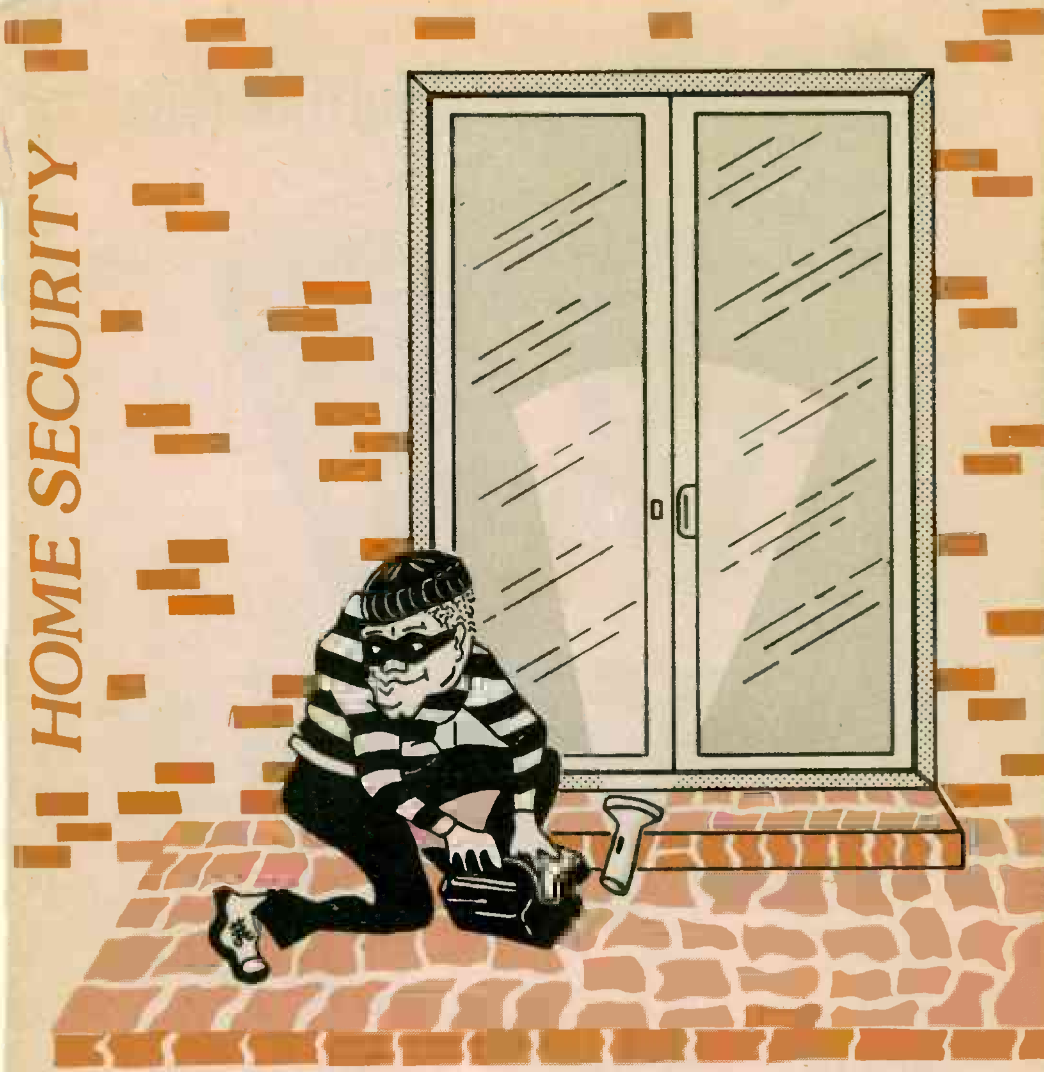
HOME SECURITY

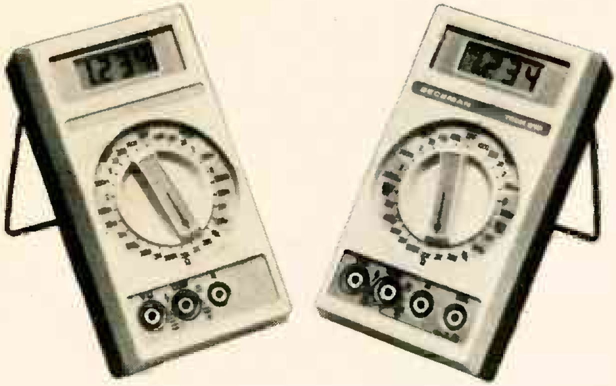


- Computer Corner
- Multi-trace Adapter

nri journal

March/April 1980

Beckman Digital Multimeters



Perfect for working on televisions, major appliances, stereos, air conditioners, and automobiles. LCD readout takes the guesswork out of meter reading. These 3-1/2 digit multimeters combine superior reliability with rugged construction. Both have a special semiconductor test function and overload protection on all ranges. Available to you now from CONAR.

Specifications

Stock No.	WT300	WT310
DC Volts	100 µV to 1500 V rms	100 µV to 1500 V
AC Volts	100 µV to 1000 V rms	100 µV to 1000 V rms
Resistance	0.1 ohm to 20M	0.1 ohm to 20M
DC Current	100 nA to 2 A	100 nA to 10 A
AC Current	100 nA to 2 A	100 nA to 10 A
Semiconductor Test	Yes	Yes
Continuity Test	No	Yes
Price	$110.00	$140.00

Special Accessories

50 kV high-voltage probe	Stock No. HV211	$35.00
200 MHz rf probe (2 kHz to 200 MHz)	Stock No. RF221	$35.00
200 A ac current clamp	Stock No. CT231	$49.00
Rugged, leather-grained vinyl carrying case with adjustable carrying strap	Stock No. DC202	$24.00

nri journal

March/April 1980
Volume 38, No.2

In this issue, Laurel Munk begins a three-part series on home security. Curt Feigel introduces us to a multi-trace adapter, and Ken Bigelow gets underway with his "Computer Corner."

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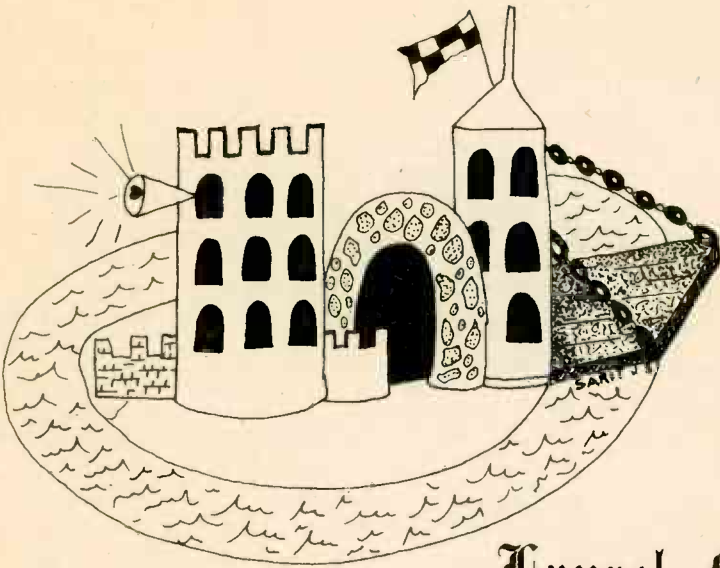
Is Your Castle Safe?



Laurel Munk

Once upon a time, people had no need to lock their doors. Today, locks often are not enough. There are over 3 million reported residential burglaries each year in the United States. The causes of the increasing crime rate are varied and most are beyond your direct control. However, a majority of American homes are actually easy to break into.

The physical security of any home can be vastly improved with the use of even the simplest of devices. The first and most important step in planning a home security system is to take a critical look at your home and identify problem areas. Often, representatives from local police departments or security firms are willing to help you do this. Once you have evaluated your home, find out what systems are available that are appropriate for your application. A home security system can be as simple as some circuitry and switches purchased at an electronics supply store for a few dollars. A system can also be as sophisticated as space-age technology purchased from or installed by a professional security firm for hundreds of dollars.

Design a system that you and your family can live with – it is still your home, not a jail. A security system that stays turned off because your family keeps triggering false alarms when it is on is a waste of money. Even worse, false alarms can tax the patience of both your neighbors and the local police. Too many false alarms, and your system will lose its credibility.

The more you understand about home security, the devices used, and the capabilities and limitations of each type of system, the more effectively you can spend your security dollar.

TYPES OF PROTECTION

There are three major categories of protection that you should consider when you decide to safeguard your home against intrusion. *Perimeter*, or point-of-entry, protection is designed to detect an intruder at the earliest possible moment – before any property is damaged or stolen. Doors, windows, gates, and fences are typical locations for perimeter intrusion detectors (usually electromechanical or photoelectric devices).

The major advantage of this type of protection is that an intruder or burglar doesn't want to spend the extra time and effort to get past your safeguards. Intruders like to do their work quickly and quietly – any delays or alarms (bells, sirens, lights, etc.) can discourage them. If you turn on a security system when you leave your home, the loud outdoor speakers will alert your neighbors even though you are not there.

The major disadvantage of perimeter protection is that it is not complete protection. Persistent burglars can cut through ceilings, floors, and walls, and some of the more skilled ones can even disable alarm systems with ease.

Zone protection provides an excellent addition to a perimeter system. This type of protection (often ultrasonic, infrared, or microwave) detects the presence or movement of an intruder in the guarded area. The advantage of this type of protection is that the system detects the intruder's movements long before the intruder can locate and disable the system. One disadvantage is that the devices used in such a system are very sensitive, and if not properly installed, can plague you with false alarms from incidental movements (by pets, drapery billowing in the breeze, etc.) within the protected area.

Spot protection provides even more security for specific objects, such as valuable art pieces, jewelry and silverware chests, and safes. The electromechanical or photoelectric devices used in this type of system sound an alarm if anyone touches or gets very close to the protected object. Spot protection is used more widely in business applications than in the home, yet it can be advantageous for the homeowner, too. For example, suppose you are having a party on the patio or ground floor and you have turned off your other alarm systems to prevent false alarms caused by the activities of your friends. A spot protection device can detect a cat burglar or an unwelcome guest who decides to "examine" your jewelry on the bureau in an upstairs bedroom.

A combination of perimeter, zone, and spot protection will not only give your home superior protection against intruders, but will also give you and your family peace of mind. Let's take a closer look at two types of security systems – electromechanical and ultrasonic – as a sample of what is used in home security today.

HOW ELECTROMECHANICAL DEVICES WORK

Most electromechanical alarms are based on the closed circuit. This is a more reliable method than a normally open circuit, which requires a contact to be made before the alarm will sound. Any time the closed circuit is broken, the alarm is activated. The basic circuitry in a closed circuit is the same, regardless of the type of sensor or detector that is used. Figure 1 shows an example of a basic circuit. Because Q1 is a pnp transistor, the positive voltage applied to its base by the 1.5 volt battery cuts the transistor off. This reverse bias in the base-emitter junction prevents any significant current from flowing through the protective circuit, shown within the dashed lines. When the protective circuit is broken, symbolized here as S1, the reverse bias on the transistor is removed. Current flow through R1 forward biases Q1, causing the transistor to conduct. Current flow through Q1 makes the voltage at the collector less negative than the -V supply voltage. This signal is coupled to the gate of the SCR through C1. Because the gate of the SCR is now more positive (actually, less negative) than the cathode, the SCR begins to conduct. The resulting current flow through R5 develops the voltage needed to trigger the alarm. The alarm will continue to sound until it is reset by turning off the -V supply or pressing the reset switch, S2.

Any attempt to bypass the protective circuit results in the triggering of the alarm. As an example, suppose the intruder short circuits points A and B in the hope of disabling the alarm. Such a connection would cause current to flow through R1, R3, and D1. The silicon diode D1 requires a voltage drop of about 0.7 volt to conduct current. However, transistor Q1 is a germanium transistor requiring a base-emitter voltage of about 0.2 volt to conduct.

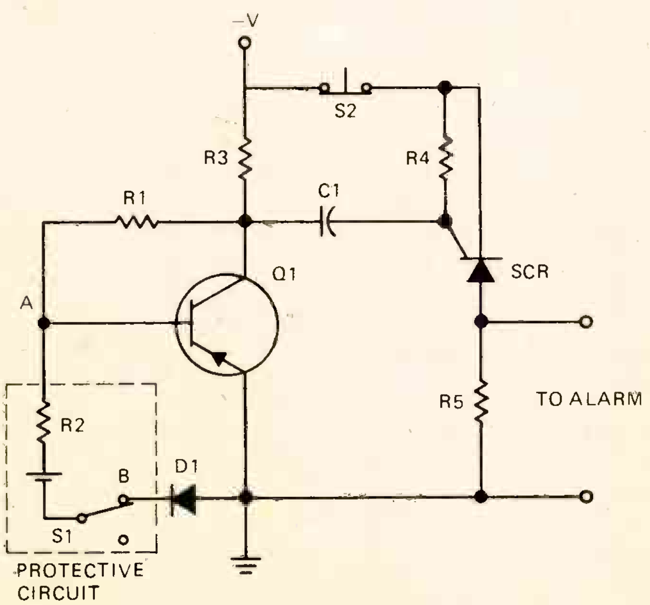
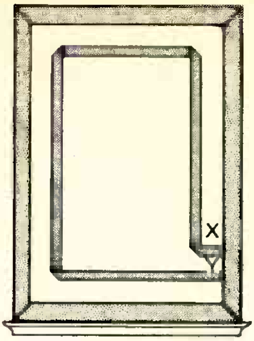
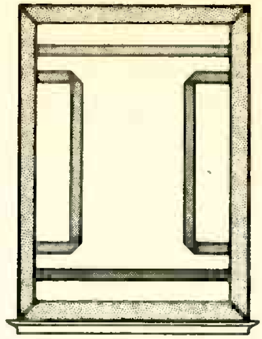


FIGURE 1. A TYPICAL ELECTROMECHANICAL ALARM CIRCUIT.



CORRECT
(A)



INCORRECT
(B)

FIGURE 2. (A) A JUMPER WIRE BETWEEN POINTS X AND Y WILL KEEP THE CIRCUIT CLOSED, WHILE THE REST OF THE GLASS CAN BE CUT OR BROKEN. (B) SINCE THE CIRCUIT IS NOT OBVIOUS, INSTALLING A JUMPER WIRE MIGHT TRIGGER THE ALARM INSTEAD OF DISABLING IT.

Therefore, the voltage developed across diode D1 would be sufficient to forward bias transistor Q1 and activate the alarm.

SOME TYPICAL DEVICES

There are many kinds of sensors and switches that can be connected to the basic alarm circuitry. Perhaps the most common of all electromechanical sensors is the metallic foil that is used to make a complete circuit around a window or glass door for perimeter protection. If you choose this type of circuit you should be careful to install the foil properly so that the circuit pattern is not obvious. Figure 2(A) shows a foil pattern where the entry and exit points of the tape are obvious – all the burglar has to do is connect a jumper between point X and point Y to keep the circuit intact and the "switch" closed. If the foil is properly installed, as shown in Fig.2(B), the intruder's attempts to break the glass or disable the circuit without triggering the alarm are made very difficult. The intruder would either have to guess which one of the four corners is the entry/exit point, or take the time to install four jumpers just to be sure.

Connections between the window foil and the rest of the circuitry should be made through special connection boxes specially designed for this purpose. Soldering wires directly to the foil will give you an unreliable system prone to false alarms. The foil tape should be inspected frequently, especially after window cleaning, to ensure that the foil has not peeled loose or become ragged or cracked. Any breakage in the foil due to improper maintenance will trigger the alarm just as surely as an intruder.

There are many types of electromechanical switches that can also be connected to the basic alarm circuitry. The most reliable ones will be those that meet the standards set by the Law Enforcement Assistance Association. Figure 3 shows a variety of electromechanical switches that a homeowner can install without a great deal of expense or difficulty.

The plunger-type switch shown in Fig.3(A) is commonly used to detect the presence of an intruder entering through a door. As long as the door is closed, the plunger remains in its assembly, completing the closed circuit. When the door is opened, the pressure against the plunger is released, and the spring moves the plunger away from its contact point. The circuit is broken and the alarm sounds. This can be a very effective device as long as the intruder doesn't suspect it is there. If a burglar has suspicions or has observed that indeed there is such a device, he will slide a thin metal plate between the door and the plunger as he opens the door, thus keeping the circuit closed.

Another reliable type of door or window switch is the magnetic proximity switch, shown in Fig.3(B). A magnetically operated reed switch is mounted on the door frame and a permanent magnet is mounted on the door itself. The switch is usually positioned so that the presence of the magnet on the closed door or window keeps the circuit closed. These magnetic switches, which cost between $3 to $5, can be installed just about anywhere in

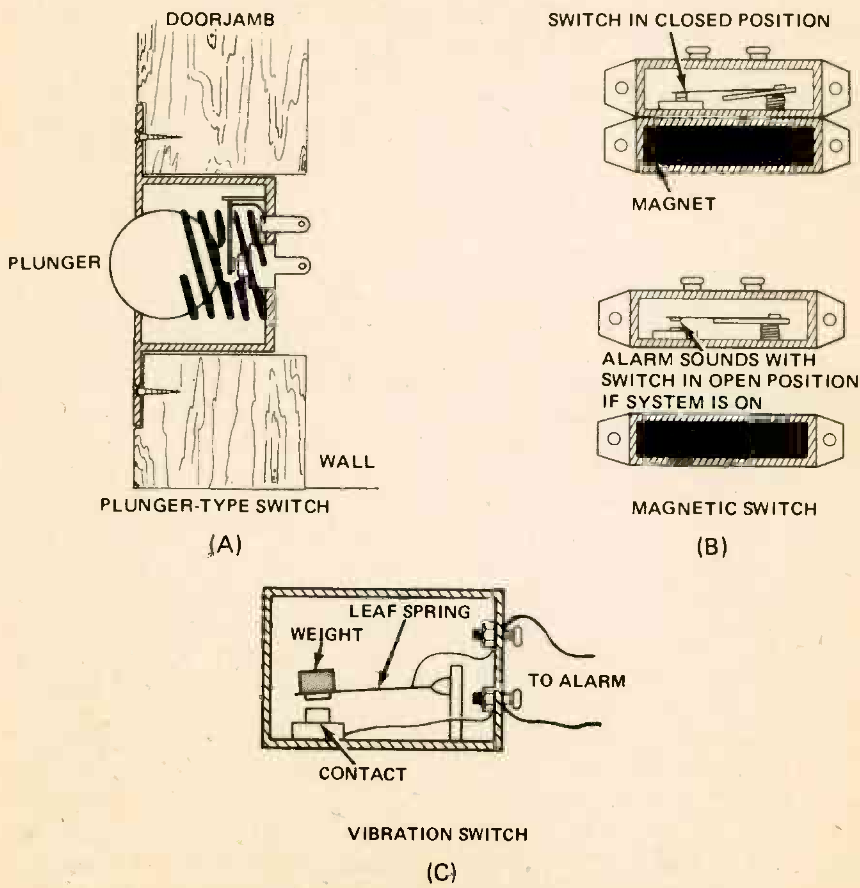


FIGURE 3. SOME EXAMPLES OF ELECTROMAGNETIC SWITCHES.

your home and can be hooked up to any existing closed-circuit system.

Good spot protection can be provided with vibration switches and pressure-sensitive floor mats. The operation of a vibration switch is also very simple. As shown in Fig.3(C), a weight is suspended on a spring over its contact. If it is a closed circuit, the switch will be closed at rest. Any vibration will cause the weight to move away from the contact and open the circuit. The weight will return to its resting position, but once the circuit has been broken, the alarm will continue to sound. This device is particularly useful in protecting automobiles. Someone starting the car, removing a battery, or jacking up the car to steal the tires will cause enough vibration to open the switch.

Pressure-sensitive floor mats are also frequently used for spot protection – particularly in businesses that have safes, jewelry cases, or file cabinets containing valuables. In the home, the mats are often concealed under a rug in a central hallway or staircase. When the intruder crosses the central area as he travels from room to room looking for valuables, the alarm will be triggered. In this way, you can protect several rooms with one device. A five-foot hall runner retails for about $20.

ADVANTAGES AND DISADVANTAGES OF ELECTROMECHANICAL DEVICES

Because electromechanical devices are so simple in operation, their usefulness is often overlooked in favor of more sophisticated systems. Actually, their simplicity makes them very effective and highly reliable. The key to good protection with electromechanical devices is proper installation and maintenance. Proper installation means doing a complete job. All the locks and switches on the first floor of a home are useless if the second floor is left unprotected. Don't let the security of an apartment depend on one door switch – use several throughout your home.

Choose the devices that are appropriate for your particular home and lifestyle. Window switches are not very effective if you prefer to cool your home in warm weather by opening the windows. Install switches that are hidden from view. Vandals and amateur burglars may be discouraged by highly visible devices, but most skilled thieves can avoid your safeguards if they spot them.

The major disadvantage of using electromechanical devices is that it is not practical or even feasible to protect every single entry point to your home. Remember, a determined thief who thinks that the rewards are great enough will find a way in that you haven't thought about. One way to outsmart a burglar is to use an electromechanical system for perimeter and spot protection, and use a more advanced system, such as ultrasonics, for backup zone protection.

ULTRASONIC DEVICES – HOW THEY WORK

Ultrasonic intrusion detectors provide excellent protection for the interior area of any home. The basic operating principle behind ultrasonic devices is simple. Ultrasonic energy is merely sound waves that are of such a high frequency that they are not audible to the human ear. As shown in Fig.4, ultrasonic waves from a transmitter completely fill a room. Most of the sound waves travel directly to the receiver. Some waves are reflected from the ceiling, walls, floor, and other hard

FIGURE 4. DIRECT AND REFLECTED SOUND WAVES COMBINE TO FORM A CONSTANT FREQUENCY AT THE RECEIVER. ANY MOVEMENT CAUSES A CHANGE IN THAT CONSTANT FREQUENCY.

surfaces before they reach the receiver. When the sound waves are reflected by various surfaces, their frequency changes. The frequencies of both the direct and reflected sound waves are constant and are combined into what is called the standing wave pattern. When these two different frequencies reach the receiver, they either reinforce or cancel each other, depending on the exact original frequency and the phase relationship between it and the changed frequency. As long as nothing in the room moves, the standing wave pattern remains constant. However, if an intruder enters the room, some of the reflected signals will change once again. The change in the reflected signal results

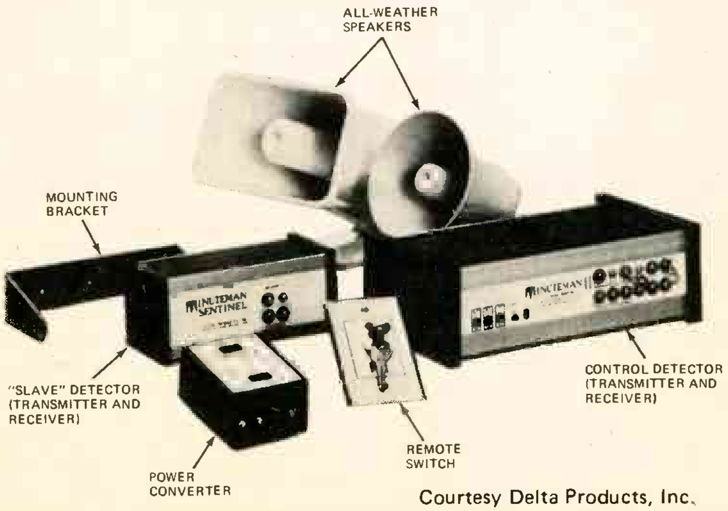


FIGURE 5. A TYPICAL ULTRASONIC ALARM SYSTEM.

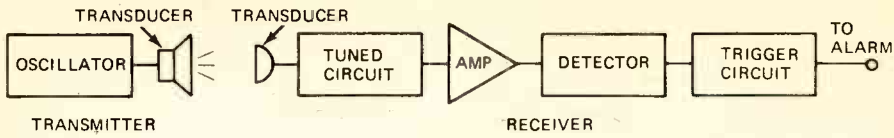


FIGURE 6. A BLOCK DIAGRAM OF AN ULTRASONIC TRANSMITTER AND RECEIVER.

in an amplitude-modulated signal, which is detected by the receiver. The alarm is then triggered.

A TYPICAL SYSTEM

A typical ultrasonic intrusion alarm is shown in Fig.5. A block diagram of the transmitter and receiver portions is shown in Fig.6. The transmitter portion consists of an oscillator operating at the desired frequency, and a transducer that converts the electrical signal from the oscillator into sound waves. The transducer used in an ultrasonic transmitter performs the same function as a conventional speaker. However, due to the high frequencies involved, it has a smaller, more rigid diaphragm. The oscillator and transmitter transducer are so simple in operation that they are often mounted in the same case as the receiver.

The receiver portion of the ultrasonic system also contains a transducer; however, its function is exactly the opposite of the transmitter transducer. The receiver transducer converts ultrasonic energy into an electrical signal. The signal is fed to a tuned circuit that is set to the frequency of the transmitter. It passes only frequencies that are close to the operating frequency, thus eliminating many false alarms caused by extraneous sounds. The signal is then fed to the amplifier and detector. The detector circuit varies in its sensitivity. It is normally set to detect the slowest and smallest moving object, yet not react to air currents. As long as nothing in the protected area moves, there will be no output from the detector. However, if an intruder causes an amplitude-modulated signal to arrive at the receiver, the detector will output an intrusion signal to the trigger circuit. The trigger circuit may contain a time delay so that only intrusion signals of at least 10 seconds duration will trigger the alarm. This eliminates false alarms due to transients on the line, curtains blowing in the breeze, or rf interference.

ADVANTAGES AND DISADVANTAGES OF AN ULTRASONIC SYSTEM

One of the major advantages of an ultrasonic system is that it cannot be easily detected by a burglar. The system is virtually tamperproof – even if the intruder could manage to locate the control unit without triggering the alarm. The key to using an ultrasonic system effectively lies in proper planning and installation. Figure 7 shows a home with an effective system. The detectors are placed for maximum coverage of critical areas without the inconvenience or expense of surplus units. Most detectors can be adjusted to be either highly directional (for narrow areas, such as hallways) or omnidirectional (for room-sized rectangular areas). Detectors should be mounted at least 10 feet away from objects such as telephones, doorbell chimes, and radiator pipes, that can emit high-frequency sounds in addition to their audible tones. Detectors should also be located

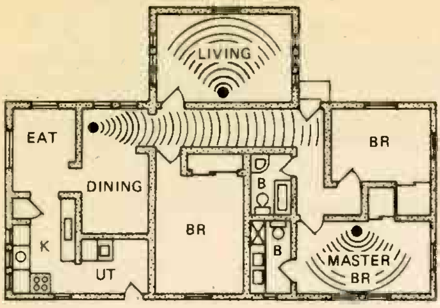


FIGURE 7. AN EXAMPLE OF ULTRASONIC DETECTOR PLACEMENT. THE CONTROL DETECTOR IS PLACED IN THE CENTRAL HALLWAY AND TWO "SLAVE" DETECTORS ARE SET UP IN ROOMS WHERE VALUABLES ARE KEPT.

away from electric fans, decorative mobiles, and other objects that might accidentally trigger the alarm.

Other than inadequate planning and improper installation, the major disadvantage of ultrasonic detectors is that they are extremely sensitive, and therefore prone to false alarms. Household pets must be confined to unprotected areas – unless the detectors are placed high enough and the wave pattern restricted enough so that their movements high enough and the wave pattern restricted enough so that their movements hard surfaces to reflect the sound waves. Rooms that are heavily curtained or contain sound-absorbing wall or ceiling material may not be effectively protected with an ultrasonic system.

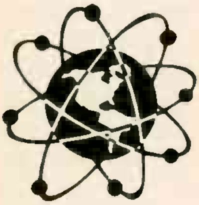
SUMMARY

Whatever type of protection you may prefer to choose for your home, you should make careful plans first. There are a wide variety of options such as direct telephone dialing to the local police, bedside "panic" buttons, entry/exit delay timers, and remote control devices, that can be added to any system, if you so desire. The protection you choose should be effective and economical for your particular situation and living habits. You should have enough protection to guard your valuables and give you peace of mind, but not so much that your home looks like Ft. Knox. It is also important to remember that no system is foolproof. A security system is not a guarantee that your home is burglarproof. However, any protection is better than leaving your home totally vulnerable. You might consider installing a few devices initially, and then expand or upgrade your protection at a later time.

ABOUT THE AUTHOR

Laurie joined the NRI staff in 1976, and is currently Publication Supervisor. She has a special interest in home security. She recalls, "When I was a child, my parents' home was burglarized. I shall never forget the sight of my ransacked room . . . everything I treasured either destroyed or gone." Laurie feels that there is truth in the old adage, "an ounce of prevention is worth a pound of cure."

Ham News



Ted Beach K4MKX

I'm sure that by now most of you know all about the outcome of the 1979 WARC convention in Geneva. That is, you know about the outcome at least as far as amateur radio is concerned. I must say that I was very pleased at the way we fared, and was not the least bit disturbed that we lost a few megahertz (1215 MHz to 1240 MHz) in the microwave region.

The really big news, of course, is the three new high-frequency bands. One is in the 30 meter range from 10.10 MHz to 10.15 MHz. That's only 50 kHz, but it should have some pretty neat propagation characteristics. The other two bands are 17 meters (18.068 MHz to 18.168 MHz) and 12 meters (24.890 MHz to 24.990 MHz). These two bands are presently occupied by various commercial services, and will not be available to amateurs until the present users have all moved to other frequencies. Some of the people who seem to know about these things say that this probably won't happen until 1984 at the very earliest, and maybe not before 1987! At the same time, the 10.1 to 10.15 MHz band might be available as early as January of 1982, only two years away.

One manufacturer, Ten Tec, has already announced a new rig that includes the three new hf bands. They plan to make production models available sometime this year. I'm sure Drake and the rest of the manufacturers will probably be coming out with new models in the very near future as well. In the meantime, if you like to do some home-brewing, you might try working up a simple converter for your ham bands-only rig so you can see what goes on these new bands.

Another bit of good news is that there is now full reciprocal operation permitted for U.S. and Canadian amateurs. That means, if you're planning a trip to Canada you can take your rig along with you and you can operate without making any prior arrangements with the Department of Communications. Unfortunately, Canada does not have a Novice (or comparable) class, so Novices will be excluded from this arrangement.

While we're on the subject of "new" things in amateur radio, here are a few items I found to be of interest in recent issues of *HR Report*, the weekly newsletter published by *Ham Radio* magazine.

First of all, in the very near future, the Federal Communications Commission may have to stop allowing volunteer examiners to be used to administer Novice tests. Volunteer examiners were declared to be illegal by the FCC's lawyers. If their opinion is upheld, it will mean that Novice tests will again have to be taken at FCC field offices like all other amateur (and commercial) tests. That, coupled with the "no fee" policy in effect right now, could really put a large dent in the FCC budget.

Another recent FCC action allows photocopies of licenses to be considered valid substitutes for the original. This rule became effective December 21, 1979. Also, the FCC is continuing work on "plain English" revisions for the amateur Rules and Regulations (Part 97), which should be available sometime this year. The Commission has also published new and updated individual syllabi for the various amateur license classes, copies of which are available from the FCC field offices. Hopefully, these will reflect some of the "new" examinations we've been hearing about lately.

Finally, the long-awaited authorization to use ASCII as well as Baudot teleprinter code on the ham bands will probably be coming early in 1980, if indeed the announcement has not already been made by now. I have a feeling that this will mean a great deal more computer interconnections, with much more widespread sharing of programs among the hams who are also interested in computers. We'll also probably see more data networks set up as a result of this decision. More about these interesting nets another time.

Now, let's see who we've heard from since last time. Again, not too many people have written in since our last issue. If you're a ham and haven't written in, please do so and let us know who you are and what your involvement in amateur radio is. We would all like to hear from you.

We received a photo of Conrad, KA5BUX, operating in his very neat shack, but unfortunately we were unable to reproduce it properly here in the *Journal*. It is a very good photograph, but there are two reasons we can't use it. First of all, it's a color print, which is quite difficult to redo in print as a black-and-white photo. Secondly, the overall shading is too dark. That would mean everything would be very muddy looking. The best type of photos are black-and-white pictures with normal to light contrast so the details will show up. We *do* welcome photos, and look forward to getting them from you.

At any rate, Conrad's photo showed a nicely built station console that houses a Swan 350 transceiver with calibrator. This, along with a Heath SWR meter and an MFJ antenna tuner, lets Conrad work cw to his heart's content on 80 and 40 with his 30 foot high dipole. He also works two meters using a Drake TR-33C and a Cushcraft beam. Very nice, Conrad, and we're just sorry we were unable to use your photograph.

WB8UTC is a graduate of the NRI amateur radio course and is now taking the Communications course, hoping to get a job one of these days with R.L. Drake Co. In addition, Chuck has a Realistic (Radio Shack) DX160 receiver that he feels does as good a job as the newer DX300 receiver I mentioned briefly in a recent "Ham News" column. This rig covers almost the same frequencies as the DX300 and costs about half as much. It does not have a digital readout, but Chuck says it's easy to add an $85 kit-type digital readout. The one he used came from

Torrestronics Inc.
4850 Hollywreath Ct.
Dayton OH 45424

The unit has a 4-digit readout with resolution of 100 Hz, 1 kHz, 10 kHz, or 100 kHz and will read frequencies from 1 to 50 MHz. It should mate with most receivers and transceivers with little or no modification.

The DX160 (which I have not seen in stores or in recent catalogs) looks to be a very good receiver for the money, so by all means latch onto one if you can. Chuck uses his almost exclusively and likes it very much. The adjustable BFO is an added plus over the fixed BFO of the DX300.

PJ3AX wrote to tell us that he had just gotten his Class A license, and included a copy of the Amateur Rules under which amateurs in the Netherlands must operate. The rules are quite short as compared to Part 97, and interestingly enough, the examinations on rules and theory are conducted orally. The Class A license is generally equivalent to our General Class license, and requires a 10 minute sending-and-receiving code test (five minutes receiving and five minutes sending), at 12 wpm. The Class B license is similar in many respects to our Novice license, requiring a code test at 8 wpm and less radio theory. Thanks for the information, A.P. It is always interesting to see how other countries handle their amateur radio licensing.

KC2M writes that he enjoys both his NRI course in Communications and the "Ham News" column in the *Journal*. Thanks on both counts, Walt. He was writing mainly to see if it would be all right to visit NRI when he comes to Washington in February. The answer, of course, is we are always glad to meet our students and graduates, and if we're

Bill	KA4KCP	N	Mt. Olivet KY
Conrad	KA5BUX	T	Tryon OK
Chuck	WB8UTC	—	Dayton OH
A.P.	PJ3AX	A	Aruba Neth. Ant.
Walt	KC2M	E	Leroy NY
Paul	WA2DII	G	East Aurora NY
John	KA3CCK	—	Avonmore PA
Douglas	KA3EDI	N	Connellsville PA
Danne	WD4HMC	A*	Sarasota FL
Glen	WB8EYT	G	Canton OH
Ralph	KA9CTD	A*	Galesburg IL
Joe	WB9NWR	G	Bloomington IL
Maurice	VE2ESK	—	Montreal PQ Can.
Bob	K9UJA	—	Schaumburg IL

*Just Upgraded — Congratulations!

NRI "GET TOGETHER" SCHEDULE FOR 1980

	75/80	15	40	75/80	15	40
MARCH	4	11	18	25		
APRIL		1	8	15	22	29
MAY	6	13	20	27		
JUNE		3	10	17	24	

TIMES:

CW	8:30 - 9:00 p.m. EST
SSB	9:00 - 9:30 p.m. EST

FREQUENCIES:	CW*	SSB*
15 Meters	21.150	21.400
40 Meters	7.130	7.280
75/80 Meters	3.730	3.980

*+5 kHz in case of QRM or QRN

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given enough advance warning we can usually arrange to have someone give you the "grand tour" of your school so you can get to see and meet the people at the other end of the mailbox. As this is being written in January, Walt has not yet dropped by, but rest assured we're looking forward to his visit.

A few people have written concerning the Get Togethers, and Paul, WA2DII was the first. Paul warmed up his Kenwood TS120-S on November 18, 1979 to try out the 40-meter cw Get Together. Conditions were particularly bad that night, with the noise (QRM?) running about 20 dB over S9 at Paul's QTH. At any rate, a "CQ NRI" managed to net NØBFO (Jerry) in South Carolina, followed by WB3HNA in Baltimore. Jerry is an NRI graduate, but WB3HNA is not. He just dropped in to say "hi" since no one seemed to be responding to Paul's calls.

As the evening progressed (and conditions got worse!), Paul finally managed to work four more NRI students or graduates before things folded. They were: Dave, KAØP in Missouri; Lin, WDØHFR in Nebraska; Bob, N5ARM in Lousiana; and Larry, KB7BU in Montana. Not too bad, all things considered. We've heard from N5ARM before, but the others are new. Thanks, Paul.

KA3CCK also had some good luck on the December 4, 1979 Get Together on 75. What follows is a portion of John's letter to me. "Go arounds were run through about three times over the hour and a half session. There were eight of us on. The following list is the NRI students or grads who checked in.

WD4FHS	Mickey	SC
N4CET	Bob	GA
KAØDCS	Harry	MO
WA2VON	Mike	NY
WB5YQY	Emmett	AR
KA4ZYR	Bill	TN
KA4JAV	Jim	GA
KA3CCK	John	PA

So, Ted, get that rig of yours brewing and join us next time which is December 22, same time, same frequency. It was a really nice get together and I am looking forward to the next one."

Thanks very much, John, and I'm only sorry that I am still QRT at the moment. I would like nothing better than to meet you all on the air.

KA3EDI writes that he got his Novice license back in September and is really enjoying being an amateur. Doug says that he is still having problems with the code, but that some "on the air" practice should get him ready for the 13 wpm General test by May. His rig is a Kenwood TS520 that he uses with dipole antennas on 40 and 80. He has a converted CB antenna that he uses with an antenna tuner on 10 and 15. Doug usually gets together once or twice a week with a group of friends for a "Novice Net" code practice session. He says they all get a lot out of the session and suggests that more such nets be established around the country to encourage upgrading from Novice to General. Good idea, Doug, but it takes work and enthusiasm like yours to get things done.

Glen, WB8EYT, was written up first in this column in the November/December issue. He phoned from Ohio on December 5, 1979 and we had a real nice telephone QSO, although I did not take notes. Thanks for the call, Glen.

KA9CTD has written before, but this time it was to let us know he had just passed his Advanced test. Nice going, Ralph. He met WB9NWR on two meters, and discovered that Joe is also an NRI student in the Communications course. Since then, they have had more or less regular get togethers at the high end of 40 (around 7295) and invite anyone interested to check in. They try for daily schedules from 1900 UTC to 1930 UTC since they both work evenings.

Ralph also does some work on other bands, and managed a QSO with KC4USV in Antarctica on 20 meters the other day. Ralph was using 180 watts to a dipole (on SSB), so it doesn't take fancy gear when conditions are right!

We had a short, but very nice, eyeball QSO with VE2ESK, Maurice, and his lovely YML recently. Maurice and his wife were on their way to Florida from Montreal. From there, they planned to go to the Virgin Islands for a vacation. Maurice has listened in on some of the Get Togethers and even managed to work a station in Texas on one occasion, although he didn't remember the call or the date. Thanks, Maurice, and do stop in to see us any time you are in the Washington area.

Finally, I got a letter from Bob, K9UJA the other day, and Bob has an idea whose time has perhaps come. He has designed (patent pending) what he calls a "confirmation mailer" to encourage QSLs from reluctant stations. It's sort of a reverse QSL, in that the sender fills out the two-part card and sends it to the station operator who needs only sign it and return it to the sender. Bob has versions for amateur use and for CBers as well, and plans to begin advertising them in the amateur magazines very soon.

If you would like more information on this new card, drop Bob a line at:

Bob Zittnan – K9UJA
513 S. Cedarcrest Dr.
Schaumburg IL 60193

The cards come with complete instructions for both the sender and the receiver, and are printed on various colored card stock.

Well, that's about it for this time. We'll try and sit in with you on some of the upcoming Get Togethers. But, as always, if you don't hear me, do enjoy yourselves and let us know what's going on out there among the NRI amateur fraternity.

Very 73 – Ted K4MKX

Resistance/Capacitance Bridge

CONAR Model 312

$85.50
Assembled
Stock No. WT312

$59.50
Kit Form
Stock No. UK312

Exclusively from CONAR . . . A superb instrument for the electronics technician, with solid-state circuitry and digital readout. The Model 312 uses two 7-segment LED displays visible through a window in the front panel — a foolproof method for determining the unknown value of a resistor or capacitor. **Capacitance Range** — 10 pF to 1 μF. **Resistance Ranges** — 10 ohms to 10M. **Power** — 110-120 VAC; 60 Hz.

Tube Tester

CONAR Model 224

Every full- or part-time technician needs the Model 224 for his bench. It helps you make better job estimates and pays for itself quickly in extra profits. It's perfect for experimenters and hobbyists, too. ■ Accomodates all series string and other up-to-date tube types. ■ Open element tests. ■ Independent filament terminal selection. ■ Visible filament continuity tests. ■ Interelement short tests. ■ Power Requirements — 110-120 VAC; 50/60 Hz. ■ Weight — 10 lbs. ■ Dimensions — 10-1/2"H X 15-1/4"W X 4-3/4"D. See CONAR Electronics Catalog for complete specifications.

$129
Assembled
Stock No. WT224

$85
Kit Form
Stock No. UK224

Signal Generator

CONAR Model 281

$165
Assembled
Stock No. WT281

$99
Kit Form
Stock No. UK281

■ Digital readout. ■ AM modulation from 0% to 50%. ■ True FM modulation using a dual varactor modulator.

SPECIFICATIONS

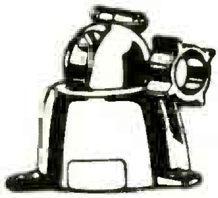
Accuracy — Better than 1%. **Attenuator** — Continuously variable control provides a minimum attenuation of 40 dB at 30 MHz and below. **Modulating Frequency** — Low-distortion 1000 Hz sine wave. **Maximum Deviation** — 0-40 kHz at 4.5 MHz, 0-80 kHz at 10.7 MHz, and 0-200 kHz at 21.4 MHz. **Output** — Unmodulated rf, amplitude-modulated rf, frequency-modulated rf, and 1000 Hz audio. **Output Amplitude** — 0 dBm (200,000 microvolts), 3 dB into 50 ohms, 180 kHz through 30 MHz. **Audio Output (1000 Hz)** — 8 volts peak-to-peak into 1 megohm. **RF and Modulated RF** — Continuously variable from 175 kHz to 30.500 MHz.

CONAR

PanaVise Tool Systems

Original Base

Model 300



Stock No. VS300

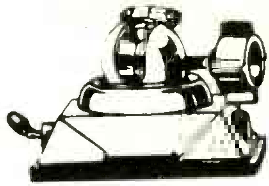
$13.95

Designed for all normal, permanent installations. Three lugs spaced 120 degrees apart provide maximum mounting stability.

Height: 3-13/16".
Diameter: 5".

Vacuum Base

Model 380



Stock No. VS380

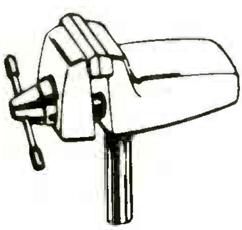
$18.95

Attaches securely to any smooth, non-porous surface. Ideal for a variety of setups. Half-turn of mounting lever attaches and releases powerful suction pad.

Height: 3-13/16".
Base: 5" X 4-1/2".

Original Vise Head

Model 303



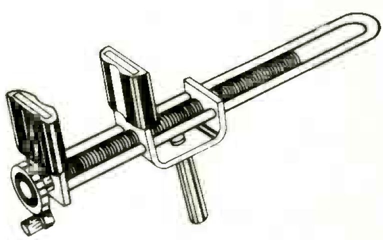
Stock No. VS303

$14.95

Wide 2-1/2" jaws open to 2-1/4". Head is pressure diecast aluminum alloy with steel and brass inserts. Hammertone gray/green finish. Replaceable nylon jaws.

Head

Model 366



Stock No. VS366

$14.95

Hold all types of items gently and firmly with the Model 366. It opens a full 6-1/2", has reversible neoprene jaws, and is an excellent all-round head for the craftsperson, hobbyist, or technician.

A Multi-trace Adapter

This is an "idea" article for the advanced experimenter. It is not a step-by-step assembly project, and unless you have had considerable practice building circuits from "scratch," we suggest that you not attempt to build the multi-trace adapter. We do, however, recommend that you experiment with the various simple circuits discussed. Doing so will provide you with some very good "hands-on" experience using digital and analog circuits.

Working with logic circuits frequently requires a comparison of the time relationship between two or more signals. Propagation delays and coincidence of leading edges may determine how well a circuit works, if at all. In addition to a discussion of the basic theory of multiple signals on a single screen, we include in this article information on available hardware, and enough detail to allow the enterprising experimenter to construct his own adapter.

by Curtis Feigel

MULTIPLE TRACES

One method of showing two signals with a single trace is to *alternate*: First show one signal, then the other signal. But, it is quite possible that the signals as displayed may have a different phase relationship. To cure this we *chop*: Display a short segment of one signal, then a short segment of another. By chopping each signal into twenty or so segments, then showing alternate segments of each, we can ensure that the time relationship is maintained. The trace may resemble a dotted line, but it should still be readable.

THE ANALOG SWITCH

In order to chop signals, we need to switch the scope input between signals very quickly. As long as the chop frequency is faster than any incoming signal, the time relationship displayed remains accurate. One convenient device for performing this operation is the CMOS 4052 analog switch. The 4052 acts exactly like a two-pole, four-position rotary switch, but it can be controlled digitally.

To use the 4052, we must supply +5 volts, −5 volts, and a ground reference. The chip can be controlled by TTL level signals (0 volts to +5 volts), but it must have a −5 volt supply to operate properly in the analog mode. A 2-bit binary word specifies which of the four possible positions the switch will be in.

In its OFF state, each switch is essentially an open circuit, while the ON state looks like a 120 ohm resistance, from input to output. Current may flow in either direction through the switch, and the switch may change at rates up to 3, MHz. Theoretically, we could switch between four input signals at this rate. Unfortunately, the switch operation is not instantaneous. There is a 5 microsecond period between the OFF and ON states, which produces a nonlinear trace as the switch makes a transition from high to low impedance.

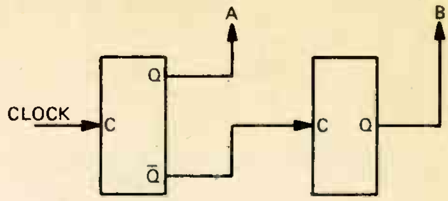


FIGURE 1. A 2-BIT BINARY COUNTER USING JK-TYPE FLIP-FLOPS.

In order to display each of the input signals, we will need a 2-bit binary counter. This is easily implemented with two flip-flops by using the output of the first flip-flop to clock the second, as shown in Fig.1. Of course, this stage of the circuit could be built from a standard TTL dual JK flip-flop, but the CMOS chips are not much more expensive, and have greater noise immunity. Using 4013's or 4027's also maintains a stable design philosophy throughout the circuit.

Both the 4013 (D-type flip-flop) and the 4027 (JK-type flip-flop) will handle 10 volt signals. In fact, their maximum clock frequency is higher (10 MHz) at 10 volts than at 5 volts; but, since the analog switch requires TTL level control signals, we will use only 5 volts. This reduces the maximum clock frequency to an unspectacular, but adequate, 3 MHz.

We can generate the chop frequency with another common CMOS chip, the 4001 quad two-input NOR. Connected as inverters, two NOR gates produce a very nice square wave in the astable multivibrator circuit of Fig.2. Again, a low operating voltage (+5 volts) limits the frequency response of the integrated circuit. Propagation delay goes from 25 nanoseconds at 10 volts to 60 nanoseconds at 5 volts. The circuit shown

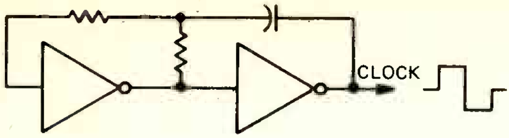


FIGURE 2. AN ASTABLE MULTIVIBRATOR SQUARE WAVE OSCILLATOR.

has a frequency range from about 4 kHz to about 200 kHz, and an almost 50% duty-cycle (symmetrical) output.

By stringing these three simple circuits together, we create the electronic equivalent of a two-pole, four-position rotary switch that automatically changes several thousand times a second. There are still a few details to take care of, though. The most important of these is that with the present setup, all the signals will be superimposed over the same ground reference line.

The easiest way to cure this is to offset each input by a different level, thus the second pole of the analog switch becomes useful. One pole is used to switch the input signals, while the other pole switches position levels. Unfortunately, we cannot simply tie both outputs to the scope input. Remember that the analog switch allows current to flow in either direction, so we could end up feeding our position level into the circuit that is under test. We need a buffer between the two outputs that will sum the signal and the position level without providing a direct path between, yet provide an output that still resembles the test signals.

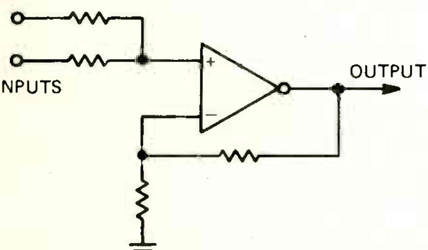


FIGURE 3. A UNITY-GAIN SUMMING AMPLIFIER.

The key words here are *buffer* and *sum*. The output must be the sum of a signal and a dc voltage level, with the inputs electrically separate. Since the output must resemble the input, we might use a differential input op amp, such as shown in Fig.3. This version uses a 741 op amp, connected as a unity-gain, noninverting summing amp. This prevents the position voltage from affecting the circuit under test.

One other possible problem involves the scope triggering. If the internal trigger function of the scope is used, the image will jitter; but if external triggering is used, the sweep may trigger on the chopped position level, rather than on the actual signal. The circuit of Fig.4 can be used to buffer one input signal, to drive the scope's external trigger circuitry.

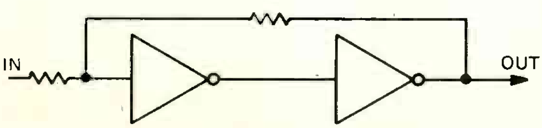


FIGURE 4. A TRIGGER BUFFER.

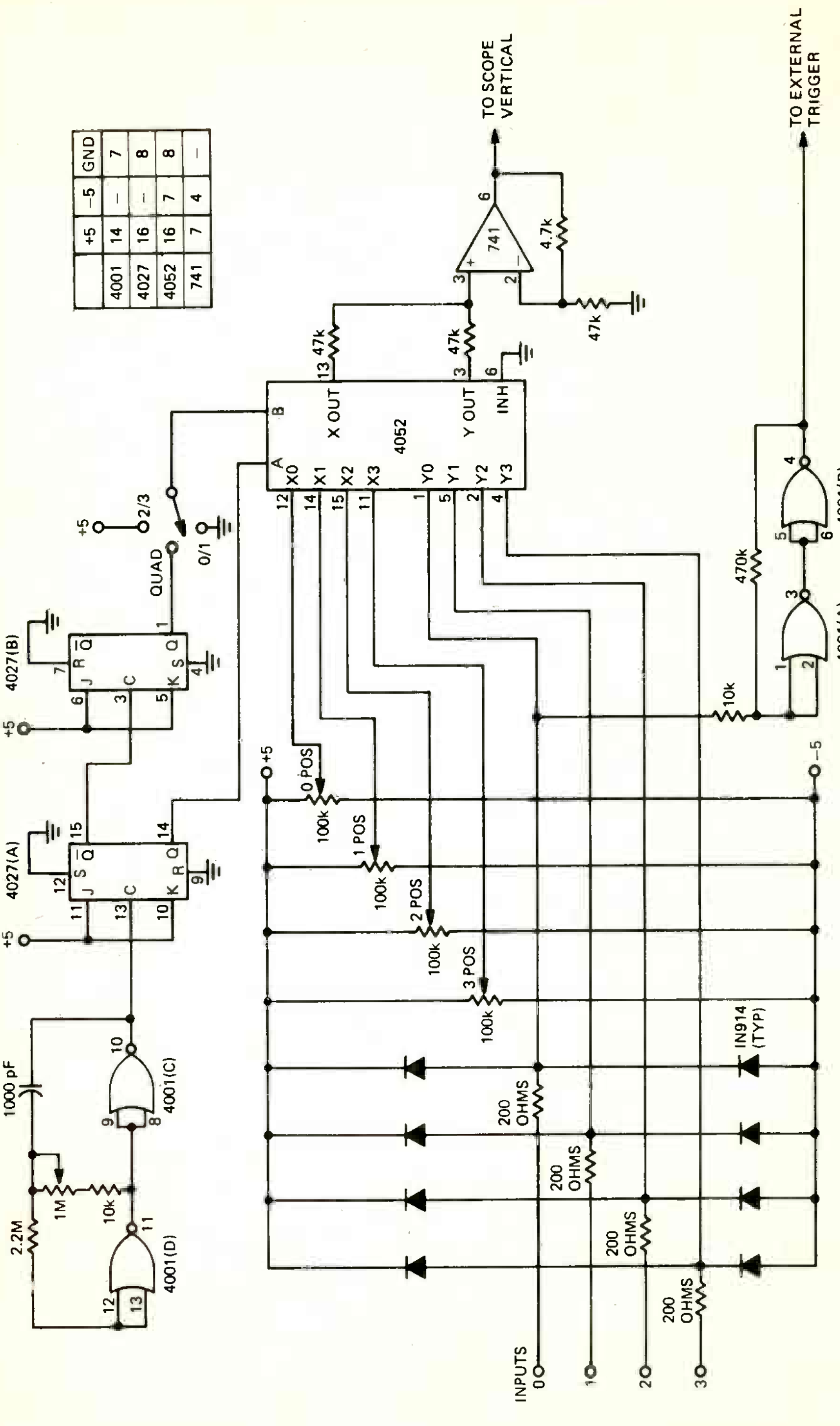


FIGURE 5. THE COMPLETED CIRCUIT.

TABLE I
SOURCES OF PARTS

Active Electronics Box 1035 Framingham MA 01701	Hobby World 19511 Business Center Drive Northridge CA 91324	Quest Electronics Box 4430 Santa Clara CA 95054
Digi-Key Box 667 Thief River Falls MN 56701	JAMECO 1021 Howard Ave. San Carlos CA 94070	Solid State Sales Box 74A Somerville MA 02143
	Poly Paks Box 942 Lynnfield MA 01940	

COMPLETING YOUR ADAPTER

The complete circuit diagram of the prototype unit is shown in Fig.5. This is simply the interconnection of the previous circuit ideas. Keep in mind that component values are not critical. You can probably get most of the parts from a Radio Shack store or from one of the mail-order suppliers listed in Table I.

Using the multi-trace adapter is not difficult. Simply provide a suitable ±5 volt supply, connect the op amp output to the scope vertical input, and connect the trigger buffer to the external trigger input. It may be necessary to adjust the chop frequency for maximum readable display. Note the addition of a three-position switch at the counter "B" output. This allows the converter to display only two traces at a time. In the prototype, this is the most commonly used mode. Although protection diodes and current-limiting resistors are provided, it is best to keep the input signal between +5 volts and −5 volts.

IMPROVEMENTS

There is quite a bit of room for improvement, all at the expense of simplicity. Perhaps most desirable would be a blanking circuit, which would eliminate the vertical lines as the trace alternates between signals. This would make the display much more readable.

More linear response is obtainable from complex summing amplifier circuits, especially when a reliable ±15 volt supply is available. This could be augmented by input preamps with attenuators, and so on. You might also find adding an amplifier ahead of the 4001 Schmitt trigger would improve trigger sensitivity. Of course, all of this is very useful, but adds complexity. The main attraction of the circuit described here is its simplicity.

ABOUT THE AUTHOR

Curt Feigel is a former electronics engineer and consultant. He recently left the NRI Instruction team to take a position as technical editor with *Byte* magazine. Curt still finds time to work on projects like the multi-trace adapter at his own workbench at home.

CONAR presents...

Halide Leak Detector

Compact and lightweight, this halide gas leak detector has an accuracy of almost 100 parts per million of any chlorinated refrigerants, such as Freon, Carrene, methyl chloride, and ethyl chloride. One valve for positive flame control. Lights instantly, with brilliant color changes. Valve and burner parts are all brass.

★ Long-lasting, heavy-duty replaceable reaction plate
★ 2' flexible search hose
★ Can be used with either propane or LP fuel
★ Propane tank included

$29.95

Stock No. AW004

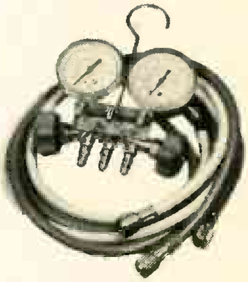
System Analyzer

A compact, lightweight, all brass body with easy-acting hand wheels. Full-floating, non-rotating piston valve with special refrigerant "O" ring and nylon seat makes this manifold gauge suitable for deep vacuum and pressure applications. Supplied with 3' red and blue search hoses, and a 5' yellow charging hose.

★ 1/4" SAE male flare connections for hose
★ 2-1/2" standard gauges with unbreakable clear lens
★ Compound BLUE gauge 0-30" vacuum, 0-350 lbs pressure
★ Pressure RED gauge 0-500 lbs pressure
★ Temperature scale on both gauges for R-12, R-22, and R-502

$39.95

Stock No. AW011



Vacuum Pump by J/B Industries

This high-performance vacuum pump is the essential tool for all air-conditioning and refrigeration technicians. Provides for fast and complete evacuation of water contaminants. Built for continuous duty — performance may actually improve with age! A gas ballast allows for a clean vacuum on even the "wettest" system. Complete with 3-conductor cord. Features: single-stage rotary vane, direct drive, and rugged grip for easy carrying.

SPECIFICATIONS

Free Air Capacity: 84 liters/min (3 cfm). **Ultimate Vacuum:** 0.030 Torr. **Pump Speed:** 1725 rpm, 1/4 hp, 120 VAC. **Operating Temperature:** 40°C, ±5°C rise. **Intake Port:** 1/4" or 3/8" male flare. **Oil Capacity:** 21 oz (32 oz supplied). **Weight:** 24 lbs. **Dimensions:** 11" H X 5-1/2" W X 14" D.

$199.95

Stock No. AW008

Alumni News

Harry Taylor

The NRI Alumni Association has been in existence more than 50 years, serving the need for continuing training for our graduates.

Many people who complete a technical training program feel the need for a little more practical knowledge before they go off on their own. This is where the Alumni Association can be useful. By meeting regularly with other NRI graduates, you have an opportunity to meet new friends, learn from each other, and develop potential employment contacts. Take a look at the following chapter reports to see what's going on in the chapter nearest you.

The NRI staff is always ready and willing to help its active alumni and it's always a pleasure for me to help solve a difficult problem. Our chief instructor, Joe Schek is also available to members of the Alumni Association.

There is a lot of interest in video recording and in solar heating among the membership. We have, therefore, made copies of these lessons available to the Alumni Chapters. If your chapter librarian does not have them, please let me know and I'll be glad to send copies of your choice to the librarian.

DETROIT CHAPTER

The subject of the December meeting was TV troubleshooting. Ellsworth Umbreit, one of our members and a highly respected technician, talked about some of the problems and solutions he encountered during his service work.

Ellsworth has connections with the Detroit branch of a well-known manufacturer of electronics kits. From time to time, he is called on to look at unusual troubleshooting problems. He explained a number of the more interesting problems and their solutions at the meeting. One thing we learned is, you should approach a kit differently from the way you approach a factory-assembled unit. The kit may never have worked properly, therefore, normal troubleshooting logic may not be applicable.

Ellsworth's philosophy on education is very practical: If you need to know how to do a job, take a course and learn how to do it. In addition to Ellsworth's training in electronics, he has studied auto air conditioning. He feels this training lessens his dependance on other technicians.

Sam Mangiopane brought in a TV problem at the January meeting, and Ray Berus and Bruce Rittenhouse jumped on it right away. Sam's television, an RCA portable, would not receive one channel. After performing a number of tests, we found that the aft (automatic fine tuning) had a malfunction. After correcting the aft problem and re-adjusting the fine tuning, the problem was resolved.

Training on solid-state circuitry is planned for the near future and we will take up solid-state devices and their applications. If you need help on transistors, SCRs, and similar devices and circuits, get in touch with the members and come to our regular meetings.

FLINT/SAGINAW VALLEY CHAPTER

Radio servicing was one of the topics at our meeting held in late November. Dennis Besser brought in a 5-transistor receiver with "no output." We used a Sencore Super Cricket transistor checker on it, and found two bad output transistors. This instrument checks transistors in or out of the circuit, making it unnecessary to disconnect a transistor for testing.

A while back, we ran into an interesting color problem in an RCA CTC25A chassis. The color would drop out of sync whenever you touched the chassis. We traced it to a rosin solder joint between the color oscillator coil and the color oscillator tube socket. The set had worked only because of a high resistance or capacitive coupling between the coil and tube pin. After applying a hot soldering iron to the solder joint, the problem was corrected. We found the circuit board had been dip-soldered and the solder did not "take" properly on that joint.

Finally, at a recent meeting we outlined our program for the first three months of 1980. The members expressed a strong desire to continue practical training exercises on home entertainment equipment and on small- to medium-sized appliances.

NEW YORK CITY CHAPTER

The election of officers was held at the December meeting. All the incumbents were reelected.

Chairman Sam Antman followed the election with a discussion on a TV set that had fallen off a table and landed on its face.

When power was applied, a flash appeared inside the set. After checking the set, Sam discovered the fuse had blown. This had caused the flash and a resulting strong, burnt odor around the tuner. The tuner shaft was also bent. After removing the barrel of the tuner a burnt resistor was exposed. It was a 1200 ohm resistor in the B+ plate supply of the 3HA5 rf amplifier. Then Sam noticed two contact springs touching – one of them was ground. This accounted for the burnt resistor. He replaced the resistor, straightened the springs and tuner shaft, put the tuner back together, and replaced the fuse.

When he applied power again, nothing happened. He then checked the filament string and everything checked OK. However, closer examination revealed a cracked 4.7 ohm, 4 watt ceramic resistor in the ac circuit. Next, he found a rectifier diode shorted. When he replaced the diode and the resistor, the set started. The shorted tuner spring in the B+ circuit caused the failure of the plate resistor, diode, fusible resistor, and ac line fuse, as all of these parts were in series – one after the other.

NORTH JERSEY CHAPTER

Al Mould presented a Zenith Sight and Sound cassette and service manual discussion on the power supply of the Zenith System-3 color TVs. In the System-3 chassis, most of the operating voltages are obtained from scan-derived power supplies. Voltage is regulated using a very complex pulse-width modulation circuit. This month's discussion covered the theoretical background of this supply. Next month we will cover troubleshooting.

Paul Howard brought in an RCA CTC85 color TV. Paul demonstrated module removal, using a tool that is attached to each set of this series. He

DIRECTORY OF ALUMNI CHAPTERS

DETROIT CHAPTER meets at 8 p.m. on the first Friday of each month at St. Andrews Hall, 431 E. Congress Street, Detroit. Chairman: James Kelly, 1140 Livernois, Detroit. Telephone 841-4972.

FLINT/SAGINAW VALLEY CHAPTER meets 7:30 p.m. the second Wednesday of each month at Andy's Radio and TV Shop, G-5507 S. Saginaw Road, Flint. Chairman: Dale Keys. Telephone (313) 639-6688. Shop phone (313) 694-6773.

NEW YORK CITY CHAPTER meets at 8:30 p.m. the first Thursday of each month at 1669 45th Street, Brooklyn. Chairman: Sam Antman, 1669 45th Street, Brooklyn.

NORTH JERSEY CHAPTER meets at 8 p.m. on the second Friday of each month at the Players Club, located on Washington Square in Kearney, N.J. For information, contact Paul Howard, 950 Carteret Avenue, Union, N.J. 07083. Telephone (201) 964-8492.

PITTSBURGH CHAPTER meets at 8 p.m. on the first Thursday of each month at the home of Jim Wheeler, 1436 Riverview Drive, Verona, Pa. 15147. Chairman: George McElwain, 100 Glenfield Drive, Pittsburgh, Pa. 15235.

SAN ANTONIO CHAPTER meets at 7 p.m. on the fourth Thursday of each month at the Alamo Heights Christian Church Scout House, 350 Primrose St., 6500 block of N. New Braunfels Street, (three blocks north of Austin Hwy.), San Antonio. All San Antonio area NRI students are always welcome. A free annual chapter membership will be given to all NRI graduates attending within three months of their graduation.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets at 8 p.m. on the last Wednesday of each month at the home of Chairman Daniel DeJesus, 12 Brookview Street, Fairhaven, Mass. 02719.

SPRINGFIELD (MASS.) CHAPTER meets at 7:30 p.m. on the second Saturday of each month at the shop of Norman Charest, 74 Redfern Drive, Springfield, Mass. 01109. Telephone (413) 734-2609.

TORONTO CHAPTER meets at McGraw-Hill CEC, 330 Progress Ave., Scarborough, Ontario. For information, contact Stewart J. Kenmuir at (416) 293-1911.

discussed the power supply in this set, which incorporates start-up circuits to power the horizontal oscillator, buffer, and driver stages. The majority of the receiver's operating voltages are then derived from flyback transformer sources, and the start-up circuits are shut down. The set uses a 150 volt supply that is not isolated from the power line. Therefore, an isolation transformer must be used.

Troubleshooting projects included a 19" Magnovox set with a sync problem brought in by Bob Morello, and a 12" Panasonic solid-state set with a raster, but no picture or sound was brought in by Harry Ala. Sam Britt brought in a 12" black-and-white GE, which Dick Wagstaff rejuvenated with his Heath IT5230. Sam also brought in a Sharp 3K-63 with no vertical deflection. Dick Wagstaff, Ted Krawczyk, and several others helped Sam isolate the trouble to the vertical oscillator stage. The base voltage of the transistor was positive instead of a negative 0.75 volt.

PITTSBURGH CHAPTER

In December we held our annual election of officers. Our new chairman is James Brugh. Past chairman, George McElwain, was elected to our Board of Directors. After the meeting, we held our Christmas Party and took some time to reflect on the importance of comradship.

During 1980, we hope to increase the range of topics covered in our meetings and to continue providing practical help and training. Primarily, we expect to work with more consumer electronics equipment and spend more time on business operations.

SPRINGFIELD, MA CHAPTER

Our November meeting featured a tour of the Springfield Telephone Switching Center. This tour was arranged by Joe Gaze, one of our members.

We started the tour at the "old cable vault" where we found literally miles of inactive cables that had been replaced. It was easy to see the technological changes, since the space required for the new cables was about one-quarter of the space taken up by the old ones. We also saw the machinery that provides pressurized dry air, which is maintained throughout the cable system to prevent the entry of moisture.

We then proceeded to another floor where the cables terminate at banks of connection terminals. Here individual lines are connected into the telephone system by the use of small plug-in coils.

Next we had a chance to see an example of troubleshooting. With the aid of a "dial hand set," the technician can test any line by a connection to the line in question. He dials in the code number and in seconds a mechanical voice calls out the number of the line being tested.

We were then taken to another floor where we were introduced to the computer that tells the technician when there is trouble and where to look for it.

Robert E. Bonge

Robert E. Bonge, past national vice-president and past chairman and secretary of the San Antonio (Alamo) Chapter of the NRI Alumni Association, died on Nov. 25, 1979. Long-time members of the Alumni Association and of the San Antonio Chapter are saddened by the passing of this inspiring, energetic, and devoted friend.

The computer, which is located about 90 miles away, constantly monitors the 100,000 subscriber lines in this area and monitors itself. It responds to all of the various troubles that occur on the phone lines.

Concluding our tour, we were told that this particular computerized system has eliminated the need for three floors of the older relays and associated equipment. This has permitted an increase in service without adding to the facilities.

All of the members who took the tour found it a most interesting and educational evening.

CHAPTER VISITS

The schedule of local chapter visits by the executive secretary of the NRI Alumni Association for 1980 is shown below.

All NRI graduates and students are invited to attend these Alumni Chapter meetings. As the executive secretary, I will demonstrate various types of equipment and present technical information that you will find helpful and interesting. This will give you more insight into what NRI Training is all about and what lies ahead for you in various technical fields. Other NRI staff members attend some of these meetings, so you may get an opportunity to meet some of the people who participate in your training.

If you would like to attend an Alumni Chapter meeting, contact your local chapter at the address or phone number given in the "Directory of Alumni Chapters" on page 26 or contact me here at NRI. If you contact me, I will send you a reminder a few days before the meeting scheduled in your area.

Schedule of Chapter Visits

San Antonio Chapter	Thursday, April 24
Pittsburgh Chapter	Thursday, May 1
North Jersey Chapter	Friday, May 9
Southeastern MA Chapter	Wednesday, Sept. 24
Flint/Saginaw Valley Chapter	Wednesday, Oct. 1
Detroit Chapter	Friday, Oct. 3
Philadelphia/Camden Chapter	Friday, Oct. 17 (tentative)
Springfield MA Chapter	Saturday, Nov. 8
New York City Chapter	Thursday, Dec. 4

The following ballot lists the names of those nominated to serve as officers of the NRI Alumni Association for the 1980 term. Please fill out your ballot and return it to NRI as soon as possible. The names of those elected will be announced in the next issue of the *NRI Journal*. POLLS CLOSE AT MIDNIGHT ON TUESDAY, APRIL 15, 1980.

For President (vote for one):

Sam Antman New York City, NY	Paul Howard Union, NJ

For Vice President (vote for four):

Ray Berus Detroit, MI	Sam Dentler San Antonio, TX
George McElwain Pittsburgh, PA	Al Mould Kearny, NJ
Richard Wagstaff Kearny, NJ	Willie Foggie New York City, NY

Your Name ____________________ **Student Number** ____________

CONAR Presents...

7-Drawer Chest

$67.50
No. CY1007

An excellent tool chest with self-storing drop front lock panel, felt-flocked replaceable drawer liners, tumbler lock and two keys, and gray baked-enamel finish.

Solid-State Ignition Analyzer

$23.50
No. AC474

More than an ignition tester – a diagnostic analyzer that lets you analyze the operating condition of electronic ignition systems in all American cars. When the light blinks, the component is satisfactory. If the light stays on, the component is defective. Operates with LED display to check magnetic pickup, modules, and coil circuits.

Solid-State System Tester

$23.50
No. AC472

A pocket-sized tester that hooks to a car battery. Five LEDs for diagnoses of all 12 volt auto systems, either positive or negative ground. One light tells all. Check battery voltage, charging rate, wiring, alternator, regulator, and diodes – all with one tester! All instructions are fully defined on the decal.

Battery Charger

$5.50
No. AC662

Gives a quick start in any weather and can't overcharge. Precision transformer keeps battery charged. Plugs into any 120 VAC outlet and includes UL listed cord and trickle charge of 12 V, 1 ampere.

Honors Program Awards

In the tradition of NRI's pursuit of excellence in training, the following graduates who earned NRI diplomas in November and December also earned unusual recognition under the NRI Honors Program. On the basis of their grades, these graduates distinguished themselves by earning the right to honors listed below, in addition to their regular NRI diploma. This distinction is made part of their permanent NRI record.

WITH HIGHEST HONORS

Kenneth John Barr, Framingham MA
Charles William Bem, Jr., Zephyrhills FL
Richard M. Birt, Charlottetown PEI CANADA
Terence M. Breen, Millville WV
Skip W. F. Cadwallader, Orlando FL
E. J. Chandler, Indianapolis IN
William J. Conley, Titusville PA
E. J. Connelly, Leavenworth KS
William V. Deardoff, Philadelphia PA
Randell A. Eis, Unadilla NE
Clifford W. Farmer, Oak Grove KY
Lynn S. Gorrell, Burlington IA
Robert Le Grand, Jr., Upper Saddle River NJ
Harry James Hunt, O'Fallon MO
Scott Eric Kenyon, Holley NY
Donald J. Kleeberger, Perrysburg OH
Robert W. Jervis, Columbus OH
Bobby W. Johnson, Pasadena TX
Larry Stuart Judd, Ridgefield CT
John V. Labbe, Munroe Falls OH
William E. Lester, Kerrville TX
Lindsey S. Lewis, Delta CO
Clayton Timothy Logue, Weiser ID
Dennis C. Lytle, Pineville LA
Thomas C. McNallan, Rochester MN
Arthur Q. Oaks, Cambridge Springs PA
Norman W. Reed, Lewiston NY
Girard K. Russell, Elk Grove Village IL
Richard E. Samborski, Buffalo NY
Robert L. Umholtz, Pine Bluff AR
Michael A. Wilusz, South Portland ME

WITH HIGH HONORS

Richard Anderson, New Cumberland PA
Irving G. Apparicio, Galveston TX
James Kendall Baird, Dalton GA
Jim Baker, Toronto ON CANADA
R. William Balcom, Litchfield NH
Paul Wilson Bartow, Syracuse NY
Ralph David Bascom, Morrison MO
Alban E. Beete, East Elmhurst NY
Layle E. Bengtson, Longmont CO
John David Bennett, South Range WI
Ethel Lynn Blazyk, White Sands NM
Keith P. Borland, Oak Grove MO
William P. Bowers, Mathis TX
Douglas Braunsdorf, South Amboy NJ
Phillip E. Brewington, APO New York
Timothy C. Broderick, Fort Bragg NC
Mark Lee Bryant, Malvern PA
Donald Henry Butler, Medford OR
Norman C. Butterfield, Tacoma WA
S. J. Caddy, Chicago IL
Billy Earl Carter, Sherwood AR
Jon S. Cassidy, Douglassville PA
Robert Allen Cates, Yorktown VA
Joe H. Cawthon, Holland TX
Richard Eugene Chapell, Coudersport PA
Gary A. Cockram, Roanoke VA
Robert Lee Cole, Minot AFB ND
John J. Collins, Pembroke MA
Bruce A. Conklin, New Paltz NY
Jerry C. Cooper, Columbus OH
Lloyd F. Cornue, Lake Geneva WI
Jimmy Lewis Couch, Keller TX
Richard C. Cunningham, Chicago IL
Gary Lee Davidson, Grand Forks AFB ND
Ronnie Loyd Day, Norwood OH
Craig Kendrick Dean, Lakewood CA
Wayne Robert Denis, Virginia Beach VA
James Dharmawan, Ignace ON CANADA
Thomas P. DiBattista, Berwick PA
Seth M. Dinwiddie, Greenfield Center NY
James D. Dunn III, Sparta GA
Mark S. Edelinski, FPO San Francisco
Hermann W. Eisenmann, Palm Bay FL
Jerry Ted Eubank, West Carrollton OH
John F. Fay, Bardonia NY
James C. Fetty, Jr., Steilacoom WA
Forrest R. Fogle, Dayton OH
Brian L. Force, Manchester NH
Victor E. Formentelli, Pataskala OH
James Bruce Francis, Baltimore MD
Maurice H. Galvin, Sherbrooke PQ CANADA
Rosemary Garrabrandt, Monroe NY
Bruce Duane Garvais, Englewood CO
Valmore E. Gaudreau, San Diego CA
Joseph R. German, Jr., Van Wert OH
Greg Gibson, Cadiz OH
Jerry Gilkison, Memphis TN
Edward A. Glaesmann, Humble TX
Walter L. Goodwin, San Francisco CA
James P. Gorichanaz, Greenfield WI
Virgil M. Gress, Huntingburg IN
John L. Haglund, Lakeville MN
George W. Hallgren, Potomac MD
William D. Hamlin, Wappingers Falls NY
Wayne Herbert Hanson, Reading MA
James Kenneth Hatt, Rocky Point NY
James K. Hatton, Jr., Washington DC
Roland E. Hayhurst, Columbus OH
John A. Hein, Jr., Truth-or-Consequences NM
Robert F. Hendrix, Houston TX
David N. Hentges, Middletown RI
Stanley L. Hibbard, Pottstown PA
Larry D. Hite, Mt. Pleasant IA
James Charles Hunn, West Point NY
Rodney Harry Hust, Tappen ND
Kenneth R. Hutcherson, Birmingham AL
James M. Johnson, Columbus GA
Gerald E. Jones, Toledo WA
Robert Ward Jones, Jr., Portland OR
Joseph H. Katz, Glastonbury CT
Ledru L. Kershaw, Union OR
Lewis E. King, San Francisco CA
George Vincent Kozak, Osceola Mills PA
James C. Krall, Manitowoc WI
Dale E. Kuhl, Red Wing MN
David D. Lampman, APO New York
Keith Lawson, Norton AFB CA
Gail J. Leitzel, Ellsworth AFB SD
Max J. Leon, Baton Rouge LA
Gordon Lewis, Augusta GA
Dennis Bradley Loch, Goldsboro NC
Richard H. Lorenzetti, Greenville NC
Raymond Joseph Lynch, Quincy MA
Frank Vincent Macioci, Wellfleet MA
Michael G. Maddox, Louisville KY
Gary M. Maneval, Minot AFB ND
Richard Manning, Lambert PQ CANADA
David Earl Marsh, Groves TX
Burnett W. Martin, Elkhart IN
Hoard D. McIntyre, Dallas TX
David A. McReynolds, Bunker Hill IN
David Gene Miller, Sprague River OR
Randy S. Mills, Rockford IL
James W. Mitchell, FPO New York
Larry E. Mowatt, Hominy OK
Frederick M. Murray, Gainesville FL
Clarence Gene Newman, Walker MO
Arnel Lee Nichols, Kenton OH
George A. Nikol, Baltimore MD
Gary Lee Niswonger, Piqua OH
William F. Norman, Oakhurst OK
Barry A. Norris, Charlotte NC
Kenneth F. Nuhn, Moscow ID
Patrick J. O'Connor, Morrisonville NY
Charles L. O'Dell, Athens GA
William Francis Olbeter, Staten Island NY

Norman K. Owens, Newport RI
Dominador G. Paet, Ewa Beach HI
Walter Panych, Hadashville MB CANADA
Sanford L. Parker, Cleveland TN
George W. Patterson, Fairfield CA
Ronald L. Posey, Imlay City MI
Bruce Power, Tallahassee FL
Frank Richard Proper, Hampton VA
Rolando Puntawe, Baguio City PHILIPPINE
Jerry David Ray, Boone NC
James Michal Rayle, Empire MI
George W. Richard, Westville OK
Frederick K. Richardson, Woodbridge VA
Robert P. Richardson, Columbus MS
John C. Riley, Mulberry FL
Terrence T. Riley, Jr., Iselin NJ
Randall W. Rittle, Bristol VA
Ronald K. Ruddell, Chariton IA
Michael A. Rudnick, Anamoose ND
Frank P. Rutigliano, Ridgway PA
Glenn Earl Salaun, Metairie LA
Robert A. Salstrand, Coarsegold CA
Stephen Roger Sanders, Shreveport LA
D. W. Satterfield, Rivesville WV
William K. Sawyer, Langley AFB VA
Richard Eugene Scanlon, Ridgeland SC
John J. Schaller, Sr., Cookeville TN
Melvin J. Schneider, Tallahassee FL
Larry Allen Schultz, Stratford IA
Mundell Semans, Jr., Lancaster PA
Dave H. Shade, Boerne TX
Norman A. Shane, Cranford NJ
Steven B. Shatinsky, Camptown PA
Walter L. Shaw, Sacramento CA
Elliott Sheres, North Miami Beach FL
Claire Marie Silva, Kaneohe HI
Larry Wilson Sims, Pelzer SC
Harold D. Singer, Las Vegas NV
Don C. Sizemore, Marshall MI
Bobby Joe Smith, Pauline SC
Kevin D. Smith, Mt. Vernon IL
Edward S. Smykowski, Jr., Chicago IL
James R. Snowden, Tye TX
Jefferson C. Snowden, APO New York
Eugene Maris Sobieck, Fort Sill OK
William C. Stamper, Springer NM
Wayne T. Stephens, Lubbock TX
Robert B. Stevenson, Vincennes IN
Werner K. Stiefel, Oak Hill NY
Kenneth E. Summers, Virginia Beach VA
Arthur S. Swenson, Jensen Beach FL
Robert Nelson Thompson, Gilman IA
Mario Toscano, College Point NY
John Howard Tosh, Nashville TN
W. H. Trousdale, Albuquerque NM
Michael K. Ungerman, Key West FL
Tony L. Ussery, Richmond VA
Cletus J. Vincke, Newport News VA
Richard Wilson Wade, Ft. Lauderdale FL
Ronald A. Weaver, Ocean Springs MS
Rene J. Weber, Millersburg OH
William Weiser, Philadelphia PA
Mark E. Werner, Boulder CO
Gilpin N. Wescoat, Jr., APO San Francisco
Kenneth Coe Wells, Ballston Spa NY
Henry Alfred West, Gaithersburg MD
Richard E. Westbrook, Virginia Beach VA
Ervin B. Williford, Spring City TN
William E. Witting, Chicago IL
Roland C. Woltman, Brooklyn NY
Roger A. Wuest, Elmendorf TX
Ted Wychopen, Mallaig AB CANADA
Gary Zelensky, Prince Albert SK CANADA

WITH HONORS

Woodrow Abbott, Porters Lake NS CANADA
Fred B. Adams, Arlington VA
Johnny Lynn Adams, Independence KS
Richard C. Adams, Mexico NY
Alvin J. Albert, Stafford Springs CT
Vivian Ann Allen, Albuquerque NM
Robert P. Alvarez, San Jose CA
Carlos Amaral, Stanford CA
David Lee Anderson, FPO San Francisco
Herbert M. Arnold, Birdsboro PA
Vernie E. Ates, Jr., MCB Quantico VA
Michael D. Atz, La Junta CO
Leigh J. Bacon, Atascadero CA
Edward G. Baggett, Sandston VA
David John Baldwin, Hill AFB UT
Don Barefoot, Calgary AB CANADA
Michael F. Bartholomew, Hellertown PA
Brian Lee Bashore, New Cumberland PA
Duane E. Baugher, Wichita KS
Eugene J. Beckman, Jr., Summerville SC
Gary I. Belloni, APO New York
Jimmie D. Benson, Muskogee OK
Sherril Alvin Bjornson, Hastings MN
Glen P. L. Blake, Pickering ON CANADA
Don Pat Blount, Arlington TX
Michael W. Bolden, St. Louis MO
David John Bonnet, San Antonio TX
Richard Edmund Booth, Churchville MD
Kenneth G. Bouchard, Jay ME
Craig T. Bouckaert, Waterford MI
Carl E. Bowen, Oxford AL
David Thornton Bowen, Bradford RI
Terrance R. Bowman, Herndon VA
Gerald E. Brady, Nellis AFB NV
Carl Ray Brown, Harrogate TN
Edward R. Brown, Altamont IL
Roger Wentz Brownell, APO New York
Mark Joseph Bruflodt, APO New York
Bruce J. Brunner, Dos Palos CA
Craig A. Buckner, Mission KS
Gary Buitrago, Tulsa OK
Raymond E. Burnell, Jr., Virginia Beach VA
James A. Caballero, Katy TX
William E. Callister, Greeley NE
Ralph Lee Carpenter, Warner Robins GA
Ronald E. Carron, FPO Seattle
Raymond Eugene Chase, Crimora VA
David W. Chrisman, Columbus MS
Bruce R. Clark, Cortez CO
Timothy J. Clarkson, Ypsilanti MI
Elgie Clayton, Jr., Emory TX
William D. Clayton, Summerville SC
Boyd Elon Cockman, Robbins NC
James William Cole, Aldrich MO
Dennis Warren Cook, Manistee MI
Ross Richard Cooke, FPO San Francisco
Scott Cooper, Jay FL
Paul D. Cor, Salt Lake City UT
Richard C. Craig, South Bend IN
Roger Owen Crocker, Phoenix AZ
Constantino G. Cueto, FPO San Francisco
Garwood Clarence Dane, El Monte CA
Max Daniels, Roanoke VA
Thomas G. Darter, Dermott AR
John Dee Davis, Jr., Clearwater KS
Richard C. Davis, Arlington VA
James L. Deese, Sr., Raleigh NC
Luciano DiPaolo, Western ON CANADA
Donald Joe Dowdy, Lynwood WA
Nelson R. Downend, Dallas PA
Patrick S. Doyle, Bagley MN
William C. Duvall III, Charlottesville VA
L. W. Dye, Lomita CA
John D. Ebert, Richmond VA
Allen Crist Eckhoff, East Peoria IL
F. G. Edelhoff, Kelowna BC CANADA
Robert A. Edge, Colorado Springs CO
Douglas L. Essex, Wilmington DE
Donald L. Eubanks, Kinston NC
G. V. Evans, Prince Albert SK CANADA
Iris Denson Evans, Raleigh NC
Alford J. Flaig, Holland NY
Peter M. Flannery, Winter Park FL
James F. Flavell, Jefferson LA
A. Gerardo Flores Y. Flores, DF MEXICO
Richard K. Fortner, Laurel MD
Vivian Grace Fox, Norfolk VA
Charles H. French, Minneapolis MN
Gerald W. French, Kalamazoo MI
Vernon C. Funkhouser, APO San Francisco
Bruce Robert Gaal, Brunswick OH
David L. Gartman, Mobile AL
Joseph J. Gatyas, Jr., Fords NJ
Steven F. D. Genovese, Tallahassee FL
George F. Gest, Stockton NJ
Paul Gilbertson, Auburn WA
Lawrence E. Glatz, Shadyside OH
Donald M. Goldsberry, Honolulu HI
William R. Gower, Ft. Mitchell KY
Dennis E. Graham, Indianapolis IN
Kenneth D. Gravely, Clarksville TN
Richard David Grimes, Ottawa ON CANADA
LeRoy Lee Halfast, Spartansburg PA
Timothy Lance Ham, Lexington SC
Herbert G. Hamer, Sun City AZ
Stuart E. Hartigan, Monrovia CA
Kenneth D. Hartwig, Baubette MN
Raymond Walton Harvey, Laverne OK
Clifford Haynes, Takoma Park MD
Gary John Headrick, Atlanta KS
Billy Ray Heard, Tulsa OK
Frank R. Heitzman, APO New York
Robert L. Hemminger, Fostoria OH
Denis M. Herber, Camp Springs MD
Lewis Martin Heying, Jefferson City MO
Dennis C. Hiatt, Mount Airy NC
Rodney Allen Hignite, Ft. George Meade MD
William Hodgins, Hamilton ON CANADA
George R. Howlett, Jr., Salisbury MA
Jay Earl Huff, Sr., Mount Airy MD
Mark Humphry, North Vancouver BC CANADA
John Charles Hurley, Ewa Beach HI
David L. Hurst, APO New York
Clifford Isenor, Lantz NS CANADA
James L. Jackson, Jefferson GA
John Jacques, Sherwood AR
Jerry T. James, Charlotte NC
Nathan F. Johnson, Dixon IL
Orlando C. Johnson, South Charleston WV
William Henry Johnson, APO San Francisco
John T. Johnston, Northglenn CO
Charles Scott Jones, Coeburn VA
Thomas H. Jones, Fayetteville NC
Thomas William Jones, Weirton WV
Richard E. Kamp, Massillon OH
Anthony R. Kampa, Walthill NE
Melvin A. Kaufman, Arthur IL
Kevin Stewart Kay, Rome NY
Gerald R. Keaveny, Mt. Rainier MD
Dennis Kennedy, Fairfax VA
Amon L. Kincaid, Jr., Riverdale CA
Robert L. Klingensmith, Springfield VA
Thomas L. Klosterman, Coldwater OH
Albert T. De Koning, Sunburst MT
Eugene T. Korzeniowski, FPO New York
Douglas P. Lamb, Mt. Prospect IL
Emiliano Guagtemo Lara, Colts Neck NJ
Laurence F. Laveroni, Three Forks MT
Adam F. Lenckus, Schaumburg IL
Paul Tomas Lex, Spring Lake NC
Steve Little, Statesville NC
David Littleton, Orlando FL
Robert D. Lively, Austin TX
David L. Lloyd, Monroe NE
Kenneth John Lyons, Anamosa IA
Jon Reed Lyter, Ben Lomond CA
Howard R. McCort, Rock Springs WY
William J. Mahoney, Wisconsin Rapid WI
Bob Marcum, Sierra Vista AZ
Albert S. Mares, Santa Fe NM
Edward G. Marshall, Layton UT
John H. Martin, Philadelphia PA
John R. Means, Alexandria LA
Ver N. D. Mesecher, Sr., Beaumont TX
Donald William Meyers, Wilkes-Barre PA
Brin Richard Mileski, Oneonta NY
Roger Dale Miller, Mayfield KS
Larry Benjamin Millsap, Dracula GA
Donald J. Montgomery, Centerville OH
James Bradley Moore, Abilene TX
Bill Gene Moss, El Paso TX
Bernard F. Murphy, Jr., Methuen MA
Myron L. Murray, Americus KS
Lauri Joseph Mulju, Fort Polk LA
Stanley D. Myers, Westphalia IN
Michael O. Mygatt, Hill AFB UT
William S. Nakonechny, Colonia NJ
Lawrence Nicklas, Jr., Warren PA
Mark Richard Nolin, Hudson Falls NY
James R. Osborn, Freeburg IL
Hugh Paddock, Tuba City AZ
Michael G. Parnell, Arcadia IN
Albert Pasnetkus, Detroit MI
A. C. Pendleton, St. John NB CANADA
Sherman Ray Peters, Cowden IL

John M. Peterson, Simsburg CT
Norman Ray Petree, Sr., Moyers OK
Levi Phelps, Hamilton OH
Gregory R. Pintner, Cleveland OH
Stanley R. Pitts, Jacksonville FL
Robert Earl Pressler, Romulus MI
Caesar Quick, Fayetteville NC
Richard Michael Raia, Massapequa NY
James G. B. Ranson, Jr., APO New York
Henry F. Ramm, Springfield VA
Jesse Reyes, Lawton OK
David M. Richards, Cherry Hill NJ
Roy Richie, Dearborn MO
Frank F. Rivers, Jr., Plattsburgh NY
Ronald Ray Robertson, Willow Springs MO
Edward L. Robinson, Oceanside CA
Luis A. Rodriguez, Lancaster PA
Harold M. Roebuck, Massillon OH
John Roebuck, Sacramento CA
Tim Rohig, Gillam MB CANADA
William R. Rollins, Fort Smith AR
Frederick M. Rubino, Kittery ME
Thomas F. Russell, Eglin AFB FL
Ralph W. Schoener, Jr., Akron OH
Richard C. Schoessow, Jr., Wayne MI
Roy Eugene Scoggins, Quitman LA
Allan R. Sears, Sackville NB CANADA
Donald Joseph Seelen, Pierz MN
Brian Keith Settle, Georgetown IN
Terrance D. Shamp, Cambridge Springs PA
William D. Sharp, Anchorage AK
Sam Shipler, Hayfork CA
Robert F. Shon, Manassas VA
Donald L. Shores, Avon MA
Odis C. Sikes, Jr., Wenatchee WA
Robert E. Simmons, Dover DE
Jesse E. Smith, Cummings KS
Raymond A. Smith, Hamden CT
Robert Lester Smith, Columbia SC
Richard A. Sorensen, Ronkonkoma NY
Roy Britton Stanley, Holt FL
James Stanton, Amarillo TX
Jim Stapaules, Hollenberg KS
Paul C. Steffen, Saginaw MI
Jerry M. Stephens, Washington DC
Raymond P. Stern, Jr., FPO New York
Adam M. Stevenson, Moyock NC
H. Roger Stoll, Warroad MN
William Russell Story, Chattanooga TN
Kurt P. Streit, Potomac MD
Joseph C. Sullivan, Troutville VA
Al C. Swenson, Ozone Park NY
Gerald D. Tate, Springfield VA
Joseph F. Taylor, Green River WY
Malcolm S. Taylor, Portage MI
Michael J. Tigner, Chesterhill OH
Ivan A. Tillman, Baton Rouge LA
Steven Charles Tipton, Hamlin NY
Harold L. Trammel, Portland TN
Kenneth L. Traylor, Anderson IN
Theodore Tucker, Depew NY
Jasmin L. Vaillancourt, Goffstown NH
Wayne J. Valliere, New Bedford MA
Richard F. VanBlooys, Grand Rapids MI
Hector Varela, Englewood NJ
Homer Lee Vaughn, Minot AFB ND
Harry J. VonMalder, Brockton MA
Willis R. Walker, Mountain City TN
Leslie M. Wallace, Jr., Albert Lea MN
Donald F. Walsh, Green Cove Springs FL
James Wannamaker, Picton ON CANADA
Bruce Warren, Jacksonville FL
John A. Watson, Jr., Wrightsville PA
Dennis Lynn Weekly, Cameron WV
Todd Stewart Weiler, Marshfield WI
Robert E. Wells, FPO New York
Joseph William Werner, Greensburg IN
Peter Wescott, West Babylon NY
William E. White, Craig CO
Albert G. Whitehead, Corpus Christi TX
George Wiarda, Kawkawlin MI
Nolan Vonzel Wilson, Greensburg IN
Roland Alfred Wiborg, Elizabeth City NC
Michael D. Wilkinson, Jacksonville FL
Marion C. Williams, Jr., Frankford WV
Bernard G. Wilson, Tipton MI
William W. Winn, San Diego CA
James A. Wirth, West Chicago IL
John D. Witherill, FPO Seattle
Dennis A. Woodall, Brandon FL
George E. Workman, Jr., Blytheville AR
Orvis Arnold Wyman, Curllsville PA
Henry Ying, Gander NF CANADA
Tom Yungwirth, Green Bay WI
Alfred J. Zappi, Ormond Beach FL
Nick A. Zimmerman, Clovis NM

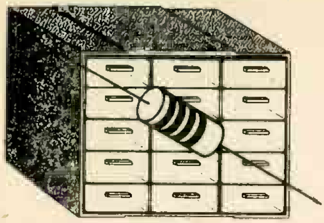
ANNOUNCEMENT

The National Institute for Automotive Service Excellence (NIASE) will offer **tests for certification of automobile mechanics** on May 1, 6, 8, and 10; **heavy-duty truck (including bus) mechanics** on May 1, 6, and 10; and both **body repair** and **painting and refinishing** on May 8, 1980. Test centers are located in about 260 cities across the United States. Applications must be in by March 31, 1980. For a copy of the *Bulletin of Information*, which includes a registration form, sample test questions, and detailed information about the tests, write to NIASE, Suite 515, 1825 K Street, N.W., Washington, D.C. 20006.

Job Ops

Broadcast ADV. Reports of Darby, Pennsylvania is looking for technicians with two years of audio, TV, and video tape recorder experience. NRI graduates interested in making $4.70 per hour may send their resumes to Broadcast ADV. Reports, c/o Jim O'Neill, Chestnut at 5th Street, Darby, Pennsylvania 19023.

Components . . .

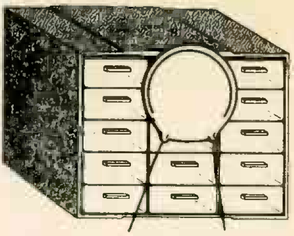


CONAR
RESISTOR ASSORTMENT

- 172 first-quality resistors
- 10%, 1/2 W or better
- 15 drawer cabinet included

$15.95

Stock No. UK28



CONAR
CAPACITOR ASSORTMENT

- 120 top-grade ceramic tubular, ceramic disc, and paper capacitors
- Rated at 400 V or 600 V
- 15 drawer cabinet included

$27.95

Stock No. UK29

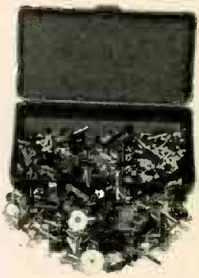
. . . and Hardware!

THE
CONAR
HELL BOX

It's a bargain hunter's delight! Over 1000 nuts, bolts, screws, washers, lugs, and bushings. All types and sizes, literally thrown together in a handy storage box.

$6.50

Stock No. CY501



CONAR
25 DRAWER WORKBOX

Over 3001 pieces in a variety of sizes, the workbox includes:

- Sheet metal screws
- Wood screws
- Machine screws
- Bolts
- Flat washers
- Lockwashers
- Cotter pins
- Finishing nails
- Tacks
- Common nails
- Nuts

$29.50

Stock No. CY25

Free with each 25 drawer workbox! A handy guide to common repairs around the home. Tells how to use basic tools, how to repair screens and leaky faucets, and more.

CONAR COUPON SPECIALS

Clip and Send in this Coupon with your Order

BEARCAT 220
20 Channel Crystalless Scanner

Stock No. EN220 $349

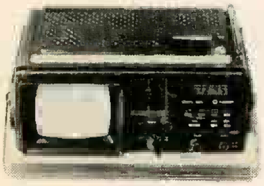
Seven bands – low and high VHF, UHF, UHF-Gov't, UHF-T, 2 meter (Ham), and Aircraft ■ Scan 20 frequencies at once or 2 banks of 10 channels each ■ Advance directly to a desired channel or step 1 channel at a time ■ Search the entire marine or aircraft band with a single button ■ Connectors for external antennas, external speakers, and ac/dc power ■ A separate scan speed control.

SAVE $30 SAVE $30

Coupon Expires May 1

Clip and Send in this Coupon with your Order

WEBCOR'S Portable
Entertainment Center



Stock No. EN51 $229

Wake to alarm AM/FM radio or TV ■ 4-1/2" B/W TV ■ LCD clock ■ Powered 4 ways – 117 VAC, 8 "D"-cell batteries, rechargeable battery pack, 12 V jack for car, boat, etc. ■ Comes with ac cord, earphone, shadow mask, and instruction book.

SAVE $30 SAVE $30

Coupon Expires May 1

Clip and Send in this Coupon with your Order

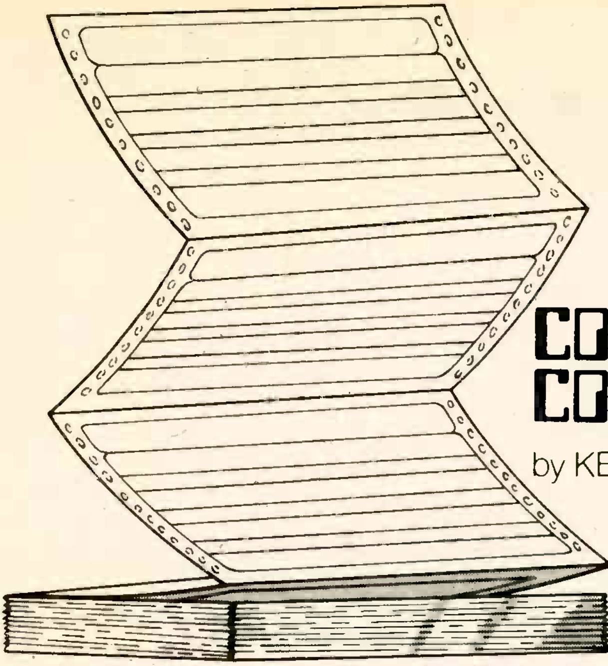
CONAR Model 255 Oscilloscope
in kit form

Stock No. UK255 $195

The Model 255 is ideally suited for color and monochrome TV, AM/FM and transistor radios, hi-fi and stereo amplifiers, plus numerous industrial electronic applications. The Model 255 is 100% solid-state for superior stability, reliability, and ease of maintenance. See the CONAR Electronics Catalog for a complete description.

SAVE $20 SAVE $20

Coupon Expires May 1



COMPUTER CORNER

by KEN BIGELOW

This article, and related articles in later issues of the *Journal*, will be concerned primarily with the Model II Microcomputer. This is the computer offered as part of the new NRI Microcomputer course.

The purpose of this series of articles is to present programs and hardware that can be used with the Model II Microcomputer to perform a wide variety of functions. Most of these applications programs will be short, and many of them will be fully relocatable. In fact, it will be possible to run many of them on other 6800- or 6802-based microcomputer systems. The hardware will be kept as simple as possible, and will always be arranged so that it can be connected directly to the Model II. However, as with the applications programs, the hardware will be readily adaptable to other compatible computer systems.

Figure 1 shows the Model II Microcomputer as it appears when fully assembled, at the conclusion of Training Kit 10MC. However, it is not necessary to complete the computer before using it to run programs. In fact, the student will have an operating computer after completing Training Kit 8MC (the second computer kit). At this point, the computer will appear as shown in Fig.2. Although it may not look as impressive at this stage as the completed Model II, it is already fully capable of running machine-language programs up to 4K (4096 bytes) in length, and of saving and reloading those programs using the built-in cassette interface. In its final form, the Model II can still run the same machine-language programs, but it is also capable of running programs in BASIC, using the built-in BASIC interpreter.

Because the NRI Microcomputer Course is new, no one has yet completed all four kits comprising the computer. Therefore, the remainder of this article will be devoted to a program that

FIGURE 1. THE NRI MODEL II MICROCOMPUTER.

can be run on the computer as it stands following Training Kit 8MC. As more Training Kits are completed, more complex programs and BASIC programs and routines will appear. However, we will also have additional programs that can be run directly on incomplete computers.

USING THE DOUBLE-PRECISION ARITHMETIC PACKAGE

One of the main requirements of almost any program is to perform the basic arithmetic functions of addition, subtraction, multiplication, and division. At the same time, however, a limit of 0 to 255, or −128 to +127, is often too small to be of practical use. Also, it is generally desirable not to have to move both operands to special memory locations to perform the arithmetic operations. All of these problems can be arithmetic package, such as the one shown in the listing at the end of this article.

In order to use the double-precision routines in this package, it is necessary that the operands reside in adjacent locations in memory. The exact locations in memory are unimportant, but

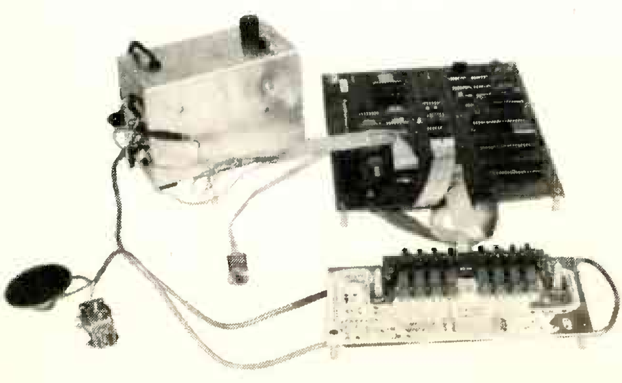


FIGURE 2. THE COMPUTER AT THE CONCLUSION OF TRAINING KIT 8MC.

the order in which the operands appear must be as shown in Fig.3. Furthermore, the index register (X) must contain the address of the high-order byte of the second operand. Then the low-order byte will appear at 1,X. The first operand will be located at 2,X and 3,X. This permits indexed addressing to be used throughout all operations, so that the arithmetic routines do not need to contain specific operand addresses.

The order in which the operands appear is unimportant for addition and multiplication. During subtraction and division, however, it is extremely important that the operands be in the correct sequence. In order to be sure that this requirement is met, it is best to maintain this sequence for all operations. Therefore, when using these routines, make sure that the X register points to the high-order byte of the addend, subtrahend, multiplier, or divisor, as shown in Fig.3. Then the augend, minuend, multiplicand, or dividend should appear in the next two bytes beyond. Also, the high-order byte should precede the low-order byte of each operand. This is consistent with the normal way in which 16-bit numbers are handled by the CPU.

The double-precision routines themselves are as direct and straightforward as possible. For example, the addition routine, DPADDX, first saves the contents of accumulator A on the machine stack. (This is desirable to avoid complicating the calling program, and is necessary anyway, because the multiplication and division routines use DPADDX.) The addition routine then gets the low-order byte of the augend, adds the low-order byte of the addend, and stores the sum in place of the low-order byte of the augend. The next step is to get the high-order byte of the augend and add the high-order byte of the addend. However, the carry

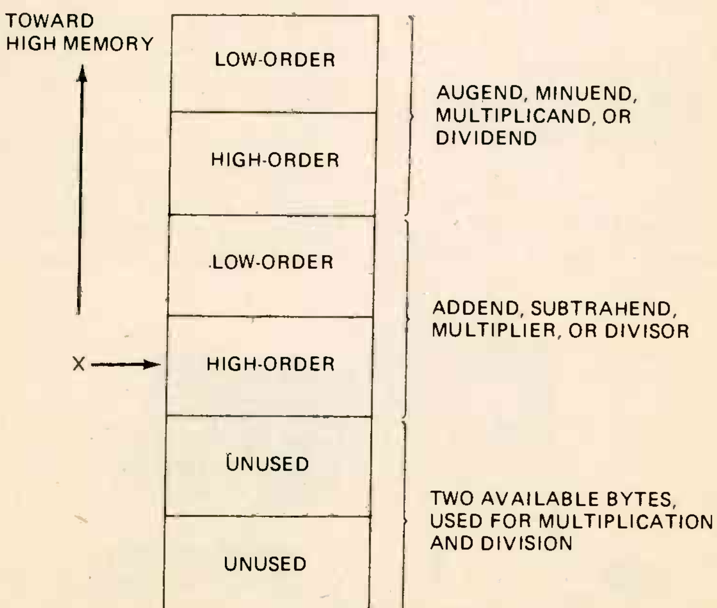


FIGURE 3. THE REQUIRED OPERAND FORMAT FOR THE DOUBLE-PRECISION ARITHMETIC PACKAGE.

generated by the addition of the low-order bytes must be included when adding the high-order bytes. This is accomplished by using the ADC (ADd with Carry), instead of ADD. The carry flag was set or cleared by the ADD instruction, but was not affected by either the STA or LDA instruction. The resulting sum is stored in place of the high-order byte of the augend. Finally, the original contents of accumulator A are recovered from the stack, and control is returned to the calling program. The sum has replaced the augend, and the index register has not been moved.

The double-precision subtraction routine, DPSUBX, is the same as DPADDX except that in this routine, the subtrahend is subtracted from the minuend instead of being added. For this reason, it is essential that the operands appear in the order indicated in Fig.3. When the subtraction process is completed, the difference will have replaced the minuend.

PERFORMING DOUBLE-PRECISION MULTIPLICATION AND DIVISION

Double-precision multiplication is somewhat more complicated than either addition or subtraction. There are several methods that can be used to accomplish multiplication. The easiest way to visualize the process is to consider it as a series of repeated additions. Unfortunately, this process takes the greatest amount of time, and requires extra programming to keep track of any carries out of the double-precision product. This latter process is necessary because the total product of two 16-bit numbers is 32 bits long, and must be accounted for throughout the process.

A second possible method is the shift-and-add process. This is much faster than the repeated addition method. Furthermore, if the multiplicand and product (rather than the multiplier) are shifted, the problem of outgoing carries takes care of itself. However, this method cannot handle negative numbers. Therefore, the signs of the operands must be checked to determine the final sign of the result. The operands must both be made positive (if necessary) before starting. The product might also have to be converted to negative form (if one operand were negative). It would be preferable to use a multiplication method that will work directly with either positive or negative numbers and produce the correct signed product.

The procedure that meets these requirements is known as *Booth's algorithm*. Unlike other multiplication methods, Booth's algorithm looks for transitions between Ø and 1 in adjacent bits of the multiplicand. The step-wise procedure can be stated as follows:

1. Imagining a Ø bit to the right of the LSB of the multiplicand, compare the two rightmost bits, from right to left.
2. If the two bits in question are the same, proceed to Step 5.
3. If there is a Ø-to-1 transition, subtract the multiplier from the product.
4. If there is a 1-to-Ø transition, add the multiplier to the product.
5. Keeping the MSB of the product the same, shift the multiplicand and product one bit to the right.
6. If there are any bits in the multiplicand left to compare, go back to Step 1. Otherwise, stop.

While this procedure requires some thought to understand it thoroughly, it is actually very easy to implement. It runs very fast, and occupies very little memory space. This is the procedure that is used by the double-precision multiplication routine, DPMPYX.

The product generated by DPMPYX is 32 bits long. Therefore, it replaces both the multiplicand and the multiplier, with X pointing to the most significant byte. In order for the product to remain as a double-precision number, the high-order half must be ØØØØ for a positive result, or FFFF for a negative result. Then the double-precision product that replaced the multiplicand will be correct and valid. If any other value appears as the high-order two bytes of the product, an overflow has occurred, so the product is no longer a correct double-precision value.

DPMPYX must actually keep track of six bytes simultaneously. These are the growing product, the diminishing multiplicand, and the complete multiplier. To do this, it assumes that the two bytes immediately below the original multiplier are unused and therefore available. It calls the subroutine DPMVOP to decrement X twice and move the multiplier down two bytes. DPMVOP then clears the original multiplier to start with a zero product, and initializes accumulator B to the shift count of 16.

When the multiplication process is complete, the index register is incremented twice to restore it to its original value, and the original contents of the two accumulators are restored before control is returned to the calling program.

Division can be performed by either a repeated subtraction method or by an alternate shift-and-subtract method. The latter method is preferred, not only because it is faster, but because it will not lock up if division by zero is attempted. In such a case, it returns a quotient of FFFF and a remainder equal to the original dividend. Such a result can easily be used to detect an illegal operation.

Unfortunately, there is no known equivalent to Booth's algorithm that will operate for division. Therefore, the double-precision divide routine, DPDIVX, uses the alternate shift-and-subtract approach. This makes the routine relatively fast, but does preclude the use of signed numbers; both dividend and divisor must be positive numbers. If they are negative, they will be treated as unsigned binary numbers, for which an unsigned binary quotient and remainder will be generated. These results will be correct, provided that the calling program treats them as unsigned binary numbers.

As with DPMPYX, DPDIVX must keep track of six bytes. These include

About the Author

Ken Bigelow joined us in 1969. Since then, Ken has served NRI in a number of capacities. Most recently, he wrote the experiments for the Microcomputer course, and is interested in expanding its capabilities as much as possible.

"This series of articles is aimed at presenting a variety of applications programs, as well as various ideas for hardware expansion. I'm eager to give new ideas a try, so be sure to drop me a line with your suggestions."

the growing quotient, the diminishing dividend (which will eventually become the remainder), and the complete divisor. Therefore, DPDIVX, like DPMPYX, calls DPMVOP as soon as the contents of the two accumulators have been saved. Then accumulator A is cleared to initialize the quotient bit. The dividend and cleared bytes are shifted one bit to the left in preparation for the first trial subtraction. DPSUBX is called to perform the trial subtraction. If it is successful, there will be no borrow bit upon return from DPSUBX. Therefore, the SBC A #$FF instruction will leave Ø1 in accumulator A. On the other hand, if the result of the subtraction is negative, indicating a failure, the carry flag will be set to indicate a borrow. In this case, the SBC A #$FF instruction will leave ØØ in accumulator A. Thus, accumulator A will contain the correct quotient bit generated by the trial subtraction. If this bit is Ø, the divisor must be added back to the dividend to cancel the subtraction.

In either case, the new quotient bit is added to the growing quotient. Then the shift count is decremented. If the shift count is not zero, the partial quotient, dividend, and cleared space are again shifted left one bit, and the process is repeated.

Finally, as with DPMPYX, the index register is restored to its initial value, and the two accumulators are restored before control returns to the calling program. The quotient has replaced the dividend and the remainder has replaced the divisor. The index register points to the remainder.

APPLICATIONS

All of the double-precision routines are written using only indexed and relative addressing. No monitor or ROM routines are required at any time. As a result, this double-precision arithmetic package is totally relocatable. That is, although it is shown as starting at address 3FØØ, it can easily be moved to any other location in memory, and will run there without being modified. Furthermore, the same double-precision package can be used on any other computer that uses a 6800 or 6802 microprocessor as its CPU, without any modification. However, when this program is moved to another location or machine, it must be moved as a single block of 112 bytes. The internal sequence of routines must not be changed, or the routines will not work properly.

In order to use any of the double-precision routines, it is only necessary for the calling program to place the two operands, in the proper sequence, into four successive memory locations, and then set X to the first memory location. Then a JSR to the starting address of the appropriate routine will cause the desired operation to be performed. The index register will be unchanged upon return from the subroutine, so indexed addressing can immediately be used by the calling program to recover the result for use within that program.

The applications for these routines are limited only by your imagination. A few typical applications would be ordinary mathematical calculations, determining the memory space required by a memory array of any number of dimensions, or calculating memory offsets. Of course, any variation on these or any number of other applications may still call for these routines. You may also find that variations on these routines will be helpful in a given program.

In future issues of the *Journal*, I'll continue to discuss applications programs, as well as hardware expansions and applications for the Model II Microcomputer. Meanwhile, if you have any ideas you'd like to share, please let me know. Write to me at NRI, 3939 Wisconsin Ave., Washington, D.C. 20016.

PROGRAM
DOUBLE-PRECISION ARITHMETIC PACKAGE
BY
DATE

PAGE 1

Location	B1	B2	B3	Label	OP	ACC	Operand	Comments
3FØØ	36			DPADDX	PSH	A		DOUBLE-PRECISION ADD.
1	A6	Ø3			LDA	A	3,X	
3	AB	Ø1			ADD	A	1,X	ADD LOW-ORDER BYTES.
5	A7	Ø3			STA	A	3,X	
7	A6	Ø2			LDA	A	2,X	
9	A9	ØØ			ADC	A	Ø,X	ADD HIGH-ORDER BYTES, WITH
B	A7	Ø2			STA	A	2,X	CARRY FROM LOW ORDER.
D	32				PUL	A		
E	39				RTS			SUM REPLACES AUGEND.
F	36			DPSUBX	PSH	A		DOUBLE-PRECISION SUBTRACT.
1Ø	A6	Ø3			LDA	A	3,X	
2	AØ	Ø1			SUB	A	1,X	SUBTRACT LOW-ORDER BYTES.
4	A7	Ø3			STA	A	3,X	
6	A6	Ø2			LDA	A	2,X	
8	A2	ØØ			SBC	A	Ø,X	SUBTRACT HIGH-ORDER BYTES,
A	A7	Ø2			STA	A	2,X	WITH BORROW FROM LOW ORDER.
C	32				PUL	A		
D	39				RTS			DIFFERENCE REPLACES MINUEND.
3F1E	36			DPMPYX	PSH	A		DOUBLE-PRECISION MULTIPLY.
F	37				PSH	B		USES BOOTH'S ALGORITHM.
2Ø	8D	33			BSR		DPMVOP	MAKE SPACE FOR FULL PRODUCT
2	8D	42		DPMPY1	BSR		SH4R2X	SHIFT PRODUCT AND MULTIPLICAND.
4	2B	2A			BMI		DPMD9	QUIT IF LAST SHIFT.
6	24	FA			BCC		DPMPY1	C = Ø MEANS NO CHANGE.
8	8D	E5			BSR		DPSUBX	Ø TO 1 CHANGE: SUBTRACT.
A	8D	3A		DPMPY2	BSR		SH4R2X	SHIFT PRODUCT AND MULTIPLICAND.
C	2B	22			BMI		DPMD9	QUIT IF LAST SHIFT.
E	25	FA			BCS		DPMPY2	C = 1 MEANS NO CHANGE.
3Ø	8D	CE			BSR		DPADDX	1 TO Ø CHANGE: ADD.
2	2Ø	EE			BRA		DPMPY1	GO BACK AND SHIFT.

PROGRAM: DOUBLE-PRECISION ARITHMETIC PACKAGE

PAGE 2

BY: DATE:

Location	B1	B2	B3	Label	OP	ACC	Operand	Comments
4	36			DPDIVX	PSH	A		DOUBLE-PRECISION DIVIDE.
5	37				PSH	B		USES SHIFT-AND-SUBTRACT.
6	8D	1D			BSR		DPMVOP	MAKE SPACE FOR REMAINDER.
8	4F			DPDIV1	CLR	A		CLEAR QUOTIENT BIT.
9	68	Ø5			ASL		5, X	SHIFT QUOTIENT AND
B	69	Ø4			ROL		4, X	DIVIDEND LEFT ONE BIT.
D	69	Ø3			ROL		3, X	
F	69	Ø2			ROL		2, X	
41	8D	CC			BSR		DPSUBX	MAKE TRIAL SUBTRACTION.
3	82	FF			SBC	A	#$FF	IF NO BORROW, IT SUCCEEDED,
5	26	Ø2			BNE		DPDIV2	AND QUOTIENT BIT IS 1.
7	8D	B7			BSR		DPADDX	ELSE, ADD DIVISOR BACK.
9	AB	Ø5		DPDIV2	ADD	A	5, X	INSERT LATEST QUOTIENT BIT.
B	A7	Ø5			STA	A	5, X	
D	5A				DEC	B		COUNT OFF ONE CYCLE.
E	26	E8			BNE		DPDIV1	REPEAT UNTIL DONE.
5Ø	Ø8			DPMD9	INX			RESET X AND
1	Ø8				INX			
2	33				PUL	B		RECOVER <A> AND <B>.
3	32				PUL	A		QUOTIENT REPLACES DIVIDEND,
4	39				RTS			REMAINDER REPLACES DIVISOR.
3F55	Ø9			DPMVOP	DEX			OPEN A CLEAR SPACE FOR
6	Ø9				DEX			EITHER THE REMAINDER
7	A6	Ø2			LDA	A	2, X	OR THE HIGH-ORDER HALF
9	A7	ØØ			STA	A	Ø, X	OF THE PRODUCT.
B	6F	Ø2			CLR		2, X	
D	A6	Ø3			LDA	A	3, X	
F	A7	Ø1			STA	A	1, X	
61	6F	Ø3			CLR		3, X	
3	C6	1Ø			LDA	B	#16	SET SHIFT COUNT.
5	39				RTS			
6	67	Ø2		SH4R2X	ASR		2, X	SHIFT PARTIAL PRODUCT
8	66	Ø3			ROR		3, X	AND MULTIPLICAND RIGHT
A	66	Ø4			ROR		4, X	ONE BIT.
C	66	Ø5			ROR		5, X	
E	5A				DEC	B		COUNT OFF ONE SHIFT.
F	39				RTS			

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