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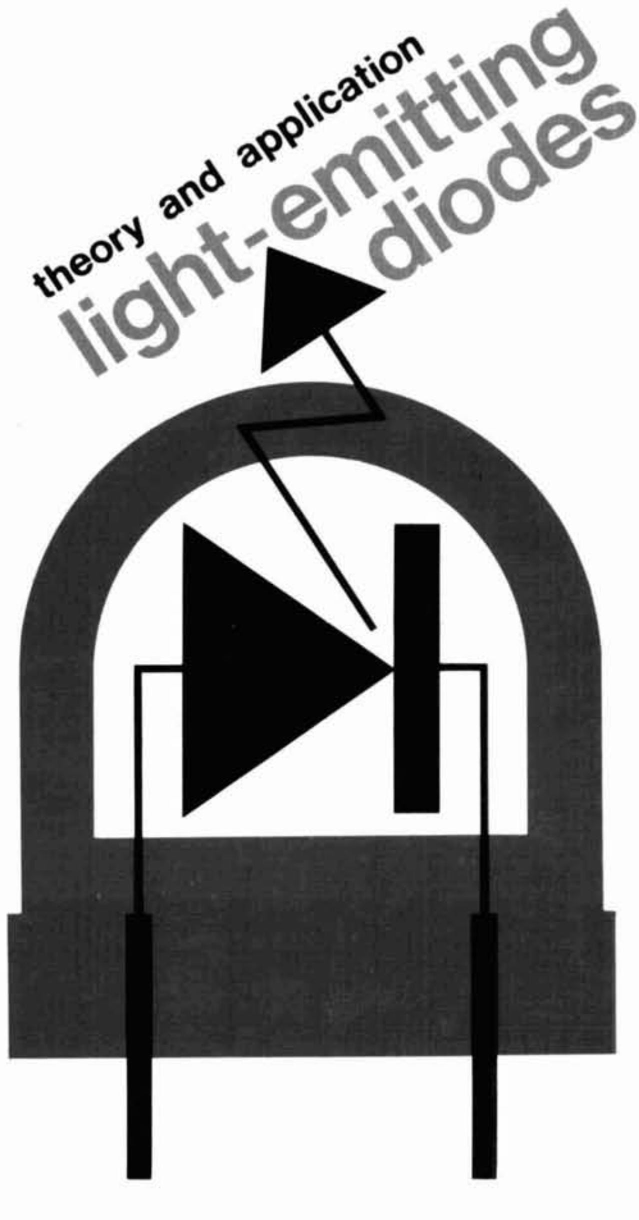
ham radio magazine

AUGUST 1980



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More Details? CHECK—OFF Page 94

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contents

Observations & Comments

Living things change and *ham radio* is no exception. Since the passing of Editor-In-Chief Jim Fisk, I have been asked to take over his editorial page, at least during this difficult transition period. His is not an easy act to follow. Jim was close to the pulse of Amateur Radio, its problems, and the direction in which it's going. Jim did a superb job, and certainly all active Amateurs benefited by Jim's "second look."

My job is to try to carry on the precedent set by Jim in illuminating issues that affect Amateur operating, technology advances, and the future. I'm not as close to the immediate issues of Amateur Radio as Jim was, but that's going to change. I'll have to educate myself so that I can carry on *ham radio's* editorial page in the established tradition. I ask the support of readers in bearing with me.

I'd like to introduce in *observations and comments* some contributions by Amateurs who have something constructive to say. This material will reflect *your* ideas, problems, and what to do about them. If your contribution is positive, it could end up as a guest editorial. Here are some ideas:

Much has been published on FCC proposed rule making affecting Amateurs. If such PRM would have an impact on your sphere of interest, we'd like to hear about it. Give us the pros and cons from your point of view. If your contribution is in the best interest of Amateur Radio, we'll print it in *observations and comments*.

Do you have a club? We'd like to know about the problems you may have encountered in running a ham club so that others may benefit. What about a club paper? How do you run yours?

Say you're a contest operator. What can be done about the selfish attitudes of those who interrupt contest operation?

You've run across a new adaptation of current IC technology. Let's hear about it. Can it be adapted to Amateur Radio?

You don't like the restrictions on satellite communications. Why not? Do you have a better solution?

What about slow-scan TV and interference by SSB operation? The upper end of the 20-meter band is a good example. Is time-sharing the answer?

These are just a few ideas that come to mind. Others are welcome from our readers and will certainly be considered.

The object of this column is to present ideas and comments from our readers that will provide a positive thrust forward for other Amateurs. Reader contributions will be supplemented by editorial comment on current issues and their relationship to Amateur Radio. The idea behind this column is to present an image of what our readers think. Let's hear from you.

Alf Wilson, W6NIF
technical editor

comments

surplus tubes

Dear HR:

The comments by KB5EY and W6SAI in the December issue were very interesting. I, too, have a collection of 813 tubes and presently use one on 75 meters. I am building a near-kW transmitter which will use two in a class-C final.

But let me say something about those surplus, commercial and military, tantalum plate triodes, like the 100-TH and the 250-TH. They were advertised by Eimac many years ago as "gas-free." They can be bought (without warranty) for one or two dollars each at club auctions and flea markets. This is definitely not a "wad" of money. Interestingly, forty years after manufacture these tubes are still "gas-free." If not abused, and such abuse is readily discerned visually, they will perform as per specifications. I am now using a pair of Heintz and Kaufman HK-24 tubes that were made in 1939 in a class-C final on ten meter FM! No TVI, either.

My present collection includes such gems as the 35-T, 100-TH, 250-TH, and 450-TH — with spares. With these tubes 70 per cent (or more) efficient single-band class-C finals are planned. What old timer can deny the romance of ham radio that comes from a room softly illuminated with the glow from those tungsten filaments, and the nearly-white hot plates of a pair of (quite) fully loaded tantalum plate triodes?

Byron H. Kretzman, W2JTP
Huntington, New York

speech processors

Dear HR:

I read with interest the letter by Walter Schreuer of Maximilian Associates and the reply by Wes Stewart concerning his split-band speech processor. Since I have done some comparative on-the-air testing of the two designs, I think that my findings will be of interest.

For my tests, I used three different speech processors: a Vomax, a N7WS split-band, and a quasi-logarithmic audio clipper. All three units were connected to a switching system that allowed instantaneous switching of the various units between the transmitter and microphone. The units were adjusted to provide the transmitter with an equal amount of drive measured by observing the metered ALC level.

Various tests were run with some of the local fellows on 10 meters as well as with DX stations on several bands. At the beginning of the contact, I explained the test I was about to run and asked the operator to note his preference, which unit he thought sounded the best, as well as which provided the most signal "punch." First, a transmission was made with no audio processing to be used by the receiving station as a reference. The three speech processing units were designated **A**, **B**, and **C**, and the stations were not told which was which until the test sequence was completed.

A test run was made by using unit **A**, then unit **B**, then unit **C**; in between testing the units I switched back to a "No Processing" mode for comparison. By keeping a record of these tests, I found that approximately 90 per cent of the stations preferred the N7WS design split-band processor. Operators who preferred the N7WS design said that although there was as much — or slightly more — than average power output with the Vomax, the N7WS design sounded "crisper." Monitoring my signal with a separate receiver, it sounded to me as though the Vomax suffered from a highly restricted audio bandwidth, with the most notable point being the lack of low frequencies.

I've heard others on the air using the Vomax, and it seems that, while some operators sound excellent, others suffer from the same problem I observed during my tests. This leads me to conclude that the microphone audio response and/or timbre of the operator's voice will determine the audio quality when using the Vomax. (I should point out that only one Vomax unit was available for these tests; I would have liked to have been able to obtain another unit to see if it had the same characteristics.) The quasi-logarithmic processor, while contributing punch to the signal, did not fare well during these tests when compared with the other units because of its high percentage of distortion.

I make no claim that these tests were scientific or definitive; they were conducted only to satisfy my personal curiosity.

Gale A. Steward, K3ND
Quakertown, Pennsylvania

speed of light

Dear HR:

I would like to comment on the paper published in January, 1980 issue by Harold Tolles, W7ITB, regarding the speed of light. The measurement of the speed of light is a difficult task to accomplish, at best, to the precision quoted today. It should be noted that the speed of light has been given to at least six places since before 1930, i.e., 2.99796×10^8 meters per second (m/s). This value has, so to speak, converged to 2.997924580×10^8 m/s as recommended by the Committee on Data for Science and Technology, and the International Council of Scientific Unions (CODATA-ICSU) in 1973. The principal improvement in the knowledge of the speed of light has been the reduction in the measurement uncertainty from 4000 m/s in 1929, to 1000 m/s in 1951, to 100 m/s in 1963, to 1.2 m/s in 1973. Surely four parts per billion is adequate for ham radio work!

It should be noted that these speeds are in vacuum. When light propagates through any material (e.g., air), its speed is reduced by a factor of one over the material's index of refraction. The index of refraction of air, for example, is dependent on the temperature, pressure, and frequency of the EM radiation on a "point-by-point" basis (for most rf work, electron density distribution in the atmosphere plays a significant role), from which one can (reasonably) infer that the speed of an EM wave varies over the path of propagation. Finally, I suggest that we and Mr. Tolles not despair about c and simply use 3×10^8 m/s, which is good to 0.07 per cent; this value is adequate for all Amateur Radio requirements.

R. Barry Johnson, W4MLM
Rancho La Costa, California

receiver dynamic range

Dear HR:

WB6CTW is to be complimented for his fine article on measuring receiver dynamic range in the November, 1979, *ham radio*. His technique makes it possible for the average Amateur to make meaningful measurements with homebrew equipment. WD6FMG, N6ST, and I have been using Hewlett-Packard signal generators to perform similar measurements. Based on our experiences, I would like to offer several comments on this subject.

1. The measurement of dynamic range for either third-order intermodulation (undesired mixing of two interfering signals) or gain compression (overload by one interfering signal) is not particularly sensitive to the exact difference in the frequencies of the signals. Any difference between 20 and 100 kHz can be used. If the signals are too close together, i-f skirt rejection or local oscillator noise sidebands confuse the measurements; if they are too far apart, the rf preselector attenuates one or both of the signals.

2. Various receivers will show somewhat different results if tested on different bands. Just the same, if all of the receivers in **Table 1** of the article were tested on 40 instead of 20 meters, the ranking would probably be similar. Therefore, the cost of the crystals for the two oscillators could be saved by using some Novice band crystals from the junk box.

3. When performing the two-tone test, misleading measurements may be obtained with some receivers if the AGC is allowed to reduce the rf gain. The intermodulation signals should be kept weak enough that the S-meter barely moves. In some receivers, the stage that generates the intermodulation is a mixer or second amplifier stage that follows a stage with AGC. As the level of the two interfering signals is increased to the point that the intermodulation product appears out of the noise, passes through the i-f filter, and reaches the detector, the AGC will reduce the rf gain. Less signal reaches the intermod generating stage, and less intermod is produced than would be the case if the AGC were disabled. AGC, of course, also decreases receiver sensitivity.

The dynamic range of a receiver is the difference between the weakest signals it can detect, and the largest signals it can handle simultaneously. Unfortunately, different values for dynamic range will be measured depending on the definition of a "weak" signal. Some of the companies that publish dynamic range performance seem to use creative specsmanship. In one case, the measured value of dynamic range is much better if the sensitivity and intermodulation are compared for a weak signal of S-6 than for a weak signal of S-1. Can you guess which value is the published value?

4. The article suggests that gain compression can be tested with only one signal. This procedure will often give false and inflated results. It is much better to tune the receiver to a weak signal; then adjust the amplitude of a second signal on a different frequency until reception of the first signal is impaired.

For example, a while ago we checked the performance of a popular synthesized 2-meter handheld transceiver. This rig was claimed to have 80 dB rejection 30 kHz away. The signal level for full quieting was measured. Next the receiver was tuned 30 kHz away. Then the amplitude of the signal generator was increased by approximately 80 dB, at which point the receiver was again fully quieted. From this test, one might suppose that the dynamic range was 80 dB.

The receiver was next tested using two signal generators. The first one was tuned to the receiver frequency, frequency modulated with a 1 kHz tone, and adjusted in amplitude until full quieting was achieved. The second signal generator was tuned 30 kHz away and increased in amplitude until the 1 kHz modulation of the first signal became noisy. The difference in the two signal strengths was only 56 dB . . . a lot less than the 80 dB measured the first way!

5. Based on testing one of each model, the TS-520S is much improved over the TS-520 and even slightly better than the TS-820. Owners or prospective owners of the TS-520S should perform their own measurements before they panic.

Paul A. Zander, AA6PZ
Los Altos, California

presstop

A LAW PROHIBITING "INTERFERENCE by Radio Transmitter" has been enacted by the Township of Winslow, New Jersey, in the aftermath of TVI/RFI problems experienced by a local Amateur, WB2SZK. Just over a year ago a neighbor complained of TVI plus interference to his stereo, electronic organ, and intercom. Stubs cured the TVI problem, but filters were only partially effective on the other equipment. WB2SZK, after urging the neighbor to seek manufacturer's help with the remaining problems, was summoned to court in November for violation of a township nuisance ordinance and ordered to stay off the air for 30 days pending FCC inspection. When he refused, he was fined $250 and costs.

The FCC's Inspection in early December gave WB2SZK a clean bill of health, and the complainants were so advised. On December 19 the township then adopted a new ordinance, Chapter 50-10.2, that makes it unlawful to transmit any radio signal that "...causes or creates electrical, visual or audible interference..." or "...annoys, disturbs or endangers the comfort, repose, health, peace, safety or general well being of others within the township." Any interference with "...receiving sets, musical instruments, phonographs or other machine..." is included under the ordinance's omnibus coverage.

WB2SZK Was Again Summoned for hearing, this time under the new ordinance, in February. On his request the FCC submitted a 1977 Public Notice citing federal pre-emption of the control of radio transmissions to township officials, but to no avail. His attorney was able to obtain an interim injunction from the New Jersey Superior Court halting prosecution under the new ordinance, but at a May 2 hearing the Superior Court judge upheld the township ordinance on the grounds that there is no specific federal pre-emption of control of radio communications—it's only implied.

Since This Decision Contradicts previous decisions on the pre-emption question, it sets a dangerous precedent and must be challenged. Over $1000 (including $500 from the Mt. Airy Pack Rats) has already been spent, and the necessary appeal in Federal Court will cost much more. Contribution checks made out to Harry B. Stein, W3CL, with the notation "Randy Bynum Defense Fund" can go to 2087 Parkdale, Glenside, Pennsylvania 19038.

A NEW COMMUNICATIONS ACT REWRITE bill, S-2827, has been introduced in the Senate by the Senate Communications Subcommittee. Combining the better and less controversial ideas of the previous rewrite proposals (S-611 and S-622), the new bill includes the 10-year license term, authorizes the FCC to require TVI rejection standards for TV receivers, and—most important—gives the FCC authority to delegate license examination authority to nonemployees.

The Full Text Of S-2827 appears in the June 13 issue of the Congressional Record. Because of the very pro-Amateur-Radio aspects of this revised bill, Amateurs are again urged to write their Senators and Representatives as well as the Subcommittee Chairman, Sen. Ernest F. Hollings (D., South Carolina), and minority leader, Sen. Barry Goldwater. A complete list of the Senate Committee members who are directly concerned with S-2827 appears in the May, 1980, QST editorial. Some Washington observers believe that, with public support, S-2827 has a good chance of being passed by Congress this year.

SSTV AND FACSIMILE WOULD BE permitted on all Amateur voice frequencies above 3775 kHz, under a Notice of Proposed Rule Making adopted by the Commission June 3. Personal Radio Docket 80-252 proposes dropping the present subband restrictions on SSTV, meaning that Generals as well as Advanced and Extra class licensees would be able to use that mode on 80 through 15 meters. Facsimile would be permitted on the same frequencies thus opened to SSTV. 160 was not included in the NPRM at this time, as that band is still shared with Loran, Amateur Radio being a secondary user through 1981. Under the proposed rules change, bandwidth for either mode would be limited to SSB bandwidths below 50 MHz, and to AM bandwidths above.

Comment Due Date is September 22, with Reply Comments due October 22.

FCC'S NEW EXAMS SCORED AN "A" with the first group of applicants who took them recently. According to instructors from several parts of the country, their students rated the new FCC efforts well written, unambiguous, and closely related to the new FCC study guides. They also liked the practical emphasis on operating procedures in the Technician/General-class exams with more technical subjects covered in the higher class tests. Congratulations to Jay Jackson, AF4O, and the other FCC staff members who are responsible for the new exams.

HAM RADIO'S NEW TECHNICAL Editor is Alf Wilson, W6NIF. Alf is no stranger to ham radio, having been Jim Fisk's technical right-hand man since the magazine's early days. He will be working on ham radio through the summer to help ensure its continued technical accuracy while the search for a permanent editor continues. Prior to his retirement several years ago, Alf was a Technical Publications Specialist for General Dynamics in San Diego.

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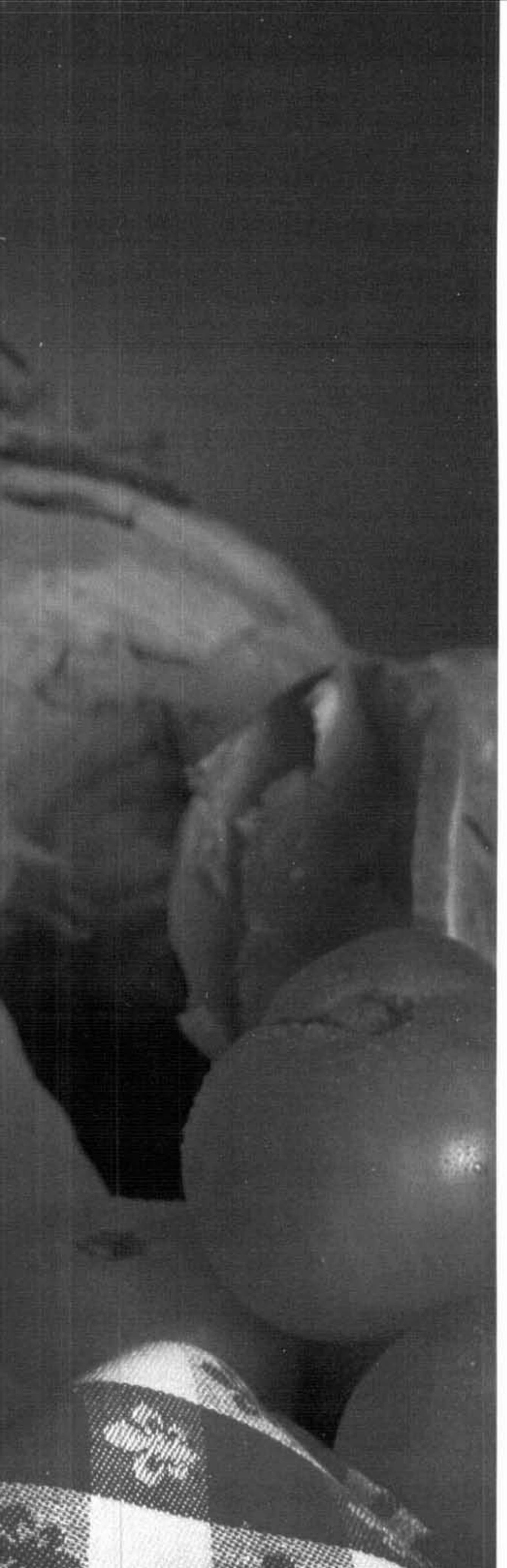


light-emitting diodes: theory and application

A digest of LEDs — how they work and how they're used in many of today's electronic circuits. Also included is a simple logic probe for testing digital circuits

Learning the theory of the electronic devices we use can be greatly enhanced by putting the theory to work with a weekend construction project. This is just what we have in this article: some basics, a few applications, and a very easy construction project. A few hours invested should yield a good understanding of light-emitting diodes (LEDs) and a unique logic probe that fits well with today's technology.

Initially these LED devices were too expensive for the Amateur or experimenter, but their wide acceptance and availability now make them a workable addition to our hobby. As Amateurs continue their transition from vacuum tubes, through transistors and into integrated circuits, the LED will become more valuable as an indicator, display, or active component.

For practical applications we can think of the LED indicator, or the individual segments of a LED display, as being the same as any other diode; much like the power diodes used as rectifiers, or the small-signal diodes used as detectors. As with any diode, we must operate within the parameters of the device as specified by the manufacturer. Under these conditions the LED will function well.

To illustrate the relationship between a silicon diode and a LED, I've shown both devices under similar conditions in **fig. 1**. Both are forward biased, and the current through each is limited by the series resistor, R1. The voltage drop across the silicon diode, or its threshold voltage, is approximately 0.6 volt. If the value of R1 is changed, the current through the diode will vary, but the voltage across the diode will remain fairly constant. In effect, the diode will act as a voltage regulator. The diode could be used as a shunt regulator in the same manner as a voltage-regulator tube found in many receivers and VFOs of the past. In semiconductor circuits, one or more of these diodes are often used as regulators and clamps, making good use of this threshold action.

The same conditions exist for the LED except that the threshold voltage is higher, usually about 1.6 volts for the red LEDs. As with the silicon diode, varying the series resistor will vary the current through the LED and thus its intensity, but the voltage drop across the LED will remain fairly constant at 1.6 volts.

From **fig. 1** it can be seen that all we must do to activate a LED is apply forward bias and limit the current to a safe value, as specified by the device manufacturer. As shown in **fig. 1**, a simple application of Ohm's law is all that's needed to use the LED as an indicator. An understanding of the basic principles of the diode will enable you to get started in the applications of LEDs.

Fig. 2 illustrates the parameters of a typical red LED. As shown, 100 per cent of the rated intensity is achieved with 1.6 volts at 0.020 ampere. These parameters were used to calculate the series-resistor value in **fig. 1**. The threshold voltage for colors other than red vary from this norm. Typical values are, for amber devices, approximately 2.0 volts. For green units threshold approaches 4.0 volt level.

These numbers are adequate approximations for general use and will provide a starting point for unknown surplus units. The amber and green LEDs generally require more current than the red LEDs to achieve equal intensity. However, our eyes are very understanding in this area, and the current through the diode can vary over a formidable range without a profound effect on the indicator's appearance.

By Ken Powell, WB6AFT, 6949 Lenwood Way, San Jose, California 95120

applications

We tend to think of LEDs as low-voltage devices primarily associated with transistors or integrated circuits. However, with suitable current-limiting resistors, these devices will function equally well in higher-voltage circuits. The type 4403, for example, has an isolation voltage rating between the leads and case of 300 volts. This rating allows the device to serve as an indicator in moderately high voltage circuits.

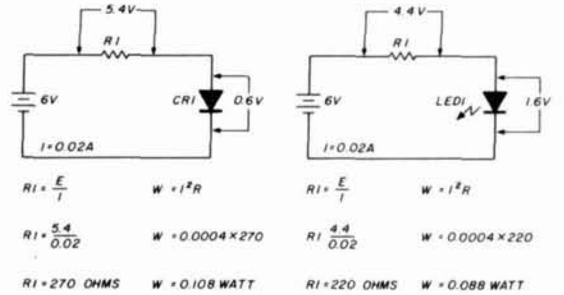
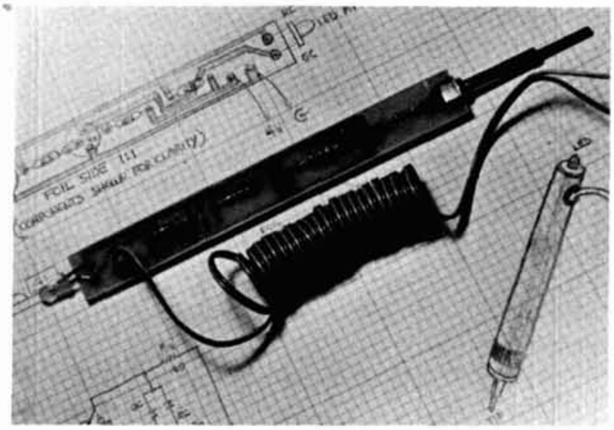
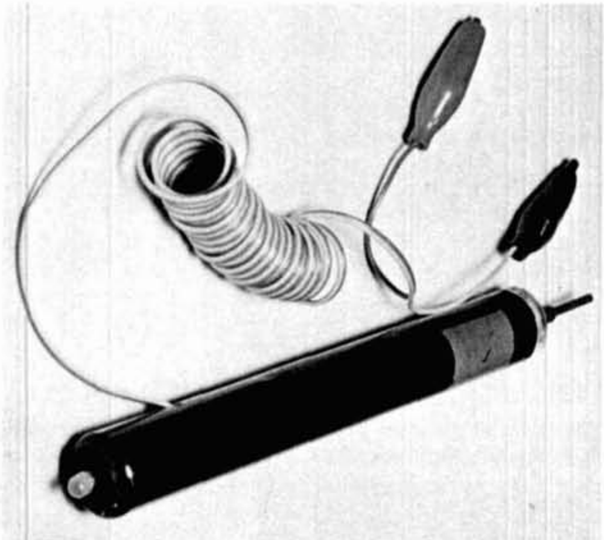


fig. 1. Silicon diode and LED under similar operating conditions: each is forward biased, and current through each device is controlled by series resistor R1. Threshold voltage across the silicon diode is about 0.6 volt, whereas that across the LED is somewhat higher, usually about 1.6 volts (for red LEDs). Simple application of Ohm's law determines device operating parameters.



Complete logic-probe board ready for assembly.



A logic probe for testing digital circuits. A few parts and as many pleasant hours at the workbench produced this useful and handsome piece of test gear.

Voltage monitor. Fig. 3 illustrates this principle by the use of a LED to monitor the power-supply voltage in a tube-type receiver. The calculations required to determine the value of the series resistor is shown; note that this application is no different than the basic circuit discussed in **fig. 1**. From this application it can be seen that we're not limited to low-voltage or solid-state circuitry in the use of LED devices. With higher voltage applications, the series-resistor value becomes greater along with increased power requirements; but the physical size is still within reason, and the looks are more in keeping with today's technology.

The majority of LED applications encountered are in dc circuits, but these devices aren't limited to dc and make excellent indicators for ac if some precautions are taken in their application. One of the parameters not yet discussed is the reverse-voltage specification. The reverse breakdown voltage of LEDs is

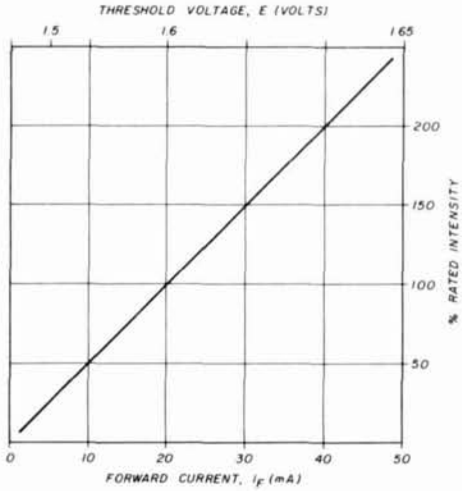


fig. 2. Intensity of a typical red LED as a function of threshold voltage and forward current. One-hundred per cent of rated intensity occurs with 1.6 volts at 20 mA. These data were used to calculate the series resistor, R1, in *fig. 1*.

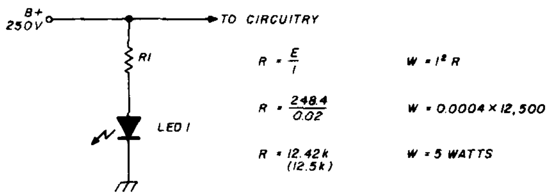


fig. 3. A voltage monitor that can be used, for example, in a power supply of moderate voltage. Calculations for series-resistor values are shown.

generally low, so particular attention must be paid to this specification. The reverse breakdown voltage for the type 4403 is typically 3 volts, meaning that the reverse bias voltage must be kept below this level.

Filament-circuit monitor. In **fig. 4** an LED is used to monitor a filament circuit, and a diode is placed inversely in parallel with the LED to limit the reverse voltage applied to the LED to approximately 0.6 volt, or the threshold of the silicon diode. This diode will protect the LED during negative excursions of the filament voltage. As in the previous circuits, the limiting-resistor value is calculated with Ohm's law as shown in **fig. 4A**, but the power must be calculated as in **fig. 4B**, since the current flow will be greater on the negative half cycles when shunt diode CR1 is conducting. That is because of the difference in LED threshold voltage and that of the silicon diode. In this case, the difference in power is minimal but should be taken into account, particularly with higher source voltages and higher threshold LED devices, such as amber and green units. The reverse-voltage parameter is an important factor and must be kept in mind when thinking about LED applications.

Color transistions. Another type LED, the MV-5491, is illustrated in **fig. 5**. This unit is actually

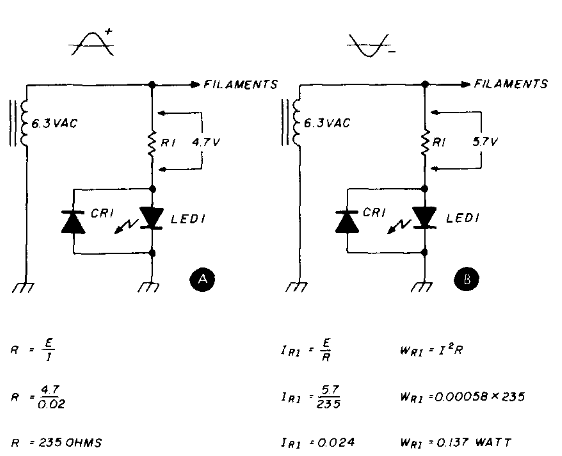


fig. 4. Using an LED to monitor a filament circuit. The limiting-resistor value is calculated as in (A), but the power dissipation must be calculated as shown in (B).

two LED junctions in a single package placed inversely in parallel. One of the parallel diodes is red; the other is green. As with the LEDs discussed earlier, the threshold voltages of the two diodes are different, so a bit more thought is required in their application.

With the MV-5491, the color can be changed by reversing the voltage applied to the diode pair; and with the application of an ac voltage, an alternating color that approximates yellow can be obtained. This device can achieve four states: red, green, amber, and off.

In **fig. 5A** the red diode is conducting and the limiting resistor, calculated for a specification of 1.65 volts at 0.20 ampere, controls the current through

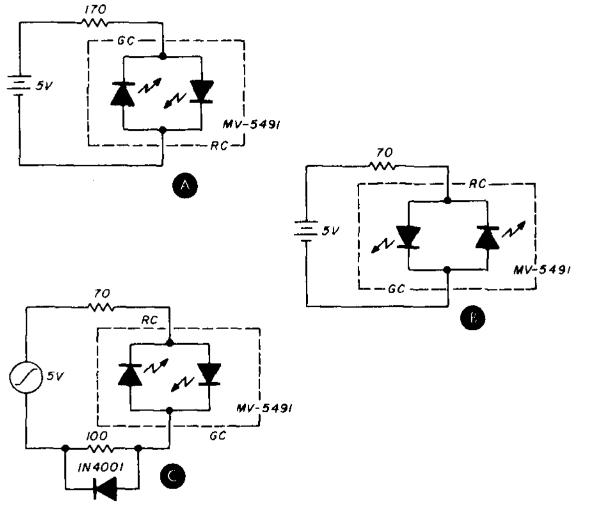


fig. 5. Example of a dual-diode LED, type MV-5491. This device is actually two LED junctions in single package placed inversely in parallel. Sketches (A), (B), and (C) show, respectively, how the LED colors are generated. (A) shows the diode pair in a red configuration; (B) shows green. With the application of an ac voltage and the use of a compensating diode, as seen in sketch (C), an amber color can be generated.

the diode. In **fig. 5B**, the green diode is in conduction, and the limiting resistor has been chosen to provide 3.0 volts at 0.020 ampere. Because of the difference in the specifications of the red and green diodes, external components must be used to provide compensation. **Fig. 5C** illustrates this compensation in the form of a silicon diode that will shunt the 100-ohm resistor when the green LED is conducting. Reversing the polarity of the input voltage will reverse bias the silicon diode, placing an effective 170-ohm resistance in series with the red LED. In this manner the correct voltage and current can be furnished to the dissimilar LED junction.

LED drivers. So far in the discussion all the LED applications have been of the static type. To make these units dynamic, or to turn them on and off with signals, a switching device must be added in series with the LED to control the current flow. In **fig. 6** a transistor switches the LED on and off with a signal or logic level to be monitored. In **fig. 6A** the voltage across each element of the circuit is shown with the transistor in conduction and the LED indicator lighted. The calculation for the current-limiting resistor is the same as in previous illustrations except for the added voltage drop of the transistor, usually on the order of 0.2 volt. As in previous illustrations, 1.6 volts appears across the LED and 3.2 volts across the limiting resistor. In **fig. 6B** the circuit is shown with the transistor cut off and the LED indicator extinguished. In **fig. 6C** a similar circuit is depicted for use with a negative power supply.

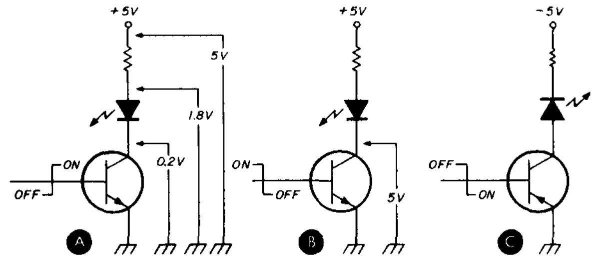


fig. 6. Dynamic application of LEDs. A transistor controls current flow; that is, a switching device is used. (A) shows the transistor conducting (LED illuminated); (B) shows the transistor cut off (LED extinguished). In (C) a circuit is shown for use with a negative power supply. In these applications the device is called an "LED driver."

Integrated circuits lend themselves well to driving LED devices, and six LEDs can be controlled from a single IC package. The SN7406 and SN7407 are well suited for this application. The 7406 is a hex-inverter with each of its output circuits rated at 0.040 ampere and 30 volts. As shown in **fig. 7**, the 7406 will cause the LED to conduct when conditioned with a high, or positive, input. The 7407 is the same basic package but is a noninverting circuit, so a high input will yield a non-conducting, or high output, extinguishing the LED.

In applications requiring more than one LED indicator, the 7406 and 7407 form a very compact and cost-effective circuit. They are useful for adding monitors to keyboards and for data bus applications. The calculations for the current-limiting resistors in this application are identical to those discussed earlier. Just about any open-collector TTL IC will work well as an indicator driver; and for practical applications, the LED current can be limited to 0.010 ampere to

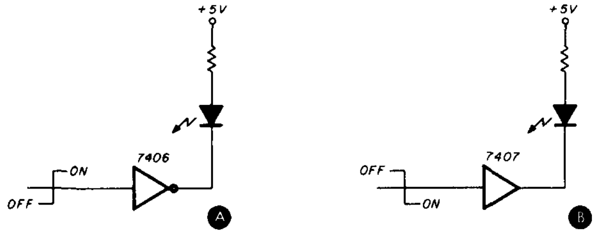


fig. 7. In this example of LED drivers using ICs, as many as six LEDs can be controlled from a single IC package. (A) and (B) show, respectively, drivers with inverting and noninverting inputs.

reduce current use. This will yield adequate light output in virtually all situations.

Driving a dual LED, such as the MV-5491, is a bit more complex. But the result of the LED changing color with changes in the signal is more dramatic and can be accomplished with ICs. **Fig. 8** shows a driver circuit for dual LEDs using one mini-dip, type SN75452, and one section of a SN7404 inverter.

The calculations for resistor values are the same as those in previous illustrations, but the power requirements are a bit more. With the driver input low, the input to IC1A is high and its output is low. In this state 4.8 volts will be dissipated across the 220-ohm resistor, placing the green cathode (GC) at 0.2 volt. IC1B, with its low input, will have a high or nonconducting output. This action will allow the green diode to be forward biased, and 1.8 volts will be dissipated across the 100-ohm resistor. When the circuit input goes high, IC1A and IC1B outputs will change state, and 4.8 volts will be dissipated across the 100-ohm resistor. The red diode will go into conduction, and 3.15 volts will be dissipated across the 220-ohm resistor. Rapid transitions of the input signal will alternate the red and green LEDs and form a somewhat amber indication.

The dual-LED indicator makes a very nice display. The ability to display a number of states with a single

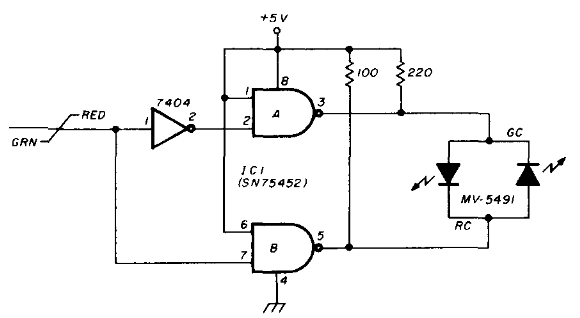


fig. 8. A dual LED driver using the type SN75452 IC. Calculations for the resistor values are the same, but the power requirements are a bit higher.

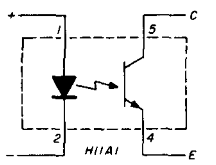


fig. 9. Application of the LED as an optical coupler. In this case the LED has been packaged with its light output focused onto a photo transistor. In this configuration the device can provide a signal path while providing electrical isolation of more than 2500 volts.

indicator is very useful, particularly in digital applications such as circuit monitoring. The IC driver circuitry could be replaced with discrete transistors if desired, and no doubt many applications for this unique device will be implemented by Amateurs and experimenters. As with many other devices, these units were expensive when first developed but are readily available at low cost today. The MV-5491 is packaged in the standard T-1¾ package and uses the same mounting hardware as most LEDs.

the optical coupler

All of the LEDs previously discussed have been indicator types, so now is a good time to take a break and look at another LED device known as the optical coupler. The coupler uses the LED for a much different purpose — that of isolation. This device can provide a signal path while furnishing electrical isolation in excess of 2500 volts. Again it is the basic LED with virtually the same parameters as those of the LED indicator. However, in the coupler configuration the LED has been packaged with its light output focused on the sensitive surface of a photo transistor (**fig. 9**). In this manner, the current flow through the LED will provide base bias for the transistor through an optical path within the package, providing signal coupling while maintaining physical isolation.

While I've not seen these devices used extensively in Amateur gear, I have used them in keyer circuits to

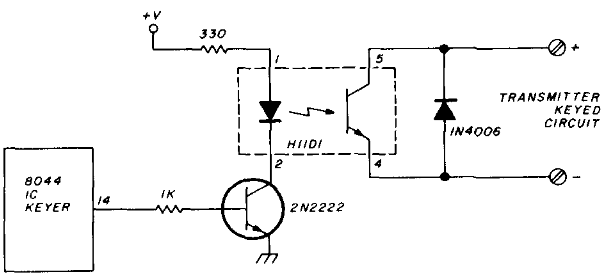


fig. 10. Use of the LED optical coupler in an Amateur keyer. Device isolates the IC keyer from the transmitter, removing grid-block keying voltage, which is sometimes rather high, from the keyer paddles.

isolate the keyer from the transmitter. They are a very effective device in this application and remove the grid-block keying voltage, which is sometimes at a fairly high potential, from the paddles. This application is depicted in **fig. 10**. The optical coupler, or opto-isolator as it is also called, is used extensively in medical and data-processing equipment. I think that, as Amateurs become more aware of the unique properties of this device, many new and worthwhile applications will ensue.

The coupler in **fig. 10**, type H11D1, is packaged in a six-pin mini-dip, so it lends itself well to today's construction techniques. Keep this device in mind for both safety and noise reduction applications.

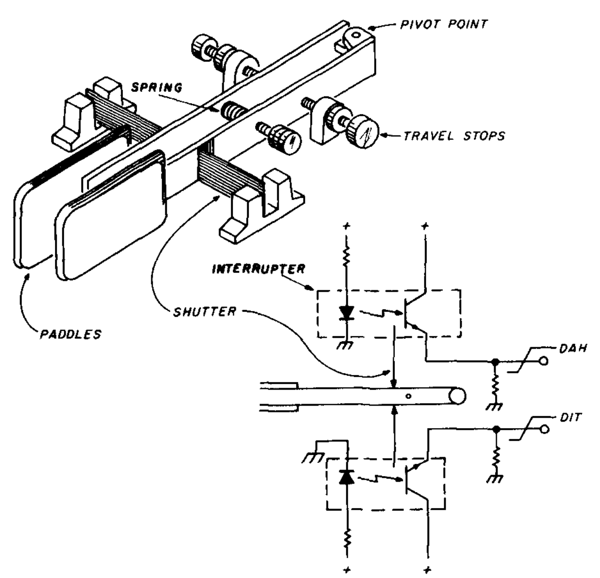


fig. 11. A contactless keyer, or "optical paddle," using an LED optical interrupter. The optical interrupter is similar to the optical coupler, except that the light path from the diode to the photo transistor can be interrupted with a shutter or other mechanical device.

optical interrupter

Another interesting device in the LED family is the optical interrupter. Its construction is similar to that of the optical coupler, except that the light from the diode to the photo transistor is accessible, meaning that the light path can be broken or interrupted with a shutter blade or other mechanical device. When this action occurs, the output transistor will be cut off, which allows an easy mechanical interface to electronic circuitry. I've not seen this device used to any great extent in Amateur applications, but I think a contactless keyer would be a good item to begin with. I've shown one in **fig. 11** and hope to build a device such as this in the near future. The ease with which it will interface digital logic makes it a natural.

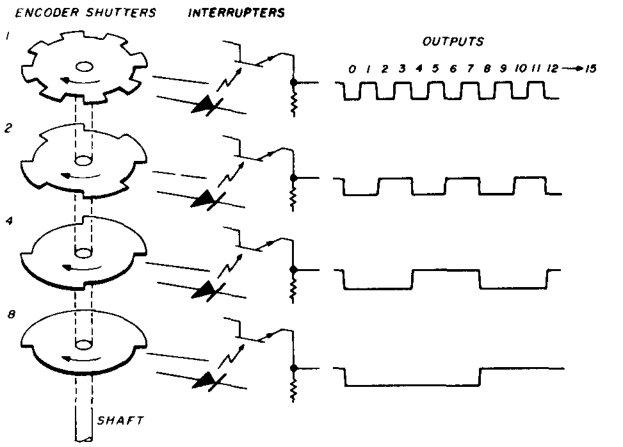


fig. 12. Example of a shaft encoder using the optical interrupter. No electrical contacts in the encoder mean increased reliability and low maintenance. BCD outputs are shown for each encoder shutter. A neat way to encode your antenna rotator for digital readout!

shaft encoder

Another application comes to mind and seems quite reasonable, since the once-plentiful selsyns are rather difficult to find these days. This application is a position indicator or shaft encoder. Using digital techniques, you could easily get sixteen discrete positions with only four optical interrupters. Adding another interrupter would double the resolution; this could be carried out to any degree desired.

By arranging the shutters and interrupters in a format such as shown in **fig. 12**, you would obtain a four-wire BCD output. This could be carried out to an eight-digit arrangement and applied to the input of a micro processor if you really wanted sophistication and had an extra eight-bit port on your micro. This would yield 256 discrete outputs or positions.

Put a device like this under your antenna rotator or weather vane and you would have a real winner! The same scheme could be used for 180-degree capacitors and multi-turn inductors for remote tuning. This low current, contactless device could form the basis for some interesting, reliable equipment.

LED displays

The seven-segment display is probably the most widely used LED display available today. This popularity has made the price right for the Amateur. The display can be thought of as seven individual LEDs placed in a single easy-to-use package and arranged to provide a numeric output. Each individual element or segment has parameters that are similar to those of the diodes discussed earlier. These devices are available in a common-anode configuration, which is generally used for applications involving a positive power supply and the common-cathode configuration usually associated with negative supply designs. **Fig. 13** illustrates both types and the physical relationship of the individual diodes as viewed from the front or display side.

This illustration shows how the characters are formed by forward biasing the individual diodes, or segments, in a prescribed manner. The character

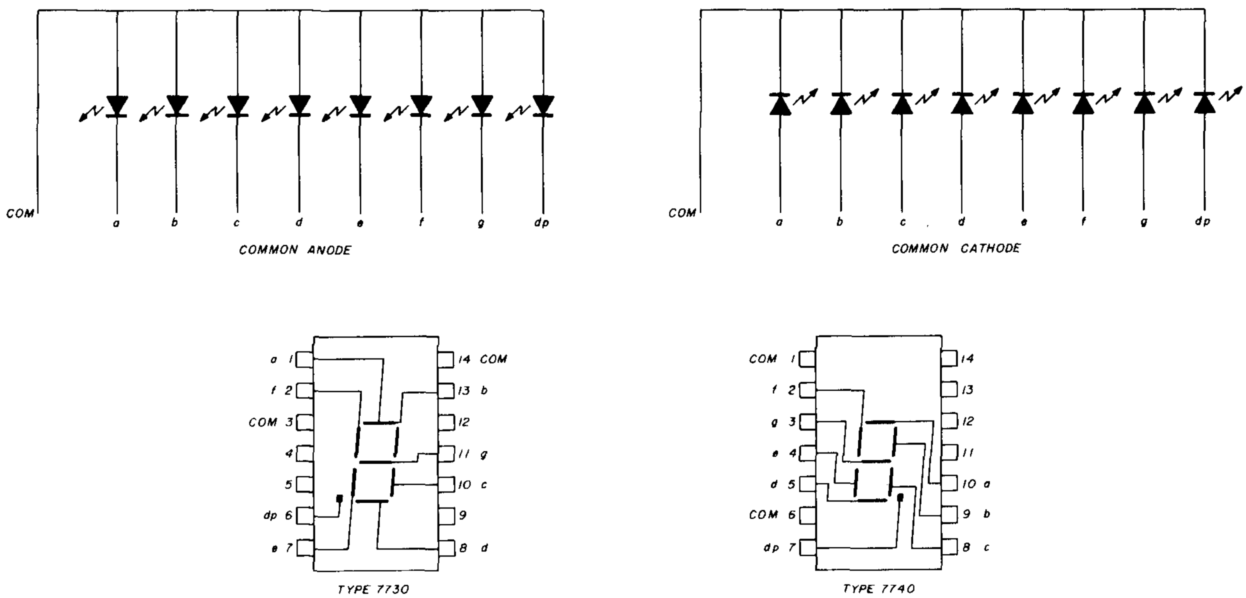


fig. 13. Examples of seven-segment LEDs designed for positive power supplies (common anode) and negative supplies (common cathode). The characters are formed by forward biasing the individual diodes, or segments, in a prescribed manner. These displays have decimal points (DP). Units are available with left-hand, right-hand, both, or no decimal point. Colors are red, green, and yellow (amber).

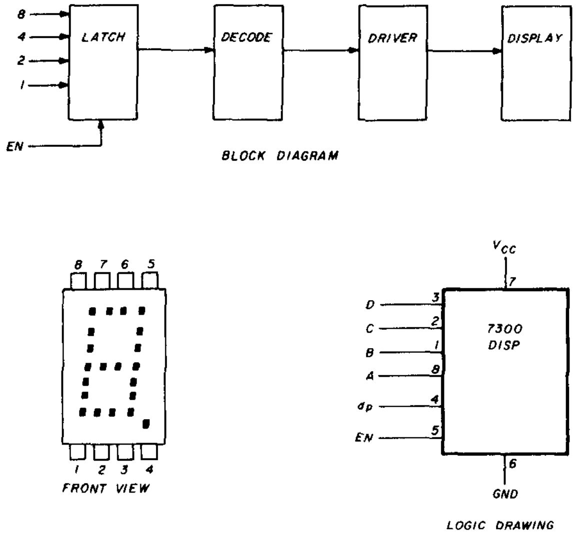


fig. 14. Integrated displays have an IC built into the package. The IC provides decoding, storage, and a display driver. Cost, however, is five to ten times that of the seven-segment type on the surplus market. Device is a dot matrix type and accepts a four-wire BCD input. Others are available with bar-type LEDs such as used in the seven-segment displays.

"O" would be formed by forward biasing the elements labeled "a" through "f." The displays used for this illustration have decimal points (dp), and units are available with left-hand, right-hand, both, and no decimal point. As with the other LEDs discussed, seven-segment displays are available in red, green, and yellow; as with the indicator units, voltage and current parameters vary accordingly.

A number of physical sizes and package configurations are available, and the price is often less than a dollar per digit on the surplus market. The units used in the illustrations are configured in a 14-pin DIP package and furnish a character height of 0.3 inch (7.6 mm). This seems to be an adequate size for most projects, and bezels are readily available to give your project a finished look.

the integrated display

The integrated display unit is a display much like the seven-segment LED, with the addition of an IC built into the display package. The IC provides decoding, storage, and display driver — all within the display package, and requires no more space than the seven-segment display. All these functions being performed by the display unit make it much simpler to use and reduces component count considerably. As can be expected, there's a hitch: the cost of the display is five to ten times that of the seven-segment type on the surplus market. This sounds very high indeed, but in figuring the total expense of the components required to do the functions of the integrated display, it's often cost effective, particularly when space is at a premium.

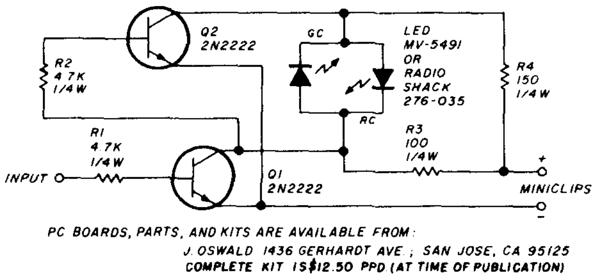


fig. 15. Schematic diagram of a logic probe that can be built in a few hours with readily available components. Logic probe output indicator yields three discrete states according to input signal or level. Power is borrowed from the circuit under test.

The integrated display illustated in fig. 14 is a dot matrix type and accepts a four-wire BCD input. Other integrated displays are available with bar-type LEDs such as used in the seven-segment display. Various types of logic configurations are available such as counters, latches, and hexidecimal decoders. These devices interface TTL logic very well and can make the design and construction of counters and similar devices relatively easy.

logic probe

The logic probe is a good application of the theory discussed earlier and makes an ideal instrument for digital testing. It can be constructed in a few hours using readily available components. The output indicator of the logic probe yields three discrete states according to the input signal or level. The probe borrows power from the circuit under test and is designed to function with the popular TTL logic families.

The circuit of the logic probe is shown in fig. 15 and is a variation of the dual LED circuit in fig. 8. When power is applied to the probe through the power leads, and the tip or input is touched to a low level or ground, Q1 is cut off. This condition will cause Q2 to conduct since the base is positive with respect to the emitter. With Q1 cut off and Q2 conducting, the green diode of the dual LED will be forward biased, yielding a green output from the LED. Touching the probe tip to a high level will cause Q1 and Q2 to complement, and the red diode will be forward biased, yielding a red output from the LED. An

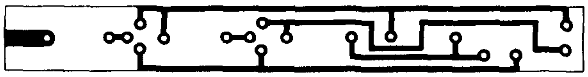


fig. 16. Full-size foil pattern for the logic probe.

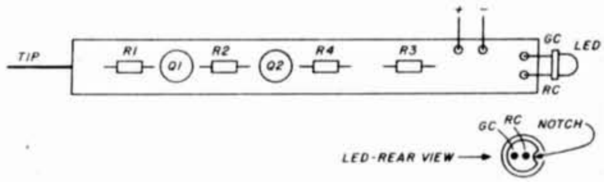


fig. 17. Logic-probe component layout.

alternating signal will cause alternating conduction of the red and green diodes and will yield an indication approximating amber. In this manner both static and dynamic signals can be traced with the logic probe.

Printed circuit construction is used for the logic probe, and a full-size foil pattern is shown in **fig. 16**. After etching and drilling the PC board, the components are mounted as shown in the component-side view, **fig. 17. Fig. 18** is a sketch of the probe assembly. I used the components from an Eico demodulator probe for construction, but any plastic or plexiglass tubing with approximately ½-inch (13-mm) ID will suffice. The end caps can be cemented in place after the PC board is slipped into the tubing, and your logic probe should be ready to go to work.

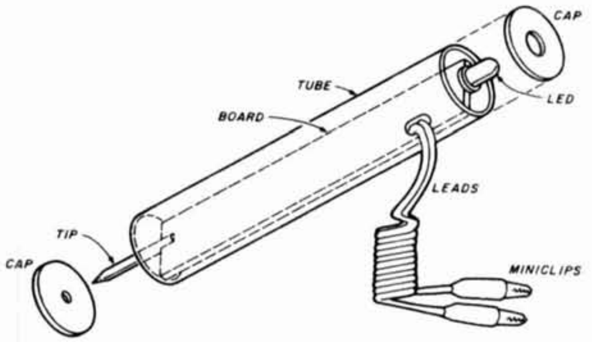


fig. 18. The logic probe. Any plastic tubing about ½ inch (13 mm) ID will suffice for the probe container.

summary

I've enjoyed building and using the logic probe and certainly found LED devices to be interesting and a very useful addition to equipment designs. As stated earlier, they are no more complex than any other diode and can be a lot more fun to use. The digital revolution is rapidly gaining acceptance in the world of Amateur Radio, and the logic probe and associated LED theory will help you to accept and enjoy the benefits we will all gain from this new technology.

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ham radio

More Details? CHECK—OFF Page 94

measuring signal-strength

Receiver S-meter readings are no guarantee of true signal strength — here's how to quantify this controversial subject

Amateur radio transmitters require many measurements, most of which are obtainable from one or more internal or external meters. Some meters have two or more scales, which are selected by switches. Readings may include grid current, plate current, high voltage, relative power, SWR, forward power, reflected power, and ALC level. Other readings may be taken with rf ammeters, rf voltmeters, frequency meters, and impedance bridges. Also, field-strength indicators may be used to adjust the dimensions of fixed or mobile antennas. These indicators are basically short-range portable receivers with loop or whip antennas and meters with arbitrary uniform scales. They are often called field-strength meters despite their inability to receive and measure distant radio signals.

Amateur radio receivers, unlike transmitters, have only one meter and no meter switch. Transceivers also have only one meter, but a switch provides two or more transmitter readings and a receiver S-meter reading. An S-meter gives relative values of signal strength on a uniform 0 to 9 scale, followed by a dB scale. It reflects the last i-f stage level of all signals by responding to the average agc voltage, and is not related to af gain. Readings are based on maximum rf gain and peaked tuning of an antenna or preselector circuit.

S-meter problems

In general, S-meter readings depend on three variables: signal field intensity, antenna characteristics, and receiver gain. Unfortunately, readings bear no fixed relationship to antenna voltage, as receiver gain varies with various makes, models, units, frequency bands, and parts of bands. Also, there is no accepted standard of input voltage for S9 readings, so various manufacturers have chosen signal-generator outputs of 25, 50, or 100 microvolts for calibration at a specified frequency. Hammarlund *Superpro* receivers for military use were made to read S9 with 50 microvolts input at 3.5 MHz, and modern receivers are not very different.

A typical receiver has a one-milliampere meter in a bridge network containing a potentiometer, which balances no-signal plate or cathode current during zero adjustment. *Superpro* receivers had a 200-microampere meter with an adjustable 1000-ohm shunt for sensitivity adjustment, and also had an AVC amplifier preceding the AVC rectifier. Modern receivers usually avoid these features. Zero and sensitivity adjustments often vary with time.

Although S-meter scales are uniform, S-units are

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not. One manufacturer states that a change of one S-number on the meter indicates a change in signal strength of approximately two to one (6 dB). Another manufacturer states that each S-unit indicates a 3-dB increase in signal strength. Both statements are thus questionable. An instruction book for a Collins receiver defined neither S9 input nor S-meter steps, but a calibration showed 50 microvolts and steps of about 1.4, or 2 to 1 in voltage ratio, or 3-6 dB, on the 80-meter band.

Since S-meter readings can be either optimistic or pessimistic, and give only qualitative information at best, it follows that quantitative readings would be more desirable. Field intensity, often called field strength, is the only true measure of signal strength. Broadcast-station operators often use field-intensity measuring equipment because they must submit field intensity data to the Federal Communications Commission. This data shows the extent of service areas and interference areas for other stations using the same frequencies.

field-intensity meters

Despite the vagaries of S-meters, Amateurs have avoided using field-intensity meters because of their cost and complexity, and also because Amateurs have no service area and interference area limits. Unlike broadcasters, Amateurs can enhance their service areas by changing frequency, power, and time of operation. Likewise, Amateurs can avoid interference by changing the same variables.

A field-intensity meter is basically a combination of a local oscillator or signal generator of known output, an attenuator, a portable receiver containing an output meter, and a loop or whip antenna of known effective height or length. Another antenna can be used if it is calibrated by comparison with the loop antenna. It follows that, with certain additional equipment, an ordinary receiver can serve as the major component of a field-intensity measuring set.[1]

High accuracy is unnecessary in field-intensity measurements of distant radio stations. Propagation conditions, such as fading, vary considerably with time. A receiving station may intercept ground waves, sky waves, or a variable combination of both, which results in multipath interference. Sky-wave fields can be measured with a horizontal antenna, regardless of whether horizontal or vertical polarization is used at the transmitter, since practically equal amounts of both types of polarization are present in the incident ionospheric field.

Radio waves are travelling electric and magnetic fields that are perpendicular to each other and to the direction of propagation. Both fields convey equal power at a distance from their source, so either field may be considered as a measure of total radiation. It is customary to measure the electric field component, which may be horizontally or vertically polarized, according to the direction of that field. Measurements of field intensity are usually expressed in units of rms microvolts or millivolts per meter at some point, which are really potential gradients.

When a radio wave strikes an antenna, it induces a voltage equal to the product of the field intensity and the effective height or length of the antenna. Thus, if the antenna voltage and effective height or length are known, the field intensity is given by the quotient of their values. Algebraically, since

$$V = EH \text{ or } EL,\ E = V/H \text{ or } V/L \qquad (1)$$

Therefore, the measurement of field intensity depends primarily on the measurement of a small, variable antenna voltage. This is usually done by substituting a measurable and attenuated local signal in place of the real signal and noting the attenuation for equal output from a receiver. Another, less used, method compares the voltage induced into the antenna by the desired signal field with that from a standard local field. In general, an incoming signal is measured by comparing it with a known calibration signal.[2]

Any kind of signal can be measured with the aid of a receiver. An S-meter will serve as a comparison output meter, as it responds to a-m or fm carrier levels of single-tone SSB modulation and shows about one-half maximum output for CW signals. Audio gain and output are of interest during tune up and zero beating the real and artificial signals for frequency match, but are otherwise irrelevant.

If the real and artificial signals are equal and the antenna characteristics are known, it should be easy to determine field intensity. In principle, a calibrated signal generator is a substitute for the antenna and its output is adjusted to give the same output-meter reading as the real signal. But it is hard to design an attenuator that is accurate at high radio frequencies. This problem was avoided over fifty years ago by putting an attenuator before the i-f amplifier in a special set, which included a local oscillator and calibrating means. The theory and operation of such a set was covered in an IRE paper and will not be discussed.[3]

effective height

The effective height of the receiving antenna must be known to complete a field-intensity measurement. A loop antenna is a standard of comparison because its effective height can be calculated. The relation is as follows.[4]

$$H = 2\pi AN/\lambda = 2.0944 \times 10^{-5} fAN \text{ meters} \qquad (2)$$

where A is the loop antenna area in square meters
N is the number of turns of that area
λ is the wavelength in meters
f is the frequency in kHz

The effective height of a grounded quarter-wave vertical antenna is not the true height, H, but $2H/\pi$ or $0.6366\,H$. It is the height of an imaginary conductor, which carries a uniform current equal to that at the base of a real conductor and radiates the same field along the horizontal. The effective height of a much shorter vertical antenna is about one-half of the true height.[5]

The true length of a horizontal half-wave dipole antenna is $143/f$ meters, where f is in MHz. This is 95 per cent of a half wave in space, but the effective length is only 62 per cent of that value, or 65.26 per cent of the true length, or $94.3/f$ *meters*. If a horizontal dipole is used to measure field intensity, the horizontal component of the field is quite independent of ground characteristics, which differ with location.

The effective lengths of horizontal dipole antennas designed for the 20, 40, and 80 meter phone bands are about 6, 12 and 24 meters respectively. Thus, 50-microvolt S9 signals would produce field intensity readings of approximately 8, 4, and 2 microvolts per meter. Other calibrations and S-readings could be used, with the assumption that S-units are 6 dB apart or 2 to 1 in voltage ratio. This shows that, with the aid of a calibrated signal generator, an ordinary receiver can serve as a substitute for a field intensity meter if accuracy is unimportant.

Broadcast stations use commercial field-intensity measuring equipment and take readings at various distances in various directions, called radials. Field intensity is plotted against distance along each radial on log-log coordinate paper and a smooth curve shows the distance to any value of interest. Distances so obtained from all radials are plotted on polar coordinate paper or map to show the contours of various field intensities, hence service areas. Field intensities of two interfering stations may be plotted against distance in opposite directions on ordinary graph paper to show regions between them where interference may occur.

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ham radio

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tone alert monitor

Design and construction of a tone call system for Radio Amateurs interested in emergency communications

Recently it has been emphasized many times that the need for Amateur Radio communications in disaster situations is very real and necessary. Many groups of Amateurs and clubs have spent money for equipment and much time in drills and practices to make themselves ready for emergency communications.

One problem that continually bothers Amateur operators who are striving to maintain their proficiency is the need to monitor one or more radio communications links. Such monitoring is necessary so that a central agent can quickly "call up" operators who can provide communications for disaster services. Many Amateur operators would be more willing to monitor for the call up if it were not for the task of listening to a party line such as a 2-meter repeater, national calling frequency on 2 meters, or other busy radio frequencies.

alert monitor

This problem of requiring an individual to monitor for an alert, either real or during practice, has inspired the design of an Alert Monitor that will alert each station without the operator having to listen to the party line chatter associated with most frequencies. The Alert Monitor is also handy for those using a receiver in a busy household or in an automobile, where a busy repeater sometimes can be annoying. The monitor can be used with almost any receiver capable of passing normal audio-frequency information. It is not recommended for SSB transceivers that can't hold tight frequency stability.

This Alert Monitor also can alert groups of stations simultaneously (Group Call), or it can alert one station at a time. The Alert Monitor operates with standard *Touch-Tone** audio. It uses two digits for normal operation and a long, single digit for the Group-Call feature.

circuit description

Fig. 1 shows the schematic. The audio is applied to the Alert Monitor through the audio-input jack and a 2.2k resistor. Audio amplitude is limited by two 1N914 back-to-back connected diodes. A 5k pot adjusts the audio input level, which is coupled to the tone decoder ICs by 4.7-μF capacitors. U-1/U-2 decode the high and low tones for the first *Touch-Tone* digit, and U-3/U-4 decode the tones for the second digit. The resistor and capacitor at the output of each decoder IC provide a delay between the time that the decoder IC senses a tone and the time that the NOR gate will respond. This prevents falsing on other audio that may be present in the decoder.

When the first digit has been received, a logic high is applied to U7A pin 1 for 2.5 seconds through timer IC U6. A logic high must be applied to U7A pin 2 during this 2.5 second period for the Alert Monitor to operate. Therefore, the second digit must be received within 2.5 seconds of the first for a valid call. This sequence ultimately sets U10B and causes Q1 to conduct. This, in turn, causes relay K1 to transfer the audio to the audio-output jack. In this condition, the audio signal is connected to the speaker, and the receiver can be monitored for the "Alert Call."

For continuous receiver audio monitoring, the monitor switch can be connected to the monitor positions and the communications receiver can then be used normally without the Alert Monitor defeating the receiver audio.

The Group Call feature works by the sending station (encoder) transmitting the second digit of the

*Touch-Tone is a registered trademark of the American Telephone and Telegraph Company.

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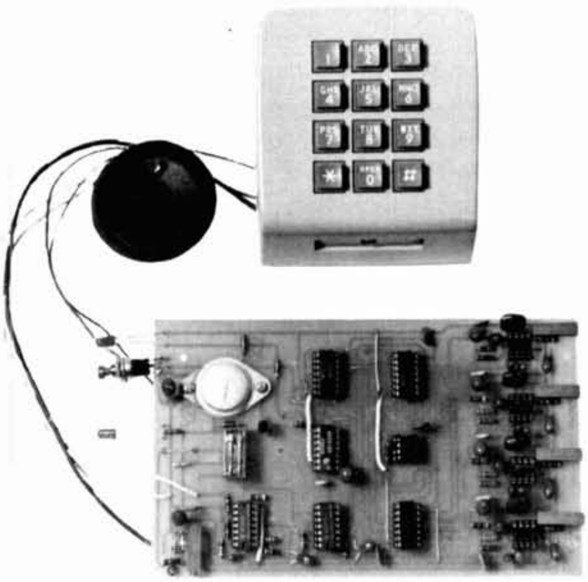
Control box of the prototype Alert Monitor.

two digits for 6 seconds or longer. In this mode, U-1/U-2 don't respond. The signal path now appears in the form of a pulse at U8A pin 6 and will, after 6 seconds, produce a logic high at U10A pin 3. If, in fact, the second tone is still being received, it will cause a logic high to be applied to U10A pin 2. This action will enable the Group Call Detector to produce a logic high, which will eminate from U10A pin 5. This high is applied to U5D pin 12. U5D is a NOR gate; and from this point on, the operation is the same as when two digits were received.

Whenever U10B is set, either by receiving the correct two tones or the Group Call tone for 6 seconds minimum, three reactions take place:

1. The audio is applied to an external speaker as described earlier.

2. A call indicator is illuminated. This is an LED mounted on the front panel.

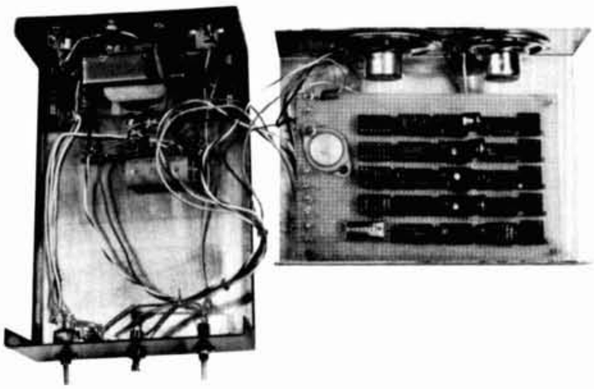


Alert Monitor built on PC board, shown here ready for alignment and testing.

3. The Alert Monitor oscillator is triggered for 4 seconds, producing a two-tone "twee-dell" audible signal from the Alert Monitor.

The reason for the visual call indicator is in case a call has been received while the operator is out of hearing range. Upon returning, if the call indicator is illuminated, the operator knows that an alert tone has been received, even though the receiver may be squelched or silent at that particular time.

To put the Alert monitor back into the alert mode, press the RESET push-button to reset U10A and B and to extinguish the call indicator LED. It will also disable the audio path through K1 contacts. This action will again silence the receiver speaker until the next proper alert tone is detected.



Complete prototype Alert Monitor showing perf-board construction, power supply, speakers, and minibox enclosure.

power requirements

Power requirement for this unit is from 8-20 Vdc at approximately 150 mA. This makes the unit adaptable for mobile operation, and the low current drain should not present any problems so far as leaving the receiver and the Alert Monitor on while away from the automobile. The prototype was built to include a dc power supply which also houses the Alert Monitor speaker as well as a speaker for receiver audio. A power supply is shown in **fig. 2**.

construction

The original Alert Monitor was constructed on a fiberglass perf board using wire-wrap sockets. All discrete components except variable potentiometers, the relay, and the capacitors associated with U12, were mounted on 14-pin header plugs. **Fig. 3** shows the wiring of the discrete components to the ICs.

No special construction practices were observed, except that all V_{CC} connections for the ICs were carried back to the power source at U12 pin 2. Each IC

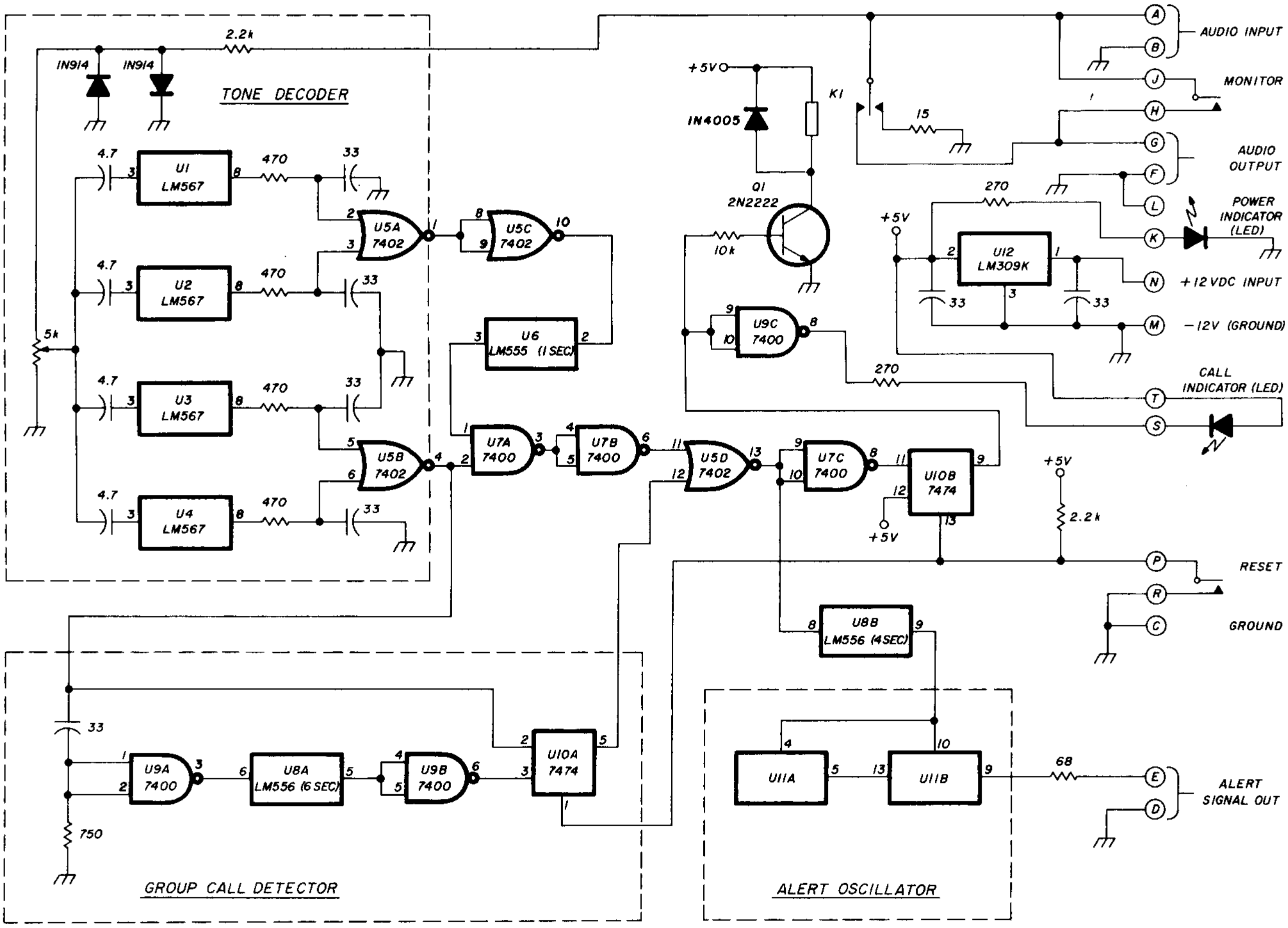


fig. 1. Alert Monitor schematic. Circuit operates with standard *Touch-Tone* audio. Two digits are used for normal operation and a long, single digit for Group Call. Original circuit was constructed on a fiberglass perf board using wire-wrap sockets, but a PC board is now available (see text).

also had its power ground returned to the central ground input point at the case of U12 to reduce transients on "daisychained" power leads, which could cause unstable operation.

Bypass capacitors across the plus and minus power connections of the ICs may be added if necessary. No heatsink was provided for the LM309K (U12). At the low-current level required for the unit, it was found to be unnecessary. The 5.0k trim-pots used for frequency adjustment and input-level adjustment are all multi-turn potentiometers. These are necessary, especially for the frequency-adjusting pots, for the vernier action needed to "tune" the LM567s to their correct frequency.

Should you not wish to use the wire-wrap method of construction, a PC board is available.* The board is single-sided and requires very few jumpers. I prefer this method of single-sided PC board because it's much easier to use or copy. All component parts used for both prototypes (perf board or PC board) were purchased from Jameco Electronics.† Of course, parts from other suppliers are acceptable, but this attempt at standardization should help the builder. The only part I did not get from Jameco was the relay. It was purchased from Radio Shack, and the part number for this item is 275-215.

alignment

Several methods for alignment of the tone decoder section are available. The fixed-value resistor connected to pin 5 of each LM567 in series with the 5.0k variable resistor and the 0.1-μF capacitor connected to pin 6 are the frequency-control elements for each single-tone detector (LM567). A good-grade Mylar capacitor should be used in this circuit to prevent frequency drift with temperature or internal leakage. If an oscilloscope is available, it can be connected to

*Order boards from MJW Boards, Route 2, Box 167-C, Berryville, Virginia 22611.

†Jameco Electronics, 1021 Howard Avenue, San Carlos, California 94070.

pin 8 of the tone decoder IC to be aligned. An audio signal of the correct frequency is applied to the audio input by connecting the Alert Monitor to the receiver with which it's to be used. Then a *Touch-Tone* signal is transmitted in the normal fashion from a transmitter.

alignment procedures

The procedures described should, of course, be done with a dummy load connected to the transmitter to avoid interference:

method 1

1. Set the audio level at the receiver for the normal listening volume.

2. Set the audio-input-level control at midrange.

3. Adjust the 5k frequency-control pot until a logic low appears at pin 8 of the first decoder IC under test.

4. Reduce the audio level by the 5k level pot in increasing amounts while adjusting the frequency-control pot to maintain the logic low output until no further sensitivity can be obtained for the IC under test.

5. Increase the audio level by the 5k level pot, with the oscilloscope moved to the next IC.

6. Adjust this IC in a like manner to the next *Touch-Tone* frequency being received.

As an alternative method, the LED connected to the tone decoder IC, pin 8, may be used to indicate that the tone decoder has received the correct tone at a sufficient level. As the LM567 detects (or locks onto) the input tone, the LED will light. (Make sure of correct polarity for the LED). When no further refinement of frequency can be made by the frequency-control pot, you'll notice that the IC will oscillate between a logic high and low. If you're using the LED method for alignment, the LED will start to dim at this point. The LEDs and the associated 270-ohm resistor may be eliminated for each tone decoder on the PC board if not used as an alignment indicator. This will not affect the performance of the circuit.

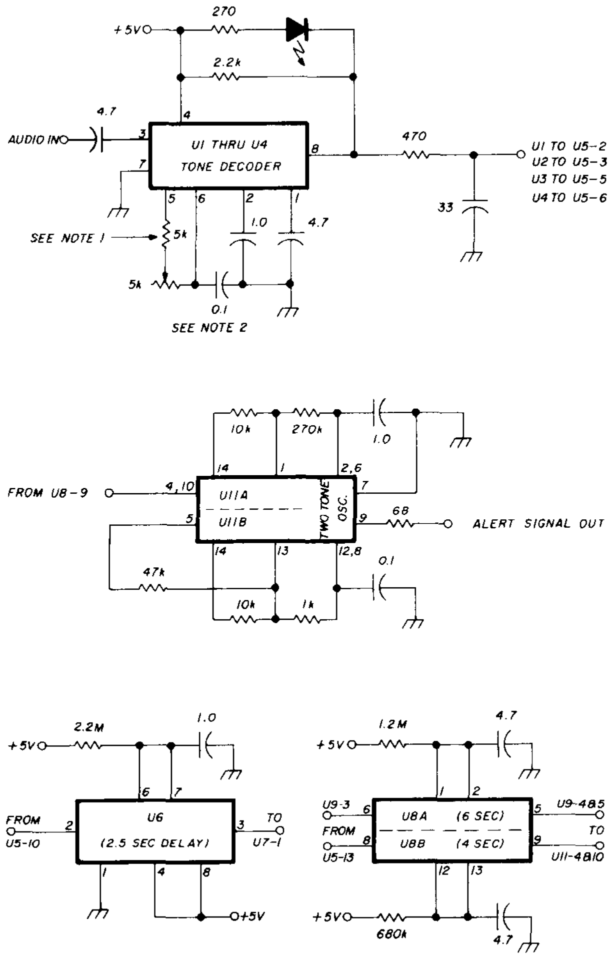


fig. 3. Discrete-component wiring to the ICs. The resistor connected to pin 5 of the tone decoder IC in series with the 5-k pot and 0.1 cap connected to pin 6 are the frequency-determining elements for each single-tone detector. A good-grade Mylar cap should be used in this circuit to prevent frequency drift with temperature.

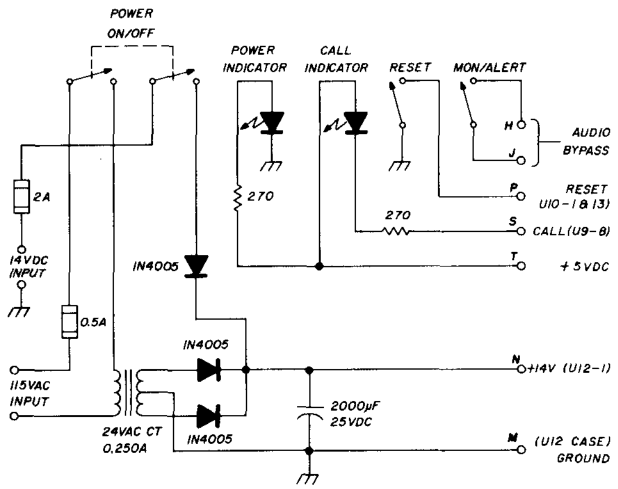


fig. 2. A power supply for the Alert Monitor.

Each *Touch-Tone* digit consists of two audio frequencies. Therefore, two decoder ICs are necessary for each digit being decoded. Through experimentation I've found that 11k will allow centering the variable pot for the lowest frequency tone, and 2.4k will allow adjustment at the highest frequency. Exact calculation of the time constants for the RC combinations can be found in the data sheets provided by the

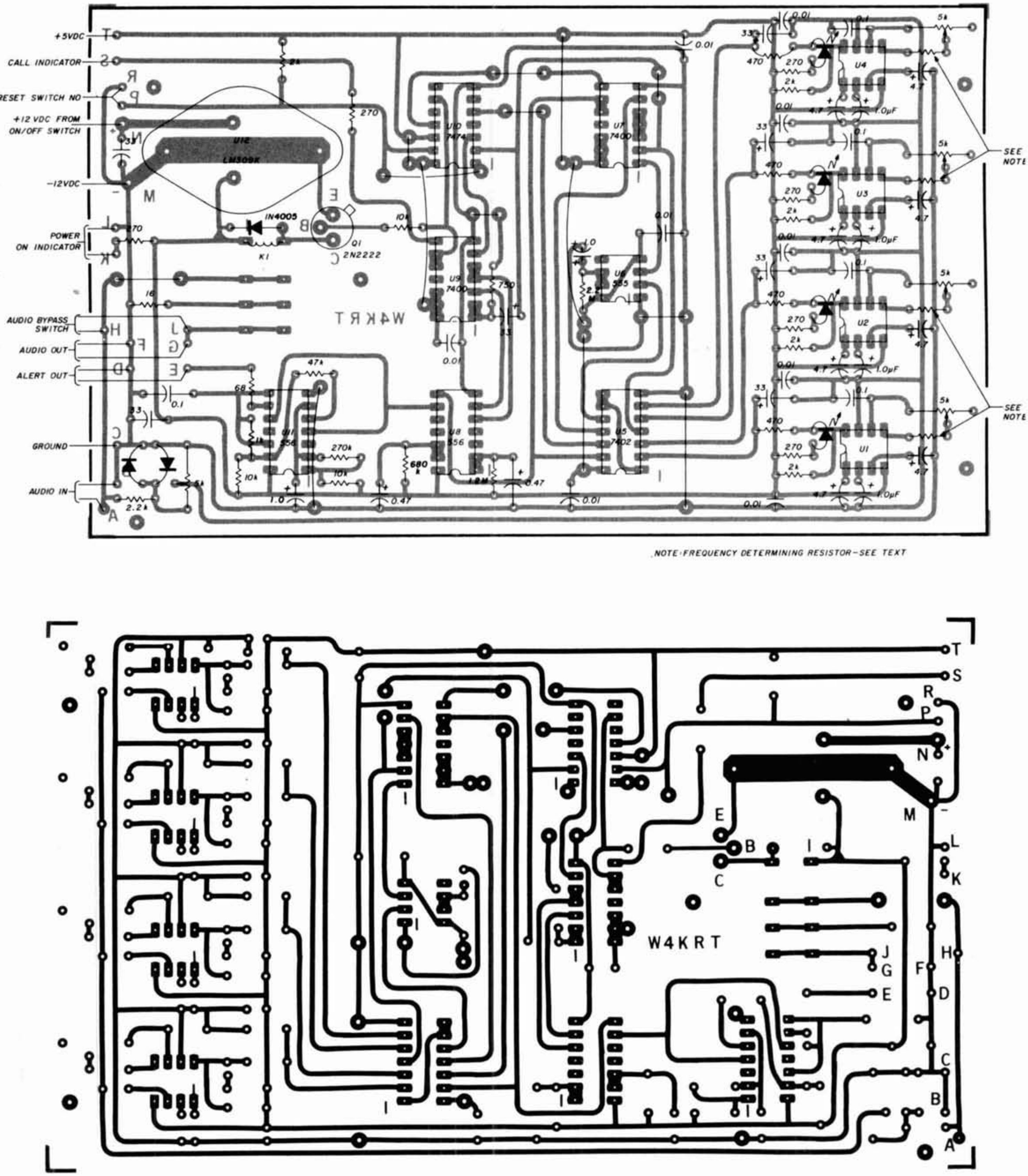


fig. 4. Above, component placement on PC board. Below, Alert Monitor PC board, foil side.

table 1. Relationship between frequencies produced by the various *Touch-Tones*.

digit	high tone (kHz)	low tone (kHz)
1	1209	697
2	1336	697
3	1477	697
4	1209	770
5	1336	770
6	1477	770
7	1209	852
8	1336	852
9	1477	852
*	1209	941
0	1336	941
#	1477	941

manufacturer. See **table 1** for the frequencies produced by various touch tones.

acknowledgments

I'd like to thank all of my Amateur friends who gave suggestions and encouragement for this project. In particular, I'd like to thank KA4GCF, Bob, for his help with the manuscript; WB4HID, Harry, for his help with construction tips; Don Bungard for his help with the PC board; and KA4HOP, Janie, my XYL, for her many hours of assistance in testing the Alert Monitor and for her typing work.

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ham radio

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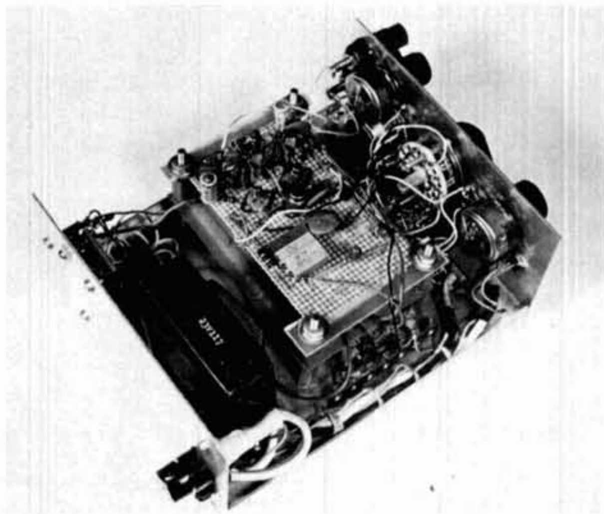
integrated circuit function generator

A function generator based on the Exar XR-2206 which features multiple waveforms over the range 10 to 100 kHz

If you are a builder, experimenter, or just like to maintain your own equipment, I am sure you appreciate the value of a good signal source. Ideally, the perfect signal source should be able to provide whatever frequency, amplitude, waveform, and impedance level required for the job at hand. But, unfortunately, like most things in life, we must compromise a little. The classical signal source was either an audio generator or an rf generator. At best, it produced a sine wave and, in the case of the audio generator, perhaps a squarewave. In recent years, a third entry has appeared on the scene. It is called a function generator and is distinguished primarily by its ability to produce a variety of waveforms (functions) through the audio and sometimes low rf frequency ranges. Its repertoire usually includes the sine, square, triangle, and perhaps saw-tooth or pulse output waveforms. The spectral purity of a particular waveform is usually not quite as good as that from a comparably priced generator that is designed to produce only one waveform, but is usually more than adequate for general purpose use.



Internal view of the function generator showing perf-board.

Until recently, high cost has relegated the function generator to the laboratory, but now several new integrated circuits have made it possible for the Amateur to construct his own for a very modest investment. The function generator described in this article uses the XR-2206 integrated circuit manufactured by Exar. This IC can supply a sine wave, triangular wave, square wave, and a 50 per cent duty cycle positive pulse and has the options of a-m and FSK modulation. The frequency can be varied from about 1 Hz to above 100 kHz and the output waveform, although not lab quality, is suitable for most Amateur applications. The manufacturer states that the sinusoidal distortion is less than three per cent over the

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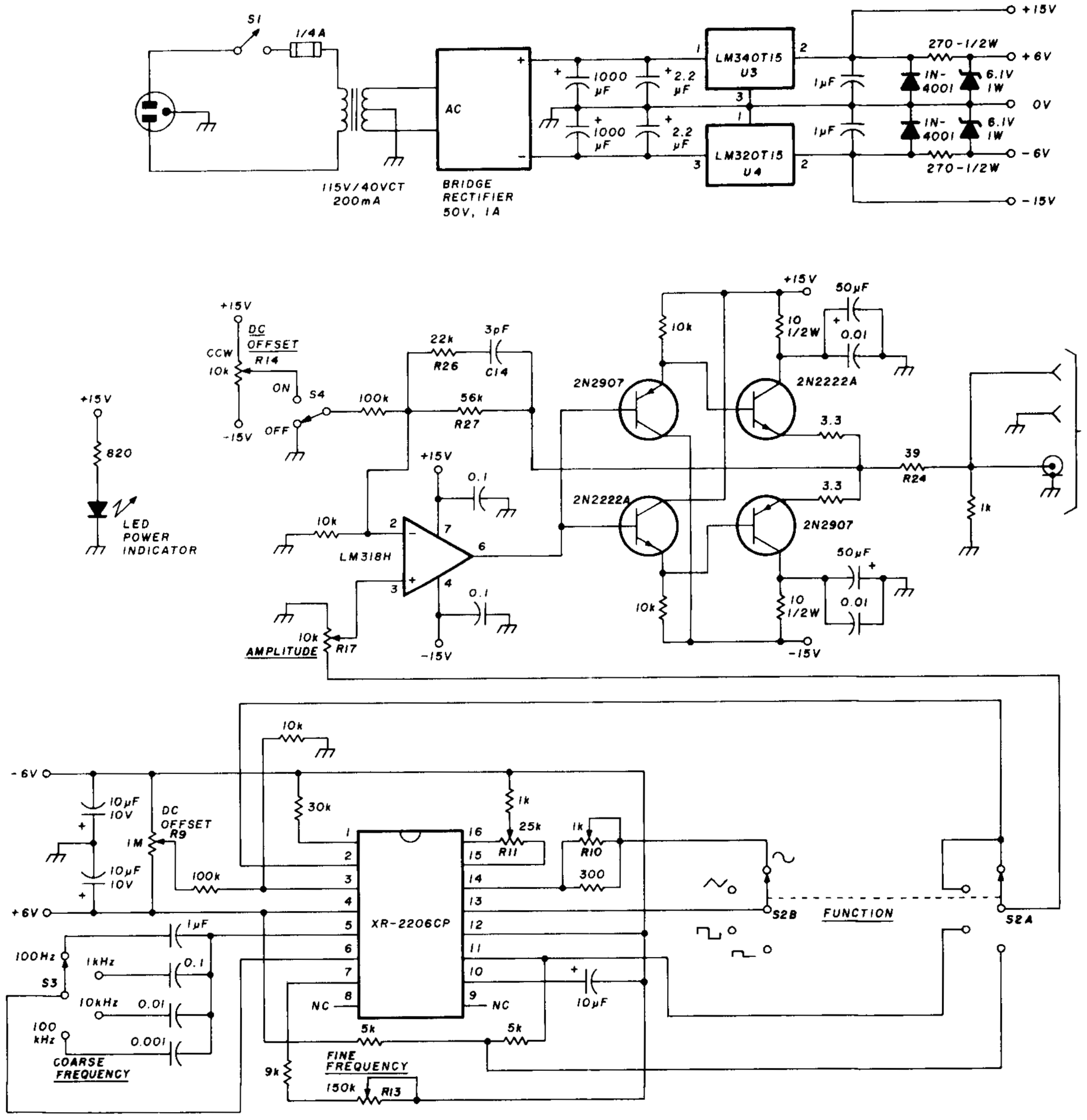

fig. 1. Complete schematic diagram of the function generator based on the Exar XR-2206 integrated circuit.

entire frequency range; this isn't bad considering the versatility and circuit simplicity.

I added a suitable power supply and power amplifier to the basic XR-2206 and came up with a very handy addition to my home workshop. The power amplifier increases the amplitude range, lowers the output impedance, and provides a means of introducing an adjustable dc offset level to the basic waveforms.

circuit description

The oscillator circuit is lifted almost entirely from Exar's application data on the XR-2206. I elected not to incorporate the a-m and FSK inputs, although they would be simple to include. R13 controls the frequency and is panel mounted. R9, R10, and R11 are all trimpots mounted on the circuit board. R10 adjusts sine wave distortion. R11 controls sine wave symmetry, and R9 is adjusted to eliminate any residual dc component in the sine and triangular waveforms. With the components shown in the schematic (see **fig. 1**), the frequency can be varied from about 10 Hz at the low end to slightly over 100 kHz at the high end in four overlapping ranges, each with a 100-to-1 ratio. S3 selects the frequency range and S2 selects the waveform. R17 is the amplitude control; it is panel mounted and controls the signal level fed to the LM318 operational amplifier which in turn drives the power amplifier stage. R26, R27, and C14 provide negative feedback around the entire amplifier section, as well as frequency compensation. R14 and S4 provide an adjustable dc component for the output waveform. R24 brings the output impedance up to the vicinity of 50 ohms. The power supply uses two three-terminal regulators and although the positive and negative voltages do not track, it has proven quite satisfactory.

construction

I built my generator in a small aluminum box with most of the circuit, with the exception of some of the larger power supply components, mounted on perfboard. U3 and U4 use the cabinet as a heatsink and the two output transistors are equipped with small push-on heatsinks.

adjustment

Initial adjustment consists of setting R9, R10, and R11 to their optimum settings. Switch S4 to the off position and select the sine wave. Be sure that the amplitude control (R17) is set so that the output waveform is not clipped when viewed on an oscilloscope. Alternately, adjust R10 and R11 for the least sine wave distortion and best symmetry. Adjust R9 to eliminate any dc component and repeat the process until no further improvement can be seen. A distortion analyzer would be helpful for these steps if one is available, but the "eyeball" technique gives fairly good results. Make these adjustments at a frequency of about 10 kHz.

operation

Operation is fairly straightforward with the exception that the square wave will have a slight dc component with S4 in the off position. This is easily eliminated by switching on S4 and adjusting R14 to eliminate the offset. The waveforms deteriorate slightly around 100 kHz, but are still useful.

For the modest investment in time and material, this little generator has proven to be a very handy addition to my shop. I'm sure that some readers may have suggestions for improvements and modifications, and I would be most interested in hearing from them.

I would like to thank Mr. Ralph Flagel for his help with the photographs.

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ham radio

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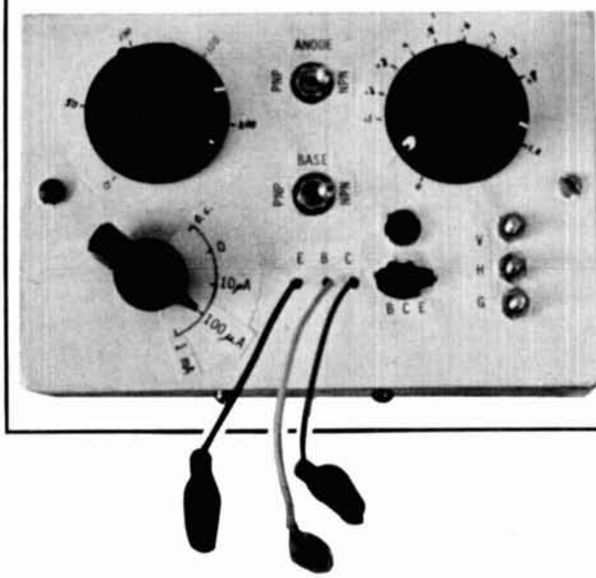
semiconductor curve tracing simplified

When used with a good scope, this versatile circuit provides a wealth of information about any unknown semiconductor

Most experimenters have accumulated a vast assortment of semiconductors, many unmarked, undecipherable, or otherwise of unknown characteristics. An ohmmeter can provide some information about them, such as which transistors are PNP and which are NPN; it can also distinguish silicon from germanium, and establish diode polarity. But to really gain detailed information requires a curve tracer and scope. A curve tracer will reveal nearly all low-frequency transistor parameters such as current gain, breakdown voltages, and input-output impedances. It will also identify, at a glance, zeners, tunnel diodes, and other specialized semiconductors, and give much valuable information about their operating characteristics.

A laboratory-type curve tracer usually injects a staircase waveform of current into the base of the unknown transistor, then displays a complete family of collector current waveforms on the screen.[1] This is an ideal arrangement, but not exactly simple. The curve tracer described here displays only one curve at a time; to look at an entire family requires the turning of a knob. I consider this a small price to pay for simplicity. It also has the advantage of providing a

The complete curve tracer unit. Upper lefthand knob controls peak collector (or anode) voltage swing. The knob on the right is the base current adjustment potentiometer, R2.



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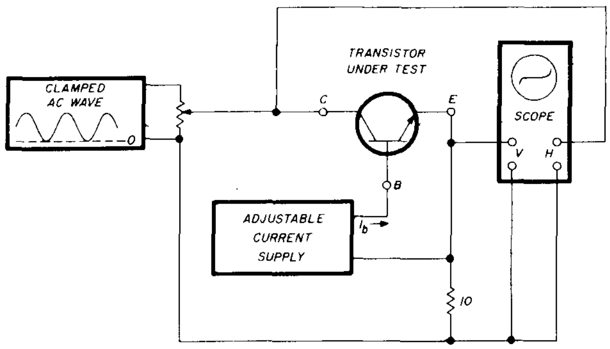


fig. 1. Simplified diagram of the curve tracer.

continuously adjustable base current, which permits the display of *any* collector curve, rather than only discrete values. It's sometimes nice to be able to see "between" those discrete curves.

theory

Fig. 1 is a simplified diagram of the curve tracer. The clamped ac supply swings the collector voltage from zero to a peak value determined by the potentiometer setting. This voltage is also applied to the scope horizontal input. Vertical deflection is provided by sampling current through the 10-ohm resistor in series with the emitter. The result is a trace of collector current vs collector voltage. The small voltage drop across the 10-ohm resistor does not significantly affect collector-to-emitter voltage; the error is only 1/10 volt for 10 mA of collector current. The 10-ohm value permits current readings to 100 microamperes per cm when the vertical gain is turned up to 1 mV per cm.

If greater sensitivity is desired, a 100-ohm resistor could be used, at the expense of a tenfold increase in error. The error in V_{CE} can be avoided by using a scope with completely independent horizontal and vertical inputs or by tolerating a downward deflection for increasing current. But since most scopes have one terminal common to both inputs (ground), and give a positive deflection upwards, the circuit was designed for this type of scope.

The clamped ac voltage for the collector is created by the simple circuit of **fig. 2A**. This voltage is positive throughout the cycle (**fig. 2B**) except for the

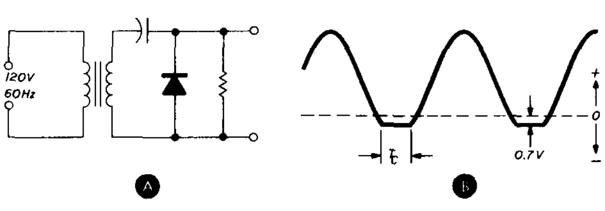


fig. 2. The simple circuit shown at *A* will produce the clamped ac waveform shown at *B*.

brief interval, T_c, when the diode is conducting. During this interval, the waveform swings slightly negative by an amount equal to the diode barrier potential, about 0.7 volt.

If the transformer and diode were perfect, the charge time, T_c, for the capacitor would be zero, and the output would be a pure sine wave. But since they are not, the waveform dwells at approximately −0.7 volt for the time it takes to charge the capacitor. In my unit a very small transformer was used, which resulted in a T_c of about 3 milliseconds; with a larger transformer it would be less. The dwell time results in a bright spot at the beginning of the trace — not really a disadvantage since it makes the origin easy to

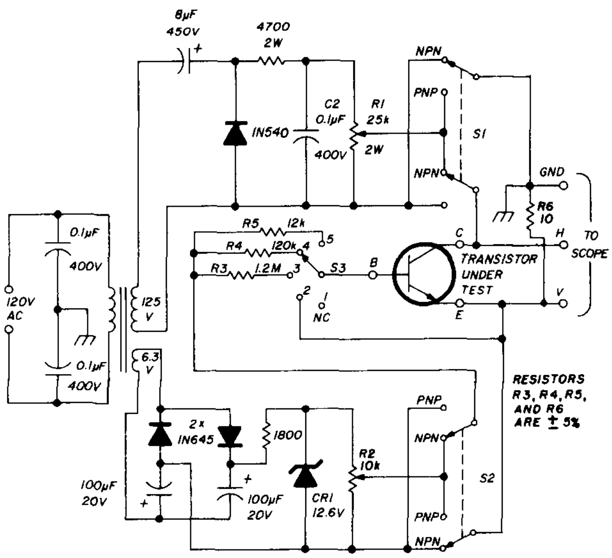
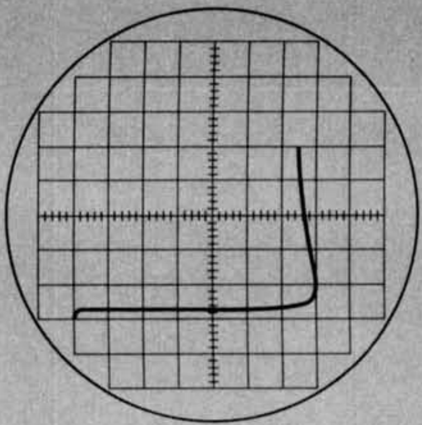


fig. 3. Schematic of the tracer. The power transformer can be a Stancor P8181 or an Allied PS8415.

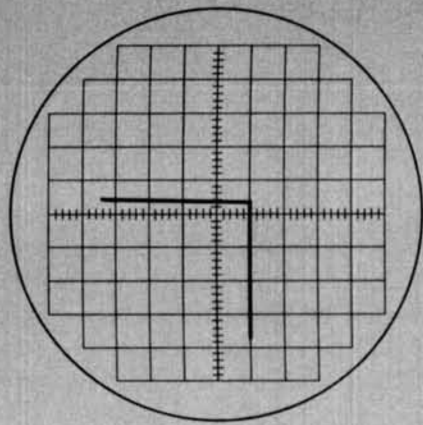
identify. The spot can be made brighter by omitting C2 in **fig. 3**.

the circuit

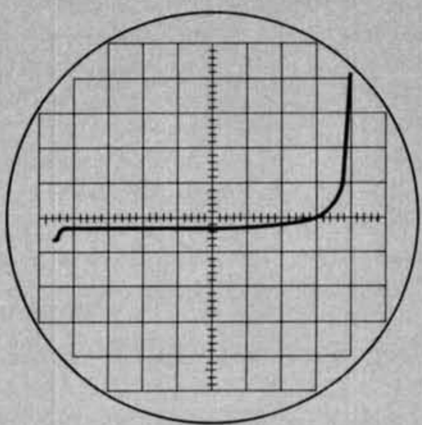
The complete circuit is seen in **fig. 3**. A small "one-tube" power transformer of the type used on early uhf TV converters, boosters, and other one-tube devices is used for the two power supplies. The "plate" winding is used for the clamped ac supply, and the 6.3 Vac "filament" winding is used for the constant-current base supply. The latter uses a full-wave voltage doubler and is regulated to a constant 12.6 volts by zener diode *CR1*. A voltage of 12.6 rather than 12.0 volts is used because of the 0.6-volt base-to-emitter voltage drop in a silicon transistor. Since this drop is about 0.2 volt for germanium transistors, base currents will be about 4 per cent higher than indicated when measuring germaniums.



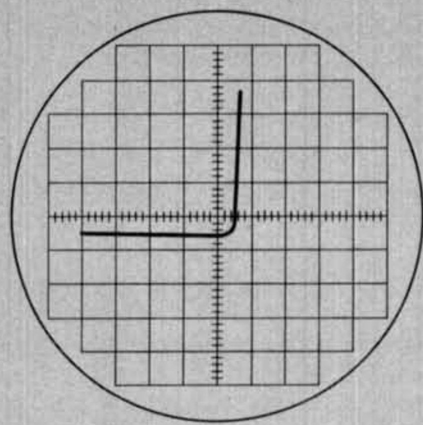
Collector characteristic curve of a 2N498 with base current of 9 μA. Scales are 20 V/cm horizontally and 1 mA/cm vertically. Notice the negative resistance effect in the avalanche breakdown part of the curve at about 120 collector volts.



Sharp breakdown characteristic of a 1N1527 zener diode at approximately 20 volts. Scales are 5 v/cm horizontally and 1 mA/cm vertically.



Collector characteristic curve of a 2N2369A with 8 μA of base current. Scales are 2 V/cm horizontally and 1 mA/cm vertically.



Reverse characteristic of a 1N914 showing avalanche breakdown at −90 volts. Scales are 20 V/cm horizontally and 1 mA/cm vertically.

Switch S3 provides three ranges for the base current adjustment pot, R2. The maximum currents, 10 μA, 100 μA, and 1 mA, are determined by resistors R3, R4, and R5. These resistance values ideally should be close tolerance, 5 per cent or better, to ensure the precise values of maximum base currents indicated on S3. The scale of R2 is calibrated 0-1.0 in divisions of 1/10 to indicate the fraction of base current shown on S3. For instance, if S3 is set to 10 μA, and R2 is at 0.4, base current would be 4 μA.

Switches S1 and S2 are polarity-reversing switches to accommodate either PNP or NPN transistors. You might wonder why these two switches are not combined into one 4-pole switch. The use of two separate switches makes possible the testing of depletion-mode fets with no further increase in complexity. For instance, an N-channel fet is tested by placing S1 in the NPN position and S2 in the PNP position. The fet source, gate, and drain are connected to the curve tracer emitter, base, and collector terminals, respectively. The result is a positive drain supply and a negative gate voltage; the latter adjustable by R2. Negative gate voltage can be measured with a VTVM connected between gate and source, or base to ground terminals on the tracer.

For the $I_b = 0$ position of S3, the base is grounded. Switch S3 also provides a fifth position in which the base is left floating, which is handy for checking BV_{CEO} and I_{CEO}.

construction

This unit was built into a 2 × 4 × 6 inch (51 ×

102 × 152 mm) chassis without much crowding of components; parts placement isn't critical.

A variety of transistor sockets can be wired in parallel to accommodate the various transistor basing arrangements in common use. It's also recommended that alligator clips on short leads be included for those diodes and transistors that will not fit into conventional sockets. These three leads should preferably be of different colors and clearly labeled **E**, **B**, and **C**.

Wirewound pots are recommended for R1 and R2. Both these controls have hand-drawn scales. The scale of R1 indicates collector (or anode) voltage in peak volts; the range is zero to roughly 200 volts peak.

operation

For best results the tracer should be used with a laboratory-type scope that has accurately calibrated vertical and horizontal deflection. I use a Hewlett-Packard 130B, which works beautifully in this application.

Nearly all work is done with vertical gain set at 10 mV per cm; the scope then reads 1 mA per cm vertically. Horizontal sensitivity, however, ranges all the way from 0.1 volt per cm to at times as much as 50 volts per cm.

Since the curve tracer operates at 60 Hz, it will tell you nothing about the frequency limitations of your transistors. To determine high frequency performance, an rf transistor tester is recommended.[2].

The current-limiting resistors in series with the base make transistor damage unlikely. However, damage is possible if R1 is run too high. When testing an unknown device, it's wise to start with R1 set near minimum and keep an eye on the scope screen as the control is gradually advanced.

At times you'll notice that part of the characteristic curve drifts upwards. This is usually due to heating of the device under test. It doesn't normally occur unless the amount of heat generated is a significant fraction of the maximum device dissipation. It's particularly apparent with germanium transistors because of their considerable temperature sensitivity.

You'll also notice the characteristic curve occasionally takes the form of a very elongated loop rather than a single trace. This is because of what is called "temperature hysteresis" and is caused by cyclical heating of the transistor junction during collector voltage peaks.[3].

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ham radio

digital logic probe

A discussion and several designs for TTL and CMOS logic probes, featuring short pulse type memories

When electronic equipment consisted primarily of analog circuitry, most maintenance and troubleshooting could be handled with a simple volt-ohmmeter and some common sense. The VOM was the one instrument that could always be found on the bench of any ham or electronic experimenter. In addition to being generally useful, the VOM had much going for it. It was relatively small and easily handled. It was generally affordable even by Radio Amateurs of very modest means. Although it wasn't a precision instrument, if one knew how to use it, very good results could be obtained. By and large, it is still a most useful tool, but it's one whose relative importance has considerably diminished.

Complementing the VOM today, as the general purpose test instrument of digital circuitry, is the logic probe. Like the VOM, the logic probe is easy to handle, convenient, inexpensive, and, when used intelligently, capable of furnishing the needed *troubleshooting information.*

There isn't much to a logic probe. It is simply a device that will indicate the "state" of an accessible point in a digital circuit. Using some sort of quick response display, like an LED for example, the probe will indicate whether the voltage at the test point is high, low, or, perhaps, alternating. Does every ham and electronic experimenter need one now? Well, that's pretty much for the individual to decide, a decision to be based on what other equipment is around the shack and whether he does his own maintenance or pays someone else to do it.

There is no getting around the fact that each new piece of electronic gear hitting the market contains more digital circuitry than did its predecessor. Not too long ago the digital circuitry in the typical ham shack might have been limited to that in the electronic keyer or, if there was a new and expensive oscilloscope, in the trigger circuit of the horizontal sweep. Today, digital circuitry is the heart of the fully synthesized, VFO, of frequency counters, modern capacitance meters, fashionable readouts and displays, to name a few places, and it's becoming ever more commonplace.

For troubleshooting these digital circuits, it is pretty tough to find better instrumentation than the simple logic probe. Coupling that observation with the fact that a generally adequate logic probe can be quickly and easily assembled at a cost of anywhere between a few quarters and a few dollars, depending upon the status of your "junk" box, it's hard to justify not having one around the shop bench or shack. Just how elegant or sophisticated a probe is needed for any given shack is easily determined and, using one or more of the following circuit ideas, built.

If all of the digital circuitry currently in your shack operates on +5 Vdc and you have no particular interest in detecting very short pulses (10 μs or less) occurring at very low frequencies, then the very simplest of TTL (transistor transistor logic) probes should suffice. If your equipment is all in the 5-volt category, but there is a reasonable chance that you'll be looking for fleeting pulses, troubleshooting the triggered sweep of a modern oscilloscope is a prime example, then the logic probe should be slightly more elegant. The probe will still be based on a TTL integrated circuit, but some technique for capturing those elusive pulses need be added.

Some of the newest frequency synthesizers and frequency counters are built around LSI, or large-scale integrated circuits. Many of these are made up of mosfet rather than bipolar transistors. They may be operating on any voltage between about +4 and

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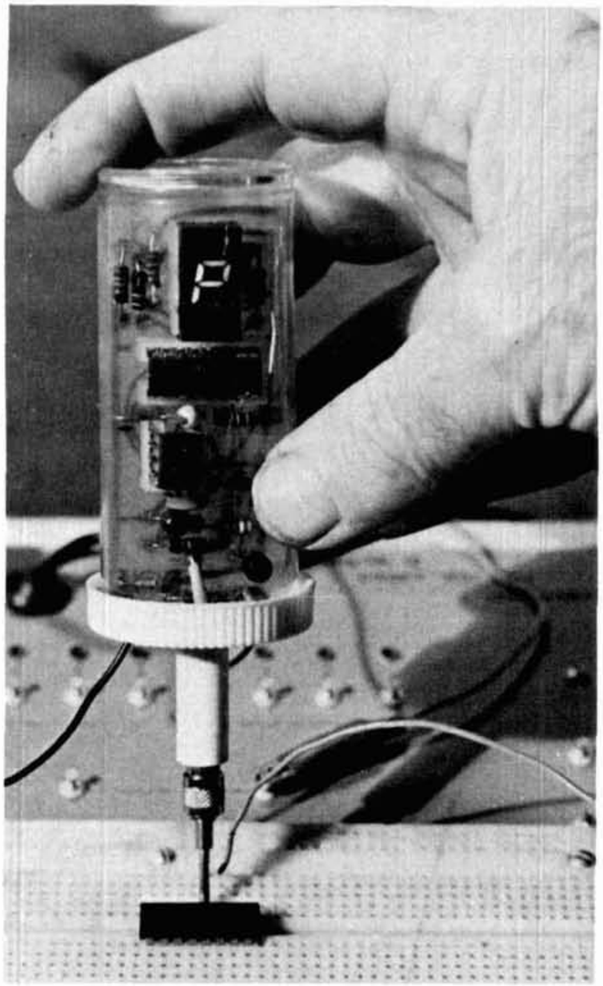

View of the digital logic probe showing the mounting and connections within the pill bottle.

+15 Vdc. A logic probe suitable for working on these circuits must be able to cope with the entire span of voltages. Such a probe is going to entail more than the basic probe discussed above. If the capability to detect very short pulses or noise spikes is desired, it will be still more elegant. However, it will be only slightly more complex. In fact, a probe capable of handling the full spectrum is so simple and little more complex than the simplest one that the only reasons for building the lesser one is that it's all you need for the foreseeable future, every part needed for it is in hand, and you have time to build it right now! Well, this very simple probe, the circuit of which is shown in **fig. 1**, has done yeoman service for me over five years and has on only the fewest of occasions been inadequate to a task at hand. It's not to be sold short.

simple logic probe

I previously pointed out that a logic probe is simply a device that will indicate the "state" of an accessible point in a digital circuit. Thus, the probe must have some sort of a readout, and its readout should be unambiguous. The probe ought to be convenient to use, and it must not upset or influence the circuit being observed. **Fig. 2** is a circuit diagram for a very simple logic probe. It should be adequate for most purposes, just as long as its use is limited to 5-Vdc circuits. With a minor exception, it's the circuit of a kit that was widely available a few years ago.

Isolation between the logic probe and the circuit under test is provided by the 10k resistor in the base of Q1, which can be any NPN switching transistor with a low-current beta equal to or greater than about 50. A 2N2222 would be just fine. All of the logic and the display drive is provided by an inexpensive 7404 hex inverter. The two LEDs make up the readout. LED A is turned on when the probe sees a high, LED B a low. If the test point has an alternating voltage, the two LEDs will blink alternately or appear to be both on depending upon the pulse frequency. Power to operate the probe is taken from the circuit under test. As each inverter of the 7404 can source about 15 to 20 mA, there's adequate current to drive the LEDs to a reasonable brightness. The current limiting resistors protect the 7404 and the LEDs. The whole thing is assembled in a salvaged plastic pill bottle or the like.

If the two LEDs are of different colors this logic probe, exactly as described, could be satisfactory. However, if only LEDs of the same color are available, the resultant readout might be something less than desirable. The logic probe is small, hand-held, and is frequently used to probe densely packed circuitry. It isn't advisable to let one's eyes stray too far from the tip of the probe if the risk of accidentally shorting a couple of pins together is to be avoided. This means that it is most advantageous if the readout is such as to permit reading "out of the corner of the eye." A distinctive difference in the readout for high or low is most desirable. An elegant and inexpensive way of accomplishing this is shown in the

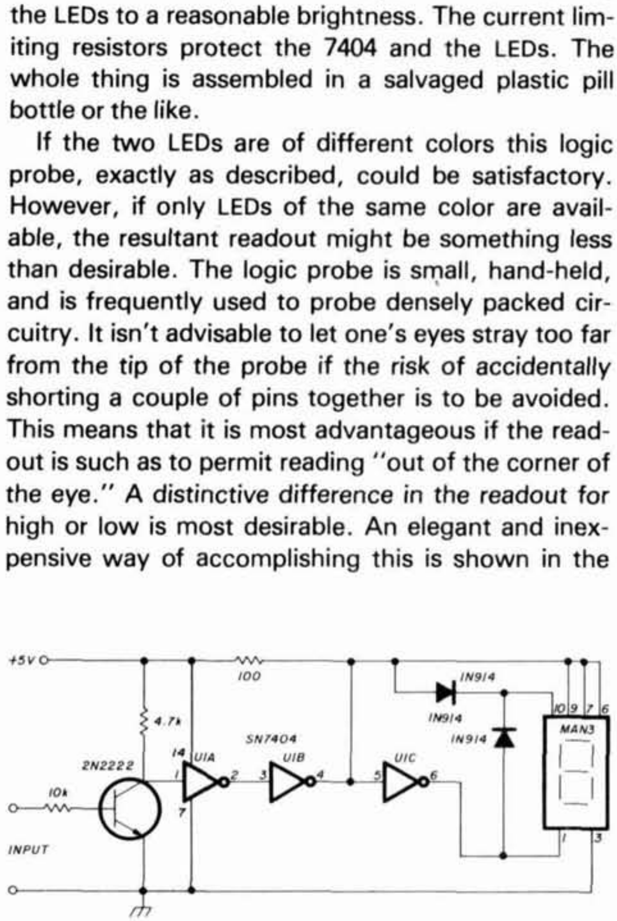

fig. 1. Schematic diagram of a simple logic probe for use with strictly 5-volt circuitry.

circuit of **fig. 1**. MAN 3A or MAN 3M LED readouts, or their equivalents, are available for as little as $1.00 (or less) on the surplus market. One of these devices coupled to the output of the SN7404 hex inverter, as shown in **fig. 1**, makes for a most ingenious little display. A high at the probe tip causes the hex inverter to drive the numeric display so that a *1* appears. A low at the probe tip results in a *0* being displayed. If there is a pulsating signal at the test point you will see a *P*.

I did not originate this circuit; it is merely one of several that were available as inexpensive kits over the past several years. The output transistors of the hex inverter source the current to drive the LED segments. As this circuit uses no current-limiting transistors between the 7404 and the display, a short in the latter will likely destroy the inverter. That's the primary weakness of an otherwise very clever circuit.

The MAN 3A was used because it was available. A common-anode display could be used with, of course, appropriate interchange of connections. The significant point is that the output transistor is capable of sinking up to 30 mA, so that you can use either a common-cathode or common-anode display. This is not true, as will be discusses later, if the TTL device is replaced with an MOS device. Referring again to the probe shown in **fig. 1**, the two leads are connected to the V_{CC} and ground of the circuit under test, and the probe is held against the test point. **Fig. 3** shows the printed circuit board layout as seen from the foil side. The overall size of the board is tailored to fit snuggly into the pill bottle so it may be necessary to make some slight changes to the printed-circuit board layout to fit any given plastic bottle.

pulse memory

When the instrumentation target is a very fleeting positive going pulse, such as in the previously suggested example of the trigger circuit of a modern oscilloscope, or if you are trying to ferret out some suspect random noise pulses in that new desk top computer, the logic probe must see and retain the high long enough to produce a visible signal on the

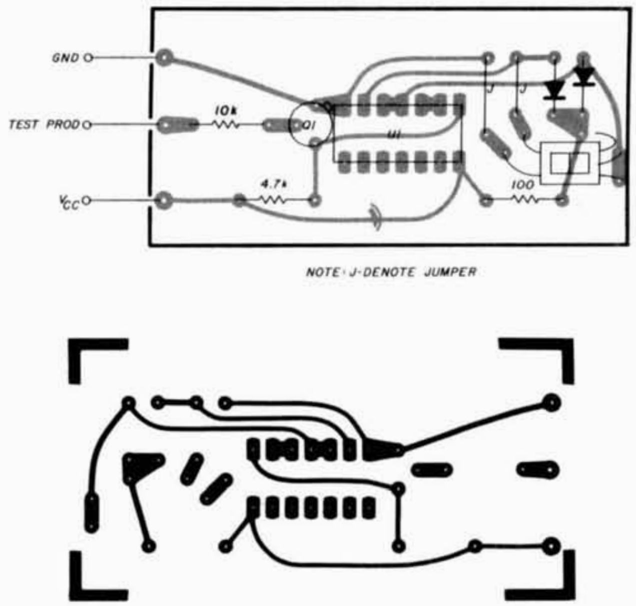

fig. 3. Etching pattern and parts placement diagram for the simple TTL logic probe.

LED display. An acceptable way of accomplishing this pulse "stretching" is through recourse to a one-shot multivibrator as a memory circuit. A very short incoming pulse, too short to be seen directly on the LED, is fed by the input amplifier of the probe to the input of the one shot, triggering it on. The output of the multivibrator is placed in parallel with one of the normal outputs of the hex inverter. The pulse duration at the output of the multivibrator is tailored by the time constants of the circuit so as to ensure a visible signal. Where the logic probe is to be used only on a +5 Vdc supply, and if there is an SN74121 in the junk box, a possible probe circuit is shown in **fig. 4**. The length of the output pulse duration needed to yield an acceptable display can be determined experimentally by varying R1, C1, or both.

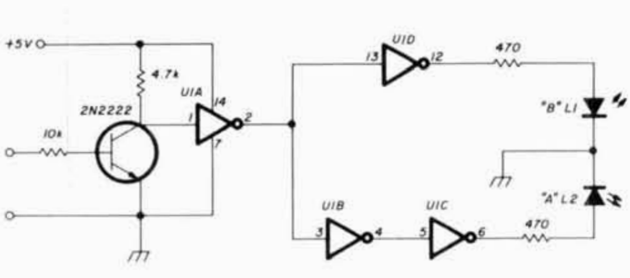

fig. 2. Schematic of the basic logic probe which used single LEDs to indicate either a high or low logic level. A cyclic signal will cause the LEDs to flash or both appear to be on due to the repetition rate.

versatile logic probe

An alternative short term memory uses the ubiquitous 555 timer. The connections for the 555 as a pulse stretcher is shown with a CMOS rather than a TTL hex inverter. Nevertheless, it can be used with the latter in exactly the same way. This, the most flexible and elegant logic probe, is presented in **fig. 5**. It can be used with any logic circuitry operating between approximately 4 and 15 Vdc. This means the logic probe can be used for RTL, DTL, TTL, or CMOS; in fact, for about any existing digital circuitry except for I^2L. On the lower side, the voltage limitation is the efficiency of the LED display. With prime LEDs, it might be possible to work down to about 3 volts. On the high side, the limitation is the upper limit on V_{DD} for the 4049 CMOS hex inverting buffer used as the logic chip and display driver. If a Fairchild F4049 is used, V_{DD} could safely go as high as 18 Vdc without damaging the probe. At any rate, it is most unlikely that the user will be confronted by voltages exceeding the range of 4.5 to about 13.8 volts so any 4049 will be acceptable and almost any surplus common-anode, seven-segment readout will work satisfactorily.

Being aware that the 74C04 and CD4069 CMOS hex inverters are pin compatible with the TTL 7404, one might well ask why go to the trouble of redesigning the circuit. Why not just replace the 7404 of the previously described logic probe with its CMOS counterpart and let the circuit go at that? There are two reasons why this cannot be done. The first has to do with the nature of the output mosfet of the CMOS chip, the second with the current limitation of the LED display.

In discussing the logic probe built around an SN7404 TTL hex inverter, note was made that the output transistors could each source about 15 mA or sink 30 mA. This permits the designer to select either a common-anode or common-cathode seven-segment LED display with the full confidence that there will be adequate current for safe direct drive of the LEDs. The 74C04 or 4069, on the other hand, are specified as being able to sink or source considerably less than 1 mA for +5 Vdc V_{DD} operation and 1.5 to 2 mA for 15-volt operation. The chip might be used with a common-cathode display, but the light intensity would be low. Used with a common-anode display, the CMOS output stage would quickly fail if it were forced to sink enough current for the LED to be acceptably visible, a function of the voltage applied to the common anode of the display and the size of the current-limiting resistors.

The problem is circumvented by turning to the CMOS 4049, a hex inverting buffer. These CMOS buffers provide both the necessary logic for the probe and a high current output capable of safely driving the LED load. It is not, however, as flexible as the TTL 7404. The CMOS buffer will typically sink about 5 mA with a V_{DD} of 5 volts and about 20 mA for a 15V V_{DD}. Under the same operating voltages, it will source only 1 to 3 mA. Thus, the TTL design option of using either a common-anode or a common-cathode configured display is closed; only a common-anode device can be used. How this is done is shown in the circuit in **fig. 5**.

The other major concern when designing the logic probe for this very wide range of operating voltages is the current limitations of the LEDs themselves. The generally useful current range of most LEDs is about 2 or 3 to 1. That is, starting with no current through the LED, current is gradually increased until first, the light output is barely adequate to be seen in a lighted room and then second until the LED fails. The current at failure will be about 2 to 3 times that at "visible." By the way, this isn't offered as a "scientific truth," but rather as an observation based on experience and generally supported by pertinent specification sheets. Q2 and ZD1 in **fig. 5** provide a voltage regulator whose output is applied to the common anode of the display. As the applied voltage at the V_{DD} lead of the probe is varied between +5 and +15 volts, the voltage at the output of the regulator varies between 4.4 and 6.2 Vdc. In the path between the output of the regulator and ground there is the 1N914, across which there will be about a 0.6-volt drop, the LED itself, which will account for a drop of 1.7 volts, and the current-limiting resistor which must make up the rest of the drop. The variation in voltage across the resistor, for the 4.4 to 6.2-volt swing, will thus be 2.1 to 3.9 volts, considerably less than 2:1 range. The LED current will be limited to the same range, one that is quite safe.

Three 1N914 diodes are shown between the 4049 and the LED readout in **fig. 5**. These diodes perform several functions so, unlike the diodes in **fig. 1**, cannot be replaced by slightly larger current-limiting resistors. This probe is designed to be used with operating voltages as high as 15 volts. Under this condition, and when the output of the buffer is in the high state, the output will approach 15 volts. Meanwhile, because of the voltage regulator, the anodes of the LEDs are close to 5 volts. The 1N914s protect the LEDs from what otherwise would be about a 10-volt reverse voltage, some 4 to 7 volts more than the maximum permitted according to the manufacturer's specifications. A second function of the diodes, or at least two of them, is to isolate the output mosfets of

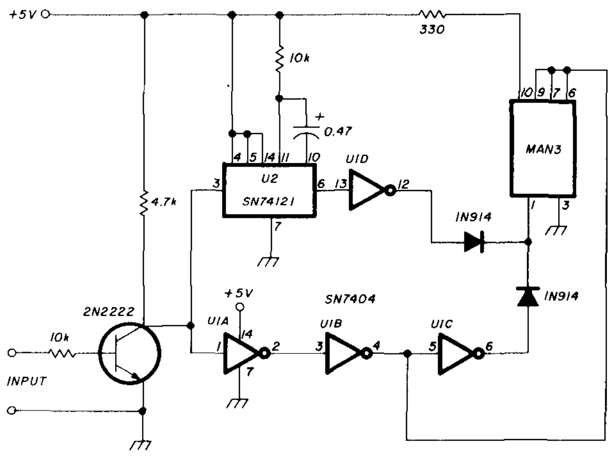

fig. 4. Diagram of the TTL probe with a short pulse memory. The monostable is used to capture any short-duration pulses for display on the LED display.

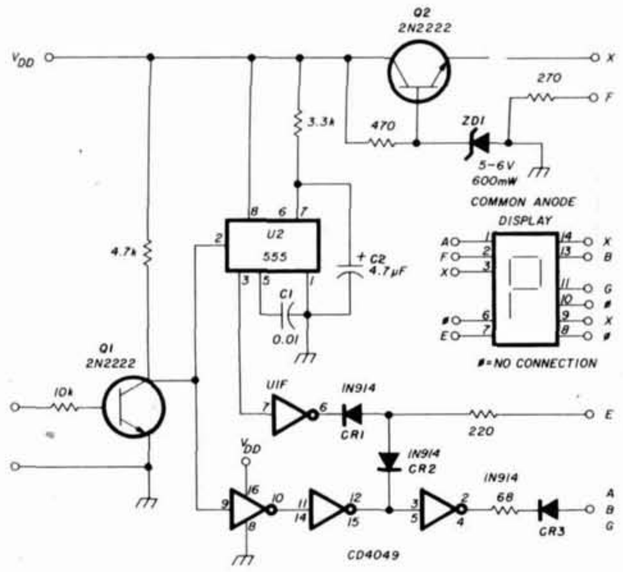

fig. 5. Schematic of the CMOS type logic probe with a short pulse memory. A 555 timer is used as the memory element; a common-anode display must be used in this version.

the inverter buffers from each other. Either of two inverters may go low to turn on segment E of the LED while the other is high. The diode isolation permits this to occur without risk to the 4049.

Unused inputs of CMOS ICs are never allowed to float. They are tied high, low, or to a used input. In the design of the circuit of **fig. 5** the inverters were simply paralleled as necessary so that no inputs were allowed to float.

Just as the pulse stretcher for the TTL-based logic probe design could have been a 74121, this CMOS-based design could as well be a CD4047A monostable/astable multivibrator. The 555 timer was used because it's smaller and was available; it is also less expensive. There's nothing unusual about the employment of the 555; the one-shot configuration is right out of the book for a negative going trigger input and a one-shot stretched output. The output pulse length is given as 1.1 RC where the RC applies to the resistor between V_{DD} and pins 6 and 7 and the capacitor between this point and ground. The component values shown on the schematic were found, experimentally, to give a pulse that was just long enough to barely flash the Litronix readout. For test purposes, 0.25-microsecond pulses were generated at a pulse frequency of one pulse per second. Readout visibility was very acceptable. The test circuit is described briefly at the end of this article.

Obviously, the readability of the output for a stretched pulse can be enhanced simply by increasing the RC time constant in the 555 timer circuit. In designing the probe, however, the duration of the stretched pulse was deliberately kept to the useful minimum; the probe readout differentiates between short pulses or noise pulses at low frequency reoccurrence rates and low frequency "clocking" phenomenon.

With a low-frequency, alternating state signal at the probe point (10 Hz or less), the readout will alternate between *1* and *o*. At a higher frequency and in particular where the duty cycle is between 20 and 80 per cent, the eye of the observer is fooled into seeing a steady *P*. For very short positive-going pulses at low-frequency rates, the display is a brief *P* followed by an extended *o*. At higher frequencies, the display takes the form of a fairly bright *o* with a dim staff to form the *P*.

None of the described logic probes will indicate the presence of a brief negative-going pulse. This is a design limitation accepted because I have never found need for that capability and because providing for it does cause some additional circuit complication. If the added capability is required, it can be achieved by modifying the CMOS logic probe as follows. Replace the 555 timer with a 556 dual timer. Isolate the two paralleled hex inverters. Connect the input of one of these inverters to the collector of Q1 and its output to the input of the added timer. Connect the output of the added timer to the input of the other freed inverter and its subsequent output to the cathode of an additional 1N914. The anode of the 1N914 connects to the anode of the existing 1N914 in the circuit coupled to the three LED segments that

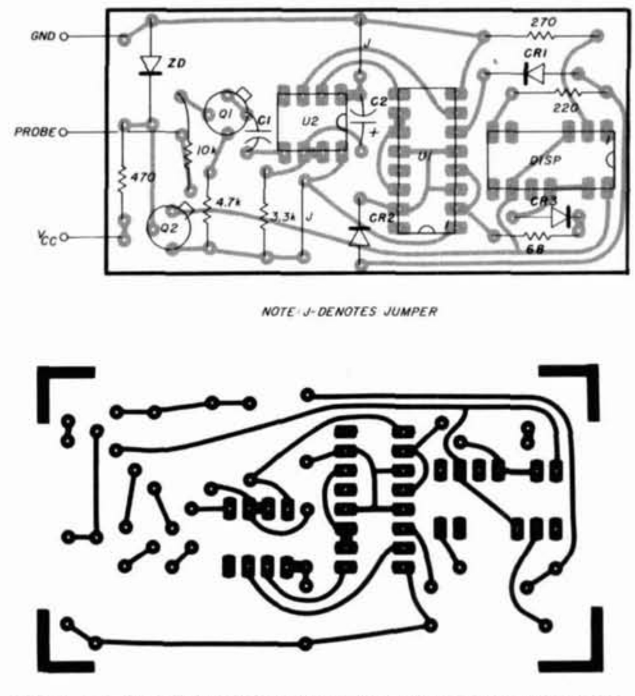

fig. 6. Printed circuit board layout and the parts placement diagram for the CMOS logic probe.

make up the switched element of the *o*. In the presence of an occasional negative-going pulse, the display should be a *1* changing to a *P* when each pulse appears. The passive components associated with each half of the 556 should be the same as those shown for the probe in **fig. 5**.

Having decided upon the circuit to be implemented, the next step is to collect the pill bottle to be used as the case. This is an important step because the size and shape of the pill bottle will determine the size and layout of the circuit. **Fig. 6** shows the circuit board layout of the CMOS logic probe described in detail above. It will be useful if your pill bottle will take a 1¼ × 2½-inch (3.0 × 6.0-cm) board.

Printed circuit board techniques were used for both probes shown in this article only because it was convenient to do so. Wire wrap techniques or even point-to-point wiring on sockets mounted in perf board would be just as good. The logic probe is fundamentally a low-frequency device. It would be difficult to find a poor construction technique as long as the workmanship is good!

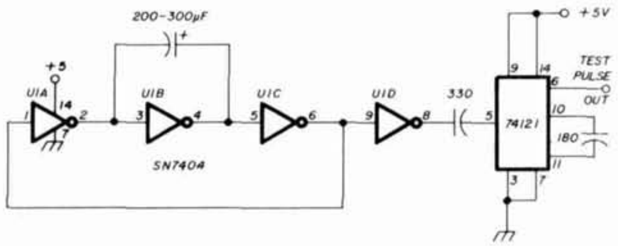

fig. 7. Pulse generator to test the short pulse memory capability of the logic probes.

Test of the completed circuit for all but the pulse stretching feature is easily accomplished. Connect the V_{DD} and V_{SS} or V_{CC} and ground wires, depending upon your choice of CMOS or TTL, to an appropriate power source. If everything is working properly the readout will display a *o*. Touch the probe to the positive voltage terminal of the power supply and the *o* should change to *1*. The circuit shown in **fig. 7** will test the pulse capture feature if one has been included. Pulse length of the output pulse of the 74121 is approximately 1400•C1 seconds. If C1 is 180 pF, the pulse at the test point would be $1400 \cdot 180 \cdot 10^{-12}$ second or approximately 0.25 microsecond.

The logic probe is a very practical instrument to have around the shop or shack. If you don't have one and can squeeze out an evening, try one of the circuits presented here. It won't be long before you begin to wonder how you ever managed to get along without it!

ham radio

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challenge for microwave-antenna designers

New ideas are needed for low-cost, efficient microwave antennas for satellite TV reception

Attention antenna-design enthusiasts: Will you be the person who develops a novel idea for low-cost antennas for satellite TV reception? There's a real challenge waiting to be met, and this challenge is a prime opportunity for Amateur Radio operators to make a significant contribution to an important new and growing segment of space-communications technology. Conventional parabolic-reflector antennas are too costly — new ideas are needed to reduce the cost of antennas with 40-50 dB gain at 4 GHz.

TV receive-only terminals

There is a TV technological revolution underway, and the advanced hobbyists who are a part of that revolution have been searching for a gallium arsenide fet low-noise amplifier or a low-cost 12-foot (3.7-meter) parabolic reflector antenna for a home TV receiver terminal. Many hobbyists have succeeded in obtaining enough gain and a decent signal from a backyard antenna aimed at one of a dozen — soon to be more — satellites transmitting from above the equator.[1].

These installations are called TV receive-only terminals, or home TVROs. Home TVROs are already the province of skilled and dedicated experimenters. The number of private terminals in operation is difficult to determine since very few are licensed, but some estimates are as high as 1000.[2]

Video programming on domestic satellites currently offers a great deal in the way of quality entertainment and information, and it will get even better in the future. Satellite distribution of these TV programs to private and shared receiver terminals allows anyone in this country to participate in a new and entertaining form of communications. Technical sessions at WESCON by J.C. Bacon,[1] J. Kinik,[2] H.P. Shuch,[3] and H.T. Howard[4] form the basis for much of the information in this article.

FCC deregulation

Much is happening in Washington to help give people these new opportunities.[1] Bills in both the Senate and House to rewrite the 1934 Communications Act have been introduced, deregulation trends are underway at the FCC, and the Executive Branch has initiated several actions to expedite these efforts.

The Justice Department has responded to the FCC in favor of deregulation of receive-only earth stations stating that the language of the 1934 Communications Act, which created the FCC, authorized regulation of transmitting devices — not receive only.[1]

The Federal Communications Commission decided on October 18, 1979, to drop its licensing requirements for satellite receiving stations.[5] The action eliminates the requirement that persons constructing a receiving antenna have it coordinated to eliminate interference. It also ends a requirement that they

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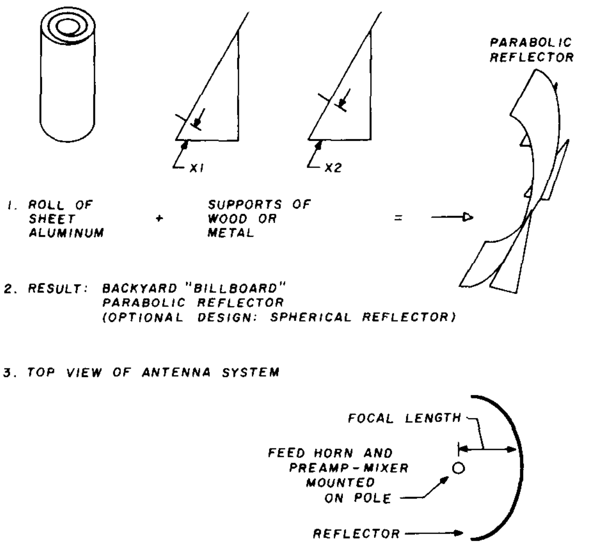

fig. 1. Billboard parabolic reflector construction for low-cost TVRO antenna.

obtain a construction permit and ultimately a license to operate the receiving station.

Those who want licenses, to obtain government protection from interference with the signals they receive, will still be able to apply, the commission said. But it also said the licensing will be entirely optional. The FCC said it took the action to eliminate the costs of the licensing process for builders of receiving stations and to end delays involved in obtaining a license.

FCC Chairman Charles D. Ferris noted that, while operators of unlicensed stations will not be protected from interference, this can normally be eliminated by relocating the station slightly, which is usually less costly than obtaining a license.[5] Operators of receiving stations will still have to obtain permission from the operators of the sending satellites to receive their transmissions.[5]

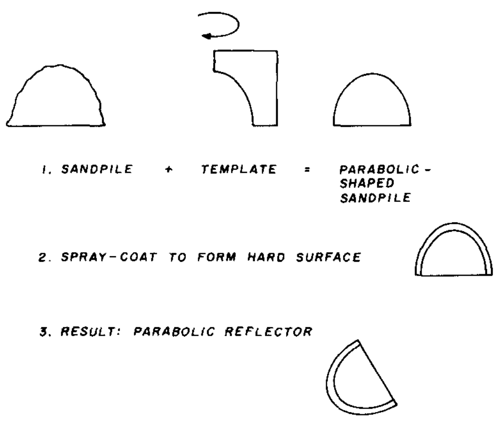

fig. 2. Sandpile parabolic reflector construction for low-cost TVRO antenna.

low-cost novel designs are needed

In January, 1977, the FCC ruling allowing the use of 4.5-meter diameter antennas for TV receive-only earth terminals created a strong need for low-cost antennas in the 4.5 to 6 meter size range for the first time.[2]

Two suppliers, Scientific Atlanta and Anixter-Mark, have invested in tooling to stamp out panels to the correct curvature on a mass production basis.[2] Another supplier, United States Tower Company, has combined a fiberglass reflector with an aluminum backup structure to realize a more cost-effective design. The nominal current price levels for the lowest-cost designs offered by the commercial suppliers are $1500 for 3-meter diameter, $4000 for 4-meter diameter, and $6000 for 5-meter diameter antennas.[2] These antenna costs must be reduced, through novel antenna designs, so that the total cost of a complete TVRO terminal can be kept low enough to be afforded by nearly everyone.

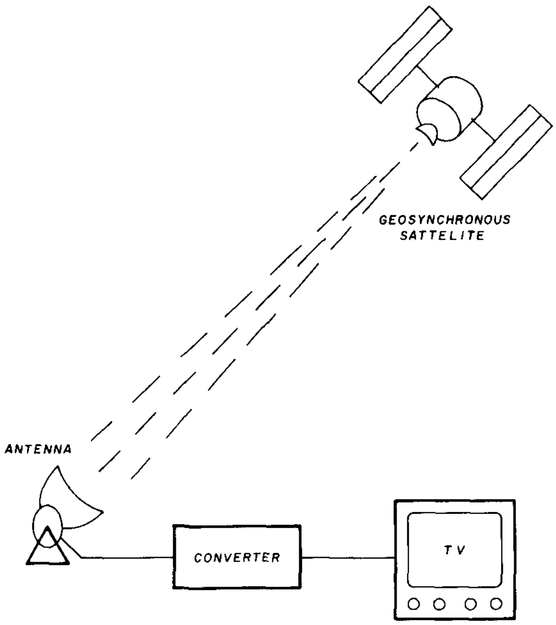

fig. 3. Typical TV receive-only (TVRO) terminal for receiving signals from geosynchronous communications satellites. Problem: Design a low-cost antenna of good structural integrity and adequate rf performance.

satellite TV signals

The technological revolution which makes possible the distribution of television programming via satellite is based on receiving DOMSAT (Domestic Communications Satellite) signals.[3] The downlink band used by most North American DOMSATs is 500 MHz wide, and for a given antenna polarization there will be present up to twelve video carriers spaced 40 MHz apart. These signals are of extremely low amplitude, and this complicates the design of TVRO antennas.

It has been shown that, for the illumination contours typical of most North American DOMSATs,[3] an optimum private-terminal antenna will exhibit on the order of +41 dBi gain.* Given the signal power (EIRP) and path loss numbers listed in **table 1**, the signal level available to the low-noise amplifier will be on the order of −90 dBm.

technical requirements

The dominant requirement for private TVRO antennas is low cost, while of course retaining reasonable structural integrity and adequate rf performance. These three considerations establish the baseline for a set of requirements, but the process of arriving at a set of such requirements is one which is more practical than scientific — thereby creating a challenging opportunity for ham radio operators and experimenters who can make a significant contribution to an important new and growing segment of space-communications technology.

A low-cost design must not require high-cost fabrication methods, tooling, or labor. It should also have a minimum weight and volume to keep costs down, and it should be designed with ease of installation in mind to avoid expensive hoisting equipment. Total installation time should be kept to a minimum. An additional requirement is that the design should be amenable to kit construction techniques. These goals, if met, can be combined with gallium arsenide integrated circuit technology[6] to develop a superior TVRO terminal.

table 1. Typical DOMSAT signal characteristics (from reference 3).

video carrier	
channels	24
adjacent channel spacing	40 MHz
orthogonal channel spacing	20 MHz
frequency band	3.7-4.2 MHz
peak deviation	10.25 MHz
maximum video frequency	4.2 MHz
pre-emphasis curve	CCIR 405-1
audio subcarrier	
frequency	6.8 MHz
peak deviation	75 kHz
maximum audio frequency	15 kHz
pre-emphasis time constant	75 μSec
composite	
EIRP	+65 dBm
path loss	−196 dB
99% power bandwidth	36 MHz
received spectral density	−206 dBm/Hz

*Gain referred to an isotropic source. **Editor.**

table 2. Technical performance goals for 3.7-4.2 MHz TVRO antenna.

	required minimum	desired
antenna gain	40 dBi	45 dBi
rf efficiency	45%	55%
wind survival	75 mph	75-100 mph

new design ideas?

The optimum low-cost TVRO antenna has yet to be designed and developed. This is an active area of research, and some new ideas are beginning to emerge. One idea, shown in **fig. 1**, requires only low-cost materials and requires no expensive metal shaping. A second idea is illustrated in **fig. 2**. This clever design is based on an idea by John, K6EJF, who suggested using spray-on material of the type often used for coating swimming pools. The template can be made of plywood and a guide-pin or rod can be driven into the sandpile for attachment to the template.

New microwave antenna designs and discoveries are bursting forth at a rapid rate. An example of this is the discovery that the snow sled saucers sold as kids' toys exhibit 22 dB of gain at S band![4] A similar antenna was constructed from a child's 25-inch (64-cm) snow sled saucer and a feed horn was made from a one-pound coffee can. The saucer is not a true parabola but is close enough to give 15+ dB of gain at 2 GHz.[7]

Will you be the person who develops a new idea for low-cost antennas for satellite TV reception? I'd like to hear from you if you have a clever idea for the construction of a new low-cost antenna. Your information may be useful during the preparation of a subsequent article on the subject of TVRO terminals. Write to Dr. D.H. Phillips, 1345 Arizona Avenue, Milpitas, California 95035.

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calculating the cascade intercept point of communications receivers

New equations for calculating a receiver's cascade intercept point are a powerful design tool

On today's heavily used Amateur bands which have many extremely strong signals, receivers with high dynamic range are required. Many articles have treated the considerations and problems of designing a high dynamic range receiver from the circuitry point of view, but a systematic approach to receiver design seems to be lacking.

receiver system design

The best way to approach a receiver design problem is with a block diagram. By identifying the various functional blocks in a receiver, the critical parameters for dynamic range (input intercept point, noise figure, and bandwidth) can be predicted for the overall receiver.

Dynamic range may be defined as

$$DR = \frac{2}{3}(IP_{i3} - MDS) \quad (1)$$

where DR = spurious-free dynamic range, dB
IP_{i3} = third-order input intercept point, dBm
MDS = minimum detectable signal (noise floor), dBm

For a system at room temperature the minimum detectable signal is

$$MDS = -174\,dBm + NF_t + 10 \log BW_n \quad (2)$$

where NF_t = overall system noise figure, dB
BW_n = system noise bandwidth, Hz

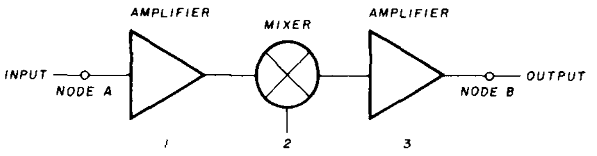
Note that the system noise bandwidth is usually well approximated by the 3-dB bandwidth of the narrowest filter in the system. The total (or cascade) noise figure of a system is

$$F_t = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_2 G_1} + \ldots \quad (3)$$

$$NF = 10 \log F_t \quad (4)$$

The minimum discernible signal can be calculated from the last three equations, but some method is needed to predict the system's input intercept.

By Brian P. Gross, WA7TDB, 2900 East Aurora Avenue, No. 146, Boulder, Colorado 80303



Gain	+ 10 dB	− 7 dB	+ 20 dB
IP_{o3}	+ 20 dBm	+ 20 dBm	+ 50 dBm

fig. 1. Simple converter used to illustrate cascade IMD equations. Note that although only two nodes are specified, there are two other nodes (on either side of the mixer) that could be used for intercept point calculations.

cascade intercept point

To obtain the intercept point for a system, the intercept points of the various functional blocks will be combined in such a way as to predict the input or output intercept of a system.

There are two ways of approaching the cascade intercept point equations. The first is to assume the intermodulation products are coherent; when the products are coherent their voltages wil add in phase. The second approach is to assume the intermodulation products are non-coherent; in this case their voltages will combine as a sum of squares.

The assumption of coherence will always result in the lower predicted intercept point and for most Amateur applications is the preferred approach. There are situations, however, where the assumption of non-coherence is reasonable; the most obvious situation is a microwave system where phase shifts between system elements may place the products out of phase.

coherent summation

The equation for coherent summation* is

$$IP_t = \frac{20}{n-1} \log \left(10^{\frac{-(n-1)IP_1}{20}} + 10^{\frac{-(n-1)IP_2}{20}} + \ldots\right)^{-1} \tag{5}$$

where n is the order of the intermod (2 for second order, 3 for third order, etc.), and

IP_m is the reflected intercept (of the appropriate order) of the mth element

All the intercepts of the various system elements must be reflected to a single node. The example in **fig. 1** will help clarify this.

First a table must be drawn up (**table 1**) that contains the reflected intercept points. Note that input intercept plus gain equals output intercept $(IP_i + G = IP_o)$.

Substituting the information in **table 1** into **eq. 5**, the input intercept (node A) turns out to be $IP_{it} = +9.14\ dBm$. The output intercept (node B) is $IP_{ot} = +32.14\ dBm$.

table 1. Table of reflected intercept points for the system of *fig. 1*. This listing not only gives the intercept information, but also pinpoints the weakest elements in a system, in this case element 1.

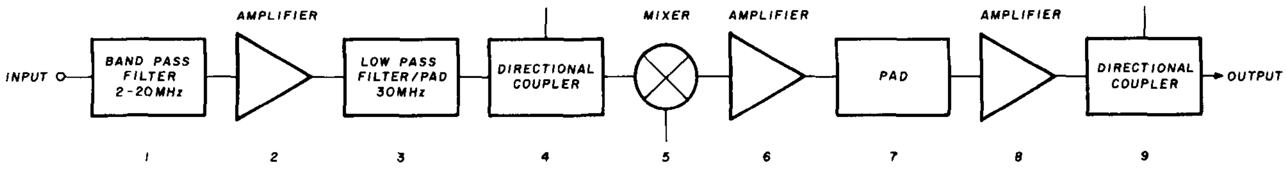
	reflected intercept point	
element	**node A**	**node B**
1	+ 10 dBm	+ 33 dBm
2	+ 17 dBm	+ 40 dBm
3	+ 27 dBm	+ 50 dBm

non-coherent summation

For the case of non-coherent summation the cascade intercept point equation is

$$IP_t = \frac{10}{n-1} \log \left(10^{\frac{-(n-1)IP_1}{10}} + 10^{\frac{-(n-1)IP_2}{10}} + \ldots\right)^{-1} \tag{6}$$

If non-coherent summation was assumed for the system of **fig. 1**, the input intercept becomes



Gain	− 0.43 dB	+ 11.08 dB	− 1.3 dB	− .25 dB	− 7.0 dB	+ 10 dB	− 4.0 dB	+ 9.5 dB	− 0.25 dB
IP_{i3}	—	+ 33.92 dBm	—	—	+ 29.75 dBm	+ 22.0 dBm	—	+ 22.5 dBm	—
IP_{i2}	—	+ 63.92 dBm	—	—	+ 62.0 dBm	—	—	—	—
NF	0.43 dB	4.5 dB	1.3 dB	.25 dB	7.0 dB	4.5 dB	4.0 dB	5.0 dB	.25 dB

fig. 2. Block diagram of a receiving converter built by the author with performance data for each of the elements in the system. When a dash is used in place of data, it indicates no contribution from that particular system element.

$IP_{it} = +9.91\ dBm$ and the output intercept becomes $IP_{ot} = +32.91\ dBm$. In this simple example the results from **eq. 5** and **eq. 6** are nearly identical. In general, however, as the system becomes more complicated, the difference between the two will be much larger.

receiving converter

The block diagram of **fig. 2** represents a receiving converter I built. It provides a convenient example system for comparing the predicted and measured parameters. Using the data in **fig. 2**, a table of reflected intercept points can be drawn up (**table 2**); by using the formula for coherent summation (**eq. 5**) the resultant input intercept can be calculated, and from **eq. 4**, the system noise figure can be calculated.

table 2. Calculated intercept point for the receiving circuit shown in *fig. 2*. Measured intercept point is shown in parentheses for comparison and shows good agreement.

	reflected intercept point	
element	IP_{i2}	IP_{i3}
2	+64.35 dBm	+34.35 Bm
5	+52.90 dBm	+20.65 dBm
6	—	+19.90 dBm
8	—	+13.90 dBm
IP_{it}	+50.84 dBm	+12.22 dBm
	(+54.0 dBm)	(+13.0 dBm)

Using **eq. 4** the predicted system noise figure is 7.1 dB; dynamic range can now be predicted. If a 500-Hz filter were placed after the system shown in **fig. 2**, then the $MDS = -139.91\ dBm$ and the dynamic range would be 101.42 dB.

Two-tone and noise figure tests were run on the system of **fig. 2** which resulted in measured $IP_{i2} = +54.0\ dBm$, $IP_{i3} = +13.0\ dBm$, and $NF_t = 6.9\ dB$. These tests show excellent agreement with the predicted data.

conclusion

The cascade intercept point equations, when used in coombination with the cascade noise figure equation, provide a powerful tool for rf system design. Derivations of **eq. 5** and **eq. 6** will be sent to interested readers upon receipt of a self-addressed, stamped envelope. With these equations a receiver designer can predict a system's characteristics without investing in any hardware.

acknowledgments

My thanks to Rich Phillips of ARGOSystems (formerly of ESL, Inc.) for initially pointing out the utility of these equations. My thanks also to Wes Hayward, W7ZOI, for kindling my interest in receiver design.

ham radio

More Details? CHECK—OFF Page 94

diode frequency divider

Using diodes as voltage-variable capacitors to produce a sine wave at one-half the input frequency

The use of diodes as frequency multipliers, and particularly as doublers, has been well known for a good many years. Such applications are covered quite well in a recent ARRL publication[1] and provide many ideas to the Amateur builder and experimenter. However, one application for diodes that I don't recall finding in an Amateur publication is their use in a frequency divider, with what is practically the same circuit!

Consider **fig. 1A**, which is a standard full-wave rectifier. It is familiar to just about every ham as is the output waveform, **fig. 1B**. The fundamental frequency has been cancelled by the full-wave circuit, and a quite respectable frequency doubler is the result.

frequency-divider circuit

Now let's change the circuit slightly to that of **fig. 2**. We will feed a signal of frequency f through a blocking capacitor to the diodes, reversing the direction taken when the circuit was a rectifier. There is another difference, as well, as the clamping action of the diodes builds up a bias voltage across the blocking capacitor, and the diodes are operating in their nonconducting range. Furthermore, the center-tapped transformer has become a center-tapped tank circuit by the addition of a capacitor that tunes the circuit to $f/2$, one-half the input frequency.

Operating in their nonconducting range, the diodes present only their junction capacitance to the circuit and are now regarded as capacitors. Even though both diodes may be of the same type and rating, their junction capacitances will not be identical, so a voltage will build up on one end of the tank circuit. The voltage on the other end will be of opposite polarity, increasing the reverse voltage on that diode, further increasing any differences in the capacitances. When the next input pulse appears, the polarity of the voltages on the tank circuit will have reversed due to the flywheel effect of the tuned tank. Thus, successive input pulses will affect alternate ends of the tank, resulting in a signal of half the input frequency. Input power transfer will probably

By **Henry S. Keen, W5TRS**, Fox, Arkansas 72051

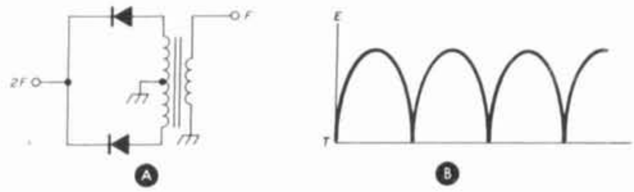


fig. 1. Standard full-wave rectifier (A) and the typical output waveform it produces (B).

be improved if some form of input matching network is used.

The power limitations of this circuit are a function of the diode characteristics, such as junction capacitance, leakage, and peak inverse voltage. Of course, power varactors are available at several bucks a throw, which would probably be more predictable in their operation; but silicon diodes out of your junk box may be pressed into service for a tryout.

suggested applications

A frequency divider such as this should offer a quick means of giving 160 meters a whirl, using the 80-meter rig, and without the necessity of building a separate new transmitter! My first use of the circuit involved a pair of top-hat diodes to reduce a 910-kHz

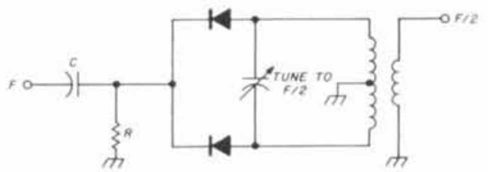


fig. 2. The diode frequency divider. A signal, f, is applied through a blocking capacitor, which reverses the signal direction. The center-tapped transformer is now a center-tapped tank circuit with the addition of a variable capacitor. Circuit delivers a good sine wave with good efficiency.

oscillator signal to 455 kHz in experiments with DSB reception. Unless the diodes are badly mismatched, it works right off. The value of resistor R of **fig. 2** should be quite high, as we are interested only in biasing the diodes into the non-conductive region. With a good pair of diodes, resistances up to 100 k would seem a reasonable figure.

This circuit delivers a good sine-wave signal with good efficiency, as there is little in the circuit to dissipate input power when the diodes function as voltage-variable capacitors.

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ham radio

an accurate and practical AFSK generator

Putting the Exar XR-2206C IC to work in a circuit for RTTY enthusiasts

It's no secret that Amateur RTTY is enjoying a huge rate of growth and energy. Much of this interest can be directly traced to the newer video display type of TTY terminal and its quiet fascination. This same upsurge has caused many old-time RTTYers to dust off the mechanical machine and join in. Regardless of the type of terminal used, electronic or mechanical, the operator must provide the tone demodulation and FSK generator between his terminal and the radio gear. Most high-frequency stations use an AFSK audio input to an SSB transmitter, thus creating a need for a good AFSK generator. A great many circuits have been developed to fulfill this need, both simple and complex.

To fulfill my need for an AFSK generator, I looked over what had been designed and found either the 555 IC type oscillator or the crystal-controlled system. The former is not known for best stability with time and/or temperature, and the latter sometimes deserves a Nobel prize for complexity and would not fit the space requirements in my new converter.

Some time ago a data sheet came across my desk on a function generator in one IC package, made by Exar.* If that data sheet was to be believed, my answer was in the XR-2206C. After thoroughly testing the final circuit (**fig. 1**), I believe this AFSK generator is the most accurate and simply practical circuit possible considering stability, space requirements, and cost.

the XR-2206C IC

The device is a function generator designed for instrumentation and communications use. It will operate from a single supply range of 10-26 volts, or a split supply of ±5 to ±13 volts. Its stability is excellent; drift rate is 20 ppm/°C. It produces very-low-distortion sine, square, triangular, ramp, or pulse waveforms. And it's ready made for FSK operation with a built-in switch to select between two timing resistors for two-frequency output. In this FSK operation, the output is phase-continuous during frequency transitions, so distortion never results during switching (a common source of trouble for many of the simpler circuits).

AFSK generator

Fig. 1 shows the simplicity of the AFSK generator. It has six trimpots (four for setting frequency and two for IC controls). Supply voltage indicated is ±12 volts. This was the supply in use for my converter, and it was borrowed to operate the AFSK generator as well.

Sinewave output from the XR-2206C is selected by connecting the 200-ohm resistor between pins 13 and 14. (If this resistor is removed, the output becomes triangular.) Pin 1 is used to set overall gain in this circuit by trimpot R5. The dc offset of an internal amplifier is set by trimpot R6 at pin 3. The 1-μF tantalum capacitor bypasses an internal reference voltage at pin 10. The value isn't critical, but a tantalum type is definitely needed here.

stability considerations

The IC data sheet indicated that, for optimum temperature stability, the timing resistors should be as close as possible to 10k. The timing-capacitor value is then adjusted to yield the desired output frequency.

Working through Exar's formulas, a capacitor value of just less than 0.05 μF is required, so I connected two 0.022-μF caps in parallel; the result turned out to be just right.

*R-Ohm Corporation, Exar Integrated Systems, P.O. Box 4455, Irvine, California 92664.

By Garry A. Boldenow, K0SFU, Route 2, Box 153, Peabody, Kansas 66866

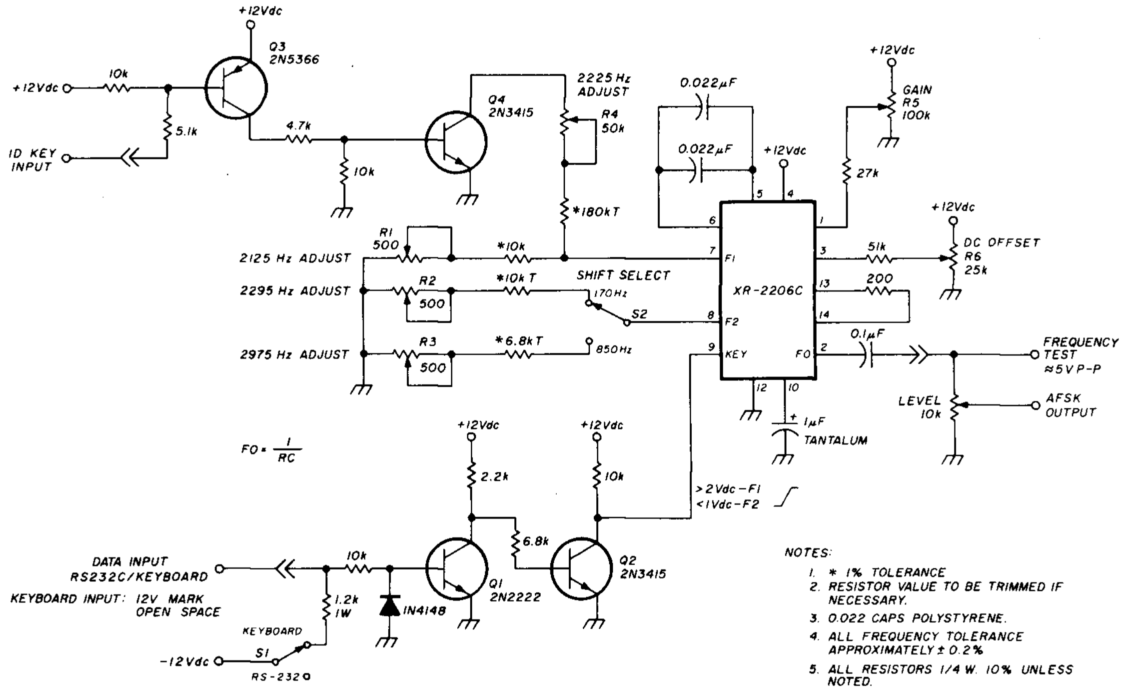

fig. 1. Schematic diagram of the AFSK generator. Circuit is built around the XR-2206C, which is a function-generator IC designed for instrumentation and communications use. This device has excellent frequency stability and low-distortion output. The circuit features optional CW IDENT circuit. Values of timing capacitors are critical; they must be polystyrene for maximum stability.

The timing-capacitor combination is connected to pins 5 and 6. These caps *must* be polystyrene for best stability. Do not use disc or Mylar caps in this application.

The timing-resistor networks connect to pins 7 and 8, with pin 7 being the F_1 frequency and pin 8 the F_2 frequency. We'll designate F_1 as mark (2125 Hz) and F_2 as space (2295 or 2975 Hz). Two resistors are selected by S2 for either 170-Hz or 850-Hz shifts. Obviously, if only 170 Hz shift is needed, delete the unnecessary components.

CW IDENT

I desired a CW IDENT feature, so I added Q3 and Q4. When the ID key input is pulled to ground or nearly so, R4 and 180-k resistor are in parallel with the 2125-Hz timing resistors, which shifts the output frequency upward 100 Hz for identification. Again, if this feature isn't needed, simply delete this little circuit.

Frequencies F_1 and F_2 (mark and space) are switched by the input at pin 9. If the level at pin 9 is greater than about 2 volts, F_1 is selected; if the level is less than about 1 volt, F_2 is selected.

input level translator

Q1 and Q2 act as an input level translator and switch for either RS-232C or mechanical keyboard inputs. This feature allows the generator to be used by the computer world as well as by traditional equipment. S1 is opened for RS-232C input signals, which will switch between + 10 and − 10 volts. A keyboard should be wired as shown to + 12 volts (or the A + level being used), and S1 is closed. This action applies − 12 volts through the 1.2 k resistor to the keyboard, which applies 24 volts at 20 mA across the keyboard contacts. A high level at the DATA INPUT will cause F_1 to be selected; a low level (or ground) will cause F_2 to be output.

construction

Construction of the AFSK generator can be by any method convenient to the builder. Layout is anything but critical. Leave room to trim the fixed timing resistors from pins 7 and 8 if necessary.

tune up

Tuning the generator will require a frequency counter and oscilloscope. Frequency setting could be done by applying the output through a known accurate tone demodulator and tuning for maximum output levels, but a counter sets frequency precisely. A scope will be needed to adjust for minimum distortion and best waveform.

Begin tuning by opening S1 and setting all trimpots to mid range.

1. Open the ID KEY input, if used. Apply a positive-level (+10 or +12 volts) to the DATA INPUT point, then apply voltage power to the circuit. There should be some kind of waveform at pin 2 or at the output side of the 0.1-μF coupling capacitor.

2. Initially, adjust R5 and R6 for best waveform. With a 12-volt supply, the output level will be around 5 volts p-p.

3. Next, adjust R1 throughout its range to determine if 2125 Hz can be set with the values as shown. If not, center R1 and trim the 10k fixed series resistor for about 2125 Hz; then readjust R1. If the 10k resistor value must be shifted by more than 5 per cent, trim the timing capacitors with other values. Try to keep the 2125-Hz resistors as close to 10k as possible. Once the mark frequency has been set, do not readjust R1 for any other frequency.

4. *If the* CW IDENT *circuit has been added, ground* the ID KEY input. Adjust R4 for 2225 Hz, trimming the 180k fixed resistor as required.

5. Next, either ground the DATA INPUT point or apply a negative voltage level.

6. Set S2 to the 170-Hz shift side and adjust R2 for 2295 Hz.

7. Trim the 10k fixed resistor with a 150k resistor to begin with, and trim from there.

8. Repeat the procedure with S2 in the 850-Hz position, adjusting R3 and trimming the 6.8k resistor as needed.

9. After all four frequencies have been initially adjusted, let the generator run for an hour or so, then carefully reset each frequency. A drift of only ±2 Hz can be expected over a long-term period and over a wide temperature swing.

10. Carefully look at the output waveform and adjust R5 and R6 for the most perfect and smooth sine waveform possible. Set gain trimpot R5 for *just less than maximum perfect waveform level*.

closing remarks

Considering the space this generator consumes inside a typical RTTY converter cabinet, and the fact that its stability is better than 0.2 per cent over a wide temperature and time range (if 1 per cent resistor and 2.5 per cent polystyrene capacitors are used), this circuit offers much in terms of simplicity and accuracy.

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More Details? CHECK—OFF Page 94

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- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3⅛ x 1¾

JE747 .... **$29.95**

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701

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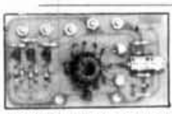
JE200....... **$14.95**



ADAPTER BOARD – Adapts to JE200 – ±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

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MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
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Z80A(780-1)	CPU	15.95
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6502	CPU	11.95
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P8085	CPU	19.95
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MM504H	Dual 16 Bit Static	.50
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MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
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2518	Hex 32 Bit Static	4.95
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2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
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A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS			
M-Z80	User Manual		$7.50
M-CDP1802	User Manual		7.50
M-2650	User Manual		5.00
ROM'S			
2513(2140)	Character Generator(upper case)		$9.95
2513(3021)	Character Generator(lower case)		9.95
2516	Character Generator		10.95
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21L02	1024X1	Static	1.95
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2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
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	*Requires single +5V power supply		
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	**Requires 3 voltages, —5V, +5V, +12V		
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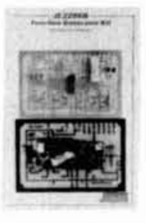
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

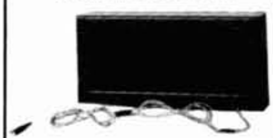
Function Generator Kit



Provides 3 basic waveforms: sine, triangle and square wave. Freq. range from 1 Hz to 100K Hz. Output amplitude from 0 volts to over 6 volts (peak to peak). Uses a 12V supply or a ±6V split supply. Includes chip, P.C. Board, components & instructions.

JE2206B.... **$19.95**

DIGITAL THERMOMETER KIT



- Dual sensors—switching control for in-door/outdoor or dual monitoring
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JE300 .... **$39.95**

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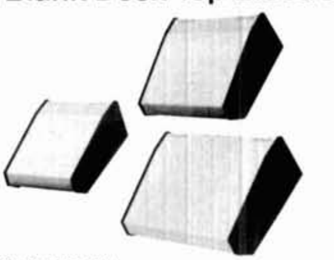

- **High strength epoxy molded end pieces in mocha brown finish.**
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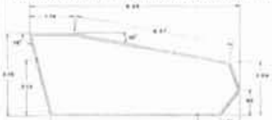
- **Rigid construction provides unlimited applications.**

CONSTRUCTION:
The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to ¼" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.



Enclosure Model No.	Panel Width	PRICE
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The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space: 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable: Low (normal) – 1070 space, 1270 mark; High – 025 space, 2225 mark.
Receive Sensitivity	–46 dbm accoustically coupled.
Transmit Level	–15 dbm nominal. Adjustable from –6 dbm to –20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

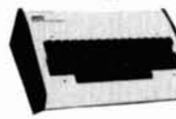
Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
- **8 each UPD416-1 (16K Dynamic Rams) 250NS**
- **Documentation for conversion**

TRS-16K **$59.95**

JE610 ASCII Encoded Keyboard Kit



The **JE610 ASCII Keyboard Kit** can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and –12V @ 10mA for operation. Features: 60 keys generate the full 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector.

JE610 (Case not included) **$79.95**

Desk-Top Enclosure for JE610 ASCII Encoded Keyboard Kit

Compact desk-top enclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 14½"W x 8¾"D.

DTE-AK **$49.95**

SPECIAL: JE610/DTE-AK PURCHASED TOGETHER (Value $129.90) $124.95

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

The **JE600 Encoder Keyboard Kit** provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation.

JE600 (Case not included) **$59.95**

Desk-Top Enclosure for JE600 Hexadecimal Keyboard Kit

Compact desk-top exclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 8¼"W x 8¾"D.

DTE-HK **$44.95**

SPECIAL: JE600/DTE-HK PURCHASED TOGETHER (Value $104.90) $99.95

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

notes on the EIMAC 5CX1500A power pentode

Some operating tips on the use of this tube in ham gear

By Arthur Reis, K9XI, 8510 Sunset, Wonder Lake, Illinois 60097

Ask any experienced ham to list the tubes most likely to be used in a linear amplifier in the Amateur service, and chances are that the 5CX1500A won't be mentioned.

And, small wonder. In this day of zero bias, high-mu triodes, the 5CX1500A doesn't really seem to be the ideal tube for ham use. It's expensive (about $500); its socket is expensive and, in this day of single-power-supply-tubes the 5CX1500 requires *three* power supplies plus filament voltage.

the case for the 5CX1500A

So, why even consider it here? For two reasons. First, at least one manufacturer of high-power linear amplifiers, Tempo, uses this tube in their Model 4K. The typical 4K owner may not know enough about his final for his own peace of mind. Second, this tube is rather common in the broadcast service, and some of these tubes, with reduced emission, have become available at reasonable prices at swapfests and such.* It is for these reasons that this article is presented.

background

The 5CX1500A was designed by EIMAC about a dozen years ago at the request of an American manufacturer of fm transmitters for the 88-108 MHz broadcast band. The need was for a final amplifier or driver tube that would operate in the 2-3 kW power range, Class B or C service, with good stability and ruggedness, a reasonable life expectancy (about 8000 hours in continuous commercial service [CCS] and high efficiency. The original 5CX1500 was the result.

*Another source of these and other high-power tubes is your local fm broadcast or TV station. The tubes are replaced after a specified number of operating hours and in many cases have a lot of life in them, especially when used in the Amateur service. Contact your local station and talk to the engineer in charge. **Editor.**

There are some problems, of course. The '1500A is a beam-power pentode, and because of its parameters, which were dictated by the specifications listed above, the tube is very difficult to construct. As a result, EIMAC is still the only manufacturer of the tube in the world. Couple this with the fact that every major manufacturer of broadcast fm transmitters in this country uses the 5CX1500A in all their transmitters designed for this power level, and you can guess the rest. The tube is not always readily available. As of this writing, however, that situation has not existed for some months.

early tube problems

Several years ago the assembly line for the 5CX1500A was moved from EIMAC's main plant in California to a new facility in Salt Lake City, Utah. Shortly thereafter, problems arose. Tube life in the field began to drop, particularly in rf driver service, but later in all fm broadcast service. Tubes began to lose emission to the point where they had to be replaced after about 3000-4000 hours. EIMAC and the broadcast equipment manufacturers began to research the problems, and two differing causes began to emerge. There was one comon denominator: the filament was being "poisoned" by gas.*

First it was discovered that the tube, especially when used in rf driver service (CCS), was being loaded much too lightly. This action resulted in high rf circulating currents in the tube, particularly across the aluminum oxide insulating ring between the suppressor ring and the anode. As a result undue heating occurred, which caused minute cracking of the ring. These cracks are not visible to the naked eye, except through the use of the special dye applied to the ring.

Second, investigators found that, on tubes made between mid-1975 and early 1979, the metal alloy used in the construction of the screen grid emitted

*An interesting sidelight on the problem of contamination of thoriated tungsten filaments by gas is discussed in reference 1. **Editor.**

excessive levels of carbon-monoxide gas, which is lethal to your typical 5CX1500A cathode. EIMAC corrected that problem early in 1979, and tubes manufactured after that date show no ill effects from that quarter.

operating tips

Now, in practical terms, what does this all mean to present and potential users of the 5CX1500A? Here are some tips on its operation that might help.

1. Load the tube as heavily as possible, consistent with the ability of your power supply to deliver the extra current. If your plate impedance is over 6000 ohms, it's too high! Reduce this impedance as much as possible by decreasing plate voltage and increasing current to reduce circulating rf currents in the tube.

2. If your tube is beginning to go "soft," determine if the problem is loss of cathode emission. To do this, record your present current drain on all tube elements that show current, and compare them to your observations when the tube was "fresh." If *all* currents are down, then the problem is low cathode emission caused by poisoning (contamination). These currents must be determined with drive power applied. Dc values alone will tell you nothing, since at radio frequencies the peak current drawn by the cathode may be 2-3 amperes. It's the inability of the cathode to deliver *that* amount of current that causes the tube to be considered "soft," no matter what the dc values may be.

3. Do *not* try to increase the cathode voltage above 5.1 volts to increase emission. For every 1/4 volt the filament is increased over its specified value, expect your tube life to drop in half (i.e., 5-1/4 volts, 4000 hours on an original 8000-hour tube; 5-1/2 volts, 2000 hours, *etc.*). Remember, this is a "carburized" thoriated tungsten filament. At the present state of the art, if the filament opens up, it can't be rebuilt.

4. If the tube is too "soft" to live with but seems to be OK otherwise (no short circuits), it can be rebuilt for about half the cost of a new tube. If indeed the cathode has been contaminated as determined in 2. above, you can ship it to Econco Broadcast Service, 1302 Commerce Avenue, Woodland, California, 95695. Unlike the process used in rebuilding other tube types, rebuilding the 5CX1500A doesn't usually require replacement of its grids. Instead, as EIMAC informs me, a process called "recarburization" is used. The tube seal is broken and a gas with a high carbon content, such as methane, is admitted. The gas-loaded tube is then fired in an oven, or its filament run at 120 percent voltage for a few seconds, during which time a new carbon coating is deposited onto the cathode. The tube time is then re-evacuated and resealed. Generally, if the tube has no other problems, the renewability rate is in the 80-90 percent range. If your tube loses here, you pay nothing more than shipping charges one way. By the way, this rebuilding process can be done more than once, thereby increasing the life of the tube in your rig.

5. If your 5CX1500A develops a short circuit, it will generally be from cathode to control grid. That's a pretty safe statement, considering the fact that the control grid is located a mere four *mils* from the cathode (the grid wire mesh is one mil thicker than that!). As the tube ages, the cathode can get brittle, and a strand from the filament may break away and fall across the grid.

Don't dismiss the idea of burning out the short in this case. I've heard of this happening several times, and a car battery is ideal for the purpose. If the short does not disappear, you'll have to admit that, with a little polishing and a walnut base, the tube makes a nice looking award for "Ham of the Year" at your local radio club. (This is particularly true of tubes manufactured before 1980, which are silver plated. EIMAC has changed the outer plating of the tube to nickel for cost reasons. There is no noticeable electrical effect on the tube.)

summary

The 5CX1500A tube may not be the best of all possible worlds for linear amplification in the Amateur service. However, for those who want a stable, *very* conservative amplifier for up to, say, 225 MHz, or for those who already are using this tube in such an amplifier, I hope this article has shed some new light on a tube that few Amateurs seem to know much about. The interested reader is referred, for further information, to "The Care and Feeding of Power Grid Tubes," by EIMAC. Data sheets for the 5CX1500A are also available from EIMAC.*

acknowledgments

My thanks to Ken Atkinson at EIMAC/Salt Lake City, Ed Numerych at EIMAC/Chicago, Dave Gilden, formerly of CECO, Ray Shurtz at ECONCO, and Bill Hoyt, Lou Pifer, and Bob Gorjance at Harris Corporation, for their help in providing information for this article.

reference

1. Alf Wilson, W6NIF, "Rejuvenating Transmitting Tubes with Thoriated-Tungsten Filaments," *ham radio*, August, 1978, page 80.

*EIMAC division of Varian, 301 Industrial Way, San Carlos, California 94070.

ham radio

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Low cost, high performance, that's the DM-700. Unlike some of the hobby grade DMMs available, the DM-700 offers professional quality performance and appearance at a hobbyist price. It features 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch high LED display, with automatic decimal placement, automatic polarity, and overrange indication. You can depend upon the DM-700, state-of-the-art components such as a precision laser trimmed resistor array, semiconductor band gap reference, and reliable LSI circuitry insure lab quality performance for years to come. Basic DC volts and ohms accuracy is 0.1%, and you can measure voltage all the way from 100 μv to 1000 volts, current from 0.1 μa to 2.0 amps and resistance from 0.1 ohms to 20 megohms. Overload protection is inherent in the design of the DM-700, 1250 volts, AC or DC on all ranges, making it virtually goof proof. Power is supplied by four 'C' size cells, making the DM-700 portable, and, as options, a nicad battery pack and AC adapter are available. The DM-700 features a handsome, jet black, rugged ABS case with convenient retractable tilt bail. All factory wired units are covered by a one year limited warranty and kits have a 90 day parts warranty.

Order a DM-700, examine it for 10 days, and if you're not satisifed in every way, return it in original form for a prompt refund.

Specifications

DC and AC volts:	100 μV to 1000 Volts, 5 ranges
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Resistance:	0.1Ω to 20 megohms, 6 ranges
Input protection:	1250 volts AC/DC all ranges fuse protected for overcurrent
Input impedance:	10 megohms, DC/AC volts
Display:	3½ digits, 0.5 inch LED
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells, optional nicad pack, or AC adapter
Size:	6"W x 3"H x 6"D
Weight:	2 lbs with batteries

Prices

DM-700 wired + tested	$99.95
DM-700 kit form	79.95
AC adapter/charger	4.95
Nicad pack with AC adapter/charger	19.95
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TERMS: Satisfaction guaranteed or money refunded. COD, add $1.50. Minimum order $6.00. Orders under $10.00, add $.75. Add 5% for postage, insurance, handling. Overseas, add 15%. NY residents, add 7% tax.

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The CT-70 breaks the price barrier on lab quality frequency counters. No longer do you have to settle for a kit, half-kit or poor performance, the CT-70 is completely wired and tested, features professional quality construction and specifications, plus is covered by a one year warranty. Power for the CT-70 is provided by four 'AA' size batteries or 12 volts, AC or DC, available as options are a nicad battery pack, and AC adapter. Three selectable frequency ranges, each with its own pre-amp, enable you to make accurate measurements from less than 10 Hz to greater than 600 mHz. All switches are conveniently located on the front panel for ease of operation, and a single input jack eliminates the need to change cables as different ranges are selected. Accurate readings are insured by the use of a large 0.4 inch seven digit LED display, a 1.0 ppm TCXO time base and a handy LED gate light indicator.

The CT-70 is the answer to all your measurement needs, in the field, in the lab, or in the ham shack. Order yours today, examine it for 10 days, if you're not completely satisfied, return the unit for a prompt and courteous refund.

Specifications

Frequency range:	10 Hz to over 600 mHz
Sensitivity:	less than 25 mv to 150 mHz less than 150 mv to 600 mHz
Stability:	1.0 ppm, 20-40°C, 0.05 ppm/°C TCXO crystal time base
Display:	7 digits, LED, 0.4 inch height
Input protection:	50 VAC to 60 mHz, 10 VAC to 600 mHz
Input impedance:	1 megohm, 6 and 60 mHz ranges 50 ohms, 600 mHz range
Power:	4 'AA' cells, 12 V AC/DC
Gate:	0.1 sec and 1.0 sec LED gate light
Decimal point:	Automatic, all ranges
Size:	5"W x 1½"H x 5½"D
Weight:	1 lb with batteries

Prices

CT-70 wired + tested	$99.95
CT-70 kit form	75.95
AC adapter	4.95
Nicad pack with AC adapter/charger	9.95
Telescopic whip antenna, BNC plug	7.95
Tilt bail assembly	3.95

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base-loaded vertical antenna for 160 meters

No room for a 160-meter beam? Try this vertical antenna which can be easily made from readily available materials

Much has been written and discussed on the best antenna for 160 meters. The most popular solution seems to be to tie the ends of an 80-meter antenna together and feed the system on 160 meters with an antenna matching network. Some Amateurs string up an inverted L antenna. Both work fine for local contacts, but if you really want to work across the country, the vertical antenna is best.

the case for a vertical antenna

Several 160-meter enthusiasts use phased vertical antennas. Their signals are outstanding all year around compared with signals from other antennas. For those who don't have room for a beam, the top-loaded vertical is the next best. The loading coil should be wound with no. 10 AWG (2.6 mm) wire. It requires a long coil and an extended tube for adjustments. I tried such an antenna, but the assembly swayed back and forth like a pendulum, and the nylon guys would not remain tight enough to hold it. After the coil broke off, I experimented with a base-loaded vertical.

base-loaded vertical

I was surprised that my signals seemed to be equally good, but not before some testing of the wire size used on the base coil. My vertical uses a 32-foot (9.8-meter) length of aluminum irrigation tubing, which is 2 inches (50 mm) in diameter. (It cost $20.00.) The tube was set on a beer bottle for an insulator and guyed with nylon rope. This assembly was backed up by burying a 6-foot (1.8-meter) length of 4 × 4 lumber into the ground and using insulators and wood blocks to secure the tube to it (**fig. 1**).

To resonate the tube to 160 meters, a series capacitor and coil were first tried. However, I was told it would be better to just use the coil. First tried was a wire coil, but later a coil made from 3/16-inch (5-mm) diameter copper tubing was substituted, and the signal increased by 1 dB.

coil construction

The inductance was wound with 3/16-inch (5-mm) diameter copper tubing which cost $9.75 for a 50-foot (15.25-meter) coil. I used a 4-inch (102-mm) diameter pipe as a mandrel and wound a coil of forty turns.

Next three pieces of plastic were cut 1 inch (25.4 mm) wide and 1/4 inch (6.5 mm) thick for the length of the coil. Holes were drilled in these strips with a drill just over 3/16 inch (5 mm), so that the copper would slide through it easily. The first hole was 1/4 inch (6.5 mm) from the end.

The holes were cut with a drill sharpened like a sheet metal drill so that it did not shatter as it came through the plastic. A small hole could have been drilled, then a large drill put through half way on each side. That takes patience. Once the pieces are snaked onto the coil and spaced, they are treated with coil dope. The coil was rugged enough to be mounted on insulators and put into a wooden dog house at the base of the antenna.

By Ed Marriner, W6XM, 528 Colima Street, La Jolla, California 92037

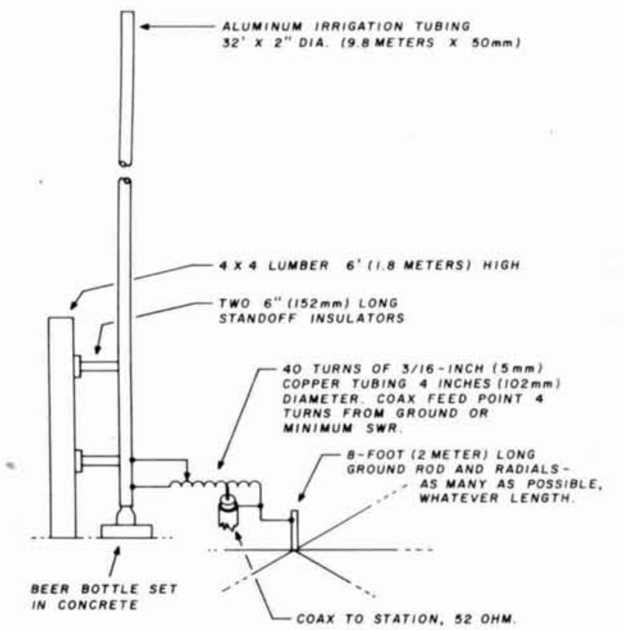


fig. 1. Construction details of a base-loaded vertical antenna for 160 meters. Antenna performs as well as a top-loaded affair and is much more stable and easier to construct. Use as many radials as possible in the ground system.

tune up

Antenna tuning was accomplished by leaving the feeder off and grid dipping the coil with it all in place. The coil was then tapped for resonance at 1820 kHz. Wide copper straps can be formed around the 3/16-inch (5-mm) copper and soldered once the proper place is found. The next step is to vary the tap for the 50-ohm feeder from the bottom of the coil for minimum SWR. Mine came out at the fourth turn up from the bottom. (This will depend on your ground system.) I used an 8-foot (2-meter) rod driven into the ground at the antenna base and four or five radials of various lengths pushed into the grass. None are over 30 feet (9 meters) long, but make them as long as you can and use as many as possible. The more the better on 160 meters.*

performance

We have a daytime 160-meter net here in California, and records are kept of signal strengths up and down the coast. At 11 AM Sunday mornings Santa Barbara checks in with signal reports. I can say this antenna receives and sends equally as well as my old top-loaded affair. I've worked the East Coast with it and am pleased to report that it is more stable and easier to construct. All in all, it seems like the best answer to many 160-meter antenna problems — if you can't have a phased array.

*Or on any frequency. **Editor**.

ham radio

digital capacitance meter

Easy to build digital capacitance meter for the home shop features ranges from 1000 pF to 100 μF

Amateurs who build or service electronic equipment sooner or later encounter the situation where replacing a capacitor with a "larger" one produces the wrong results: power supply ripple worsens or the time constant of a timing circuit decreases when it should increase. Highpass or lowpass audio might have their actual 3-dB rolloff points at 200 Hz instead of the intended 300-Hz point. Such differences often occur because the actual value of the capacitor used is different from its marked value. The best performance of narrow bandpass filters and notch filters is obtained when matched capacitors of exactly the same value are used. There are many good "100-for-a-dollar" capacitor buys available, but they often included unmarked or house-numbered units. Those 25-cent, 68-μF capacitors I bought at a hamfest were actually 6.8 μF — the reason, no doubt, they were only 25 cents!

Capacitors are among the most common components used in electronics. Most users assume that the value marked on the capacitor is its actual value; specifications simply guarantee a minimum value. Most electrolytics, for example, are specified to be within +80 to −20 per cent of their indicated value. There are a few that are within ±10 per cent of their marked value; some small capacitors are available with 1 per cent and 5 per cent tolerances. The true value of a capacitor is not important in some cases, such as audio bypass applications, while in other applications the capacitance must be accurately known to produce the desired results.

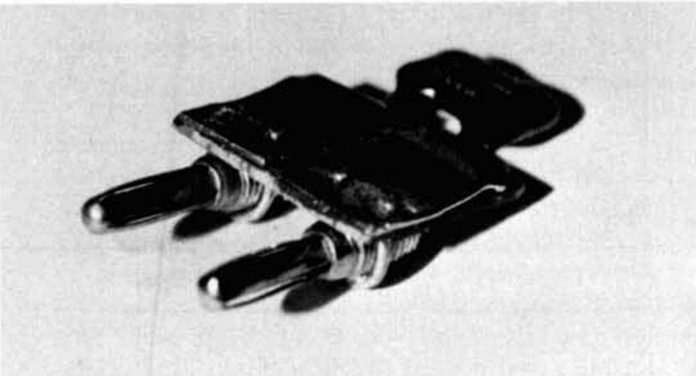
The digital-capacitor meter presented in this article was built to preclude the type of problems described above. It measures capacitors from 0.001 μF to 999 μF in six ranges, with accuracy of about 1 per cent. The three-digit display has the decimal point correctly positioned as the ranges are switched. The circuit uses low-cost components which are readily available. It requires no difficult adjustments for reliable operation and is easy to duplicate with the printed circuit board layout shown. The meter requires about 100 mA from a 5-volt regulated source, so it lends itself to battery operation if desired. The circuit includes a flashing overflow indicator.

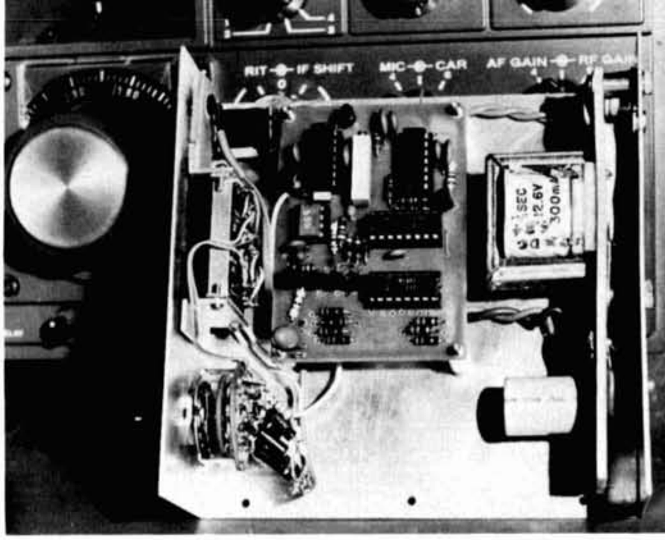
circuit description

The circuit is based upon a digital counter that counts a reference oscillator. The input to the counter is gated by the C_x monostable which has its period determined by the capacitor to be measured.

By Marion D. Kitchens, K4GOK, 7100 Mercury Avenue, Haymarket, Virginia 22069

Construction of the short lead adapter.

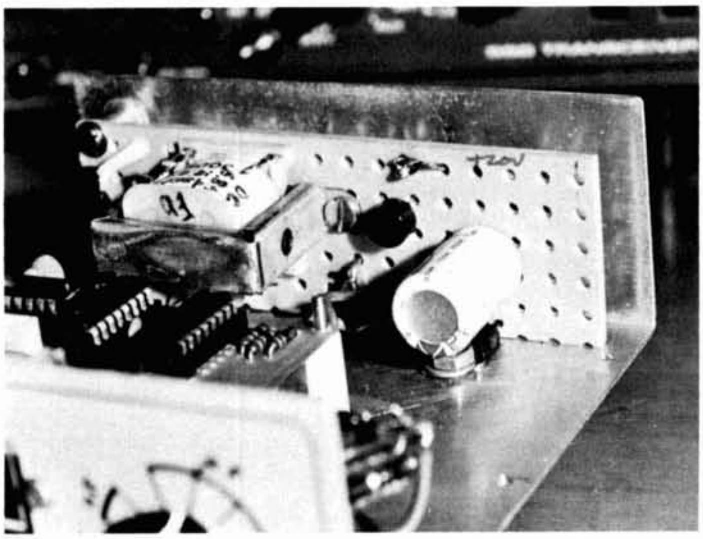




An interior view showing arrangement of the display, circuit board, power supply, and range switch. This was a prototype circuit board which has its overflow circuit mounted below the main board.

Digi Cap

Two different meters showing suggested range switch labeling for right-hand decimal displays per the text (on top) and left-hand decimal displays. The unit with the small display (top) was used to develop the circuit. The bottom unit was built by WA4RVN to verify the circuit reproducibility and performance consistency.



Closeup view of the point-to-point wired power supply. The 7805 voltage regulator is snugged beneath the 1000-μF filter. Yes, the capacitor was measured before use. Would you believe 998 μF?

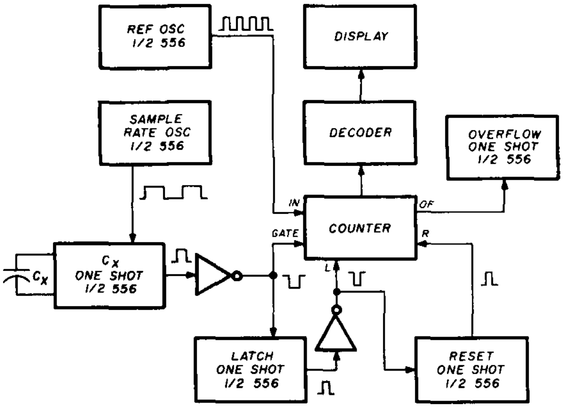


fig. 1. Functional block diagram of the digital capacitance meter. The meter is based upon the 14553 counter. The other ICs provide the necessary gating for the oscillators and display functions.

The functional block diagram is shown in **fig. 1**. About twice a second, the sample rate oscillator triggers the C_x monostable circuit. This monostable output is inverted and applied to the counter control gate. The duration of this control gate input is directly dependent upon the value of the capacitor being measured. If the reference oscillator input to the 14533 IC counter is at the proper frequency, the resulting display will indicate the value of the capacitor. One half of a 556 dual timer serves as the sample rate oscillator, while another 556 dual timer is used as the C_x monostable and reference oscillator.

The 14553 counter chip contains all the circuitry to count and multiplex three digits. It has built-in latch and reset functions and an input control gate. The counter chip's BCD output is applied to a single seven-segment decoder which drives the multiplexed LED displays. The required latch and reset functions are provided by another 556 dual timer with each of its sections operating in the monostable mode. The latch signal is applied to the 14553 at the end of the input gate enable period to store and display the accumulated count. Immediately thereafter the reset signal is applied. The 14553 holds the outputs for the displays, even though the internal counters have been reset, until the latch signal is again low. The latch signal goes low only after the capacitor value has been measured again. This produces a constant or steady display that does not flicker or count up to the final value.

The circuit timing diagram is shown in **fig. 2**. The overflow signal from the 14553 is applied to one half of a 556 dual timer to provide an overflow indication. The timer is run as a monostable to produce a flashing LED overflow indicator. **Fig. 1** shows wave forms at significant locations and indicates the direction of information flow in the circuit. The complete schematic diagram is shown in **fig. 3**.

Construction is uncomplicated when using the printed circuit board. **Fig. 4** shows the location of components on the board, while **fig. 5** shows the circuit board foil pattern. Careful examination of **fig. 4** will reveal the location of the numbered and lettered points to be wired to the display and the range switch. These points are shown on the schematic for easy reference. Switch wiring is shown in **fig. 6**. Points **X**, **Y**, and **Z** are not used.

The circuit uses a common-anode multiplexed display. The seven 82-ohm resistors near the 7446 decoder are the recommended value for displays that require around 10 mA per segment. The suggested value for displays rated at 5 mA per segment is 150 ohms. These values can be varied to achieve the desired display brightness. One unit was built without the seven current limiting resistors (to achieve the maximum brightness) and has worked without any LED burnout problems.

None of the circuit component values are critical, but best performance can be obtained with a good quality capacitor, preferably plastic, for the reference oscillator. This particular capacitor is the 0.001-μF capacitor located near the 100k pot and connected to pins 2 and 6 of U2. Q1 is used to boost the current-handling capability of the C_x monostable (U2) and should have low capacitance and a power rating of ½ to 1 watt. A 2N3906 will work with good results. Transistors Q1, Q4, Q5, and Q6 are PNP transistors, while Q2, Q3, and Q7 are NPN transistors; 2N3906s and 2N3904s can be used, respectively. Q4, Q5, and Q6 should be installed so that their emitters go to the 5-volt land, bases go to the 1 kilohm resistors, and their collectors to the anodes of the display. The overflow LED is connected with its anode to point **F** on the circuit board and the cathode to ground.

A well-regulated, 5-volt power supply capable of 100 to 150 mA is required. **Fig. 7** shows a schematic for a suitable supply. Point-to-point wiring on a insulated board is an easy way to build the supply.

Care should be taken to keep the wiring between Q1, the range switch, and the C_x input jacks as short as possible and away from the 60-Hz ac line.

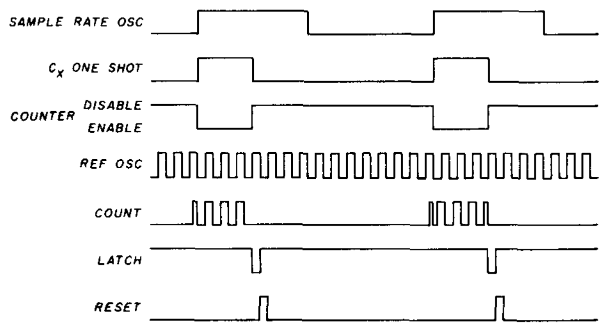


fig. 2. Timing diagram of signals in the capacitance meter.

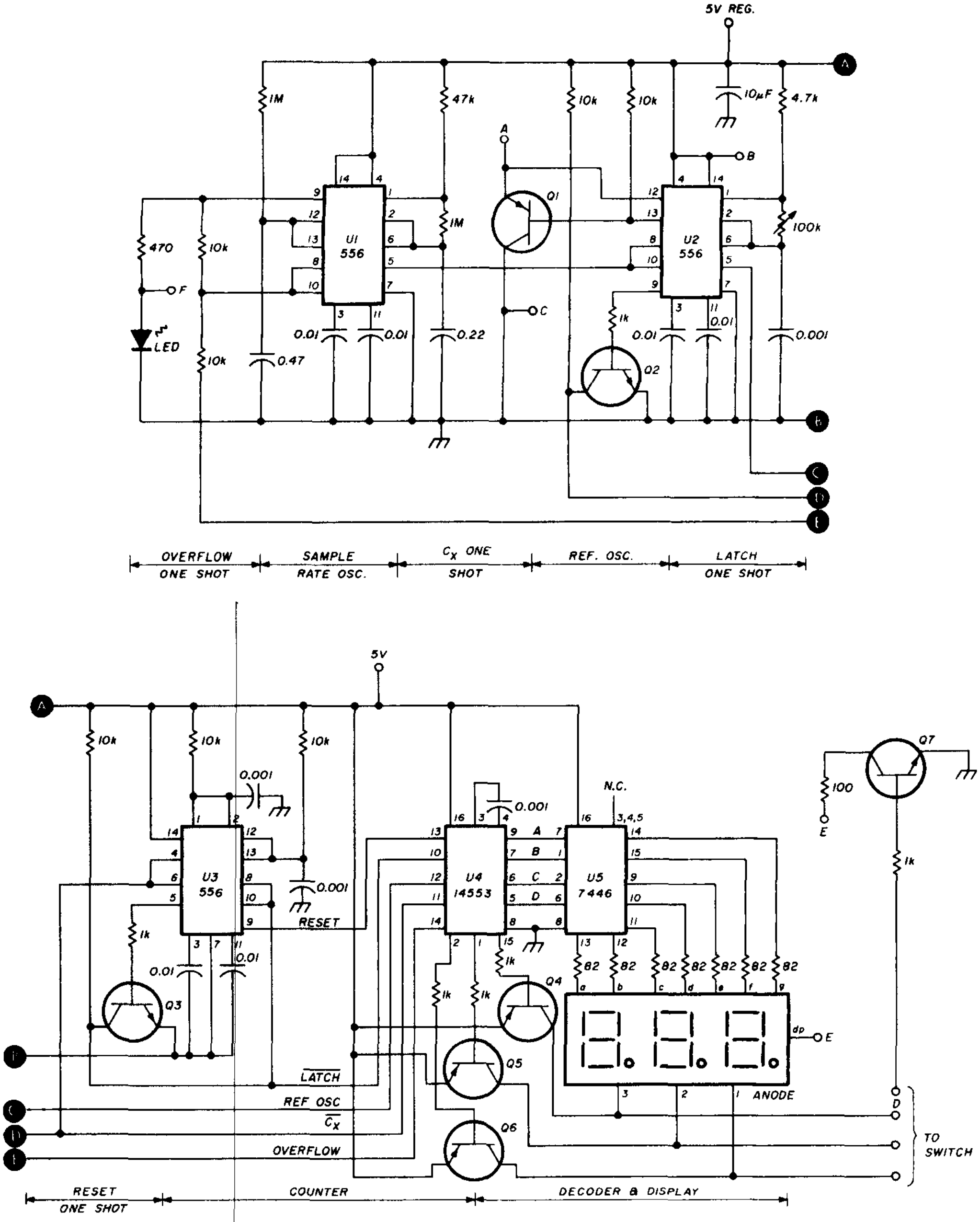


fig. 3. Complete schematic diagram of the digital capacitance meter. Suggested types for the transistors are given in the text. The current requirement of the meter is approximately 100 mA, small enough that a battery supply can be used for field use.

checkout and calibration

The circuit board should be completed and all wiring connected to the display, overflow indicator, and range switch before starting checkout. Make sure that the power supply is delivering 5 volts and is properly connected to the circuit board. At power turn on, the display should light and the overflow indicator should flash once. The display should show 000 or 001 with no connection at the C_x input. With a short across the C_x input, the display should show a number, say 433, and the overflow indicator will flash continuously. This number should not change when the range switch is moved to other positions. The display should show a number of 000 to 002 with the range switch in position 1 (see **fig. 6**) and no connection at the C_x input. An unsteady count ranging from 000 to about 060 indicates that the meter is picking up stray 60 Hz. If this happens, try redressing or rerouting the wiring between the circuit board, range switch, and C_x input jacks. K4ZKU found that reversing the ac line cord at the wall outlet would help with such a situation. A simple test of U5, the display, and

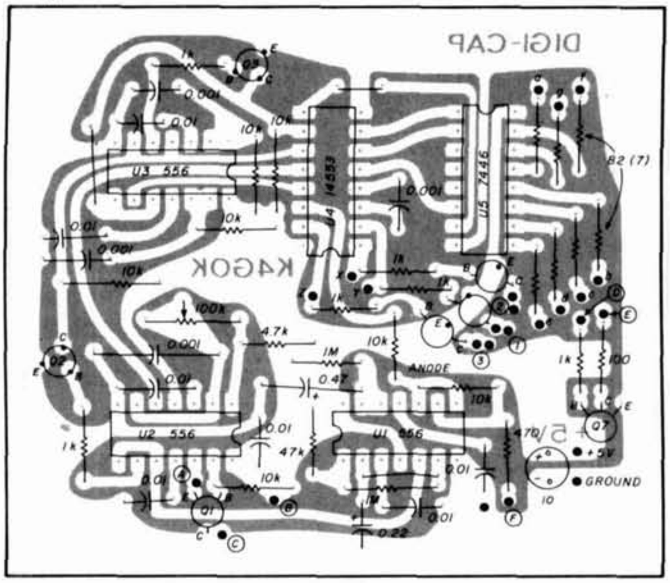


fig. 4. Parts placement diagram for the printed circuit board.

the wiring between can be made by temporarily grounding pin 3 of U5; the display should show 888.

The unit must be calibrated before use. Capacitors of known value are required. Surplus computer and audio boards are a good source for precision capacitors. I found 1 per cent capacitors from 0.001 to 2.5 μF at local hamfests. The meter should be allowed to warm up for about 20 minutes before calibration. If precision measurements in the 10s and 100s of microfarads ranges are not required, the 2000- and 200-ohm pots at positions 5 and 6 of the range switch can be replaced with 1000- and 100-ohm fixed resistors. To calibrate the meter, connect a 0.1- to 0.3-μF

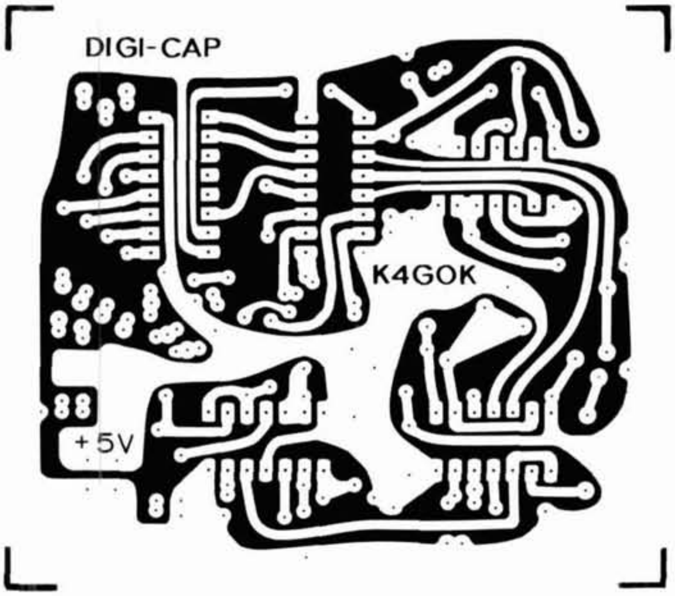


fig. 5. Foil layout pattern for the digital capacitance meter.

capacitor of known value, and with the range switch in position 3, adjust the 100-kilohm reference oscillator pot on the circuit board so that the display indicates the correct capacitor value. This calibrates the 100k-pF range (switch position 3) as well as the 10k-pF (position 2) and 1-μF (position 4) ranges. The 1k-pF is range calibrated by the 1-megohm pot at switch position 1; the 10-μF and 100-μF ranges are calibrated by the 2000- and 200-ohm pots at positions 5 and 6.

using the meter

Operation of the meter is simple. Observing proper polarity, connect the capacitor to be measured, select the largest range that does not cause an overflow, and read the capacitor value shown on the display. **Table 1** shows examples of how the display indicates various capacitor values for each of the range switch positions. The first three ranges measure in thousands of pF and the last three ranges measure in μF. The decimal point is properly positioned. Note that if a 22-μF capacitor is being meas-

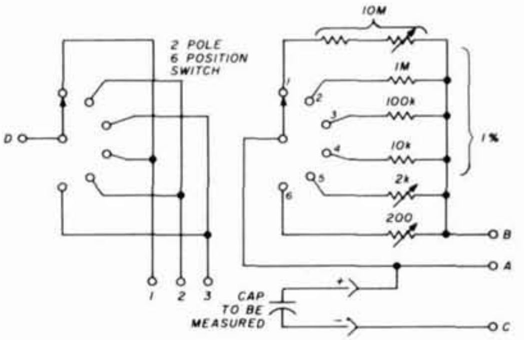


fig. 6. Switch connections for the range switch of the capacitance meter. The points specified are connected to the appropriate location on the circuit board (see fig. 4).

ured the range switch should be in position 5 and the display will show 22.0. A 0.047-μF capacitor is 47k-pF, and it will be measured with the range switch in position 2. The display will show 47.0. Labeling the first three positions of the range switch as kpF (or nF for nanoFarads if preferred), and the last three positions as μF will make the meter very easy to read.

An open capacitor will cause a 000 to 001 to be displayed. A shorted capacitor will cause the overflow indicator to flash and the display to indicate a fixed number that is independent of the range switch position.

Lead lengths should be kept short when measuring small value capacitors. The photographs show a plug-in device made from banana plugs, a small piece of copper clad board, and sheet brass.

conclusion

The digital capacitor meter has been a fun project

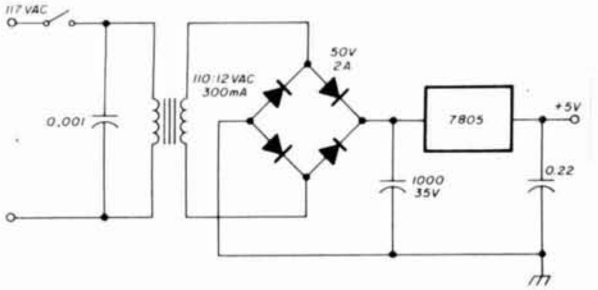


fig. 7. Schematic diagram of a small power supply suitable for home station use of the capacitance meter.

to build and it has been a time- (and agony-) saver around the ham shack. I hope that others who enjoy building and experimenting will find it to be the same. I will offer film negatives (or positives) so that builders can make their own circuit boards. Correspondence regarding the meter will be answered if an SASE is included.

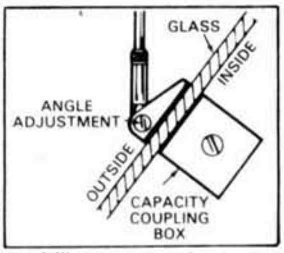
table 1. Switch positions for various measurement ranges showing display and associated capacitance value. In switch position 1, a display of 1.50 indicates a capacitance of 0.015 μF (1500 pF), a reading of 2.20 indicates a capacitance of 0.002 μF (2200 pF), etc.

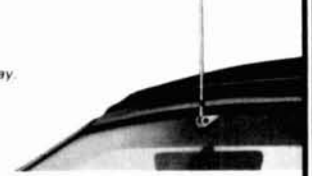
switch position	display	capacitance	range
1	1.00	0.001	1000 pF (1 nF)
2	10.00	0.010	10k pF (10 nF)
3	100.00	0.100	100k pF (100 nF)
4	1.00	1.000	1 μF
5	10.00	10.000	10 μF
6	100.00	100.000	100 μF

acknowledgments

Several hams have been of great assistance in developing the digital capacitor meter, in particular WA4RVN, K4ZKU, and W4PVA. K4ZKU provided valuable information on driving the display to full brightness, and W4PVA helped with the information on the 14553 counter chip without which the project could not have been undertaken. WA4RVN built his meter according to this article to verify the construction and checkout notes.

ham radio





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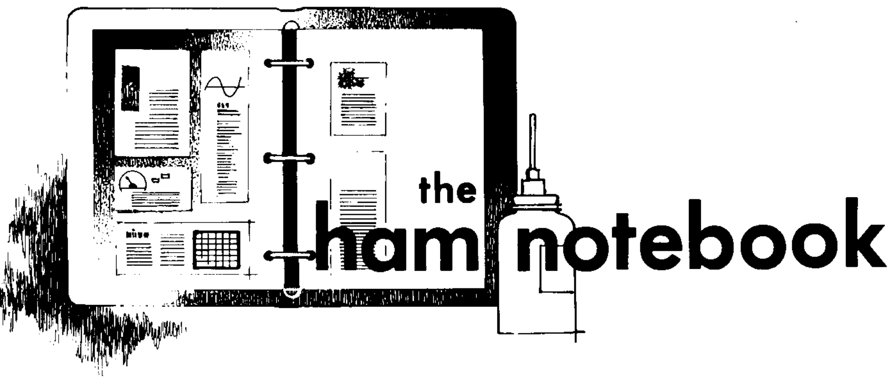

a fresh look at linear tuning

Most Amateurs expect the benefits of a linear-spaced tuning dial when they purchase new equipment. The expression "linear tuning" refers to the ability to rotate the tuning dial or knob, knowing that a certain number of kilohertz will be traversed with each turn of the knob, say 25 or 50 kilohertz. Amateurs expect to find this feature in professionally designed equipment, but rarely is it found in home-built Amateur gear. Why does this situation exist, and what can the Amateur who perfers to build his own do about it? Let's take a look at how commercial manufacturers handle the problem.

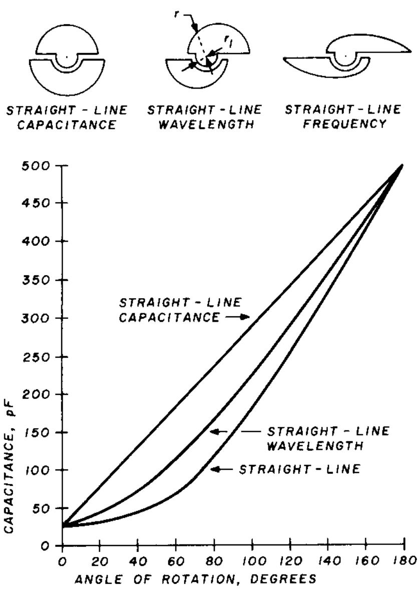

fig. 1. Characteristics of SLC, SLW, and SLF variable capacitors showing capacitance as a function of angle of rotation in typical cases, together with approximate plate shapes. (From *Radio Engineers' Handbook* by F.E. Terman, McGraw-Hill, Inc., 1943.)

Frequency change requires that we square the product of inductance, L, and capacitance, C, to effect a 2:1 frequency change. For example, the product of LC is approximately 520 for 40 meters. The product of LC amounts to about 2080 at 3.5 MHz. Since it would be mechanically unwieldy to alter both inductance and capacitance, the accepted method is to vary either the capacitance or inductance in a typical circuit. (The foregoing remarks apply to high-frequency circuitry in this discussion.)

Most manufacturers handle this situation by limiting the excursion of their oscillator circuit to, say, 500 kHz and by using a VFO coil with windings spaced nonlinearly. A tuning slug moves into the coil form and causes an inductance change. Collins refers to this method as "permeability tuning." It's a good system; unfortunately it's not suitable for easy duplication by the home builder. Another method would be to use capacitor plates with special shaping. This also poses a problem for the home builder.

variable-capacitor plate shapes

Fortunately there's a way of "making it" without having a large machine shop at your disposal. The solution to the problem came to me while watching my wife making some designs on a quilt with a mix-and-match pattern.

A look at most transmitting capacitors shows that they use half-round plates in the rotor section, whereas most capacitors for broadcast reception use different shapes. The first shape is called straight-line capacitance (SLC), while the second is called midline, or straight-line frequency (SLF). See **fig. 1**. In short, a variable capacitor with the proper arrangement of SLC and SLF plates

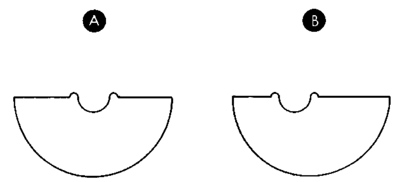

fig. 2. Comparison of rotor plates in the popular "Command" transmitter. A shows approximate shape of an SLC plate; B an SLF plate.

should satisfy the need for truly linear tuning.*

modifying transmitting variable capacitors

Some variable capacitors, which use aluminum plates spaced with washers or metal spacers, can be modified easily in the rotor section to accomplish this objective. In my case, I removed half-round plates from the middle capacitor in a Command transmitter and re-installed them on the rotor shaft of the master oscillator tuning capacitor, which had been altered by lifting out several of the SLF rotor plates.

With the correct amount of fixed L and C, linear tuning will result. If you're willing to settle for a limited frequency excursion, exceptionally high accuracy can be achieved. The

*Still another shape for variable-capacitor plates is called straight-line wavelength (SLW) in which the plates are shaped so that, when used to tune an inductance to resonance, the wavelength at resonance is a linear function of the angle of rotation. Practical capacitors use intermediate characteristics or a combination of these basic types (see **fig. 2**). **Editor.**

calibration chart (**table 1**) shows this to the last hertz. Note that this is not a one-of-a-kind experiment. Equally satisfying results have been accomplished in a half-dozen instances. There's no reason why this technique can't be applied to other ranges, such as the popular 5.0-5.5 MHz range used in many VFOs.

My original intentions were satisfied, as shown by a 3.5-3.6-MHz curve. However, high-accuracy linear readout continued throughout at least a 200-kHz span between 3.45-3.65 MHz. All of the above was achieved without trimming or bending of the master-oscillator variable capacitor plates; thus it's fair to say that similar results could be obtained by any careful experimenter or builder.

Neil Johnson, W2OLU

solid-state amplifier switching

Forget about carrier-operated relay (COR) circuits and other mechanical antenna and power switching arrangements by going solid-state. This diode-switching circuit provides maintenance-free, reliable switching without fuss or bother. Best of all, it's simple.

Simply use two quarter-wavelength sections of RG-174/U coax and appropriate diodes (**fig. 1**). The 1N4148 diodes are adequate for moderate power levels commonly used on 2-meter f-m.

David D. Holtz, WB2HTH

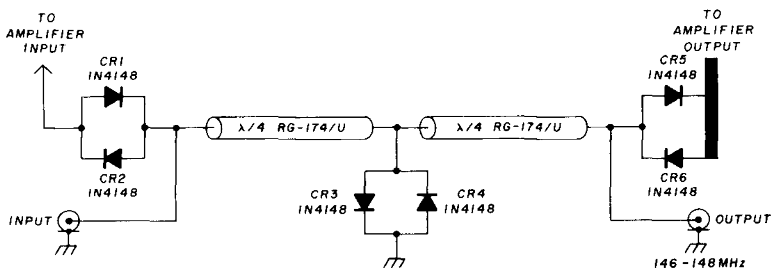

fig. 1. Solid-state switch for 2-meter f-m. Circuit was adapted from an article appearing in the April, 1973, issue of *ham radio*.

de-icing the quad

Probably more quad antennas have come to grief because of ice than from all other reasons combined. At least that seems to have been my experience. It seems that something may be lacking in our planning. A simple means of de-icing the quad should be a real boon to those who usually have a couple such examples of nature's contempt for us each winter.

The quad driven element is usually fed at bottom center through coaxial line. If, for the driven element, we use a wire having a higher resistance at dc than at rf, such as galvanized electric fence wire or smaller size copperweld, 60-Hz power, fed through the coaxial line should provide enough heat to prevent the formation of ice, or if it has already formed, to melt it. After all, ice usually forms at temperatures quite close to freezing, and this idea wouldn't require a temperature increase of more than a few degrees to thwart Jack Frost.

The average quad has at least two elements, and it wouldn't do to leave the parasitic elements out in the cold. By going to the top of the quad, opposite the feed point, one finds a voltage node. A capacitor of suitable power-handling capability may be inserted here without affecting array performance. A value of 0.01 or 0.02 μF should be enough capacitance. The same thing can be done with the reflector (and the director if you have more than two elements). A pair of wires that connect all the elements in series for dc, running parallel to the boom, should permit you to apply enough current through the coaxial line to keep the ice away. An ordinary filament transformer should supply enough power for most applications.

The diamond configuration might be preferable for this application, as more support would be provided for the capacitors and connecting wires; the square configuration makes a clearer illustration (**fig. 1**).

Henry S. Keen, W5TRS

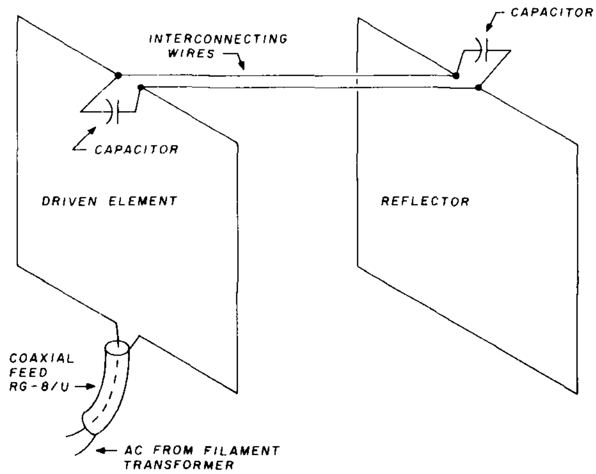

fig. 1. Power applied to a quad from an ordinary filament transformer will generate enough heat to prevent ice formation, or if already formed, to melt it. The capacitors are inserted at the voltage nodes of the elements, and don't affect array performance.

MHz electronics

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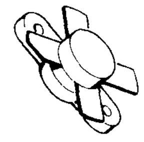

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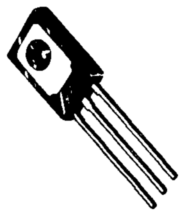

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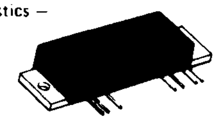

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3042-20	Directional Coupler 950 to 2 GHz 20dB Type N	125.00
3043-30/	22007 Directional Coupler 1.7 to 3.5 GHz 30dB Type N	125.00
22574	Directional Coupler 2 to 4 GHz 10dB Type N	125.00
3033	Coaxial Hybrid 2 to 4 GHz 3dB Type N	125.00
3032	Coaxial Hybrid 950 to 2 GHz 3 dB Type N	125.00
784/	22380 Variable Attenuator 1 to 90dB 2 to 2.5 GHz Type SMA	550.00
22377	Waveguide to Type N Adapter	35.00
720-6	Fixed Attenuator 8.2 to 14.4 GHz 6 dB	50.00
3503	Waveguide	25.00

PRD

U101	12.4 to 18 GHz Variable Attenuator 0 to 60dB	300.00
X101	8.2 to 12.4 GHz Variable Attenuator 0 to 60dB	200.00
C101	Variable Attenuator 0 to 60dB	200.00
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196C	8.2 to 12.4 GHz Variable Attenuator 0 to 45dB	100.00
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588A	Frequency Meter 5.3 to 6.7 GHz	100.00
140A,C,D,E	Fixed Attenuators	25.00
109J,I	Fixed Attenuators	25.00
WEINSCHEL ENG.	2692 Variable Attenuator +30 to 60dB	100.00

COMPUTER I.C. SPECIALS

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2114/9114	1K x 4 Static RAM 450ns	6.99
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2114L3	1K x 4 Static RAM 350ns	7.99
4027	4K x 1 Dynamic RAM	3.99
4060/2107	4K x 1 Dynamic RAM	3.99
4050/9050	4K x 1 Dynamic RAM	3.99
2111A-2/8111	256 x 4 Static RAM	3.99
2112A-2	256 x 4 Static RAM	3.99
2115AL-2	1K x 1 Static RAM 55ns	4.99
6104-3/4104	4K x 1 Static RAM 320ns	14.99
7141-2	4K x 1 Static RAM 200ns	14.99
MCM6641L20	4K x 2 Static RAM 200ns	14.99
9131	1K x 1 Static RAM 300ns	10.99

C.P.U.'s ECT.

MC6800L	Microprocessor	13.80
MCM6810AP	128 x 8 Static RAM 450ns	3.99
MCM68A10P	128 x 8 Static RAM 360ns	4.99
MCM68B10P	128 x 8 Static RAM 250ns	5.99
MC6820P	PIA	8.99
MC6820L	PIA	9.99
MC6821P	PIA	8.99
MC68B21P	PIA	9.99
MCM6830L7	Mikbug	14.99
MC6840P	PTM	8.99
MC6845P	CRT Controller	29.50
MC6845L	CRT Controller	33.00
MC6850L	ACIA	10.99
MC6850P	ACIA	4.99
MC6852P	SSDA	5.99
MC6852L	SSDA	11.99
MC6854P	ADLC	22.00
MC6860CJCS	0-600 BPS Modem	29.00
MC6862L	2400 BPS Modem	14.99
MK3850N-3	F8 Microprocessor	9.99
MK3852P	F8 Memory Interface	16.99
MK3852N	F8 Memory Interface	9.99
MK3854N	F8 Direct Memory Access	9.99
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8080A	Microprocessor	8.99
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MC1733L	LM733 OP Amplifier	2.40
LM565	Phase Lock Loop	2.50

MHz electronics

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(602) 242-8916

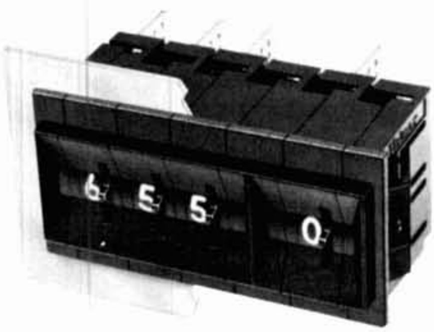
2111 W. Camelback
Phoenix, Arizona 85015

NEW products

smaller thumbwheel switch

A new line of *subminiature*, digital thumbwheel switches is now available from Unimax Switch Corporation, a subsidiary of the Unimax Group, Inc. Designated as "Series S2D," a single, rear-mounted switch (with up to sixteen positions) will require a panel cutout only 0.748 inch (19 mm) high by 0.670 inch (17 mm) wide! This size reduction for this type of switch will greatly simplify the job of laying out crowded control panels of modern electronic equipment.

In addition to their small size, the new switches offer all the "traditional" benefits found in Unimax standard digital thumbwheel switches. These include the unique degree of freedom in mounting — any Series S2D switch can be mounted either from the front or the rear of the panel simply by using different sets of end plates (in both instances, end plates fit either the left or right side, which translates into smaller inventories and simplified assembly).



Like standard Unimax digital thumbwheel switches, the new Series S2D units offer Unimax's "No-Hardware" feature — meaning that a wide variety of switching assemblies can be made by simply snapping together standard switch bodies, dividers, blank bodies, and end plates. Other Series S2D features include a high degree of reliability due to the fact that each switch consists of only five components, and has a life of 1,000,000 operations.

The new Series offers as standard the nine most widely used output codes; other codes can be supplied on request. Standard output codes include Single-Pole Decimal, 10-Position; 10-Position BCD, Complement only; 10-Position BCD only; 10-Position BCD with Complements; Single-Pole, 16-Position, Binary; and Single Pole, Repeating. For more information contact Unimax Switch Corporation, Ives Road, Wallingford, Connecticut 06492.

CompuClock

CompuClock from Comtronics, Inc., is a free-standing, non-interruptible digital clock, delivering time and date on software command. Time is also visually displayed, and the date appears with the push of a button.

Time and date are delivered on software command to an RS232C computer port as a serial string of 21 ASCII characters. For example:

03:17:16 PM [SP], 01-31-80 [CR] [LF]

where [SP], [CR] and [LF] refer to the ASCII codes for space, carriage return and line feed. This output can be supplied to any format desired.

CompuClock has a backup power supply and maintains the time and date precisely in the event of power failure. The visual display goes out to save the battery, but time can be maintained for up to two weeks until power is restored.

For more information write Comtronics, Inc., 105 N.W. 43rd Street, Boca Raton, Florida 33431, or phone Chuck Staples at (305) 392-8700.

Keithley hand-held DMM

Keithley Instruments announces its first hand-held digital multimeter (DMM). The 3½ digit Model 130, with a large LCD display is intended to be a technician's tool. Priced at only $99, it is a basic instrument, designed to meet the needs of the field service technician. It is easy to use, straightforward, and rugged.

Keithley has gained considerable market share with the complete line of bench digital multimeters that it has brought out in the past two years. The addition of the Model 130 rounds out that line.

A survey conducted by Keithley found that most service technicians prefer rotary switches and liquid-crystal displays (LCD). They also want a hand-held model that is convenient in a bench situation, so the display is the same size, 0.6 inch, as the displays on Keithley's bench instruments.

In addition, the simplicity of construction makes the Model 130 the most rugged hand-held DMM on the market. For more information write Keithley Instruments, Inc., 28775 Aurora Road, Cleveland, Ohio 44139.

mini-mount antennas

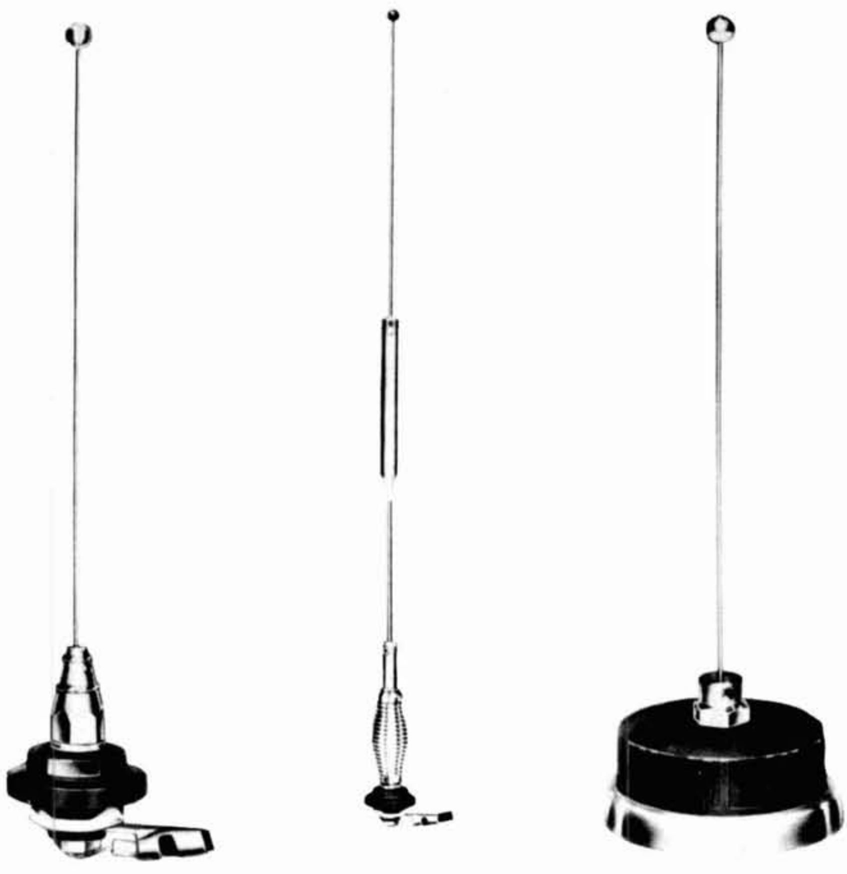
A complete line of eight low-priced miniature antennas, featuring the new Mini-Mag Mount and Mini-Mount, are now available from Antenna Incorporated.

Designed to fill the need for low-cost business communications antennas, six of the miniature antennas cover the 5-dB-gain uhf band and two cover the 1/4-wavelength 136-512 MHz band. The 136-512 MHz Model 42013 1/4-wave Mini-Mag magnet-mount antenna is priced at $21.25. The mount has a 2-inch diameter magnet and stands 1-1/4 inches high with the whip adapter; overall length with 136-MHz antenna whip is 20 inches. The electrically equivalent Model 42008 Mini-Mount is priced at $11.81. The Mini-Mount is adaptable for installation in either a 3/4-inch or 3/8-inch hole (although the installer must have access to the underside of the roof in order to use the 3/8 inch mount). It also stands 1-1/4 inches with whip adapter and 20 inches with 136 MHz antenna whip.

The 3/8-1/4 inch Mini-Mount is also available on 450 MHz skirt antennas at a price of $30.00 in these frequency ranges: 406-420 MHz (Model 43128); 420-435 MHz (Model 43228); 435-450 MHz (Model 43328); 450-470 MHz (Model 43428); 470-490 MHz (Model 43528); 490-512 MHz (Model 43628).

The 3/8-3/4 inch Mini-Mounts come with 17 feet of RG-58/U coaxial cable and PL-259 in-line connectors, as does the 42013 Mini Magnet Mount.

For more information on the new miniature line, and other Antenna Incorporated antennas, write Randall J. Friedberg, Antenna Incorporated, 26301 Richmond Road, Cleveland, Ohio 44146, or phone (216) 464-7075.



NEW products

Heath IC timers self-instruction program

Heath Continuing Education, a division of Heath Company, Benton Harbor, Michigan, announces a new self-instruction program which covers integrated-circuit timers. The new program, Model EE-103, includes an introduction to the common types of IC timers, how each works, what they do, and where they are used.

Among the types of IC timers covered are the popular 555 and 556 series general-purpose timers; the 322 and 3905 wide-range, precision, monostable timers, and programmable timer/counters — including the 2240 binary programmable timer/counter; the 2250 BCD programmable timer/counter; and the 8260 seconds/minutes/hours BCD programmable timer/counter.

The program's self-teaching text, with the assistance of review quiz questions and lab experiments, completely covers how each timer works and how each is used — in logic functions, output drive circuits, time-delay relay circuits, wide-range pulse generators, phase-locked loops, universal appliance timers, as precise clock sources, and many others.

All of the electronic components required to perform the experiments are included with the program. The Heathkit ET-3300 Laboratory Breadboard is a recommended option.

The EE-103 IC Timers course is one of four Electronic Technology Series self-instructional programs. They are designed to provide detailed knowledge for engineers, technicians, and other technical people. Other programs in the series include Operational Amplifiers (EE-101, $39.95), Active Filters (EE-102, $29.95), and Phase-Locked Loops (EE-104, $49.95).

For more information on the EE-103 IC Timers Self-Instruction Program — priced at $39.95 mail-order FOB Benton Harbor, Michigan — send for a free catalog containing more than four hundred other useful electronic kits. Write Heath Company, Dept. 350-230, Benton Harbor, Michigan 49022, or pick up a copy at the nearest Heathkit Electronic Center (units of Veritechnology Products Corporation).

Heath Company is a subsidiary of Zenith Radio Corporation.

hand-held digital multimeter

The new Fluke Model 8024A, "The Investigator," 3½-digit digital multimeter detects logic states, finds loose connections, shorts, hot spots, and peaks (and holds them). Convenient visual and audio indications have also been added.

The 8024A provides all of the ranges, functions, and features of its highly successful predecessor, the Fluke 8020A, plus the ability to detect logic state changes from +0.8 volts ("0") to +2.5 volts ("1") at pulse rates (TTL) up to 20 kHz. An audio indication and arrows on the LCD display indicate "up" and "down", "1" or "0".

A peak and hold feature allows the

More Details? CHECK—OFF Page 94

user to concentrate on taking a reading when working on a sensitive or hazardous circuit then view the reading on the LCD display. This feature is provided for ac/dc volts and ac/dc current and provides a short term memory, also useful in capturing the peak value of a transient signal such as motor starting currents. It also provides the capability of detecting intermittent open circuits in connections or cables, sounding an audible signal as well as providing the visual display.

The 8024A will also read directly in Celsius degrees the output of any type "K" thermocouple, over a range of −20 C to 1265 C. This feature will be important to anyone servicing process control and air conditioning systems, detecting heat rise in electrical motors, and system or circuit components. Whenever it becomes necessary to measure temperature in operating systems or hardware, the 8024A provides an early and economical solution to these types of problems.

For additional information, write Frank Partin, at John Fluke Mfg. Co., P.O. Box 43210, Mountlake Terrace, Washington 98043, or phone (206) 774-2322.

More Details? CHECK—OFF Page 94

NEW products

Larsen improved magnetic mount

Larsen Electronics, Inc., of Vancouver, Washington, has improved their Magnetic Mount design to give it even stronger holding power and reduce even further the chance of scratching the vehicle finish.

Larsen's super-strength magnetic assembly has been engineered to closer tolerances for more holding power per square inch. Every magnetic mount leaves the Larsen factory fully "charged" to maximum flux density.

In addition, the Larsen Magnetic Mount has a new boot of resilient Nordel that will not crack or harden, even with long-term exposure to weather and sunlight. This rubber-like boot also minimizes the possibility of scratching the finish of the vehicle to which it is attached.

Also, the capacitive coupling shield on the underside of the mount has been beefed up to make it less subject to accidental puncture stress.

For more information, write Larsen Electronics, Inc., P.O. Box 1686, Vancouver, Washington 98668.

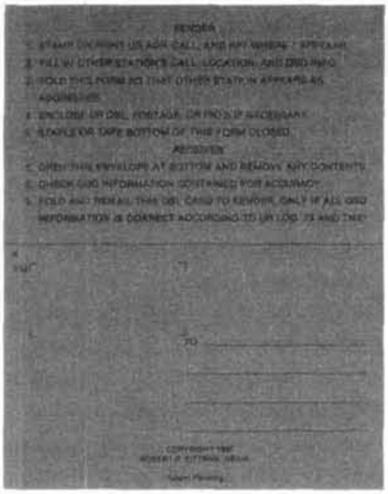
confirmation mailers

Here's a neat package that will help you get a return QSL (confirmation of QSO) from those overburdened contest stations or DX operators.

Called Confirmation Mailers (CMs), the mailer is a double postal card, printed on both sides, and arranged so that you (the sender) can fill in the *information needed to confirm a contact,* from both your station and the guy at the other end. All the recipient needs to do is confirm that the QSO information is correct (date, time, band, report, etc.), and mail half of the card back to you.

The double card can be folded and taped or stapled so you can enclose return postage stamps or IRCs to further induce the other station to confirm the contact.

CMs are priced at $5.50 for 30, and *are available from* Robert Zittnan, K9UJA, P.O. Box 94973, Schaumburg, Illinois 60193.



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DEADLINE 15th of second preceding month.

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OMNI A/B SERIES with 217, 218, 248, 243, 6 months old, $899. SB-221 new, $500., SB-634 $125., or will trade any of above for Collins gear KWM-2, S-line, 30-L1, accessories, etc. John, N1JM, (315) 699-3268.

MOBILE HF ANTENNA 3.2-30 MHz inclusive, 750 watts PEP, center loaded, tuned from the base, eliminating coil changing or removing from mount. Less than 1.5 to 1 VSWR thru entire coverage. $129.95 ea. plus shipping. Contact your local dealer, if none in your area order direct. Anteck, Inc., Route One, Hansen, Idaho 83334. (208) 423-4100. Master Chg., and VISA accepted. Dealer and factory rep. inquiries invited.

WANTED: Eimac SK-710 socket for 4CX300. R. Guerin, 24 High Range Rd., Londonderry, NH 03053. (603) 432-7305.

VERY In-ter-est-ing! Next 3 issues $1. "The Ham Trader", Wheaton, IL 60187.

NEW, Exciting Amateur Operators' Picture Yearbook, sponsored by the First United Pentecostal Church, Inc. Send call sign, address, photo, and $20 to Lee Kent, WD0FFZ, P. O. Box 236, Malden, MO 63863. You will receive one copy of the book for each $20. Tell everyone.

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FOR SALE: SATELLITE TV 3.7-4.2 GHz down converter 70 MHz I-f PCB with parts provision for on board local oscillator, $75.00. Birkill 4 GHz LNA PCB bipolar or gas-fet, $15. Both for $25.00 — SASE to Norman Gillaspie, 2225 Sharon Rd., 224 Menlo Park, CA 94025.

WANTED: Radio Frequency Amplifier AM 494/GR. Any condition, with or without tubes — Top Dollar. K8MKJ, 6128 Lodi Lane, Saline, MI 48176.

SPECIAL SALE: Alliance HD-73 Heavy Duty Rotor $99.99 plus $3.00 shipping Continental USA. MC and Visa accepted. Scanner World, USA., 10-H New Scotland Ave., Albany, NY 12208. 518-436-9606.

RECONDITIONED TEST EQUIPMENT for sale. Catalog $.50. Walter, 2697 Nickel, San Pablo, CA 94806.

10-40 MHz SYNTHESIZER provides continuous coverage 1-31 MHz in 100 Hertz steps with your 9-MHz i-f. PCB, kit, or wired. SASE for data sheet. Petit Logic Systems, P.O. Box 51, Oak Harbor, WA 98277.

WANTED: Early Hallicrafter receivers, transmitter, accessories, parts, manuals for my collection. Special interest in silver colored panel receivers and ones with "airplane" dials. Also need "ultra Skyrider" SX-10, "Skyrider Commercial" SX-12 and others. Chuck Dachis, WD5EOG, 4500 Russell, Austin, TX 78745.

RADIO BROADCAST TECHNICIANS: Voice of America has opportunities in Washington, D.C. for qualified Radio Broadcast Technicians. These positions require a comprehensive background in the recording, maintenance, studio and field areas. Salary range: $10.59-$14.87 per hour depending on qualifications. U.S. citizenship required. Submit standard Federal application form, SF-171, to International Communication Agency, MGT/PDE (1-78) Washington, D.C. 20547. An Equal Opportunity Employer.

WANTED: EICO #720 or #723 xmtr, Hallicrafters HT40 xmtr and HA5 vfo. J. Titus, Box 242, Blacksburg, VA 24060 (703) 952-2684.

CB TO 10 METER PROFESSIONALS: Your rig or buy ours — AM/SSB/CW. Certified Communications, 4138 So. Ferris, Fremont, Michigan 49412; (616) 924-4561.

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QSL'S: No stock designs! Your art or ours; photos, originals, 50¢ for samples & details (refundable). Certified Communications, 4138 So. Ferris, Fremont, Michigan 49412.

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ATLAS OWNERS DD6-C and 350XL Digital Dial/Frequency Counters. $175.00 + Shipping (Calif. add tax). Mical Devices, Box 343, Vista, CA 92083.

ANTIQUE (PRE-1950) TELEVISION SETS WANTED. Will pay top dollar for unusual or pre-WWII sets, Arnold Chase, 9 Rushleigh Road, West Hartford, Connecticut 06117 (203) 521-5280.

MANUALS for most ham gear 1937/1970. Send 25¢ for "Manual Catalog." H.I., Inc., Box H864, Council Bluffs, Iowa 51502.

SOLAR CELLS .4v, 4" diameter, 2 amps. $8.75, 10 for $85.00 plus shipping. Kenneth Foster, 1742 Dowd, St. Louis, MO 63136. (314) 522-6667.

MOBILE IGNITION SHIELDING provides more range with no noise. Available most engines. Many other suppression accessories. Literature, Estes Engineering, 930 Marine Dr., Port Angeles, WA 98362.

TEST EQUIPMENT: Tektronix 1L20 spectrum analyzer, 1 to 4200 MHz $1,000.00. AIL precision test receiver $300.00 (used for extremely accurate noise figure measurements). AIL automatic noise meter $200.00. Hewlett-Packard noise source, 1 to 500 MHz $80.00. K3AP, Parkhurst Drive, Salisbury, MD 21801. (301) 742-7333.

BUY-SELL-TRADE. Send $1.00 for catalog. Give name address and call letters. Complete stock of major brands new and reconditioned amateur radio equipment. Call for best deals. We buy Collins, Drake, Swan, etc. Associated Radio, 8012 Conser, Overland Park, KS 66204. (913) 381-5900.

WANTED: A GR 1606A/B rf impedance bridge or HP 250A/B RX meter. Please describe condition and price. W0VDJ, 250 Ogden St., Denver, Colorado 80218.

CW/SSB FILTERS: IC audio install in any radio, sharp CW, stagger tuned SSB — $15, $32. SASE info: W8CBR, 80 W. Mennonite, Aurora, OH 44202.

FREE HAM/COMPUTER NEWSLETTER: Send self-addressed stamped envelope for your copy. W5YI; P.O. Box #10101; Dallas, Texas 75207.

TO SELL: Mirage B1016 2-meter linear amplifier with preamp, like new — $195. Yorx AM-FM stereo 8-track, good condition, $75. Radio Shack variable DC supply, good condition, $15. ADC equalizer, new condition, $55. Yaesu CPU-2500R 2 meter mobile, like new — $300. Optex photostat machine, $100. Mitchell Rakoff, 6433 98th St., Rego Park, NY 11374. Phone: (212) 830-0097.

ICOM INTERNATIONAL USER'S CLUB. Details SASE N8RT, Pohorence, 9600 Kickapoo Pass, Streetsboro, Ohio 44240.

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WANTED: Hallicrafters SX88 Band Selector Drive Belt (Made like timing belt) K9EY, P.O. Box 1225, Bloomington, Indiana 47402.

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MACROTRONICS M800-M80 RTTY SYSTEM for TSR80 microcomputer. Hardware and software tapes for CW, RTTY, and ASCII. Manual and bulletins. $130.00. Write: A. W. Hubbard, 5705 Junonia-S.P.V., Ft. Myers, FL 33908.

HW-2036A WITH MICODER II and QST digital readout. $205.00. WD4GRI, 1907 Lodgepole, N. Augusta, SC 29841. (803) 279-6513.

NEGATIVES MADE FOR PC BOARDS from magazine articles (up to 5" by 7"). Send page and $6.00 or write: Graham Johnson Studio, 2 Spruce Terrace, Portland, CT 06480.

Coming Events

NEW YORK: HAM-O-RAMA '80 on September 12th and 13th at the Erie County Fairgrounds in Hamburg. Exhibits, tech programs, prizes, flea market. Plenty of free parking, free RV hookups. Advance tickets $3 — contact Ron Brodowski, KC2P, 260 Hilltop Drive, Elma, NY 14059. (716) 652-6754.

RADIO EXPO "80" Lake County fair grounds, Rt. 45 & 120. Sept. 6 & 7 — advanced tickets $2.00, $3.00 at gate. Write: Radio Expo Tickets, P.O. Box 1532, Evanston, IL 60204. Exhibitor information call (312) BST-EXPO.

ILLINOIS: Fox River Radio League Hamfest, Sunday, August 24th, Kane County Fairgrounds, St. Charles. Free outside flea market - inside display area. Table discounts available. Contact Gary Senesac, KA9ADP, 926 Britta Lane, Batavia, IL 60510. Tickets: $1.50 advance; $2 at gate. Contact Jerry Frieders, W9ZGP, 1501 Molitor Rd., Aurora, IL 60505. Talk-in on 146.94.

OHIO: The Way International of New Knoxville Ohio annual Rock Of Ages festival on August 10-16. Christian Music Festival on 3.930, 7.230, 14.330, and 146.52 MHz. Commemorative "ROA 1980" QSL's will be sent to those stations worked.

NEW JERSEY: The Englewood Amateur Radio Association's 21st annual QSO party from 2000 UTC Saturday, August 16 to 0700 UTC Sunday, August 17 and from 1300 UTC Sunday, August 17 to 0200 UTC Monday, August 18. Phone and CW are considered same contest. A station may be contacted once on each band — phone and CW are considered separate bands. New Jersey stations may work other New Jersey stations. General call is "CQ New Jersey" or "CQ NJ". Suggested frequencies are: 1810, 3535, 3900, 7035, 7135, 7235, 14035, 14280, 21100, 21355, 28100, 28610, 50-50.5 and 144-146. Suggest phone activity on even hours; 15 meters on odd hours (1500 to 2100 UTC); 160 meters at 0500 UTC. Exchange consists of QSO number, RST and QTH (ARRL section or country). Logs, showing UTC date and time, band, and emission, must be received no later than September 13, 1980, at: Englewood ARA, Inc., PO Box 528, Englewood, NJ 07631 with #10 SASE enclosed.

NEW JERSEY: Sussex County Amateur Radio Club's second annual hamfest at Sussex County Farm and Horse Show grounds on Plains Rd. off Rte. 206 in Augusta, NJ. Indoor and outdoor flea market. Outdoor sellers at door: $5 or $4 preregistered. Indoor sellers: $6 at door or $5 preregistered. $1 door prize ticket. Free admission. For info and preregistration: Sussex Co. A.R.C., P.O. Box 11, Newton, NJ 07860 or Ed Woznicki, AC2A, (201) 852-3268. Talk-in on 147.90/30 and 146.52 simplex.

RHODE ISLAND: East Bay Amateur Wireless Association's QSO Party. Two periods: August 16 1700-0500 August 17, and August 17 1300-0100 August 18. Stations work other R.I. stations and the rest of the world. Same band may be worked once per band and mode. Frequencies: CW: 1810, 3550, 3710, 7050, 7110, 14050, 21050, 21110, 28050, 28110. Phone: 3900, 7260, 14300, 21360, 28600, 50.110, 144.2. Use of FM simplex is encouraged. (NO REPEATERS). Logging: must show: date, time (GMT), call, exchange, band and mode. Deadline: SASE and logs by September 15.

OHIO: Warren A.R.S. Hamfest, August 17, 1980 at the Trumbull Branch, Kent State University. Huge flea market, tech forums, DX programs, dealer displays, XYL activities. QSL W.A.R.A., P.O. Box 809, Warren, Ohio 44482.

FINDLAY HAMFEST: The 38th Annual Findlay Hamfest greets you on Sept. 7th with a fine new indoor/outdoor location, The Hancock Recreational Center, just east of I-75 exit 161, on the north edge of Findlay, 40 miles south of Toledo. Main Prizes: a TS-120s W/supply, two TR-2400's, and an AT-120 matcher. Tickets $2.00 advance and $2.50 at the door. Reserve your tables early: $2.50 per ½. Open Saturday 17:00 till 22:00 for forums and set-up, Sunday at 05:00. Join the over 6000 people attending Findlay Hamfest this year and spend your bucks on the best! For tickets, info, and reservations send S.A.S.E. to P.O. Box 587, Findlay, Ohio 45840.

TEXAS: Golden Spread Hamfest and convention on the evening of August 1 and all day August 2 and 3 at the Student Activities Center of West Texas State University, Canyon, Texas. Commercial displays, Swapfest, ARES program, Station operation demonstration, guided tours, bingo, Navy and Army MARS meetings, ARRL forum, Tech sessions and many door prizes. Preregistration is $5.00. At the door: $6.00. Sponsored by the Panhandle Amateur Radio Club of Amarillo, Texas. Talk-in on 146.07/.67, 147.99/39, and 146.52.

More Details? CHECK—OFF Page 94

PENNSYLVANIA: Butler County Amateur Radio Association's hamfest on Sept. 7 in the Butler Farm Show Grounds at Roe Airport. Free parking, $1.00 donation admission. Overnight camping welcome. Handicap parking available. Food and refreshments. Many prizes including Kenwood TS-520 SE Transceiver, specials and others. For more info: Dan Metrick, WA3GDS, 130 Rieger Rd., Butler, PA 16001. (412) 283-1719.

MAINE: The Sandy River Amateur Radio Club will hold a Hamfest/Flea Market on Saturday and Sunday, August 16th and 17th, 1980, at the Farmington Fair Grounds, Farmington, Maine. Admission will be $1.00. No charge for tailgating. Commercial dealers welcome. Door prizes both days and a raffle on Sunday at 1:00 P.M. Free camping available from Friday starting at 5:00 P.M. until Sunday afternoon. Refreshments and snacks during the days and a lobster or chicken dinner late Saturday afternoon. Talk in on 146.37/97 and 146.52. For information and map, send S.A.S.E. to Charles Stenger W1HTG, Box 111, East Dixfield, Maine 04227.

VIRGINIA STATE ARRL CONVENTION: The Fifth Annual Tidewater Hamfest and ARRL Virginia State Convention will be in the great new Virginia Beach, Virginia Arts and Conference Center, October 4 and 5, 1980. ARRL, Traffic, DX Forums, XYL free bingo and lounge. Admission $3.50. Advance admission ticket drawing for Kenwood FM transceiver. Flea market spaces $3.00 day. Ticket and information - TRC, P.O. Box 7101, Portsmouth, Virginia 23707 SASE.

NEW JERSEY: The Ramapo Mountain Amateur Radio Club will hold its annual flea market on Saturday, August 16, 1980, at the American Legion Hall, Oak Street, Oakland, New Jersey. Indoor tables are $5.00 and tailgating is $3.00. No admission fee for buyers. Refreshments will be available on premises. Talk in on 147.49/146.49 WR2AHD or 146.52 simplex. Call Bud Hauser WA2JUO at 201-797-8471 or 791-0589 for advance reservations and information.

THE ANNUAL LAPORTE COUNTY HAMFEST will be held rain or shine, Sunday, Aug. 24, 1980, at the County Fairgrounds on Highway 2, west of LaPorte, Indiana (50 miles S.E. of Chicago). Paved flea market area outdoors. Indoor tables $1.00 each. Overnight trailer hookups available on site for early birds. Advance tickets $2.00 with SASE to P.O. Box 30, LaPorte, IN 46350.

OHIO: The 44th annual Cincinnati Hamfest will be September 21. Location: Stricker's Grove on State Rte. 128 in Ross, Ohio. Exhibits and booths, prizes, flea market, entertainment and a sensational and thrilling air show by The Hawks. Admission and registration: $4.00 in advance. For information, contact W8ALW, WA8STX, or K8CKI.

INDIANA: 10th annual Lafayette Hamfest will be Sunday, August 17 at the Tippecanoe County Fairgrounds in Lafayette, 18th St. at Teal Rd. Flea Market set-ups can be made anytime after 1800 hours Saturday. Pre-registration and grand prizes will be ICOM IC-2A Synthesized 2M Hand-held with Tone Pads and Chargers. Also B&W AC-DC portable TV and others. Refreshments available. Cost: $2.50 each by mail in advance to qualify for pre-registration prize or at the gate. Mail orders: Send SASE with check or money order to K9KRE, J. B. Van Sickle, R. R. #1, Box 63, West Point, IN 47992. Talk-ins on 146.73 repeater and 146.94 simplex. Call in station is W9REG.

NEW YORK: Seaway Valley Hamfest at Louisville, N.Y. in the Louisville Municipal Arena on September 7. Turn south off Rt. 37 near Rt. 131 and Louisville School. Host Club: Massena Amateur Radio Club. Registration and Flea Market: 9:00 A.M. Activities: Flea Market, door prizes, raffles, auction, ladies program, children's activities and others. Registration and door prizes: $2.50 Adv. sales: $2.00. Children under 12 free. Ticket Manager: Lois Ierlan, WA2RXQ, 725 Proctor Ave., Ogdensburg, NY 13669.

WEST VIRGINIA: Cedar Lakes Hamfest on August 10 at the Cedar Lakes FFA-FHA Conference Center, Ripley, WV. Flea Market, Forums, Demonstrations, Prize Drawings, Ladies and Children Activities. Cafeteria on grounds. 9 A.M. to 4 P.M. Talk-In on 146.52/.52 and 146.07/.67. Advanced tickets $2.00 — 3 for $5.00. $2.50 at the door. Bob Morris, WA8CTO, 308 Edgewood Circle, Ripley, WV 25271.

WASHINGTON: Radio Club of Tacoma's 14th annual "Hamfair" will be on August 23rd and 24th at Pacific Lutheran University, Tacoma, Wash. Door prizes, flea market, banquet, exhibits, and much more. Contact Joe Winter, 819 N. Mullen, Tacoma, WA 98406. Talk-in on 88/28.

NEW JERSEY: Gloucester Co. A.R.C.'s second annual hamfest on August 24 from 8 to 3 at the Gloucester County College, Tanyard Rd., Sewell. Tailgaters set up at 7:00. Indoor and outdoor spaces available. Food and prizes. Tickets $2.00 in advance, $2.50 at the door. Dealers and tailgaters $5.00. Talk-in on .52 and .78/.18. For info and tickets, contact Bob Grimmer, KN2QWO, 229 William Ave., Barrington, NJ 08007.

INDIANA: Crooked Lake's 22nd annual hamfest and F.M. picnic. Door prizes, large electronic flea market, overnight camping (small fee), bar-b-q, and big exhibition hall. Tickets: $2.00 by donation. Talk-in on 147.81/.21 and 146.52. August 3. Presented by the Steuben County Radio Amateurs.

DELAWARE: Fifth annual New Delmarva Hamfest on August 17th at Gloryland Park, Bear, Del. Admission: $2.00 in advance, $2.50 at the gate. Tailgating, $2.50. Tables under pavillion, $4.00. Prizes, food, etc. Talk-in on .52 and .13/.73. For more info, send SASE to Stephen Momot, K3HBP, 14 Balsam Rd., Wilmington, DE 19804.

ALABAMA: North Alabama Hamfest on August 17 at the Von Braun Civic Center in Huntsville, Al. Free admission. Prizes, exhibits, forums, flea market, ladies activities, and tours of the Alabama Space and Rocket Center. Hamfest supper on Satuday night. Camping sites with hookups available on a first-come, first-serve basis. Flea market tables available for $3.00. Talk in on 3.965 and .34/.94. Write: NAHA, P.O. Box 423, Huntsville, AL 35804.

KENTUCKY: Bluegrass Amateur Radio Club's annual Central Kentucky Hamfest on August 10 at the Fasig-Tipton Sales Paddock, Newtown Pike, Lexington, Ky. Grand prizes, hourly door prizes, manufacturer's exhibits, indoor/outdoor flea market, forums and guest speakers. More info: SASE Edward B. Bono, WA4ONE, 2077 Dogwood Dr., Lexington, KY 40504.

FLORIDA: Jacksonville hamfest and ARRL Florida State Convention on August 2nd and 3rd at the Orange Park Kennel Club. Intersection of I-295 and U.S. Highway 17. Interesting programs and forums, with exhibits and displays. Special hotel rates available. Advanced registration: $3.00, $3.50 at door. Jacksonville Hamfest, 1249 Cape Charles Ave., Atlantic Beach, FL 32233. Swap tables: $5.00. Order from Andy Burton, WA4TUB, 5101 Younis Rd., Jacksonville, FL 32218.

ILLINOIS: Rockford Amateur Radio Association's hamfest and A.R.R.L. Convention on August 31 at the Grand Exhibition Hall, Winnebago County Fairgrounds, Pecatonica, IL. Speakers, seminars, presentations, contests, commercial dealers, and more. More info: James L. Ambruoso, Hamfest Chairman, Rockford Amateur Radio Assoc., 3712 Huffman Blvd., Rockford, IL 61103.

CALIFORNIA: The Antelope Valley A.R.C.'s DXpedition to Alpine County on August 16 and 17. All bands, modes and county hunter nets used. Operated under K6OX. All QSO via K6GXO, sase necessary. Plans may change due to weather or availability of gas. More info: K6OX, Box 1221, Lancaster, CA 93534.

OHIO: DX-Pedition to the Center of the World will be operated by the Warren Amateur Radio Club, from 1300 GMT August 2, to 2000 GMT August 3. Freqs. are 28.625, 21.360, 14.285, 7.235, 3.900 MHz SSB. Also 21.125 for CW fans. QSL for a beautiful certificate with a large SASE to W8VTD, Box 809, Warren, OH 44482.

ILLINOIS: Hamfester's Radio Club's 46th annual hamfest on August 10 at Santa Fe Park, 91st and Wolf Rd., Willow Springs, Ill. More info: Les Taylor, WB9ZPP, Hamfest Chairman, 8960 W. 105th St., Palos Hills, IL 60465.

VERMONT: Burlington Amateur Radio Club's International Hamfest on August 9th and 10th at the Old Lantern Campgrounds 14 miles south of Burlington. Flea Market, Commercial exhibitors, traditional Can-am tug-of-war and door prizes. Admission: $4.00. For more information, contact Hap Preston, W1VSA, Box 312, Burlington, VT 05402. Talk-in on .34/.94, W1KOO/RPT.

CONNECTICUT: Super Scarafest "80" at the North Haven Ramada Inn at Exit #12 of I-91 in North Haven, CT. Held on August 16 & 17. Exhibits, giant flea market, and on Sunday, an all day auction. Prizes all day both days. Grand prizes will include a solid state low band transceiver, synthesized two meter handie-talkie, microcomputer, 600 MHz frequency counter, and over 60 others. Call Jeff Wayne, W1YLV at (203) 281-6038 between 9 A.M. and 9 P.M., E.S.T. for more details.

ILLINOIS: Illiana Repeater System, Inc. Amateur Radio Club's 11th annual hamfest will be August 30 and 31 at the Georgetown, Illinois fairgrounds. Advanced donations are $1.50 for adults and $2.00 at the gate. Children 14 and under are free. Flea markets, commercial exhibitors, RTTY setups, antique wireless Assn. display, homebrew builders contest, USAF MARS station and other interests. Meals and refreshments served. Overnight camping available. For more info or advanced tickets send SASE to Illiana Repeater System, Inc., P.O. Box G, Catlin, IL 61817.

OHIO: Union County Amateur Radio Club's Hamfest 80 on August 23 and 24 at the Fairgrounds in Marysville, Ohio. Talk-in on .52 or use club repeater 147.99/39. Door prizes, Huge swap area, and plenty of good food. For more info: U.C.A.R.S., 13613 US 36, Marysville, OH 43040.

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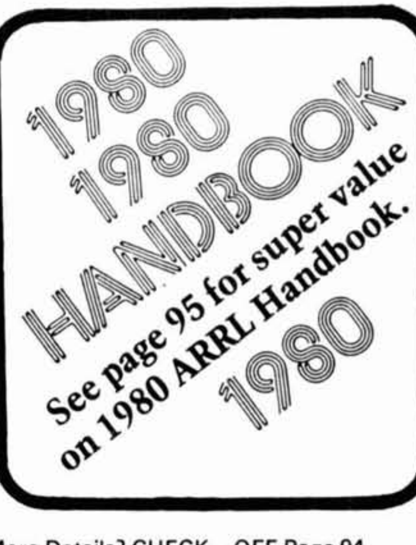

More Details? CHECK—OFF Page 94

DOUBLE YOUR PLEASURE

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Work Both 2 and ¾ Meters With Yaesu's New FT-720R

The FT-720R series is a compact VHF/UHF mobile transceiver that harnesses the incredible power of the microprocessor to bring you top-operating flexibility. Start with the FT-720R Control Head, then add either the 10 watt FT-720RU 440 MHz or 25 watt FT-720RVH 2 meter RF Deck. You can clamp the Control and RF Deck together or use an optional remote cable to hide the RF Deck. The best news is still to come! By using the optional S-72 Switching Box and two remote cables, you can use a single Control Head for operation with both the 440 MHz and 2 meter decks, giving you a high-performance two band FM station for your car or home. Compare the features below, then ask your dealer for a demonstration of the fabulous FT-720R series. . . another winner from the performance leader . . . Yaesu.

- Four simplex/repeater memory channels, plus receive-only memory channel.
- Scanning controls on microphone with search for busy or clear channel.
- Optional 32 tone CTCSS module for accessing private repeaters.
- Colorful, easy-to-read LED power output/S meter.
- Built-in 1800 Hz tone generator.
- Priority channel with search-back feature.
- Pause feature that holds, then restarts scan, on busy or clear channels.
- Digital display of last four digits of operating frequency.
- Single Control Head may be used for operation on both 440 MHz and 2 meters via optional switching box and remote cables.
- Extremely compact size, light weight.

FT-720RVH	Specifications	FT-720RU
144.00-147.99 MHz	Frequency Coverage	440.00-449.975 MHz
10 kHz	Synthesizer Steps	25 kHz
25 watts	Power Output	10 watts
.32 uV for 20 dB quieting	Sensitivity	0.5 uV for 20 dB quieting
±6 kHz (—6dB) ±12 kHz (—60 dB)	Selectivity	±12 kHz (—6dB) ±24 kHz (—60 dB)

Price And Specifications Subject To Change Without Notice Or Obligation

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480

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