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75¢ ■ SEPT. 1975

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MITS Altair Computer Report II

MITS Announces Lower Memory Prices!

On July 1, 1975, **MITS lowered the price** of the Altair 1K Static Memory Card (88-1MCS). The kit price was dropped from $176 to **just $97** while the assembled price was dropped from $209 to $139.

This price reduction was made possible by a reduction in the price of the Altair 1K 8101 memory chips.

Also affected was the price of 88-MM 256 byte (word) memory modules. The $53 kit price was lowered to just $14 and the $61 assembled price to $26.

Altair BASIC—Not Just Anybody's BASIC

Altair BASIC is an easy-to-use programming language that can solve applications problems in business, science and education.

You will find that with only a few hours of using BASIC that you can already write programs with an ease that few other computer languages can match.

Altair BASIC doesn't compromise power for simplicity. While it is one of the simplest computer languages in existence, it is also a very powerful language.

ALTAIR BASIC comes in three versions. The first of these is a 4K BASIC designed to run in an Altair with as little as 4,000 words of memory. This powerful BASIC language has **6 functions** (RND, SQR, SIN, ABS, INT, and SGN) in addition to **15 statements** (IF . . . THEN, GOSUB, RETURN, FOR, NEXT, READ, INPUT, END, DATA GOTO, LET, DIM, REM, RESTORE, PRINT, STOP) and **4 commands** (LIST, RUN, CLEAR, SCRATCH).

The second ALTAIR BASIC option is the 8K BASIC designed to run in an Altair with as little as 8,000 words of memory. This BASIC language is the same as the 4K BASIC only with **8 additional functions** (COS, LOG, EXP, TAN, ATN, INP, FRE, POS) and **4 additional statements** (ON . . . GOTO, ON . . . GOSUB, OUT, DEF) and **1 additional command** (CONT). This BASIC has a multitude of advanced STRING functions and it can be used to control low speed devices—**features not normally found in many BASIC languages.**

The third ALTAIR BASIC is the EXTENDED BASIC version designed to run on an Altair with as little as 12,000 words of memory. It is the same as the 8K BASIC with the addition of PRINT USING, DISK I/O, and double precision (13 digit accuracy) add, substract, multiply and divide.

Altair BASIC is only the beginning. MITS is currently engaged in an extensive software development program. Other software now available includes an Assembler, System Monitor, and Text Editor.

Altair software comes with complete documentation.

One Month Specials

The Altair Users Group is quite possibly the largest computer hobbyist organization in the World. It is both a means of communication among Altair Users and a method of building a comprehensive library of Altair programs. All Altair 8800 owners are entitled to a free, one year membership in this group.

For one month only, you can become an Associate Member for one year at a reduced rate of $10 (regularly $30). Among other benefits you will receive a subscription to the monthly publication, **Computer Notes,** which contains complete update information on Altair hardware and software developments, programming tips, general computer articles and other useful information.

Now available is the **Altair Software Documentation Book I** which contains technical data on the Altair Assembler, Text Editor, System Monitor and BASIC language software. This documentation is free to purchasers of Altair BASIC. For one month only, it is being offered for only $7.50 (regularly $10).

Offers good until September 30, 1975.

The 1K Static Memory Card contains 1024 bytes of memory with a maximum access time of 850 nanoseconds.

Now ready for production is the new Altair 2K Static Memory Card (88-2MCS) with 2048 bytes of memory. Like the 1K Static Memory this new card contains memory protect features and provisions for disabling the ready.

It has a maximum access time of 850 nanoseconds and is engineered with the finest components available. It is inexpensively priced at $145 kit and $195 assembled.

HARDWARE PRICES:

Altair Computer kit with complete assembly instructions	$439
Assembled and tested Altair Computer	$621
1,024 Byte Static Memory Card	$97 kit and $139 assembled
2,048 Byte Static Memory Card	$145 kit and $195 assembled
4,096 Byte Dynamic Memory Card	$264 kit and $338 assembled
Full Parallel Interface Card	$92 kit and $114 assembled
Serial Interface Card RS232)	$119 kit and $138 assembled
Serial Interface Card (TTL or Teletype)	$124 kit and $146 assembled
COMTER II*	$780 kit and $920 assembled

*The Comter II Computer Terminal has a full alpha-numeric keyboard and a highly readable 32-character display. It has its own internal memory of 256 characters and complete cursor control. Also has its own built-in audio cassette interface that allows you to connect the Comter II to any tape recorder for both storing data from the computer and feeding it into the computer. Requires an RS232 Interface Card.

SOFTWARE PRICES:

Altair 4K BASIC	$350
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Altair PACKAGE ONE (assembler, text editor, system monitor) Purchasers of an Altair 8800, 8K of Altair Memory, and Altair I/O	ONLY $30

NOTE: When ordering software, specify paper tape or cassette tape.

Warranty: 90 days on parts for kits and 90 days on parts and labor for assembled units. Prices, specifications, and delivery subject to change.

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SEPTEMBER 1975 Vol. 46 No. 9

ON THE COVER

This electronic doorbell is really a computer in disguise. You program it to play the tune of your choice. The memory is a PROM. To get started now, ***turn to page 33.***

A NEW TURNTABLE that doubles as a changer is available from B.I.C. We've run it through our lab so we could tell you how well it works. **.... see page 53**

TOO MUCH SIGNAL at the antenna terminals of your TV receiver can cause some serious problems. Why this happens and what you can do about it are described in the article starting on page 58.

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looking ahead

TV's 'boundaries'

Giant-screen displays, huge reduction in bandwidth and higher-resolution pictures are distinct technical possibilities within the next 10 years. These are among the conclusions in a three-volume report, *Technological Boundaries of Television*, issued by the FCC after a two-year commissioned study by consultant Raymond Wilmotte.

Wilmotte's report sees 4 × 6-foot pictures as within the purchasing power of high middle-class homes within the next decade. He cites the "Sampledot" system already developed by General Electric as a major step toward a drastic cut in television bandwidth. G-E has achieved television transmissions in 25 percent of the present bandwidth with only minor picture impairment, and Wilmotte forecasts that the picture of the future may require only 5 or 10% of the existing bandwidth for a sharpness equal to that of present broadcasts.

He also sees the possibility of increasing the resolution of the television picture to 1,100 lines, but says the effect would make "a difference that is very noticeable to some, but not very significant to others." He adds this tribute to the current TV standards: "Generally speaking, the quality obtainable today on a good television set can be considered as very good. It is indeed surprising that the complex standards established over 20 years ago were so good that in this age of rapid technological advance, no truly significant improvements have been found."

His study sees direct satellite-transmission worth further investigation and questions whether "the benefits of uniformity of service, of providing even remote and mountainous areas with the same quality of service available to large cities, were given the consideration they deserve." He also believes careful study should be given to frame-grabbers and vertical-interval transmissions which could present graphic or written material along with TV broadcasts.

As to the concept of a nation completely connected by cable, Wilmotte feels it "is a long way off in time and would require an enormous investment." The report concludes that private industry, rather than government, should continue to finance hardware research.

Slipped disc

The videoplayer seems once again to be sinking slowly over the horizon—into the future, that is. As reported here, both RCA and Philips-MCA have pledged to have their respective videodisc systems on the American market late in 1976. Now Zenith, which has extensively researched videodiscs, comes up with the statement that it won't market any such device until "1979 at the earliest." It's not that Zenith isn't sold on videodiscs—indeed, it's enthusiastic—but it doesn't see it as ready for serious marketing for four years or more.

At any rate, you're well advised not to hold your breath. Like the giant-screen electroluminescent picture-on-the-wall TV, the practical family-priced videoplayer is another gadget which moves further into the future as time goes by. Don't miss our exclusive report in 1979 forecasting a home videodisc system by 1982. To be followed by a subsequent report in 1982 forecasting . . . well, you know.

Domestic satellite TV

Nothing has excited broadcasters and cable-TV operators in recent years so much as the inauguration of domestic satellite service. At press time, Western Union's *Westar* was the only one in operation over the U.S., but the Canadian satellite was being used by some American companies and the launching of the RCA bird was anticipated. The Corporation for Public Broadcasting, in charge of facilities for the nation's non-commercial broadcasters, has already advertised for bids for 160 earth stations. The advantages over using the telephone company's land lines for TV, according to CPB President Henry Loomis, include not only cost but the fact that a television signal can be carried by satellite interlaced with two pairs of sound tracks, providing stereo radio and stereo or two-language television on the same carrier. In addition, specialized programs can be used selectively by stations with specialized interests (for example, Spanish-language programs could be beamed to New York, Chicago and Los Angeles) without the necessity of these outlets being located in the same geographical area.

The idea of connecting cable systems via satellite for pay-TV broadcasting is picking up steam rapidly. The nation's biggest cable-TV owner, Teleprompter, is requesting permission to erect 20 earth stations and plans eventually to make Home Box Office service available to more than 80% of its over one million subscribers across the country. UA Cablevision has already started preparing for Cable-TV earth stations, and virtually every other major cable operator is excited about the prospect. The independent television networks, such as TV News and Target Network, are exploring use of the satellite to distribute their programming to stations. The major networks, of course, have been looking into the situation for years but could be the last to move because of their long-time ties with AT&T.

Crowded CB

As badly crowded as the Citizens' band is, it's bound to get worse before the FCC finally gets around to doing something about it—such as enlarging the band and switching all transmissions to SSB. One major clue came at the recent Consumer Electronics Show in Chicago. The CES this year seemed to mark the debut of CB as a major consumer product—as did the Newcom show held earlier in Las Vegas. Some 28 of the CES exhibitors displayed CB radios—mostly mobile, and some in strange formats, such as combination eight-track tape player, stereo FM, AM and transceiver.

Virtually every CB manufacturer was back-ordered. Many of them weren't accepting any new customers. They all agreed their product was in demand, but nobody really knew why. There were some suggestions that consumer demand might not be as great as it appeared, and that most of the clamor for CB equipment may be from dealers who had suddenly discovered the field and wanted to enter. For years CB was traditionally a parts-house product, but recently it has moved into such huge chains as Sears, Ward and J. C. Penney—and the next step is to the appliance dealer and the discounter. Just filling up the distribution pipelines requires a huge supply. Suppose there's not a real consumer boom—just a distribution boom? Well, that means shoppers for CB gear might get themselves some great bargains in about a year when disillusioned retailers start liquidating their CB inventories.

Zoom

In a new TV-model season virtually devoid of innovation, one feature stands out. This is the "zoom" feature on a new remote-control by Zenith. When the viewer presses the zoom button on the noiseless hand-held remote unit, the center portion of the picture is enlarged by 50% for an instant close-up.

Now, this may sound a little familiar to old-timers. As a matter of fact, the same principle was used in the first Zenith black-and-white sets (the ones with the round picture, remember?), except that the close-up was activated by a switch below the picture tube.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Talk about Microwave Tube Replacements and whose name comes up first?

Amperex.

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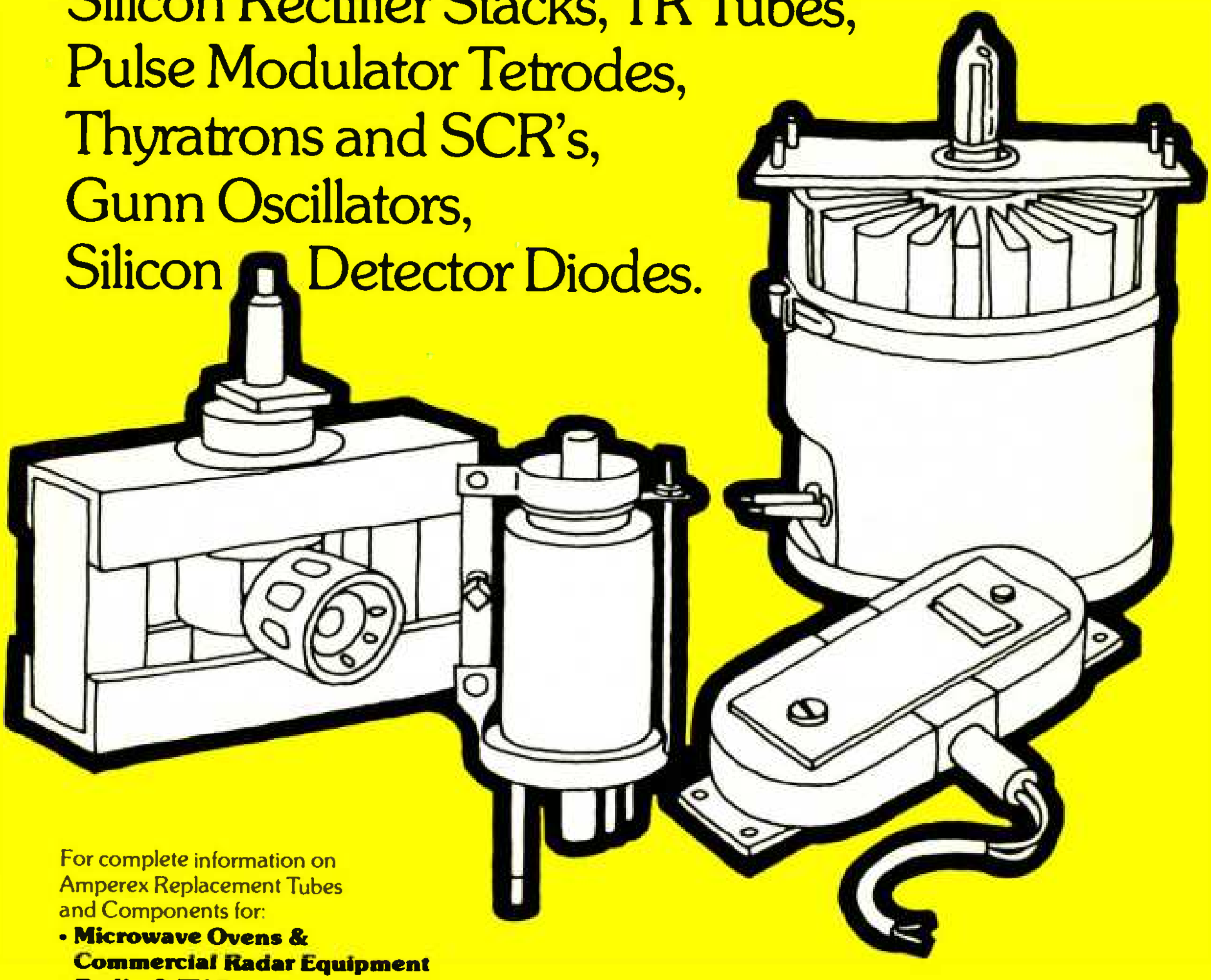

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Last of the pioneers is gone—Alexanderson dies at age 97

Ernst Frederik Werner Alexanderson, the last survivor of the great radio pioneers of the turn of the century, died May 14. He was 97 years old. Famous as the inventor of the high-frequency alternator that made high-power transatlantic radio telegraphy possible, for early work in television and for numerous other radio inventions, he also did important early work in high-voltage DC power transmission. He was granted 342 patents during his lifetime, 322 of which were awarded him during his 46-year career with General Electric—an average of one patent every seven weeks.

E. F. W. ALEXANDERSON

Born in Sweden and educated there and in Germany, he came to the United States in 1901. He immediately visited Dr. Charles Steinmetz of General Electric, whose works he had read, and started to work for G.E. In 1904 he was entrusted with the task of constructing a high-frequency alternator—to generate power at 100 kHz—following specifications supplied by Professor Reginald Fessenden. It was completed after two years' work and experiment, and installed at Fessenden's station at Brant Rock, Massachusetts. There, on Christmas Eve, 1906, it transmitted over a radius of several hundred miles, the first voice and music broadcast in history.

Not entirely satisfied with Fessenden's approach, Alexanderson designed and built another alternator with an iron core and other new features. When demonstrated, it was so much better than earlier machines that Fessenden himself had the Alexanderson ideas embodied in two alternators General Electric was building for him at the time. The Alexanderson alternator became the standard transmitter for high-power radio transmission until it was superseded by tube transmitters.

Alexanderson's invention of the magnetic amplifier was used first as a magnetic modulator for the alternator. Also superseded by vacuum-tube devices, magnetic amplifiers are still used in some applications where a rugged and reliable device for controlling alternating current with small amounts of DC is required.

Applying his theory of multiple tuning for long-wave antennas, Alexanderson further improved transatlantic transmission. Six tuned downleads along the mile-long antenna of the New Brunswick (NJ) station, which had a power of 200 kW and an antenna current of 400 amperes, increased its output ten times.

During World War I, the government turned to Dr. Alexanderson for help in receiving radio messages through impenetrable German interference. He and an assistant, Harold Beverage, found that an antenna consisting of a wire two miles long stretched in the direction of Europe, with another two-mile wire stretched in the opposite direction and connected to it through balancing coils, not only eliminated the German radio barrage but also greatly reduced natural static.

In 1919, the Radio Corporation of America (now RCA) was formed, with General Electric as one of the parent companies. Alexanderson became the chief engineer of the new company. He divided his time from 1919 to 1924 between R.C.A. and G.E., and supervised the construction of radio stations in various parts of the world. At the opening of a new Swedish transatlantic station, he received the Order of the North Star from King Gustav V.

Alexanderson turned his attention to television in the late '20's. His transmitter was in his lab and he had a receiver in his home. Thus, in 1927, he had the first demonstration of home television. (After retiring from G.E. in 1948, he again joined RCA for a time, as a consultant working in the field of color television.)

As early as 1923, Alexanderson had applied for a patent for an inverter, a device to change AC to DC and to reverse the process. Following the issue of the patent—in 1931—he carried on work in the extremely-high-voltage transmission of power. In 1936, under Alexanderson's direction, G.E. installed a pioneer high-voltage DC power line between Schenectady and Mechanicville, about 15 miles away, using inverters to step the current up to high-voltage DC for transmission and to change it back to AC at ordinary voltages at the other end.

Dr. Alexanderson was elected to the Royal Academy of Sweden—the body that bestows the Nobel Prizes in science—in 1934. Besides the Order of the North Star, he received the IRE Medal of Honor in 1919, Knighthood of the Polish Order of Polonia Restituta in 1924, the John Ericsson medal in 1928, the Edison Medal of the AIEE in 1944, the Cedergren Gold Medal from the Royal Technical Institute of Sweden in 1945 and the Royal Danish Medal in 1946. He was a fellow and past president of the IRE and a fellow of the AIEE, before the two merged into the present IEEE, and received a number of honorary degrees from U.S. and Swedish institutions.

Widowed twice, Dr. Alexanderson is survived by his third wife, four children, nine grandchildren and five great-grandchildren.

Driverless busses are on the way!

A driverless bus is being studied at the Transport and Road Research Laboratory, Crowthorne, Berkshire, England. The original object of research was to reduce dangers due to driver fatigue. The solution that was discovered was—eliminate the driver! The bus remains over a buried electrical cable in the roadway and will follow it around fairly sharp bends.

THE MAN IN THE DRIVER'S SEAT in this bus is not driving; he is observing and reporting on the action of a driverless bus.

The object of research is now to provide a commuter or interurban bus, using a driver to take the coach through the town and pick up passengers. Then it moves out onto the roadway, the driver

(continued on page 12)

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Circle 4 on reader service card

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Almost half of the successful TV servicemen have home study training and with them, it's NRI 2 to 1.
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**Summary of survey results upon request.*

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As a part of NRI's Master Course in TV/Audio servicing, you build a big-screen solid state color TV with every modern feature for great reception and performance. As you build it, you perform stage-by-stage experiments designed to give you actual bench experience while demonstrating the interaction of various stages of the circuitry. And your TV comes complete with console cabinet, an optional extra with other schools. Likewise, NRI's instruments are a cut above the average, including a 3½ digit precision digital multimeter, triggered sweep 5" oscilloscope, and integrated circuit TV pattern generator. They're top professional quality, designed to give you years of reliable service. You can pay hundreds of dollars more for a similar course and not get a nickel's worth extra in training and equipment.

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new & timely

(continued from page 6)

lines it up with the guiding cable, sets the speed for the trip, and departs. Closing the door starts the bus that proceeds automatically to the city of its destination.

An optical detector emits a modulated infrared beam that is reflected to a photocell on the bus from any object blocking the road, applying brakes and stopping the vehicle till the road is clear. On arrival at the end of the cable, the bus stops and is boarded by another driver, who guides it through the town and debarks passengers. The bus is still confined to the grounds of the research institute, but one 80-mile stretch of motorway has already been fitted up with a buried cable. So it may not be long before at least one driverless bus is seen plying the roads of England!

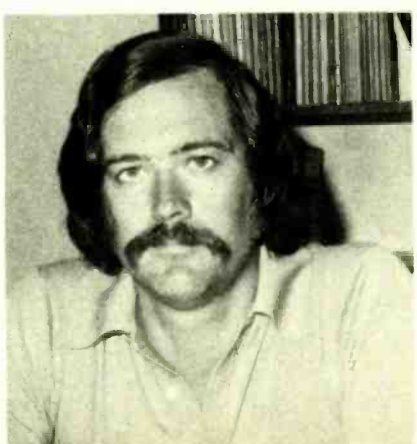
Hugo Gernsback Memorial Awards continue for 1975-76

Radio-Electronics makes a scholarship grant of $125 annually to eight deserving students—one in each of eight leading home-study electronics schools, to be used in furthering their education in electronics.

Called the Hugo Gernsback Scholarship Awards, these grants are made annually in honor of Hugo Gernsback; radio pioneer, inventor, author and founder of this magazine, who all his life missed no opportunity to encourage the young to study electronics.

This is the fifth year of the Hugo Gernsback Scholarship Award program, and is a continuation of a somewhat simllar scholarship program Gernsback used to administer personally in his lifetime .

RCA has added to this award by donating an RCA WV-529A service special volt-ohm-milliammeter to the student scoring next highest in the scholarship program.



L. DENNIS PAGE

Nominated by the Grantham School of Engineering of Los Angeles as their most deserving student is L. Dennis Page, Tucson, AZ. In a letter of thanks to Grantham and **Radio-Electronics,** Mr. Page says: "Although electronics has been a hobby of mine most of my life, my participation in a formal engineering course began when I enrolled at Grantham. As a direct result of the education I received, I have been able to obtain several patents on electromechanical inventions relating to residential swimming pools, and have also started Logical Projects Co., an electronics R & D lab.

"It is obvious that I owe an enormous debt of gratitude to Grantham for the opportunity of gaining an extensive and practical engineering education. I would like also to thank **Radio-Electronics** for their award and recognition, and for directing attention to the invaluable services provided by the correspondence schools."

PO HING MAN

The second award, an RCA WR-529A VOM, goes to Po Hing Man, of Hong Kong and Orillia, Canada. Born in Hong Kong, he studied electronics in the Chun Nam Electronics Institute there, and was able to emigrate to Canada in 1970 where he worked as a TV technician. Learning through a **Radio-Electronics** ad that he could earn an ASEE in the Grantham School of Engineering, he enrolled, and continued his studies while working as a TV repairman, then as working supervisor for Texas Instruments, and later as technical representative in Electrohome Ltd. Now on an extended vacation to visit his parents, he will visit the school on his way back to receive his ASEE, and then hopes to return to Orillia in time to enjoy the end of "the beautiful Canadian summer." **R-E**

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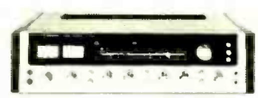

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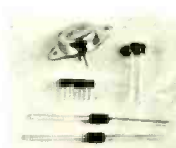

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letters

PARTS SURVEY

I read the letter from Robert Briner in the June issue of **R-E** about his problem of obtaining parts overseas for projects. I now have nine months experience with several firms and received all the parts I ordered. The time it took to receive the parts varied from firm to firm. Here is a list of my experiences with the firms.

James Electronics	Belmont, CA	7–10 days
Poly Paks	Lynnfield, MA	2–3 weeks (getting better)
International Electronics Unlimited	Monterey, CA	2–3 weeks
Southwest Technical Products	San Antonio, TX	3–4 weeks
Meshna Electronics	Lynnfield, MA	2–3 weeks
Delta Electronics	Lynnfield, MA	3–4 weeks
Solid State Sales	Somerville, MA	3–4 weeks
Howard W. Sams & Co.	Indianapolis, IN	7 weeks
Altaj Electronics	Dallas, TX	1–1½ months

All the times are from the day I wrote the letter until I received the parts.

I would also like to obtain the book, *Computer Architecture*, mentioned in the Mark-8 brochure. The publisher was listed as Van Nostrand-Reinhold, but no address was given.

H. K. BERKHOUDT
Rotterdam (23)
Holland

Thanks for the survey. The address of Van Nostrand-Reinhold is 450 West 33rd St., New York, NY 10001—Editor.

FOR SALE

Not so long ago I invested over $100.00 for the purchase of IC's for the TV Typewriter. Now that I am the proud new owner of my own computer terminal, I would like very much to sell the IC's since I no longer have use for them. In addition, I located and bought the Xtal. Instead of returning the parts, I would like to help someone having trouble locating them by selling the following in one package:

Quantity	Description
12	2524 (MOS)
1	2518 (MOS)
1	2513 (MOS)
1	MC4024
1	7400 (TTL)
1	7401 (TTL)
4	7402 (TTL)
1	7406 (TTL)
1	7408 (TTL)
2	7410 (TTL)
2	7432 (TTL)
2	7473 (TTL)
1	74165 (TTL)
2	74197 (TTL)
1	555 (TIMER)
1	4561, 920-kHz series resonant crystal.

I'm asking $100.00 for the whole deal and $90.00 for all except the TTL IC's.

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TV TYPEWRITER

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Also pictured above are other units — 5" solid state oscilloscope, vector monitor scope, solid-state stereo AM-FM receiver with twin speakers, digital multimeter, and more. It's the kind of better equipment that gets you better equipped for the electronics industry.

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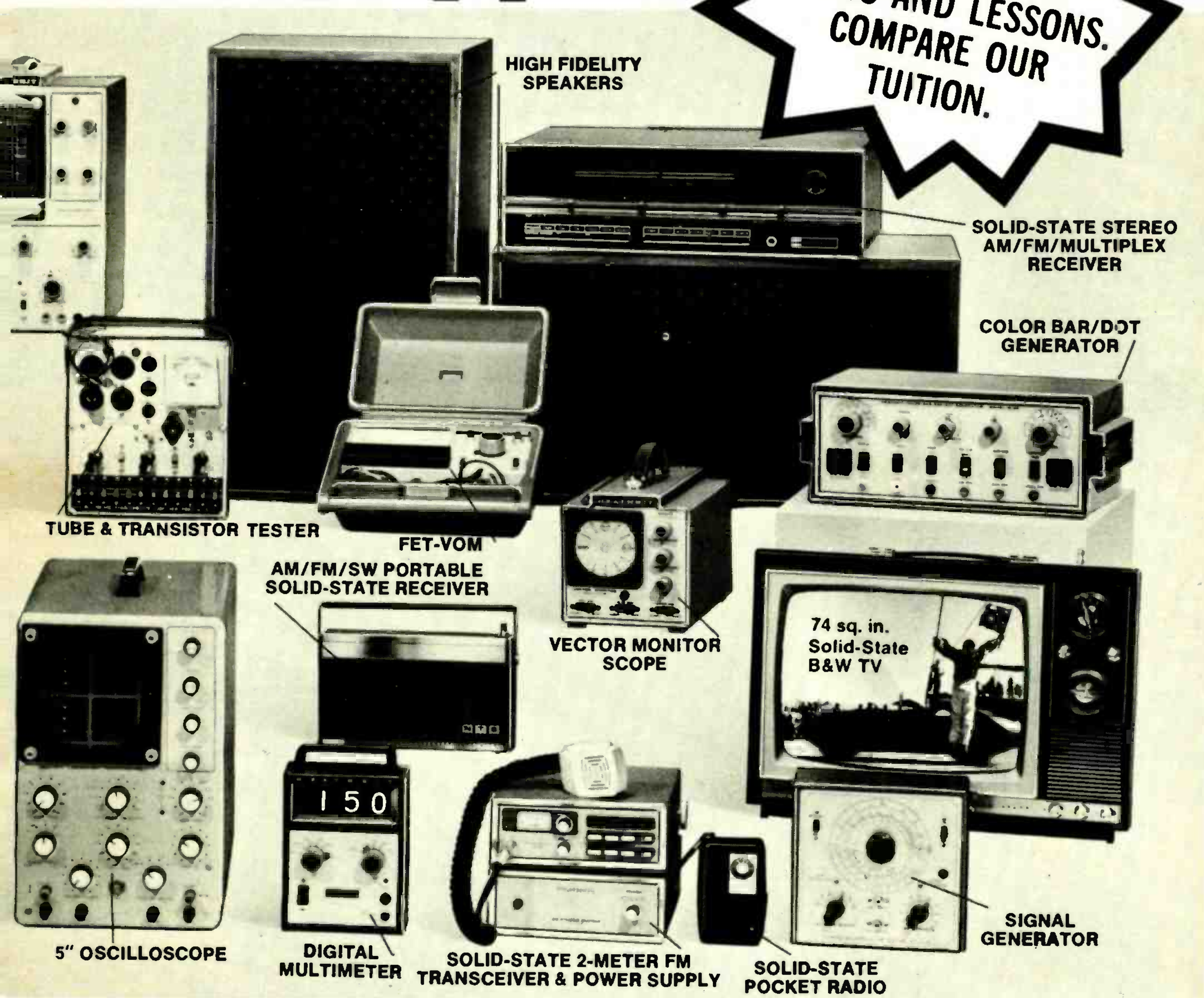

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equipment reports

Data Precision Model 5740 Multifunction Frequency Counter

Circle 83 on reader service card

THE DATA PRECISION CORP., OF WAKEFIELD, MA 01880, has brought out a new multiple function digital counter. It is their *model 5740*; it has an LED display almost 0.5 inch high, that is very bright and easy to read. It will read frequencies up to 100 MHz, and also read time periods, period average, total of events, and even read total elapsed time in a "stopwatch" mode. (Switch it to "Seconds" and it starts counting by hundredths of a second and keeps on. It'll go on doing this up to a total of 99,999.99 seconds. They say that this is 27.8 hours, and I'll take their word for it. I didn't wait.)

The display has automatic decimal placement. It reads out in kilohertz. Four separate gate-times can be selected by the panel switch: 10, 1.0, 0.1, and 0.01 seconds. This gives resolutions of 0.1 Hz, 1.0 Hz, 10 Hz and 100 Hz. Translation; the display is "updated" at each of these time periods; in the .01-second position, the readout is corrected once every hundredth of a second, and so on. The display is very steady, by the way; little "flicker" of the last digit.

The main features of this type of instrument are accuracy and time-base stability. The *model 5740* is guaranteed to a ±1 count ± the time-base stability. The last is given as ±0.1 ppm (part per million) and is field-adjustable if necessary. The stability is .01 ppm/sec. (More on this later on.)

The main application of such an instrument in the radio-TV field is frequency measurement; for two-way radios all the way from CB sets up to police radio and some aircraft bands. The sensitivity of the *Model 5740* is good enough so that this can be done very easily. All you do is hook a short lead to the input for a pickup rod, key the transmitter and look at the display. Even for the very low RF output of CB walkie-talkies, it will give stable readings with very loose coupling to the input. (Someone told me about a clever trick you can do with an instrument like this. Put it in the shop window, turned on, with a test lead antenna on it. A sign in the window invites passers-by to check the frequency of their CB radios. They can key the transmitter and see the readout instantly. This attracted a great deal of attention!)

I handed the *Model 5740* over to a friend of mine who has an avionics shop, with a lot of highly accurate equipment. He ran quite a few tests with it, and gave me the results. (I felt a little like Tom Sawyer, but it was easier than working.) He was quite impressed. Here are some of the results he got. It will count to 30 MHz with only a (measured) 10-mV input on the X1 position of the attenuator. (This is spec.) It also counted all the way to 100 MHz with only 40-mV input (better than spec which is 50 mV to 100 MHz).

My friend has a very expensive counter, along with the highly accurate RF signal-generators needed for avionics work now. He checked the *5740* against these. He commented on the excellent stability from a cold start, and also on an all-day run. It was compared against an instrument having a 3×10^9 part per million per day time-base stability. He was even more impressed after he found the price of the *5740* was $295.00.

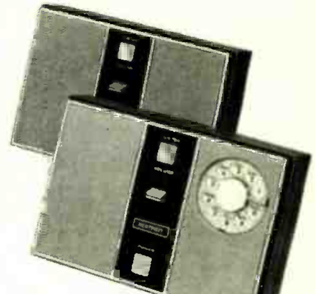
Several CB walkie-talkies were checked on it. Also, he ran tests through the frequency-synthesizer of a larger CB set. It could be used to check and verify the frequency of any crystal in this complicated circuit. A .01-μF coupling capacitor was used, with a simple test lead. My friend was so impressed, in fact, that I had a time getting it away from him.

After I finally got it back, I took it to my shop, and spent some time playing with it. I checked the frequencies on all my RF signal generators, and was pleasantly surprised. I also ran tests on the marker crystals in my IG-57 Heath sweep generator, and was pleasantly surprised again; these were all right on the button. It also told me that a seldom-used trap marker wasn't working. A little twiddle of the coil, and it too checked out.

The *model 5740* is a very compact instrument. It takes up little room on the bench, and it can be shelf-mounted. The display is big and bright enough to be read at any practical distance. There are also facilities for remotely controlling start-stop for timing events. A BCD interface connector can be used to interconnect it to other instruments, systems components,

(continued on page 26)

Your NEW Heathkit Catalog is ready



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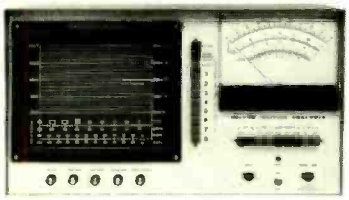

New Professional 12" Ignition Scope — Kit or Wired

Does more than others for $1000 less. Spots tough ignition problems on all types of systems in 3, 4, 6, 8 cyl. or 2-rotor Wankel engines; sets itself automatically for no. of cylinders. Big 12" screen has 2 calibrated primary and secondary voltage grids plus dwell angle indications. Special circuit maintains trace length regardless of RPM. Displays "superimposed" patterns, single cyl. pattern, primary or secondary "parade" patterns. "Power balance" feature even helps spot bad valves or rings. 8" meter with tach & DCV ranges. Optional low cost timing light, alternator adaptor & cart. Kit CO-2500 $379.95; Assembled WO-2500 $695.

New Automobile Intrusion Alarm Kit

Total Protection. Alarm mounts anywhere; connects to switches on doors, hood, & trunk. Underdash switch arms or disables unit. Adjustable delay time allows you to quickly enter or leave car without triggering alarm, but opening trunk or hood triggers alarm instantly. Alarm sounds car horn in repeated 2-minute cycles. Kit GD-1157 Alarm $24.95; Kit GDA-1157-1 Siren (gives yelping sound louder than car horn) $19.95.

New Programmable Digital Stop Watch Kit

Another "first" from Heath. 2 IC counters, 8 digits & 7 functions with typical accuracy to ±0.003% and resolution to 1/100th of a second. Function 1 (Start/Stop Elapsed) times individual events while also counting total. Function 2 (Sequential) times each part of event & displays each separately while timing overall event. Function 3 (Total Activity) accumulates total elapsed time of a series, excluding time between events. Function 4 (Split) displays cumulative time to each "split" point while continuing overall event time. Function 5 (Start/Stop Activity) shows separate time for each event & totals all individual times. Function 6 (Programmed Upcount) counts up to "learned" time. Function 7 (Programmed Downcount) counts down from "learned" time. Stop watch can "learn" time from other functions or be programmed up to 9 hours, 59 minutes, 59 seconds. Has jacks for external triggering devices and alarms. Includes nickel-cadmium batteries & charger. Kit GB-1201, $99.95.

New Digital Wind Speed & Direction Indicator Kit

Unique. Two big, bright digits show wind speed to 99 mph. As you build, choose 2 readout modes: miles, knots, or kilometers per hour; front panel light shows mode in use. 8 incandescent lights show wind direction at principal compass points; adjacent lighted bulbs give 16 point resolution. Remote transmitter boom clamps to TV mast. Styled in black plastic to match Heathkit GC-1005 Digital Clock and ID-1390A Digital Thermometer. Kit ID-1590, $69.95 less cable.

New — Two-Way Telephone Amplifier Kits

Now, hands-free telephone use with amplified "talk" and amplified "listen" — with or without dialer. Talk & listen from 10' away. Voice-actuated circuitry switches from talk to listen without feedback or clipped words. Listen button lets you monitor line without built-in microphone activated. Dialer model may be used with or without regular telephone. Includes 4-prong jack & phone coupler connector. Battery powered. Kit GD-1112 (no dial) $49.95; Kit GD-1162 (w. dial) $69.95.

New Public Address Sound System Kits

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New Variable Isolated AC Supply

What every tech & hobbyist needs. The IP-5220 isolates equipment under test from the AC power line and provides an AC output which is variable from zero to 140 volts. Great for locating circuit faults caused by high or low voltage or testing equipment with unknown power requirements. Power rating is 360 volt-amperes, continuous. Variable output current rating: 3A. max. Direct output curent rating: 10A. Two meters: voltmeter 0-150 VAC; ammeter: 0-1 & 0-3A. Ammeter and variable output socket are fused. Kit IP-5220, $109.95

New Oscilloscope Calibrator Kit

For time calibration, it generates a 0.5 second to 1 μsec square wave in 1-2-5 sequence accurate to 0.01% with 200 mV peak (⩽3% overshoot) and ⩽4 ns rise time. Voltage calibration ranges are 1 mV to 100 v. in decade sequence, accuracy within 2%, DC plus variable 2 Hz to 10 kHz in 1-2-5 sequence (internal stnd. accuracy within 1%). Use it to calibrate scopes up to 35 MHz and voltmeters; it's also a fast rise time squarewave generator and good bench freq. standard. Kit IG-4505 $44.95

New —Lowest cost Triggered 5 MHz Scope Kit

The scope everyone can afford, and it has the performance you need. DC-5 MHz band width, 100 mV vertical sensitivity with X1, X10 & X100 attenuation, AC or DC. Automatic, positive locking horizontal sweep continuously adjustable from 20 ms to 200 ns/cm. Stable displays due to zener regulated amplifiers and sweep. 5" round flat-face CRT with 8 x 10 cm graticle. Simplified controls and switches make it easy to use. Lightweight, durable blue plastic cabinet; white panel. It's the best instrument buy in years. Kit IO-4560 $119.95

New 21" (diag.) Digital Design Color TV Kit

All the advanced technology of digital circuitry in a smaller screen size. **Electronic touch-to-tune** varactor front end (nothing mechanical to wear out) with computer-like programming board for up to 16 channels. **On-screen channel numbers,** adjustable in brightness, position, and duration. **On-screen digital clock;** a low-cost option; programmable in 12 or 24 hour format, displays 4 or 6 digits. **Fixed-filter IF,** a Heath exclusive that assures better pictures longer, never needs instrument alignment. **100% solid state** — more ICs than any other — sophisticated circuitry that results in less interference, better color tints, improved sensitivity, greater noise immunity, improved picture definition. **Black negative matrix 21V picture tube** for brighter, sharper pictures. **Total touch-tune remote control** — low cost option that operates all functions, including recall of time & channel.

Easier to build & service — thanks to extensive modular design and built-in servicing tools including digital-design dot generator, front access slide-out Service Drawer, new picture centering and pincushioning correction circuits, and Test Meter. **Enjoy the best in TV design** — now in smaller size at lower cost. Kit GR-2050 $599.95. Kit GRA-2000-6, remote control, $89.95. Kit GRA-2000-1, digital clock accessory, $29.95. Contemporary or Mediterranean cabinets from $119.95.

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Circle 100 on reader service card

(continued from page 24)

etc. The normally high-Z input, 1.0 megohm with 25-pF shunt, can be converted to 50 ohms with an adapter. X1 and X20 dB attenuators can be switched in, if needed. Up to 250 volts RMS input or 500 volts peak AC or DC can be used with no damage. Response time is very fast; it can count pulses as close as 15 nanoseconds apart without losing them.

All in all, quite an impressive performance, and at a price that is well below previous instruments with comparable performance. **R-E**

Triplett Model 60 VOM

Circle 96 on reader service card

THE TRIPLETT CORPORATION, MAKERS OF many VOM's have come up with a new one. It is their special ruggedized *Model 60*. They've also got a *Model 60-A* that is a duplicate, with slightly greater accuracy and a mirror-scale meter. They say both are "ruggedized" and they mean it. This thing is protected against everything but floods. Earthquakes probably wouldn't bother it at all.

For protection against physical damage, such as being knocked off the bench or dropped, the *Model 60* has a very tough plastic case. The meter face and controls are recessed. The case has a "roughened" texture to provide the user with a better grip. They say that you can drop it five feet onto a cement floor with only a small chance of damage to case or movement. They told me to try this, and I did. I'll admit that I started with a gingerly drop of about a foot onto a padded bench, but finally I got up courage enough to try the full distance. They were right. It didn't even faze it.

Aside from the case, the meter movement is the part most likely to be damaged. The *Model 60* has a special type of ruggedized suspension, and from peeping inside, it seems to be shock-mounted. The meter will stay within ±4% of its rated accuracy after such a drop. A special CONFIDENCE-TEST is provided for an instant check. All you do is switch to OHMS x 10K, check the mechanical zeroing of the needle, then short the prods and adjust the ohms zero with the OHMS ADJUST control. Then switch to the TEST position (which is next on the switch). If the needle stops within the special block, in the center of the ohms scale, it's OK.

The meter movement and resistors are very thoroughly protected against electrical damage. There's a diode module connected across the meter movement; and three fuses are used beside this. Two of these, a 1/8-A and a 1.0-A, are for protection against normal overloads. Spares for these are stowed inside the case, right beside the fuse holders.

Finally, for protection against those cases where the VOM is accidentally hooked across a very high voltage circuit, on the ohms scale of course, a special 2-A, 1000-volt fuse is used. It can interrupt an arc with a total energy of *20 kilowatts*! An ordinary VOM would be destroyed instantly, with a dangerous explosive arc inside the case. In other words, it would blow up in your face!

Beside all of these things to protect the VOM, every precaution has been taken to make it safe for the user, too. There are no exposed metal parts on the case at all. The test leads have special jacks and plugs. The jacks are a recessed-male type, and the plugs are made of a soft plastic so that the ends of the test leads are completely covered. Slip-on clips can be used on the prods; these are insulated, also.

If the worst does happen, the design of the *Model 60* provides for fast repair. The meter movement is a module which can be replaced with ease. The whole thing can be taken apart by removing only eight screws.

We've been so busy with the safety features that the main things have been ignored. This is a standard VOM, 20,000-ohms-per-volt on DC. Eight ranges from 0-1 volt up to 1000 volts, in the handy 1-3-1-3 calibration. The AC voltage ranges start at 0-3 volts, up to 1000 volts. A dB scale is also provided. Four DC current ranges, from 0.1 mA up to 1000 mA (1 A). Resistance ranges go from ×1, with a 12-ohm center-scale, to ×10K. To read AC current, the *Model 10* clamp-on adapter can be used.

A special carrying case can be had, with space to store the *Model 60*, the clamp-on AC ammeter and other accessories. Some of these are high-voltage probes to read up to 30 KV AC or DC, a high-current DC shunt, and a pair of special hook probes, very small, for getting into tight places in PC boards.

This instrument is designed for use in industrial electronics or electrical work, schools, radio and TV shops, and any other place where you need a tough, accurate VOM that can really take it. **R-E**

Hermon Hosmer Scott is dead at 66

Hermon Hosmer Scott, electronic engineer and inventor, died April 13 at Wellesley Hospital, Newton, MA. He was the founder and former president of H. H. Scott, Inc., Maynard, MA.

Best known for his high-fidelity products, Mr. Scott was a pioneer in audio design and invention. He held many patents, among them were an early frequency-sensitive dynamic noise suppressor, resistance-capacitance oscillators and selective circuits.

He founded H. H. Scott, Inc., in 1948, retiring in 1972.

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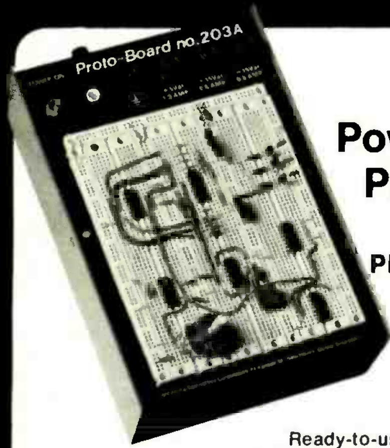

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- Fuse • Power Switch
- Power-On Light
- 9.75"L x 6.6"W x 3.25"H
- Weight: 5 lbs.
- 5V, 1 AMP regulated power supply

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OUTPUT SPECIFICATIONS

Output Voltage	5V ± ¼V
Ripple & Noise	@ ½ AMP 10 millivolts
Load Regulation	Better than 1%

PB-203A
- 3 QT-59S Sockets
- 4 QT-59B Bus Strips
- 1 QT-47B Bus Strip
- Fuse • Power Switch
- Power-On Light
- 9.75"L x 6.6"W x 3.25"H
- Weight: 5 lbs.
- 5V, 1 AMP regulated power supply (same as PB-203)
- +15V, ½ AMP regulated power supply
- −15V, ½ AMP regulated power supply

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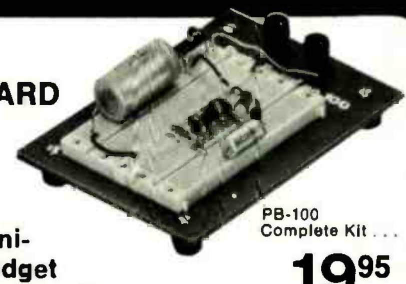
OUTPUT SPECIFICATIONS

Output Voltage	15V, internally adjustable
Ripple & Noise	@ ¼ AMP, 10 millivolts
Load Regulation	Better than 1%

PROTO BOARD 100



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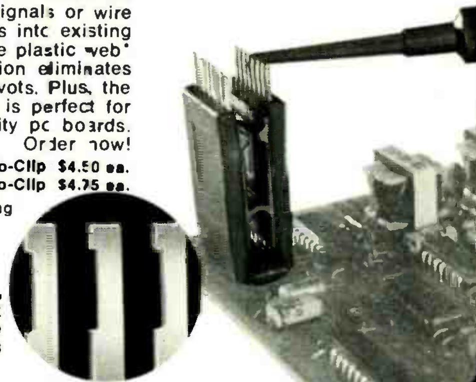

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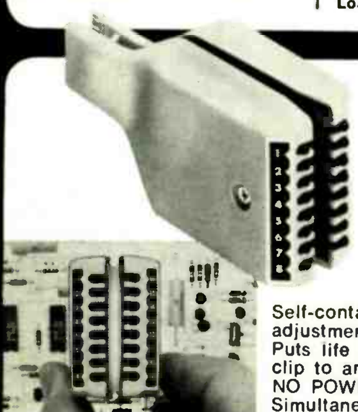

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That's why we planned this learn-at-home program to hold your attention and make each principle you learn more vivid... easier to remember!

We'd like to think you'll rush home from work each evening—anxious to haul out your course materials and get down to business!

Let's talk about what we do to keep you interested.

For one thing, we don't just send you books.

Oh, books are important. In fact, this program includes a complete set of carefully prepared texts. And there's no way you can get along without them.

But if you decide to spend some of your time learning electronics at home, you're going to get a lot more than books. You're going to take your jacket off, roll up your sleeves and actually get your hands on modern electronic equipment. You're going to explore it... experiment with it... put it together yourself!

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One evening, when you get home from work, you'll find a large package waiting for you. When you open it, you'll find a set of electronic components.

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As you build this 25" diagonal color TV, you investigate the digital circuitry that allows the automatic channel selector to go directly to preselected channels—as well as discovering the circuitry behind channel numbers and a digital clock that appear on the screen. You find out why the Black Matrix picture tube makes for such exceptional color clarity. You explore "state-of-the-art" integrated circuitry and the 100 percent solid-state chassis.

Once you've built this TV, you've rounded out your electronic training and gained new occupational skills.

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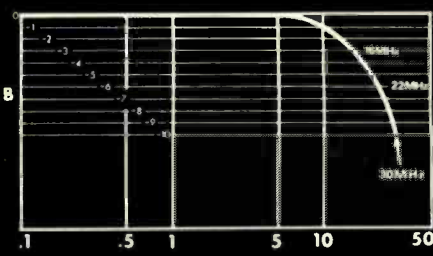

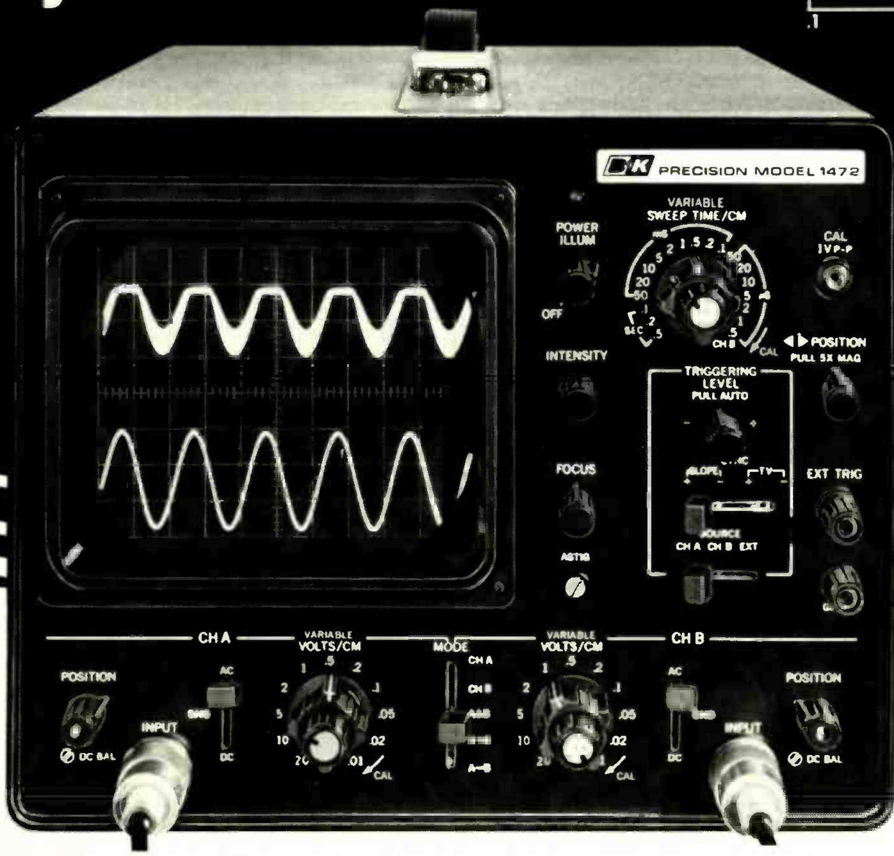

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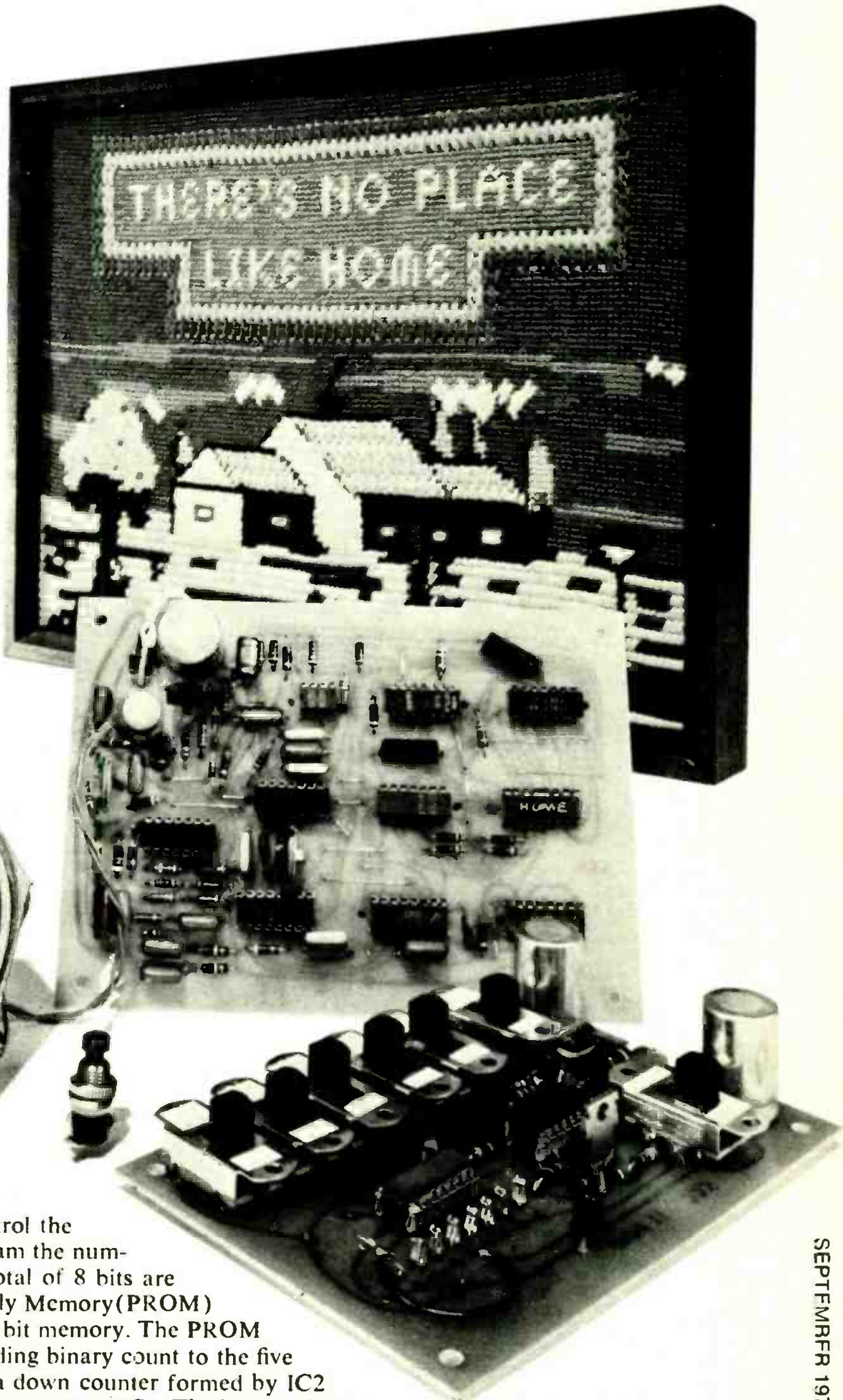
Circle 11 on reader service card

IC Doorbell Plays Your Song

You can program your own tune into this device and connect it to your doorbell. It features a PROM with a 32-note capacity

by RALPH E. COUSINO



MUSIC CAN RECALL A PLEASANT MEMORY ESPECIALLY if it's your favorite melody. This article describes an electronic music box that you can build and program to play your favorite tune. Use it in place of your doorbell or as a wakeup alarm on your digital clock. The electronic music box can be used for any audible signalling application. It provides a full range of two octaves for a total of 24 notes including tremolo. Momentarily closing the start circuit, the unit plays its programmed tune, through a maximum of 32 notes, one at a time, with a hold of up to 4 beats-per-note. It automatically shuts off at the end.

Circuit operation

A complete schematic of the electronic music box is in Fig. 1. The twelve notes for one full octave are generated by frequency division of a master oscillator formed by IC10-b. This 21,560-Hz master oscillator is frequency modulated for tremolo by a phase shift oscillator using operational amplifier IC5-d. Frequency division of the master oscillator ouput is done by cascaded programmable counters IC8 and IC9. After division by IC8 and IC9, the narrow output pulse is fed to IC10-a to form a wider pulse. This pulse is connected to the clock input of J-K flip-flop IC3-b that divides the input frequency by two, if the clear input is high, thereby generating the next lower octave. The tone can be muted by driving the clear input of IC10-a low. This is done by making the four inputs to NAND gate IC7-b high.

Programming IC8 and IC9 for frequency division requires 5 bits. Another bit is required to control the frequency divider. Two more bits are used to program the number of beats a note should be held. Therefore, a total of 8 bits are required for each note. The Programmable Read Only Memory (PROM) IC6 provides an 8-bit by 32-word memory or a 256 bit memory. The PROM is stepped through each word by applying an ascending binary count to the five address lines. The ascending count is delivered by a down counter formed by IC2 and IC3-a. The address counter is clocked by a beat generator, IC1. The beat-generator

PARTS LIST

All resistors are ¼-watt, 10%, unless noted
R1, R12—6.8 megohms, 5%
R2, R27, R28—100,000 ohms
R3, R6, R16, R18, R21, R30, R31, R32, R33, R34, R35, R36, R37, R39—1,000 ohms
R4, R5—330 ohms
R7, R19, R20—10,000 ohms, 5%
R8—500,000 ohms trimmer potentiometer
R9—27,000 ohms
R10, R11, R38—470,000 ohms, 5%
R13—820,000 ohms, 5%
R14, R24—4.7 megohms, 5%
R15, R25—2.7 megohms, 5%
R17—3.9 megohms, 5%
R22—4,700 ohms
R23—50,000 ohms trimmer potentiometer
R26—2.2 megohms
R29—33,000 ohms, 5%
C1, C3, C11, C18—.047 µF polyester film
C2, C6, C7, C10, C13, C14, C15, C20—.1 µF polyester film
C4, C5—2 µF, 10 volt electrolytic
C8—220 µF, 10 volt electrolytic
C9—300 pF ceramic
C12—.0047 µF polyester film
C16—2,200 µF, 16 volt electrolytic
C17, C19—20 µF, 10 volt electrolytic
IC1—555 timer
IC2—7493 TTL
IC3—7473 TTL
IC4—7405 TTL
IC5—3900 linear quad amplifier
IC6—8223 PROM (un-programmed)
IC7—7420 TTL
IC8, IC9—74193 TTL
IC10—74123 TTL
D1, D2, D3, D4—1N4148
D5—1N751A
D6, D7, D8, D9—1N4002
Q1—2N3394
Q2—2N3638
Q3—2N5296
T1—117-volt primary, 6.3-volt @ 0.6A secondary
F1—¼-amp fuse
Misc.—fuse holder, line cord, 8-ohm speaker, cabinet, printed circuit board, wire, solder, hardware.

The following parts may be ordered from Cousino Circuit Company, 3313 Brace Street, Burbank, CA 91504
#K11-EMB—Kit of all items in Electronic Music Box parts list, except miscellaneous items, fuse and transformer. Includes PC board and un-programmed PROM. $36.95 postpaid within USA.
#KHS11-EMB—Same as #K11-EMB except PROM is pre-programmed with "Home Sweet Home" melody. $39.95 postpaid within USA.
#11-EMB—Drilled glass epoxy printed circuit board for Electronic Music Box. $6.95 postpaid within USA.
#K11-PGM—Kit of all parts in parts list for PROM Programmer except miscellaneous items. Includes printed circuit board and programming data for several melodies. $21.95 postpaid within USA.
#11-PGM—Drilled glass epoxy printed circuit board for PROM Programmer. $5.95 postpaid within USA.
California residents add sales tax.

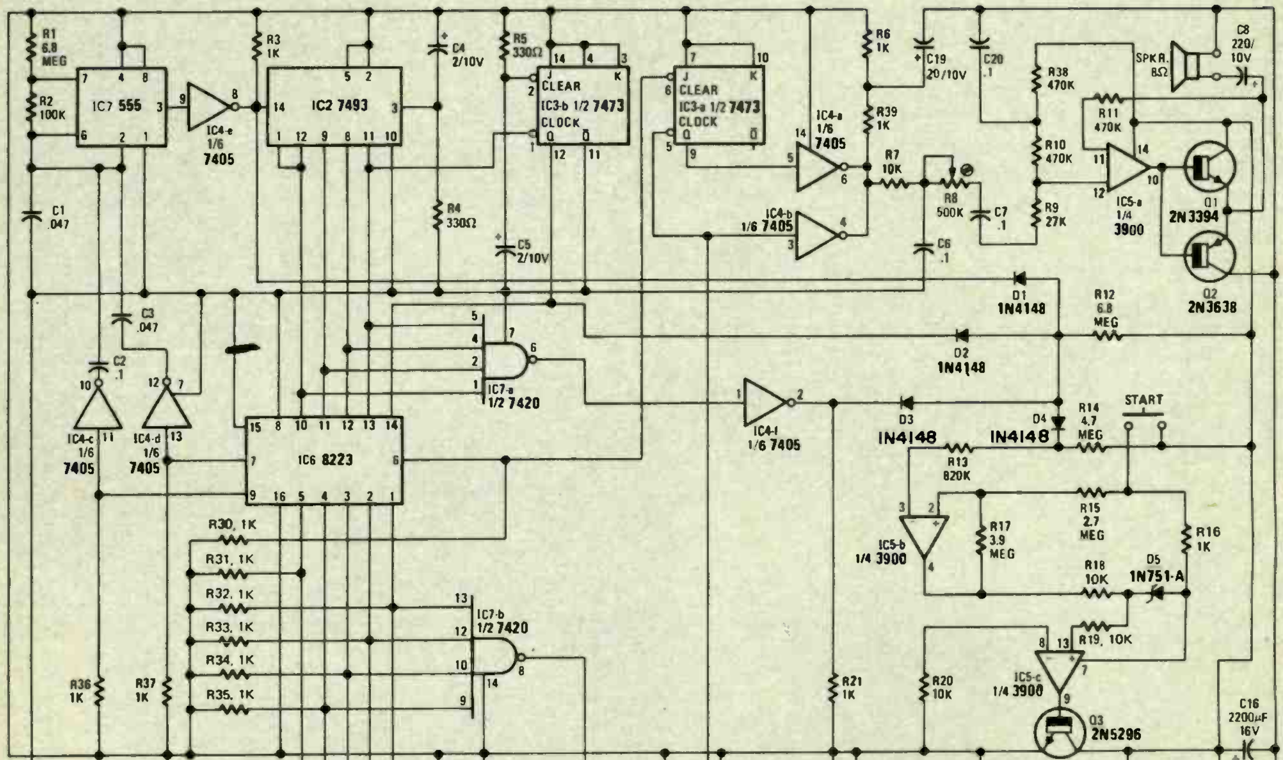


FIG. 1—ELECTRONIC MUSIC BOX schematic diagram.

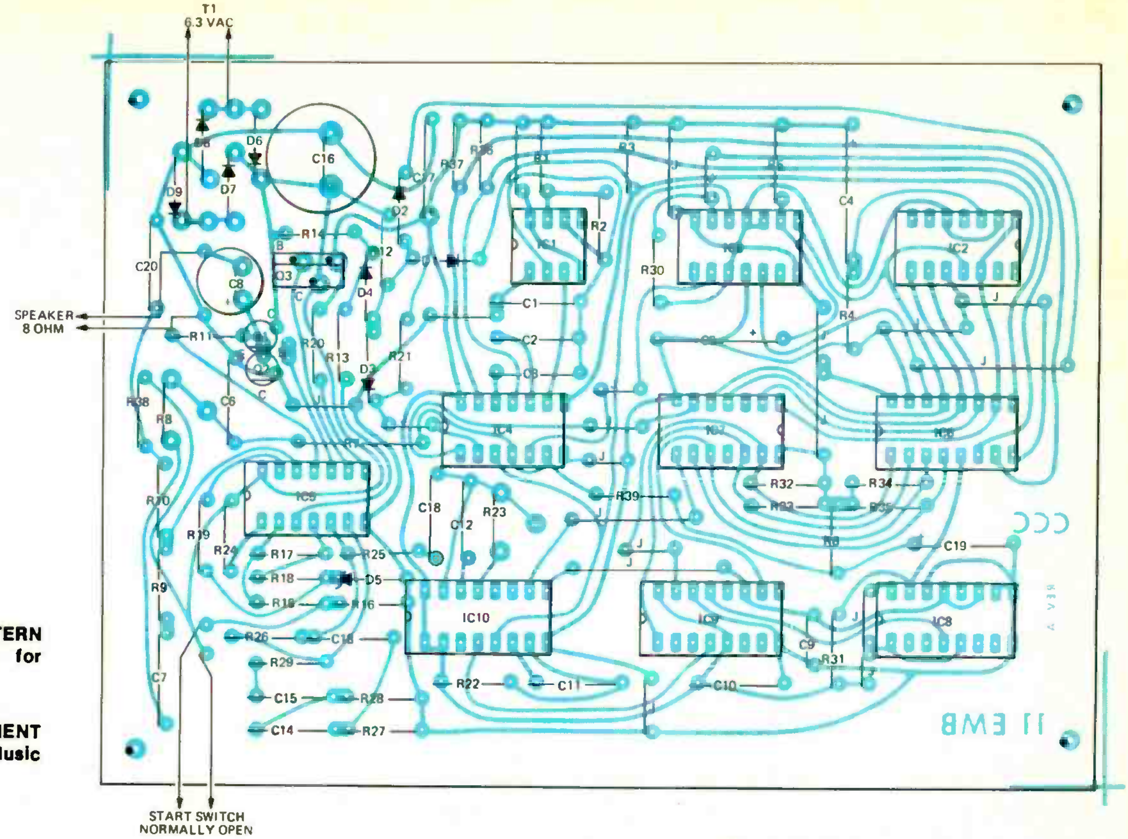
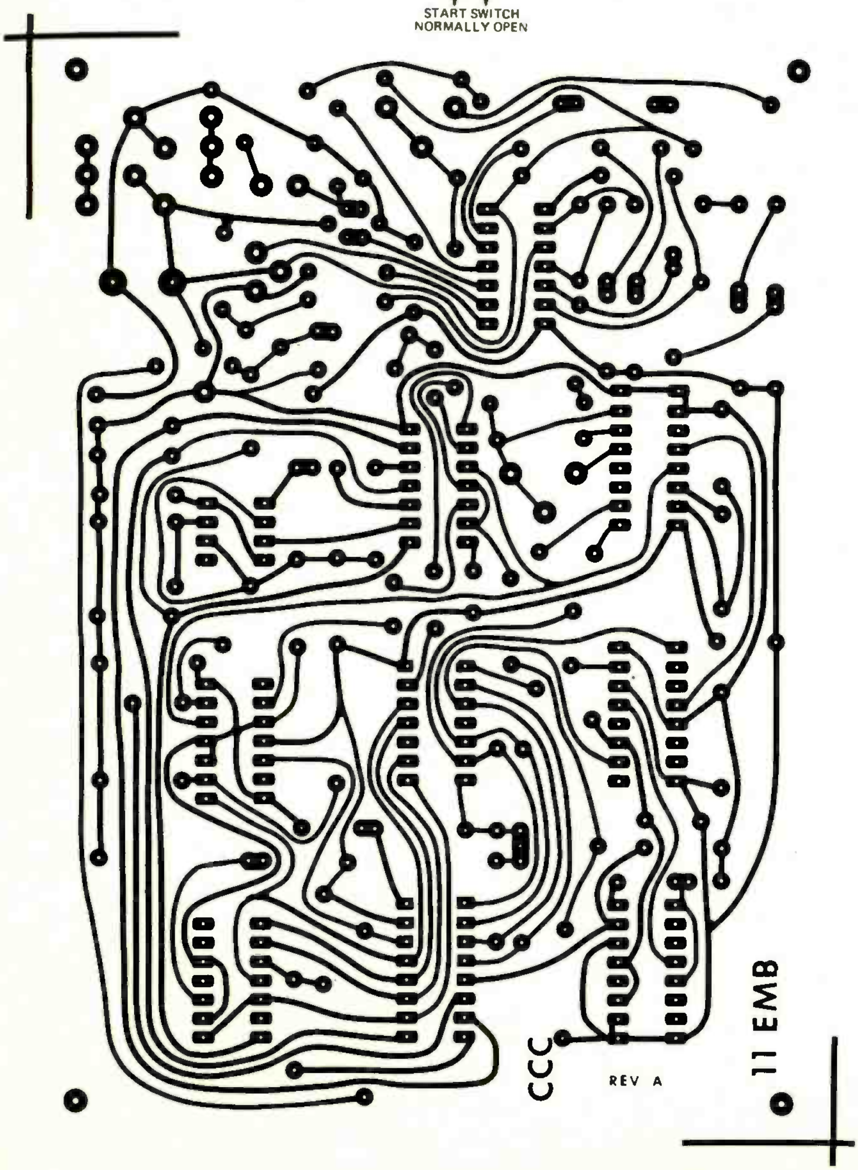


FIG. 2 (below)—FOIL PATTERN of printed circuit board for Electronic Music Box.

FIG. 3 (right)—COMPONENT LAYOUT for Electronic Music Box.



rate is controlled by capacitors C1, C2 and C3. These capacitors are grounded by IC4-c and IC4-d depending upon PROM programming. This controls the duration of time each note is held.

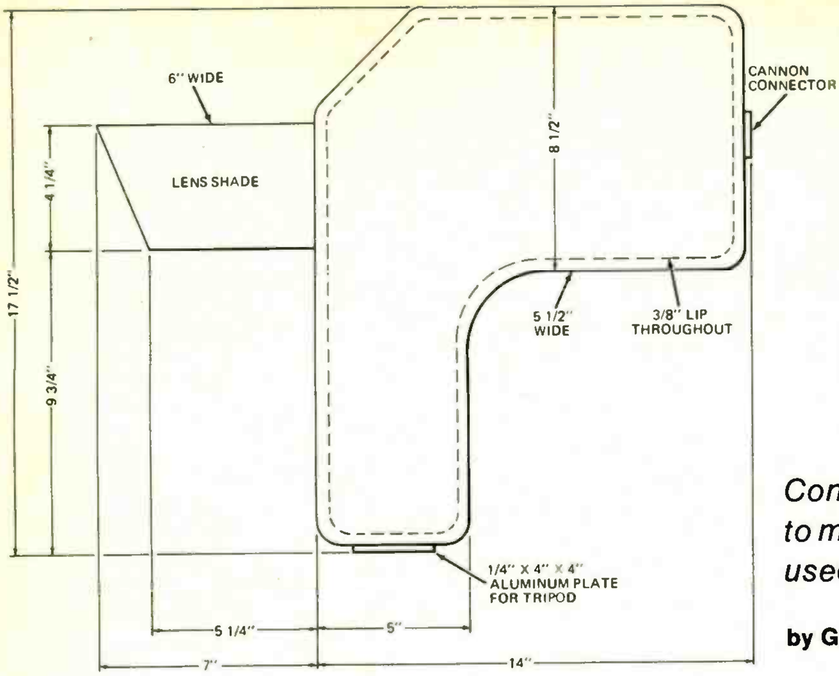
Inverters IC4-a and IC4-b provide an output pulse whether frequency divider IC3-b is enabled or not. This pulse is delayed by R7 and C6, and fed to operational amplifier IC5-a through a volume control R8. This amplifier drives a complimentary transistor pair that is coupled to the output speaker by C8.

Voltage for all IC's is supplied by the regulator consisting of transistor Q3 and operational amplifier IC5-c. The operational amplifiers are connected to the unregulated input voltage and are therefore always on. Operational amplifier IC5-b is connected as an R-S flip-flop. Closing the start circuit drives the output of IC5-b high turning on the voltage regulator supplying 5 volts to the IC's. When the program is finished, all address lines of the PROM go high. The address lines on IC7-a with inverter IC4-f reverse bias diode D3. This along with D2 reverse biased plus the positive going beat pulse on diode D1, causes the IC5-b flip-flop to reset, shutting the unit off.

Construction

In view of the circuit complexity, printed-circuit boards are a must. The PC board layout is shown in Fig. 2 and component location is detailed in Fig. 3. Insert and solder components and jumpers as shown using care to observe the polarities of diodes and capacitors.

(continued on page 104)



LEFT SIDE VIEW

Build this COLOR TV CAMERA

Concluding this series, we show you how to modify the two receivers that are to be used as the sync source and color monitor.

by GARY DAVIS

LAST MONTH WE DISCUSSED THE CAMera head, as well as adjustment and registration of a low-cost color TV camera. This month we will conclude this series by examining the modification of the two TV sets for use with this camera. The camera requires 6V P-P of vertical sawtooth drive, a suitable vertical blanking pulse, −12V DC, +300V DC, 6.3V AC, and a horizontal drive pulse with 70 to 80V P-P amplitude. All these voltages are supplied from the black and white monitor.

The set I use for this purpose is a Panasonic Model TR-900IM. The modifications for this model can serve as a guide in modifying your own set. However, you will have to experiment with your set until you can generate the voltages and waveforms described. The vertical sweep signal is taken from the TV set by simply adding a 15-ohm resistor in series with the TV vertical deflection coil. The sawtooth voltage developed across the resistor is sufficient to drive the camera vertical deflection coil directly. Should the camera picture appear upside down, the two wires to the 15-ohm resistor coming from the camera should be reversed. The vertical blanking pulse is obtained from the normal pulse developed across the set's vertical yoke and applied directly to transformer T1. If the pulse is greater than 100V P-P, a voltage dropping resistor should be placed in series with the primary of T1. The −12V DC signal was taken directly from the set's −12V busline. The +300V DC signal is generated from an extra unused winding tap on the flyback transformer. (Suitable horizontal pulse voltage may be available at the agc keyer winding.) The 300V P-P

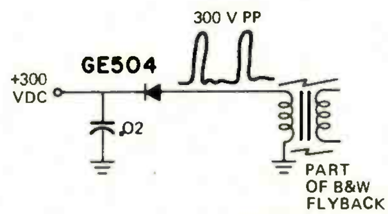


FIG. 5—METHOD OF DERIVING the 300 volt DC supply voltage from the black-and-white TV receiver.

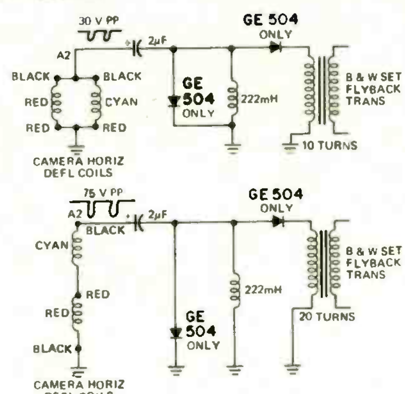


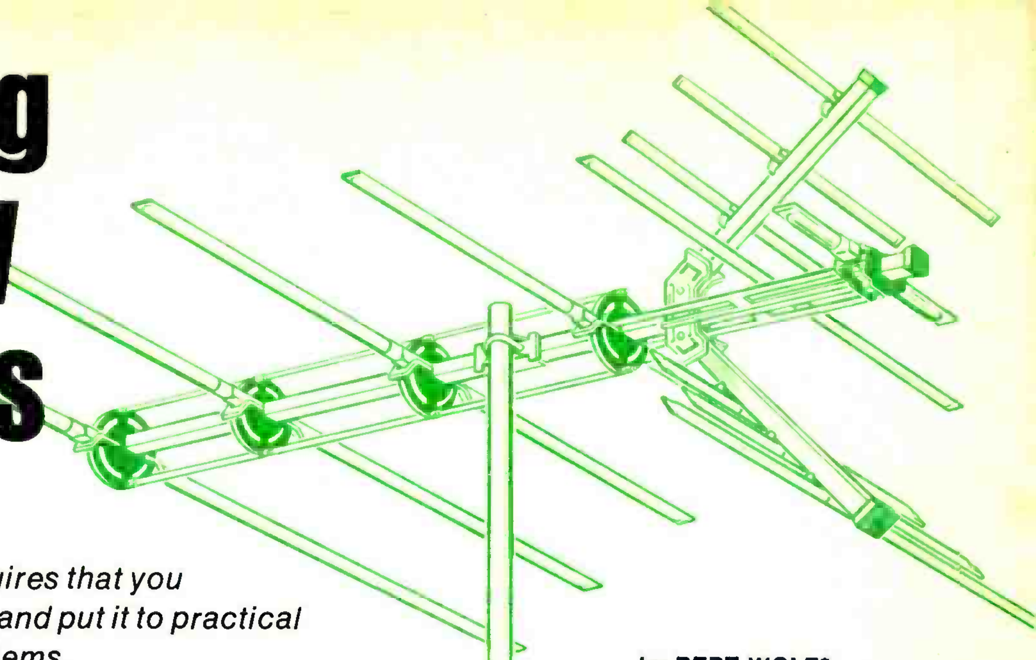
FIG. 6—TWO POSSIBLE APPROACHES for deriving the synchronizing signals from the black-and-white TV receiver.

horizontal pulse is simply rectified and filtered as shown in Fig. 5. Voltage dropping resistors may be necessary in some sets, and of course, a separate +300V power supply could be incorporated if necessary. Since my set did not have a 6.3V AC signal available, a filament transformer was added to power the vidicon tube filaments. **This 6.3V AC signal was also sent to the vertical blocking oscillator base through a .22 µF coupling capacitor.** This locks the vertical oscillator to the power line frequency thereby eliminating any 60-Hz hum wiggles in the picture.

The horizontal yoke drive-pulses are obtained from a second unused winding tap on the flyback transformer. This tap provided the correct waveform, but at double the needed amplitude. As the flyback transformer on this set is a sealed unit with only the taps exposed, the camera horizontal yokes were wired in series and connected to the tap through a 2 µF capacitor. On other sets, different approaches must be taken. Two possible approaches are shown in Fig. 6. Transformer T2 consists of ten turns of well-insulated hook-up wire, loosely wound around the flyback. On most sets the voltage amplitude is approximately 4V P-P per turn. The voltage at the output of T2 must be exactly correct, as added resistive elements such as width controls would alter the horizontal waveshape. The horizontal deflection coils could be connected in parallel, or by doubling the number of turns on transformer T2, they could be wired in series. Each horizontal deflection coil requires 30 to 40V P-P for proper deflection. Figure 6 should serve only as a starting point. Some added experimenting may be necessary. All generated waveforms should be checked with an oscilloscope to observe amplitude and waveform polarity. All waveforms should be close to those shown on the waveform chart before proceeding. It is important that the modifications do not affect normal operation of the TV set, as it can be used as a monitor until you are ready to modify the color receiver. It is also convenient if the set can still be used as a regular TV when the camera head is disconnected. Details of the sheet-metal case are shown above.

(continued on page 73)

Installing TV-MATV Antennas



Obtaining good results requires that you understand antenna theory and put it to practical use to solve reception problems.

by BERT WOLF*

INSTALLING TV-MATV ANTENNAS IS A LITTLE like repairing TV sets. Some men pull tubes, change resistors and take voltage readings with only a foggy notion of how a TV set really works. The really good service technician understands what is going on inside the circuitry. Therefore, he can track down troubles rapidly and solve even complex problems.

Many men who put up antennas have only a very hazy understanding of how they work and why. The good antenna installer, however, understands antenna theory and puts it to work to solve reception problems. Let's review antenna theory in brief and then see how it can be put to practical use.

As the current in a TV transmitting antenna starts its first half-cycle (an antenna is driven with alternating current), a wavefront of energy expands outward in all directions. As the wavefront gets farther from the antenna, it becomes thinner and thinner. Then, the current in the TV transmitting antenna reverses as the second half-cycle starts, causing a second wavefront to start expanding outward. Like the alternating current that caused them, the two wavefronts are opposite in polarity.

The third wavefront (third half-cycle of alternating current) is the same polarity as the first, and the fourth wavefront (fourth half-cycle of alternating current) is the same polarity as the second. The distance between two successive wavefronts of the same polarity is called the wavelength (denoted by the Greek letter λ, or lambda). It is interesting to note that once a wavefront leaves the antenna, it is absolutely independent of its source.

A given TV transmitting antenna may produce wavefronts that are either horizontally or vertically polarized, depending on how current flows through the antenna. All TV stations in this country transmit horizontally (E Plane) polarized TV signals, by FCC edict.

The simplest type of receiving antenna is a half-wave dipole—a dipole whose length is approximately half the distance between two wavefronts of the same polarity. If we hold a half wavelength dipole in a horizontal plane so that the wavefronts from the antenna pass through it, the TV signal will induce an electrical current in the dipole. (See Fig. 1-a). If we connect a meter to the antenna, we can see an indication of this induced current. The direction of the electrical current induced in the dipole reverses with each succeeding wavefront.

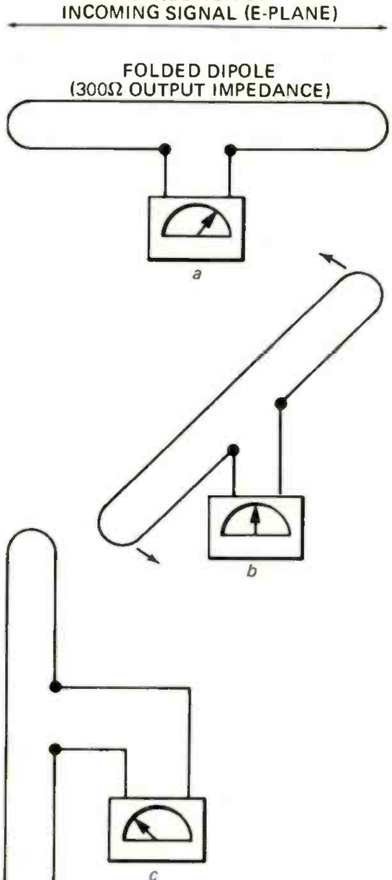


FIG. 1—ANTENNA ORIENTATION affects signal pick-up. Maximum signal pick-up occurs when antenna is positioned horizontally as shown in a. As the antenna is rotated, signal pick-up decreases as shown in b. Minimum signal pick-up occurs in vertical position as shown in c.

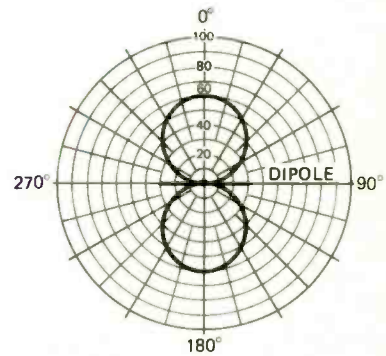


FIG. 2—POLAR PLOT for dipole antenna. Maximum signal pick-up occurs at 0 and 180.

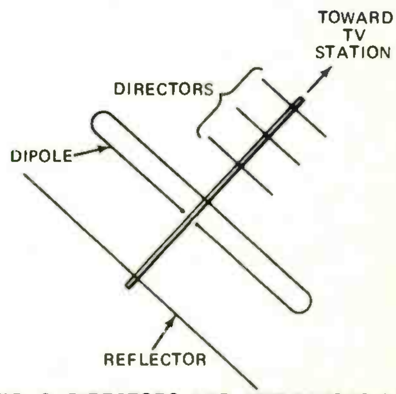


FIG. 3—DIRECTORS AND REFLECTORS increase signal pick-up from desired direction, decrease signal pick-up from other directions.

Now, suppose we rotate the antenna slowly to a vertical position. As we do, less and less of the dipole is cut by the transmitted signal (see Fig. 1-b). In the vertical position, induced current is reduced to a minimum because the dipole has very little

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length in the horizontal plane (see Fig. 1-c).

At this point, suppose we return the dipole to its original position (Fig. 1-a). Then, we rotate the dipole slowly until it is at right angles to the transmitted signal. Again, the dipole will look shorter and shorter to the incoming signals and induced current will fall to a minimum.

For maximum signal pickup, therefore, the dipole must face the TV transmitter head on, with the length of the dipole in the horizontal plane. This is what we mean by antenna orientation.

Performance

A good way to visualize the effect of orientation on signal pickup is with a polar plot. To make a polar plot, we start with the antenna facing head-on to the transmitter for maximum signal pickup. We adjust the received signal for a maximum reference point on the polar graph paper. Then, we rotate the antenna horizontally a full circle (360°).

Figure 2 shows the polar plot that results with a half-wave dipole. The transmitting antenna is at 0°. Pickup is greatest at 0° and 180°. Signals that come into the dipole from the side (90° and 270°) are hardly received at all.

The lobe centered at 0° is called the forward lobe. The lobe pointing to 180° is called the back lobe. Back lobes are useless to us. To minimize back-lobe pickup and to maximize front-lobe pickup, directors and reflectors are added (see Fig. 3). The result is the polar pattern shown in Fig. 4.

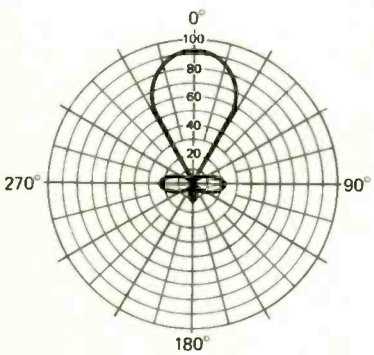

FIG. 4—POLAR PLOT of antenna shown in Fig. 3.

The performance of an antenna is specified by several parameters:

Gain. The term gain is somewhat misleading when applied to antennas because antennas don't actually amplify signals. However, in a given location, some antennas will pull in more signal than others. We use the amount of signal picked up by a dipole as our standard, calling it unity gain or 0-dB. (0 dB is not equal to 0 microvolts of signal. It merely means 1 times the standard signal.) An antenna that pulls in twice as much signal than a dipole under identical conditions is said to provide 6 dB gain. (6 dB equals twice the signal voltage.) Generally speaking, the larger the antenna, the more gain it provides.

Front-to-back ratio is the ratio of the front lobe to the back lobe. A dipole has a front-to-back ratio of 1:1. A good modern high-gain antenna might have a front-to-back ratio of 10:1 (20 dB) or more.

Front-to-side ratio is the ratio of the front lobe to the largest side lobe.

Flatness of response. The gain of some antennas vary widely with frequency. Most VHF antennas are designed to provide more gain on the high-band channels than the low-band channels, but variation within channels should be very gradual. Flatness of ±1-dB within any given channel is recommended for good color reception. Fluctuations of over 2-dB within a channel can result in phase shifts which cause color distortion.

Antennas that use a system of directors and reflectors are called *Yagis*, after their Japanese inventor. Two other types of antennas are commonly used today for TV reception—log-periodic antennas and aperture antennas. Most modern home TV antennas today are log-periodic types.

Log-periodic antennas use periodic spacing of active elements rather than dipoles with reflectors and directors. The basic periodic design provides flat response and constant gain across its entire bandwidth. In some ways this is good, but in other ways its a problem. The fact is that we need more gain on high channels to compensate for the fact that transmitted signal loss increases with frequency.

Some way had to be found, therefore, to make log-periodic antennas more efficient on high VHF-band channels (7 thru 13) than on low VHF (2 thru 6) channels. This was done by *multi-moding*, making a single element work in both high and low VHF-bands simultaneously. This is possible because an element that resonates at 1/2-wavelength for Channel 2, for example, also resonates at 3/2-wavelength at Channel 7.

Multi-moding does provide extra gain on the high band, but it introduces another problem. Figures 5 shows the polar pattern of a 3/2-wavelength dipole. Notice the large side lobes at 45° and 315°. These lobes are undesirable because they can pick up ghosts. Engineers from each of the major antenna companies have devised ways to eliminate the side lobes.

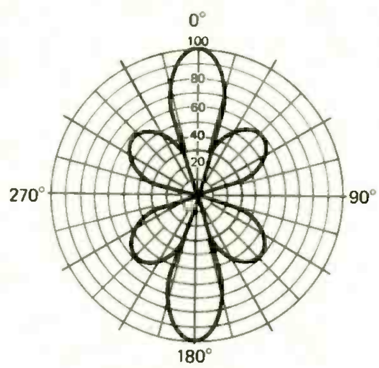

FIG. 5—POLAR PLOT of a 3/2-wavelength dipole.

Channel Master and Kay Townes use parasitic elements to buck out the center currents that cause the side lobes.

Winegard achieves multi-moding with stubbed-element extensions. Each high-impedance stub represents a half-wave dipole on the high band, shunting most of the energy away from the longer (low VHF band) portions of the element. Therefore, each element operates on both the high band and the low band, with very small side-lobes.

Jerrold solves the problem by using high-impedance (450 ohms) transmission line. The high-impedance transmission-line couples the elements at the second resonance rather than the third resonance. In effect, the 3/2-wavelength element becomes a one-wavelength element, with a good, clean polar pattern. Shifting to one-wavelength elements also creates a buffer zone at the rear of the antenna, improving the front-to-back ratio.

JFD's approach is to "Vee" the elements forward to eliminate side lobes.

Figure 6 shows a typical aperture type antenna, using a dipole with a reflective screen. Aperture antennas are generally used for UHF reception, to provide a large vertical capture area. In UHF aperture antennas, the dipoles are all quite similar, but there is a large variation in the types of reflecting-screens that may be full parabolics, parabolic sections or simple corner reflectors.

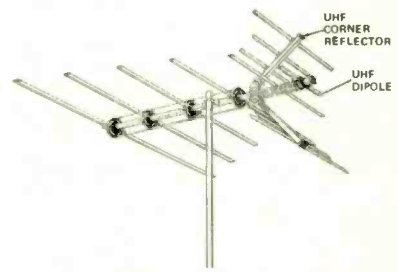

FIG. 6—JERROLD MODEL VU-931S.

One phenomenon important to TV reception is that receiving antennas reradiate signals. At best, we can use only half of the signal picked up by a dipole. The other half is reradiated in exactly the same pattern as the reception polar pattern.

The reradiated signals intersect with the signals from the transmitter. At intersections where the transmitted signals and reradiated signals are of the same polarity, they add. At intersections where the transmitted signal and reradiated signals are of opposite polarity, they subtract. In other words, reradiation makes the TV signals stronger at some points and weaker at others.

While both transmitted and reradiated signals are constantly moving, the points of intersections are fixed in space. Therefore, we call the fluctuations of stronger and weaker signals "standing waves in space."

Dipoles are not the only things that cause reradiation. Anything metal does the same thing. Pipes, conduits, electrical wiring, aluminum gutters all act as reradiators, which form standing waves in space.

What's more, virtually any surface, metallic or not, can reflect TV signals. As a result, on a given rooftop there may be areas of cancellation where TV reception is very poor, and other areas of addition, where signals are extra strong.

This is an especially important factor at UHF, because wavelengths are shorter. Sometimes a difference of just a foot or two height above the rooftop makes a tremendous difference in TV reception. What's more, the best reception height often varies with atmospheric conditions. (And reflections from passing aircraft can cause "airplane flutter" in some cases.) However, these problems can be overcome by using UHF receiving antennas with large vertical capture areas.

Home TV vs MATV antennas

Electrically, home TV and MATV antennas are quite similar. In fact, home TV antennas are often used successfully for small MATV systems.

Usually, however, you can afford to spend more for an MATV antenna serving 200 sets than you are willing to spend for a home antenna. Professional quality MATV antennas may provide slightly better performance than home antennas, but their prime advantage is mechanical ruggedness. Elements are generally thicker, better made and better put together.

Home systems almost invariably use broadband antennas—either a single all-channel antenna or separate UHF and VHF antennas. MATV systems use broadband antennas sometimes, but frequently use separate low-VHF band, high-VHF band and UHF antennas, or single-channel antennas. Separate antennas for each chanel cost more, but usually do a better job, especially under difficult reception conditions. Rotors are impractical for MATV, so if TV stations are in different directions, multiple antennas are a must.

Figure 7 shows a typical ruggedized broadband MATV antenna and Figure 8 depicts an MATV antenna array.

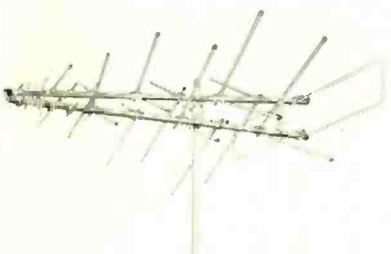

FIG. 7—JERROLD MODEL J-283X.

Installation techniques

The professional antenna installer should have professional tools. You can't do a good job with just a screwdriver and a pair of pliers. In addition, you need:

1. A set of nut drivers. ¼" and ⅜" fit most antenna mounting needs.
2. A set of ratchet wrenches, or open-ended wrenches. (Ratchet wrenches are preferred because they are faster.)
3. A staple gun for running downlead indoors.
4. A coax connector crimping tool.
5. A good field-strength meter.
6. A good compass and an area air map to determine antenna orientation.
7. A hammer heavy enough to drive ground rods.

Other useful accessories include a leather tool belt, acrylic spray for waterproofing outdoor twinlead connections, roofing tar for sealing holes made by standoffs, screw eyes and other mounting hardware, and caulking compound for use in sealing up holes made to take coaxial cable indoors. (Caulking compound is recommended for coax, but cannot be used with twinlead.)

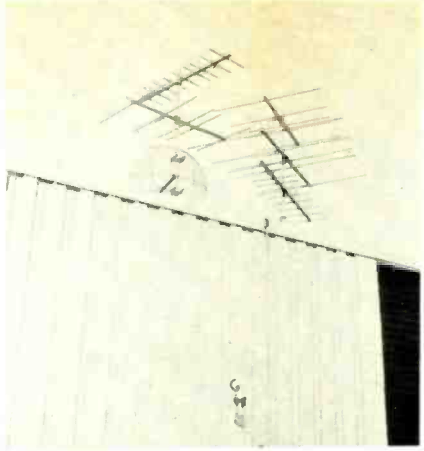

FIG. 8—MATV antenna array.

Your first step is to decide what antenna, or antennas to use and how to mount them. Don't go by manufacturer's mileage specifications alone. Discuss local reception conditions with your antenna supplier and try to get recommendations from installers who are familiar with what works best in given locations. For most home installations, advice of this type is usually all you need to select an antenna. In problem areas and for *all* MATV systems, use a field-strength meter with a small test antenna to determine exact signal conditions. Move the test antenna to various heights and to different locations to find the strongest, cleanest signals available.

If you suspect interference problems, connect a portable TV set directly to the test antenna and study pictures on all channels carefully.

Make a note of picture and sound carrier levels for each channel and use the field-strength meter to determine the frequency and direction of interfering signals. If you are not thoroughly experienced in choosing antennas, contact representatives of the antenna manufacturers. Most major manufacturers will be glad to give you specific advice on antenna selection and how to eliminate interference.

Avoid tall masts wherever possible. A 5-ft. mast is easier to install and makes for a very rugged installation. The 10-ft. masts are more difficult and 20-ft. masts are not recommended at all. (If you have to go up 20 ft. above the roof, use a tower.)

As you will discover with your test antenna and field-strength meter, there is often a strong correlation between antenna height and signal strength. For the most part, putting the antenna up higher means stronger signals. You have to weigh this advantage against the mechanical disadvantages of going up high. It costs more, and is more subject to wind stress.

In strong signal areas, 5-ft. masts are all that is required. In suburban areas, you may need a taller mast, but it may well be easier to simply use a higher gain antenna. Suppose, for example, that the signal level at 5-feet above the roof is 500 microvolts on your test antenna, whereas at 10-feet you can get 700 microvolts. The difference between 500 microvolts and 700 microvolts is only 3 dB. In other words, a better antenna will do as well at 5-feet above the roof as a smaller antenna at 10 feet, provided the better antenna has 3-dB more gain.

The most common home antenna mounts are chimney mounts, wall mounts, roof mounts and tripod mounts. Chimney mounts are easiest, but do represent some problems. For one thing, chimney gases blacken and attack aluminum elements. For another thing, chimney mounts often cause damage to chimneys.

Roof mounts invariably require guy wires, as shown in Fig. 9.

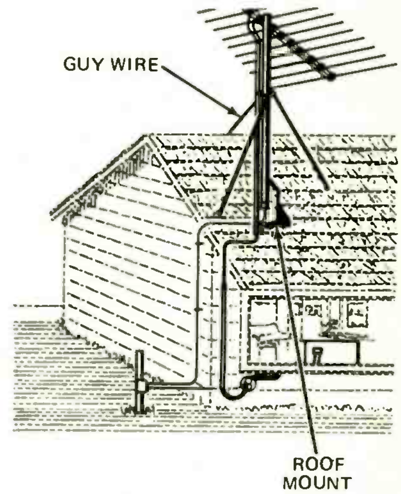

FIG. 9—ROOF MOUNTS require guy wires for secure installation.

All of these mounts work well if properly installed. The most important thing is to make sure that all wood screws bite deeply into solid wood. A bolt that goes through only a thin piece of wood, such as a wall facing, is useless. It will probably come out, causing the antenna to topple and defacing the roof or wall.

If a specific bolt doesn't hit a beam or rafter, use a 5" square of ¾-inch plywood inside the attic to catch a lag-bolt and hold it firmly.

If you must use guy wires, be sure they are securely anchored into solid wood.

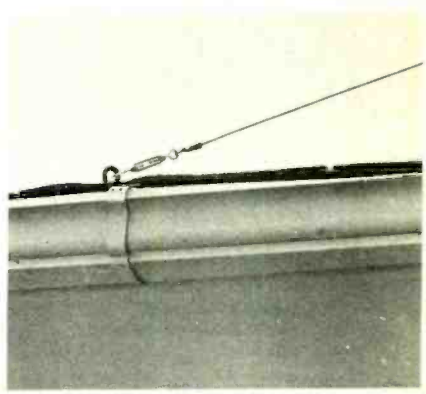

FIG. 10—TURNBUCKLES are required for stressing guy wires.

Use eye bolts or guy hooks, together with turnbuckes (see Fig. 10). Vinyl covered guy wire is recommended, since it is im-

(continued on page 74)

All About OSCILLOSCOPES

Oscilloscopes often look easy but there's more to them than meets the eye. This article explores some of the measurement techniques.

by CHARLES GILMORE*

ALTHOUGH THIS SECTION CAN NOT POSSIBLY be a comprehensive discussion of all oscilloscope measurements, it reveals a number of rule of thumb techniques that permit rapid analysis of many different circuits. These are primarily involved in servicing and anlayzing problems of common circuits.

Amplifier response testing

To analyze an audio amplifier, we feed a square-wave signal into the input jack of the amplifier and observe the amplifier's output wave form. Figure 25-a shows a dual-trace comparison of the input (upper) square wave signal and the output (lower) waveform. Lack of low-frequency response is obvious. Figure 25-b shows the opposite problem, lack of high-frequency response. The effects of Figure 25-a may also indicate too low a frequency is being used to permit AC vertical coupling. Figure 25-b may also indicate that the oscilloscope is being used near its upper bandwidth limit. Before testing an amplifier or other device for square-wave response, it is advisable, especially with a single-trace oscilloscope, to check the appearance of the square wave at the highest and lowest frequency limits to be used. If the oscilloscope itself will degrade the wave form, all measurements must take this degradation into consideration. Determining that a hi-fi amplifier still meets reasonable limits of frequency response may be ascertained by square wave testing.

When determining the frequency response of an amplifier by performing a point-by-point plot of frequency response, a dual-trace oscilloscope can be used as the readout device. The input sinewave is monitored on one channel and the output sinewave is monitored on the second channel. As the test frequency is increased, the input amplitude should be readjusted to produce constant deflection. The output amplitude is measured and recorded. For this measurement, the bandwidth of the oscilloscope must at least be equal to that of the amplifier being tested.

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If a square wave with a fast risetime is available, the risetime of the amplifier may also be readily measured. If the amplifier risetime and its 3-dB frequency are known, the high-frequency characteristics of the amplifier are defined. An amplifier with the product of the risetime and bandwidth that is much greater than 0.35 will have poor upper high-frequency response, while one substantially less than a 0.35 will produce overshoot (undesirable high-frequency response).

Phase delay

The dual-trace oscilloscope can be used to measure phase delay through an amplifier. A sinewave is applied to the amplifier and is monitored on one channel. The output waveform is monitored on the second channel, and the time differential between the two waveforms is observed. The measured time-delay, divided by the period of the input signal, multiplied by 360° gives us the phase-shift in degrees. Lack of a uniform phase-shift across the amplifier bandwidth indicates a non-uniform frequency response.

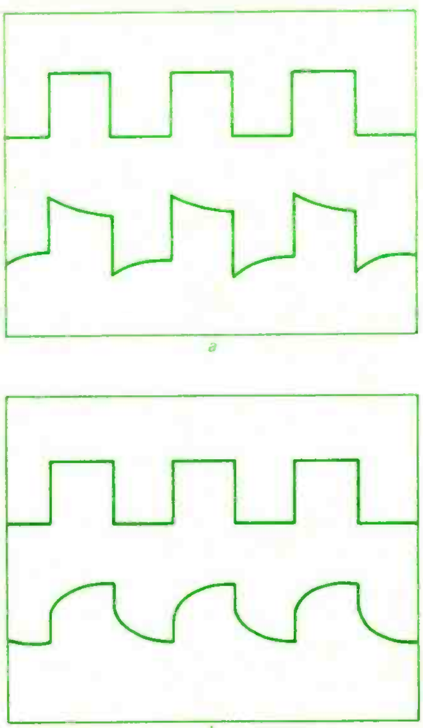


FIG. 25—A SQUARE WAVE FREQUENCY RESPONSE TEST. a) Poor low frequency response is indicated. b) Poor high frequency response is indicated.

In many audio and industrial amplifiers, the complementary-pair output stage is very popular. Complementary amplifiers are prone to two failures; both are readily identifiable. With a sinewave applied to the input, and the output observed on an oscilloscope, complete failure of one of the complementary-pair will produce an output signal that looks like the output of a half-wave rectifier.

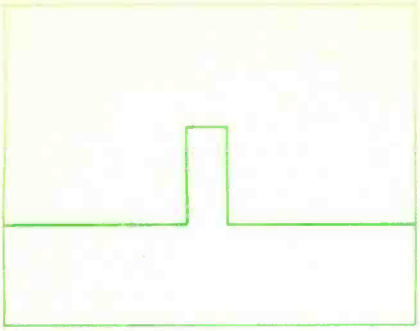
The second problem, not quite as obvious or as easy to repair, is caused by improper biasing. To operate properly, the complementary-pair must switch between the positive-going output device and the negative-going output device when the output waveform passes through zero volts. If there is a biasing failure, this does not happen. The result is called crossover distortion. A detailed examination of the zero-crossing portion of the waveform will reveal a step, indicating crossover distortion.

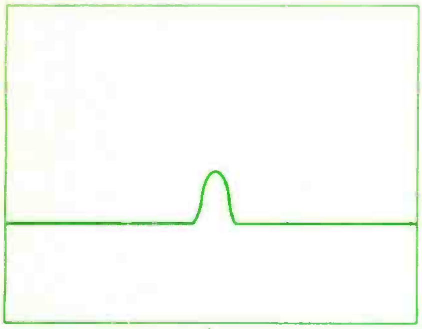
Partial failure of a power supply or input overdrive can cause clipping. Again, examine the output waveform to identify whether the clipping is either single-sided; frequently indicating a power supply or biasing failure: or whether it is symmetrical; indicating total power supply failure or input overdrive.

Severe harmonic distortion can be detected with an oscilloscope as a noticeable deterioration of the shape of a sinewave. With a dual-trace oscilloscope, the output sinewave can be compared to the input sinewave by superimposing them. Less than 3% distortion is very difficult to see on an oscilloscope. To detect distortion levels below 3%, you should rely on a distortion analyzer.

Analysis of logic circuits

The analysis of logic circuits without





b

FIG. 26—THE EFFECT OF VERTICAL BANDWIDTH on pulse response. a) A 25-ns wide pulse as seen on a 50-MHz oscilloscope. b) The same 25-ns wide pulse as seen on a 15-MHz oscilloscope.

an oscilloscope, from either design or servicing standpoints, can be close to futile. Anyone attempting to design or service logic circuits with any frequency should certainly own a dual-trace oscilloscope. Although vertical delay lines are not an absolute must, they add considerably to logic analysis. Logic circuits usually have timing and pulse characteristics that cannot be ignored. When a logic circuit fails and a check of the power supply and other such basic items indicates a logic problem, the first area to check is the amplitude and timing characteristics of the driving pulses. Frequent failure points for digital equipment are the circuits that convert signals from analog levels to the levels and shapes required for the digital circuits.

With some of the slower logic families, especially MOS, pulse-width measurements can reveal a pulse too narrow for the logic family in use.

A note of caution here. Many common logic circuits operate at speeds that are high, compared to the bandwidths of low-cost oscilloscopes. Narrow pulses can easily be lost because the oscilloscope does not have the bandwidth to display them. Figure 26 shows pulses photographed on a wide bandwidth (50 MHz) oscilloscope and the same pulses on a medium bandwidth (15 MHz) oscilloscope. An oscilloscope with a bandwidth of 15-MHz or greater is the recommended minimum when servicing TTL circuits.

When attempting to observe spiking, the oscilloscope must have enough bandwidth to observe the spike. In a TTL circuit, a 15 to 20-manosecond spike is enough to trigger a flip-flop, but cannot be seen on a 10-MHz oscilloscope, and would be of reduced amplitude on a 15 MHz oscilloscope. Spiking can also occur directly

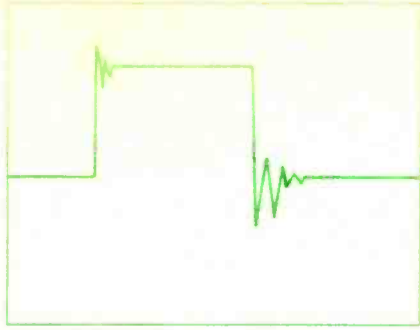


FIG. 27—RINGING AT THE LEADING OR TRAILING EDGES of a pulse in a logic circuit. Ringing may be present within the logic circuit due to improper grounds, terminations, or other signal path conditions. Ringing may also be caused by the measurement apparatus itself. If the amplitude and shape of the ringing appear to change substantially while running your hand up and down the test cable, suspect the mea urement technique. Ringing of this sort may also change considerably with changes in placement of the ground clip.

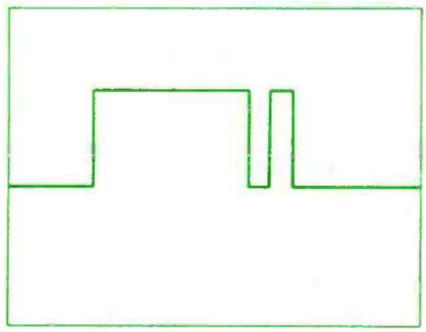


FIG. 28—ONE OF THE EFFECTS OF EXTENSIVE RINGING within a logic circuit. Limitations in vertical bandwidth may reduce the amplitude of this pulse. An input/output comparison of the succeeding stage with a dual-trace oscilloscope may reveal the true effect of the pulse.

after a mechanical contact closure (where the contact tends to bounce). This would be observed as a repeated number of spikes following the actual contact. However, this is very difficult to observe due to the narrowness of the spikes and the infrequent operation of the mechanical switch. A storage scope is required to observe this phenomenon.

When analyzing circuits involving counters, a frequent problem is excessive counts. There are two common causes of excessive counts. Ringing (see Fig. 27) sometimes produces spikes that are large enough to cause a second count. Oscillation, or noise, in analog interface circuits can frequently cause excessive counting too. Often these result in conditions similar to those shown in Fig. 28. When examining ringing in logic circuits, proper use of the probe and its accompanying ground clip are extremely important. A long ground clip, or one attached at some distance from the point of measurement, can cause ringing in the measurement itself. When attempting to observe logic circuits, a ×10 (low capacitance) probe should be used. Direct measurement with a coaxial cable frequently presents an excessive capacitance to the logic circuit, causing flip-flops, for example, to become inoperative.

Logic circuits often present situations demanding great writing speeds from an oscilloscope. A typical situation is the need to display a very short time span, such as 100-ns-per-division, when the triggering repetition rate is low, for example, 1 millisecond. To overcome this, turn the intensity up, turn the graticule illumination down, and use a viewing hood. There is a point beyond which even the finest oscilloscopes will not write due to insufficient repetition rate. Unfortunately, this situation is not uncommon with logic circuits. The storage oscilloscope is a partial answer, but often they lack adequate bandwidth to observe logic circuits. Where possible, the best solution to this problem is modifying the circuit being tested to temporarily increase the basic repetition rate sufficiently to observe the desired waveforms.

Television analysis

The complex waveform containing synchronizing and video information from a television transmission cannot be analyzed without the aid of an oscilloscope. As noted earlier, the oscilloscope is so important to television analysis that two specialized forms of the instrument have been created.

The top trace in Fig. 29 shows the video

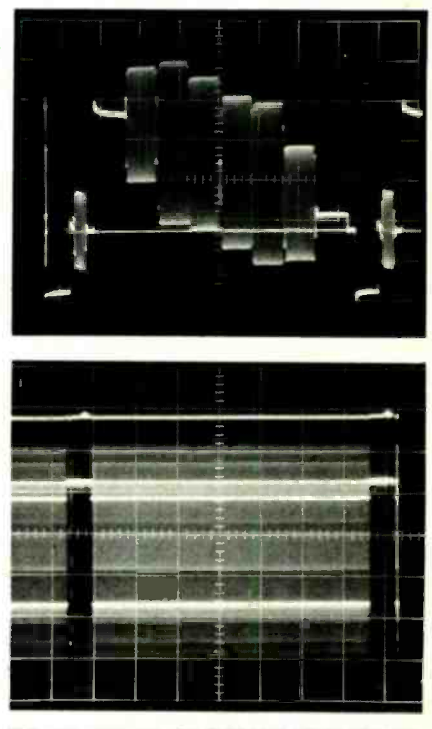


FIG. 29—COLOR TELEVISION TEST SIGNAL displays. The top trace shows the video signal between two horizontal sync pulses. The video signal is modulated by a color-bar generator. The lower trace shows the same video signal between two vertical sync pulses.

signal from a color television receiver. The display shows a single line of the television raster when it's modulated by a color-bar generator. The bottom trace in Fig. 29 shows the same video signal as shown in the top trace, except an entire frame of the television raster is shown. In this case, the time base of the oscilloscope is slowed down relative to the time base setting used to obtain the top trace.

Signals such as Fig. 29 should be observable at the output of the video detector and through the video stages on most television sets. The horizontal and vertical synchronizing signals can be easily traced through their respective circuits in case of difficulty in these areas. The top trace in Fig. 29 shows the 3.58 MHz color burst after the leading edge of the horizontal synchronizing pulse.

When the oscilloscope is used with a sweep generator to examine the bandpass characteristics of high-frequency circuits, it is used simply as an X-Y display. A typical example is shown in Fig. 30. The

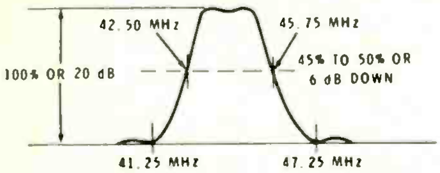


FIG. 30—IF RESPONSE CURVE of a black and white television receiver. The curve is obtained using an oscilloscope and a sweep/marker generator.

oscilloscope shows the amplitude vs. frequency characteristics of a 45-MHz intermediate-frequency amplifier of a television receiver. In this case, the sweep generator and its built-in demodulator provide the vertical signal as well as the sweeping signal. Using the sweep from the generator ensures the oscilloscope sweep is always in phase with, and has the same distortions as, the sweep changing the frequency of the signal generator. An alternative method is to use the output signal from a sweep generator to synchronize the sweep oscillator of the oscilloscope. However, if the sweep generator is swept by a sinewave, as is common on low cost sweep generators, the oscilloscope will also be swept by a sinewave as well. This will result in improper frequency vs. position relationships on the display.

Figure 31 shows the vector display gen-

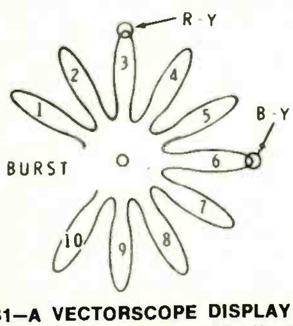


FIG. 31—A VECTORSCOPE DISPLAY shows the rainbow pattern produced by the red and blue signals of a color television receiver with the luminance signal removed.

erated on a vector oscilloscope monitoring a color television set driven by a color bar generator. If the oscilloscope is not specifically designed as a vector monitor, an X-Y oscilloscope may be used. Horizontal bandwidth of at least a few MHz is required for this application. The vector monitor may be used to adjust the amplitude of the 3.58 MHz oscillator; adjust the 3.58 MHz reactance coil, phasing the 3.58 MHz oscillator with the broadcast 3.58 MHz reference; adjust the color phase detector; check demodulation angle and linearity and adjust the chroma band pass of the receiver.

Many solid-state receivers supply both chroma and luminance information to the cathode of the TV CRT. The signal on the vector monitor will appear fuzzy unless the luminance signal is removed. This can be achieved by bypassing the luminance signal with a large electrolytic capacitor at an earlier stage.

Power supplies

Problems with power supplies, especially regulated supplies, must be detected with an oscilloscope, not a meter. A loss or reduction in value of the filter capacitor causes excessive ripple. Ripple is easily examined using the high sensitivity positions of the input attenuator and AC coupling. A dual-trace oscilloscope, with one trace monitoring the output of the regulated power supply and the other trace monitoring the input to the regulator circuitry, will show spikes on the output voltage or when the input ripple dips below the regulators capability.

A frequency problem with regulated power supplies is oscillation. Regulated power supplies are high gain amplifiers, and loss of a frequency compensating component, such as a bypass capacitor, can cause the power supply to oscillate. The power supply may have sluggish regulation characteristics as well as a high frequency output signal. Frequently, large capacitive-inductive loads will cause a power supply to oscillate. This can even occur with bench supplies.

Measurement errors

As the oscilloscope is one of the most versatile electronic instruments, it is also one of the more complicated to operate properly. Errors are frequently made, and most of them are unnecessary. Errors can be divided into two categories: those of simple operator error; and those where the display is read properly but the measurement is made improperly.

Operator errors are usually the result of an improper assumption on the part of the operator. A typical source of error is use of an oscilloscope without a prior check to ensure the horizontal and vertical variable controls are in their calibrated positions. This problem is common in shops and laboratories where the oscilloscopes are shared by a number of users. In this situation, a moment spent checking all settings on the oscilloscope, especially those not used frequently, is well worth while. Similar errors include improper trigger selection when making timing measurements, failure to include probe attenuation in amplitude measurements, and errors made when rapidly converting time into frequency.

Measurement errors often result from lack of understanding the equipment specifications. For example, the error resulting from using an oscilloscope of too low a bandwidth to analyze a logic pulse may cause the operator to miss a narrow pulse causing all the problems. Errors of this type are common on both horizontal and vertical measurements when the operator forgets the accuracy specification and assumes he has made an absolute measurement.

When connecting the probe or test cable to the circuit, the effect on the circuit of the input impedance of the oscilloscope and the test lead must be remembered. *The simple coaxial cable has a capacitance of 30 pF per foot.* With the customary 3-foot cable and 30 to 40 pF input capacitance of the oscilloscope, there is a total of 120 to 140 pF load placed on the circuit. With certain low impedance circuits, this does not cause any trouble; on some of the higher impedance circuits, severe circuit loading occurs as the test frequency is increased.

When connecting the probe or test cable, the operator must be certain the ground clip is connected to a point which is ground for the circuit under test. A frequent problem with products having both logic and analog circuits is high level logic currents in certain portions of the ground circuits. If this is the case, and a measurement is being made in the analog circuit, the proper ground point is one which does not contain current from the logic system. For this reason, the common technique of connecting the ground clip to the chassis is not wise.

The problem is even more serious as oscilloscopes become available with high sensitivities. For example, voltage drops in a foil due to return currents from a logic chip are generally not evident on an oscilloscope with a 10-mV sensitivity, but it is a serious problem on an oscilloscope with 1-mV sensitivity.

The compensated ×10 oscilloscope probe can introduce considerable error to a measurement involving high frequency characteristics, if the user fails to adjust the probe to the input capacitance of the oscilloscope. This procedure must be carried out even if the probe is moved from one channel of a dual trace oscilloscope to another.

When possible, probes should be purchased for a particular oscilloscope, matched to a particular input channel, identified as such, and never used anywhere else. Unfortunately, this is not always possible for economic reasons. In such a case, the user must be sure to check the compensation of the probe. **R-E**

TSA INSTALLATION

TELEVISION SERVICE ASSOCIATION (TSA) of Northeastern New York swore in its officers at its annual dinner dance last February. Left to right in the photo are TSA's

attorney William McCarthy, who installed the officers; secretary Richard (Dick) Swanson, Sr., Reliable Repair Service, Troy; treasurer Rolland (Ron) Flicker, Flicker TV Service, Schenectady; vice president Warren Baker, CET, Baker Electronics, Albany, and pre ident Paul J. Landor, Landor TV and Appliances, Cohoes.

State of SOLID STATE

An IC microtransmitter from Lithic Systems and Zenith's Target Tuning circuit is covered this month

by **KARL SAVON**
SEMICONDUCTOR EDITOR

MOST OF THE INTEGRATED CIRCUITS ON the scene are confined to audio and very low-frequency bands. Lithic Systems makes a communications oriented chip that operates in the high-frequency spectrum and deserves our attention this month.

Zenith's Target Tuning system uses LED's as a center-of-station tuning indicator.

LP200 microtransmitter

Figure 1 shows the schematic of the chip connected to the necessary external components needed for a Citizen band transmitter. The current drain of the circuit is 50 mA with a 12-volt supply.

Signal flow begins with oscillator Q3. L1 and C2 tune the collector of Q3 close to the operating frequency, and the series resonance of the crystal connected through C3 completes the oscillator's regenerative path from collector to emitter. DC collector and base voltages of the transistor are the same because they are jumpered by the low resistance of L1. Series-connected diodes D2 through D5 bias the base of Q3 at four junction voltages above ground—about 2.8 volts. Capacitor C1 bypasses the bias supply for 27-MHz. As long as the transistor does not saturate, the oscillator will be stable even though the base and collector are at the same DC potential. The voltage swing at the collector is limited to less than 700-mV peak-to-peak by the amount of collector current flowing in the stage. Transistor Q4 is a current source designed to conduct the required current. It is entwined in the power supply circuits which will be discussed a little later.

Emitter followers Q10 and Q11 isolate the output amplifier Q13 from the oscillator. The 2.8-volt bias at the base of Q10 is dropped by the three base-to-emitter junctions of Q10, Q11, and Q13. Q13's emitter is 0.7 volt above ground, sufficient for current source Q14 to function. The emitter of Q10 is connected to ground through R9 and diodes D6 and D7. There is about 0.7 volt across R9, so the bias current in Q10 is determined by 0.7V divded by R9's resistance value.

Q12 and Q14 conduct currents modulated by the microphone input. Q13's emitter is RF bypassed by C10, so for 27 MHz, it is a grounded emitter amplifier with its collector tuned by L2, C8 and C9 to match a 50-ohm antenna. The voltage gain of Q13 changes directly with its current originating in Q14. C10 is selected to be

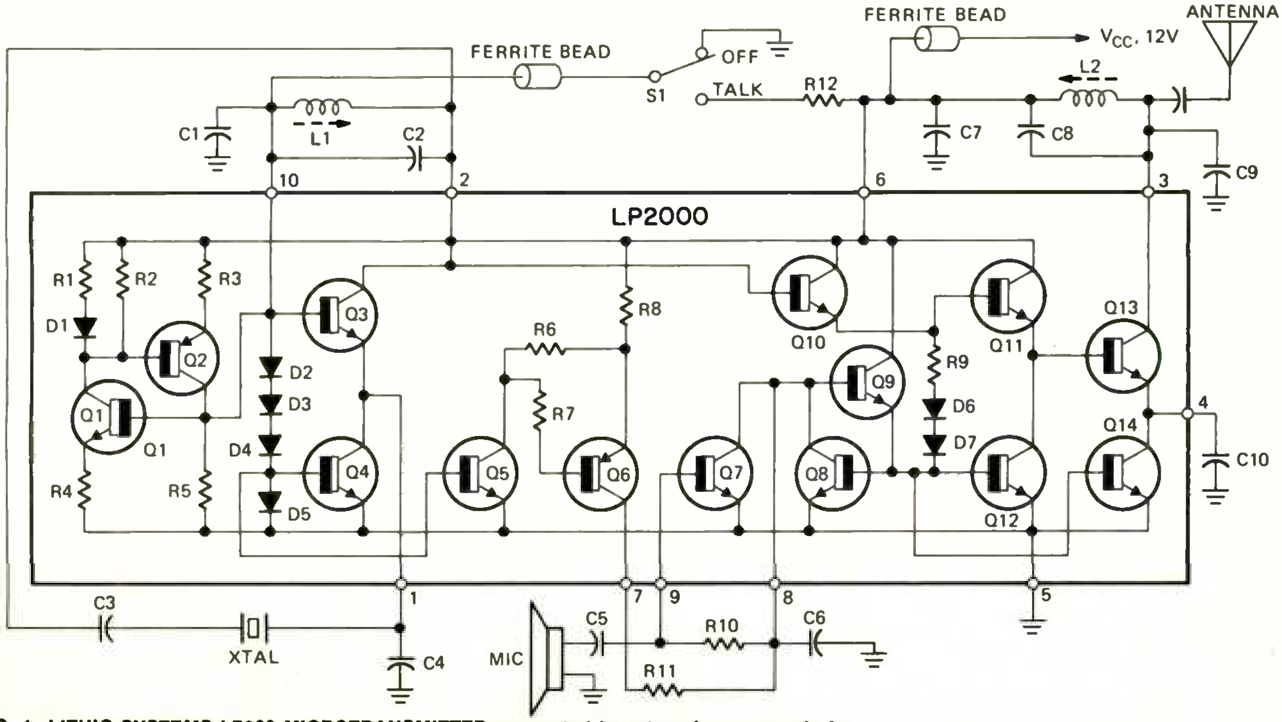


FIG. 1—LITHIC SYSTEMS LP200 MICROTRANSMITTER connected to external components for Citizens band operation.

a high impedance at the modulating frequencies, so the RF gain of Q13 and its output voltage are modulated by the audio signal. Simultaneous modulation of Q11's emitter current is a refinement that helps give an output modulation specification of 90% with less than 10% distortion.

Forgetting Q7 temporarily, notice that the collector of Q8 is connected to IC pin 7 through R11. Pin 7 sits at a fixed proportion of V_{cc}. Also note that the collector of Q8 is at 1.4V above ground because of the series connection of the bases of Q9 and Q8. An essentially constant current is supplied to the collector of Q8 by this arrangement. A current "mirror" circuit Q8-Q9-Q12-Q14 reproduces the current flowing in Q8 in both Q12 and Q14.

Current "mirrors" are favorite tools from the IC designer's bag of tricks, for they exploit the excellent matching characteristics of the integrated devices. All chip components go through identical diffusion temperature-time cycles. They are in as identical a thermal environment as possible, just a few thousandths of an inch apart. In most "mirrors", as in this case, the emitter and bases of the current input and output transistors are paralleled, and as a result, their collector currents are matched. Typically the match is better than 10%. Matching accuracies are improved when necessary by adding emitter resistors which match closer. Take time to study these "mirror" circuits as they are pointed out. You'll be seeing them again and again.

Q14 is designed with a larger base-to-emitter junction area than the other devices to conduct the proportionally larger current needed to feed the higher current output stage Q13. Q9 automatically supplies the base current requirements of Q8, Q12, and Q14. It adapts to changing conditions because of its negative feedback connection with Q8. Q7 is driven from the microphone through C5. Its collector current subtracts from the constant current feed through R11. A positive microphone voltage swing increases the collector current in Q7 and decreases the base current in Q9. The reduced collector current in Q9 reduces the current in Q12 and Q14, generating the modulation current. R10 is a feedback resistor controlling the gain and linearity of the audio preamp Q7. C6 controls the high-frequency cutoff frequency to control the audio bandwidth and rejects noise.

A regenerative power supply latch system is triggered on and off by a switching voltage applied to pin 10 of the IC. Although pin 6 is permanently attached to the V_{cc} supply, the microtransmitter does not draw current until it is triggered on by the push-to-talk button S1. D1 and Q2 form another IC current "mirror". Because of the common base connections and equal emitter resistors R1 and R2 are returned to a common tie point, the collector current in Q2 closely matches that in D1 which is supplied from Q1. There is some error in the current matching however—a portion of the Q1 collector current is needed by D1 and Q2, and by R2. This current "mirror" does not use the additional emitter follower the previous design incorporated to reduce base current errors. Pushing S1 applies V_{cc} through current limiting resistor R12 to pin 10 and the base of Q1 turning the transistor on. Current in Q1 now flows through D1 and is reproduced in Q2. Q2's collector current drives the base of Q1 and the oscillator bias diode string. At this time it is possible to open the series R12 lead to pin 10 and the current in the various supply transistors will remain latched. The momentary triggering facility is not used in the 27 MHz transmitter, but there are applications where it is valuable. Voice keyed (VOX) and remote-triggered systems are examples.

Zenith LED Target Tuning

Zenith uses LED's in their Target Tuning system in two different versions. Figure 2 shows the simpler system used in some digital clock table radio models.

The output of the last IF stage for either the AM or FM band is coupled through a capacitor to a voltage-doubling diode detector D1-D2. Q1 and Q2 are a direct-coupled LED driver amplifier. To make the amplifier sensitive, a negative feedback biasing scheme forces the two transistors to conduct lightly. Biased at very low current, the LED appears off. Just on the edge of conduction, it will light brightly with very low external drive levels. Diodes D1 and D2 are also biased slightly on so their anode-to-cathode junction thresholds do not have to be exceeded by the input signal. Their normal 0.6 volt turn-on junction voltage is compensated for by the feedback. The DC feedback path is from the emitter of LED driver Q2 through voltage divider R6-R2, through D1 and D2, and through R3 and R4 to the base of Q1. C1 is a bypass capacitor which grounds the anode of D1 for signal frequencies. As the receiver is tuned to the center of the i.f. passband, D1 conducts on the negative half-cycle of the signal to charge either capacitor C701 or C702. On the positive half-cycles the stored capacitor voltage adds to the signal to feed C2. The detected signal is fed through filter R3-C3 and R4 to turn on Q1. R4 increases the filter discharge time by isolating C3 from the relatively low input impedance of Q1. The increased collector current in Q1 turns Q2 on, which provides some 30 mA through the LED.

Some of the more elaborate Zenith hi-fi receivers have a triple LED formation on the dial pointed to show low and high tuning as well as center tuning. The center LED is green and the two outer LED's are red.

Fig. 3 is a schematic of the system. You may be surprised to see two ratio detectors. One acts as the normal FM detector and also has two outputs to the Target Tuning system. The second ratio detector is added just for frequency discrimination drive for the LED's during AM reception.

A short review of ratio-detector theory is in order: Two series-aiding connected detector diodes are driven by the L214 secondary winding of tuned transformer T207. Tertiary winding L213 is also magnetically coupled to the primary and an induced voltage is generated across it. Because L214 is tuned and L213 is not, there is a 90° phase difference between their voltages at 10.7 MHz where L214 is at resonance.

Diode CR202 along with R213, R215 and C218; rectifies the sum of

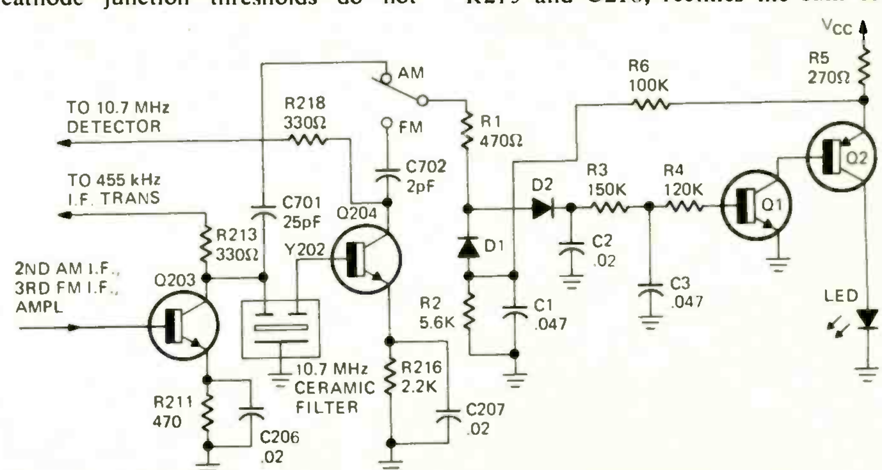


FIG. 2—ZENITH'S TARGET TUNING system. LED lights when receiver is tuned to center of IF passband.

V1 and V2 and produces a positive output marked FM+. and the combination of diode CR203, R211,R216 and R219 generates the FM− output from V1 + V3. Fig. 4-a shows that the vector sums of the two signals are equal at resonance. Since the detectors are sensitive only to amplitude, it is the size of the sum vectors that indicate their outputs. The average of the two detected sum signals becomes FM_{out} and since they are equal and opposite in sign at resonance, the output is zero.

With a shift in IF frequency the phase relationship changes; L214 is no longer at resonance. If the frequency increases, for example, the angle between V1 and V2 decreases while the angle between V1 and V3 increases. The vector sum of V1 and V2 is now greater than the vector sum of V1 and V3. Fig. 4-b shows the off-center situation. The diode detectors produce two different magnitude outputs. FM+ is larger by about the same amount that FM− is smaller. The averaged FM_{out} voltage now moves in the positive direction. It is this averaging of the positive peaks of FM+ above 10.7 MHz and the negative peaks of FM− below that creates the conventional FM "S" detector characteristic. As these changes take place, the sum of the two voltages remain constant. Only the ratio of the outputs vary and hence the name ratio detector. The difference between FM+ and FM− is stored on electrolytic capacitor C220. Some degree of amplitude modulation rejection is afforded by the capacitor because noise causes apparent carrier amplitude changes, but cannot instantaneously change the capacitor voltage and the output.

The AM ratio detector (T601-CR601-CR602) operates with the same basic phase detecting principle, but is driven differently. The open tertiary winding on the transformer forms a capacitor between the lower side of the secondary and ground. The network including C601, the tuned primary winding, and the capacitor to ground causes a 90° phase shift between the voltage across the transformer winding and the voltage at the primary tap. A DC offset is added to the output voltage by the forward biased junction of diode CR603.

AM+ and AM_{out} mark the positive above center frequency output and the "S" output respectively.

With the receiver switched to FM and center tuned, FM+ is at maximum and FM_{out} is zero. FM+ drives transistor Q603 into conduction. Q603-Q604 is a Darlington-connected amplifier with high beta. The circuit can be considered a switch although the collector of Q604 does not go completely to ground. You will note that the collector falls to (1) junction-voltage drop (VA) above ground because Q603 will saturate first preventing saturation of the second transistor. With about a 3-volt forward bias across the green LED CR606, there is a 12.8 − 0.8 − 3 = 9 volts across R610 limiting the current to 9/390 = 23 mA. Operating in this mode, Q601-Q602 is biased off by FM_{out}, keeping the HIGH tuning indicator extinguished. Q605 is biased on by the 12.8 volt supply through R612, and Q606 is held off keeping the LOW tuning LED CR607 off.

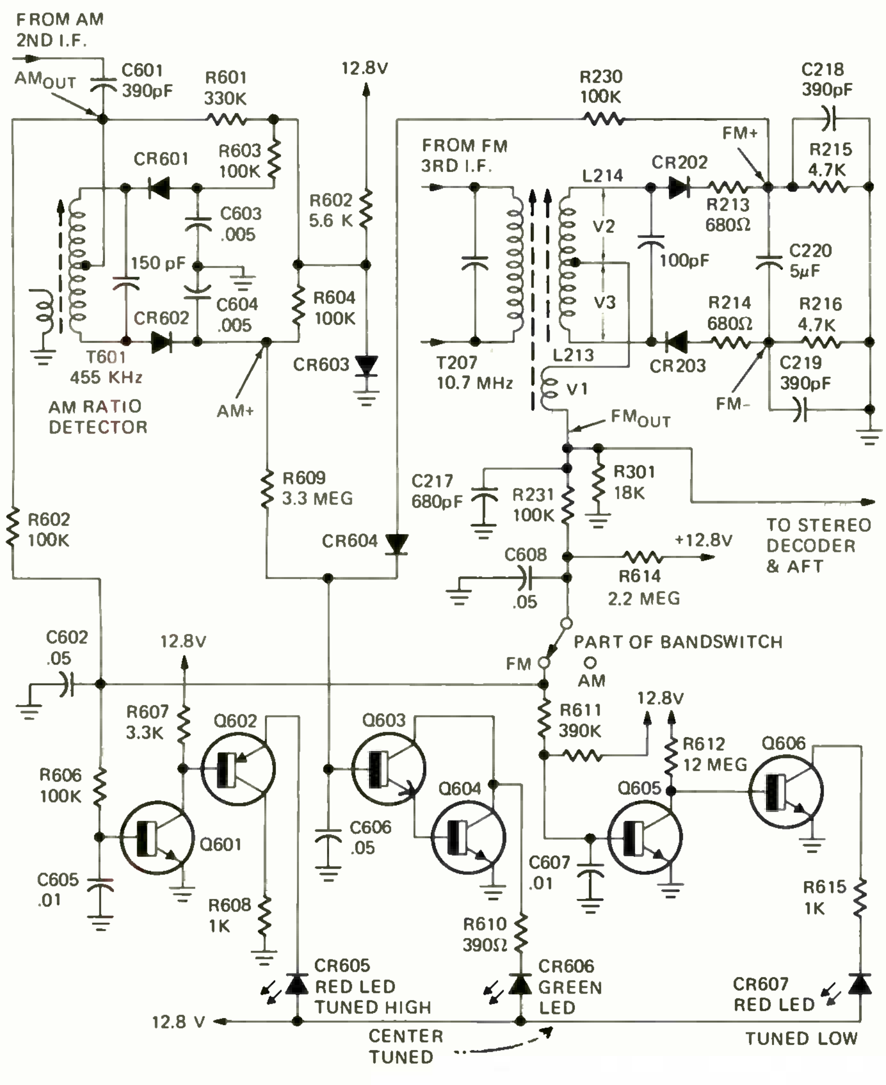


FIG. 3—THREE LED'S indicate low, high, and center tuned conditions.

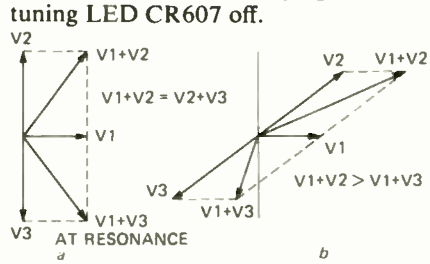


FIG. 4-a (left)—VECTOR SUM of voltages at output of ratio detector at resonance.
FIG. 4-b (right)—OFF RESONANCE condition.

Now if the FM receiver is tuned below the center frequency, FM+ is low and the FM_{out} voltage is at its negative peak. As a result, Q601-Q602 is biased off even harder than before and Q603-Q604 is off since the two V_j input threshold at the base of Q603 is not reached by FM+. FM_{out} being negative turns off transistor Q605. Its collector current being zero, the collector voltage of Q607 rises toward the supply and Q606 is turned on by the current through R613. R615 limits the diode current to about 12 mA.

Finally, when tuned above the center frequency, FM_{out} and FM+ are highly positive. Q601 and Q602 are now turned on and the tuned HIGH indicator is illuminated.

Switching the receiver to AM, the Target Tuning system works the same way. When center tuned Q603-Q604 is driven by AM+ through R609. CR604 is a disconnect diode to prevent the FM ratio detector from loading the 455-kHz ratio detector. FM_{out} and AM_{out} are matrixed through R230 and R602 to feed the "high" and "low" detectors. **R-E**

3 GUYS WHO DIDN'T GET A FREE RIDE THROUGH COLLEGE TELL HOW THEY BECAME ENGINEERS.

Signal-to-Noise-

One manufacturer's signal-to-noise the same thing as another specification can be confusing to

RECENTLY WE EXAMINED TAPE BIAS AND equalization in terms of their effect on frequency response, distortion and signal-to-noise ratios. We mentioned the fact that one manufacturer's S/N ratio may or may not tell you the same thing as that of another manufacturer. If the audio industry was plagued by ambiguous audio power ratings in the past (a problem that is to some small degree being alleviated by the new FTC power rules), the situation with signal-to-noise measurements is even more confusing to the unsuspecting audiophile. And it is as confused not only in tape deck specifications, but in those relating to phono preamplifiers and turntable performance. Let's consider each of these product categories in turn.

Tape deck S/N specifications

Signal-to-noise specifications, when listed for tape decks, are supposed to give you some idea of how much louder a desired recorded musical signal will be, compared to the inherent noise generated by the tape itself and the recorder's electronics. The variables that can make a great difference in the final spec are: the tape itself, the loudness (and acceptable distortion) of the "maximum" recorded signal, and the kind of noise that signal is being compared with. To begin with, not all manufacturers calibrate their record level meters in the same way.

One manufacturer may calibrate his "0 VU" points on the meters so that they correspond to a distortion level (during recording) of 1% while another may allow "0 dB" to correspond to 3% distortion. If a meter is calibrated to 3% distortion for "0 VU" recording level, the signal-to-noise ratio for that machine may be anywhere from 6- to 9-dB higher than a machine whose meters have been calibrated to read "0 VU" for a recording level of 1% distortion. Figure 1 shows why this is so. The recordist will naturally set level controls so that highest readings during recording reach "0" on the meters.

The unsuspecting recordist who owns the "3% THD for 0 VU" machine will therefore normally record at a higher level and, if the residual noise generated by both machines (using the same tape) is constant, recorder "A" shows a 60-dB S/N spec while recorder "B" (with the more conservatively calibrated meter) has only a 54-dB S/N ratio.

But that's only the beginning. As you can see in Fig. 1, low-frequency noise (in the region of 60 Hz—the power line frequency) is greater (in absolute terms) than high-frequency noise or hiss. A simple AC VTVM reading the output of a tape deck, with no audio applied to the tape, will tend to read the higher hum contribution rather than the lower-level "hiss" or high-frequency noise contribution.

Figure 2 shows that two recorders having widely different high-frequency noise characteristics (but the same level of "hum") can cause the meter to read the same "residual noise level" for both machines—58 dB. Unfortunately, the human ear is more responsive to mid- and high-frequencies than it is to low frequencies and, even intuitively, we know that recorder "B" will "sound" noisier than recorder "A". That is why many recorder manufacturers use a "weighting curve" when determining signal-to-noise ratios.

There have been many suggestions as to what curve should be used. Each attempts to compensate for the way human ears perceive low-level sounds, and an example of one such weighting curve is shown in Fig. 3. A filter having the response curve shown would be inserted in series with the output of the tape deck under test, and the output of the filter would then be connected to the AC VTVM. If we subtract the effect of the filter at each frequency over the entire audio spectrum, Recorder "A" now has a 64-dB S/N spec while

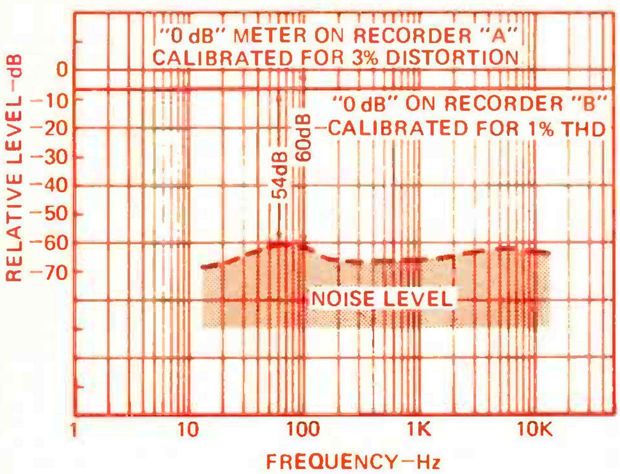


FIG. 1—SIGNAL-TO-NOISE RATIO for a tape deck depends upon the reference 0-dB level.

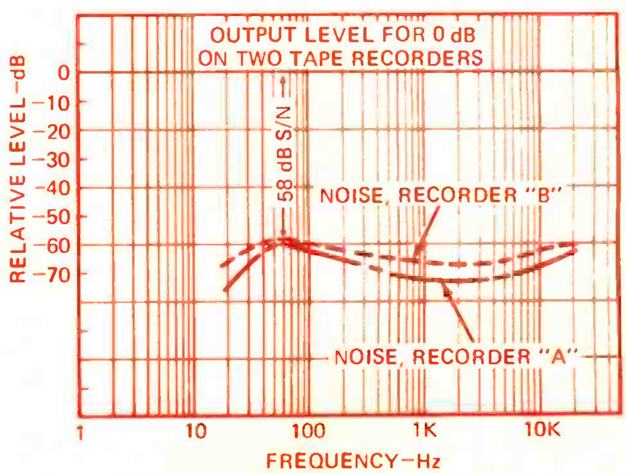


FIG. 2—A SIMPLE AC VTVM attached to the output of the tape deck will measure the largest value of noise present. Therefore, even though recorder "A" has a lower amount of hiss, the meter will read 58-dB for both units.

What does it mean?

measurement may not mean manufacturer's. This ambiguous the unsuspecting audiophile

by LEN FELDMAN
CONTRIBUTING HI-FIDELITY EDITOR

recorder "B" would produce a noise-level reading which is only 60 dB "below 0 dB recording level." (See Fig. 4.)

Obviously, it would be ideal if the tape recorder industry adopted a standard weighting curve as well as a standard distortion level from which to reference all S/N readings. Even if that degree of standardization were achieved within the industry, there would still be an additional variable that could not easily be standardized—the tape itself.

A manufacturer may calibrate his meters using a standard brand of tape that will reach 1% distortion level for 0 dB. That same brand of tape may be "over-recorded" to, say, +3 dB before 3% distortion is reached. A better brand of tape might reach the same 1% distortion level at 0 VU but might not reach 3% distortion until a recording level of +6 dB was attempted. Or, the 1% distortion levels for both tapes might not even correspond to the "0 dB" calibration point of the meters. The variations and possibilities are endless, especially when you consider the assortment of tapes currently available.

Ideally then, a manufacturer should quote weighted and unweighted S/N ratios for a given tape at a given "reference" distortion level. Users should stick to that tape (or one known to have the same characteristics) or at least be aware of the performance potential of the tape they plan to use as compared with the tape used by the manufacturer to calibrate his machine and to "write his specification sheet."

One last thought about signal-to-noise on tape. Since most tests and measurements are made using a 400 Hz or 1 kHz test tone for a reference signal, there can be variations in true S/N ratio depending upon music actually being recorded. Meters may or may not be equalized (so that they don't respond equally to all frequencies) and this, too, can give rise to widely varying "0 dB" readings depending upon the frequency content of the music being recorded at any given instant. As we said, if the FTC thought the standardization of audio power was a complex problem, imagine what they would be faced with if they tried to standardize measurements of S/N ratio when it comes to tape products!

Phono preamplifier S/N ratios

Though somewhat ambiguous too, hum or S/N readings relating to phono preamplifier performance are not subject to quite as much variation as are tape S/N readings. The most important confusion factor arises from manufacturer's desires to come up with the "highest" dB readings possible so as to place them in a favorable competitive position. Consider, first, how numbers can be "juggled" even if no auditory "weighting" networks are used in the readings. Let us suppose that a given preamplifier has an input sensitivity (at 1-kHz) of 2 millivolts. That is, a 2 mV, 1-kHz signal, applied at the phono input terminals will produce full power output from the associated amplifier section when all level controls are turned full up.

If the unit is a preamplifier only, 2 mV will produce "rated output voltage" under the same conditions. The most straightforward S/N measurement would result if we simply remove the input signal, short the input terminals, and note on the output meter how many dB lower the hum and noise is with respect to that initial output voltage.

It is, unfortunately, common practice for many manufacturers to state true input sensitivity in millivolts (2 mV in our example), but to quote S/N ratios with respect to some other, arbitrarily higher input such as 10 mV for example. Figure 5 shows what happens. A reading of 55 dB (referenced to actual input sensitivity of 2 mV) is magically transformed to a reading of 69 dB—a seeming "improvement" of 14 dB.

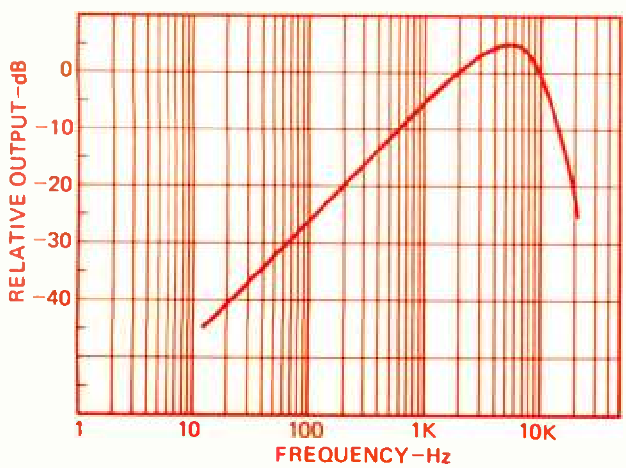


FIG. 3—RESPONSE OF TYPICAL WEIGHTING network used in making noise measurements on tape decks.

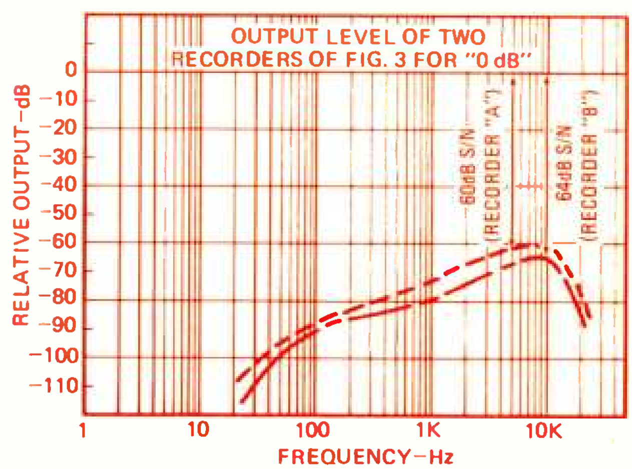


FIG. 4—LOWER HISS NOISE of recorder "A" results in higher S/N readings when using weighting curve of Fig. 3.

Of course, if you had applied a signal level of 10mV to the phono input (without turning down the level control of the amplifier), you would have been so far into clipping and distortion that the output waveform would have changed to almost a square wave instead of the sinusoidal input you started with. Furthermore, if you had been guided in your choice of phono cartridges based on input sensitivity and had selected a cartridge having a nominal output of 2 mV, the arbitrary 10 mV reference used by the manufacturer is meaningless—and so is his stated 69 dB S/N figure!

Manufacturers may or may not use weighting curves in measuring S/N ratios of phono preamplifiers. As shown in Fig. 6, three popular weighting response curves are used, identified as "A", "B", or "C" weighting curves. Depending upon which curve a manufacturer elects to use, S/N readings can vary over a range of as much as 26 dB if the noise consists primarily of 60 Hz hum, or by as much as 17 dB if noise content is primarily 120 Hz in nature. "C" weighting and "A" weighting have been the most popular of the three common weighting curves used by amplifier manufacturers in making these measurements. Fundamentally, there should be no objection to their use providing the manufacturer clearly states that he is using one or the other in his measurement. Probably, the ideal situation would be for a manufacturer to give both weighted and unweighted S/N figures, stating which weighting curve is used, and using the actual input sensitivity referred to full output. Supplying all of this information would lead to standardized results, or at least results that the knowledgeable audiophile could properly interpret.

In the CBS (ARLL) method, frequencies below 500 Hz are rolled off at a rate of 6 dB-per-octave while above 500 Hz, the filter attenuates frequencies at a rate of 12 dB-per-octave. The DIN "A" system (unweighted) attenuated frequencies below 10 Hz at 6 dB-per-octave rate, while in the case of the DIN "B" method (weighted) attenuation is at 12 dB-per-octave above and below a reference frequency of 315 Hz.

As if that weren't bad enough, the four popular measurements do not employ the same reference frequency or amplitude for establishing "0 dB", below which the rumble measurement is to be made. The reference signal is usually recorded at the beginning of the test record and permits the tester to set up his gain control so the measuring meter will read "0 dB". Then, when the quiet grooves begin, he simply "reads down" and obtains the residual reading —which represents rumble.

However, the NAB system uses a reference signal at 100 Hz, with a recorded velocity vibration. Basic evaluation of the signal picked up by the cartridge can be treated in two ways. The first is to evaluate it as it is picked up without regard to how we hear it, giving the same emphasis to all frequencies. The second is to try to evaluate the rumble based upon how our ears hear it.

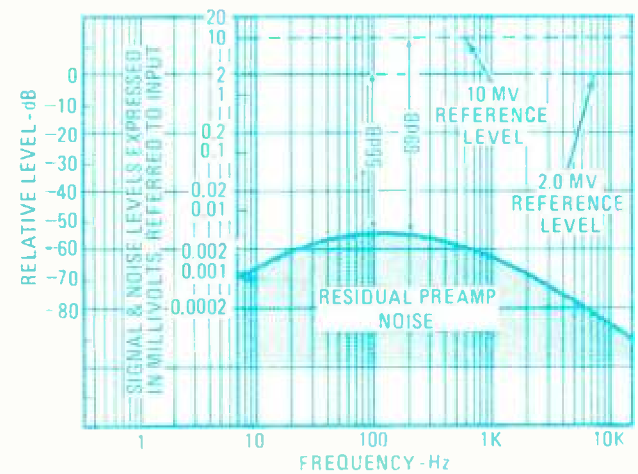
Variations in rumble readings when using one measurement system or the other arise from two causes. First, of course, there are the different weighting curves used for the four popular systems. These are illustrated in Fig. 7. The NAB system considers all offending frequencies over the range from 10 Hz to 500 Hz equally, and rolls off filter response below 10 Hz at a rate of 6 dB-per-octave, with frequencies above 500 Hz attenuated at a rate of 12 dB-per-octave.

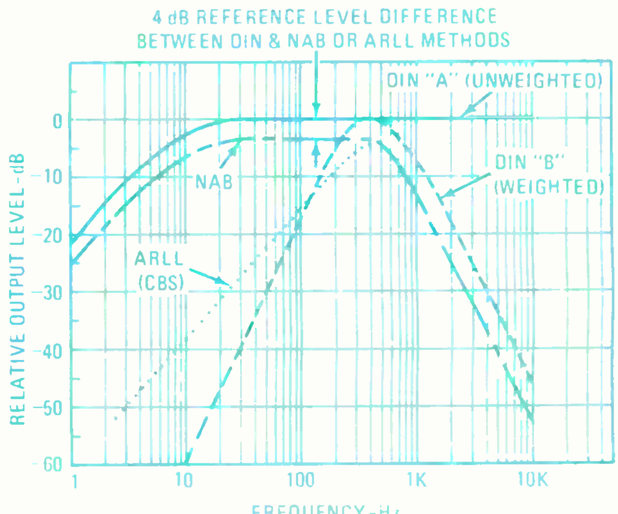
Turntable rumble

When it comes to turntables, the signal-to-noise ratio that we are most concerned with is rumble—loosely defined as low-frequency noise in the range of frequencies below 500 Hz and extending all the way down to sub-sonic frequencies of just a few Hz. Here again we are faced with at least four popularly accepted methods of measuring rumble as a single "dB" number below some reference signal level. The methods used are known as the NAB method, the ARLL method (proposed by CBS), the DIN "A" (or unweighted) system and the DIN "B" (weighted) rumble measurement.

Basically, rumble measurements are performed with the record player operating at 33⅓ RPM. A standard test record is used that has unmodulated or "quiet" grooves near its outer edge. Any signal picked up by the cartridge while playing these grooves is a result

(continued on page 86)





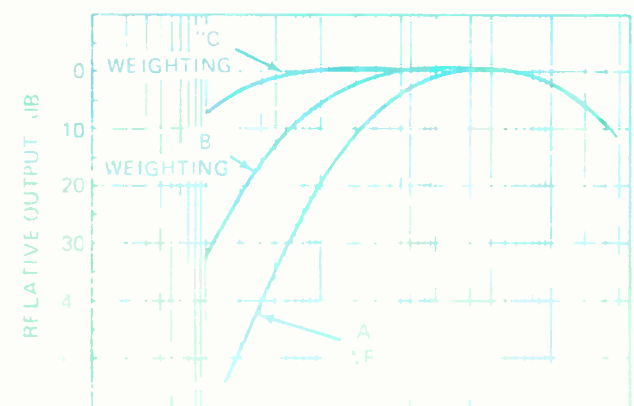


FIG. 5 (upper left)—PHONO HUM AND NOISE can be made to appear better by using a higher input signal reference level.
FIG. 6 (left)—THREE POPULAR WEIGHTING NETWORKS used in making S/N measurements on amplifiers and preamplifiers.
FIG. 7 (above)—RESPONSE CURVES of various weighting filters used in making turntable rumble measurements.

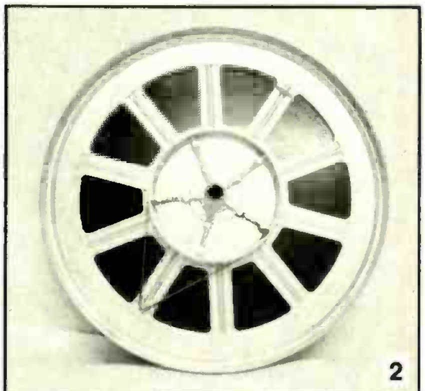
1

Radio-Electronics® Tests B.I.C. Model 960

by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

B.I.C. STANDS FOR BRITISH INDUSTRIES COMpany, and while this firm first gained fame by introducing a line of well known British made record changers, the model 960 turntable system that we tested is manufactured completely in the United States. The model 960 shown in Fig. 1, is the mid-priced of three units developed by B.I.C. over the last two years. The higher priced unit, model 980, sells for just over $200.00 and a newly introduced model 940 sells for $109.95. All three models use belt drive for turntable rotation—an approach not previously found in multiple-record players. Belt drive eliminates the need for an intermediate idler-wheel that provides the necessary coupling between the high-speed motor and the inner rim of the turntable platter in most record changers. Besides the vibration absorbing qualities of a belt, this means one less rotating bearing point as well and eliminates another wearing surface. (There can be no "flat spots" on the idler wheel if there is no idler wheel!).

The 960 comes with turntable installed, and there is no need to fuss with the belt at the outset. However, recognizing that this part may someday require replacement, B.I.C. has made belt installation extremely simple. A view of the underside of the turntable is shown in Fig. 2. Note that most of the mass of this non-ferrous disc is concentrated at the outer rim (the black sections seen are the underside of the turntable mat, where aluminum has been removed) for increased "flywheel effect" during rotation. A pair of pins are provided that permit the user to install the belt between the inner rim of the platter and one of the pins, as shown. The platter is then re-mounted and a couple of spins of the turntable by hand guide the newly installed belt into proper position about the motor shaft pulley shown in Fig. 3. A plastic guide determines belt position on the pulley.



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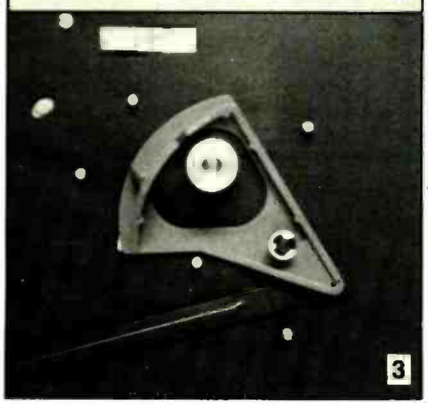

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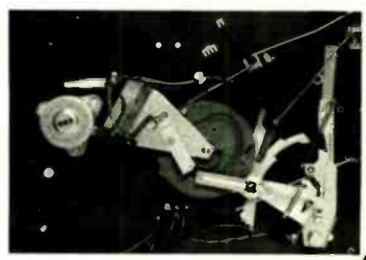
A view of the underside of the model 960 is shown in Fig. 4. Compared with other typical "record changer" mechanisms, the number of parts, linkages and gears has been reduced to a surprising minimum. This reduction in complexity is made possible because of B.I.C.'s new approach to multiple record playing which they call "programming". Most record changers rely upon a sensing arrangement in combination with linkages affixed to the center spindle to trigger the record and pickup arm cycling sequence. In the case of the model 960, the user simply selects the number of plays desired by means of a front panel slide control—anything from single, manual play all the way up to 6 plays. Simply stated, the machine will then "cycle" the number of times programmed. If, for example, three records are stacked and the unit is programmed for "3", each record will be played and then the unit



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turns off after the last record has been completed. If, however, the unit had been programmed for "6" and only three records had been mounted in place, the last record will be repeated for three additional playings. Thus, it is possible to "program" the unit for up to 6 playings of a single disc, if desired. Cycling in the manual or automatic mode can also be accomplished by lightly touching a "cycle" button on the front panel at any time during playing or to initiate playing in the manual mode. Before analyzing the pickup arm features, we should point out that the synchronous motor used in the B.I.C. 960 is a 24-pole type, which means that it rotates at the slow speed of only 300 RPM, further reducing the possibility of audible vibration. The 300 RPM speed is equivalent to a basic rotational frequency of 5 Hz, well below audible limits.

SUMMARY OF MANUFACTURER'S PUBLISHED SPECIFICATIONS:

DRIVE SYSTEM

Motor: 300 RPM 24-pole synchronous. **Drive:** Belt. **Speeds:** 33⅓ and 45 RPM. **Rumble,** (DIN B): Better than 65 dB. **Wow and Flutter,** (WRMS): Less than 0.05%.

PICKUP ARM SYSTEM

Bearing Friction: Less than 5 mg horizontal; 6-8 mg vertical. **Pivot To Stylus Length:** 8.6". **Effective Pickup Arm Mass:** 18 grams. **Pickup Arm Resonance:** below 9 Hz. **Maximum Lateral Tracking Error:** 0.35 degrees/inch. **Vertical Tracking Angle:** 15 degrees (adjustable to suit cartridge). **Tracking Force Range:** 0 to 4 grams. **Tracking Force Accuracy:** within 0.1 gram. **Anti-skating Adjustment Range:** 0 to 4 grams, elliptical or conical (selectable). **Cueing System:** Damped in both directions; rate adjustable from 1 to 3 seconds. **Pickup Arm Wiring Capacitance:** Less than 20 pF per channel.

GENERAL SPECIFICATIONS

Power Requirements: 105-130 VAC, 60 Hz (50 Hz adaptable).
Dimensions: (Including optional base and dust cover): 17-1/16 inches wide by 14-11/16 inches deep by 6⅞ inches high (16 inches high with dust cover in raised position).
Shipping Weight: 12 lbs. **Price:** $159.95.

TABLE 1

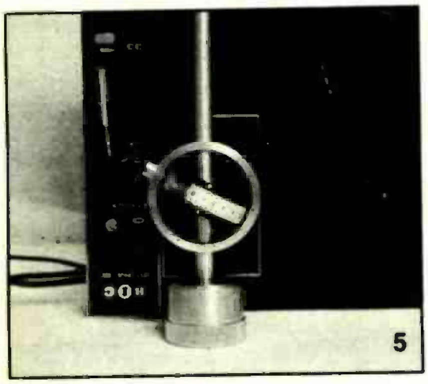
Manufacturer: **British Industries Company** Model: 960

TURNTABLE SYSTEM MEASUREMENTS

PERFORMANCE CHARACTERISTICS	R-E MEASUREMENTS	R-E EVALUATION
Wow-and-flutter (% WRMS)	0.04	Excellent
Rumble, unweighted (dB)	47	Very Good
Rumble, (DIN weighted "B" (dB)	67	Very Good
Speed accuracy (%)	within 0.3%	Excellent
Speed adjustment range (± ___%)	N/A	N/A
Speed build-up time (rotations)	Less than 0.5	Excellent
COMPONENT MATCHING CHARACTERISTICS		
Tracking force range (___ to ___ grams)	0 to 4.0	
Anti-skating force range (___ to ___ grams)	0 to 4.0	
Available speeds (RPM)	33⅓ & 45	
Drive system	Belt	
Motor type	300 RPM synchronous	
Power requirements	105-130 VAC 60 Hz	
MISCELLANEOUS EVALUATIONS		
Adequacy of controls		Excellent
Automatic features, performance		Excellent
Speed stability		Excellent
Vertical pickup arm friction		Very Good
Lateral pickup arm friction		Excellent
Quality of construction		Excellent
OVERALL TURNTABLE SYSTEM RATING		Excellent

Pickup arm design features

A close-up of the rear section of the 960 tonearm is shown in Fig. 5. The pickup arm is mounted on needle bearings in a gimbal ring. On top of the gimbal ring is a single scale which reads out tracking force



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as well as anti-skating adjustment force. Tabs on either edge of the scale permit individual or simultaneous adjustment of these two important operating parameters. A knurled counterweight is used to balance out cartridge and pickup arm weight initially. An additional separate lever is used to select conical or elliptical stylus operation, rather than two individual anti-skate scales commonly used on other turntables. The cueing lever raises the pickup arm or lowers it, and both motions are effectively damped. Since cueing rate will vary depending upon climatic conditions (in hot weather, the viscous material tends to flow more easily), and since users may prefer different rates of pickup-arm descent, a screwdriver adjustment permits the user to vary cueing rate from about 1 second to 3 seconds. The pickup-arm cartridge shell is plugged into the side of the tubular arm and four positive male contacts engage mating socket holes, eliminating the possibility of erratic electrical contact sometimes encountered with slide or spring loaded connection points commonly found in other pickup-arm assemblies. The entire shell can be tilted by means of a screwdriver adjustment so that it ends up parallel to the record surface regardless of the height of the cartridge used. A separate plastic gauge is supplied with the model 960 for proper stylus overhang adjustment. Although the Fig. 1 shows the model 960 with its single-play spindle installed, a taller spindle is supplied for multiple record playing and, when several records are stacked on this spindle they are firmly retained in place by a spring loaded post at the left rear of the machine, providing a stable two-point record suspension.

Performance measurements

Results of our laboratory measurements are summarized in Table I. Wow and flutter as well as unweighted and weighted rumble measurements compared favorably with measurements obtained on much costlier turntable systems, including those employing direct-drive slow speed motors. Since the 960 uses a line-connected synchronous motor, speed accuracy and consistency is really a function of power supply frequency and accuracy of machining of the motor pulley steps. Accuracy was within 0.3% for both 45 and 33⅓ RPM speeds. Correct speed was reached within a half rotation after turn-on, indicating excellent motor torque for the platter and minimum frictional losses.

Tracking force was measured by means of a separate gauge. We determined that the calibration marks on the rear of the arm gimbal were accurate to within 0.1 gram over the entire range from 0 to 4 grams. We were also pleased to find that even with several records on the turntable platter, tracking force remained within 0.1 gram of nominal calibration settings. Some multiple-record players tend to alter tracking force as records are stacked on the platter, but not the model 960. All of our tests were conducted using an Empire 4000D/III cartridge at a tracking-force setting of 1 gram.

Additional measurements (not shown in the summary table) included a reading of internal pickup arm wiring capacitance, which turned out to be 18 pF per channel. The audio cables supplied with

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **British Industries Company** Model: 960

OVERALL PRODUCT ANALYSIS

Retail price	$159.95
Price category	Medium
Price/performance ratio	Excellent
Styling and appearance	Excellent
Sound quality	N/A
Mechanical performance	Excellent

Comments: The B.I.C. model 960 represents a real departure from conventionally designed "record changers." While innovation for its own sake does not necessarily mean improved performance, in the case of this model, many of the new design approaches have resulted in mechanically and audibly superior record playing. The "programming" feature, which permits single or repeat play of a record plus multiple play of up to six discs is fool-proof—the kind of arrangement that prompts the user to wonder why no one ever thought of it before. The use of belt drive and a slow-speed motor in a multiple-play machine improves rumble and wow-and-flutter figures to levels previously achieved in so called "manual" turntables. Pickup arm adjustment flexibility is as total as that we have encountered on many a separately sold pickup arm, and better than some. Handling of records during multiple-disc play is positive but gentle and tends to refute the long-standing generalization that "record changers" are inherently inferior to single play turntables. In fact, the model 960 might well be considered a top-performing manual turntable in its price category. The fact that it can play up to six records sequentially is a welcome bonus.

the 960 measured an additional 55 pF per channel. With these cables in use, total capacitance-per-channel was therefore 73 pF, well below the 100 pF maximum recommended by most manufacturers of CD-4 type cartridges.

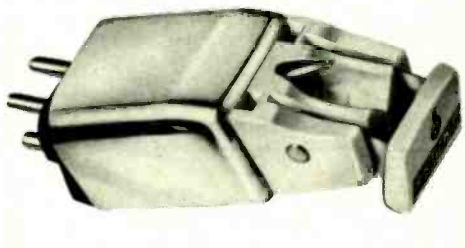
Use and listening tests

Having established the fact that rumble and wow-and-flutter were extremely low and that speed accuracy was just about perfect on the model 960, our main concern during listening tests had to do with the unit's ability to suppress acoustic feedback.

Acoustic feedback is often mistaken for rumble, especially when it is present in amounts insufficient to reproduce a continuance and obvious howling sound. Actually, the two effects are unrelated. Acoustic feedback results from improper mechanical isolation of turntable and pickup arm from the mounting surfaces. This induces vibrations back into the system when playing at very loud volume levels. In the case of the B.I.C. model 960, we were able to position the turntable system within a foot of the nearest speaker system and heard no evidence of acoustic feedback even when playing at louder-than-life levels. This excellent isolation is, no doubt, due at least in part tc the four shock mounts which were specifically designed for the B.I.C. turntables and are made of an elastomeric compound. No metal springs are used in the suspension. We noted, too, that tapping the base of the turntable system while records were playing did not cause skipping or mistracking, nor did repeated activation of the cycle button that requires only about 250 grams of pressure to activate the changing cycle.

While physical appearance has relatively little to do with performance of a turntable system, we cannot but help comment on the attractive, low-profile design of the model 960—a form factor which is carried over into B.I.C.'s other models. One wonders how all those record playing options were incorporated into such a trim looking, aesthetically pleasing product. It is obvious that a great deal of human engineering went into these newly designed units as well. All needed controls are nicely grouped together on a single narrow panel which runs the length of the system from front to back at the right of the platter and pickup arm. Even such small details as the curved finger-lift on the cartridge shell have been fashioned for ease of use, and the pickup arm rest has been designed to prevent accidental dropping of the pickup arm with its extended platform. This platform can also lock the pickup arm in place during transportation by means of an easily flipped pickup arm lock which captures the tubular section of the arm in place.

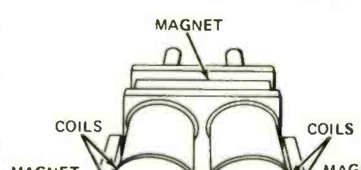
With multiple play turntable systems such as the B.I.C. model 960 available, the age-old question of whether to buy a single-play or a multiple-play record player must be answered on the basis of personal preference and record-playing lifestyle rather than on the basis of performance—since the model 960 certainly performs as well as most single-play units.



1

Radio-Electronics® Tests Empire 4000D/111

EMPIRE CARTRIDGES ARE AVAILABLE this year in two basic series. The 2000 series includes five models ranging in price from $29.95 to $69.95 and these are designed to play stereo as well as matrix four-channel records. Differences between the models are mainly in tracking force requirements and frequency response, with the upper three models incorporating a nude elliptical diamond stylus of 0.2 and 0.7 mil diameters. The 4000 series is intended for playback of CD-4 as well as stereo or matrixed discs and the three models offered range in price from $84.95 to $149.95. Again, differences are mainly in frequency response and required tracking force. We tested the highest priced of these three units as a stereo cartridge and also in terms of its ability to reproduce CD-4 discs properly. Although Empire recommends this cartridge only for use with top-performing manual turntable systems, we found that it performed well when installed in the pickup arm of the B.I.C. model 960 turntable system also reviewed in this issue.



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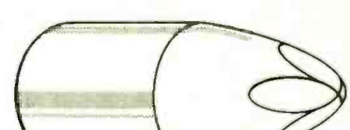
SUMMARY OF MANUFACTURER'S PUBLISHED SPECIFICATIONS:
Frequency Response: 5 Hz to 50,000 Hz. **Output Voltage** at 3.54 cm/sec groove velocity: 3.0 mV. **Channel Separation:** more than 35 dB. **Tracking Force Range:** 0.25 to 1.25 grams. **Stylus tip:** "nude" diamond with 0.1 mil tracing radius. **Price:** $149.95

A closeup view of the Empire 4000D/III is shown in Fig. 1. The cartridge is equipped with an easily replaceable stylus assembly which includes a hinged stylus protection guard.



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The cartridge itself is completely shielded. Construction of the cartridge is rather unique in that four separate coils are used, together with four magnetic poles and three separate magnets (see Fig. 2.) Empire maintains that this arrangement results in better balance and hum rejection and lower overall stylus assembly mass. As for the stylus tip itself, a sketch of its shape and polished surfaces is shown in Fig. 3. In order to trap the closely spaced groove undulations of a CD-4 record (which

(continued on page 71)

TV Typewriter II
screen-read board

Add this optional plug-in board to the TV Typewriter II and you can automatically access information that has been typed onto the TV screen.

by ED COLLE

IF YOU EVER NEED TO USE YOUR TV Typewriter II (see **Radio-Electronics,** Feb. 1975 issue) in a situation where you want to acquire information that has been typed onto the TV screen and into another parallel input device, you will probably want to use the screen read board. The TV Typewriter II's memory is constantly addressed and read out to generate the video data used by the television display. So the idea is to capture and hold the data in a particular location in memory and tell the parallel input device thru a "data ready" line that the data is ready to be used. When the parallel input device accepts the data, it in turn tells the screen read board thru the "data accepted" line to seek and provide data in the next character location. The screen read board retrieves information in the screen cursor location and continues until a manual switch stop command is given or if desired, until an exclamation point is encountered.

Since the cursor is automatically advanced by the screen read board, it is seldom seen at fast read rates that may be as high as the memory read speed or 16.6 ms. This speed can only be achieved if the parallel input device connected to the screen read board can accept the data at a one character-per-microsecond or faster rate. This speed is very useful when performing memory search routines where you are looking for a specific character or symbol somewhere in memory. If the device connected to the screen read board is not capable of handling a 1-ms acquisition time, but is capable of a 63-ms rate, the entire screen can be read in about 500 milliseconds. In both situations, however, up to 16.6 milliseconds of delay may be encountered between the time the read command is given and the time the screen read board actually begins accessing data. This allows the memory address counters to cycle to the current cursor location.

The entire circuit is built on a 3-1/16 in. × 4½ in. fiber glass circuit board which is plugged onto connector strips J5 and J6 on the main board of the TV Typewriter II next to the cursor board.

(continued on page 76)

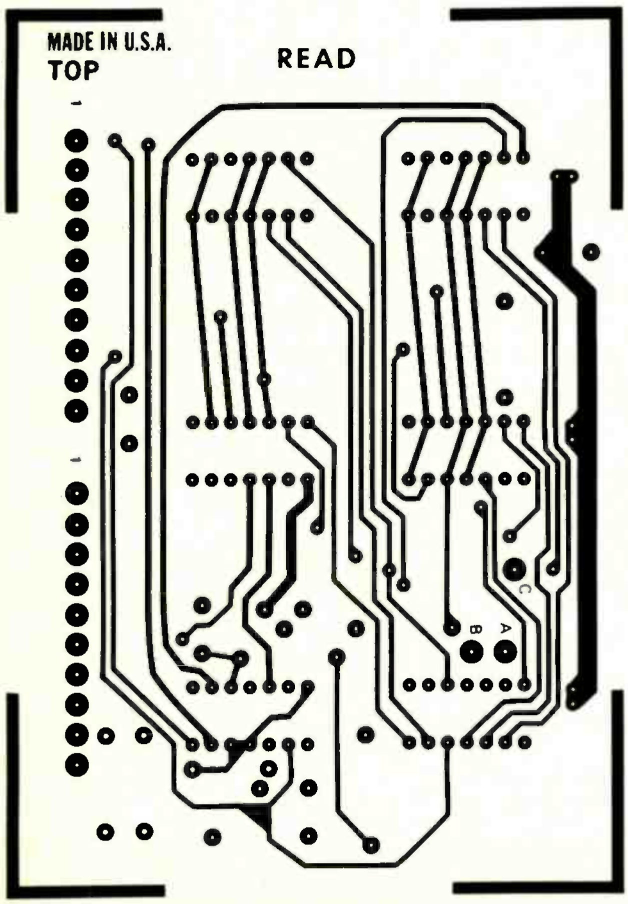


FIG. 2—FOIL PATTERN for component side of double-sided board shown full size.

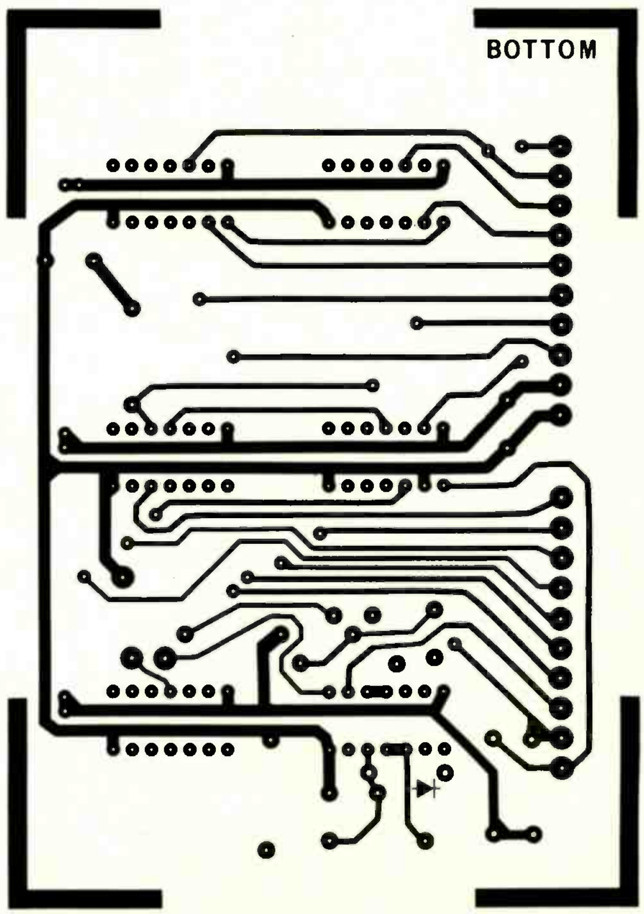


FIG. 3—FOIL PATTERN for foil side of double-sided board shown full size.

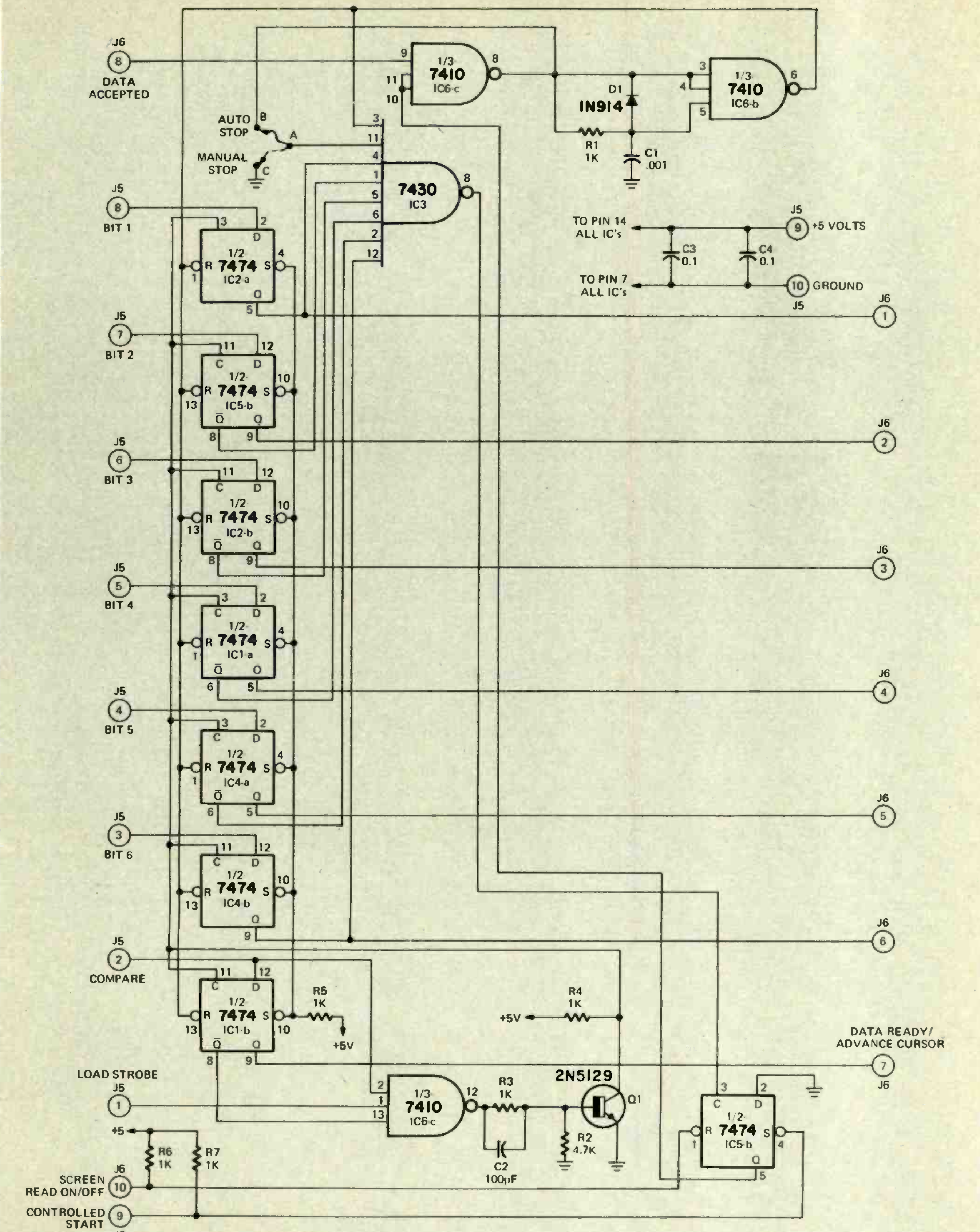
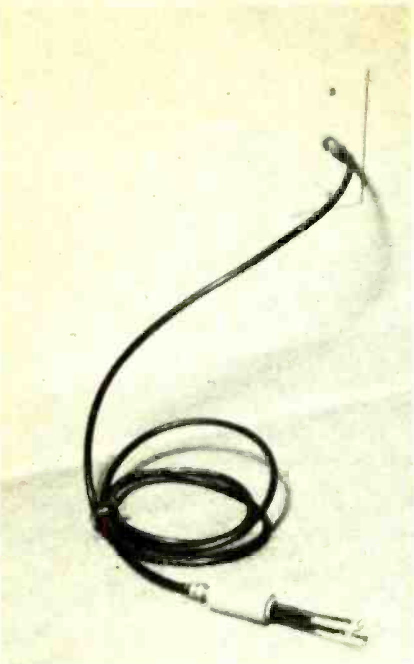


FIG. 1—SCREEN READ BOARD schematic diagram.

PARTS LIST

R1, R3-R7—1000 ohms, ¼-watt, 10%
R2—4700 ohms, ¼-watt, 10%
C1—1000 pF polystyrene
C2—100 pF polystyrene
C3, C4—0.1 μF, 12V
D1—1N914 silicon diode
Q1—2N5129 transistor
IC1, IC2, IC4, IC5—7474 dual type D flip-flop
IC3—7430 eight input NAND gate
IC6—7410 triple 3-input NAND gate.



What is the Signal Level *NOW?*

The signal level at the antenna terminals of a TV receiver can affect the RF and IF response. Know the signal level before you blame the receiver.

by CEDRIC WESTERN*

WHAT PROCEDURE DO YOU FOLLOW TO analyze and correct a problem when you enter the home on a TV service call? Normal procedure would be to ask the customer about the symptoms, switch the set on, check for burning, check for raster, turn up the sound, check the picture, etc. If the raster is not full-size, you should obviously check for low line-voltage. This is easy to do by using an AC voltmeter to measure the voltage being supplied by the wire coming out of the wall. Of course you know how much of it there should be. But what about the other "wire coming out of the wall," the one that supplies the antenna signal. Is this signal of the proper voltage level? Do you know how much it is supposed to be? Do you know the consequences of too little or too much signal voltage?

In the early days of TV with a roof-top antenna for each set, it was easy to know what the typical signal level was for a particular geographical location. The antenna installer usually had a field-strength meter and supplied some numbers to go with the signal level.

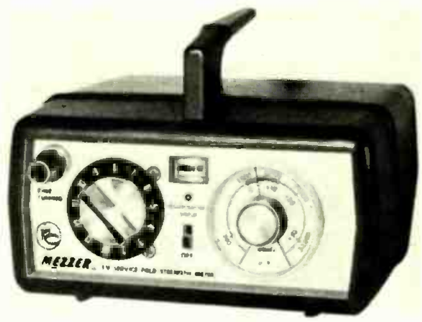
Today we have a different problem. There are probably as many, or more, "wires coming out of the wall" that carry an antenna signal which has been amplified, levelled, compensated and adjusted then distributed to several points. This is typical of all CATV and MATV systems, including the increasingly popular private-residence amplified MATV systems.

The signal level should be between 1000μV and 4000μV (0dBmV to +12dBmV). This has been determined as the prime antenna signal-level for color TV reception. With the individual roof-top antenna, this level has been fairly easy to attain in most prime reception areas.

But what about all those amplified systems? Here we have a different story. You may encounter installations where the strong local signals have been attenuated to a few hundred microvolts and the weaker, distant signals have been amplified to several millivolts—and you have no way of knowing this without measuring it. There no longer exists a typical signal level for your geographical location.

Signal related problems

There is a pit-fall for which the best service technician may be an easy victim. This is the assumption that the signal is what it is supposed to be.



CASTLE MEZZER MODEL TVS field-strength meter measures the antenna signal level.

In the case of the individual antenna, the signal will be either typical, a little weaker or a little stronger. A weak and snowy picture can be compensated for by adjusting the AGC control for the best picture and least snow. If the signal is strong enough to cause signal

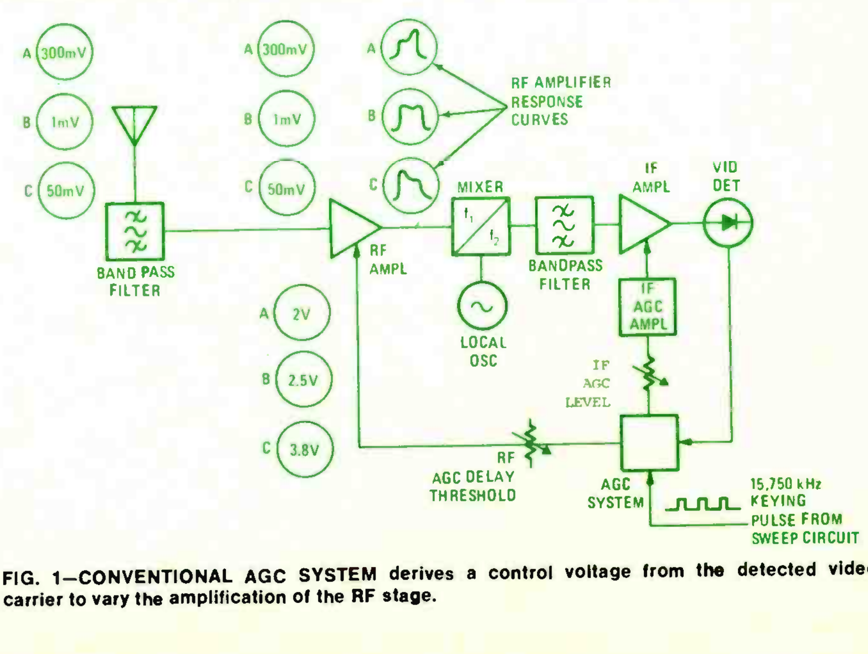


FIG. 1—CONVENTIONAL AGC SYSTEM derives a control voltage from the detected video carrier to vary the amplification of the RF stage.

*President, Castle Television Tuner Service, Inc., Chicago, IL.

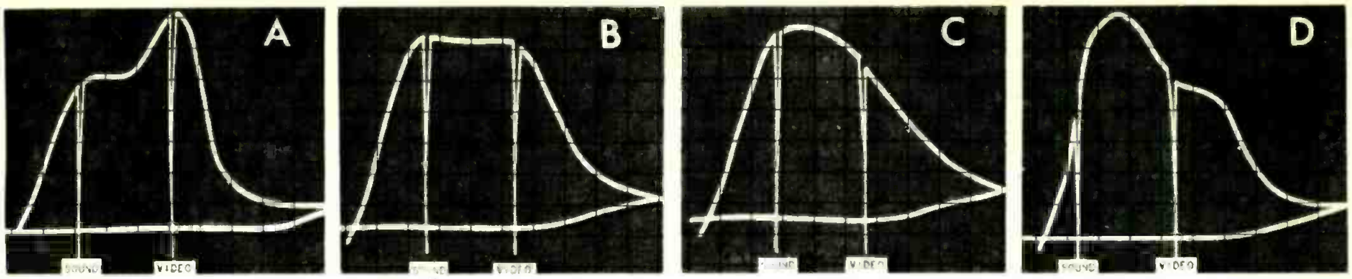
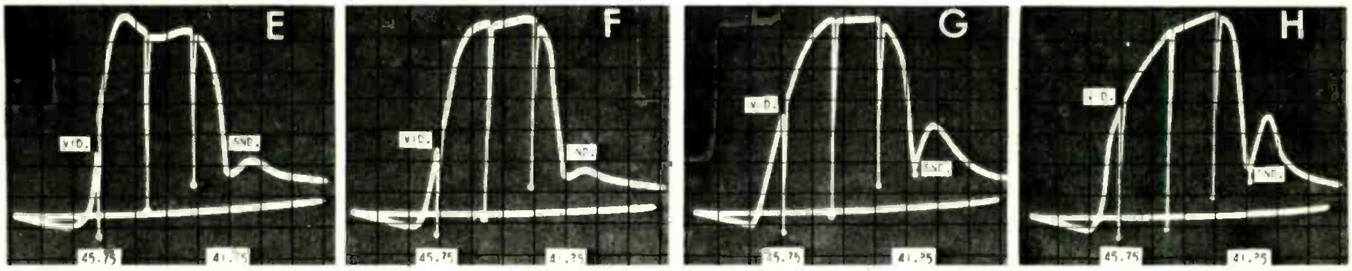


FIG. 2—RF RESPONSE of a transistor TV tuner. Curve a shows response with an input level of 300 μV and an AGC level of 2V. Curve b; input level 1 mV, AGC level 2.5V. Curve c; input level 25 mV, AGC level 3.5V. Curve d; input level 50 mV, AGC level 3.8V.

FIG. 3—IF RESPONSE of a transistor TV. Curve e shows response with an input level of 300 μV and an AGC level of 2.8V. Curve f; input level 1 mV, AGC level 2.9V. Curve g; input level 300 mV, AGC level 3.5V. Curve h; input level 1V, AGC level 4V.



clipping, adjust the AGC to reduce the amplification in the RF and IF stages. If there is a combination of weak and strong signals on different channels, compromise and adjust the AGC for best possible reception on all channels. With an individual roof-top antenna, the compromise adjustment may be reasonably successful.

The amplified systems, however, may have assorted signal levels on different channels, ranging from 200μV to 60,000μV or more! The modern color-TV receiver may well be designed to have the dynamic range of 50dB, or more, to deal with this tremendous variation in input signal level. Can this tremendous variation in signal level degrade reception?

Tilt with AGC

Figure 1 shows a block diagram of a conventional AGC system. When the AGC system changes the RF AGC voltage to compensate for changes in signal level, it changes the amplification of the RF stage. It also does other things; the amplifier's nonlinear characteristic causes intermodulation distortion and at the same time the input and output capacitances of the RF stage change. This is true of tube, bipolar transistor and field-effect-transistor RF stages. These changes affect the frequency response (bandpass curve shape) of the RF stage. This change in frequency response changes the originally designed flat response of the wide-band RF stage so that it is no longer flat. This characteristic is commonly called "tilt with AGC." Figure 2 shows this characteristic.

A similar distortion (tilting) occurs in the AGC controlled wide-band IF stages. See Fig. 3.

FIG. 4—PIN DIODE ATTENUATOR ahead of RF bandpass amplifier reduces signal proportional to detected video carrier level.

What does this tilt with AGC do to the performance of the color-TV receiver? Firstly, it changes the relative amplitude of the luminance signal and consequently changes the relative luminance content of the detail in the picture. Secondly, it changes the phase characteristics of the system and therefore influences the chroma information of the picture.

However, it can be seen from the two sets of response curves that, fortunately, the RF and IF response curves tilt in opposite directions. At low signal-levels and suitable AGC, the RF tilt places the video carrier at a higher level than normal while the IF tilt places the video carrier at a lower level on the IF curve. At very high signal-levels with appropriate AGC voltages, the opposite action takes place and the video carrier is at a lower level on the RF curve and at a higher level in the IF. By careful design of the AGC and signal amplification systems of the receiver, the manufacturer is able to track the two AGC voltages so that the RF and IF tilts complement each other to result in a uniform overall passband over a wide-range of input signals.

But remember, the initial problem is the relative difference in antenna signal levels. This is where the attempts at correcting any unusual reception problems caused by the signal level should be made—in the antenna system, not in the receiver!

Future solution

There is a good solution to the problem of handling a wide range of signal levels without tilt with AGC. It requires use of PIN-diodes as an attenuator ahead of the RF stage in the tuner.

(continued on page 88)

Step-by-step TV Troubleshooters Guide

When repairing a television receiver, make sure the repair is complete, otherwise you're asking for trouble.

by STAN PRENTISS

AS COLOR SETS AGE, THE NEED FOR REPAIR naturally increases. The frequency of repairs depends upon the basic design, quality of components, usage, and the *completeness* of the electronic and electrical repairs. A half-repaired receiver, of course, is no better than a temporarily "fixed" washing machine or automobile—neither are going to continue working for long. Servicing by the random substitution of parts may *assist* owners for another hundred hours or a thousand miles, but the old problem always return and often brings along new ones as well. So let's take a look at some outstanding examples that are immediate problems.

A filament transformer for G-E

Picture tubes do arc, and in transistor-IC receivers the results are sometimes catastrophic unless there's suitable protection built in for the solid-state devices. Usually, there are two common methods of dealing with such arcs. The first method is to install arc suppressors. These look like capacitors and come in different shapes and sizes but are nothing more than spark gaps. The second method is a filament transformer, with enough DC superimposed from the power supply to balance heater-cathode potentials and therefore remove the reason for most arcs. The more expensive sets often include both, while some sets simply have series or shunt diodes installed to either block or bypass these undesirable transients.

G-E's JA chassis was this company's initial entry into the low-cost solid-state color market and, as with most "first go arounds," there have been several modifications to aid reliability and performance. In addition to a kit for the brightness and contrast functions, an EP64X26 filament transformer can be added as an isolation supply for the picture tube heaters. The reason for this transformer installation (kit includes full instructions) is to prevent picture tube arcs. When a large arc occurs in this chassis, the brightness limiter, R188, possibly R408, one or more of the R-G-B grid color drivers and perhaps IC501 can all be affected. These are shown in a simplified diagram in Fig. 1. Here, the entire chroma section can be affected as well as part of the luminance subsystem and the +135-volt power supply that furnishes the operating potential for both

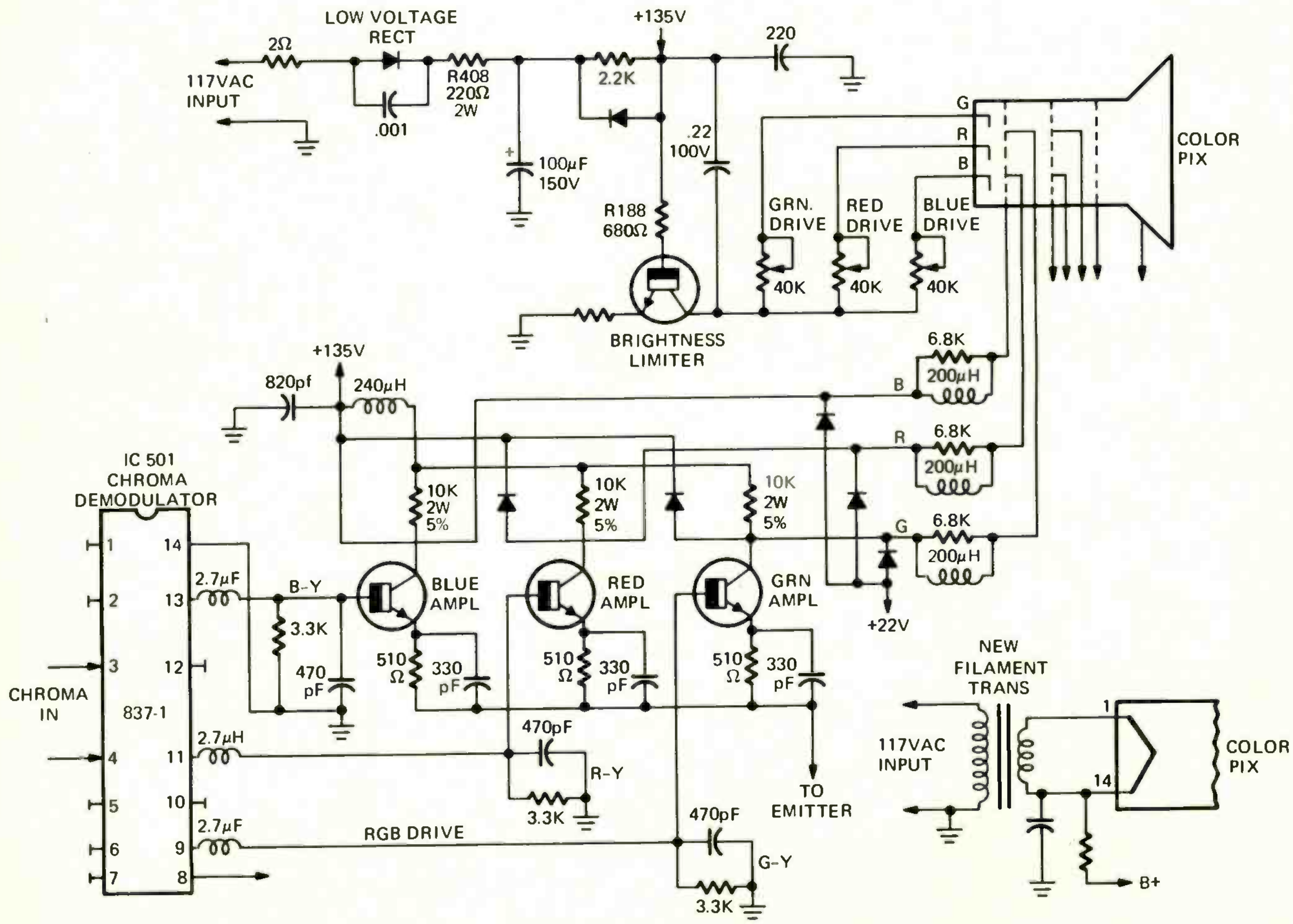
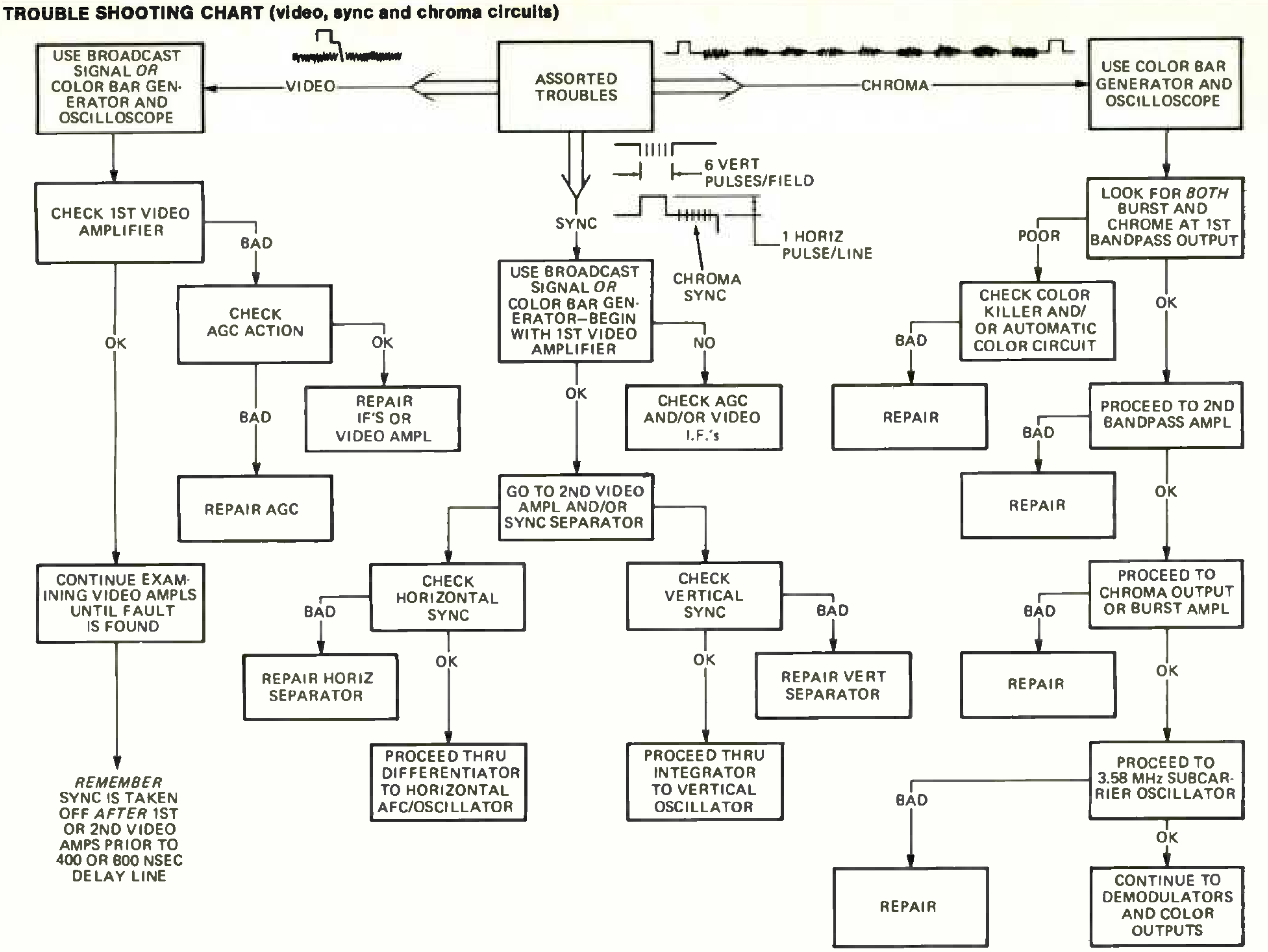


FIG. 1—GENERAL ELECTRIC'S JA chassis can develop internal arcs in the pix tube that can affect the chroma section.

TROUBLE SHOOTING CHART (video, sync and chroma circuits)



the chroma and horizontal oscillator and output. So the effects are rather all-inclusive. And if the transistors and resistors are simply replaced with the same unmodified picture tube still installed in the set, the identical *zap* occurs all over again. Therefore, a filament transformer becomes a necessity.

Beam current protection

The brightness limiter (Fig. 2) in the JA chassis (now QB) is worth looking at in detail if, for no other reason, than it's unique. Further, it differs radically from the larger YA versions in that the JA/QB are grid-drive receivers, while the YA is an R-G-B cathode-drive set with control grids at AC ground. This initial design evolved ostensibly to prevent blanking and limiting from affecting the demodulated luminance-chroma signal in order to produce a cleaner picture. The overall objective, of course, is to prevent excessive beam currents from draining too much high voltage and damaging luminance and high voltage components in the receiver. Various values of emitter resistor RX limit 10-in. pix tubes to 600-microampere drains; 16-in. pix tubes to 1.2 mA; and 19- and 23-in. pix tubes to something less than 1.5 mA. Transistor Q113 normally continues in conduction and passes the 11.1-μs horizontal and 1.4-ms vertical blanking pulses from the Q111 V-H blanker. Meanwhile, capacitor C166 is charged through R187 and the +135-volt supply on one plate and through the collector of Q113 on the other. During normal operation, C166 maintains most of its charge and Q113 has little limiting effect on the three R-G-B cathodes because it remains in moderate saturation. When the grids, however, respond to larger than ordinary signals, the cathodes force more current through the collector of Q113, developing a bucking voltage across its emitter resistor. Soon, collector and emitter voltages tend to become equal, and the added positive emitter potential causes Q113 to lessen conduction or cut off entirely, returning the pix tube beam current to safe design limits. Capacitor C168 is a small filter, D107 a transient prevent diode, R186 the Q111 collector load, and R184-R185 the constant bias network for the vertical-horizontal blanker input.

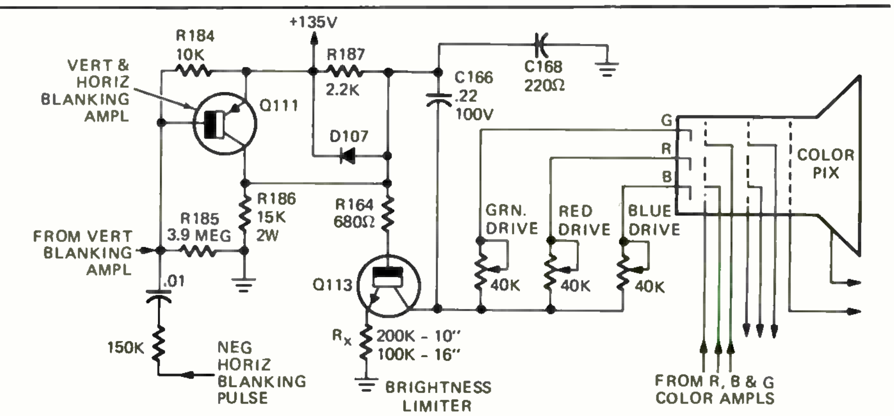


FIG. 2—CIRCUIT DIAGRAM of General Electric's brightness limiter in the JA chassis.

CTC38/39 Luminance-blanker-color problems

The RCA CTC38 and CTC39 color receivers are both hybrid (transistors and tubes) sets manufactured and distributed by RCA, beginning in 1969-1970 and many are still going strong. We'll use portions of the CTC39X schematic for both receivers.

An AGC problem that often occurs is intermittent leakage or shorting of capacitor C285 (terminal LL on PW200) at the 1st video plate end of AGC control R101 (see Fig. 3). This potentiometer varies the bias voltage at the grid of video amplifier V203-B. The plate of V203-B directly sup-

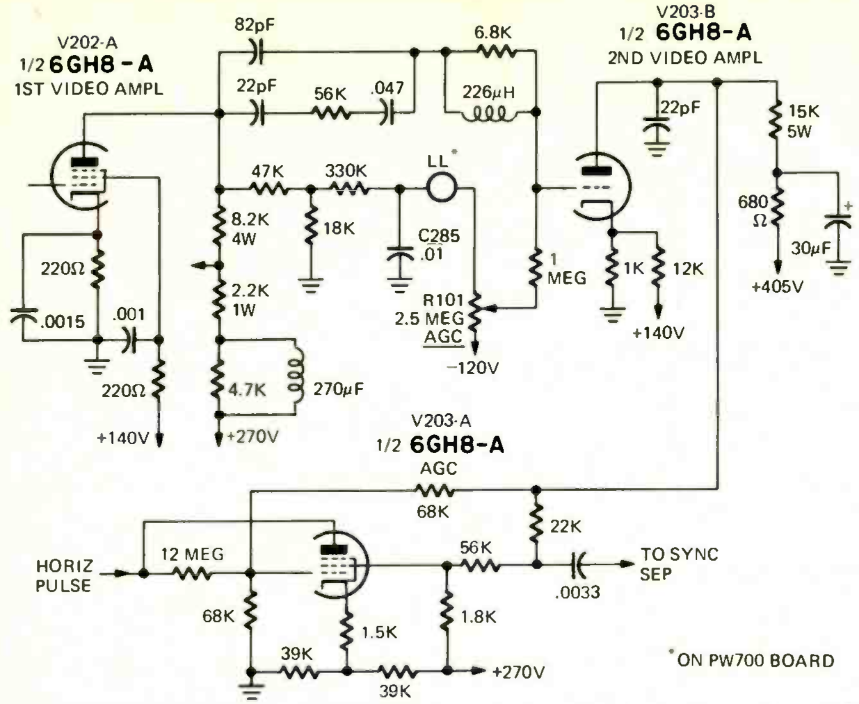


FIG. 3—PARTIAL SCHEMATIC of RCA's CTC39X chassis. This chassis can develop AGC problems.

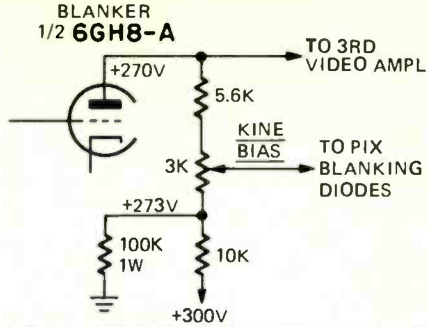


FIG. 6—ALTHOUGH THE rating of the 100K resistor is higher than any other resistor in this voltage divider circuit, it may eventually open or singe.

plies the grid of the V203-A AGC amplifier. Naturally, if either grid input or bias is upset, the video IF stages will react as though there is a bonafide AGC problem which usually occurs, in this instance, as the receiver heats up to full operating potential. Spraying the transistor IF's with a cold spray, unfortunately, exhibits the same intermittent effect.

Chroma bandpass transformer T701 opens (no color) or develops shorted turns in the upper half of the secondary (Fig. 4) causing a bluish-green outline around screen images that appear as video ringing. When this occurs, color sync is barely adequate. Why? Because the first bandpass stage is inevitably the initial chroma amplifier as well as the burst amplifier. So, although there are AC coupling capacitors to both the second bandpass and burst amplifier grids, the color control still has one end to ground and the transformer is serving a dual function which usually means a relatively heavy load. Under these conditions, an open or short among the fine secondary coil windings is not extraordinary.

Third video amplifier V707 (Fig. 5) often has its contrast control virtually open (PW700, terminals AB/BA). Naturally when this happens the cathode is almost floating since its ground return is interrupted and there is very little video output. The cause is sustained current through the 100-ohm potentiometer, whose power handling ability could be increased or a very small larger-wattage resistor put in series. Otherwise, replace the control with its originally-numbered part and wait another six or seven years for it to go again.

Portion of raster pulls up from the bottom. Most often you look for a grid overdrive condition—if there is foldover—but sometimes the real reason could fool you. A screen-suppressor interelement leakage of the horizontal output tube, which connects to the cathode of the vertical output tube can be the culprit. Cathode voltage is reduced, consequently the control grid voltage increases relatively and the tube drives into saturation. This exhibits the same characteristics as ordinary coupling capacitor leakage. The 50 μF cathode capacitor C131 forming the normal parabolic vertical convergence voltage, can also open, affecting convergence as well as inducing vertical problems. Electrolyte in solution, of course, dries out, and such capacitors can easily open when this occurs and filtering ceases.

Voltage dividers in any circuits—even our old friend the horizontal blanker—can induce certain peculiar problems over long periods of use that will surprise you if you're not careful. Figure 4 is an excellent example in a CTC 38, where the blanker plate is connected through a 5.6K load resistor, a 3K bias potentiometer, and a 10K dropping resistor to the 300-volt supply. However in some versions, at the junction of the 10K and 3K potentiometer is a 100K 1-watt resistor to ground. This, of course is a voltage divider to drop the 100K-10K junction voltage slightly (7 volts) for positive load and voltage limit protection. The problem is that after a few years use, the 100K singes or opens, producing blanking problems that look like ordinary amplifier problems in the picture. In its normal triode configuration, the 6GH8A tube is designed to draw some 13 mA. However, as a pulse amplifier it may draw 20 mA or more, but only for about 10-μs at a time because it's only *on* during horizontal retrace. The question is: with all other series resistors connected to the plate rated at ½-watt, and the 100K at 1W, why does the 100K go?

You can, of course, draw the circuit in Fig. 4 into a three-legged rectangle and solve for the I1-I2 currents in each leg by simultaneous equations. But you'd have to do this in both steady state *and* in the pulsed state. It's much easier to see that the 270 volts measured at the top of the resistor string (plate of the amplifier) is also present (with a 3-volt addition) at the 3K-10K junction when the amplifier is *not* conducting. This means that 273/100 × 10^3 equals 2.73 mA, and 2.73 × 10^{-3} × 270 equals 0.738 watt. On the other hand, the small drop across the 10K resistor amounts to only about 3 mA during steady state. And, although there is more of a drop during tube conduction, this is a period of only 10μs during a 60-μs duty cycle. With but 1/6 of the total current, this puts it back in limits. Therefore, the 100K to ground will take major punishment from day-to-day when pushed to within less than 300 milliwatts of its rating, and is bound to have problems eventually. So, for first aid, you may either increase the 100K rating to 2 watts, or possibly the 10K to 1 watt. **R-E**

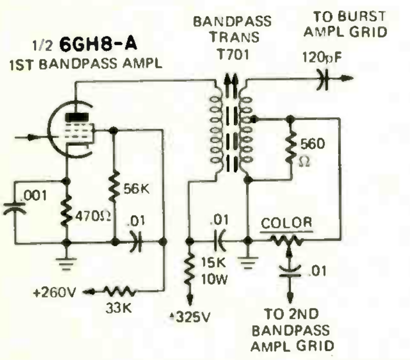


FIG. 4—CHROMA BANDPASS stage of RCA's CTC39X chassis.

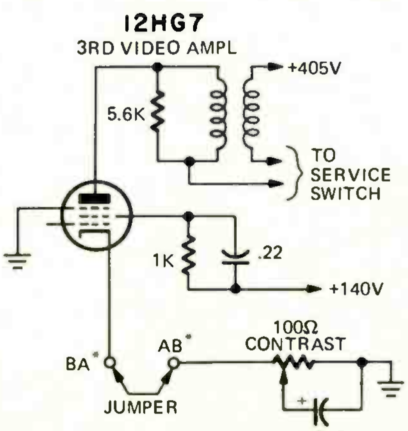


FIG. 5—CONTRAST CONTROL in RCA's CTC-39X chassis can develop problems due to insufficient current-handling capacity.

*BA & AB ARE TERMINALS ON PW700 BOARD

R-E's Service Clinic

Increased focus voltage

I wouldn't have believed it if I hadn't seen it!

by JACK DARR
SERVICE EDITOR

THIS COLUMN HAS ALWAYS BEEN DEvoted to discussing the strange and unusual faults found in TV sets, and the explanation of their causes. It's based on actual benchwork, with the faults that occur in the field. It has always been my contention that there is a logical explanation for every kind of problem, no matter how odd or mysterious it may seem. I am the question-answerer—the explainer of the inexplicable—the unscrewer of the inscrutable. (Also known among my colleagues as the Balmy Swami!) For those who enjoy seeing the biter bitten; those who think it "sport to see the master hoist by his own petard—hang on, fellows. Here it comes!

The victim (villain?) is a Curtis-Mathes CMC-22. The complaint was a sudden rise in the 6JE6 cathode current, together with a slight dimming of the raster, and a very severe blurring of the picture. It was referred to me by a "friend", after much checking in his own shop. All the tubes in the high-voltage section were new.

I turned it on and off several times, with no result. This condition was a long-term intermittent, of course. No joy; perfect picture, color, focus, etc. Then it happened. Current jumped up to 300 mA., picture blurred. "Ah, ha! I know what this is. Focus trouble." Grabbing a FETVOM, with a high-voltage probe, I checked the focus voltage. It was easy to get at since the cage was open. I looked at the reading and said, "No. This can't be!" (The meter had been loaned out the previous week.) So, I picked up the other FETVOM with a high-voltage probe and hung it on the focus terminal. Now, I had two meters at the same place with the same reading. **9500 volts!** That was why I didn't believe the first meter. In focus problems, the voltage always goes *down* (or does it?).

I turned it off, checked a couple of parts and turned it back on. Same thing. Like everyone else, I'd seen focus troubles in hundreds of TV sets, but the voltage always went down. I had NEVER seen one where the voltage went UP. Not this much, anyhow. The voltage was quite steady. No sound of arcing, etc., no smell.

Next step; turn it off and sit there and look at it. What could do this? Practically everything else in the circuit would reduce the focus voltage if it went bad. Hey; how about that 66-megohm bleeder resistor? Maybe this is open. This is a stock focus circuit, used in millions of TV sets (see Fig. 1).

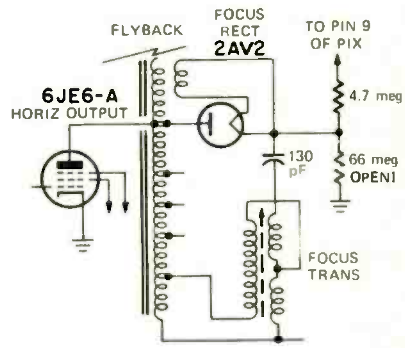


Fig. 1

The circuit has five parts counting the focus rectifier tube, which was new.

I disconnected the ground end of the bleeder. Turned the set on and read the voltage. Hmm. Now the focus voltage is exactly normal! Picture, 6JE6 current, everything. Even the focus control works.

Replaced the bleeder. No change! I examined the original bleeder resistor. One side was discolored, two of the turns were obviously burnt. So, the bleeder resistor was open. That won't make the voltage go up.

Now we come to the funny stuff. While the focus voltage had gone far above normal with the bleeder resistor open, it had also been quite normal most of the time with the original resistor undoubtedly open. It was also normal without any bleeder resistor in there at all. So, where did the excessively high focus voltage *come from*?

Like all focus circuits of this type, it is driven by a 5000-volt plus pulse coming from the plate of the horizontal output tube. Since any change in this pulse would have also changed the high voltage (which remained normal), this isn't likely. No known failure of any part in the focus circuits could have caused it. I have run many sets with the focus transformer completely disconnected to check for shorts. This usually leaves the focus voltage at its upper limit of about 5,500 volts. This is a "lossy" type of control-reaction.

The reaction of the 6JE6 cathode current suggested that the doubled focus voltage was causing a heavy increase in beam current, making the

(continued on page 68)

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge and the more interesting ones will be printed here.

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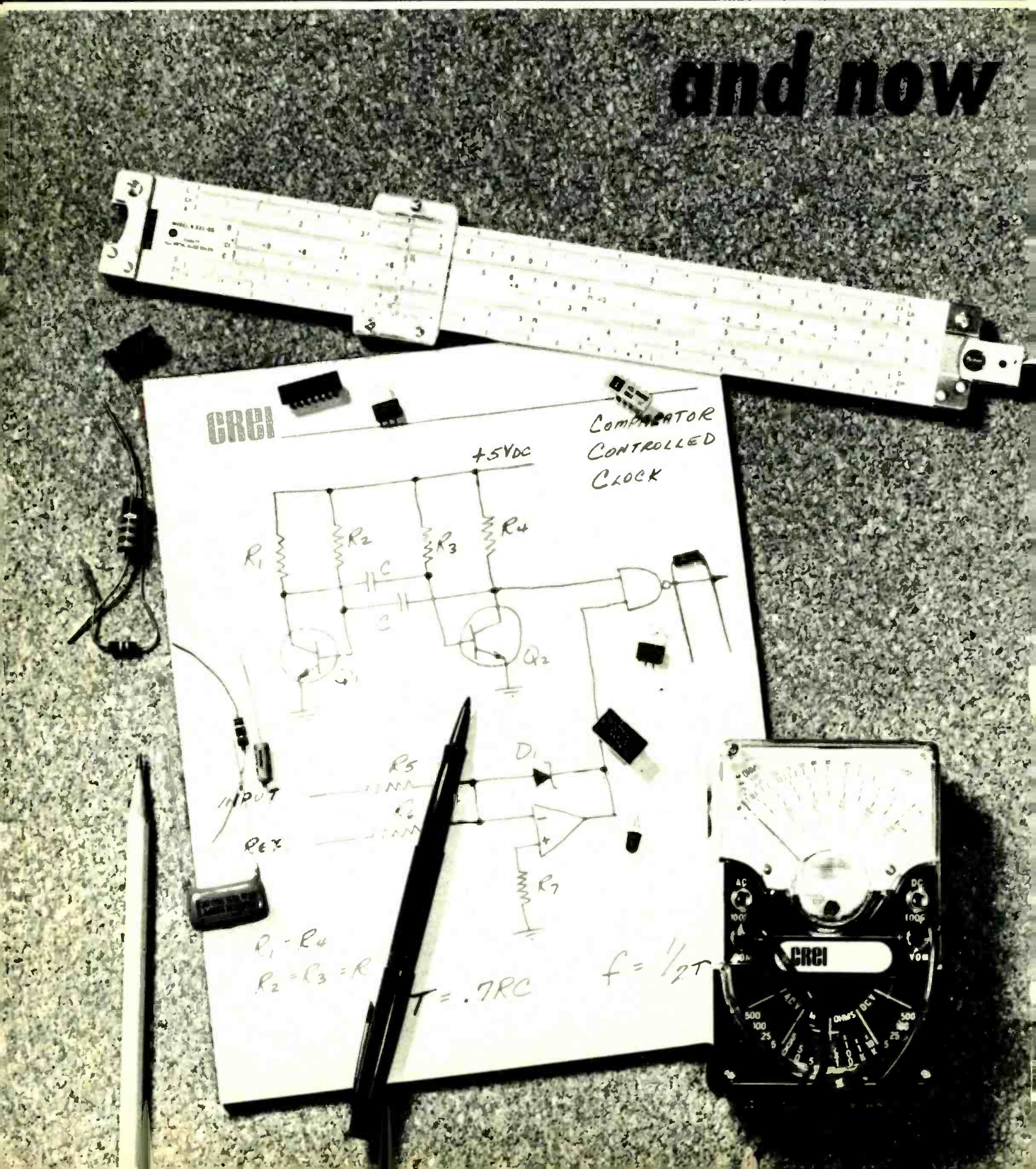

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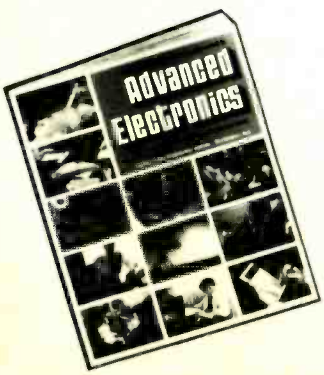

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SERVICE CLINIC

(continued from page 63)

load on the 6JE6 greater. The drastic imbalance between the focus voltage and high voltage made the raster defocus and blur very badly, exactly the same reaction you see when focus voltage is *low*.

So, there you are gentlemen. After replacing the 66-megohm resistor, the set was cooked for several hours with the current and focus voltage monitored closely. No change. The focus circuitry was heated, then cooled; no change. Things were jarred around this area. The only result was a severe flicker, which turned out to be the cathode-break adapter under the 6JE6 tube; it was trying to fall out of the socket. I will swear on a stack of Rider Manuals (for younger readers, make this a stack of Sams Photofacts) that this is a true story, transcribed from my bench notes with only the expletives deleted.

Frankly, at this moment, I have no idea as to what could be a logical cause for what happened. Any ideas or comments from readers will be welcomed. (Especially if anyone else has ever run into the same thing.)

Epilog

After writing the shuffle-draft of this, I set it aside. The next day I went back to the shop where the set still was, and ran through all of the tests again. While "lying awake with a dreadful headache" in the night, an improbable answer occurred to me. Could this have been due to some kind of oddball *leakage* from the high voltage, *inside* the picture tube? I had thought enough of this during the initial tests to rap sharply on the picture tube neck, without even a flicker. This time, I pulled the base off the picture tube, turned the set on, and hooked the high-voltage probe to the focus pin on the picture tube base. The idea being that if there was any leakage at all, I should see some voltage at this pin. Results? Zero voltage. I made this measurement with tube well warmed up, I should add.

So, you tell me. The crystal ball isn't doing a thing to help. I can't even get good clear snow on the crystal ball, let alone a picture. I can now say that I am definitely a CET. That is, if that means "Confused Electronic Technician"! Let's hear from you! **R-E**

reader questions

THE RIGHT TREE, BUT MAYBE THE WRONG LIMB

This Panasonic CT-66 color TV has an odd problem. The screen goes very dark after only a few minutes of operation. I've checked everything I can think of. The voltage on the grid of the G-Y amp tube goes to +6.8 instead of the +2.0 it should have. The 15K plate resistor gets hot. Am I barking up the wrong tree?—E.L., Poseyville, IN.

Nope. I don't think you're far enough out on the limb! Your grid bias on this stage is far too positive. So your plate current is too high and your plate voltage is too low (too far toward negative.) I think you'll find that all of the other difference-amplifier tubes will show the same thing. This, of course, will make the picture tube *grids* too far negative, which will hold down the beam-current and your picture goes dark.

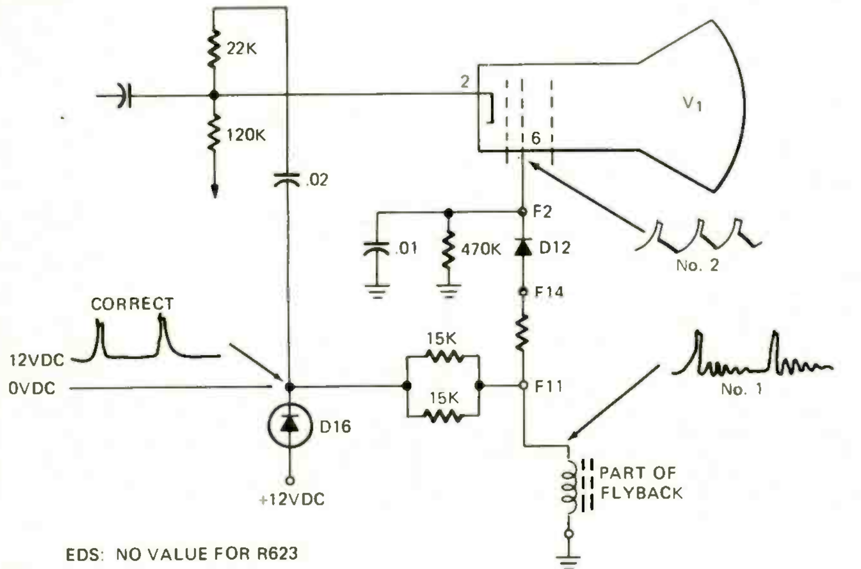
Most likely cause here, leakage in the 0.22 μF blanker-coupling capacitor that is connected to the common cathodes of the difference-amplifier tubes. Since the grid resistors are returned directly to the cathodes, that's probably where your excessively high positive grid voltage is coming from. Another possible cause might be a bad solder joint on either end of the common cathode resistor, or an increase of its value.

VERTICAL LINES ON SCREEN

The screen of this Craig 6305 B/W TV shows 5 or 6 vertical lines. I can't seem to find out where they are coming from Any ideas?—DM., Middle Village, NY.

Check your blanking diodes. The normal waveform from the flyback has several ringing pulses along the baseline; this is during the *scan* time. So, if the blanking diode is bad, they get through.

(Field feedback: reader checked blanking diode feeding picture tube grid, which was OK. However, another diode, feeding the cathode showed the whole "flyback waveform" on its cathode! Turned out to be a bad solder joint on the anode. This took the +12 volt bias off the diode, see diagram.)



DARK SCREEN WITH SOUND

I'm trying to work this old set over for a friend (RCA CTC-15) I get a dark screen, with sound. Nothing seems to be smoking, but I can't get a raster. I'm enclosing a table of the voltages I get. Can you see anything that would cause this?—J.C., West Islip, NY.

Right now, two things that might be causing trouble. One, your picture tube cathodes read +380 volts, and they should be close to +300 volts. Your control grids are OK at +200 volts. However, normal bias is a −100 volts and you've got a −180 volts. This is enough to cut the picture tube off.

Also: I see you get only +1800 volts on the focus voltage output. This is far too low and can also make the raster go out. Your high voltage is good at 24 kV, but you need at least 4,500 volts focus. Both of these could be caused by weak tubes in the video output and focus rectifier sockets.

BACK NUMBER

The screen of this Admiral H10 color chassis looks exactly like the color photo on the cover of R-E. July 1968. I've changed all of the tubes in the color circuits and checked the deguassing coil, etc. No luck. I can degauss it with an external coil and the problem clears up for a while. Comes back, though. Where could this be?—W.H., Porter's Lake, NS.

(For the benefit of those who do not have a file of back issues, this cover showed a color TV with the screen covered with large blobs of colors.) Try this; *disconnect* the set's degaussing coil. Demagnetize the picture tube with your external coil. Now check. If the discoloration goes away, let it play for about half an hour. If it's still going all right, turn it off and on several times at intervals of about 2-3 minutes.

If the problem does not come back, the trouble is in the set's degaussing coil or, more likely, in the switching VDR-thermistor combination or thermal switch if this version has one. The degaussing coil is actually "regaussing" the picture tube because it is staying in-circuit all the time.

Used to run into this at regular intervals; haven't had a case of it for some time. They run in streaks.

SCREEN DARK, PLENTY OF HIGH VOLTAGE

I wrote you about this some time ago. I finally located the cause of the problem, (screen went dark, but no loss of HV!) After going around and around, I found that the plate voltage of the video amplifier tube dropped to zero! Digging this out, it turned out that the plate contact of the socket wasn't making too good contact with the PC board. Replacing this socket cleared up the trouble. Thank you for your trouble.—J.J., Cumberland, MD.

Thank you, J.J.! Glad you found it.

NO PICTURE

The raster is perfectly clean on this Truetone 2DC3916C-17 set. Everything else seems to be okay. What is it?—M.D., Hatfield, AR.

For a crystal-ball guess, it's another crystal—the germanium crystal diode in the video detector. This is fairly common in this chassis. You'll see a little flat metal shield on top of the chassis behind that last IF coil can. *Don't* take this off; the video detector isn't under there! (Ask me how I know.)

Instead, unsolder the lugs of the last IF can and take it off leaving the transformer in place. You'll find the video detector diode mounted vertically on the back side of the coil form. *Clip* this off; don't try unsoldering it. Replace it with one of RCA's high voltage detector diodes, part No. 12844. This will hold; ordinary detector diodes have a hard time for some reason!

HORIZONTAL/COLOR PROBLEM

The original complaint on this Zenith 14A9C50 was "no picture; smoke." Flyback shorted That much was easy. I put in a Zenith replacement and a few tubes that were low. Ran fine, but came back to the shop with a complaint of poor horizontal sync. Changed the AFC diodes and this cured the problem. Now, it's back!

This time the complaint was color drift after about half an hour of operation. This could be cleared up by turning the horizontal hold control CCW. But; when you change channels, it falls out of horizontal sync again! Now what the heck.—E.S., Endicott, NY.

Set the horizontal hold so that the picture stays in-sync when you change channels. Now check the color. In many sets, you'll see that the horizontal-hold control will affect the color. It will drop out or change hues some time before the picture falls out of sync! The hold range is wider than the color-hold range.

If this takes half an hour to show up, it seems to be a thermal. From a cold start, try warming up some of the resistors and capacitors in the horizontal oscillator and AFC circuits. You can do this by holding the tip of a hot soldering iron on the body of the part. If this causes any change, replace that part. The basic cause of the color trouble is probably a little too much phase shift of the gating pulse. This affects the burst and can even make it drop out.

Alternate; after the trouble shows up, try *cooling* various parts in that circuit to see if you can make it come back. **R-E**

EMPIRE 4000/III TEST

(continued from page 55)

contains frequencies up to and including 45 kHz), the usual conical or elliptical stylus shape has been found wanting.

Various manufacturers have solved this problem by devising new stylus tips shapes, the most familiar of which is the well known Shibata stylus invented in Japan. Empire has come up with its own stylus tip shape which it calls "4 dimensional," and the tracing radius of this shape is said to be only 0.1 mil. As for the "nude" diamond referred to in the published specifications, readers unfamiliar with that term may be surprised to learn that lower cost styli really consist of a light metal tube that has a tiny chip of diamond affixed to it by some adhesive substance. A more costly arrangement involves the use of a tip that is made entirely of a larger chip of diamond and is polished to its required tubular shank shape and tip dimensions. Such "nude" diamonds are more likely to be positioned correctly than the cemented chip variety, and hence their advantage in this application.

Structurally, the 4000D/III comes with a separate holding bracket that is first installed in the cartridge shell. Once this delicate task is accomplished, the cartridge body is simply popped into place, retained by the previously installed bracket. This makes installation far easier than would be the case if the screws have to be installed through the cartridge body.

TABLE I

PHONOGRAPH CARTRIDGE MEASUREMENTS

Manufacturer: **Empire Scientific Corp.** Model: **4000/III**

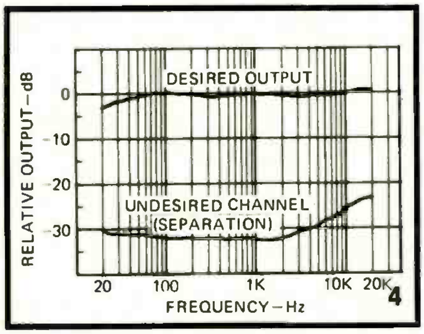
	R-E Measurements	R-E Evaluation
FREQUENCY RESPONSE (Hz-kHz, ± ___ dB)	20-50, 2 See Fig. 4	Excellent
STEREO SEPARATION		
Separation, 1 kHz (dB)	32	Very good
Separation, 10 kHz (dB)	25	Excellent
Separation, 30 kHz (dB)	12	Very good
CHANNEL BALANCE, 1 kHz (dB)	0.5	Excellent
TRACKABILITY MEASUREMENTS		
Stylus velocity at 1 kHz (CM/Sec.)	27	Very good
Stylus velocity at 10 kHz (CM/Sec.)	18	Very good
COMPONENT MATCHING CHARACTERISTICS		
Output level, 1 kHz, 3.54 CM/Sec. (mV)	2.9	
Optimum load impedance (ohms)	100K	
Tracking force range (___ to ___ grams)	0.25-1.25 (1 optimum)	
Cartridge weight (grams)	N/A	
OVERALL PHONO CARTRIDGE RATING		Excellent (CD-4) Very Good (Stereo)

Performance measurements

The most important measurement of any phono cartridge is, of course, frequency response. As shown in the curves of Fig. 4, the frequency response of the 4000D/III is amazingly flat over the entire audio range from 20 Hz to 20 kHz, deviating by no more than 1 dB or so. (Although Empire claims response down to 5 Hz—with no tolerance provided—this seems to be a case of "specmanship" and we could not confirm the claim using any

(turn page)

of our test records which provide frequencies down to 20 Hz.). Separation, also plotted in the graphs of Fig. 4, is an outstanding 32 dB at mid-frequencies, decreasing to about 25 dB at 10 kHz. Channel balance was within 0.5 dB from left output to right output at a nominal mid-frequency of 1 kHz. The output voltage for 3.54 cm/sec groove velocity was 2.9 mV as against 3.0 mV claimed.



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At 1 kHz, the cartridge was able to track groove velocities of up to 27 cm/sec successfully with a tracking force of 1.0 gram. Attempting to operate at lower tracking forces reduced tracking capability rapidly and we feel that the 1.0 gram setting is ideal for both stereo and CD-4 reproduction with this model.

A separate plot of frequency response from 1 kHz to 50 kHz was measured. A special JVC test record (TS-1003) was used for this purpose and the results showed a dip in response above 20 kHz. But the cartridge continues to deliver adequate output to 50 kHz, falling off quite rapidly above that frequency. It should be understood that since the "carrier" contained in a CD-4 groove is modulated by FM, it is not too important that frequency response be "flat" out to 45 kHz—only that there be sufficient output to activate the CD-4 demodulator circuits. At 45 kHz there was still more than 1.5 mV of output available for a 3.54 cm/sec groove velocity.

Listening tests

While the Empire 4000D/III certainly produced excellent listening results when playing stereo records, we have tested and listened to less expensive cartridges which do just as well in this regard and even track a bit better at high groove velocities and lower tracking forces. It was when we played our newer CD-4 records that the 4000D/III really justified its high price. At the low 1-gram tracking force (unusual for CD-4), we encountered no drop-outs of front-back separation, and no audible signs of distortion.

Audio fans accustomed to hearing a bit of "sizzle" at the high end (usually the result of false resonant peaks above 10 kHz) may have to get used to this truly flat and accurate reproduction as heard with an Empire 4000D/III, but in our opinion this is the kind of response a good cartridge should have. If you insist on that accentuated treble, use your tone controls to compensate for tweeter deficiencies, not random cartridge resonances that are, for the most part, unpredictable anyway. We'll take our cartridge output flat. **R-E**

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Empire Scientific Corp.** Model: **400D/III**

OVERALL PRODUCT ANALYSIS

Retail Price	**$149.95**
Price Category	**High**
Price/Performance Ratio	**Good**
Styling and Appearance	**Very Good**
Sound Quality	**Excellent**
Mechanical Performance	**Very Good**

Comments: The Empire 4000D/III is one of the most expensive phono cartridges on the market. In terms of stereo performance, its price might not be justified if a user had no intention of listening to CD-4 records now or in the future. Its superiority is evident when it is called upon to reproduce discrete 4-channel discs. It is one of the very few cartridges capable of tracking the high frequencies of a CD-4 disc at 1 gram (most others require about 2.0 grams or even more), and, considering its stylus shape, this is equivalent to the record wear that might be introduced by a conventional stereo cartridge tracking at 0.5 grams or even lower. Properly terminated with 100K ohm loads and around 100 pF of shunt capacitance, its frequency response in the audio range is almost "ruler-flat," and reproduced sound is totally uncolored or peaked. Tracking ability of heavily recorded discs is excellent, and distortion is extremely low. Stylus assembly replacement is simple, and the stylus is more rugged than might be expected from such a low tracking-force unit.

BUILD A COLOR TV CAMERA

(continued from page 36)

Color monitor

The color receiver I use is a RCA CTC31 chassis. All part references mentioned can be found in the *RCA Field Service Guide for RCA Color-TV Receivers 1969-1970, Volume 3, #ERT-202*. The modifications described here cover the RCA CTC31 chassis only. However, they outline the general procedure necessary to modify a typical color receiver so that it may be used as the color monitor.

Four separate signals are fed to the receiver; cyan video, red video, horizontal sync and vertical sync which is mixed with the cyan video in the camera head. The cyan video signal serving also as the luminence signal is connected directly to the set's video path immediately after the video delay line. This is point AE on the circuit board PW700. The second video IF amplifier tube V204 should be removed from the set to prevent noise from the tuner from mixing with the added luminence signal.

The cyan signal is amplified and inverted by transistor Q6 to drive both the G-Y and B-Y amplifier grids simultaneously. The grids are joined together by a .5 μF capacitor so the signal arrives at pin 9 of both 6GH8-A tubes, V701 and V704-a. The red signal is amplified and inverted by transistor Q5, then sent to the grid of the R-Y amplifier-pin 9 of V707-a.

Sync circuits

The negative-going vertical sync pulses contained in the cyan signal saturates transistor Q7 (see Fig. 3). This inverts the pulse and provides an 18V P-P vertical sync signal. Transistor Q8 is saturated by the incoming horizontal sync pulse fed separately from the camera head. The common collector load resistor R29 provides the 18V P-P composite sync signal which is applied to the sync separator tube grid—Pin 9 or the 6GH8-A, V206-b.

Although many sets will accept signals similar to those described above, other sets may require signals of different amplitude and color signal phase. A general guide when modifying your set would be to simply observe correct amplitude and picture phase with an oscilloscope while the set is tuned to a commerical color TV station. Then try to insert the red, cyan, and sync signals from the camera and amplifier unit at similar amplitudes and phases at their respective points. Single stage phase invertors may be added in the red, cyan, and sync circuits if necessary, or the signal amplitudes may be altered as required for your particular set. **R-E**

INSTALLING TV-MATV ANTENNAS

(continued from page 39)

pervious to weather, relatively kink-free and much easier to handle.

Whichever kind of mount you choose, do as much assembly work on the ground as possible. Attach the coaxial cable to the antenna output through a matching transformer. If you wish, use a weather boot to protect the coax connector. Next, run the cable along the antenna boom and tape it to the mast before climbing the roof. Coaxial cable is recommended over twinlead because it keeps out interference, minimizes ghosts and smears, is easier to install and lasts longer. If twinlead is used, it should be passed through the antenna strain relief as shown in Fig. 11.

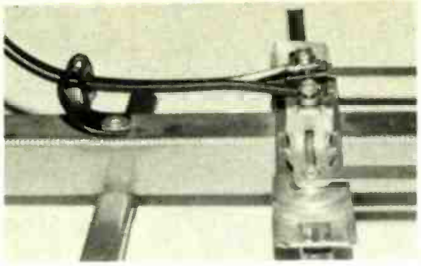


FIG. 11—TWINLEAD should be passed through the antenna strain relief.

If a rotator is used, that too can be completely assembled and wired up on the ground. Figure 12 shows an installation where a trap is used to eliminate interference from a local TV channel and a preamplifier is used to build up the signal from a distant station. A rotator is used to aim the antenna toward the station desired. This type of installation is very ef-

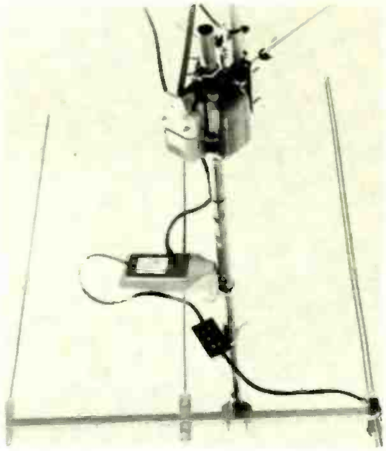


FIG. 12—INSTALLATION with rotator, trap and preamplifier.

fective in providing long distance as well as local reception. Notice that a drip loop is used at the input to the preamplifier and that the coax is taped to the mast with enough slack to allow for 360° rotation. A compass is used to aim the antenna due north. to coincide with the rotator control setting.

MATV antennas are often stacked on the same mast, for convenience. According to theory, you should leave at least ½-wavelength or more spacing between antennas—about the distance of the longest antenna elements. In actual practice, this is seldom done except in difficult signal areas. With a 2-foot to 3-foot spacing, you can fit three antennas on a single 10-ft. mast.

Coaxial cable is always used for MATV systems. Therefore. MATV antennas have 75 ohm outputs. Figure 13 shows how a

FIG. 13—DRIP LOOP prevents water from running along cable and into connections during a rainstorm.

drip loop is left at the antenna output terminal to prevent water from running along the cable and into the connections. The cable is then securely dressed along the antenna boom and fastened to the mast. The best way to get the coax cable indoors is through a weatherhead, as shown in Fig. 14.

Grounding

The National Electrical Code requires that all TV antennas and masts be grounded. Only two types of grounding electrodes are acceptable:

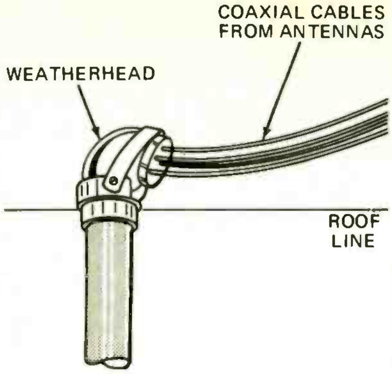


FIG. 14—WEATHERHEAD should be used to run cables indoors.

1. A metal cold water pipe. (Hot water pipes don't provide suitable ground.)
2. A ground rod at least ⅜" in diameter, driven at least four feet into the ground.

Cold water pipes are often used to ground MATV antennas, but home antennas are usually grounded through ground rods. Twinlead can be grounded through a lightning arrestor. For coaxial cable, use a grounding block. In either case, use heavy gauge grounding wire, attaching it to the mast as well as the downlead.

Towers

Towers get antennas up high with no possibility of roof damage. They are rugged and not at all difficult to install. When repairs or adjustments are required, towers are easy and safe to climb (with a climbing belt). Finally, towers look professional for both home and MATV installations.

The two basic types of towers are free standing and bracketed. Free standing towers require a concrete base, but can be placed anywhere. Bracketed towers are simply staked into the ground, with support coming from a bracket that is fastened to the house or building involved. Thus, bracketed towers must be right next to a building.

Small towers can be assembled completely on the ground and "walked up" by two men with a rope. Taller towers are usually installed one section at a time. Base pieces are fastened firmly in place and then the installer climbs the tower to add additional sections.

This is a fairly easy one man job if you use a long rope with a hook on the end of it. Climb to the top of the tower, hook your leg firmly around it, fasten your safety belt and you are ready to pull up another section. Lower the hook to snag a section, pull it up, fit in place and secure it with nuts and bolts.

In installing TV antennas, always strive for excellence. Remember, antennas and downleads are subjected to wind, rain, snow and sleet. A little extra care in installation can mean years of extra service for the installation. For example, if you use a level to make sure the mast is absolutely perpendicular, it not only looks better, it lasts longer. Conversely, downlead that flaps in the wind quickly frays and breaks. There is little room for carelessness or sloppiness in antenna installation. **R-E**

SCREEN-READ BOARD

(continued from page 36)

How it works

Figure 1 shows the schematic diagram. The "compare" and "load strobe" signals from the main board tell the screen read board when the memory has been indexed to the current cursor location and when the data is actually ready for reading. These signals are gated with the "ready to load" signal from IC1 pin 8 forcing IC6-c pin 12 low and transistor Q1's collector high. This loads each of the holding registers, IC1-a, IC2, IC4 and IC5-b, with the memory data located in the cursor position. The "data ready" line goes high and the "ready to load" line, IC1 pin 8, goes low signaling that valid data is contained in the holding registers and inhibiting IC6-c from clocking in new data. The cursor is also advanced one forward position or carriage return/line feed if in column 32, since the "data ready" line drives a transistor on the cursor board which is wire OR'ed to the cursor counter "forward" input on the main board. It is for this reason that the screen read board must always be used in conjunction with a cursor control board.

When the device connected to the read board accepts data it must put a low on the "data accepted" line, J6-8. This in turn dumps the holding registers and resets the "data ready" line. A variable delay has been built into the read board which allows for a premature "data accepted" acknowledge-

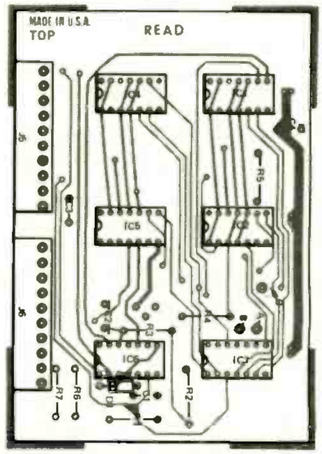


FIG. 4—COMPONENT LAYOUT.

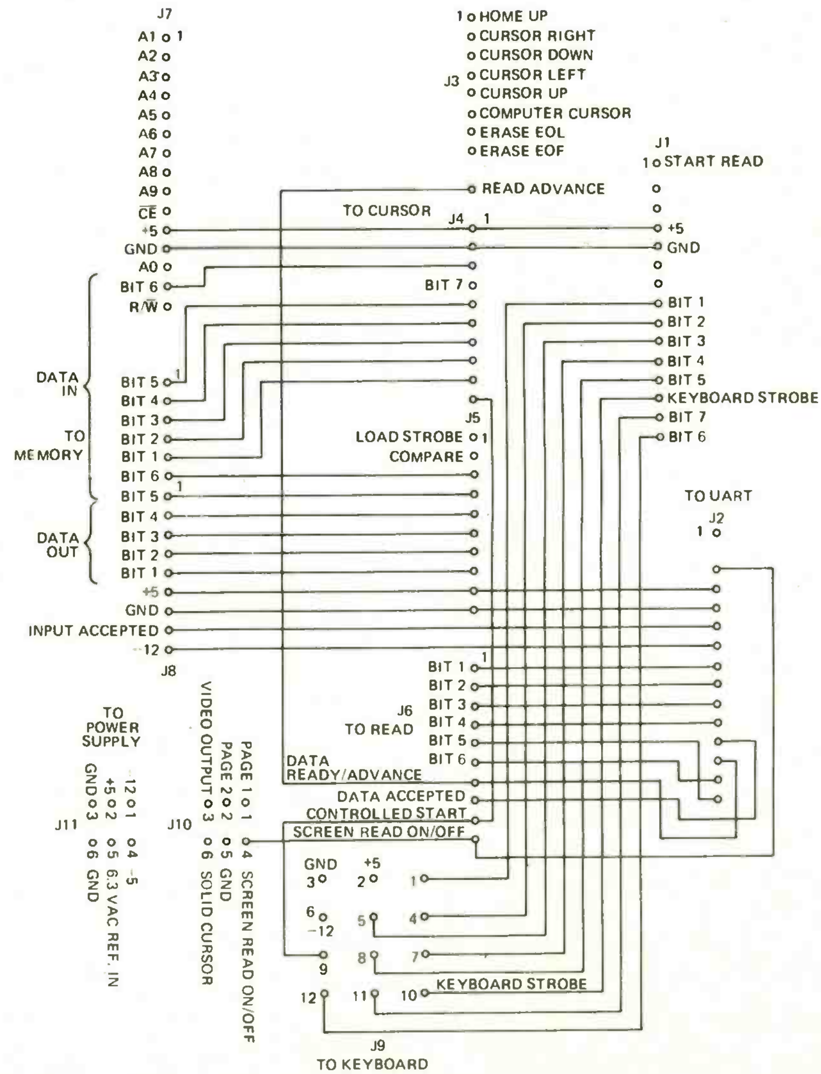


FIG. 5—JACK INTERCONNECTION diagram of TV Typewriter II.

ment since some devices connected to the read board generate the acknowledge signal and yet require that the holding registers not be dumped immediately. The delay time can be increased by making capacitor C1 larger, however, for maximum output speed the capacitor should be made as small as possible with a minimum capacitance of 100 pF. New data is then loaded into the holding registers and the "data ready" line goes high, completing one cycle of the operation which continues until a stop command is received from the screen read ON/OFF switch, or if the auto stop jumper is installed, a /. This clocks the Q output of IC5-a low and stops the screen read function. The controlled start input, J6-9, must be pulsed low either with a manually operated switch, computer controlled cursor or a combination since the input may be wire OR'ed to initally start the read sequence or restart it after a stop. Note however that the screen read ON/OFF switch must be in the ON position.

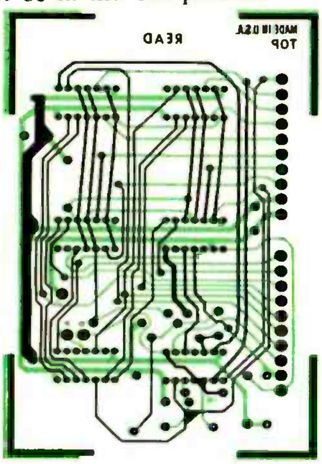


DIAGRAM SHOWS how both foil patterns overlap to form a double-sided board.

Assembly

The board assembly is easy since there aren't many parts, but be sure to orient the transistor, diode and integrated circuits correctly. The foil pattern for both sides of the double-sided board is shown in Figs. 2 & 3. Figure 4 shows the component layout. When plugging the assembled screen read board onto the main board, be sure not to plug in the board backwards. Since all of the pins were used there was not room for an indexing key, so be sure to orient the board the same as the memory and cursor boards. Also be sure that the main board of the terminal is working properly before plugging in the screen read board onto it. The jack interconnection diagram of the TV Typewriter II is shown in Fig. 5.

You can use the jack interconnection diagram of the TV Typewriter II to determine how the screen-read board connects to the rest of the circuitry. **R-E**

Great leap ahead for pay TV due with satellite programming

More than 800,000 persons will be served with Home Box Office pay cable television programs by one company alone this Fall. Teleprompter, largest cable TV operator in the country, plans to build 24 earth stations across the country to receive programs via satellite and retransmit them to its subscribers. The new service will be available to 82 of Teleprompter's 140 cable systems by the end of 1976.

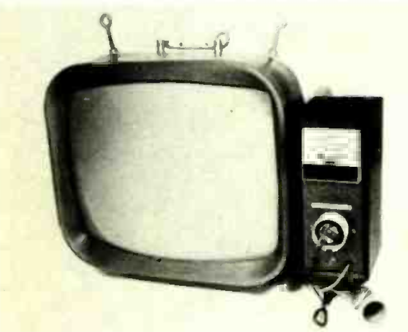
Home Box Office has contracted with RCA Global Service for satellite facilities and will begin distributing programs by satellite late this year. At present, it provides about 70 hours of programming a week over cable and microwave nets.

Manhattan Cable Television, which has a franchise for the lower half of Manhattan, NY, now offers Home Box Office programs to more than 17,000 subscribers. They pay $9 per month for the special paid program service in addition to $9 per month for the regular cable hookup. Teleprompter, covering the upper half of Manhattan, is offering Home Box Office programs to its 55,000 subscribers, beginning late summer or early Fall. It also expects to be able to offer the pay programs by microwave transmission to seven other Teleprompter cable systems in New Jersey, New York and Connecticut.

new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card inside the back cover.

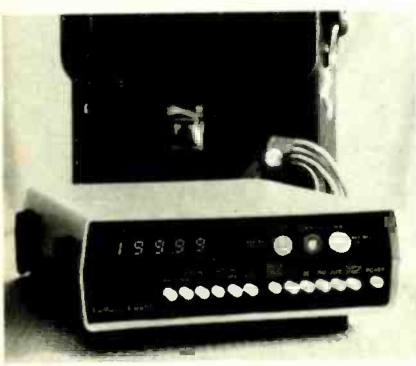
SOLID-STATE REGULATOR. *Chek-A-Color High Voltage Regulator, model CK2000* will adapt most existing test equipment for safe servicing of color TV receivers rated to 35,000 volts. Unit connects quickly and easily without modification to most test jigs currently in use. A 15-watt varistor and all solid-state 15-watt thick-film divider network comprises of specially designed circuit that provides regulated 22 kV to the picture tube from a re-



ceiver anode voltage range of 22 to 35 kV. Three programmers supplied with the *CK2000* match receiver voltages in ranges from 19 to 26 kV; 25 to 31 kV and 27 to 35 kV. Regulator protects against test jig picture tube X-radiation exceeding Federal standards, providing installation instructions are observed. Power dissipation reserve protects jig and receiver from excess voltage. The regulator is also designed to prevent arcing of jig picture tube and to eliminate possible tube damage.—**GTE Sylvania Inc.**, One Stamford Forum, Stamford, CT 06904.

Circle 31 on reader service card

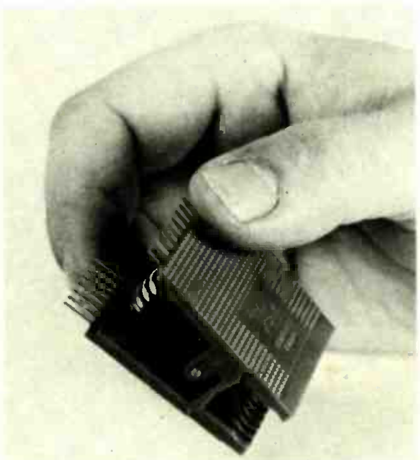
PORTABLE 4½" MULTIMETER, *model 4440,* includes a crystal-controlled frequency-counter option. Handy for communications, field service and laboratory applications. By overflowing the most significant digit, the counter can be used as a digit counter in CB applications. Unit has 5 ranges for DC volts, AC volts, DC current, AC current and frequency with 6



ranges for resistance measurements. Operates for 150 hours from disposable alkaline batteries. Options include rechargeable batteries, recharger, carrying case, 20-amp current shunt, 36-kV high-voltage probe, external shielded input cable set. Basic multimeter is $299.00—**VALHALLA SCIENTIFIC, INC.**, 7707 Convoy Ct., San Diego, CA 92111.

Circle 32 on reader service card

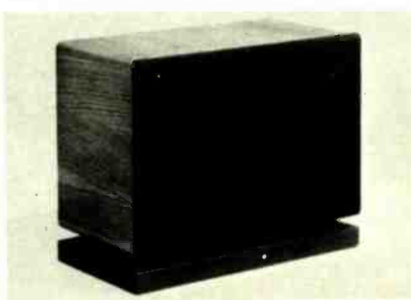
IC TEST CLIP, for 24 pin dual-in-line packages, *Dip Clip model 4124* reduces the possibility of accidental shorting while testing live circuits. Numerous hand probes can be connected quickly for hands-free testing. Features include: nickel-silver contacts, spring-



loaded wiping action of contact pins for good electrical connection, friction-grip contacts, positive positioning to prevent accidental shorting of adjacent leads.—**ITT Pomona Electronics**, 1500 E. Ninth St., Pomona, CA 91766.

Circle 33 on reader service card

SPEAKER SYSTEMS, *Contrara group. Contrara R,* illustrated, is a rectangular system that serves as either a bookshelf or floor model. It features an 8-inch bass reproducer with butyl rubber surround for improved linearity and transient response, coupled with a 2.5 cm (1-inch) domed high-frequency re-



producer. Frequency response: 50—24,000 Hz, with a crossover at 1750 Hz in 12-dB-per-octave segments. Power handling capacity is 50 watts at 8 ohms. Oiled walnut cabinet, textured black fabric grille. $125.00. *Contrara S* is a square shaped enclosure that doubles as either bookshelf or floor model. It also has an 8-inch bass and 1-inch domed high-frequency reproducers. Same specifications and price as the model *R*. Major difference is the enclosure dimensions. The *Contrara P* is a floor standing pedestal enclosure priced at $225.00. Has dual 8-inch bass reproducers and a 1-inch domed high-frequency reproducer. Frequency response from 38—24,000 Hz, crossover at 1750 in 12 dB-per-octave segments. Power handling capacity 75 watts continuous at 8 ohms.—**Jennings Research, Inc.**, 64 North Fair Oaks Avenue, Pasadena, CA 91103.

Circle 34 on reader service card

MONITORING HEADPHONES, *model HP-100,* delivers an unusually flat, wide frequency-response with very low distortion and at sound pressure levels usually unattainable with conventional designs. A special ear-seal effectively screens out extraneous sounds, providing almost complete isolation, at no sacrifice

in comfort. Frequency response: 20-20,000 Hz, Impedance: 8 ohms ±20% (1 kHz), Output sound pressure level: 90 dB ±3 dB/mW at 1 kHz (Re: 0 dB = 0.0002 μBar), Maximum Input Power: 500 mW, channel balance of output SPL to be less than 3 dB at 1 kHz, Cable: 8-ft. long, Earcap: foam padded and covered with soft vinyl, Weight: 14.3 oz., Price: $50.00. —**Nakamichi Research, Inc.**, 220 Westbury Avenue, Carle Place, NY 11514.

Circle 35 on reader service card

TUNER CLEANER, *Tuner 600* is packaged in 6 oz. areosol cans fitted with a flexible spray tube to facilitate cleaning of sensitive tuner contacts and channel switches without changing the capacitance and frequency response. Manufacturer claims *Tuner 600* is 99.8% chemically pure, non-flammable and non-conductive. It is said to immediately eliminate contact disturbances, penetrates deep to dissolve and clean away contaminants. An instant drying, no-residue tuner cleaner perfectly harmless to all components. Companion products include *Kontakt-Chemie 60,* the oxide dissolving treatment for electrical contact disturbances. *Kontakt 61,* the anticorrosion lubricant for contact surfaces and *Kontakt WL* for the cleaning and degreasing of soiled electrical contacts. Other products in the complete line of 16 sprays for electrical and electronic production and maintenance

include *Video-Spray 90*, the magnetic head cleaner, and *Anti-Statik Spray 100*, the static eliminator.—**Regmo Data Corporation,** 6992 Oxford St., Minneapolis, MN 55426.

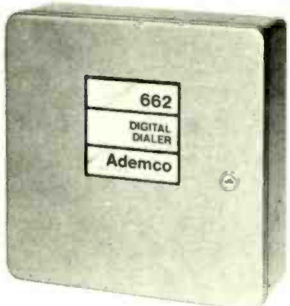
Circle 36 on reader service card

CASSETTE DECK, *model A-170*, has a DC servo-controlled motor that provides smooth, accurate tape flow. Any transport mode can be engaged without pushing the stop but-

ton first. Separate bias and equalization switches permit the user to maintain compatibility between the unit's record electronics and the latest state-of-the art tape formulations. It uses IC Dolby noise reduction system in conjunction with the tape switches. Other features include dual wide-scale VU-type level averaging meters, front panel mic and headphone jacks, variable slide controls for input/output level adjustments and a three-digit resettable tape counter. $220.50—**TEAC Corporation of America,** 7733 Telegraph Rd., Montebello, CA 90640.

Circle 37 on reader service card

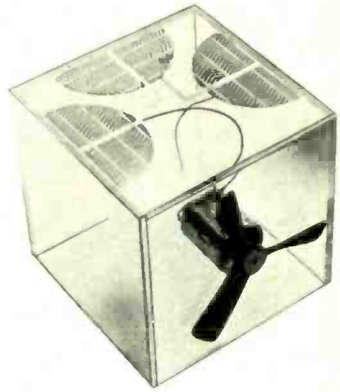
DIGITAL DIALER SYSTEM, *model 662*, consists of a digital-dialer receiver and digital-dialer printer. This system is capable of monitoring up to 999 locations using standard telephone lines. Each location being moni-



tored has a *model 662* digital-dialer installed. When an alarm occurs, this unit senses the dial tone and dials immediately. If dial tone is not present, the *662* will hang up and pick up the line again in an attempt to dial out. Once it has completed dialing, the *662* waits for an acknowledgment from the receiver before beginning to transmit its message. The *660* receiver picks up the line as soon as it senses an in-coming call. It then transmits an acknowledgment signal which permits the *662* to begin leaving its message. At the same time, the *661* printer stamps out the account number, date, time and type of alarm condition being transmitted. When the *660* receives two consecutive sets of identical messages, it sends out another acknowledgement signal terminating the alarm sequence. The receiver is now ready for other alarm signals. A test message can be sent at any time by simply pressing a button. This permits users to check their transmitters at any time.—**Alarm Device Manufacturing Co.,** Syosset, NY 11791.

Circle 38 on reader service card

SOLAR ENERGY CUBE. When placed in the sun, this clear plastic 4" cube gives you a fast demonstration of how sunlight converts to kinetic energy. Three highly efficient sili-



con solar cells power its motor to turn the propeller. The unit actually produces 1.5

Circle 24 on reader service card

Circle 25 on reader service card

Circle 26 on reader service card

Circle 27 on reader service card

VDC, 825 mA of current to run the motor. Nothing to wear out, it's an easy way to carry a solar demonstration anywhere. All you need is the cube and the sun. $19.95.—**Edmund Scientific Co.,** 380 Edscorp Bldg., Barrington, NJ 08007.

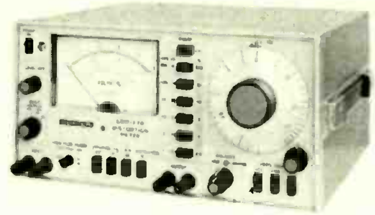
Circle 39 on reader service card

RECHARGEABLE BATTERIES, *nickel-cadmium* D, C, AA and heavy-duty D for consumer and industrial applications. Available individually or in pairs in blister packages. Four charging devices are also available.

One model is designed for D, C, and AA batteries and is priced at $10.99. There is also a 48-battery charging unit—one model for D and one for C size batteries—$175.00 each. **Mallory Distributor Products Company,** 4760 Kentucky Avenue, Indianapolis, IN 46241.

Circle 40 on reader service card

DISTORTION METER, *model LDM-170,* for audio circuits also measures signal-to-noise ratio and signal levels in all audio frequency circuits. Offers a balancing circuit to suppress the fundamen al frequency in the 20Hz—20kHz range while distortion products are fed to a stable, high-gain amplifier for meter readout. Distortion can be measured



as low as 0.1% while signal-to-noise ratio can be determined from 70 dB. Signal levels can be read from 100 μV to 300 V. The amplifier is effective to 200 kHz and measurements are possible up to and including the 10th harmonic of 20 kHz. The unit also has a high-pass filter with a cutoff at 500 Hz; + 6dB-per-octave attenuation. There are output terminals for scope connections to observe waveforms or for use as a pre-amplifier in low-level circuitry. The unit is $549.95, measures 6½"H x 12½"W x 12"D and weighs 13 lbs.—**Leader Instruments Corp.,** 151 Dupont Street, Plainview, NY 11803.

Circle 41 on reader service card

PRECISION GRIDS. A new line of clear, polyester scales designed for critical measuring, dimensioning and checking of artwork, negatives and drawings, such as those required in the printed circuit industry. These new scales have an overall accuracy of ±.002" and ±.0005" between adjacent lines at 70°F, 50% relative humidity. Regular line width is .001" and all accent lines are .002" thick.

There are three decimal accuscales available; 1X, 2X and 4X standard. The 1X standard comes in two lengths, 18" and 36". Both

Circle 28 on reader service card

Circle 29 on reader service card

2X and 4X Accuscales are available in 36" length only. Prices range from $17.50 to $24.50, depending on accuracy and length.

Technical Bulletin No. 1018. For your free copy write—**Bishop Graphics, Inc.,** 20450 Plummer Street, Chatsworth, CA 91311.

Circle 42 on reader service card

SCANNING MONITOR, hand-held *Bearcat.* Compact receiver measures 6¼ x 1½ x 2¾ in. and is available in two models: a two-band version that covers both low and high VHF bands; and a single-band model, covering UHF frequencies. Both hand-held units have four-channel operation and LED channel indicators plus individual channel switches. Also included is an AUTO/MANUAL selector

switch plus volume and squelch controls. Both units come with a telescoping antenna and a provision for an optional rubberized antenna is also provided. Units weigh only 11 ounces powered by 4 AA batteries and have the following characteristics: VHF sensitivity .6 μV, UHF 1.2 μV, audio output is 250 mW. IF crystal frequency is 10.8 mHz. Scan rate is 8 channels per second. $129.95. Crystals are not included. **The Electra Company,** 300 South on East County Line Rd., Cumberland, IN 46229. **R-E**

Circle 43 on reader service card

Circle 30 on reader service card

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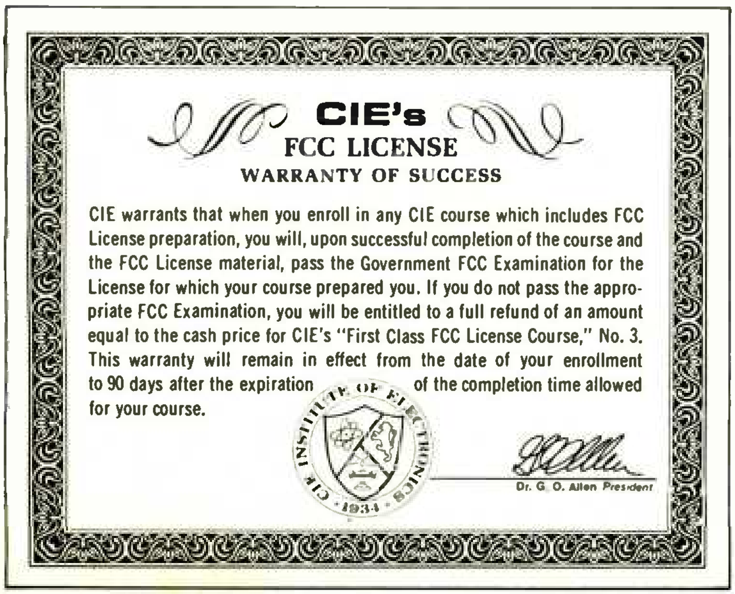

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SIGNAL-TO-NOISE

(continued from page 52)

of the turntable system's mechanical of 1.4 cm/sec. The ARLL method has a recorded tone of 1 kHz for reference, and it is recorded at a velocity of 5.0 cm/sec. Both DIN methods use 315 Hz as the reference frequency, recorded at a velocity of 2.71 cm/sec. Because of the playback equalization curves used in phono preamplifiers (the familiar RIAA characteristics which boost bass response by prescribed amounts), the choice of frequencies will determine different reference levels even if the recorded velocities were identical. Figure 7 takes this into account and shows that readings made using the NAB method will be 4 dB poorer than those made using the DIN or ARLL methods, even if the weighting curves were the same for all methods—which they are not!

Interpreting rumble specs

It is clear from all this that there is no direct way to correlate rumble readings made using one technique with those using another method. We would have to know more than a single "dB number" to really make comparisons from method to method. What we can say, generally, is that if the rumble content consists primarily of very low, sub-sonic frequencies, these will be emphasized by NAB and DIN "A" readings and will tend to be ignored by ARLL and DIN "B" readings in varying degrees. Designers of turntables generally resort to more sophisticated measurement techniques when trying to reduce rumble of their products. Generally, spectrum analyzers are used and frequency sweeps of filters are employed so that specific offending rumble frequencies can be charted, analyzed and dealt with. A single meter reading of rumble, in dB, cannot pin-point the offending frequencies in this way and you are better off analyzing rumble content "by ear" than by trying to evaluate the manufacturer's "rated" rumble figure in very meaningful terms.

Table I will give you some idea of how different commonly encountered "rumble frequencies" would show up using any one of the four described "rumble measurement" single-meter-reading standards discussed so far. It takes into account the weighting curves used in the four methods as well as the different reference recording levels used in each of the measurement techniques. As an example, if your turntable had an inordinately high amount of 30 Hz rumble (a common frequency of rumble in systems using 1800 RPM motors, since 1800 divided by 60 seconds equals 30), the unweighted DIN rumble figure would be 4-dB *better* than the NAB rumble figure—simply because of the different reference levels used to establish "0 dB" output. Using the ARLL or DIN "B" methods, however, the weighting curves used in these methods would tend to "ignore" the 30 Hz contribution by amounts indicated in the table (28 dB and 36 dB down respectively) and, using a single VTVM, the rumble figure would then be based on other rumble frequencies which occur in regions where the "weighting curves" of the methods provide less attenuation to these frequencies.

It is clear that if you suspect that your turntable is troubled by very low-to sub-sonic rumble, the NAB and unweighted DIN "A" methods will show this clearly, whereas the DIN "B" and ARLL methods will tend to ignore it. It should be equally clear that manu-

TABLE I

Effect of rumble measurement methods on rumble readings at various critical rumble frequencies. +dB readings mean that rumble reading will be better by amount shown compared to readings taken with no weighting network and referenced to higher DIN signal level. (—)dB readings mean that rumble reading will be poorer by amount shown, compared to readings taken with no weighting network and referred to higher DIN signal level.

FREQUENCY (Hz)	DIN UNWEIGHTED	NAB UNWEIGHTED	DIN WEIGHTED	CBS/ARLL
5	+7	+3	+72	+42
10	+2	−2	+60	+36
15	0	−4	+51	+32
30	0	−4	+40	+26
60	0	−4	+27	+17
90	0	−4	+20	+13
120	0	−4	+14	+10
180	0	−4	+7	+6
240	0	−4	+3	−1
300	0	−4	+1	−2
315	0	−4	0	−2

(**NOTE:** While this table provides a means for correlating readings of specific rumble frequencies using any one of the four systems described, it *cannot* provide correlation between overall single-meter readings of rumble since such readings do not provide information as to what are the offending rumble frequencies.)

facturers who understand this and are bothered with sub-sonic rumble frequencies are probably going to use the DIN "B" or the ARLL method.

The best solution, from the point of view of the consumer, would probably be for manufacturers to specify both an unweighted and a weighted rumble figure—and for all to use the same weighting curve and reference level in listing these specifications. Until and unless that happens, about the only thing the hapless turntable system buyer can do is to audition turntables by turning up the volume real high during a quiet passage of the record and listening for all forms of low-frequency rumble. Watching the woofer cone of a speaker system can be helpful, too, since the cone will move visibly when driven by sub-sonic frequencies that might otherwise not be heard—especially if the amplifier used is of the direct coupled output type. And one more thing, as if we haven't covered enough. Try to do this auditioning using the same phono cartridge you plan to use in your system at home. Since some cartridges roll off at low frequencies faster than others, the cartridge used to check for rumble is still another important variable in the rumble measurement story. **R-E**

High-capacity nickel-cadmium battery holds up under high discharges

The industry's first sub-C nickel cadmium cell to combine high capacity with a high discharge rate has been announced by the Battery Business Dept. of General Electric Co.

The new 1.2 ampere-hour cell offers as much as 20 per cent improvement in capacity at high discharge rates over conventional 1.0 ampere-hour cells. It owes this ability to improvements in the construction of its elements that increase the area of actual active surface. The negative plate is of perforated and stippled sheet steel, while the positive plate is, more conventionally, a nickel sheet with a highly porous sintered nickel plaque applied to it.

NEW HIGH CAPACITY/DISCHARGE CELL developed by General Electric offers 20 per cent improvement in deliverable capacity over older sub-C nickel-cadmium cells. Capacity is 1.2 amp-hou s at 1.2 volts. It measures 1.6 inches high with a .875-in. diameter.

Offering increased power at higher current levels than has heretofore been available in sub-C nickel-cadmium cells, the new cell is especially suited for applications with high-drain requirements as well as for portable garden tools, small appliances and scientific and medical instrumentation.

Pocket calculators may create hazardous interference

A recent letter to *Wireless World* magazine calls attention to the possible dangers of operating pocket electronic calculators near sensitive instruments. The writer refers to severe inaccuracies in measurements obtained from an electroencephalograph when a calculator was operated near its pickup.

This quote comes from *Approach*, the national aviation safety review of the U.S. Navy, December, 1974:

"... hand-held electronic calculators cause a degree of interference in ADF (automatic direction finder) signals when the calculator is operated in close proximity to the ADF antennas.... It is not necessary that operations be performed, only that the calculator be turned on. Pilots should be aware of this and use ADF indications cautiously when hand-held calculators are being used."

Circle 63 on reader service card

WHAT'S THE SIGNAL LEVEL NOW?
(continued from page 59)

This is currently being used by several manufacturers of TV receivers in Europe, where it is anticipated that volume production of VHF and UHF PIN-diodes will bring the cost down to a level where it will be practical to use it in all TV tuners. It will no doubt appear in future receivers manufactured in this country and could probably be called automatic-attenuation-control or AAC.

It can be seen from the block diagram (see Fig. 4) that this system of signal-level control uses a DC voltage proportional to the detected IF carrier signal, just like conventional AGC; but instead of using this voltage to cause gain reduction in an active amplifying stage, it is used to attenuate the signal level in a passive circuit. This is a far cleaner method of signal level control without intermodulation distortion or tilt problems in the RF stage.

With the advent of lower cost PIN-diodes used in conjunction with simpler control voltage systems derived from the detected IF carrier, it may be expected that such an AAC system would cost no more than the complex AGC systems incorporated in todays solid-state color-TV receivers.

Present solution

The currently available way to solve the signal level problem is to measure the antenna signal right at the antenna terminals of the TV receiver and correct the signal level there.

To do this requires a TV field-strength meter. One such device is the Castle Mezzer$_{TM}$ model TVS field-strength meter that sells for $69.95. To use this device, the unknown signal is first fine-tuned for maximum indication on the tuning meter, then nulled to a precise meter reading by the calibrated attenuator. The unknown signal-level is then read on the attenuator scale, having been nulled against the known amplification of the instrument. The proper color-TV reception signal level of 1 mV to 4 mV (0 dBmV to + 12 dBmV) is conveniently centered on the attenuator scale and indicated by a different colored band. The total range of the attenuator allows indication of signal levels from 300 μV to 30,000 μV.

If the signal-level is outside the range of the attenuator scale (300 μV – 30 mV), something should be done to correct the antenna signal. If some channels have signals at the low-end of the instrument's range, and some at the high end, correction of the antenna system—so that the signal level is within the desirable limits—will be essential if the receiver is to perform properly and give excellent results.

Conclusion

The knowledge of the signal-level will not correct the problem, but the time saved by properly understanding the problem and concentrating on correcting the antenna signal instead of trying to service a perfectly good receiver will certainly make the TV service technician's job a lot easier.

It should be emphasized that proper tracking of the RF and IF AGC system is essential for proper operation of the receiver. The manufacturer designed these control systems for optimum performance of the receiver. Follow the manufacturer's service instructions for adjustment of the AGC control carefully whenever adjustments are made. Set up adjustment of a new receiver requires this careful attention, as does the readjustment of a receiver being connected to a new antenna. **R-E**

Plug-in bedtime computer

The British Oxygen Co. (London, England) found that its computer is useful for a large number of intricate projects, some of which required a great deal of computer time. Only trouble—at certain points in the computations, problems could arise that could be dealt with only by a few of the company's top experts. And this could happen at any time in the

SLEEPY-TIME COMPUTER is hooked up to handle problems at all hours of the day and night.

24 hours. So the company has installed terminals in the homes of four of their top computer personnel—two men and two women—and is now able to use their willing services 24 hours a day.

The photo shows executive John Laycock, manager of the company's computer center, aroused at 4 A.M. to tackle a problem the night staff can't cope with. With the phone cradled in the terminal apparatus, the data flashes on the monitor screen, so that Mr. Laycock can explore the difficulty and supply the solution with the help of the typewriter keyboard that forms part of the terminal equipment.

service questions

NO HIGH VOLTAGE, NO BOOST

I had a small picture, both directions, in this Zenith 14Z36. I tried a new deflection yoke. Now, I lost the high voltage, and the boost dropped from +740 volts to only +320 volts! Putting the old yoke back did the same thing. What happened?—W.M., Yucaipa, CA.

Probably something in the horizontal winding of the yoke, or in the connections. The fact that you read +320 volts shows that the damper tube is conducting normally. Check continuity of the horizontal winding, the boost capacitor, and above all, check the cathode current of the 6HB5 horizontal output tube. If this is an *open* circuit (boost capacitor, yoke winding, etc.), your current will be about half normal. If it's a short, the current will be high.

ALL VOLTAGES LOW?

I have this receiver with a real funny symptom. Every voltage in the thing is low; about half normal. What kind of fault could cause this?—L.J.H., Indianapolis, IN.

Only one thing that I can think of, odd though, it might seem. There is a 220-volt power transformer in it! Has this been brought back from overseas?

(Field feedback; reader says "Yes! Now I find out that the owner's brother used it in Germany while he was in the service! Quick fix: I got a low-priced 2:1 transformer, hooked it into the primary winding and now it works like a charm!")

SUBSTITUTE FOR 26D6 TUBE?

I need a 26D6 tube for a 392/URR surplus radio receiver. Can you tell we where I could find one, or a possible substitution?—W.Y., Emmett, ID.

The 26D6 is a pentagrid converter listed in G-E's *Essential Characteristics* book. I don't see any mention of this in a substitution manual. However, this tube has a 7CH base. Among other tubes with the same basing are the 18FX6, and in the industrials, 5750, 5915 and 7036. A little "double-crossing" discloses that the 5750 is a "special 6BE6." So with a little juggling of heater connections, you might be able to use this one, or even a 12BE6. The original circuit may have been wired for use on a 24-volt battery system.

TUNING-UP THE BAR-DOT GENERATOR

I've never used a color-bar generator before, and I've just bought one. I'm having problems in getting it set up to make convergence adjustments. Can you give me some hints? —M.B., Louisville, KY.

A couple, at any rate. First, tune the set to a working channel. Then connect the bar-dot to the antenna terminals. Now, set it to CROSSHATCH and adjust the set's fine-tuning and the bar-dot tuning dial for the sharpest pattern. Watch out especially for the *vertical* lines.

You can run into stumps under certain conditions. If the set has a VIDEO PEAKER control, be sure that this is set to sharp. In some sets, you can wipe out the vertical lines entirely by setting this to soft. Be *sure* that you make any vertical adjustments on the set *before* you do any convergence. If you make these last, you'll upset the convergence waveforms, and the convergence. Be sure that your contrast control isn't set *too high;* this can cause blooming!

FUSE WIRE?

The filament fuse in this RCA CTC-25 is burned out. I have found the other trouble, and now I'd like to replace this. Can't find any listing of this kind of fuse wire in any of the catalogs, though. Should I use a regular fuse?—M.R., St. Petersburg, FL.

This is called a fuse, and I guess it is, really. However, it's just a short piece of No. 26 bare copper wire; solid, for best results. Slip a piece of braid spaghetti over it for luck. This will burn out if there is a short-circuit heavy enough.

TRANSFORMER COLOR CODING

I have a power transformer with no data on the leads. It's a Motorola 25D65663A02-H. Can you tell me what the different leads are?—S.P., Addison, IL.

After a good deal of running and screaming, and some luck, I found it. This is a power transformer used in a Motorola WKTS-584Y chassis (Sams 692-2). Here are the colors and AC voltages.

Primary: Black, red/black; 115 volts. 5V heater; heavy yellow, 2.0A. 6-volt heater; green, green/yellow, 10A. High voltage; two red, (center-tap; red/yellow). 270 volts, 250 mA. These are EIA standard color codes for power transformers.

BEADY EYE

I have a Sprague TO-3 Tel-Ohmike capacitor tester. I've checked out the power supply, etc., but I can't get the 6E5 eye-tube to open as wide as it should. Also, I'm not too sure of the calibration. Are there adjustments?—R.T., Tallahassee, FL.

Your eye trouble is most apt to be due to a drift in the value of the target resistor on the 6E5 tube. If you can't find this, take the tube out of the socket and pull up the fiber disc. It may be one of the LBD types nestled in a slot in the socket (LBD; Little Bitty Devil). If this has gone up, you won't get a "wide eye." You can replace this with a larger resistor by running two leads out of the socket and mounting the resistor on the back.

Calibration. Get a few good capacitors, and check them. First one, then two in parallel, three in parallel, and so on. Note the dial-readings, and this will tell you how it's doing. The pot used in the bridge is a 3,000 ohm linear wirewound.

REPEATED LOSS OF VERTICAL

We have a Sylvania EO-1 chassis in for repair of a loss of vertical sweep after two minutes. The voltage at the collector of the vertical output transistor goes to zero. Transistor reads about 300 ohms emitter to collector. We've replaced this several times in the last few years, using different makes, all rated at high voltage. What's going on? Do you know of any modifications to this chassis?—H.P., Tulsa, OK.

Answer: no. I haven't heard of a modification in this circuit, but something is very peculiar! The transistors you mentioned certainly should stand up. Read the emitter current while bringing the line voltage slowly up from zero. Should be 140 mA.

(Field Feedback from reader. We tried your suggestion. Found that this stage was fed from the +185 volt source. After finding that we could get a full raster with a line voltage of only 55 volts or so, we changed the source for the vertical output collector supply to the +120 volt regulator point. At first, we could not change this with the regulator, but found a couple of resistors that were off value. Now we have full sweep, and the transistor is running cool well within its rated limits. Thanks.")

This was Howard Phillips, of Phillips Radio-TV Service, Tulsa, OK. **R-E**

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TEST EQUIPMENT of all kinds are clearly illustrated and described in this 24-page catalog. Here's everything from an FET Multimeter through mutual conductance tube testers, sweep and marker generators, power supplies, oscilloscopes, stereo analyzer and such unusual items as a power monitor, 7-in-1 bias supply, a simple filament checker. —**Sencore,** 3200 Sencore Drive, Sioux Falls, SD 57107.

Circle 46 on reader service card

STYLUS BROCHURE. *Visit to the Small World of a Stylus* tells you all the things you've always wanted to know about a phono stylus. Explains a demanding world in which a phono stylus must exist and why specific specifications are important to the stylus purchaser.—**Shure Brothers, Inc.,** 222 Hartrey Avenue, Evanston, IL. 60204.

Circle 47 on reader service card

TEST EQUIPMENT, *catalog #4400.* 60-page catalog lists the full line of this manufacturer's test instruments from panel meters to digital panel meters to controller accessories, temperature testers, solid-state FET VOM's, oscilloscopes, frequency counters, chart recorders and a variety of test equipment accessories that are all described in this catalog.—**Simpson Electric Company,** 853 Dundee Avenue, Elgin, IL. 60120.

Circle 48 on reader service card

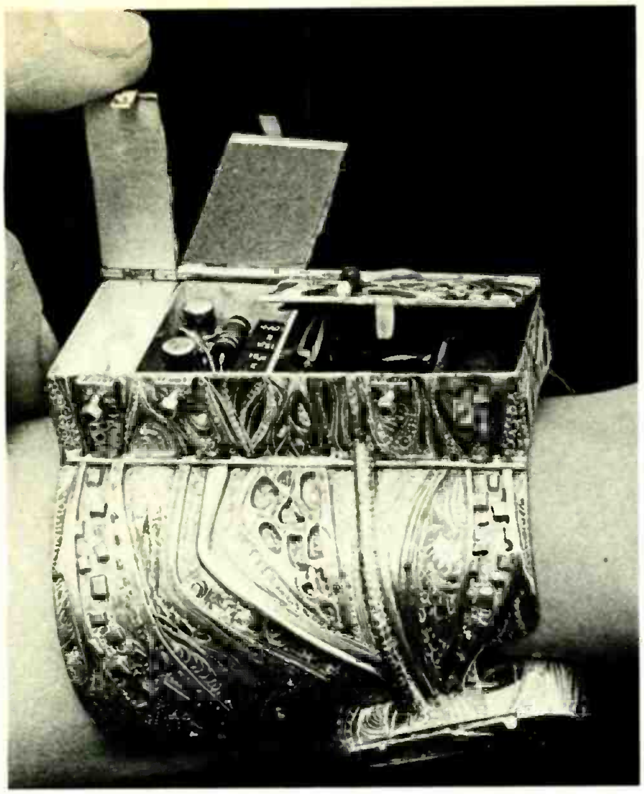
AM STEREO BOOKLET, describes RCA's proposed AM stereo broadcast system. It discusses evaluation criteria for AM broadcast systems, and describes the system that RCA demonstrated at the 1975 NAB convention.—**RCA Broadcast Systems,** Audio/Radio Equipment, Building 2-7, Camden, NJ 08102.

Circle 49 on reader service card

MAGAZINE OF TELEPHONE SECRETS, available by subscription. If you really want to know the inside story on how the Telephone Company works, if you want to know more about the phone company, this is one way to find out.—**Teletronics Company of America,** 22035 Burbank Boulevard, Woodland Hills, CA 91364. **R-E**

Circle 50 on reader service card

BRACELET WARNS OF HEART STRAIN



USEFUL AS WELL AS ORNAMENTAL, this beautiful silver-and-gold bracelet was designed to aid persons with a heart condition. It houses a small sensor to monitor the wearer's heart rate. A small lamp flashes with each heart-beat. If the heart is stressed or becomes irregular because of a heart ailment an alarm sounds from within the bracelet.

books

BASIC COLOR TELEVISION COURSE, by Stan Prentiss. TAB Books, Blue Ridge Summit, PA 17214. 420 pp. 8½ x 5¼ in. Hardcover $9.95; Softcover $6.95.

This new comprehensive up-to-date textbook gives the beginning technician or s.udent a thorough background in television receiver basics.

A discussion of color acquaints the reader with the characteristics of this phenomenon, how colors are mixed and reproduced on a picture- tube screen. Once acquainted with these basics, the reader is shown how to analyze the performance of a receiver and to make the necessary adjustments to achieve optimum results. Next, the author explains how the circuits of each section of a TV set functions with emphasis on solid-state circuits. All circuits are thoroughly discussed, including those used only for monochrome reproduction.

Included are many troubleshooting tips and procedures as well as alignment techniques for each section of the receiver requiring circuit adjustments.

MANUAL OF LINEAR INTEGRATED CIRCUITS, by Sol D. Prensky. Reston Publishing Co., Inc., Box 547, Reston, VA 22090. 289 pp. 9 x 6 in. Hardcover $16.95.

This volume explains and illustrates the field of linear integrated circuits including op-amps and all other forms of linear IC's. It offers a thorough discussion of the underlying principles strengthened by a host of application schematics. In addition, there is a comprehensive selection guide and cross-references for IC type numbers. There is also a complete section on bread-boarding and testing techniques. As a practical presentation of basic principles, there are more than 100 application schematics and the cross-reference index describes well over 300 manufacturers type numbers with identifying codes for second source types.

ALL-IN-ONE TV ALIGNMENT HANDBOOK, by Jay Shane. TAB Books, Blue Ridge Summit, PA 17214. 304 pp. 8½ x 5¼ in. Hardcover $8.95; Softcover $5.95.

This comprehensive guide describes the procedures for aligning all major brands of TV receivers. Whether a beginner or an old-timer, the user of this new detailed guide will find that it will more than pay for itself. The whole alignment process is simplified by providing step-by-step procedures for aligning the tuner, rf, i.f. and sound stages for many of the most popular sets.

If anyone needs to know anything about TV circuit alignment, he'll find it in this comprehensive, well illustrated book.

HANDBOOK OF ELECTRONIC TABLES & FORMULAS, Fourth Edition, by Donald Herrington & Stanley Meacham. Howard W. Sams & Co., 4300 West 62nd Street, Indianapolis, IN 46268. 254 pp. 8½ x 5¼ in. Hardcover $6.95 (in Canada $8.35).

This revised and updated edition covers the basic formulas and laws so important in all branches of electronics. In addition to the basic formulas, the book contains constants, standards, symbols, codes, design data, mathematical tables as well as service and installation data.

The book includes a 4-color foldout chart of the latest FCC allocations for the entire frequency spectrum.

SOLID-STATE IGNITION SYSTEMS, by R. F. Graf and G. J. Whalen. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, IN 46268. 136 pp. 8¼ x 5¼ in. Softcover $4.50 (in Canada $5.40).

Solid-state ignition is a fact of life in the modern car. There are many types of systems reflecting the various schools of thought about what constitutes the ideal solid-state ignition system. In this book, you will find all the known commercially available methods of solid-state ignition. The authors have conducted careful examinations of original equipment designs as well as add-on systems and all are presented here in great detail. The first chapter describes the phenomenon of spark ignition in easy-to-understand terms. Chapter two then relates how the conventional ignition system produces a spark. Chapter three covers semiconductors and how they are used in ignition systems. Chapters four and five give complete details on existing systems. The last chapter provides data for servicing and troubleshooting modern electronic ignition systems. R-E

next month

OCTOBER 1975

■ **Build A 4-Channel Synthesizer**

Its heart is a single IC and it costs less than $20. The unit effectively turns 2-channel stereo into 4-channel surround sound.

■ **Hi-Fi Accessories You Could Use**

A roundup of lesser known hi-fi accessories that can help you get more out of your system.

■ **Vertical FET In Power Amplifiers**

A new design in solid-state devices that makes high-power low-noise amplifiers with specs that are hard to match. See how it works in a modern amplifier.

■ **R-E's Lab Test Hi-Fi Reports**

This month we look at the Pioneer front-loading cassette deck and the Soundcraftsmen audio equalizer.

■ **State-Of-Solid-State**

Get the lowdown on new solid-state devices—how they work and how they are used.

■ **Step-By-Step Troubleshooting Charts**

Servicing a color TV is often a challenge, but here's a methodical troubleshooting system that makes it easier.

Circle 88 on reader service card

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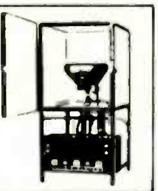

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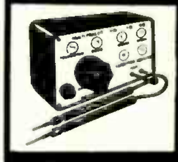

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1404AT	Single 1024 Bit Dyn MOS S/R	3.50
1702A	2048 Bit Erasable Elect. Reprogrammable Static MOS RAM	23.95
2102P	1024 Bit Static RAM MOS	3.95
8008R	8 Bit Central Processing Unit	44.00
8080	8 Bit Parallel CPU	195.00
TMS4030NL	4K RAM 4096 Bit	19.95

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2N3415	$.17
2N3563	.15
2N3564	.15
2N3565	.15
2N3566	.15
2N3567	.15
2N3568	.15
2N3569	.15
2N3640	.15
2N3641	.15
2N3643	.15
2N3702	.17
2N3703	.17
2N3704	.17
2N3705	.17
2N3706	.17
2N3707	.17
2N3708	.17
2N3709	.17
2N3710	.17
2N3711	.17
2N3819	.29
2N3820	.35
2N3903	.15
2N3904	.15
2N3905	.15
2N3906	.15
2N4058	.17
2N4059	.17
2N4060	.17
2N4061	.17
2N4062	.17
2N4123	.15
2N4124	.15
2N4125	.15
2N4126	.15
2N4250	.15
2N4275	.15
2N4401	.15
2N4403	.15
2N5400	.22
2N5447	.16
2N5449	.16
2N5525	.39
TIS43	.39

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C-MOS

	1-9	10 up
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4001AE	.26	.25
4002AE	.26	.25
4004AE	5.83	5.82
4006AE	1.35	1.34
4007AE	.26	.25
4008AE	1.79	1.78
4009AE	.60	.59
4010AE	.59	.58
4011AE	.26	.25
4012AE	.26	.25
4013AE	.47	.46
4014AE	1.49	1.48
4015AE	1.26	1.25
4016AE	.56	.55
4017AE	1.20	1.19
4018AE	1.49	1.48
4019AE	.52	.51
4020AE	1.49	1.48
4021AE	1.34	1.33
4022AE	1.11	1.10
4023AE	.26	.25
4024AE	.90	.89
4025AE	.26	.25
4026AE	3.72	3.70
4027AE	.60	.59
4028AE	.98	.97
4029AE	1.27	1.26
4030AE	.44	.43
4033AE	3.01	3.00
4035AE	1.27	1.26
4040AE	1.49	1.48
4041AE	4.06	4.05
4042AE	.75	.74
4043AE	.60	.59
4044AE	.60	.59
4047AE	3.54	3.53
4048AE	1.43	1.42
4049AE	.52	.51
4050AE	.52	.51
4051AE	1.34	1.33
4052AE	1.34	1.33
4053AE	1.34	1.33
4055AE	2.68	2.58
4056AE	3.43	3.39
4060AE	1.50	1.49
4066AE	.90	.89
4069AE	.78	.68
4071AE	.26	.25
4076AE	1.68	1.48
4081AE	.26	.25
4508AE	2.30	2.20
4510AE	1.98	1.78
4516AE	2.30	2.20
4518AE	3.28	2.98
4520AE	1.88	1.68
4528AE	2.30	2.20
4901AE	.43	.36
4911AE	.43	.36

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SLA21	Yellow	3.50
SLA7	Red	1.60
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DL81	Red	6.00
DL10	Red	6.00
DL10A	Red	4.00
DL101	Red	4.90
DL57	Red	9.90
DL61	Red	12.00
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DL402	Red	4.00
DL701	Red	3.40
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DL707	Red	2.38
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XCITON		
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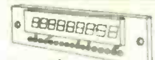

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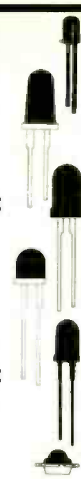

LEDs

.125" dia.		
209	Red	$.25
209	Yellow	.35
209	Green	.35
.160" dia.		
216	Red	.25
216	Yellow	.30
216	Green	.30
.200" dia.		
220	Red	.25
220	Yellow	.30
220	Green	.30
LOW PROFILE		
226	Red	$.25
226	Yellow	.30
226	Green	.30
226	Orange	.30
5053	Red	.35
5053	Yellow	.40
5053	Green	.40
5053	Orange	.40

216 = MV5024
5053 = MV5053

MV50 Red $.30

7400N TTL

7400N	$.13	7444N	$1.05	7496N	$.85	74161N	1.28
7401N	.17	7445N	.93	74100N	1.30	74162N	1.50
7402N	.14	7446N	1.10	74104N	1.25	74163N	1.48
7403N	.17	7447N	.88	74105N	.45	74164N	1.22
7404N	.20	7448N	1.00	74107N	.40	74165N	1.78
7405N	.20	7450N	.15	74109N	.75	74166N	1.50
7406N	.30	7451N	.20	74110N	.72	74170N	2.60
7407N	.30	7453N	.20	74111N	.92	74173N	1.55
7408N	.18	7454N	.26	74114N	.92	74174N	1.20
7409N	.22	7455N	.37	74115N	.92	74175N	1.60
7410N	.18	7460N	.25	74118N	1.51	74176N	1.30
7411N	.27	7462N	.37	74121N	.37	74177N	1.50
7412N	.52	7464N	.37	74122N	.37	74180N	.73
7413N	.65	7465N	.37	74123N	.90	74181N	3.20
7414N	1.80	7470N	.30	74125N	.48	74182N	.75
7415N	.37	7471N	.49	74126N	.64	74184N	2.90
7416N	.22	7472N	.32	74128N	.94	74185N	2.29
7417N	.34	7473N	.38	74132N	1.74	74188N	4.90
7420N	.17	7474N	.33	74136N	.92	74190N	1.49
7421N	.60	7475N	.60	74140N	2.50	74191N	1.20
7422N	.27	7476N	.33	74141N	1.19	74192N	1.40
7423N	.48	7478N	.55	74145N	1.08	74193N	1.00
7425N	.34	7480N	.60	74147N	2.35	74194N	1.35
7426N	.25	7481N	1.19	74148N	2.20	74195N	.80
7427N	.31	7482N	.90	74150N	.99	74196N	1.90
7428N	.52	7483N	.65	74151N	.75	74197N	.80
7430N	.20	7484N	3.02	74152N	1.50	74198N	2.00
7432N	.25	7485N	2.50	74153N	1.05	74199N	2.09
7433N	.62	7486N	.36	74154N	1.48	74200N	5.90
7437N	.36	7489N	2.40	74155N	1.08	74221N	1.75
7438N	.35	7490N	.54	74156N	1.18	74251N	1.75
7439N	.39	7491N	1.00	74157N	1.18	74278N	2.95
7440N	.16	7492N	.60	74158N	1.44	74279N	.99
7441N	.95	7493N	.60	74160N	1.50	74293N	.95
7442N	.69	7494N	1.20			74298N	2.24
7443N	.95	7495N	.80				

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15	70	
18	50	
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2602-1B	8.00
2602-2B	8.00
MK4102P	11.40
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IL16	1.80
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ILD74	1.75
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74LS

74LS00	$.50	74LS76	.92
74LS01	.58	74LS78	.92
74LS02	.58	74LS107	.92
74LS03	.58	74LS109	.92
74LS04	.60	74LS112	.92
74LS05	.63	74LS113	.92
74LS08	.58	74LS114	.92
74LS09	.58	74LS138	2.38
74LS10	.58	74LS139	2.38
74LS11	.58	74LS151	2.10
74LS15	.58	74LS153	2.38
74LS20	.58	74LS157	2.10
74LS21	.58	74LS158	2.40
74LS22	.58	74LS160	2.70
74LS27	.64	74LS161	2.70
74LS30	.58	74LS170	5.92
74LS32	.64	74LS174	3.02
74LS38	.65	74LS175	2.90
74LS51	.58	74LS181	3.72
74LS54	.58	74LS251	2.55
74LS55	.58	74LS253	3.05
74LS73	.92	74LS260	.58
74LS74	.92		

9300 SERIES

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9318PC	2.30
9321PC	1.20
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9340PC	5.00
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1N4003	1.20	9.00	80.00
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1N4005	1.40	11.00	100.00
1N4006	1.50	12.00	110.00
1N4007	1.60	13.00	120.00

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CY2237	DAC, 12 Bit, Low Drift	69.00
CY2735	DAC, 4 Digit BCD, Low Cost	79.00
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74S00N	.45	74S74N	1.30	74S158N	2.40
74S02N	.80	74S85N	6.10	74S160N	4.70
74S03N	.75	74S86N	2.70	74S161N	4.70
74S04N	.75	74S112N	2.20	74S174N	3.30
74S08N	.80	74S113N	1.50	74S175N	3.30
74S10N	.75	74S132N	3.60	74S181N	10.20
74S11N	.65	74S133N	.90	74S189N	5.10
74S20N	.80	74S138N	2.40	74S194N	3.30
74S30N	.80	74S139N	2.40	74S195N	3.30
74S32N	.80	74S140N	.90	74S251N	2.40
74S40N	.80	74S151N	2.40	74S253N	2.40
74S51N	.80	74S153N	2.40	74S257N	2.40
74S64N	.80	74S157N	2.40	74S258N	2.40
				74S260N	.90
				74S280N	5.70

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Type	V	W	Ω	Price
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LM354A	6-27	2.80	8	2.50
TAA611B12	6-15	1.15	8	1.60
TAA621A12	6-27	1.40	8	2.00
TBA641B11	6-18	2.20	4	3.00
TBA800	5-30	4.70	8	2.20
TBA810AS	4-20	2.50	4	3.00
TBA820	3-16	0.75	4	1.70
TCA830	5-20	2.00	4	2.20
TCA940	6-24	6.50	8	4.40

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14 pin DIL	.25	.22	.20
16 pin DIL	.28	.25	.23
24 pin DIL	.67	.61	.55
28 pin DIL	.88	.80	.72
36 pin DIL	1.09	.98	.89
40 pin DIL	1.24	1.12	.92
WIRE WRAP-GOLD			
14 pin DIL	.45	.41	.37
16 pin DIL	.54	.49	.44
SOLDER - GOLD			
14 pin DIL	.34	.31	.28
16 pin DIL	.37	.34	.31
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4 pin TO-5	.65		
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75453N	1.00

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7522N	4.25
7523N	1.75
7524N	2.00
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LM300H	1.20	LM311D	1.90	LM715CH	4.30
LM300N	1.20	LM311M	1.75	LM715CD	4.60
LM301AH	.90	LM311N	2.00	LM723CH	.90
LM301AM	.80	LM312H	2.70	LM723CN	.75
LM301AN	1.10	LM318H	2.60	LM725CH	5.00
LM301M	.90	LM324N	1.90	LM725CD	5.20
LM301H	.90	LM331N	2.20	LM733CH	1.40
LM302D	3.50	LM339N	3.20	LM733CD	3.50
LM302N	1.30	LM320-5K	2.90	LM733CN	1.30
LM302H	1.50	LM320-5T	2.50	LM741CH	.45
LM304H	1.50	LM320-12K	2.90	LM741CD	1.25
LM305H	1.05	LM320-12T	2.50	LM741CM	.44
LM305AH	1.05	LM340-05K	2.60	LM741CN	.70
LM305N	1.00	LM340-06K	2.60	LM747CH	1.70
LM306H	.95	LM340-08K	2.60	LM747CN	.90
LM307H	.75	LM340-12K	2.60	LM747CD	2.50
LM307M	.95	LM340-15K	2.60	LM748CM	.55
LM307N	1.50	LM340-18K	2.60	LM748CN	.55
LM308H	1.20	LM340-24K	2.60	LM777CH	2.15
LM308AH	5.00	LM555CM	.90	LM777CM	2.10
LM308D	2.00	LM556CN	1.30	LM3046CN	.95
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LM309H	1.75	LM709CN	.45	SG4501T	2.20
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LM310H	1.60	LM710CN	.90	LM5000K	7.50
LM310M	1.80	LM711CH	.90		

LOW POWER TTL

74L00N	.34
74L02N	.34
74L03N	.39
74L04N	.39
74L10N	.34
74L20N	.39
74L42N	1.62
74L51N	.34
74L73N	.74
74L74N	.89
74L90N	1.62
74L93N	1.74
74L95N	1.62
93L00	1.50
93L01	1.60
93L08	3.20
93L09	1.80
93L10	2.80
93L11	4.20
93L12	1.80
93L14	1.70
93L16	3.20
93L18	3.50
93L21	1.50
93L22	1.80
93L24	2.80
93L28	3.70
93L34	4.00
93L38	4.20
93L40	6.50
93L41	6.50
93L60	3.00
93L66	2.70

HIGH SPEED TTL

74H00N	.34	74H53N	.36
74H01N	.25	74H54N	.36
74H02N	.30	74H55N	.36
74H04N	.38	74H60N	.36
74H05N	.37	74H61N	.36
74H08N	.40	74H62N	.36
74H10N	.36	74H71N	.80
74H11N	.36	74H72N	.74
74H20N	.36	74H73N	.90
74H21N	.36	74H74N	.87
74H22N	.36	74H76N	.90
74H30N	.36	74H101N	.80
74H40N	.36	74H102N	.80
74H50N	.36	74H103N	1.10
74H51N	.36	74H106N	.95
74H52N	.36		

2524V

Recirculating 512 Bit Dynamic Shift Register

1—24: $3.40 25 up: $3.30

FM STEREO DEMODULATOR

XR1310 $3.20

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C3101A	7.30
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IM5501CDE	7.30
IM5501CPE	5.80
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MM5560N	5.80
DM8599N	5.80
93403PC	5.80

MOS-LSI

P1101A	6.90	C2102-1	8.00	4035	4.95
P1101A1	8.50	P2102-1	5.40	4102	4.95
1402AN	5.40	C2102-2	8.00	7552	4.95
1403AH	8.00	P2102-2	5.50	7552-1	5.40
1403AN	5.40	2505K	3.30	7552-2	5.50
1404AH	8.00	2512K	5.50	8102	4.90
1404AN	5.40	2521V	4.00	8102-2	5.10
1405A	4.10	2524V	3.40	9102PC	5.50
1506	4.00	2525V	5.30	MM5025N	20.00
1507	4.00	2533V	8.50	MM5026N	20.00
1602	33.00	2602	4.95	MM5027N	20.00
1702	33.00	2602-1	5.40	MM5055N	5.50
C2102	8.00	2602-2	5.50	MM5056N	5.50
P2102	5.00	3341PC	8.20	MM5057N	5.50
		4034	5.50	MM5058N	5.50

MM

MM404H	12.00
MM405H	23.00
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MM407H	6.50
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MM454F	18.00
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MM506H	3.20
MM507H	3.20
MM550H	5.90
MM551H	5.60
MM555H	5.60

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SI-1010G	10W	$6.40
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SI-1030G	30W	18.70
SI-1050G	50W	24.90
SI-1050G	50W	24.90

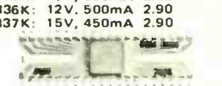
IC POWER REGULATORS

LM335K:	5V, 600mA	2.40
LM336K:	12V, 500mA	2.90
LM337K:	15V, 450mA	2.90

POWER TRANSISTORS

BU204	3A	1300V	$4.14
BU205	3A	1500V	4.95
BU206	3A	1700V	5.94
BU207	6A	1300V	5.85
BU208	6A	1500V	6.93
BU209	6A	1700V	8.64

COM2601 USRT



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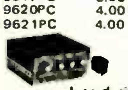

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SBA550	Signal processor	10.14	10.14	7.92
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SL437D	IF & AGC for NPN tuners	13.52	13.52	10.56
SL442	Switch mode power supply control	9.24	7.92	6.60
SL450	Power sup. & Syn. sep.	11.09	9.50	7.92
SL456A	TV IF system	7.39	6.34	5.28
SL456B	TV IF system	7.39	6.34	5.28
SL457A	TV IF system	7.39	6.34	5.28
SL457B	TV IF system	7.39	6.34	5.28
SL901	Color demodulator	10.14	10.14	7.92
SL917	Color decoder	13.52	13.52	10.56

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SP521	Binary rate multip.	13.94	12.49	11.04
SP522	Phase loc. div. & com.	13.94	12.49	11.04
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SP1005B	Dual 4 I/P OR/NOR gate	1.71	1.48	1.25
SP1006B	Dual 4 I/P OR/NOR gate	1.71	1.48	1.25
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SP1008B	Triple 3 I/P NOR gate	1.71	1.48	1.25
SP1009B	Triple 3 I/P NOR gate	1.71	1.48	1.25
SP1010B	Quad 2 I/P NOR gate	1.71	1.48	1.25
SP1011B	Quad 2 I/P NOR gate	1.71	1.48	1.25
SP1012B	Quad 2 I/P NOR gate	1.71	1.48	1.25
SP1023B	Dual 4 I/P clock driv.	2.80	2.40	2.00
SP10398	PECL to sat. logic trans.	6.07	5.20	4.33
SP1204B	Dual 4 I/P OR/NOR gate	2.17	1.86	1.55
SP1205B	Dual 4 I/P OR/NOR gate	2.17	1.86	1.55
SP1206B	Dual 4 I/P OR/NOR gate	2.17	1.86	1.55
SP1207B	Triple 3 I/P NOR gate	2.17	1.86	1.55
SP1208B	Triple 3 I/P NOR gate	2.17	1.86	1.55
SP1209B	Triple 3 I/P NOR gate	2.17	1.86	1.55
SP1221B	Quad 2 I/P NOR gate	2.17	1.86	1.55
SP1223B	Quad 4 I/P clock driv.	3.50	3.00	2.50
SP1239B	PECL to sat logic trans.	7.60	6.51	5.42
PECL III — SP1600 SERIES				
SP1660B	Dual 4 I/P OR gate Hi-Z	15.00	12.00	10.00
SP1662B	Quad 2 I/P NOR gate Hi-Z	16.50	13.20	11.00
SP1664B	Quad 2 I/P OR gate Hi-Z	16.50	13.20	11.00
SP1670B	Single D F/F Hi-Z	27.00	21.60	18.00
SP8000 SERIES HIGH SPEED DIVIDERS				
SP8600A	÷ 4 at 250MHz	25.20	21.60	18.00
SP8600B	÷ 4 at 250MHz	11.06	9.48	7.90
SP8601A	÷ 4 at 150MHz	15.96	13.68	11.40
SP8601B	÷ 4 at 150MHz	10.08	8.64	7.20
SP8602A	÷ 2 at 500MHz	95.00	81.43	67.86
SP8602B	÷ 2 at 500MHz	26.82	22.99	19.16
SP8603A	÷ 2 at 400MHz	71.68	61.44	51.20
SP8603B	÷ 2 at 400MHz	20.29	13.39	14.49
SP8604A	÷ 2 at 300MHz	34.58	29.64	24.70
SP8604B	÷ 2 at 300MHz	15.40	13.20	11.00
SP8607B	÷ 2 at 600MHz	40.99	35.14	29.28
SP8613B	÷ 4 at 700MHz	49.00	42.00	35.00
SP8614B	÷ 4 at 800MHz	56.00	48.00	40.00
SP8615B	÷ 4 at 900MHz	67.20	57.60	48.00
SP8616B	÷ 4 at 1GHz	81.20	69.60	58.00
SP8616D	÷ 4 at 950MHz	74.20	63.60	53.00
SP8620B	÷ 5 at 400MHz	45.92	39.36	32.80
SP8621B	÷ 5 at 300MHz	31.78	27.24	22.70
SP8622B	÷ 5 at 200MHz	25.13	21.54	17.95
SP8630B	÷ 10 at 600MHz	69.82	59.84	49.87
SP8630D	÷ 10 at 550MHz	58.80	50.40	42.00
SP8631B	÷ 10 at 500MHz	53.20	45.60	38.00
SP8632B	÷ 10 at 400MHz	42.00	36.00	30.00
SP8634B	÷ 10 (BCD) at 700MHz	81.20	69.60	58.00
SP8635B	÷ 10 (BCD) at 600MHz	70.00	60.00	50.00
SP8636B	÷ 10 (BCD) at 500MHz	60.20	51.60	43.00
SP8637B	÷ 10 (BCD) at 400MHz	50.40	43.20	36.00
SP8640A	÷ 10/11 (ECL) at 200MHz	28.00	24.00	20.00
SP8640B	÷ 10/11 (ECL) at 200MHz	12.99	11.14	9.28
SP8641A	÷ 10/11 (ECL) at 250MHz	32.20	27.60	23.00
SP8641B	÷ 10/11 (ECL) at 250MHz	19.04	16.32	13.60
SP8642A	÷ 10/11 (ECL) at 300MHz	58.80	50.40	42.00
SP8642B	÷ 10/11 (ECL) at 300MHz	25.20	21.60	18.00
SP8643B	÷ 10/11 (ECL) at 350MHz	35.00	30.00	25.00
SP8650B	÷ 16 at 600MHz	70.00	60.00	50.00
SP8651B	÷ 16 at 500MHz	53.20	45.60	38.00
SP8652B	÷ 16 at 400MHz	42.00	36.00	30.00
SP8655A	÷ 32 at 100MHz	63.00	54.00	45.00
SP8655B	÷ 32 at 100MHz	21.00	18.00	15.00
SP8657A	÷ 20 at 100MHz	63.00	54.00	45.00
SP8657B	÷ 20 at 100MHz	21.00	18.00	15.00
SP8659A	÷ 16 at 100MHz	53.20	45.60	38.00
SP8659B	÷ 16 at 100MHz	18.90	16.20	13.50
SP8665B	÷ 10 at 1.0GHz	98.00	84.00	70.00
SP8666B	÷ 10 at 1.1GHz	107.80	92.40	77.00
SP8667B	÷ 10 at 1.2GHz	119.00	102.00	85.00
SP8670B	÷ 8 at 600MHz	63.00	54.00	45.00
SP8671B	÷ 8 at 500MHz	49.00	42.00	35.00
SP8672B	÷ 8 at 400MHz	37.80	32.40	27.00
SP8685A	÷ 10/11 at 500MHz	116.20	99.60	83.00
SP8685B	÷ 10/11 at 500MHz	35.00	30.00	25.00
SP8690A	÷ 10/11 at 100MHz	63.00	54.00	45.00
SP8690B	÷ 10/11 at 100MHz	19.60	16.80	14.00
MNOS NON-VOLATILE MEMORY ELEMENTS				
NOM201C	Single MNOS trans.	4.44	3.80	3.17
NOM202C	MNOS transistor pr.	7.39	6.34	5.28
NOM204C	Quad MNOS trans.	12.94	11.09	9.24
NOM401C	8x8 MNOS array	33.26	28.51	23.76
INTERFACE CIRCUITS				
SP701A	MOS analog switch drv.	14.15	12.38	10.61
SP701B	MOS analog switch drv.	10.56	9.24	7.92
SP702A	MOS logic driver	14.15	12.38	10.61
SP702B	MOS logic driver	10.56	9.24	7.92
SP703A	MOS logic & clock drv.	14.15	12.38	10.61
SP703A*	MOS logic & clock drv.	18.32	16.03	13.73
SP703B	MOS logic & clock drv.	10.56	9.24	7.92
SP703B*	MOS logic & clock drv.	14.78	12.94	11.09
SP704A	MOS logic & clock drv.	14.15	12.38	10.61
SP704A*	MOS logic & clock drv.	18.32	16.03	13.73
SP704B	MOS logic & clock drv.	10.56	9.24	7.92
SP704B*	MOS logic & clock drv.	14.78	12.94	11.09
SP721B	Balanced line driver	8.26	7.23	6.20
SP721B*	Balanced line driver	12.67	11.09	9.50
SP722B	TTL driver	8.26	7.23	6.20
SP722B*	TTL driver	12.67	11.09	9.50
SP723B	TTL driver	9.40	8.24	7.05
SP723B*	TTL driver	13.73	12.01	10.30
SP724B	Dual TTL driver	11.83	10.35	8.87
SP724B*	Dual TTL driver	16.47	14.41	12.36
SP740B	Current comparator	30.41	26.61	22.81
SP740B*	Current comparator	37.83	33.11	28.38
SP741B	Current comparator	30.41	26.61	22.81
SP741B*	Current comparator	37.83	33.11	28.38
SP751A	MOS analog switch drv.	18.32	16.03	13.73
SP751B	MOS analog switch drv.	14.78	12.94	11.09

* FLAT PACK

EXAR ICs

		1-9	10 up	100 up
XR-100K	XR-chip cust. IC des. kit	$80.00	$80.00	$80.00
XR-8101	NPN trans. array, sm. sig.	3.50	3.50	3.50
XR-8102	PNP array	3.50	3.50	3.50
XR-C101	NPN array, sm. sig.	3.50	3.50	3.50
XR-C102	PNP array, lat. & subs.	3.50	3.50	3.50
XR-C103	NPN array, pwr.&schottky	3.50	3.50	3.50
XR-C104	Diffused resistor array	3.50	3.50	3.50
XR-C105	Diffused & pinch resis. array	3.50	3.50	3.50
XR-C106	Bal. mod.& NPN,PNP cur. source	3.50	3.50	3.50
XR-S200	Multi-function IC	28.00	23.00	21.00
XR-205	Waveform gen. IC	8.40	7.35	6.30
XR-205K	Waveform gen. kit	25.00	25.00	25.00
XR-210	FSK mod. demod.	5.20	4.55	3.90
XR-210M	FSK mod. demod.	10.40	9.10	7.80
XR-215	Gen. purpose PLL	6.56	5.74	4.92
XR-320	Timing circuit	1.52	1.33	1.14
XR-555CP	Timing circuit	1.07	.94	.80
XR-556M	Dual timing circuit	10.56	9.24	7.92
XR-556CN	Dual timing circuit	2.88	2.52	2.16
XR-556CP	Dual timing circuit	1.82	1.60	1.37
XR-567M	Tone decoder	12.96	11.34	9.72
XR-567CN	Tone decoder	1.84	1.61	1.38
XR-567CP	Tone decoder	1.68	1.47	1.26
XR-1310P	Stereo demod.	3.20	2.80	2.40
XR-1310EP	Stereo demod.	3.20	2.80	2.40
XR-1468CN	±5V tracking VR	3.84	3.36	2.88
XR-1468CP	±5V tracking VR	2.54	2.23	1.91
XR-1488N	Quad line driver	5.76	5.04	4.32
XR-1488P	Quad line driver	5.20	4.55	3.90
XR-1489AN	Quad line rec.	4.80	4.20	3.60
XR-1489AP	Quad line rec.	4.32	3.78	3.24
XR-1568M	±15V track. VR	14.32	12.53	10.74
XR-1568N	±15V track. VR	7.20	6.30	5.40
XR-1800P	Stereo decoder	3.20	2.80	2.40
XR-2206N	Monolithic funct. gen.	$11.20	9.80	8.40
XR-2206P	Monolithic funct. gen.	10.24	8.96	7.68
XR-2206CN	Monolithic funct. gen.	6.16	5.39	4.62
XR-2206CP	Monolithic funct. gen.	5.12	4.48	3.84
XR-2207M	VCO	15.44	13.51	11.58
XR-2207N	VCO	7.76	6.79	5.82
XR-2207P	VCO	6.72	5.88	5.04
XR-2207CN	VCO	4.80	4.20	3.60
XR-2207CP	VCO	3.84	3.36	2.88
XR-2208M	Op. multiplier	17.76	15.54	13.32
XR-2208N	Op. multiplier	8.88	7.77	6.66
XR-2208P	Op. multiplier	7.92	6.93	5.94
XR-2208CN	Op. multiplier	5.60	4.90	4.20
XR-2208CP	Op. multiplier	5.20	4.55	3.90
XR-2211CN	FSK demod./tone decoder	7.57	6.62	5.68
XR-2211CP	FSK demod./tone decoder	6.88	6.02	5.16
XR-2240M	Prog. timer/ctr.	19.52	17.08	14.64
XR-2240N	Prog. timer/ctr.	8.80	7.70	6.60
XR-2240P	Prog. timer/ctr.	7.20	6.30	5.40
XR-2240CN	Prog. timer/ctr.	6.24	5.46	4.68
XR-2240CP	Prog. timer/ctr.	4.80	4.20	3.60
XR-2556M	Dual 555 timer	10.56	9.24	7.92
XR-2556CN	Dual 555 timer	3.52	3.08	2.64
XR-2556CP	Dual 555 timer	3.20	2.80	2.40
XR-2567M	Dual 567 tone decoder	16.94	14.83	12.71
XR-2567CN	Dual 567 tone decoder	7.90	6.92	5.93
XR-2567CP	Dual 567 tone decoder	5.18	4.54	3.89

The Function Generator Kit features sine, triangle and square wave. THD 0.5% typ., AM/FM capability.
XR-2206KA FUNCTION GENERATOR KIT $18.95
Includes monolithic function generator IC, PC board, and assembly instruction manual.
XR-2206KB FUNCTION GENERATOR KIT $28.95
Same as XR-2206KA above and includes external components for PC board.

STANDARD MICROSYSTEMS

		1-9	10 up	100 up
COM2502	Universal asynchronous receiver transmitter	$13.20	$10.60	$ 8.80
COM2502P		8.00	6.85	5.95
COM2017		13.20	10.60	8.80
COM2017P		8.00	6.85	5.95
COM2502H		25.00	20.00	16.00
COM2017H		25.00	20.00	16.00
COM2601	Univ. sync. rec./trans.	30.00	24.00	20.50
COM5016	Dual baud rate gen. prog. div.	12.00	9.60	8.00
	Keyboard encoder ROM			
KR2376-ST	Keyboard encoder ROM	20.00	17.50	15.00
KR3600-ST	10-channel multiplexer	20.00	17.50	15.00
NMX5010	10-channel multiplexer	12.00	9.60	8.00
CAL1022	12-digit print. cal. sgl. chip MOS/LSI circuit	60.00	52.00	45.00

ELECTRONIC ARRAYS

1024 BIT READ/WRITE RANDOM ACCESS MEMORY
N-CHANNEL, SILICON GATE

	1-24	25 up	100 up
EA 1500AJ	$21.00	$16.80	$14.00
EA 1500ASJ	16.00	14.40	12.00

PREMIUM QUALITY TRANSISTORS

2N173	2.15	2N877	2.50	2N1921	3.00	2N2600	7.10
2N178	1.00	2N894	2.00	2N1924	1.30	2N2604	1.80
2N293	.60	2N918	.20	2N1934	9.40	2N2605	.50
2N2938	.65	2N956	.40	2N1990	.80	2N2646	.70
2N321	.50	2N960	.50	2N2060	2.10	2N2648	4.00
2N327A	1.40	2N962	.50	2N2065A	1.80	2N2658	7.00
2N334	1.40	2N967	.50	2N2080	5.00	2N2708	.25
2N336	1.00	2N981	2.00	2N2081A	2.50	2N2712	.30
2N338A	1.25	2N984	1.00	2N2100	3.00	2N2713	.15
2N389	9.00	2N10158	16.00	2N2102	.50	2N2715	.18
2N393	2.70	2N1016B	18.00	2N2148	.70	2N2716	.18
2N3988	1.00	2N1026	1.50	2N2192A	.66	2N2754	95.00
2N404	.20	2N1035	2.00	2N2193	.45	2N2802	9.80
2N417	.50	2N1136	1.50	2N2193A	.90	2N2808	9.00
2N420	1.20	2N1137A	2.00	2N2218	.26	2N2833	4.00
2N424	9.00	2N1142	2.20	2N2218A	.30	2N2880	11.00
2N439	1.00	2N1143	2.00	2N2219	.30	2N2890	4.60
2N443	1.15	2N1168	.75	2N2219A	.38	2N2892	6.70
2N456	1.30	2N1174	1.50	2N2221	.25	2N2893	9.80
2N497	1.40	2N1234	15.00	2N2221A	.26	2N2894	.50
2N501A	4.00	2N1302	.30	2N2222	.24	2N2895	1.00
2N508A	.40	2N1305	.35	2N2222A	.26	2N2903	4.00
2N5128	2.90	2N1377	1.50	2N2259	1.10	2N2904	.30
2N555	.50	2N1404	.50	2N2270	.40	2N2904A	.36
2N586	1.00	2N1408	.60	2N2289	3.70	2N2905	.32
2N594	1.50	2N1420	.50	2N2290	6.00	2N2905A	.34
2N630	3.50	2N1483	1.20	2N2297	1.00	2N2906	.18
2N652A	1.00	2N1485	1.60	2N2322	1.80	2N2906A	.20
2N677C	5.50	2N1523	5.00	2N2323	1.90	2N2907	.20
2N681	2.00	2N1534	1.00	2N2324	2.40	2N2907A	.30
2N682	2.50	2N1540	1.10	2N2325	2.60	2N2913	.90
2N683	2.70	2N1543	3.50	2N2326	3.40	2N2914	1.40
2N685	3.40	2N1544	.90	2N2327	4.60	2N2916A	4.05
2N686	4.00	2N1549	1.35	2N2328	5.00	2N2925	.20
2N689	7.00	2N1551	4.00	2N2329	7.00	2N2926	.15
2N697	.25	2N1582	4.00	2N2356	6.00	2N2947	14.50
2N700	4.00	2N1554	2.00	2N2356A	7.00	2N2949	6.00
2N705	.60	2N1557	1.70	2N2369	16.00	2N2950	6.50
2N706	.20	2N1560	3.30	2N2368	.30	2N2969	31.00
2N706B	.40	2N1595	1.50	2N2369	.20		
2N711	.40	2N1596	1.60	2N2382	4.50		
2N711B	.60	2N1597	2.20	2N2440	3.50		
2N718A	.30	2N1598	2.00	2N2453	3.00		
2N720A	.50	2N1599	2.30	2N2465	7.50		
2N741	1.50	2N1605	.45	2N2475	.60		
2N744	.35	2N1613	.50	2N2476	.80		
2N759	1.00	2N1671	2.00	2N2484	.25		
2N759A	1.00	2N1693	15.00	2N2511	1.50		
2N760	.50	2N1711	.50	2N2518	6.00		
2N760A	.70	2N1715	.70	2N2526	4.50		
2N829	3.00	2N1720	5.00	2N2527	5.50		
2N834	.35	2N1899	69.00	2N2537	1.30		
2N859	6.00	2N1907	5.00	2N2538	2.50		

2N3019	1.50	2N3502	1.40	2N3693	.21	2N3906	.22
2N3022	18.00	2N3503	1.60	2N3694	.22	2N3909	.80
2N3053	.35	2N3506	7.50	2N3702	.18	2N3924	3.50
2N3054	.80	2N3544	4.00	2N3705	.25	2N3925	4.80
2N3055	.95	2N3548	2.80	2N3707	.17	2N3945	.90
2N3060	3.00	2N3549	3.00	2N3710	.20	2N3954	5.00
2N3066A	1.20	2N3553	1.80	2N3711	.18	2N3954A	5.50
2N3070	1.30	2N3563	.15	2N3725	.36	2N3955	2.70
2N3107	.80	2N3564	.14	2N3730	1.50	2N3955A	3.20
2N3109	.75	2N3565	.18	2N3731	2.00	2N3957	1.60
2N3117	1.00	2N3567	.19	2N3740	1.20	2N3958	1.40
2N3130	5.00	2N3568	.30	2N3763	5.00	2N3964	1.10
2N3133	.80	2N3569	.17	2N3771	2.20	2N3971	1.00
2N3202	16.00	2N3584	1.80	2N3772	2.30	2N3972	1.40
2N3209	.90	2N3599	38.00	2N3773	2.40	2N4012	10.50
2N3227	2.40	2N3614	1.10	2N3789	3.00	2N4037	.70
2N3239	3.00	2N3616	1.25	2N3793	.25	2N4045	1.95
2N3247	3.90	2N3617	2.60	2N3796	3.00	2N4093	1.05
2N3250	.50	2N3634	8.00	2N3799	3.20	2N4120	3.90
2N3371	4.00	2N3638	.18	2N3805	10.50	2N4124	.20
2N3375	5.50	2N3642	.19	2N3807	4.80	2N4126	.26
2N3390	.50	2N3643	.14	2N3819	.30	2N4141	.26
2N3393	.20	2N3645	.15	2N3823	.70	2N4142	.17
2N3398	.25	2N3646	.10	2N3843	.70	2N4143	.16
2N3442	2.20	2N3656	8.60	2N3856	.25	2N4208	2.05
2N3445	5.00	2N3657	9.00	2N3865	7.00	2N4220A	1.00
2N3467	1.50	2N3680	6.00	2N3866	1.10	2N4225	3.80
2N3468	1.90	2N3684	1.25	2N3903	.20	2N4226	3.95
2N3500	4.00	2N3685A	1.50	2N3904	.22	2N4227	.35
2N3501	6.50	2N3692	.20	2N3905	.20	2N4228	.50
						2N4234	1.50
						2N4235	1.90
						2N4248	.17
						2N4249	.18
						2N4250	.22
						2N4258	.34
						2N4291	.35
						2N4293	.50

2N4303	.30	2N4890	.90	2N5407	29.00
2N4341	1.35	2N4898	1.10	2N5409	32.00
2N4347	1.50	2N4905	2.00	2N5414	6.50
2N4348	2.00	2N4922	1.00	2N5449	.25
2N4352	2.00	2N5016	12.80	2N5453	5.40
2N4356	.30	2N5036	1.18	2N5457	.40
2N4395	1.30	2N5061	.32	2N5458	.40
2N4399	6.40	2N5064	.48	2N5467	32.00
2N4400	.30	2N5086	.30	2N5562	12.50
2N4401	.32	2N5088	.40	2N5563	9.00
2N4402	.34	2N5089	.46	2N5636	13.50
2N4403	.40	2N5105	3.10	2N5637	27.00
2N4416	.90	2N5127	.16	2N5655	.85
2N4429	6.00	2N5130	.20	2N5657	1.20
2N4430	8.60	2N5133	.16	2N5679	1.40
2N4441	.95	2N5138	.16	2N5742	41.00
2N4442	1.10	2N5154	7.10	2N5778	.55
2N4443	1.40	2N5157	9.90	2N5923	12.80
2N4852	.80	2N5198	4.30	2N6027	.50
2N4858	1.10	2N5202	2.20	2N6028	.65
2N4859	1.20	2N5294	.70	2N6076	.20
2N4863	5.50	2N5306	.27	2N6099	.95
2N4870	.60	2N5354	.30	2N6101	.85
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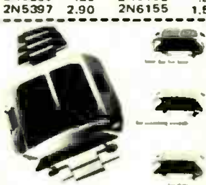
NEW Solar Powered Watch with 100-YEAR CALENDAR



Solar cells draw power from the sun (10 to 15 minutes per day) or from ambient light (slightly longer) to keep batteries fully charged. Batteries operate up to 10 years. LSI circuitry is programmed to provide a calendar to the year 2100, automatically adjusting for 30 and 31 day months, even leap years. Automatic brightness control adjusts LED for perfect viewing even in outdoors. Shows minutes and hours, counts out seconds or shows the date. Easily adjusts to reset hour or date without affecting calendar. Shock and water resistant. Accurate to 5 seconds per month. Price: $500.00 each.

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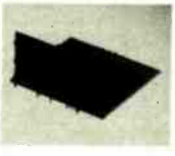

This is a 3½ digit, 0-2 volt Digital Voltmeter, with a .5% full scale accuracy. It is based around the Siliconix LD110, LD111 DVM chip set. The voltmeter uses MAN7 readouts (.3" high) to provide a highly readable display. The unit requires the following supply voltages: 12, −12, 5. The unit comes complete with all components to build the unit pictured at the left, that is a complete DVM less power supply.

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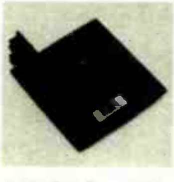
The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families: TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (HI)—1 (LOW)—o (PULSE)—P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

$9.95 Per Kit

DIGITAL COUNTER



This is a 4 digit counter unit which will count up to 9999 and then provide an overflow pulse. It is based around the Mostek MK5007 digital counter chip. The unit performs the following functions: Count Input, RESET, Latch, Overflow. The counter operates up to 250 kHz. The counter is an ideal unit to be used as a frequency counter, where the only extra components needed would be a timebase, divider chain and gate. The unit requires 5V, and −12V. The unit comes complete as shown on the left less power supply.

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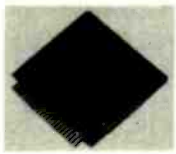

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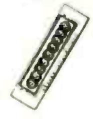

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7404	.19	7464	.35	74158	1.79
7405	.19	7465	.35	74160	1.39
7406	.35	7470	.30	74161	1.25
7407	.35	7472	.30	74162	1.49
7408	.18	7473	.35	74163	1.39
7409	.19	7474	.35	74164	1.59
7410	.16	7475	.57	74165	1.59
7411	.25	7476	.39	74166	1.49
7413	.55	7483	.79	74170	2.30
7416	.35	7485	1.10	74173	1.49
7417	.35	7486	.40	74174	1.62
7420	.16	7489	2.48	74175	1.39
7422	.26	7490	.59	74176	.89
7423	.29	7491	.97	74177	.84
7425	.27	7492	.71	74180	.90
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7442	.77	74122	.45	74193	1.19
7443	.87	74123	.85	74194	1.25
7444	.87	74125	.54	74195	.89
7445	.89	74126	.63	74196	1.25
7446	.93	74141	1.04	74197	.89
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74H10	.25	74H50	.25	74H72	.39
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4010A	.54	4025A	.25	4075A	.39
4011A	.29	4027A	.59	4078A	.39
4012A	.25	4028A	.98	4081A	.26
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74C10	.35	74C154	3.15	74C195	2.66
74C20	.35	74C157	1.76	80C95	1.35
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307	Op AMP (super 741)	mDIP TO-5	.26
308	Micro Pwr Op Amp	mDIP TO-5	.89
309K	5V 1A regulator	TO-3	1.35
310	V Follower Op Amp	TO-5 mDIP	1.07
311	Hi perf V Comp	mDIP TO-5	.95
319	Hi Speed Dual Comp	DIP	1.13
320	Neg Reg 5.2, 12, 15	TO-3	1.04
322	Precision Timer	DIP	1.70
324	Quad Op Amp	DIP	1.52
339	Quad Comparator	DIP	1.58
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V)	TO-3	1.69
340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V)	TO-220	1.49
370	AGC/Squelch AMPL	TO-5 or DIP	.71
372	AF-IF Strip detector	DIP	2.93
373	AM/FM/SSB Strip	DIP	.53
376	Pos V Reg	mDIP	2.42
377	2w Stereo amp	DIP	1.16
380	2w Audio Amp	DIP	1.13
380-8	.6w Audio Amp	mDIP	1.52
381	Lo Noise Dual preamp	DIP	1.52
382	Lo Noise Dual preamp	DIP	.71
550	Prec V Reg	DIP	.89
555	Timer	mDIP	.89
556A	Dual 555 Timer	DIP	1.49
560	Phase Locked Loop	DIP	2.48
562	Phase Locked Loop	DIP	2.48
565	Phase Locked Loop	DIP TO-5	2.38
566	Function Gen	mDIP TO-5	2.25
567	Tone Decoder	mDIP	2.66
709	Operational AMPL	TO-5 or DIP	.26
710	Hi Speed Volt Comp	DIP	.35
711	Dual Difference Compar	DIP	.26
723	V Reg	DIP	.62
739	Dual Hi Perf Op Amp	DIP	1.07
741	Comp Op AMP	mDIP TO-5	.32
747	Dual 741 Op Amp	DIP or TO-5	.71
748	Freq Adj 741	mDIP	.35
1304	FM Mulpx Stereo Demod	DIP	1.07
1307	FM Mulpx Stereo Demod	DIP	.74
1458	Dual Comp Op Amp	mDIP	.62
1800	Stereo multiplexer	DIP	2.48
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75492	Hex Digit driver	DIP	.80

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Circle 97 on reader service card

Circle 98 on reader service card

ELECTRONIC DOORBELL

(continued from page 35)

ground. Install IC5 with a temporary ground at the junction of D4 and R12. Apply power to the transformer—then press the start button and measure the voltage on emitter Q3. This voltage should be between 4.75 and 5.25 volts. Lift the temporary ground and the voltage should drop to under 0.9, the off condition. Disconnect power and install the remaining IC's, paying particular attention to orientation. The total current drain should not exceed 400-mA on and 10-mA off. Reapply power, press the start button and adjust R23 for a frequency of 21,560 HZ at the Q output of IC10-b. This can also be accomplished by listening to the melody as it is played and adjusting R23.

If you desire your melody played without tremolo, remove R25. Tremolo may also be increased or decreased by a corresponding reduction or increase in resistance of R25. The beat tempo may be changed faster or slower by decreasing or increasing capacitors C1, C2, and C3, respectively. Always maintain the capacitance ratio such that C1 = C3 = C2/2.

(continued next month)

Circle 99 on reader service card

Circle 101 on reader service card

RTISING INDEX

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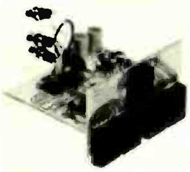

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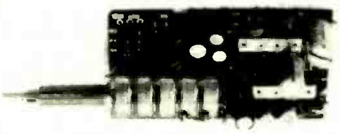
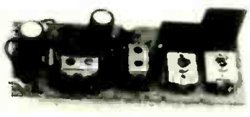


R9754

R9752



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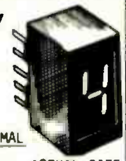

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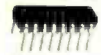

8 BIT 32 WORD MEMORY
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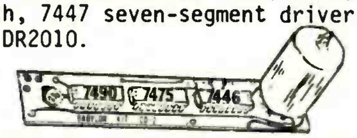
Unit includes board, 7490, 7475, quad latch, 7447 seven-segment driver, and RCA DR2010.



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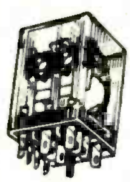

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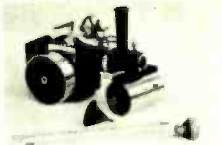

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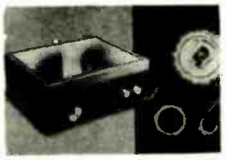

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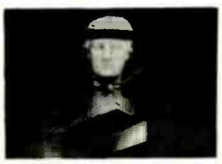

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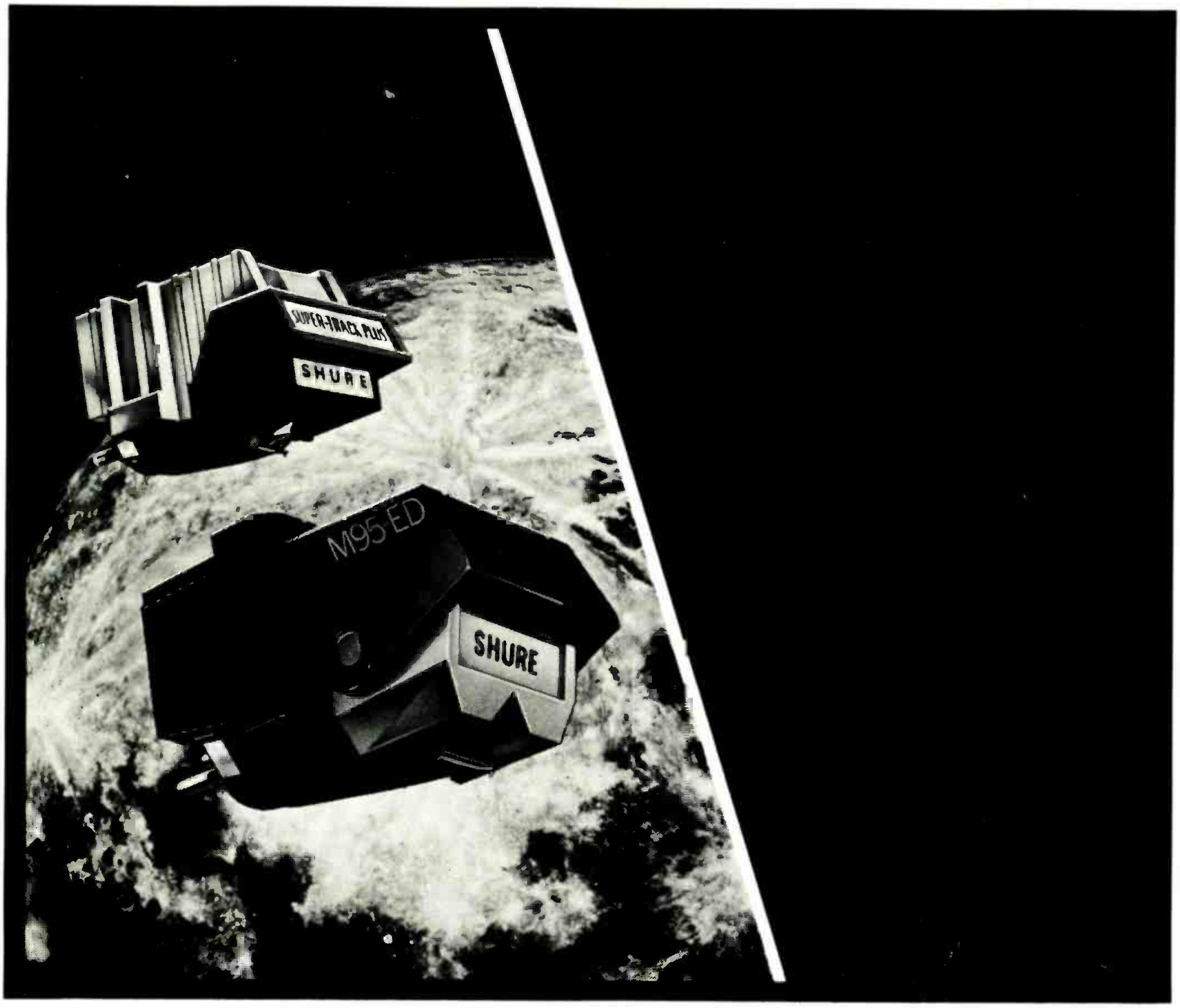
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