is independently mounted in a spring-loaded ball-socket. And they're made in unequal lengths. The longest is for the collector connection, the middle length for emitter, and the shortest for base.

Here's how you use the probe. Locate the E, C, and B connections on the foil side of the printed board. Push the needle tip of the collector prod into the C connection. Then, keeping pressure so that the tip doesn't slip off, rotate the body of the probe until the emitter tip is over the E connection; push downward until it makes contact. Keeping that pressure applied, again move the probe body around until the base tip is over its connection. Push downward some more and all three connections are made—even through resin protection—and with one hand.

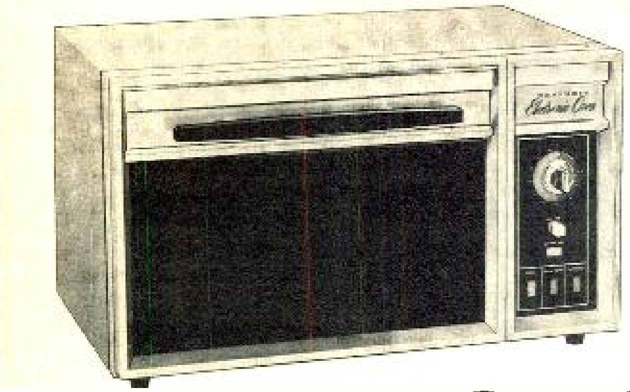
You can use the probe with just about any tester listed in the chart. It is included with the *B&K* 162 and the *Williams* curve tracer. ▲

TRANSISTOR TESTERS

MFGR.	MODEL	BIPOLAR TESTS I_{CBO}	I_{CEO}	I_{CES}	BETA	FET TESTS I_{GSS}	I_{DSS}	G_M	IN-CKT.	OUT-CKT.	WHAT ELSE IT TESTS	PRICE $(K=KIT)	COMMENTS
B & K	162	0–1A	0–1A	0–1A	a.c. 1–5000	0–1A	0–1A	0–50,000	yes	yes	diode, SCR, UJT, triac	100	
EICO	680	0–0.5A	0–0.5A	–	d.c. 2–300	–	–	–	yes	yes	diode	35(K) 55	Can be used as v.o.m.
	685	0–5mA	0–5mA	0–5mA	a.c. 2–10,000	0–5mA	0–50mA	0–50,000	yes	yes	diode, zener, SCR, UJT, triac	100(K) 150	Can be used as v.o.m.
EMC	212	0–80mA	–	–	d.c. 0–200	–	–	–	yes	yes	diode	15(K) 22	Voltmeter 0–12V; milliammeter 0–80mA; tests oscillation
HEATH	IM36	0–15µA	0–15µA	–	d.c. 0–400	–	–	–	–	yes	diode	62(K) 93	
	IT-18	0–15mA	0–5mA	–	d.c. 0–1000	–	–	–	yes	yes	diode	25(K)	Portable case
	IT-27	–	0–3mA	–	d.c. relative	–	–	–	–	yes	diode	7(K)	
HICKOK	870	0–10mA	yes	–	a.c. 1–600 d.c. 0–300	–	–	–	–	yes	–	425	Tests a.c. beta at 1000 Hz; roll chart built-in
	890A	0–50µA	–	–	a.c. 0–200	–	–	–	yes	yes	–	235	Measures B-E input res. & imp.; portable; a.c. beta tested at 1000 Hz
HY-TRONIX	900	0–100mA	0–100mA	–	d.c. 0–500	–	–	–	yes	yes	diode	287	Audible & light display; Model 103 probe $15 extra
LEADER	LTC-902	–	0–50mA	–	d.c. 0–200	–	–	–	yes	yes	diode	100	Works also as injector & tracer
LECTROTECH	TT-250	0–5mA	–	–	d.c. 0–500	–	–	–	yes	yes	–	90	
RCA	WT-501A	0–100µA	0–1A	–	d.c. 1–1000	–	–	–	yes	yes	diode	67	
	WC-506A	–	relative	–	d.c. relative	–	–	–	–	yes	diode	18	
SENCORE	TF17	0–5mA	yes	–	a.c. 1–500	0–5mA	0–50mA	0–50,000	yes	yes	diode, zener, var. cap. diode	110	
	TF151	0–5mA	yes	–	a.c. 1–500	0–5mA	0–50mA	0–50,000	yes	yes	diode, zener, var. cap. diode	130	
	TR115	–	0–50mA	–	d.c. relative	–	–	–	–	yes	–	25	
	FT155	–	–	–	–	0–200µA	0–50mA	0–50,000	–	yes	–	95	
SIMPSON	650	–	0–100µA	–	d.c. 0–250	–	–	–	–	yes	–	44	Attaches to Model 260 v.o.m.

CURVE TRACERS

MFGR.	MODEL	I_{CBO}	I_{CEO}	I_{CES}	BETA	OTHER TESTS	NO. OF CURVES DISPLAYED	COLLECTOR VOLTAGES	WHAT ELSE IT TESTS	PRICE $(K=KIT)	COMMENTS
EICO	443	–	yes	–	yes	$V_{CE(SAT)}$, BV_{CEO}	3	10V @ 12mA 10V @ 1A	diode, zener, SCR, FET	100(K) 150	Has own scope calibrator
WILLIAMS	A	yes	yes	–	yes	BV_{CEO}, $V_{CE(SAT)}$	6	cont. variable 0–80V	diode, zener, SCR, FET	135	



Be Cool: Cook With a MICROWAVE OVEN

By WILLIAM STOCKLIN/Editor

You can cook a frozen TV dinner in 3½ minutes or bake a potato in 4 minutes with the new Heath GD-29 microwave oven.

BUILDING *electronic* kits, particularly for the first few times, is quite a satisfying experience. But if you're looking for a change, as we were, then why not build the new *Heath* microwave oven? There isn't a printed-circuit board in the entire assembly and, except for an avalanche diode, the few solid-state devices are in the pre-built interlock assembly. The kit is basically mechanical—you have a few switches and lamps; a relay, electrolytic capacitor and transformer; and a lot of sheet-metal parts to put together. Anyone can build it, and the odds are that it will work the first time. It took us 10 hours but the average time should be 10-15 hours.

Microwave ovens are not new. The original idea was a spin-off from microwave technology utilizing magnetron design concepts, resonant cavities, and waveguide technology from radar development laboratories. The first commercial designs came out around 1947 and were used in restaurants (shortly thereafter, in vending machines too). Chances are that many who have eaten out or done much flying recently have tasted food cooked by microwaves.

It wasn't until a few years ago, though, that engineering know-how was able to develop an oven for the consumer market that featured compact size, operated off standard 120-V, 15-ampere house power lines, and could be offered for under $500. (Now, of course, we even have kits.)

Microwave ovens do cook as fast as they claim. You can boil eight ounces of water in two minutes, bake a potato in four minutes, and prepare an average beef roast in 15 minutes (5 min/lb). Frozen food can be defrosted in minutes, too (2-3 min/lb) for spur-of-the-moment meals. These ovens are ideal for vegetables, fish, and stew-meat, too, but they do not prepare all foods equally as well. Pie crusts and browning of meats, for example, would best be done in conventional gas or electric ovens.

The Microwave Spectrum

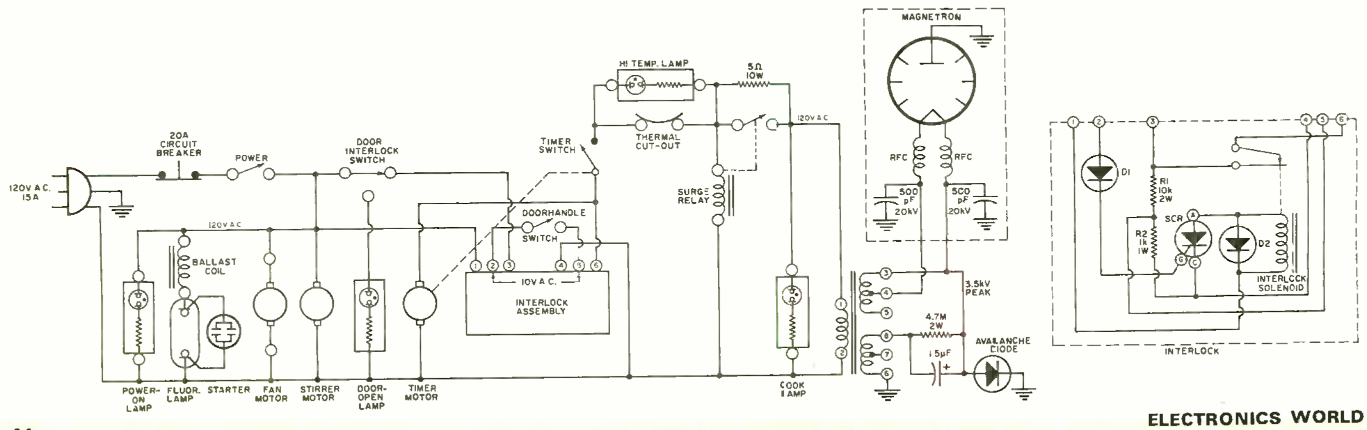
The microwave spectrum ranges from 500-10,000 MHz, falling between the u.h.f. TV and infrared bands. For the most part, these frequencies are used for radar and microwave communications. There are two exceptions, however—the 915 MHz and 2450 MHz channels allocated for industrial, scientific, and medical use. These are the operating frequencies for microwave ovens and industrial systems for food-processing, wood-drying, and other purposes. The 915 and 2450 MHz bands are ideal for microwave cooking; at lower frequencies food is heated more slowly, and at higher frequencies the food surface is heated too quickly.

The *Heath* oven operates at 2450 MHz, using a *Litton*-5201 magnetron producing 650 watts minimum r.f. output power. Power is fed into a length of S-band waveguide measuring 3.40 x 1.25 in. in cross-section, and then to the oven cavity. A "mode-stirrer" (fan) distributes energy throughout the oven.

One of the problems with microwaves is that they are easily reflected so that it is not advisable to use an empty oven or metal pans which are reflective and may cause overheating. As a precautionary measure in the *Heath* design, power is turned off when temperatures become excessive due to no-load operation, fan-motor failure, or even a dirty filter.

There are two areas of major concern to the microwave oven designer: (1) radiation leakage, and (2) finding a fool-

Fig. 1. Wiring diagram of Heath GD-29 microwave oven. The door interlock and magnetron/waveguide are supplied assembled.



proof method of eliminating the possibility of the magnetron operating while the door is open.

Minimizing Microwave Radiation

Effective July 1, 1971, the new standard of the Radiological Health Bureau, U. S. Department of Health, Education & Welfare (HEW) restricts microwave radiation from ovens at the point of manufacture to 1 mW/cm² at a distance of 5 cm. Actually, no one knows precisely what the danger level is, but HEW will insist that this standard be met as a safety precaution. Microwave radiation is non-ionizing—as are infrared rays, radio waves, and other low-frequency radiation—and they do not produce irreversible damage. Therefore, there is no cumulative effect. This differs considerably from x-radiation which destroys tissue that cannot be repaired; x-rays are ionizing radiation and their effects are cumulative.

We measured radiation from the *Heath* oven with a *Narda* Model 8200 radiation survey meter. This new instrument should find wide acceptance as the standard measuring device for microwave ovens in service shops across the country. It is a much lower-priced version of its Model 8100; both give the same results. In checking all possible points of radiation from the *Heath* oven, the maximum we found was the ridiculously low figure of 0.2 mW/cm². This was far below what we had thought possible.

HEW has also set what might be termed a "use" standard for microwave ovens. They should never radiate more than 5 mW/cm² at 5 cm in their entire lifetime. It is this figure that field technicians should abide by; if radiation ever goes beyond this point, protective measures should be taken.

It is important that the builder of this kit pay particular attention to the assembly of the conductive-vinyl door seals, and care should be taken not to scratch the Teflon-coated capacitive seal plate inside the door. Any scratch on this coating may cause arcing and permit leakage.

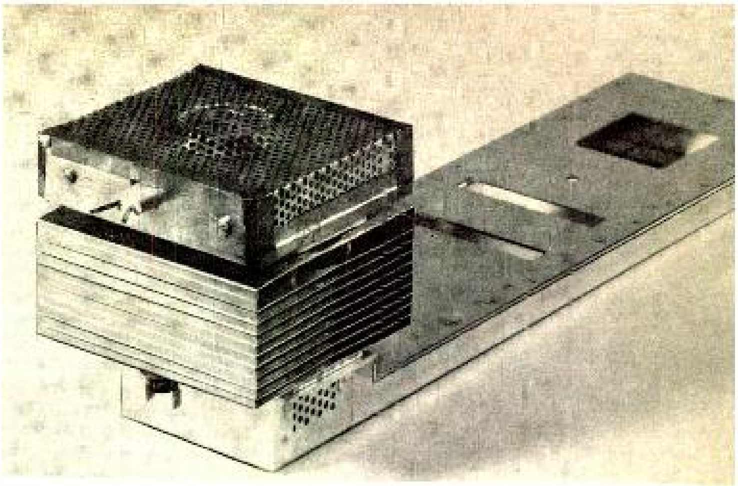
Other Safety Features

For obvious reasons, all power to the magnetron must be off prior to opening the door. The oven incorporates two interlock switches for this purpose. When a.c. power is applied between lugs 1 and 4 of the interlock assembly (Fig. 1), it is applied across the SCR through the interlock solenoid. However, the SCR will not conduct until it is triggered by a small positive voltage on the gate (G). This is supplied from a voltage divider consisting of *R*1 and *R*2 (through lugs 2 and 5) when the door handle switch is depressed. The a.c. voltage is rectified by *D*1. The SCR then conducts, energizing the interlock solenoid and releasing the door lock. At the same time, the interlock switch contacts are open; this, in turn, opens the circuits to the magnetron. (Diode *D*2 is used to short out reverse voltage surges that might be developing across the solenoid.)

When the oven door is opened, the door interlock switch is mechanically actuated to further disable the magnetron circuit. The system is foolproof. (A rather interesting situation could occur, however, in the event of electric power failure while the oven is in use. It would then be impossible for the door to be opened until power was restored.)

Heating Phenomenon

The microwave interaction is produced by what can be called "molecular friction." Molecules moving back and forth orient themselves with the electric field, causing heat, but the degree of temperature rise depends on the type of molecule. (Some move too slowly.) Water is an ideal medium for microwave heating since it has both a high dielectric constant and high loss. It is the basis of microwave cooking, in fact. All foods cooked this way must contain water. For this reason, paper plates, glass, or crockery containers absorb little energy and are heated only indirectly by the food they contain.



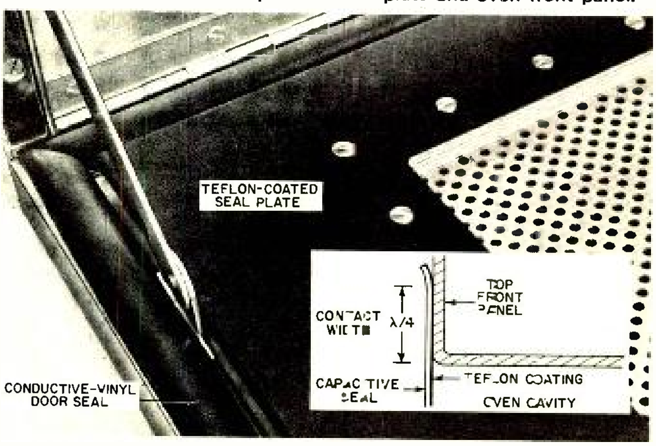
The magnetron and waveguide come pre-assembled and are mounted on oven with 25 nuts and bolts. Magnetron is a Litton L-5201 producing a minimum of 650 watts r.f. output.

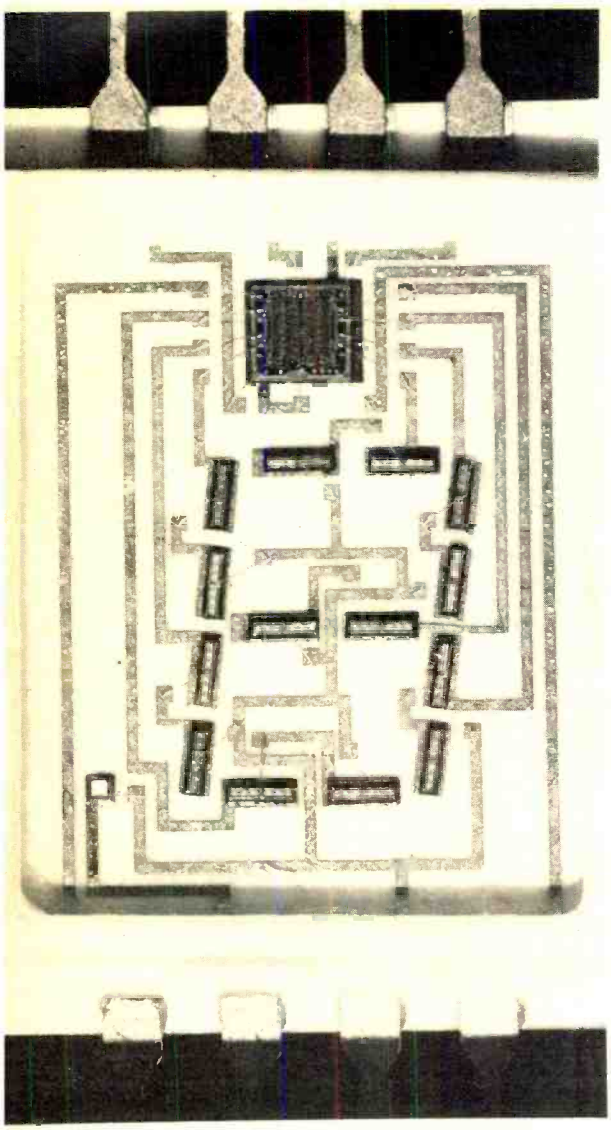
With microwave cooking, not only is cooking time drastically cut, but so is dish-washing time. Food can be cooked in glass, ceramic, or even paper plates, and served on the same dish. Anyone using the microwave oven for the first time might as well forget all he has learned about conventional gas or electric ovens. Microwave cooking is an entirely new phenomenon and is gaining in popularity as the modern approach to home-cooking. ▲

For those interested in building their own microwave radiation tester, the U. S. Dept. of Health, Education & Welfare recently issued a booklet, "Inexpensive Readout for a Commercial Thermocouple Microwave Power Density Probe" (BRH/DEP 70-31, PB 192-377), which completely describes construction of such a unit including circuit diagrams and mechanical assembly details. The design is based on the use of Narda's *Model 8122 probe and the cost is estimated at about $50 for the parts plus $150 for the probe. For a copy of the booklet, send $3.00 to National Technical Information Service, Springfield, Virginia 22151.*

The radiation tester we used (as described in the article) is Narda's *Model 8200, which is available at $295 including probe and carrying case. For further details, see item in "New Products" Department.*

Inside door, showing vinyl seal on outer edge and the Teflon-coated capacitive seal. This Teflon seal overlaps an area of the oven front panel when the door is in the closed position. The contact width of this area is equal to ¼ wavelength of the fundamental frequency of 2450 MHz. The energy in the oven cavity sees a parallel transmission line ¼-wavelength long which is terminated in an open-circuit. Such an open-circuited line appears as a short circuit at its input end, effectively shorting the oven front panel to the door. The Teflon coating maintains a uniform separation between the door and oven front panel, acting as a dielectric between the two capacitor plates, forming the transmission line. This Teflon prevents arcing between the capacitive seal plate and oven front panel.





The Optoelectronic Revolution

By LOTHAR STERN and IRWIN CARROLL
Semiconductor Products Div., Motorola Inc.

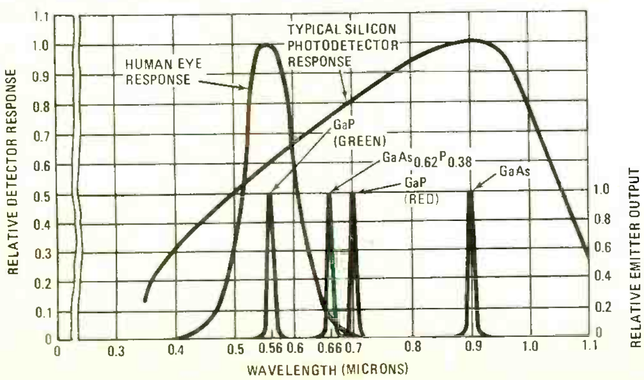
Long-lived and low-power solid-state devices are starting to invade the fields presently served by incandescent lamps and glow-discharge display tubes. Used as light sources, light modulators, indicators, displays, detectors, couplers, and sensing arrays, here's what's available now and future prospects.

This 7-segment solid-state readout is a custom hybrid unit with ◀ the decoder-driver IC chip (top) mounted in the same package.

FOR some time, two technologies have been moving along separate but gradually intersecting paths. Now that their courses are destined to meet, this could produce a wave of new applications. The two technologies are *optics* and *electronics* and the relatively new term—optoelectronics—coined to describe this merger, has captured the attention and fired the imagination of scientists, engineers, technicians, and experimenters.

The field of optoelectronics deals mainly with the twin phenomena of converting light into electric current and, conversely, turning an electric current into light. Neither of these is new. The phototube and the solid-state cadmium sulphide photocell are early and successful examples of light detectors while tungsten-filament and gas-filled bulbs have been serving as light sources for many years. But all of these components have limitations that restrict their use to rather mundane applications. Only the relatively recent development and mass production of silicon photodetectors and light-emitting semiconductor diodes, combined with large-scale integration of their required electronic circuitry, have lifted these restraints. Today, although the actual utilization of these new optoelectronic devices is still minimal, the variety of optoelectronic products in mass production is large enough to move the technology from experimentation to implementation. Moreover, there exists a custom-product capability so that the only limitation on applications will be the imagination of the equipment design engineer.

Fig. 1. Relative response of silicon photodetector compared to wavelength of light output produced by various light-emitters.



Light-Emitting Diodes

In electronic equipment, incandescent and neon lamps will soon have strong competition from light-emitting (semi-conductor) diodes (LED's) in applications ranging from indicators to displays. And the reasons are obvious.

For a start, the response of LED's is many times faster than that of previous devices. While incandescent lamps work very well at d.c. and respond even in the low audio-frequency range, LED's can faithfully follow frequencies well into the megahertz region. Also, solid-state devices are much less fragile than their glass counterparts. Finally, their anticipated lifetime is far greater. While the life of an average incandescent indicator bulb may reach 5000 hours and that of an average neon lamp could extend to 10,000 hours, it is estimated that the life expectancy of an LED is on the order of 20 to 30 years. (*Some special incandescent* *and neon lamps have life expectancies as great as ten times the previous figures.—Editor*) In addition, high-volume manufacturing techniques are expected to quickly establish price levels for solid-state devices that are competitive with today's well-established and mass-produced incandescent lamps.

Most of today's light-emitting diodes are either made of gallium arsenide, which produces infrared radiation (approximately 9000 angstroms) when the diode is forward biased, or of gallium arsenide phosphide which produces a visible red light of about 6600 angstroms. Both are being manufactured in quantity and both have specific applications. The visible-light diodes are designed to be used as panel lights, circuit-condition indicators, light modulators, displays, and the like. Infrared emitters are recommended for card and tape readers, for shaft and position encoders, and for other applications where photodetectors can take the place of the human eye. Since the infrared wavelength of gallium arsenide coincides with the optimum response for silicon detectors, this provides a system of optimum efficiency (Fig. 1).

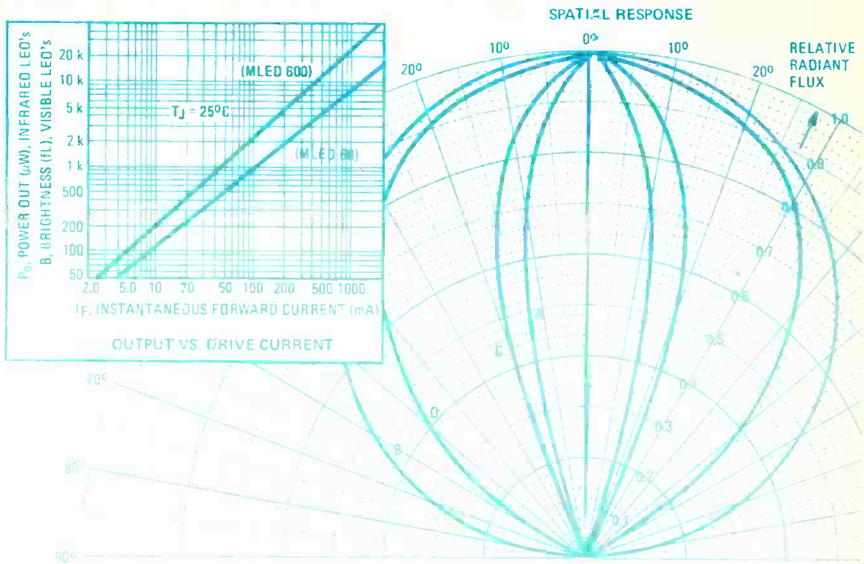


Fig. 2. The power or light output of two typical LED's for various forward currents. Also shown are four spatial responses available.

Although the variety of light emitters is limited at the present time, engineers are using packaging variations to broaden the scope of their application. Each of the various packages may house the same emitter chip, but the shape and materials used in the package determine device characteristics—and its price.

One inherent characteristic of light-emitting diodes is the linear change of light intensity with current. The limiting-current value is set by the power dissipation capability of the package in which the die is housed. Thus, an efficient heat-dissipation package permits operation at higher current, hence greater light output. Moreover, the shape of the package determines spatial radiation distribution (Fig. 2).

From a materials standpoint there are three different package types: plastic, metal, and ceramic. The metal packages are generally hermetically sealed and have a lower thermal resistance than the plastic units. Thus, they are suitable for use over a higher temperature range and can be operated at a higher maximum current. As a result, they can produce a brighter light output. On the other hand, the plastic-packaged devices are considerably less expensive and are usually preferred in commercial, industrial, and consumer applications. Ceramic packages are currently being used for readouts of the seven-segment type.

But this is only the start of differences. Of the two *Moto-*

Inside the LED

Of all the light generated in an LED, only a small fraction actually reaches the outside world. There are two basic factors that account for most of these losses: the low transparency of the LED material to the wavelength being emitted and the high index of refraction of the LED material.

A few of the possible paths that the generated light can take are shown in the illustration. The longer the path through the material, the greater will be the absorption of the light. As can be seen, light leaves the junction in all directions. The gold backing used for bonding reflects light emitted towards the back of the die adding somewhat to the forward-emission radiation.

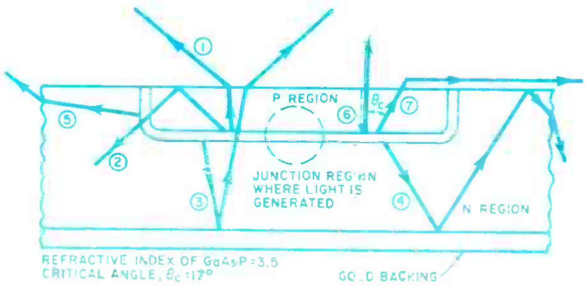
The "bending" of the light being emitted is due to the high index of refraction of gallium arsenide phosphide as is the light being reflected from the inside surface back into the die. If the light strikes the surface at an angle greater than the critical angle θ_c, it will be reflected back into the die.

The critical angle can be increased by placing the die in a material which has an intermediate index of refraction such as epoxy or plastic. Additional shaping of the plastic can also enhance the radiation characteristics.

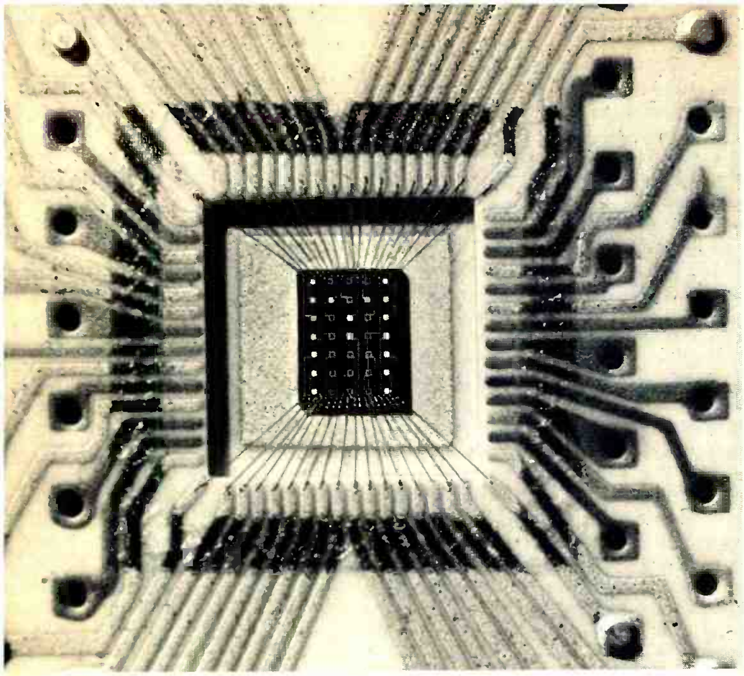
Even when the generated light strikes the surface in an ideal manner, perpendicular to the internal surface (normal incidence), a certain portion of the radiation is reflected back into the die. This is due to the reflection coefficient which is also a function of the index of refraction.

The reflection coefficient can be reduced by coating the surface of the die with a transparent material that has an intermediate index of refraction. The thickness of this coating should be an odd number of quarter wavelengths of the emitted light as measured in the intermediate material. A common material is SiO_2, while SiO or Si_3N_4 is also being used.

A combination of die-coating and encapsulation in an intermediate material can improve bare-chip efficiency by a factor of 2 or more. In addition, using a red plastic encapsulation that will pass the emitted radiation improves viewing contrast.



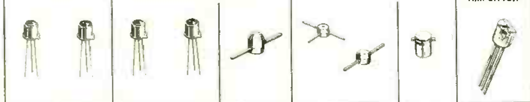
LEGEND:
1. Directly emitted ray from top surface
2. Internally reflected ray from top surface
3. Specularly reflected ray leaving top surface
4. Diffusely reflected ray
5. Ray leaving side of chip
6. Ray with normal incidence with dotted line showing effects of reflection coefficient
7. Ray striking top surface at critical angle θ_c, and emerging ray parallel to surface.



Monolithic 5 × 7 alphanumeric GaAsP light-emitting diode array.

	CASE 234	CASE 171(2)	CASE 81A (SUBMINIATURE)	CASE 247	CASE 209
	PLASTIC		HERMETICALLY SEALED		
Spatial Response	A	C	A	B	A
Max DC Current (mA) / Wavelength	40 / 80	50 / 80	75 / 150	75 / —	— / 150
Visible Light (6600 Å)	MLED 50	MLED 600	MLED 610	MLED 630	—
Infrared (9000 Å)	MLED 60 MLED 90	MLED 900	MLED 910	—	MLED 930

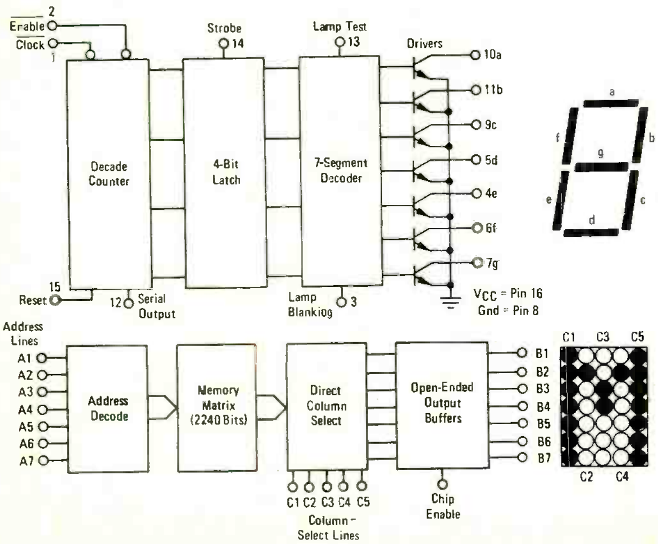
Fig. 3. Some currently available light-emitting diode packages, together with some of their important operating characteristics.



	DIODES		LOW-DENSITY TRANSISTORS			HIGH-DENSITY TRANSISTORS			DARLINGTON AMPLIFIER
Package	Metal		Metal		Plastic	Plastic		Metal	Plastic
Spatial Response	A	D	A	D	A	B	B	A	B
Output (Min)	0.3 μA/mW/cm²	1.2 μA/mW/cm²	0.02 - 0.4 mA/mW/cm²	0.2 - 0.8 mA/mW/cm²	0.2 mA/mW/cm²	0.04 mA/mW/cm²		0.04 - 0.25 mA/mW/cm²	1.0 - 4.0 mA/mW/cm²
Switching-Time Range	1.0 ns		6.5 - 11.0 μs Max			6.5 μs Max			400 μs Max

Fig. 4. Silicon photodetectors are available as diodes, transistors, Darlington amplifiers. Typical specs are indicated.

Fig. 5. (Top) Combined counter-latch-decoder-driver and 7-segment readout. (Bottom) Circuitry needed for 5 × 7 dot matrix.



rola packages, it would appear that the primary difference is one of size. This, however, accounts for some rather startling variations in spatial response—and in subsequent applications. In the small package, the chip is near the center of the curved dome so that emission of light radiated at an angle is at a maximum. Hence, the angle of visibility is quite wide, making these devices suitable as pilot lights, fault-indicators, and in other wide-angle-visibility applications. In the larger package, the die is mounted some distance from the dome. This results in internal reflections that produce a rather narrow beam. Visibility is therefore limited to a relatively narrow angle, although the output is less diffused and appears brighter. This type of unit is better suited for "directional" applications such as modulators, tuning indicators, optical data links, and the like.

Similar considerations apply to metal-cased units so that careful evaluation of the unit's spatial emission characteristics is recommended before making a final selection (Fig. 3).

Photodetectors

The susceptibility of semiconductor-device characteristics to impinging light has been known since the earliest days of the technology. Indeed, the variations in leakage current in glass-packaged diodes, due to changes in light levels, was a nuisance that was corrected only at considerable extra expense. Yet, it is this phenomenon that is being exploited for light-sensing purposes and today's semiconductor photodetectors are designed to optimize this effect.

Silicon photodetectors are widely available in three electrical configurations: diodes, transistors, and Darlington amplifiers. Each successive variation produces an improvement in sensitivity, but at the expense of speed (Fig. 4).

The different characteristics of these variations make them suitable for different applications. The photodiodes, with their extremely fast (nanosecond) response, are ideal for laser detection as well as for ultra-high-speed demodulation, switching, and decoding. Their low current (microamps) output, however, makes subsequent amplification necessary.

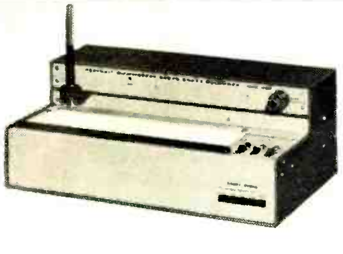
Phototransistors, on the other hand, have respectable outputs in the mA region, but their switching times are measured in microseconds. Accordingly, they are more suitable for industrial inspection, processing, and control systems. To increase their versatility, such devices are available in miniature as well as subminiature packages, the later being recommended for tape and card reading, character recognition, and other applications requiring high density mounting.

Finally, the photo Darlington transistors have outputs high enough to act as industrial drivers, but speeds that are limited to several hundred microseconds.

The Impact of LSI

The explosive growth of solid-state optoelectronics is greatly enhanced by maturing large-scale integration (LSI) capabilities. Not only from a size standpoint, but from power-supply requirements as well, both technologies are entirely compatible. It is this compatibility that provides new potentials for widespread implementation. For example, the mere replacement of an incandescent or neon-lamp readout with a solid-state unit might not be of sufficient importance to warrant an equipment re-design. But the concomitant reliability improvements, space reductions, and cost advantages could provide an ample incentive.

A case in point is the combined counter-latch-decoder-driver circuit (Fig. 5) which, in conjunction with a hybrid-type LED readout, provides this kind of advantage. Moreover, an integrated-circuit chip can be placed in the same package with the readout for a fully operative, single-package digit. Such devices have been produced, but are not yet generally available.



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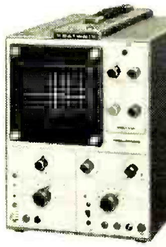

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Another LSI circuit for potential use in conjunction with solid-state readouts is the MMOS-1 2240-bit character generator. This circuit can generate the outputs required for 64 different USASCII characters to be displayed on a 5 × 7 dot matrix of light-emitting diodes.

Clearly, the combination of circuit and display arrangements offers a number of possibilities for compact portable equipment which would not be feasible without these interlocking technologies.

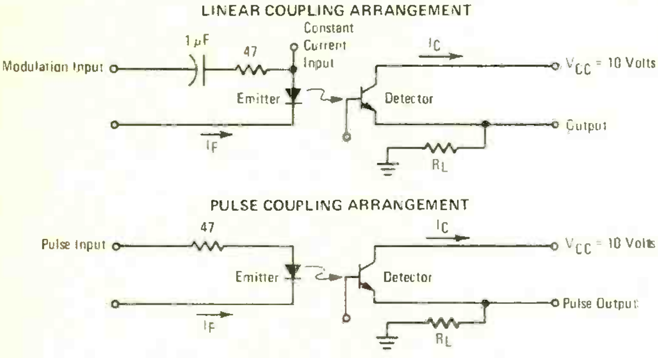
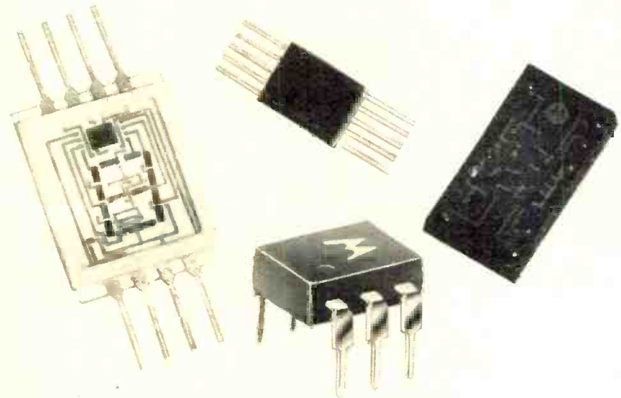
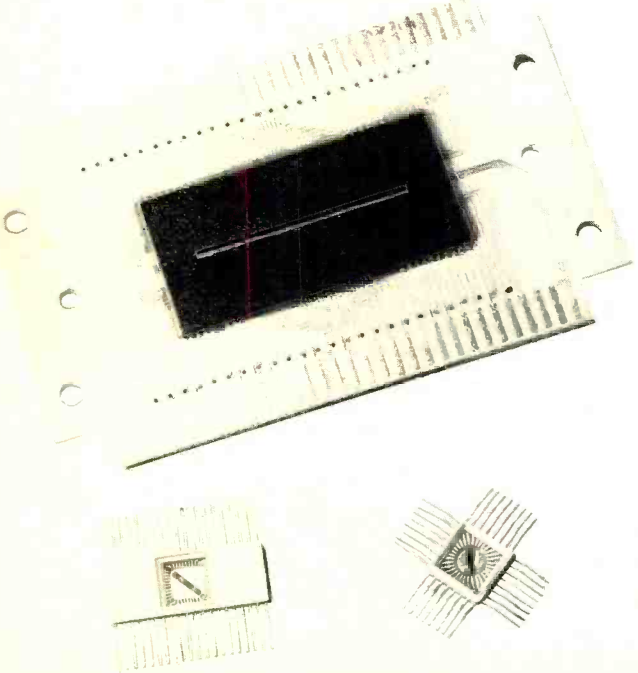


Fig. 6. The circuit arrangements that can be employed with optoelectronic couplers for linear, analog-type signals or for pulses.



Across the top are three 7-segment readouts showing different packaging techniques. Unit at top center has red cover and one at right is on black background, thus obscuring display segments in both cases. Device at bottom center is optoelectronic coupler.

A group of optoelectronic detector arrays. The large device is 100-diode monolithic array; smaller ones are standard arrays.



Optoelectronic Arrays

Like other semiconductor components, discrete optoelectronic devices, such as combined light-emitting diodes and photodetectors, have many uses. But their real potential lies in optoelectronic arrays which, like complex integrated circuits, are apt to gravitate toward custom designs. There will be, and indeed already are, a significant number of standard arrays. But these are produced more to demonstrate functional capability and manufacturing proficiency than an expected high-volume sales potential.

Of course, there are exceptions. Certain light-emitting displays (*i.e.*, 7-segment readouts) do represent a huge market for standard parts; so do punched-card and tape-reading assemblies for standardized computer equipment. Many products for these functions have already emerged. But large as these specific markets are expected to be, they are nothing at all compared to the potential offered by custom designs.

An over-all glimpse of what is imminent and the possible impact on future designs, is best obtained by looking at some of the products that are now, or soon will be, available.

Optoelectronic Couplers

An excellent example of optoelectronic utilization to replace conventional electronic components is the optical coupler. Consisting of an infrared-emitting diode coupled to a phototransistor in a single package, the device advantageously replaces interstage transformers and relays as well as coupling and feedback networks.

Consider as an example the MOC1000 coupler. The unit can be used as a linear-signal coupler or transformer and as a pulse coupler or relay (Fig. 6). In the former mode, a constant current supplied to the light emitter biases this diode and, since the output (infrared in this case) is directly proportional to the diode current, any increase or decrease of diode bias current resulting from an applied modulation input, causes corresponding variations in light output. These are coupled to the phototransistor detector which provides an equivalent linear output current. In this particular device, the output current is typically 60% of the input current and the bandwidth is 700 kHz. Other devices, with an emitter-detector current gain greater than unity, are now available on a limited basis.

As a pulse coupler, the device requires no bias current. The detector is either "off" (with a dark-current of typically less than 20 nA) or "on" (with a maximum continuous forward current of around 35 mA).

Used as an electronic relay, it is fast—much faster than mechanical relays—and it has no contacts to "bounce," pit, or corrode. It is small, insensitive to vibration, and unlike other forms of electronic relays, its output is completely isolated from the input.

Obviously, couplers of this type could be produced with a wide variety of gain, sensitivity, and output current.

Light-Emitting Displays

The cold-cathode gaseous display has been "king of the hill" for so many years that it is familiar to everyone working with digital electronic equipment. Now, however, its reign is being threatened by solid-state optoelectronic readouts that offer a number of advantages.

Optoelectronic readouts are smaller than their gaseous counterparts. Their numerals are only ⅛" to ¼" high, compared to over ½" for the latter. Yet, they are so clear, sharp, and easy to read that they appear to be larger. Moreover, their bright red color makes them easily visible and distinguishable at a respectable distance. They operate at low voltage which makes them more compatible with transistors and integrated circuits than are gaseous displays.

Optoelectronic displays come two ways—monolithic and hybrid. The monolithics are smaller but less expensive. They are designed for instruments, calculators, and other indicators read at short and medium distances. Hybrids are better suited for distance viewing, as in panel readouts. There's even work going on in combining the optoelectronic readout with all the associated electronic circuitry in a single package, so that each digit will be a complete, self-contained entity.

Sensing Arrays

Individually packaged photodiodes and phototransistors can be board-mounted in large numbers to form discrete-device arrays. The smallest packages can be spaced as closely as 85 mils, but that's not nearly close enough for a great many applications. For extremely high-resolution requirements they are available as standard monolithic arrays of up to 39 photodiodes or phototransistors in a single package, while custom monolithic arrays can include more than 100 devices. In a typical array, the diode chips are spaced on 5-mil centers with the active-element area per chip being 4.5 by 5 mils. These arrays are designed for optical pattern and character-recognition equipment, mark sensors, and a wide variety of other sophisticated and critical applications.

Nor is this necessarily the optimum or maximum array size. On a custom basis almost any linear or two-dimensional design can be obtained for special purposes, including star-pattern recognition for navigation.

Some special sensor arrays being produced for standard off-the-shelf availability include card and tape readers. Currently *Motorola* is producing 10- and 12-cell arrays with standard card spacings (0.087" and 0.250", respectively) and 9-cell arrays with 0.100" spacing for tape reading. These arrays consist of individually packaged cells that have been carefully matched for uniform sensitivity and then subsequently repackaged in array form. From these, it is but a short jump to corresponding light-emitting arrays. Since standard light-emitting diodes are individually housed in the same type packages as light sensors, they can be molded in the same type array forms as the detectors to assure a perfect match.

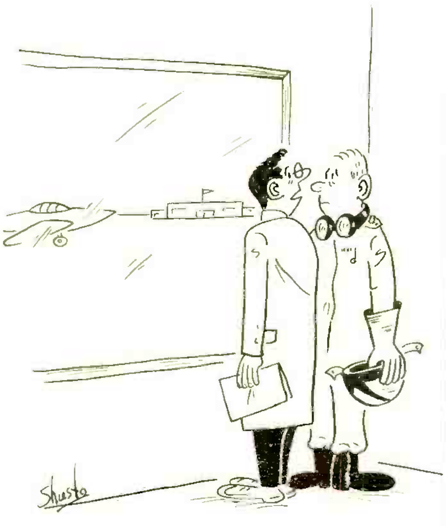
The Green Light

To date, materials used for most semiconductor light-emitters have been gallium arsenide (GaAs) and gallium arsenide phosphide (GaAsP)—for infrared and visible red light. There is, however, a strong demand for a green-light emitter, not only for the psychological impact of green light, but also because the eye is far more sensitive to green.

Green light can be obtained most readily from gallium phosphide (GaP), a material that is more difficult to process than GaAsP, but its advantages far outnumber its drawbacks. The first difficulty encountered is that of crystal growing. Because gallium and phosphorous have greatly differing vapor pressures, crystal pulling must be carried out in a special crystal "puller" capable of operating at pressures of 1500 psi (100 atmospheres). The importance of GaP is due to its dual nature—it can be used for red-and green-emitting devices, depending on the dopants used. As a red emitter, GaP is more efficient than the more common gallium arsenide phosphide. However, the eye is not as responsive to the GaP characteristic wavelength so that apparent visual response is approximately equal for both types.

One significant advantage of GaAsP over GaP (as a red emitter) is that GaAsP devices exhibit a linear relationship between light ouput and current input up to very high current values. Therefore, such units can be pulsed at high currents to yield an apparently high output (as long as power dissipation is kept within the thermal capability of the die and package). Gallium phosphide, on the other hand, saturates very quickly at increased current levels, with the resulting light output reaching a fairly constant value.

Although GaP devices of either red or green light are now in short supply, GaP holds promise of being the material of the future. The role of GaAsP could well be like that of germanium devices—there will always be some cases where it will prove to be the best choice. ▲



"Now don't worry, if something doesn't work right, remember—it's still in the design stage."

Advertising A Service Business

The consumer revolt means that not only products but services must be offered on new and different terms.

By **John Frye**

A LATE afternoon thundershower had broken the end-of-June heat wave, and the doors of Mac's Service Shop stood wide open to welcome the cool damp air. Barney was glancing over the evening paper that had just been delivered while Mac made out a parts order. Matilda had already gone home.

"Hey, Mac," Barney said to his employer, "have you noticed a rather subtle change in advertising lately? Seems to me there's a lot less unfounded bragging about products and services and more down-to-earth talking with the customer."

"I've noticed," Mac nodded, "and I think it's a reaction to the consumer revolt, or whatever you call this new respectful look at the customer many companies are taking—with, it must be admitted, a little helpful prodding from Ralph Nader and some forceful nudging from declining sales. For the first time many manufacturers are seeing their customers as intelligent individuals to be reasoned with, instead of as a herd of sheep easily led or stampeded in any desired direction by the expenditure of enough advertising dollars."

"I know you too well to believe you're 'agin' advertising," Barney observed.

"That's right. I'm a firm believer in advertising to keep a business growing. But I think the age of the Big Lie in advertising is over."

"What do you mean by that?"

"I think it was Hitler's Goebbels who is supposed to have said that if you repeated any lie, no matter how monstrous, often enough and emphatically enough, people would believe it. For several years many advertising companies have paid a tacit tribute to this theory. Hitting 'the message' hard was the thing—much more important than the essential truth of the message. This is the kind of advertising that depends heavily on reiterated slogans and bold statements that may be paraphrased as: 'You can depend on Manufacturer X,' or 'Manufacturer Y's products are better because of constant research,' or 'Quality is a must with Manufacturer Z.'

"All too often money that would have justified these claims had it been spent on quality control and quality-directed research was diverted into advertising on the erroneous theory that people really didn't appreciate quality and were more swayed by what they read and heard than by what they actually experienced with the products.

"I know how I feel when I hear a TV announcer sounding off on the sterling quality of the products of a certain manufacturer and recall having to return two defective percolators of that manufacturer before I finally got a good one, or remember returning a new electric can opener twice to his authorized service center because it simply would not open cans, and each time having it come back just the way it left. I finally had to repair it myself.

"I know I am not alone in my feelings. Today's consumer is much more sophisticated and much less gullible than the customer for whom this kind of advertising was designed. He does not believe that after the salesman has married him to a product the two of them will necessarily 'live happily ever after.' He wants to know: What if the product is defective or later breaks down? What responsibility does the manufacturer assume and what provisions has he made for keeping the product working?"

"I've seen several examples of the new kind of advertising," Barney observed. "I read that *GM* was carrying on an experiment in Chicago for a limited time in which any purchaser of a *GM* car in that area who felt he was not getting satisfactory service on his new car from the local dealer could call the factory free of charge and discuss his complaint. And I'm sure you saw *Whirlpool's* TV advertisements in which *Whirlpool* washer owners anywhere in the U.S. were given a telephone number they could call in the event that they could not get proper service on their appliances locally. *Avis* took full page ads to invite their customers to 'Yell if *Avis* does something wrong' on a toll-free hot line."

"These straws in the wind have not escaped my notice," Mac said, "and I'm convinced the radio-TV service operator would do well to align his own advertising with these trends."

"Could be," Barney agreed, "but that will add another requirement to what I have always felt was a tough assignment: advertising a service business. We have problems not present in advertising a product. In the first place, we are trying to sell something intangible. We have nothing a customer can see, lick, sniff, hear rattle, or pinch. We can't take advantage of Wheeler's advice that 'the sizzle sells the steak' because service doesn't sizzle."

"You're right. In a sense we have to sell our customers a pig in a poke. Not only do we have to persuade them they need the pork, but we must convince them our invisible pig is better than any other pig they can buy. In short, we are denied any sort of sensory appeal and must rely on purely intellectual persuasion. Any advertising man worth his salt—and all women—know it is much easier to appeal to the senses than to appeal to the intellect."

"How can the service technician give his advertising this New Look?"

"His first aim must be to narrow the credibility gap between what his advertising says and what the average customer believes about radio-TV service. Thanks to the admitted shady practices of some technicians and to the representing of these practices by newspapers and magazines as being typical of the whole industry, that credibility gap can use a lot of narrowing. The only way to make people believe you is to tell the exact truth as simply and unequivocally as you can without ever making an exception. That sounds easy, but it's not. I never cease to be amazed at how people can misunderstand a statement in which there is no intent to deceive if that statement is not written with crystal clarity."

"How's he going to get his message across? TV advertising is too expensive for the average service shop. Anyway, I've never seen a TV advertisement for service of any kind that impressed me very much—with the possible exception of some of the clever, and I'm sure quite expensive, oil company ads. I am not much impressed by shots of the interior or exterior of the service shop, nor by a picture of the service trucks all lined up, nor by an obviously posed picture of a young housewife becoming almost as ecstatic about the radio-TV service she gets from you as she does about the way her laundry comes out when she uses Brand X detergent. None of this is very convincing."

"I agree. TV advertising is most effective when it can 'show the product.' That's why I think it is most worthwhile when it is used by a service organization to plug its emblem. Well-written spot announcements on local radio stations aired during programs popular with adult audiences can be quite effective in keeping your business in front of the public.

"But neither of these afford much elbow room to practice the new honesty-in-advertising technique we were discussing. Personally, I think the most effective means of doing this is contained in the weekly short columns in newspapers I notice several widely different businesses are using: automobile dealers, funeral parlors, real estate firms, and banks, for example."

"I'm not sure I know what you're talking about."

"Well, these are usually boxed stories of a couple hundred words. Quite often a head-and-shoulders cut of the person whose name appears at the bottom is used at the top of the story. These stories are educational in nature and their title spotlights this feature. For example, one used by car dealers might be entitled *How to Buy a Used Car*, or *When Do You Need a Tune-Up?*, or *The Best Time to Trade.* In each case, to be effective, the story must be written so as to give the impression the author is genuinely interested in helping the reader."

"How do you picture us using this medium?"

"One way would be to acquaint our customers with the fairness of our charges. Take for instance the mark-up on tubes and other parts. Many people think we are crooks because our tube charges are higher than the wholesale prices they see in catalogues. We could explain such mark-ups are justified because we give time-and-place utility to the replacement items. We attempt to have them ready and waiting on our shelves when the customer needs them. Otherwise he would have to order the parts himself from a distant parts store, pay postage on them, wait for several days or even weeks for delivery, and return the parts for examination and possible replacement if they were defective.

"To avoid all these inconveniences for him, we tie up a lot of our capital and expend lots of time and energy maintaining a large stock of parts. Quite often we suffer losses because items become obsolete on our shelves. If anything we sell is defective, we replace it immediately and then wrestle with the distributor about making it good to us. The mark-up on parts is a long, long way from being all pure profit. In fact, we simply cannot afford to absorb all the expense of maintaining a large parts inventory. The mark-up on parts is simply a means of making this operation pay its own way."

"I get the idea," Barney said. "We could do another column on What is and What is not Covered by our Service Guarantee and Why. This is a frequent source of misunderstanding. It should not be too difficult to make an intelligent customer see that if we replace one tube in a TV set we should be responsible for it alone and not for the other umpteen tubes in the set."

"You have the idea, but don't let's forget our primary aim is to instill confidence and trust in the customer's mind by showing that we have his interest at heart. Along that line other stories could be: TV Checks You Can Make Before You Call a Service Technician, How to Keep Service Charges to a Minimum, It May Not Be the Picture Tube, and How to Care for Your Tape Recorder."

"You know," Barney mused, "this new advertising approach may usher in a new Era of Good Feeling between manufacturers and their customers that will benefit both. If so, it is not coming a bit too soon. Growing distrust and cynicism on the part of customers had already reached the place where conventional advertising dollars were largely wasted. More and more advertising was regarded as pure propaganda aimed at moronic minds. It will take a while to erase that impression, but at least we're making a start." ▲

CONSUMER ELECTRONICS ANNUAL

The 1971 "Consumer Electronics Annual" which describes an industry that is having an increasingly greater impact on the daily lives of all Americans, has been published by the Consumer Electronics Groups of the EIA.

This handy booklet describes developments in the consumer electronics field over the past 51 years and supplies statistics on TV sets, radios, phonographs, audio components, tape equipment, and allied products. Also included in this 40-page publication are a chronology of consumer highlights, radio and TV stations, glossary of terms, and allied trade associations.

For from 1 to 24 copies the price is 50 cents each, dropping to 25 cents in quantities from 25 to 99. Order from Consumer Electronics Group, Electronic Industries Assn., 2001 Eye St., N. W., Washington, D.C. 20006. Payment must accompany all orders. ▲

Telephone Attachments

(Continued from page 29)

in general, the various signal specifications while the dial-pulse description is shown in Fig.3. The central-office equipment is designed to expect at least one second of "on-hook" interval between calls, although a 10-second interval is better design practice. To receive a dial tone after the "off-hook," your equipment must wait at least three seconds, although again a 10-second wait is recommended. Once your equipment starts dialing, the maximum period between digits should be no longer than 10 seconds. Even though Fig. 3 shows a minimum interdigit time of 600 milliseconds, a minimum of one second is recommended to avoid close tolerances.

The specifications in Table 1 are nominal and exact values may vary with local phone circuits. The 600-ohm impedance, for example, may actually be as low as 400 or as high as 1000 ohms. Speech transmission levels can vary even more widely. The typical value of –2 dBm, approximately 0.75 mW, may be as low as –12 dBm or 0.075 mW, although this would make for a weak-sounding phone connection.

Most customer equipment will have little trouble meeting the out-of-band limits, although stray signals from the bias oscillator of a tape recorder could conceivably get into the phone line. Note also the requirement that no single-tone signals in the 2450- to 2750-Hz band are to be used. ▲

Table 1. General specs for voice-connecting arrangements.

VOICE TRANSMISSION	
Transmission loss:	0 dB
Frequency range:	300-3000 Hz
Impedance:	600 ohms (nominal)
Speech transmission level:	–2 dB to –12 dB over a 3-second interval
OUT-OF-BAND LIMITS	
3995-4005 Hz	At least 18 dB below in-band
4000-10,000 Hz	Less than –16 dBm
10,000-25,000 Hz	Less than –24 dBm
25,000-40,000 Hz	Less than –36 dBm
Above 40,000 Hz	Less than –50 dBm
INTERNAL IMPEDANCE (subscriber's equipment)	
600 ohms in voice band (resistive)	
SIGNALING CONSIDERATIONS	
Because of tone-signaling devices used for network-control functions, customer devices should have no signals with energy solely in the 2450-2750 Hz band. If such signals are present, at least equal energy in the 800- to 2450-Hz band must be present.	
D.C. SIGNALS AND POWER	
Any d.c. must be less than 10 mA into the voice transformer of the coupler.	
Max. between any conductor	135 volts d.c.
and ground:	50 volts d.c.

Measuring Color-TV X-Rays

(Continued from page 39)

emitted from the face of the color picture tube. A single survey meter may be used, provided you are thoroughly familiar with its characteristics, calibration, accuracy, and energy dependence.

To begin with, the TV set should be "off" and a background count taken. This background reading will then be subtracted from x-ray readings (if any). The high-voltage control should be adjusted by an authorized factory representative in accordance with factory specifications. In most cases, since the TV receiver was factory adjusted, there should not be any above-acceptable x-rays emanating from it. Using just the front-panel controls of the TV set, survey the receiver under four operating conditions: 1. set the brightness control for the darkest viewing picture, 2. set the brightness control for maximum brightness, 3. set the TV receiver off-channel with maximum brightness, and 4. survey the TV with the brightness control set for normal viewing.

When performing a survey, pass the survey meter and/or detector very slowly about 2 inches from all cabinet surfaces, including the bottom and rear of the TV set (see Fig. 3). Above all, remember that the x-ray reading on the meter will fluctuate and an average reading should be taken. If readings above acceptable levels are detected, you can in most cases reduce x-rays to a safe level by performing one or more of the following: 1. properly adjusting the high voltage, 2. replacing the high-voltage and/or shunt-regulator tubes, and 3. installing tube shields. Once the suspected fault has been corrected, the TV set should again be surveyed to insure that the x-radiation has been minimized.

A word of caution for the electronics service technician. Always be consciously aware of the possibility of radiation emission from other products as well as from TV receivers. Full knowledge of the products you service is a "must" in order to protect yourself, and those around you, from these insidious hazards. In many service shops, service technicians and their fellow workers risk unnecessary exposure. To cite one example, a color-TV receiver was out of its cabinet, lying on the side of the chassis with high-voltage tube shielding missing, and the set turned on. This is not only an electrical hazard, but also a radiation hazard. A TV receiver, which must be "on" after repairs, should be isolated from service personnel. The service technician working on a TV receiver should disable all hazardous circuits or use radiation shielding. The high voltage should be checked and/or adjusted as per the manufacturer's specifications with a calibrated high-voltage meter and probe combination before the color-TV receiver is returned to its owner.

For those who may want to build their own GM survey meters, the Public Health Service has issued a booklet entitled, "Simple X-ray Detection Instrument for Television Service Technicians." The PM number is BRH/DEP 70-14. The booklet costs $3.00 and is available from the Clearinghouse for Federal, Scientific, and Technical Information, Springfield, Virginia 22151.

The *Victoreen Company* and the *Eberline Instrument Corp.* have complete lines of battery-operated color-TV survey instruments for anyone wishing to purchase one. Information is available by writing to: *Victoreen Instrument Div.*, 10101 Woodland Ave., Cleveland, Ohio 44104 and to *Eberline Instrument Corp.*, Santa Fe, New Mexico.

REFERENCES

"Conference on Detection and Measurement of X-ray Radiation from Color Television Receivers." U.S. Department of Health, Education, and Welfare, Public Health Service.

"Color Television and the X-Ray Problem." Federal Trade Commission

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BOOKS

"CIRCUIT PROBLEMS AND SOLUTIONS" by Gerard Lippin. Published by *Hayden Book Company*, Inc., New York, N.Y. Three volumes: 188, 125, and 90 pages, respectively. Prices $3.95, $3.95, and $3.55. Soft cover.

This three-volume set has placed major emphasis on practicality and is designed to supplement and amplify standard texts on electricity or serve as a reference source.

Volume I covers elementary methods, volume 2 covers network theorems, while volume 3 deals with transistor and tube circuits. In each volume the approach is a mathematical analysis of individual circuits and, since the scope is wide, these three volumes provide a handy source book for information on everything from Ohm's law, resistive circuits, series and parallel circuits, through *delta* to wye transformation, Millman's Theorem, to tube and transistor constants, decibels, audio voltage and power amplifiers, to resonant circuits. Each volume includes appendices on conversion factors, trigonometrical ratios, and four-figure logs so each book is self-contained. Problems are worked out, making this series suitable for home study if desired.

* * *

"HANDBOOK OF ELECTRONIC TEST EQUIPMENT" by John D. Lenk. Published by *Prentice-Hall, Inc.*, Englewood Cliffs, N.J. 451 pages. Price $15.00.

This handbook is for practicing and/or in-training technicians and is designed to familiarize them with all types of test equipment they are liable to encounter in their work. By providing basic information on how the various meters and test devices work, technicians can quickly figure out the operation of more sophisticated equipment by analyzing them circuit by circuit or stage by stage.

In eleven major sections the author deals with analog meters, digital and differential meters, bridge-type test equipment, signal generators, scopes and recorders, electronic counters, amplifiers, frequency and time standards, probes and transducers, wave analyzers, and microwave test equipment. A special appendix covers digital logic circuits.

The material is informally written, lavishly illustrated, and, above all, practical. This text can be used in lieu of instruction manuals on equipment operation or to amplify instructions provided by the manufacturer.

* * *

"RADIO SPECTRUM HANDBOOK" by James M. Moore. Published by *Howard W. Sams & Co., Inc.*, Indianapolis, Ind. 181 pages. Price $7.95.

This is a relatively painless way for the non-specialist to obtain all the information he requires regarding the allocation of the radio spectrum without having to plow through voluminous government files and multi-volume Rules and Regulations.

For those without any technical background, the author has provided two chapters explaining the nature of radio waves and receiving equipment but the bulk of the material deals with allocations, l.f. and v.l.f., medium frequencies, high frequencies, v.h.f. and u.h.f., and the types of services operating in the various bands.

The text includes tables covering almost every conceivable aspect of the subject from call-sign assignments to the types of equipment that can be used in the various services. While emphasis is on allocations and services in the U.S., certain foreign assignments are also covered where long-distance transmissions might be involved.

* * *

"ELECTRONIC DESIGN DATA BOOK" by Rudolf F. Graf. Published by *Van Nostrand Reinhold Company*, New York. 307 pages. Price $17.95.

This is a varied compilation of data needed by engineers, technicians, hams, and students, presented in the form of nomograms, tables, charts, and formulas. It is not intended to instruct the user on the theory or derivation of such data but to serve merely as a quick reference source for information.

The material is divided into six functional sections which deal with frequency data, communications, passive components and circuits, active components and circuits, mathematical data, formulas and symbols, and physical data.

The large format of the book and the generous size of the nomograms, diagrams, tables, and charts make this an easy-to-use addition to any technical library.

* * *

"HOW TO USE VECTORSCOPES, OSCILLOSCOPES & SWEEP-SIGNAL GENERATORS" by Stan Prentiss. Published by *Tab Books*, Blue Ridge Summit, Pa. 17214. 253 pages. Price $7.95 hardbound, $4.95 soft cover.

Although the author admits that there are already hundreds of books on scopes, vectorscopes, and sweep and signal generators on the market, he feels that covering all three of these instruments in a single volume is justified since his emphasis is on how such equipment should be used, not the nuts-and-bolts of the circuitry.

In ten chapters he deals with scopes in general; vectorscopes; basic uses for a scope; sampling, storage and spectrum-analyzer scopes; sine, square, and triangular waves; push-button alignment and sweep generators; vectorscope troubleshooting and chroma alignment; finding faulty components with a scope; IC and transistor circuit troubleshooting; and tracking down stereo multiplex faults with the vectorscope.

The text is elaborately illustrated and the only reservation regarding this book is that the author concentrates on *Tektronix* and *Telequipment* scopes to the exclusion of other models, which may be disconcerting to those not familiar with these lines.

* * *

"ELECTRONIC ORGAN SERVICING GUIDE" by Robert G. Middleton. Published by *Howard W. Sams & Co., Inc.*, Indianapolis, Ind. 126 pages. Price $4.95. Soft Cover.

This volume has been prepared for the service technician who is accustomed to working on hi-fi equipment but has hesitated to tackle electronic organs, despite their proliferation in private homes as well as clubs, churches, and other public places. The author contends there is nothing to be "scared" of in organ servicing and proceeds to demonstrate how easily the hi-fi technician can make the switch to organ servicing (which can be a profitable field, according to the author).

The nine chapters cover general principles; preventive maintenance and evaluations; adjustments and minor repairs; tone-generator troubleshooting; servicing the keying system; tracking down troubles in the voicing section; piano/harpsichord, glockenspiel, and special voicing networks; amplifier servicing; and troubleshooting electronic-organ power supplies.

The text is clear, concise—expanded and augmented by a wealth of large, easy-to-read diagrams, charts, partial schematics, photographs, and tables. Equipment needed to service the organs is also discussed and pictured. A glossary of terms peculiar to electronic organs has been included as has a frequency chart of the tempered scale, and a reference chart to standard electronic schematic symbols as used in the text. ▲

Miniature Wide-Range V.L.F. Tuner

By N.H. BROWN/Associate Engineer Senior
Tucson Engineering Lab., Hughes Aircraft Co.

Using magnetic bias to control large inductance changes (15 mH-100 μH) makes design of miniature tuners for low-frequency applications feasible.

THE *LC* circuits for low-frequency applications become large and cumbersome when conventional methods are used to vary the value of either *L* or *C* to cover the low-frequency spectrum from approximately 1 kHz to 600 kHz.

To cover this frequency range with a variable capacitor and fixed inductors would require a capacitor with many plates and very large physical dimensions, plus a bank of fixed inductors that could be band-switched into the circuit.

A variable permeability device has been developed that is capable of covering this frequency range with a single inductor and a miniature fixed capacitor. This is made possible by using an inductor whose value can be changed from 15 mH to 100 μH.

This large inductance change is accomplished by changing the permeability of a ferrite toroid core upon which the inductor is wound. Magnetic bias is applied to the core by two small permanent magnets in a unique arrangement whereby one magnet is held in a fixed position while the second magnet is rotated 180 degrees in polarity relationship to the fixed magnet. The core to be controlled is positioned between the two magnets.

When *M1* is aligned with *M2* in unlike polarity, flux lines are in effect short-circuited, flowing directly between unlike poles and having minimum effect on the core. This is the point of maximum inductance. As the shaft carrying *M1* is rotated toward the point where like poles of the magnets will be aligned, an increasing number of flux lines are forced to flow through the core until near saturation is reached at the 180-degree point. This is the point of minimum inductance. Flux linkage through the core follows a path that would not normally be expected, maximum linkage occurring when like magnetic poles are aligned.

A prototype was constructed to the dimensions shown in the diagram, using an *Indiana General* ferrite core Type CF101 of 0-6 material, 0.230" o.d., 0.120" i.d., and 0.060" thick, wound with 100 turns of No. 35 magnet wire. The magnets are 0.5 inch in diameter, V-grooved with normal N-S polarity, and have a flux density of approximately 350 gauss. The air gap between magnets and core is adjusted to approximately 0.01 inch. Minimum inductance can be adjusted by this air gap up to the point of core saturation. The inductance, as measured on a *Boonton* Q-meter, was 15 millihenrys maximum and 100 microhenrys minimum for a 180-degree shaft rotation. Average *Q* over this range was 40.

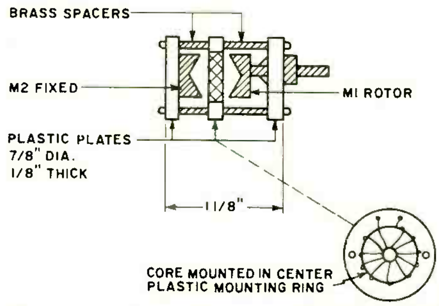
With a fixed capacitor of 0.001 μF shunting the inductor, the tuning range is 40 kHz to above 600 kHz. This range can be extended down to 7 kHz by the addition of a 0.047-μF capacitor.

This type of construction and inductance control makes possible the design of miniature tuners for the low-frequency spectrum, and would allow the design of small, portable v.l.f. receivers, chokes, band-pass filters, etc.

Only one type of ferrite material has been investigated at this time and perhaps materials of other types would yield similar or improved results. The primary purpose of this article is to point out the technique and feasibility.

(Note: A patent disclosure (PD-68529) on this device is on file with Hughes Aircraft, *Culver City, Calif.)* ▲

Dimensions and construction details on v.l.f. tuner with an inductance range of 15 millihenrys to 100 microhenrys.



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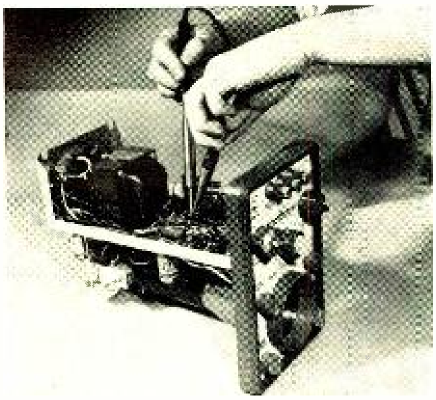
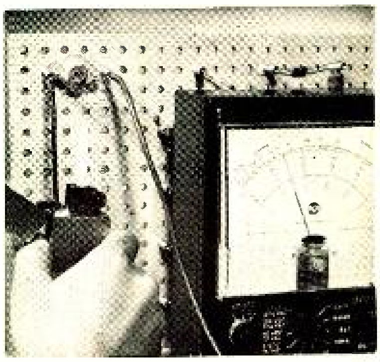
RCA

Construction of Multimeter.



Construction of Oscilloscope.

Temperature experiment with transistors.



Remote U.H.F.-TV Signal-Seeking System

By PAUL LeFEVRE

Sylvania Electric Products Inc.

Here is a circuit developed by Sylvania that provides the TV viewer with means to remotely select u.h.f. channels.

THE eight-function remote-control system described in this article provides the user with the capability of two-direction (up-band and down-band) signal seeking on the u.h.f. TV channels, in addition to the usual seven functions (volume up and down, color increase and decrease, tint red and green, and v.h.f. channel). In effect, this system provides nine remote-control functions using only eight frequency channels. The use of eight channels is dictated by the limited frequency spectrum falling between the second and third harmonics of the TV horizontal oscillator, which is used for remote control, and the necessary separation between these eight channels to assure proper operation of the system.

Since this article is concerned with the u.h.f. signal-seeking system, only the circuits pertaining to this function are discussed.

Operation of Circuit

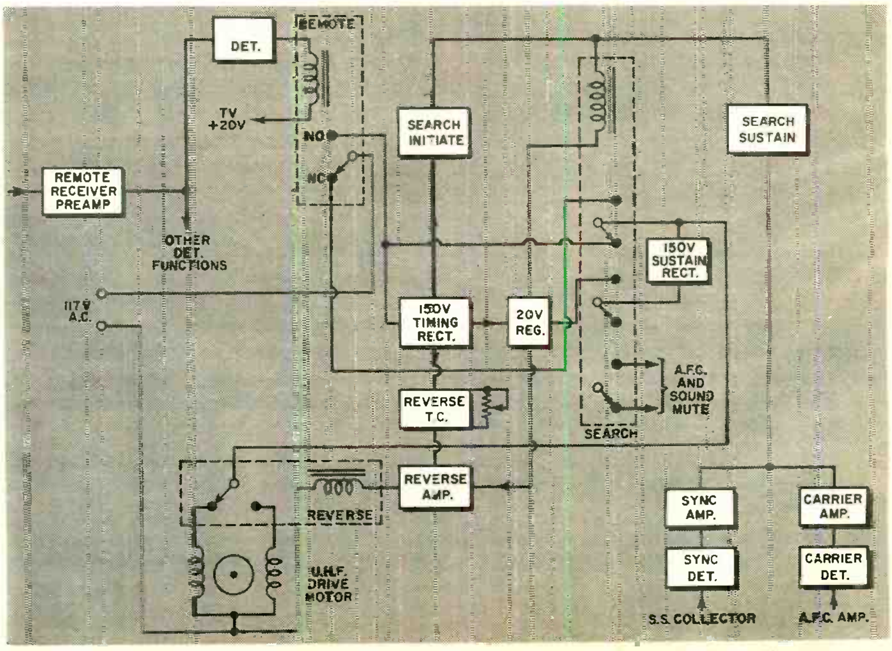
The circuit for the remotely controlled u.h.f. signal-seeking system was designed to work in conjunction with a detector to stop a conventional motor-driven u.h.f. tuner on-channel, within the a.f.c. pull-in range, and to provide the user with remote control of the direction in which the tuner starts. Reversing on command is also provided.

To obtain two-direction control using one function, a 34.25-kHz ultrasonic signal, generated by a transistor oscillator in the remote-control unit, is sent for 0.75 second or less for up-band, and one second or more for down-band direction of search. The tuner doesn't move while either signal is being sent but does start when the transmitter switch is released. Tuner direction can be changed while in the process of signal seeking using the same method; the result is ease and reliability of u.h.f. TV-channel selection without confusing the user.

Relay Control

A search relay and a reversing relay in conjunction with a remote relay, which is in the remote receiver and is operator-controlled, provide full control of the u.h.f. drive motor. This has two stator windings tied together at one point and fed back to one side of the 117-volt a.c. power source. Thus, referring to the block diagram, it can be seen that the drive motor is energized by connecting one of the stator windings through contacts on the reverse, search, and remote relays to the other side of the power source. Note that the state of the reverse

Block diagram of Sylvania's D-12 remote-control u.h.f. signal-seeking system.



relay determines direction of rotor rotation.

How It Works

When the transmitter switch at the remote unit is pressed, an ultrasonic signal is generated that is picked up by a microphone transducer at the input of the Remote Receiver Preamp circuit, amplified, and fed to the appropriate detector circuit. In this case, since the remote units is in the u.h.f. mode, the 34.25-kHz signal transmitted by the transistor oscillator activates the Detector circuit for the u.h.f. circuitry. The output of the detector circuit, in turn, energizes the remote relay causing both the 150-volt Timing Rectifier and 20-volt Regulated supply to switch on. The 150-volt timing circuit, acting through the Search Initiate circuit (a transistor circuit operating in the common-emitter configuration) to the 20-volt supply, energizes the search relay. Accordingly, when the transmitter switch is released, the remote relay is de-energized causing the 150-volt timing circuit to switch "off" and the 150-volt sustain rectifier circuit to switch "on" through the normally open contacts of the search relay. Although the 150-volt timing circuit is "off," the search relay is maintained in its energized state by the Search Sustain circuit (a transistor circuit operating in the common-emitter configuration) and 20-volt regulated source. It should be noted at this time that during search initiate (search relay energized) the 20-volt source is supplied from the 150-volt timing circuit and during search (u.h.f. motor energized) by the 150-volt sustain circuit.

The u.h.f. drive motor, initially activated when the remote relay was energized and maintained by the 150-volt sustain rectifier circuit, runs in the direction determined by the state of the reverse relay and will continue to run as long as the search relay remains energized. However, referring to the diagram, it can be seen that if the remote relay is held closed by the operator, after the search relay is energized, the motor remains inoperative. This keeps the search tuning operation fully automatic yet controlled by the operator.

Once energized, the search relay remains in this state until the two detectors feeding the search-sustain circuit receive the sync (15.75 kHz) and carrier (45.75 MHz) signals, coincidentally. With the receipt of these two signals, the search relay is de-energized, thereby opening the 150-volt sustain circuit and causing the u.h.f. drive motor to stop. The response is fast enough to stop the motor reliably on station.

Timing Circuit's Function

The function of the Reverse T. C. and the Reverse Amp. timing circuits is to delay the energizing of the reverse relay when the 150-volt timing circuit is switched on. In effect, this action prevents the circuit from interpreting any quick succession of short-hold transmissions as a long-hold one. In addition, the reverse amp circuit helps maintain constant timing at all line voltages between 105 and 132 volts. Consequently, when the long-hold (1 second or more) transmission signal is received, the reverse relay, after a short delay, is energized and the u.h.f. drive motor actuates the tuner down-band. When a short-hold (0.75 second or less) transmission signal is received, the reverse relay will remain in its de-energized state and the motor will drive the tuner up-band.

Band-End Switch

A switch, which is an integral part of the signal-seeking system and not shown in the diagram, is actuated when the tuner dial mechanism reaches either end of its travel; at the top of the band it energizes the reverse relay from the 20-volt source, causing the motor to reverse its direction to down-band, and at the low end of the band it shorts the 20-volt regulated source to the ground-return circuit de-energizing the search relay and terminating the search. With the receipt of the next short-hold signal the motor will drive the tuner up-band, removing the 20-volt source from the ground-return circuit and restoring the normal search operation. This arrangement for shut-off prevents the possibility of continuous search that may be initiated inadvertently when there is no broadcast or when there is an antenna or circuit malfunction.

At the end of search, either on-station or at the low end of the band, both 150-volt supplies are shut off leaving the circuit in a passive state yet alert to the next command from the remote transmitter.

In addition, contacts are provided on the search relay so that the TV audio is muted during the u.h.f. signal-seeking operation. ▲

"You'll need 24 hours to fix this one. I've been working on it!"

Understanding Complex Waveforms

By LAWRENCE S. NICKEL
Engineer, General Electric Co.

The harmonic content of various types of non-sinusoidal waves and the use of oscilloscopes to observe such waves.

WAVEFORM analysis is a complex field which can be very difficult to understand. Let's talk first about square waves, for instance. You may know that square waves have a lot of harmonics. What you may not know is that square waves have no even harmonics. Perhaps you know that the strength of the harmonics decreases as you go up in frequency.

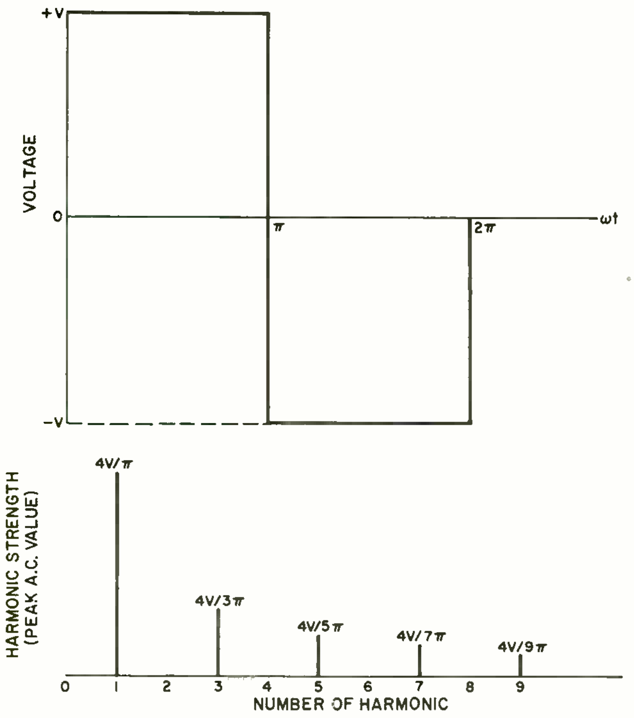


Fig. 1. The square wave at the top has a line spectrum (up through the first nine harmonics) as shown at the bottom. Wave has no d.c. component, hence no "0 harmonic."

For the square wave (with its 50% duty cycle, or "on" half of the time) this is certainly true, but for the pulse (other than 50% duty cycle), this is not necessarily so. Depending on the duty cycle, the fundamental or first harmonic may be strong, the next few harmonics decrease in strength, and then the following several harmonics may be stronger again.

We are concerned here with only periodic waveforms. A periodic waveform is one which repeats itself exactly each time interval, and this time interval is called the period. Each periodic waveform which is non-sinusoidal will contain certain harmonics, the first of which is the fundamental. If the period is t (time), then the frequency f (in hertz) of the fundamental is $1/t$. No frequencies lower than the fundamental may be found in any complex waveshape.

A logical method for displaying the harmonic content of a waveform is by use of line-spectra charts. Refer to Figs. 1 through 3. These charts indicate the relative positions and strengths of each harmonic (only the first few harmonics are shown). Often a line is included at zero frequency to indicate the d.c. (average) value of the wave.

The set of harmonics are named Fourier series. According to theory the strength of the members (harmonics) of this series gets weaker and eventually goes to zero at infinite frequency. Since the waveform is actually the algebraic sum of all harmonics (which would include all those out to infinity), as we add higher and higher harmonics we get a closer and closer approximation of the actual waveform.

One way to predict the strengths of the harmonics of a particular waveform is by using integral calculus; however,

Fig. 2. Harmonic composition of triangular waveform. Note presence of d.c. component and rapidly falling harmonics.

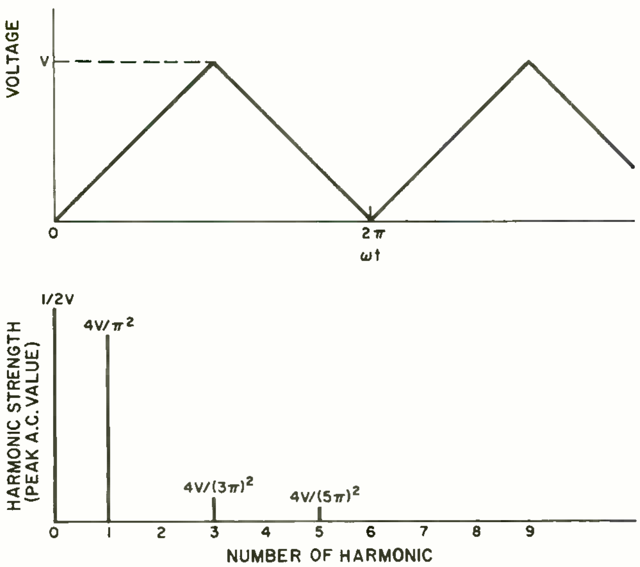
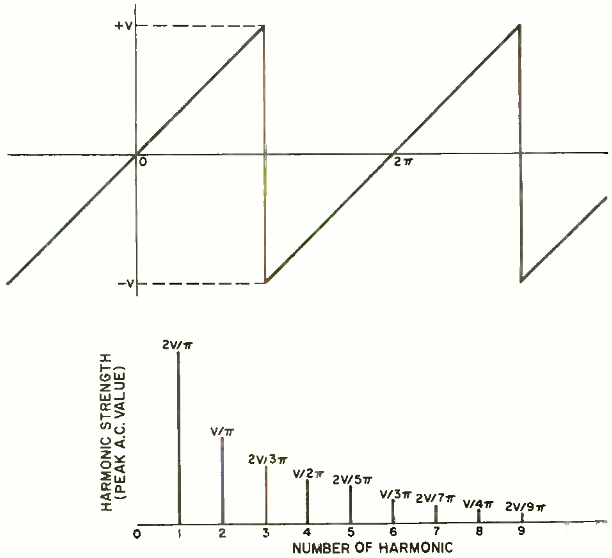


Fig. 3. This sawtooth waveform has the harmonics shown. Note that odd and even harmonics are included in waveform.



by using data with the harmonic strengths already worked out as shown in the figures, we can draw some conclusions. For instance, the ninth harmonic of a square wave is fairly weak compared with the lower harmonics. This means that if your oscilloscope has a bandwidth approximately ten times the fundamental of the square wave, you can get a fairly accurate reproduction of the square wave on the scope screen. If your oscilloscope had a bandpass of up to 1 MHz with a very sharp cutoff there (which is unlikely) and you fed in a perfect 500-kHz square wave, you would see a 500-kHz sinusoid on the screen.

The shape of the waveform is directly related to its risetime. This is the time for the value of the wave to go from 10% to 90% of its maximum value. In general, the faster the risetime, the stronger the higher harmonics. If the wave has sharp bumps or spikes, it will have strong harmonics up to many times the fundamental. There is also a correlation between sound and waveshape. The waves with the sharp points (sawtooths, square waves, and triangular waves) are the ones that are rough or sharp sounding. The sine wave is the "smooth-sounding" one.

There is a relationship between bandwidth and risetime that is true for most oscilloscopes. The formula for expressing this is $T_rB=0.35$, where T_r is the risetime of scope (μs) and B is bandwidth of scope (MHz). By knowing the risetime of your scope you can figure the approximate signal risetime it will display with little or no distortion.

Suppose you feed a pulse into your scope. If the risetime of the waveform is slow (long) with relation to the risetime of the scope amplifier, then the scope will be able to reproduce the waveform accurately. But if the pulse has a risetime almost as short as or shorter than the oscilloscope's risetime, the scope amplifier will not be able to move the stored charge in the capacitors of the scope amplifier rapidly enough, and distortion occurs.

A simple formula relating the various risetimes is: $t3=\sqrt{t1^2+t2^2}$, where $t1$ equals the scope risetime, $t2$ equals the actual signal risetime, and $t3$ equals the risetime which will be observed on the scope screen. Suppose the scope risetime is 3 μs. If a pulse is fed in with a 40-μs risetime, the observed risetime on the screen is almost exactly 40 μs. So the scope has not distorted the pulse much. Suppose the wave put in has a risetime of only 4 μs; we will then see a pulse on the screen with a 5-μs risetime. This risetime has been distorted or "stretched out" by 25%. Hence, we need to know risetime *and* frequency if we really want to know if the scope is giving a true picture. ▲

NEW PRODUCTS & LITERATURE

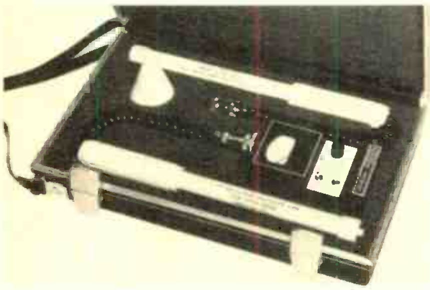
For additional information on items identified by a code number, simply fill in coupon on Reader Service Card. In those cases where code numbers are not given, may we suggest you write direct to the manufacturer on business letterhead.

COMPONENTS ▪ TOOLS ▪ TEST EQUIPMENT ▪ HI-FI ▪ AUDIO ▪ CB ▪ COMMUNICATIONS

RADIATION MONITOR

The new Model 8200 radiation monitor complies with the requirements specified for test equipment in the proposed performance standards as published by the Department of Health, Education and Welfare in the Federal Register dated May 22, 1970.

The "Mini-Surveyor" has a calibration frequency of 2450 MHz but other frequencies are available on special order. It features two full-scale power reading ranges 10 mW/cm^2 and 100 mW/cm^2 with the Model 8223 probe and 2 mW/cm^2 and 20 mW/cm^2 with the Model 8221 probe. Accuracy of the probe calibration is ± 1 dB (calibrated at 2 mW/cm^2 at a distance of 96 inches at 2450 MHz; stated accuracy applies over the complete power-density range of the probe). Accuracy of the instrument is $\pm 3\%$ of full scale.



The complete unit (Model 8200) includes meter, battery, one probe as selected by the customer, and a 2-inch spacer. A data sheet, 17-14, providing complete details on this lightweight, portable instrument is available on request. Narda

Circle No. 3 on Reader Service Page

P.A. AMPLIFIERS

Three solid-state p.a. amplifiers for general purpose or professional applications have been introduced as the Models PA-25, PA-50, and PA-100.

The PA-25 has a power output of 25 watts r.m.s., 50 watts peak, at less than 5% distortion. Frequency response is 100 to 10,000 Hz. The PA-50 is rated at 50 watts r.m.s., 100 watts peak, while the PA-100 provides 100 watts r.m.s. and 200 watts peak, both at less than 5% distortion.

All three units are designed to operate from 105-120 volts, 60 Hz a.c. power sources and measure 15⅛" × 5¼" × 10½" deep. Lafayette

Circle No. 4 on Reader Service Page

STEREO PREAMPS

Two new stereo preamplifiers that provide the voltage gain, equalization, and choice of impedances necessary to operate magnetic phono cartridges and tape playback heads have been introduced as the Models M64 and M64-2E.

According to the company, the preamps provide complete freedom from microphonics, extremely low noise, and the ability to use 50 feet or more of output cable when operated as an impedance converter and buffer amplifier.

Both models have a single slide switch for selecting equalization for phono, tape, or flat. Positions provide RIAA equalization for magnetic stereo cartridges, NAB equalization for tape heads, and flat for microphones or for use as a buffer amplifier.

The M64 operates on 120 volts, 50/60 Hz or from an auxiliary 24- to 36-volt d.c. supply while the M64-2E operates on a line voltage of 240, 50/60 Hz. Shure

Circle No. 5 on Reader Service Page

SPEAKER-SYSTEM KIT

A kit version of the Acoustic Research AR-3a speaker system is now available as the AS-103.

The kit uses three AR drivers in a sealed acoustic-suspension enclosure to deliver a virtually flat response from 30 to 20,000 Hz. The 12" woofer provides clean bass down to 30 Hz while the special AR hemispherical dome mid-range and tweeter, combined with a specially engineered crossover network provides transparent sound to well beyond audibility. Separate output-level controls on the rear of the cabinet for both mid-range and tweeter allow the user to custom-tailor the sound to suit the acoustic environment.

The walnut cabinet measures 25" high × 14" wide × 11¾" deep and will fit on a bookshelf or can be used as a floor-standing system. Heath

Circle No. 6 on Reader Service Page

METRIC TOOL KIT

A 100-piece metric-measure tool kit has just been introduced as the JTK-17 MM. The kit is designed for field engineers' use on foreign-made and international-design equipment having metric-measure fasteners and parts. Virtually every normal tool likely to be required when making repairs or adjustments to electronic or data-processing equipment has been included.

Emphasis has been placed on fastener tools—those needed to dismantle and reassemble complete systems. The tools are packed in an attaché case with two removable pallets. The case measures 4½" deep and has a solid wood frame with mahogany paneling. The hardware is solid brass. Partitioned compartments of the case hold larger tools and parts. Space for service manuals and documents is provided in the cover. A Triplett #310 v.o.m. tester to fit into the case is available as an optional accessory. Jensen Tools

Circle No. 7 on Reader Service Page

4-CHANNEL STEREO DECODER

A kit version of the new Electro-Voice "Stereo-4" decoding system is now available as the AD-2002. The new system permits the audiophile to enjoy the sound of 4-channel stereo at modest cost. The decoder, when used in conjunction with an existing stereo system and a second amplifier and speaker system, permits listening to 4-channel stereo of any tape, record, or stereo-FM broadcast that has been encoded using the EV matrixing system.

According to the company, assembly of the kit takes about 2 to 4 hours using the step-by-step manual and giant fold-out pictorials supplied. Connection and operation are equally simple. Front-panel knobs control "on-off"/master gain and source switching; the rear panel provides complete inputs and outputs. All circuitry, including the IC, is identical to the EV unit. Heath

Circle No. 8 on Reader Service Page

SOLDERING TOOLS

Two new precision soldering tools have been introduced as the W-TCP-L and W-MCP. The former is a controlled-output tool with interchangeable tips which automatically provide precise wattage control from 20 to 60 watts. Accessories are designed for maximum productivity in production-line, R&D, or service-bench applications. It is a fast-recovery unit with an isolated low-voltage power supply and flexible non-burning cord.

The Model W-MCP is a solid-state miniaturized tool for micro-soldering with a fixed-temperature element, isolated low-voltage power supply, and flexible non-burning cord set. It is offered in temperature ratings of 550 and 750 degrees F, with a variety of specialized tips to meet virtually any micro-soldering application from 5 to 20 watts. Weller

Circle No. 9 on Reader Service Page

STEREO TAPE DECKS

Two stereo tape decks, the GX-280D and GX-220D, both with glass and crystal ferrite heads have been recently introduced to the U.S. market.

The core of the GX head is made of a single crystal ferrite and the inner circumference of the heat shield is mounted and set in glass. As a result, the GX head is "dust free" from magnetic tape particles, according to the company. Thus, sound quality is not affected even under

excessively high temperatures and humidity. According to the company, wear and abrasion are almost completely eliminated and tape motion stability is enhanced because of the high degree of glass and crystal ferrite hardness.

The GX-280D is a 4-track, 2-channel stereo/mono system which operates at $7\frac{1}{2}$ and $3\frac{3}{4}$ in/s. It will handle up to 7" reels. Response is 30-24,000 Hz ± 3 dB at $7\frac{1}{2}$ in/s. Signal-to-noise ratio is better than 50 dB. The GX-220D is a 4-track, 2-channel stereo/mono deck which operates at $7\frac{1}{2}$, $3\frac{3}{4}$, and $1\frac{7}{8}$ in/s. Frequency response and signal-to-noise ratio is the same as the 280D at $7\frac{1}{2}$ in/s. Both have three heads and three motors.

Complete specifications on these new decks are available on request. Akai

Circle No. 10 on Reader Service Page

DIGITAL MULTIMETER

A new multimeter with a digital display has been put on the market as the Model 3469A. The instrument makes average a.c. measurements from 1 millivolt full-scale to 500 volts over a frequency range from 20 Hz to 10 MHz, resistance measurements on its most sensitive range of one ohm full-scale to 10 megohms full-scale, d.c. measurements from 100 mV to 1000 V full-scale, and d.c. current from 1 μA to 100 mA full-scale.

A data sheet giving complete specifications on the Model 3469A is available. Hewlett-Packard

Circle No. 11 on Reader Service Page

SOUND SYSTEM

A six-mode, 70-watt sound system designed for public safety applications is now available. It can be used for public address, police siren, yelp, European siren, radio relay, and listening applications. The multiple-siren feature permits alternating the emergency signal for maximum clarity and effect while the listening mode makes it possible for two-way p.a. conversation with all windows rolled up.

Various weather-resistant, low-profile speakers are available and can be easily installed without obstructing a warning light. Full details are available on request. Standard Communications

Circle No. 12 on Reader Service Page

175-MHz FREQUENCY SCALER

The IB-102 frequency scaler, when used in combination with virtually any frequency counter on the market, provides measurement capability to 175 MHz. The unit will divide input frequencies from 2 MHz to 175 MHz, with the scaled output fed to any frequency counter with a 1-megohm input. Front-panel switches allow selection of 10:1 or 100:1 scaling ratios, with counter resolution down to 10 Hz when used with a counter having a 1-second time base. A 1:1 switch provides straight-through counting without scaling for use with frequencies within the range of the counter being used.

An exclusive input circuit triggers at extremely low signal levels. At 100 MHz, for example, only 30 mV maximum is needed to trigger. A front-panel sensitivity control and built-in meter allow adjustment of the input signal for maximum sensitivity. Pressing the "Test" switch gives a quick, accurate indication of proper counting.

The IB-102, which is supplied in kit form, comes with a heavy-duty aluminum case with combination handle/tilt-stand. Heath

Circle No. 13 on Reader Service Page

DIGITAL READOUT SYSTEM

A new displacement measuring system which operates as a ratiometer to provide a system accuracy to $+0.1\%$, $+1$ digit is now available. The system consists of a high-accuracy d.c.-d.c. linear variable differential transformer, a shielded cable with a connector at each end, and a $3\frac{1}{2}$-digit readout (0 to ± 1999).

The system operates at its rated accuracy with line voltage variations over the range of 98 to 125 V. Since d.c. transmission is used between

CIRCLE NO. 144 ON READER SERVICE PAGE

the transducer and the display unit there are no cable capacity and crosstalk problems, according to the company. Complete details are available on request. Pickering

Circle No. 14 on Reader Service Page

4-CHANNEL ADAPTER

The "Dynaquad" adapter, plus two additional speakers, combined with any existing stereo amplifier or receiver permits the reception of 4-channel sound from stereo records, tapes, or stereo-FM broadcasts.

The reflected sound components picked up automatically by the recording microphones during 2-channel recording are normally

masked by the so-called "Haas effect." These reflected sound components reproduced through the rear speakers provide the necessary 4-channel effect.

The adapter has a 4-position function switch with a special balance position for achieving precise adjustment among the four speakers in the system, a rear-level control for adjusting the volume of the rear speakers, and a function switch which may be used to operate the front and rear speakers separately. For normal listening the function switch is left in the "4 Ch." position.

The walnut-grained metal enclosure measures $5^3/_4$" wide × $4^9/_{16}$" deep × $2^7/_8$" high. Lafayette

Circle No. 15 on Reader Service Page

PANEL FUSEHOLDER

A new knob lens has been designed for the firm's "glow when they blow" 3AG indicating-type panel fuseholders and is fully interchangeable with the series 343 and 344 lenses.

The new lens is conical and extends $1^1/_8$" in front of the mounting panel and provides additional application flexibility to circuit and panel designers of electric instruments, computers, and commercial equipment, according to the company. As an added space-saving feature, the fuseholders extend only 1.56" behind the mounting panel. The fuseholder can be used as a pilot light with the lamp "on" to indicate continuous current flow. The lamp glows until the fuse blows, a reverse of the usual application of indicating-type panel fuseholders. Littelfuse

Circle No. 16 on Reader Service Page

VOLTMETER/DIGITAL DISPLAY

A true r.m.s. voltmeter that covers almost the whole spectrum of a.c. measurements has been introduced as the Model 3403A. The instrument measures d.c. and a.c. from 1 Hz to 100 MHz. Using a three-digit LED display with a fourth digit for overrange, the d.v.m. reads both in volts and, with an option, in decibels.

The a.c. voltage is measured from 10 mV to 1000 V full-scale with an accuracy of ±0.2% of

range. The instrument reads dBV from −60 to +60 with an accuracy of 0.1 dB.

A full range of options is available including autorange, BCD output, and remote programmability for systems applications. Analog outputs proportional to volts and decibels are available for use with analog recording devices.

The Model 3403A measures $4^1/_2$" × $7^3/_4$" × $9^1/_2$". Hewlett-Packard

Circle No. 17 on Reader Service Page

STEREO CASSETTE DECK

The new F-106E stereo cassette tape deck features a dual-bias selector switch and the company's exclusive "Endmatic" automatic shut-off system. With this system the tape transport stops, thereby eliminating tape tension. At the same time the tape-drive mechanism automatically disengages, avoiding any possibility of deformation to the rubber pinch roller. All push-buttons return automatically to the "off" position and the signal light indicating the end of the tape turns "on" and stays on.

The dual-bias selector provides for extended frequency response when used with the new super-dynamic cassettes. This feature permits selection of the proper bias setting for either standard or super cassettes.

The deck also features separate right- and left-channel record level controls with back-lighted vu meters, a remote start/stop control unit, tape counter, pause control, noise filter, and headphone monitoring. Frequency response is 40-12,000 Hz with wow and flutter less than 0.2% r.m.s. Concord

Circle No. 18 on Reader Service Page

MUSIC SYNTHESIZER

The recently introduced ARP 2600 P electronic music synthesizer is housed in a specially designed carrying case which provides protection against bumps and handling wear.

The synthesizer is a practical instrument for

individual performers and composers. A comprehensive manual on synthesizers, which is obtainable separately, has been prepared for guidance in operating the unit.

A table-top consolette version of the synthesizer in a wrap-around cabinet is also available. Tonus

Circle No. 19 on Reader Service Page

MIKE/PARABOLIC REFLECTOR

The new "Astro-Mike" kit, recently introduced, is designed for persons who want to tape record happenings, even at a distance.

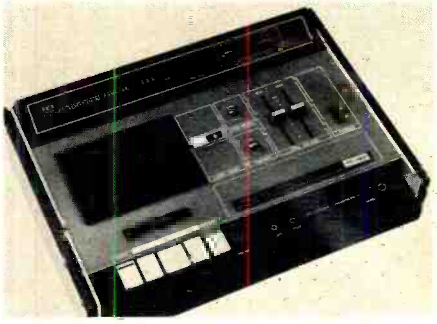
The kit includes a Model 2393B portable cassette tape recorder/player, an ultra-sensitive long-distance microphone with parabolic reflector, a hand-held remote-control microphone, a blank C30 cassette, an earphone, and six "C" cell batteries.

Complete details on this equipment are available on request. Bell & Howell

Circle No. 20 on Reader Service Page

STEREO CASSETTE DECK

The Sony Model 160 stereo cassette deck incorporates several major engineering advances including closed-loop dual-capstan drive which eliminates modulation distortion and reduces wow and flutter to an imperceptible 0.1%; a built-in peak limiter which reduces high-level transient peaks to the 0 vu level; and illuminated



tape pilot which indicates the mode of operation at a glance; and a headphone-level switch which adjusts the playback volume when monitoring through headphones.

The deck also includes a tape-select switch to optimize record equalization for standard or the new chromium-dioxide cassettes. Superscope

Circle No. 21 on Reader Service Page

CB ANTENNA

The "Sigma $^5/_8$" is a new legally installable 22-foot, $^5/_8$-wave ground plane antenna designed to provide strong, noise-free, long-distance performance. Although it must be installed 2 feet below the highest point on a house or building, the low-angle radiation take-off gives a ground hugging signal for longer distance and fewer dead spots, according to the company.

A matching loop which prevents burn-outs and detuning eliminates the need for coils or transformers. The radiator is adjustable for fine tuning and pre-marked for easy "no measuring" assembly. This telescoping section uses full circle clamps for positive electrical contact and sturdy construction. The heavy-duty radials have stainless-steel tips for reduced wind loading. The antenna is d.c. grounded to reduce static and noise. Avanti

Circle No. 22 on Reader Service Page

ENDLESS-LOOP CASSETTE

An endless-loop cassette designed specifically for industrial, business, and educational use is now on the market. The new cassette has a playing time of three minutes which, according to the company, is the longest that currently can be employed within the reliability and durability requirements of industrial use.

Endless-loop cassettes enable users to program the same message at planned intervals. They have application in alarm systems, point-of-purchase messages, and announcements in such places as elevators, museums, zoos, amusement parks, among others. Norelco

Circle No. 23 on Reader Service Page

STEREO TAPE DECK

A budget-priced 4-track stereo tape deck has just been introduced as the T-6100. The unit is enclosed in an open-faced oiled-walnut cabinet which can be mounted vertically for shelf use or operated horizontally. It features easy loading and can be single-hand threaded in seconds.

The circuit provides stabilized pressure between the pinch roller and capstan to protect the

tape and insure constant operating conditions. A sensing foil can be used to reverse the tape or it can be reversed by pushing a single button. A pause lever can be used for stopping the tape momentarily, during record or playback, making it easy to edit tapes.

The deck is a 4-track, 2-channel stereo or 4-track, 1-channel mono unit using reels up to 7" in diameter. It features three heads and can operate at either $7\frac{1}{2}$ or $3\frac{3}{4}$ in/s speeds. Frequency response is 30-20,000 Hz at $7\frac{1}{2}$ in/s and 30-13,000 Hz at $3\frac{3}{4}$ in/s. Pioneer

Circle No. 24 on Reader Service Page

SWEEP/SIGNAL GENERATOR

The Model ASG-1 audio sweep/signal generator is designed for use in the frequency range of 0 to 100 kHz. It will display the response characteristics of either active or passive circuits on a standard oscilloscope. Both swept and c.w. operating modes are provided and sweep width is variable from a few hertz to 100 kHz in a single sweep.

Output is adjustable from 0 to 5 volts peak-to-peak. A synchronized ramp output with adjustable amplitude is supplied for driving the horizontal input to the scope. If triggered operation is desired, generator blanking pulses are available. Sweep time is variable from 20 ms to 20 s for one sweep. Rameco

Circle No. 25 on Reader Service Page

STEREO POWER AMP

The Model 250 stereo power amplifier provides a full 250 watts r.m.s. continuous power throughout the audio spectrum, from 20 to 20,000 Hz, with both channels driven at or below the rated distortion, according to the company.

Among the features included in this new unit are illuminated professional output-level meters, operating over two selectable ranges permitting deflection sensitivity at output levels as low as 125 milliwatts. The amplifier is convertible for use on either 120 volts or 240 volts by simply changing internal connections to the tapped power-transformer primary.

A unique relay-operated protective circuit prevents damage to output transistors, power supply, or speakers from excessive levels of subsonic frequencies. It acts as a stabilizer, protecting speakers against high power surges and eliminating transient thumps and pops sometimes encountered in solid-state amplifiers. Marantz

Circle No. 26 on Reader Service Page

PORTABLE DIGITAL V.O.M.

The 460 digital v.o.m. features 26 switch-selectable ranges to cover a wide variety of testing situations. These include five a.c. and d.c. voltage, five a.c. and d.c. current, and six resistance ranges with accuracy from $\pm 0.1\%$ of reading, ± 1 digit.

Since no separate battery pack or power supply is needed, the unit is completely portable. Operation is from line power or batteries. The batteries are self-contained. Four nickel-cadmium rechargeable "D"-cell batteries will supply up to 8 hours of continuous operation. Power-line operation automatically recharges the batteries.

The numerical display is a $3\frac{1}{2}$-digit instant readout, with automatic overrange, plus and mi-

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nus indication. The front-panel analog meter shows peaks and nulls at a glance.

The 460 measures 4" × 8½" × 7⅞" and weighs 6½ pounds with batteries and 6¼ pounds without batteries. Bulletin T-811, available on request, gives complete details. Simpson Electric

Circle No. 27 on Reader Service Page

PROGRAMMABLE H.V. SUPPLY

A BCD digitally programmable power supply with outputs to 10 kV d.c. has been introduced as the Model RHR-10P100X241.

The unit features a line and load regulation of 0.02%, ripple of 0.1%, and an output accuracy of 0.2% of rating. It is capable of being voltage programmed by punch-card insertion to a computer or other programmer and will provide additive outputs in 10-volt steps in BCD code 1-2-4-8 in three decades, 10, 100, and 1000 volts d.c. Output current is 0 to 10 mA.

The supply is housed in a 19" rack-mounting cabinet with standard notching. Spellman

Circle No. 28 on Reader Service Page

FREQUENCY COUNTER

The latest addition to the company's line of frequency counters is the Model 150A automatic counter. This small, lightweight instrument can be operated from either standard a.c. or battery power sources to automatically measure and display frequencies from 5 Hz to 32 MHz.

Extensive use of IC's, especially medium-scale integration, makes the Model 150A compact and light. It measures only 4½" wide × 2" high × 7½" deep and it weighs less than 3 pounds. Monsanto

Circle No. 29 on Reader Service Page

NUMERICAL READOUT TUBE

The new NL-1222 numerical readout tube has a seated height of 1.456 inches, a diameter of 0.512 inch, and character height of 0.5 inch. It has been especially designed for applications where space limitations are critical, such as in modern digital instruments.

Designed for use at 170 volts d.c., the tube operates equally well in the d.c., strobe, or time-share modes, according to the company. It is available in a variety of base configurations and is designed for both solder-in and socket applications.

A data sheet with complete electrical and mechanical specifications will be forwarded on request. National Electronics

Circle No. 30 on Reader Service Page

MANUFACTURERS' LITERATURE

INSULATION RESISTANCE TESTS

How to test insulation resistance with the new "Meg-Chek" megohmmeters is described in a 34-page operation and applications handbook just published.

This handy pocket-sized booklet describes how the instruments can be used as an important tool in a preventive maintenance program. Operating instructions, setups and procedures for various test applications, and maintenance considerations are covered in detail with the help of schematics and photographs.

Copies of the handbook, Manual 17456, are available on request. Associated Research

Circle No. 31 on Reader Service Page

CAPACITORS & RESISTORS

A revised short-form catalogue that includes performance specifications on several recently introduced capacitors and resistors is now available as EPD DSF-1.

The four-page, illustrated folder lists performance characteristics, physical descriptions, and military designations for each of the company's glass and glass-ceramic capacitors and glass tin-oxide film resistors. The firm's BX semi-precision capacitors and miniature NC3 high-reliability and high-voltage flameproof resistors are also covered. Corning Glass

Circle No. 32 on Reader Service Page

KIT/WIRED PRODUCTS

Some 250 products in both kit and wired versions, in nine lines, are covered in a new 32-page catalogue now ready for distribution.

Included are photographs and complete specifications on stereo components, audio color organs, projects of various types, solid-state test equipment, accessories, strobe lights, and ham gear. Eico

Circle No. 33 on Reader Service Page

RFI SHIELDED CHAMBERS

A four-page folder which describes the construction and performance of several types of RFI shielded chambers is now available from Emerson & Cuming, Inc., Canton, Massachusetts 02021.

Chamber size may vary from 130 feet by 100 feet to 8 feet by 8 feet. The firm is prepared to design and construct the chamber to a customer's specifications or supply parts so that the customer can make his own installation or shield an existing area.

The brochure lists the typical insertion loss versus frequency which is achievable with each type of construction. The shielding effectiveness against magnetic fields, electric fields, and plane waves is also shown.

ALUMINUM ELECTROLYTICS

A new 16-page Engineering Bulletin, 3431C, providing detailed information on the company's "Powerlytic" aluminum electrolytic capacitors for use in computer main-frame peripheral power supplies, energy storage applications, and industrial control equipment, is now available for distribution.

The bulletin provides complete information on all standard ratings in the new extended-range design, performance characteristics, and a guide to application and operation which gives full data on permissible r.m.s. ripple current.

The Technical Literature Service, Sprague Electric Co., 51 Marshall St., North Adams, Mass. 01247 will forward a copy on request.

CABLE-STRIPPING TOOL

A single-page data sheet describing a new stripping tool for single- and double-braid cable is available from the Electronic Components Division of Deutsch Company, Municipal Airport, Banning, California 92220.

The brochure pictures this manual tool, which makes the clean, square-shouldered cuts required to cold strip single- or double-braid cable and leave it ready for termination, and explains its special features.

When writing, request a copy of Bulletin No. 107.

INDUSTRIAL INSTRUMENTS

Heath Company, Benton Harbor, Michigan 49022 has just issued a 68-page catalogue covering its line of scientific instrumentation for industrial and academic labs.

Pictured and described is an extensive line of kit and assembled instruments and systems including digital timing and power modules; readout modules; TTL logic circuits; binary information and auxiliary modules; universal digital instruments; lab instrumentation; servo-chart recorders; power supplies and voltage reference sources; all types of scopes, generators, and operational amplifiers; v.t.v.m.'s and resistance boxes; and spectrophotometers plus hundreds of components, accessories, and expansion circuits designed to be used with the basic equipment.

WIRE, CABLE & CORD

Standard Wire and Cable Company, 3440 Overland Ave., Los Angeles, California 90034 has just issued a 110-page technical manual and catalogue covering wire, cable, and cord for every application.

The catalogue is divided into five sections: a comprehensive listing of products with complete technical information; a glossary of wire and cable terminology; a complete listing, definitions, tables, and illustrations covering coaxial cable; a comparison chart which lists military specification wires, uses, construction, and ratings; and general wire tables, charts, and conversion factors.

VISUAL CONTROL SYSTEMS

Methods Research Corporation, 105 Willow Avenue, Staten Island, New York 10305 has just issued a new 28-page catalogue covering 49 sizes of standard boards and over 100 accessories which comprise the firm's magnetic visual control systems.

The brochure shows in pictures and text how the boards can be used for handling every type of job a company would want done in maintaining perpetual data for daily, weekly, monthly, or yearly use in scheduling, inventory control, production planning, shipping and ordering, and personnel management.

ZENER-DIODE GUIDE

A six-page zener-diode selection guide, detailing more than 700 part numbers in various packages, voltages, and amperages is now available from Microsemiconductor Corporation, 11250 Playa Court, Culver City, California 90230.

The material is presented in handy tabular form for quick selection of a specific diode to handle a particular job. Mechanical configurations are also included.

Requests for a copy of this guide should be directed to the attention of Sharad Rastogi at the company.

LOGIC HANDBOOK

Signetics Corporation, 811 East Arques Ave., Sunnyvale, California 94086 has just re-issued the second volume of its "MSI Specifications Handbook, Series 8000 Designer's Choice Logic."

This volume covers the company's arrays and provides information on design considerations, electrical characteristics, and explains the firm's "Sure" program of testing these medium-scale integrated circuits.

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Regulator Nomograms

(Continued from page 33)

we cross the center (W) scale at 0.044 watt. A half-watt resistor would be more than adequate.

Since we have a 10-volt zener, we enter this value on the first scale on the left. Since the zener will hold the voltage on one side of the series-dropping resistor at 10 volts, then the 15-volt no-load voltage of our power supply will drop 5 volts across the series resistor. This can produce a 55-mA current through the resistor of which 20 mA will be required in the load, leaving 35 mA through the zener. Entering the far-right scale at 35 mA and joining the far-right and far-left scales with a dashed line, we find the zener power to be 0.35 watt. If we assume that it is possible for the load to be disconnected, the latter two numbers could be 55 mA for the zener and 0.55-watt dissipation. Hence, in either case a 1-watt zener would probably provide an adequate safety factor.

The fourth nomogram, Fig. 5, can provide trade-offs to determine the regulation to be expected or can help to determine the parameters necessary to select a zener for a given performance. The first three scales on the left are power-calculation scales using the familiar:

$$P_Z = E_{R(load)} I_Z$$

where: P_Z is zener power consumption, $E_{R(load)}$ is zener and load voltage, and I_Z is zener current.

The three scales on the right make use of the manufacturer's data on the zener temperature sensitivity. The two scales on either side of the center (R) scale, P_Z and R_P, are used to determine the final regulation to be expected from our system. These three scales are used with the equation:

$$R_P = C_T R_T$$

where: R_P is regulation sensitivity in percent per watt, C_T is temperature coefficient in percent per °C, and R_T is thermal resistance in °C per watt.

For example, repeating the zener power calculations of the last nomogram using $E = 10$ volts on the left scale, $I = 35$ mA on the second scale, we reach $P = 0.35$ watt on the third scale.

Then if the manufacturer gives the temperature coefficient as 0.10%/°C for the zener we are considering, this value is entered on the far-right scale. If this particular zener also has a thermal resistance of 20°C/watt, this is entered on the R_T scale. A line joining these points and extending to the left will intersect the R_P scale at 2.0%/watt. Now a line joining this point with 0.35 watt on the P_Z scale crosses the R scale at 0.7% which is the over-all expected regulation. ▲

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CIRCLE NO. 139 ON READER SERVICE PAGE

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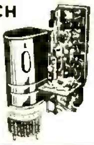

• (ITEM #7-906) -- Amazing telephone selector switch. Great experimental item. When used with two-wire telephone dial will select any number from 0 to 100. Make intercom or private system. Use to turn on remote lights, start motors, etc. Complete with contact bank. 13" x 6" x 5". (16 lbs.) Cost Over $90.00 **$6.29**

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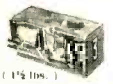

• (ITEM #21-959) -- Use to count electrically. Use to count number of times door is opened after business is closed, to show changing prices, laboratory uses, etc. Will count 1 for each pulse and will transfer 10th count to next unit. 4½" x 1¾" x 1½".

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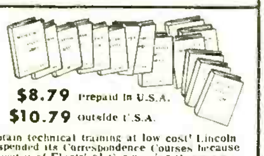

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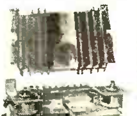

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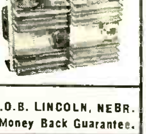

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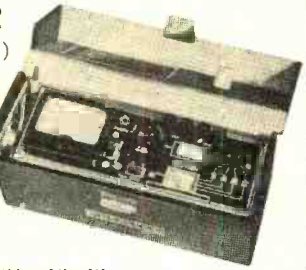

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400	.75	.85	.95
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TRIACS

PRV	1 AMP	3 AMP	6 AMP	10 AMP	15 AMP
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200	.65	.75	1.00	1.40	1.80
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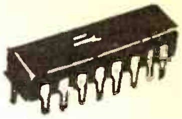

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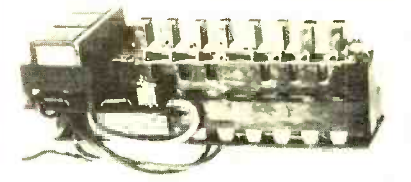
MOTOR SPEED & LIGHTING CONTROL



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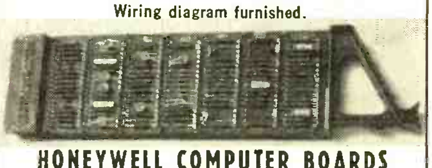

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ELECTRONICS WORLD

July 1971

ADVERTISERS INDEX

R.S. No.	ADVERTISER	PAGE
	A.P.M. Systems	69
150	Akai	26
	Allied Radio Shack	21, 73
149	Audionics	66
148	B. & F. Enterprises	77
147	B & K	54
	CREI, Home Study Division, McGraw-Hill Book Company	5
145	Cleveland Institute of Electronics Engineering	56, 57, 58, 59
144	Computronics Engineering	71
143	Crystek	4
141	Delta Electronics Co.	79
142	Delta Products, Inc.	75
140	Edmund Scientific Co.	80
116	Edsyn Inc.	54
114	Electro-Voice, Inc.	FOURTH COVER
139	General Sales Co.	76
	Goodheart, Co., R. E.	76
138	Grantham School of Engineering	22, 23, 24, 25
137	Greenlee Tool Co.	20
136	Gregory Electronics Corporation	78
115	Health Company	49
134	Johnson Company, E. F.	69
133	Judson Research & Mfg. Corp.	51
	Lampkin Laboratories, Inc.	51
132	Liberty Electronics, Inc.	78
131	Mallory & Co., Inc., P. R.	2
130	Memorex Recording Tape	SECOND COVER
129	Meshna Jr., John	79
	National Radio Institute	16, 17, 18, 19
	National Technical Schools	9
128	Olson Electronics	53
127	Park Electronic Products	78
126	Penwood Numechron Co.	53
125	Poly Paks	79
	RCA Institutes, Inc.	62, 63, 64, 65
124	Record Club of America	10, 11
123	Schober Organ Corporation, The	61
122	Sencore, Inc.	1
121	Solid State Sales	77
	Surplus Center	77
	Sylvania	12
119	TEAC Corporation of America	THIRD COVER
110	Toyo Radio of America, Inc.	55
118	V-J Products, Inc.	20
	Valparaiso Technical Institute	66
117	Xcelite, Inc.	8
	Classified Advertising	76, 77, 78, 79

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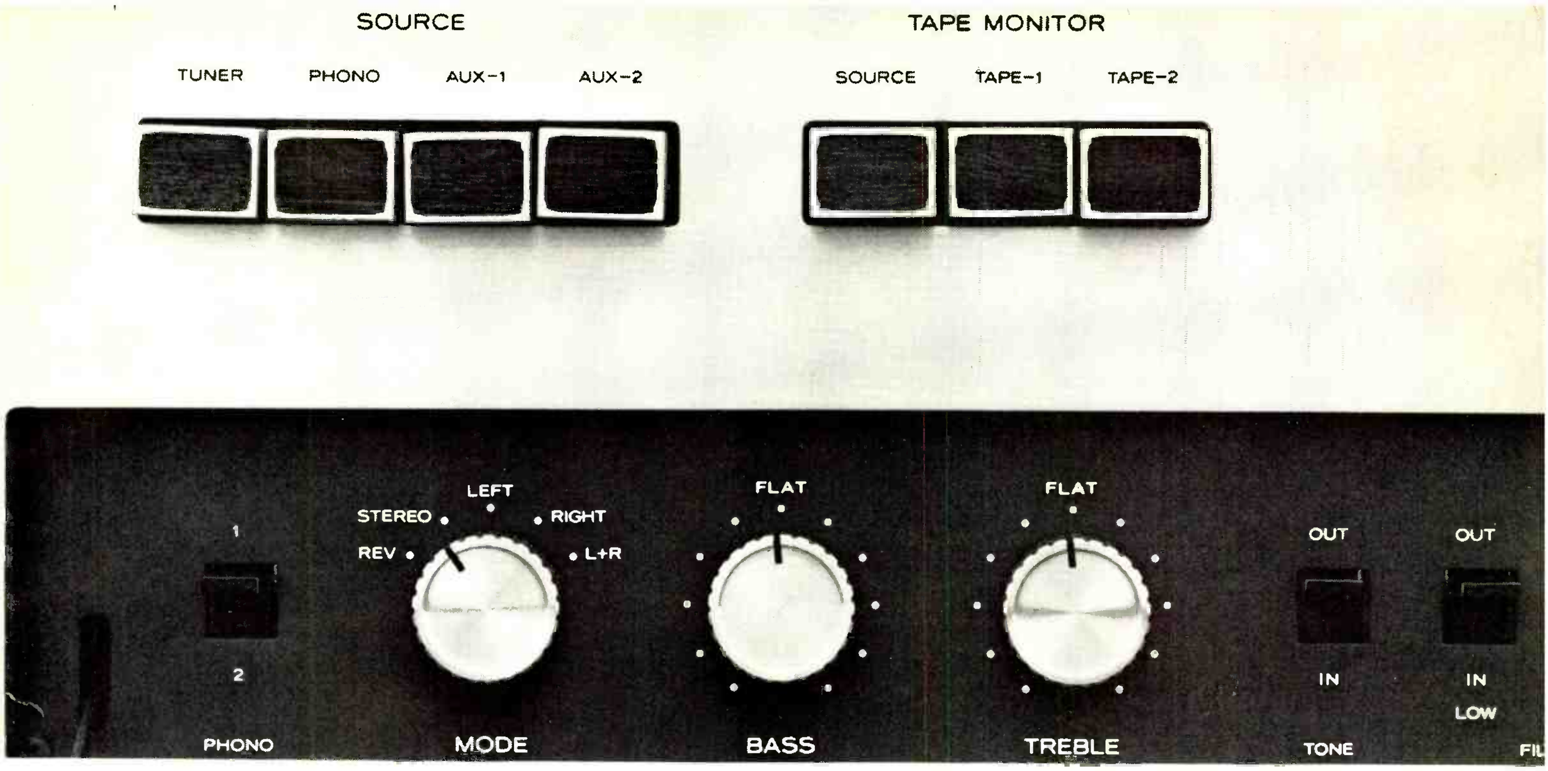


The TEAC Consort series: Tape-ability is its most important capability.

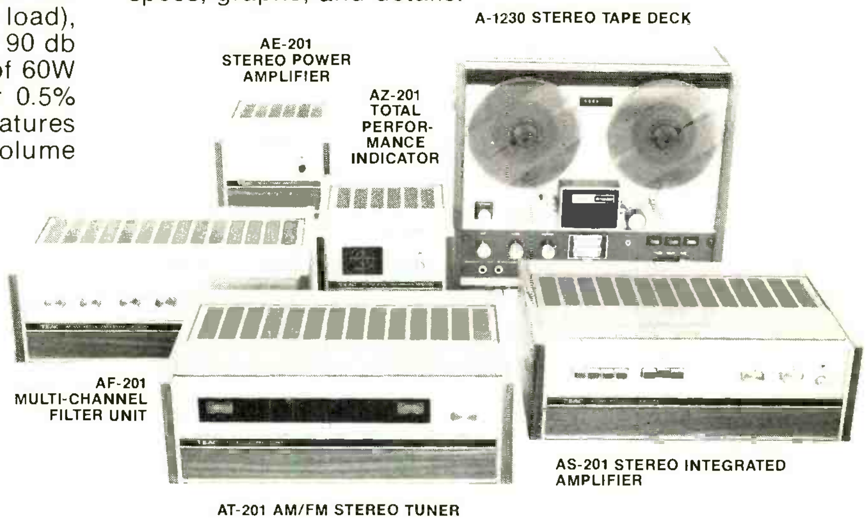
This total-capability component system is designed first and foremost for tape, as if tape had just been invented. With it, TEAC launches a new age of magnetic recording and listening.

Lead instrument of the TEAC Consort is the AS-201 Integrated Amplifier—a complete tape-oriented audio control center. It permits simultaneous recording and monitoring on as many as three tape decks, from as many as five inputs: tuner, phono (hi & low) and 2 Aux. The AS-201 incorporates differential-type amplifier circuitry—originally designed for precision computer and data recorders—as well as FET pre-amp sections to achieve very low distortion characteristics, wide frequency response (20-80,000 Hz $\pm$0.5 into 8 ohm load), S/N ratio of 70 db or more for phono inputs and 90 db or more for high level inputs and power output of 60W per Channel (rms) into 4 ohm load with under 0.5% harmonic distortion at rated output. Other features include stepped tone controls, constant S/N volume controls, automatic protective muting-circuit and many other quality conveniences.

Another major Consort instrument is the AT-201 AM/FM Stereo Tuner—a spectacular performer for both primary and fringe-area reception. It utilizes FET FM inputs for selectivity of 70 db or better, capture ratio of less than 0.1 db and distortion of less than 0.3%. Other features include variable-level FM muting, two tuning meters and output-level control.

Other fine instruments in the Consort Series include the AF-201 Multi-Channel Filter Unit for matching three-way speaker systems to any room acoustics, and the AE-201 Stereo Power Amplifier (50 W/channel) for use in multi-channel installations. Crowning touch to the TEAC Consorts is the AZ-201 Total Performance Indicator for real-time scope monitoring of FM and audio stereo separation, phasing, balance and signal strength. Also available in the series is the LS-80M 3-way speaker system with a frequency response of 30-20,000 Hz.

Step into a new era with the whole TEAC Consort Series. As the first step we invite you to write for a brochure of specs, graphs, and details.



TEAC®

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CIRCLE NO. 119 ON READER SERVICE PAGE

4-CHANNEL SOUND

Electro-Voice takes the first practical step:

EV STEREO-4™

compatible four channel

{Being more a progress report than an advertisement.}

The Promise

Thousands of people have heard 4-channel stereo reproduction at hi-fi shows and special demonstrations in the last few years. Others have read about this fascinating and rewarding technique that promises more faithful reproduction of musical performances. Early experiments have also shown 4-channel to be an effective tool in creating new sonic environments for both serious and popular musical forms. The concept has met with almost universal critical acclaim, and strong general approval.

The Problem

But alas only a handful of enthusiasts can actually enjoy this advance today. Because only a few 4-channel tapes have been produced for sale. The problem is simple, but basic: 4-channel means just that—four separate signals. And to reproduce it properly demands four of everything, right down the line.

Using four amplifier channels and adding four speakers is easy. Even creating a 4-channel tape recorder is practical (although expensive). But the stumbling block has been finding a way to put four completely independent signals in a record groove, or broadcast them over a standard stereo FM station.

And if you can't buy a 4-channel disc, or hear it on FM, the market is limited to a precious few 4-channel tape owners. But their numbers are so small that record companies just can't afford to release four channel material. So they continue to produce 2-channel stereo that you *can* play (and that they can sell in volume).

EVX-4 Stereo-4 Decoder

The Way Out

Now Electro-Voice has moved to break the impasse. With a system that can offer the significant advantages of discrete 4-channel, yet is compatible with present record playing equipment and present FM broadcasting. It is called STEREO-4.

STEREO-4 is a system that encodes four channels into a stereo signal that *can* be transmitted over FM or recorded on a disc. In the home you add a STEREO-4 decoder, plus another stereo amplifier and a pair of rear speakers. The result is reproduction that closely rivals the original 4-channel sound. Four different signals from your speakers, with a feeling of depth and ambiance you have never before heard from any record.

Admittedly, STEREO-4 is not quite the equal of 4 discrete signals. But while there is some loss of stereo separation, there is no reduction in frequency response or overall fidelity. We might note that this reduced separation actually seems to aid the psychoacoustic effect for many listeners in normal listening situations. And on the plus side, STEREO-4 offers an advantage that even discrete 4-channel cannot provide.

The Remarkable Bonus

Playback of almost all of your present 2-channel stereo library is greatly enhanced when fed through the STEREO-4 decoder. It's the result of multi-microphone recording techniques that include a remarkable amount of 4-channel information on ordinary stereo discs and tapes. Adding STEREO-4 releases this hidden information for you to enjoy.

The Details

A STEREO-4 Model EVX-4 Decoder costs just $59.95. And with it, plus 4 speakers and dual stereo amplifiers, you're equipped for almost any kind of sound available. Encoded 4-channel, enhanced stereo, regular stereo, *and* discrete 4-channel (assuming suitable source equipment). Even mono. So you have the one system that is completely compatible with the past, present, and foreseeable future.

The Present

And what about encoded 4-channel discs and broadcasts? Well, recording companies have already started mastering STEREO-4 records, and more are joining in. And STEREO-4 is now being broadcast in many major cities around the country.

The Future

Like you, we hope for the day when discrete 4-channel sound will be commonplace on records and FM, and your STEREO-4 decoder will be relegated to enhancing your present library. But that day will have to wait until some very knotty design problems are solved. And probably after a host of new FCC regulations define an utterly new system. Indeed, there is serious question whether these problems can be solved at all.

In the meantime, the STEREO-4 system is getting 4-channel recordings into the marketplace in increasing numbers, in a form that people can enjoy. Hear STEREO-4 at your E-V soundroom soon. And ask your local FM station for a schedule of STEREO-4 broadcasts. Or write us for complete information. It's not too soon to start planning for tomorrow.

ELECTRO-VOICE, INC., Dept. 714N,
629 Cecil Street, Buchanan, Michigan 49107

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2560 Nidau, Switzerland

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