ET/D

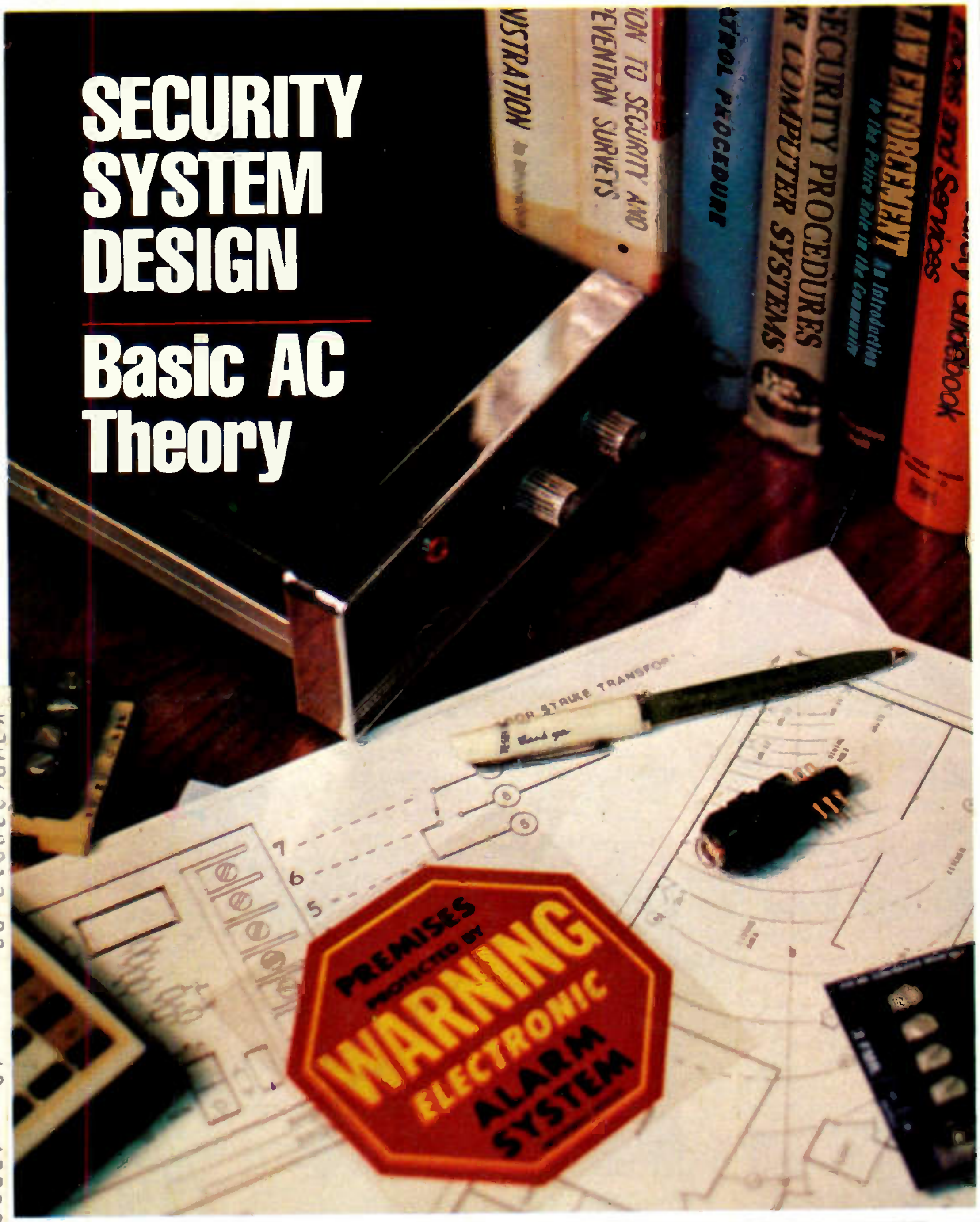
MARCH 1981 • $1.50

ELECTRONIC TECHNICIAN/DEALER

LEADING THE CONSUMER AND
INDUSTRIAL SERVICE MARKETS

SECURITY SYSTEM DESIGN

Basic AC Theory

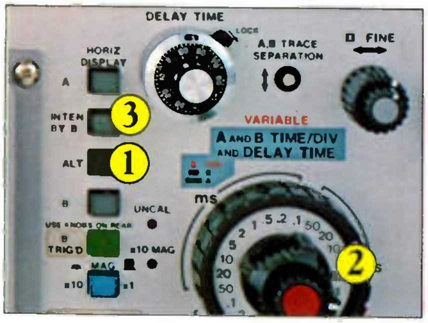


HBJ A HARCOURT BRACE JOVANOVICH PUBLICATION

No other 50-MHz oscilloscope gives you as many features as the LBO-517.

Compare the LBO-517 with all other 50-MHz oscilloscopes. Only Leader gives you total capability with:

- Calibrated delayed time-base
- Simultaneous display of main and delayed time-bases.
- Two trigger-view channels.
- 1 mV sensitivity (<10-MHz).
- Alternate/composite triggering.
- Variable trigger hold-off with B-ends-A mode.
- 20 kV accelerating potential dome-mesh CRT.
- Two-year warranty.



Very low-level signals, complex waveforms, fast pulses at low rep rates, asynchronous signals...no other 50-MHz oscilloscope handles such a wide range of demanding applications, and does it so well as the Leader LBO-517.

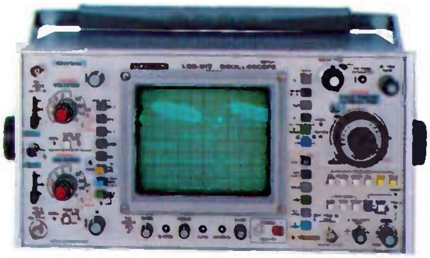
Simultaneous Dual Time Base Viewing.

Unlike many other 50-MHz units, the LBO-517 has an alternate time-base mode, (1) above. This permits simultaneous viewing of both the main "A" and delayed "B" time bases (2). The delayed time-base is also shown as an intensified portion of the main time-base display (3). Ideal for studying and measuring complex waveforms.

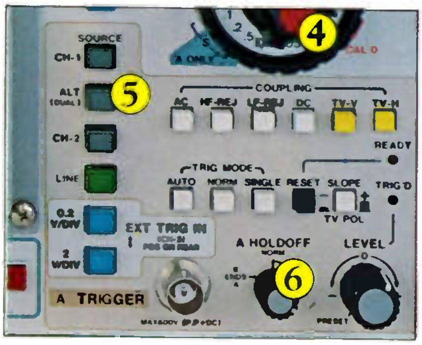
Fast Sweep Rates, Alternate Triggering, Hold-off and B-ends-A Mode.

The LBO-517 provides main sweep rates from 0.5 sec/cm to 0.05 µsec/cm in 22 steps (4). Delayed sweep rates are from 0.1 sec/cm to 0.05 µsec/cm in 20 steps. For displaying very rapid phenomena, both can be increased to 5 nsec/cm with the X10 magnifier.

The LBO-517 also offers alternate (composite) triggering (5) for stable viewing of two asynchronous signals, along with variable trigger hold-off with a B-ends-A mode (6). Variable hold-off ensures stable triggering of complex signals by ignoring intermediate false trigger points. B-ends-A is used to increase the sweep repetition rate for brighter displays of low-frequency signals.



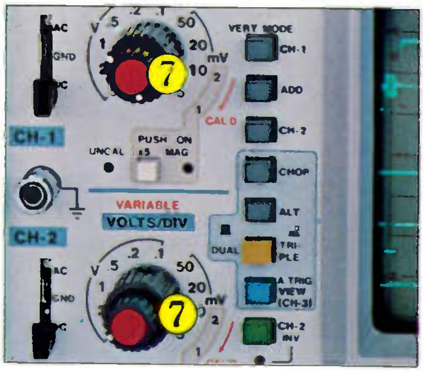
It's the surprising leader for under $2000.



Outstanding Small Signal Performance.

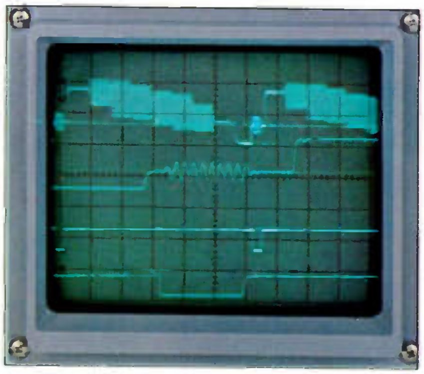
The vertical amplifiers of the LBO-517 offer calibrated deflection coefficients from 5 mV/cm to 5 V/cm in 10 steps (7). A X5 vertical multiplier delivers a maximum sensitivity of 1 mV/cm up to 10 MHz...5 times the sensitivity of more expensive oscilloscopes.

An amplified output of channel 1 is also available at a rear panel BNC connector for using the LBO-517's high sensitivity to drive frequency counters and other less sensitive instruments.



Brightest, Sharpest of All.

The LBO-517 uses a recently developed dome-mesh CRT operating with a 20-kV accelerating potential. The result is an exceptionally bright, sharp display...with an illuminated internal graticule.



Call Toll Free (800) 645-5104.

Call today, to get all the facts on the LBO-517, its two-year warranty, the name of your nearest "Select" distributor, or to arrange for an evaluation unit.

When Quality Counts

LEADER Instruments Corporation

380 Oser Avenue
Hauppauge, N.Y. 11787 (516) 231-6900
Regional Offices:
Cincinnati, Los Angeles, Dallas.

Circle No. 101 for Information Circle No. 102 for FREE demonstration

INDUSTRY REPORT

1980 Television, Home Video Tape Recorder Sales High; Color Television Sales Are Second Highest In History

Total United States market sales to retailers of television receivers and home video tape recorders were a bright segment of the economy in 1980 and reflected the strong growth of the home video industry.

Year-end statistics compiled by the Marketing Services Department of the Electronic Industries Association's Consumer Electronics Group place 1980 sales of color television receivers at 10,162,276 units, up 3.2 percent over 9,846,487 units sold in 1979 and second best industry sales to the record 10,236,319 units sold in 1978. December sales of color television totaled 1,217,156 units.

Industry sales of monochrome television receivers in 1980 were 6,285,516 units, up 0.5 percent over the 6,254,601 units sold in 1979. Sales of monochrome TV in December were 841,550 units.

Total television sales of 16,447,792 units in 1980 were the highest since 1972 when 16,523,217 units were sold. December sales of total television amounted to 2,058,706 units.

Home video tape recorder sales of 804,663 units in 1980 were 69.3 percent above the 475,396 units sold in 1979 and were the highest since the EIA/CEG, CEG PR-7 national trade association for consumer electronics manufacturers, started tracking VTR sales in 1978. VTR sales in December were 122,980 units.

The industry marketing statistics schedule for 1980 and 53 reporting weeks compared to 52 weeks in the 1979 calendar. The additional week was required to keep the sales reporting schedule, with Friday cut-offs, in line with the calendar. The 53rd week appears in the statistical schedule every six or seven years.

NAB Radio Board Opposes 9kHz AM Channel Spacing

The National Association of Broadcasters' Radio Board passed the following resolution at its meeting January 28, at the Camelback Inn, Scottsdale, AZ.

"Whereas the National Association of Broadcasters continues to be concerned that the FCC has made a decision on reducing AM channel spacing from 10kHz to 9kHz prior to conducting studies showing the impact on the public and broadcasters of such a proposal, and;

"Whereas the NAB commissioned extensive technical and economic studies which have documented the very real deficiencies associated with reduced channel spacing such as increased interference, decreased service area, and disadvantages to consumers through disruptions in service and receiver obsolescence and direct financial costs to the broadcasting industry in implementing such changes, and;

"Whereas the FCC's own Task Force on 9 kHz spacing stated that the burden of proof of changing the present system of AM channel spacing 'rests more on those who advocate change than those who defend the status quo.' Yet the Commission has not conducted studies on such basic factors as the matter of interference which would be caused by a 9 kHz spacing system. Based on the results of the studies commissioned by the NAB, the Canadian Association of Broadcasters, and others, it is clear that the burden of change to 9kHz has not been met and, indeed, the costs to the public, the industry and our national interest of reduced channel spacing far outweight the benefits;

"Therefore the NAB Radio Board opposes the shift of AM channel spacing from 10kHz and urges the U.S. govern-

ET/D

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March 1981, Vol. 192, No. 6

FEATURES

On the cover: The design of a security system must consider both cost and system effectiveness. The cover shows some of the tools of design used in the system described in this month's lead feature.

DEPARTMENTS

HBJ A HARCOURT BRACE JOVANOVICH PUBLICATION ABP ABC EIA

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ment to retain 10 kHz as the AM spacing system in the U.S. and in Region 2."

Montgomery Ward To Market RCA's 'CED' Videodisc System

RCA recently welcomed a decision by Montgomery Ward & Co. to market the RCA "CED" (capacitance electronic disc) video disc system in its national chain of retail stores.

In a statement, RCA said:

"We welcome the adoption of RCA's "CED" system by Montgomery Ward, one of the largest retail firms in the United States. We believe that this additional support for our "CED" system will help assure an even stronger introduction of this major new consumer product to the public in 1981."

Montgomery Ward joins CBS, Zenith, Sears, J.C. Penney, Hitachi, Radio Shack, Sanyo and Toshiba—companies which have also announced their intention to market the RCA "CED" system.

The RCA "CED" VideoDisc system will be offered by television receiver brands representing nearly 60 percent of the U.S. color TV business.

New Test Equipment Marketer Formed

Robert J. Liska, formerly of VIZ Manufacturing and previous to that manager of RCA's test equipment operations, recently announced the formation of North American SOAR Corporation. Located in Cherry Hill, New Jersey, N.A. SOAR will market the products of Soar Corp. of Japan. The SOAR product line includes analog and digital multimeters, oscilloscopes, power supplies, pulse generators and other instruments. N.A. SOAR is expected to be in operation about mid March.

Winegard Technical Meeting

Winegard Television Systems announces a MATV technical sales meeting to be held March 9, 10, & 11 at the Holiday Inn in Burlington, Iowa. The fee for the meeting is $50.00 and will include lunch, classroom supplies, and coffee breaks. Topics of discussion will include new products and applications, home & small MATV systems, TV reception problems, low signal problems, commercial MATV, plus others. Write Winegard Television Systems, 3000 Kirkwood St., Burlington, Iowa 52601, Attn: Technical Services Department, for full information and registration form.

ETA-I Announces Four Meetings

The Electronics Technicians Association International has announced the dates and locations for three regional technician seminars and its annual convention.

Each of the four conferences feature product displays and test equipment demonstrations; servicing seminars and business management training. Technicians can attend sessions on Satellite TV reception; Spectrum Analyzers; Current Probes; Video Disc Players; Home Security Systems and tips on improving their careers and finding higher paying jobs. Business Management School attendees will receive training in finance, accounting, use of small computers for service shops, and tips on improving communications with employees and customers.

The first regional school takes place in St. Louis on April 10th and 11th. It is followed by an April 17-18 event held in conjunction with the 26th Annual Convention of the Indiana Electronic Service Association in Evansville, Indiana. The third big weekend takes place in Houston, Texas and is hosted by the ETA Houston Chapter. It will be followed by a dance and a western barbeque.

On July 9, 10, and 11 ETA will conduct its third annual convention on the campus of Iowa State University in Ames.

Fees for the schools are set at $40 for members or nonmember technicians or business owners and $20 for students of electronics. For more information about local scheduling contact: St. Louis, Vince Lutz, 314-381-9944; Evansville, Leon Howland, 317-357-8392; Houston, DC Larson, 713-686-6545; Ames, Ron Crow, 515-294-5060; or write to ETA-I, 7046 Doris Drive, Indianapolis, IN 46224, 317-241-7783. ETD

LETTERS

ON CABLE:

Your article in the December issue of ET/D magazine commenting on the potential and real dangers involved with CATV monopolies, hit the nail on the head.

In Rhode Island we are presently involved with a CATV franchise being introduced for the greater Providence area. The E.T.G. of Rhode Island is attending the public hearings and fighting for the protection of our industry and the consumer.

All the dangers, you mentioned, of CATV controlling the sales and service of television sets, is likely to occur unless we are protected by law.

There is another danger to the consumer, if and when the CATV companies gain control of a large segment of the viewing public, they will most likely buy the broadcasting rights of sports and other entertainment programs presently being paid for by advertising. It's conceivable, and likely, with monopoly power, that CATV could and would charge a fee for each boxing event, ball game etc., and reduce the relatively free T.V. programing to game shows and old movie re-runs.

Money talks and politicians listen to its voice.

But, for those of us who still believe in a system of the people, by the people and for the people, then we the people must speak up, we must kick political behinds, we must do whatever is necessary to protect ourselves or we will be surely crushed under the power of monoply and we the people will suffer.

We the people of the E.T.G. of Rhode Island will do all we can to protect our industry and fellow citizens in this matter. I hope the battle won't be a lonely one, because the stakes are high and the ignorance of the general public is large.

Charles Whittaker
Vice-President
E.T.G. of Rhode Island
367 Smith Street
Providence, RI 02908

TALKING BOOKS:

I am in need of a way to play Talking Book records.

Quite a number of years ago, there was a device on the market that would set on the table of a record player. The player table could be set for 33 1/3 R.P.M. and the gear arrangement that drove the top table then would only run 16 2/3 R.P.M. This device worked well for these slow records.

The new record players, most of them are only playing 33 1/3 and 45.

Would like to hear from someone that has one for sale or a company that has this device for sale.

John A. Olt
1822 N.W. "A" Street
Richmond, IN 47374

SECURITY FEEDBACK:

To James Ross:

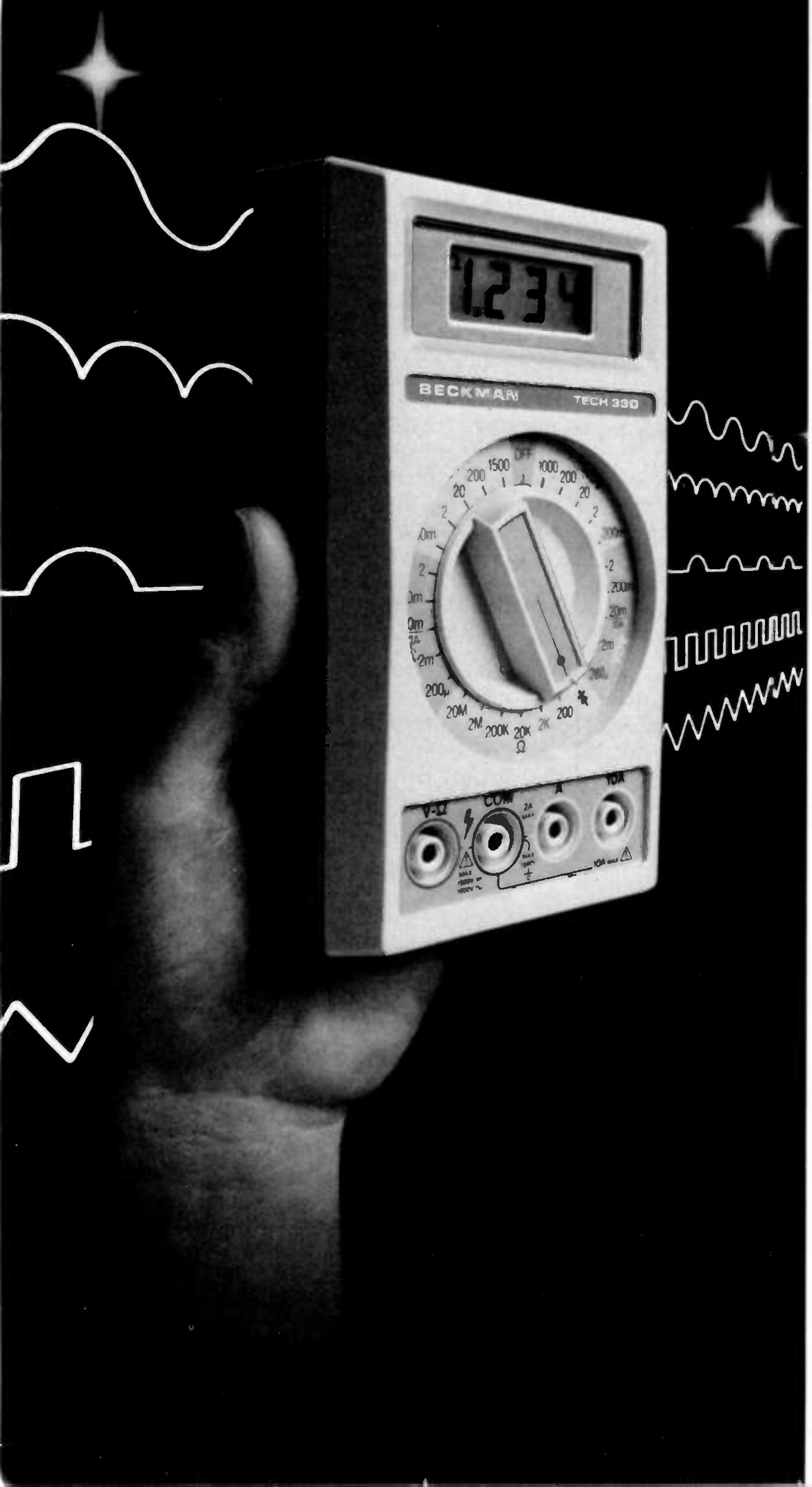
I am very pleased to see the starting of your series on "Security Electronics" in Dec. issue of ET/D magazine.

I am responding to your request to write for further information.

As with most shops facing a declining service volume, I am looking for ways to diversify my operation. I have considered adding the sale, installation and service of security equipment, to my business.

The one thing that has deterred me from going ahead is the possibility of lawsuits where burglars have managed to defeat the system which was installed.

Beckman brings a new dimension to hand held Digital Multimeters



True RMS capability at an affordable price

Now you can measure the exact power content of *any signal* – regardless of waveform. Beckman delivers the new TECH™ 330 multimeter with true RMS capability and many more fine performance features for just $210.

Unlike most multimeters calibrated to read only the true power content of sine waves, the TECH 330 extends its true RMS capability to give you accurate readings of both sine and non-sine waveforms.

True RMS makes a significant difference in accuracy when measuring switching power supplies, flyback power circuits, SCR or TRIAC controlled power supplies or any other circuit generating a non-sine signal.

The TECH 330 also accurately measures the entire audio band up to 20 kHz. But that's not all you can expect from Beckman's top-of-the-line multimeter.

Measurement Comparison Chart

Waveforms (Peak = 1 Volt)	Average Responding Meter	Beckman TECH 330	Correct Reading
Sine Wave	0.707V	0.707V	0.707V
Full Wave Rectified Sine Wave	0.298V	0.707V	0.707V
Half Wave Rectified Sine Wave	0.382V	0.500V	0.500V
Square Wave	1.110V	1.000V	1.000V
Triangular Sawtooth Wave	0.545V	0.577V	0.577V

You also get 0.1% basic dc accuracy, instant continuity checks, 10 amp current ranges, a separate diode test function, 22 megohm dc input impedance, and an easy-to-use rotary switch.

With so much capability in hand, you'll be able to depend on the TECH 330 for a long time. That's why Beckman designed it tough enough to go the distance.

Enclosed in a rugged water-resistant case, the TECH 330 can take a 6-foot fall onto concrete and still perform up to spec. And to further ensure reliable, trouble-free operation, the TECH 330 gives you 1500 Vdc overload protection, RF shielding, 2000-hour battery life, gold switch contacts, and fewer electronic components to worry about.

Add another dimension to your world of electronics. Visit your Beckman distributor today for more information on the TECH 330 and Beckman's complete line of digital multimeters, starting at $120.

For your nearest distributor, or a free brochure:

CALL TOLL FREE
24 HOURS A DAY, 7 DAYS A WEEK
1-(800)-821-7700 (ext. 517)
in Missouri 1-(800)-892-7655 (ext. 517)

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I would appreciate if you would address this particular situation and advise how one might avoid litigation, should a successful burglarly occur, after a proper installation has been made.

Any further information that you might send me on successfully entering the security business, will be appreciated and I will certainly be following your continuing articles in ET/D.
D. Bernard Fritz
Fritz Radio & Television Service
3210 St. Lawrence Avenue
Reading, PA 19606

HELP NEEDED:
I need a horizontal output transformer for a MGA color TV Chassis CH 120. The part number is 334 PO 3402. MGA cannot supply.
F. E. Sylverne
Aetna Electronics Corp.
1488 Albany Ave.
Hartford, CT 06115

I enjoy your magazine very much and get many helpful hints from the articles. Having moved into the world of VCR service, I hope you will be able to have more articles on the nitty-gritty of VCR problems, especially on VHS machines, which seem to be overlooked by most publications.

Would appreciate very much if you would print the following request for schematics and operating instructions that cannot be obtained from the manufacturers.

Would like to buy or copy schematics for the Ashin AS-700 AM, FM, Cassette car stereo and Sprague TO-5 Capacitor Analyzer. Also need schematic and operating data for the Testline 101 Transistor Curve Tracer.
A. F. Kuschner
3340 Turtle Mound Rd.
Melbourne, FL 32935

I desperately need a schematic/service manual for a model T0901C Toshiba TV set. I looked everywhere for one and have had no luck. I even wrote to Toshiba America, Inc. and they advised me that once a particular model exceeds 7 years of age they are no longer available. Any help from any reader will be greatly appreciated.

Thank you.

Keep up the good work with your magazine. I enjoy receiving it every month.
Albert Flori
95 Legion Way, Cranston, RI 02910

FROM THE EDITOR'S DESK

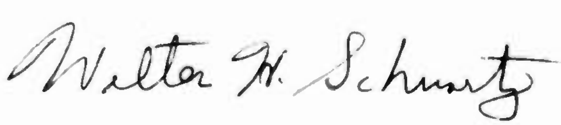
Personal computers (and small business computers) apparently had a modest prominence at the winter Consumer Electronics Show (January 8-11, at Las Vegas). Quite a variety are available and the prices start at about $200 for the most basic machine. Up to now I have wondered what the average person would do with one. I, at least, felt it would be as easy to balance my checkbook with a calculator as to program a computer and make the computer entries; my wife can find her recipes as easily in her shelf of cookbooks as to search a computer memory. Besides how much memory do you need to hold forty cookbooks? And they do fall open to certain favorites anyway.

But now the situation is beginning to change in exciting ways. There has been for some time good reason, prices being what they are, for many small business uses of computers, for bookkeeping, inventory control, etc., and now I am finding real reasons for home computers. Several companies are offering, via telephone and soon via cable TV cables, access to a wide variety of data bases and I am convinced that there will be a tremendous expansion of this sort of service in the next few years. And the costs should be moderate. One such company now states that it offers access to over 2000 data bases, business, technical, news, games, etc., and for an off-hours cost of under $3 per hour. (Cost during business hours is $15 per hour.) Last spring Sylvania was setting up a data base a technician could access thru his computer via the telephone and check factory analysis of assorted troubleshooting problems. This could be a tremendous asset to your shop, if each manufacturer provided such access to a troubleshooting data base.

For the home, news, general information (the extinction of the printed encyclopedia?), income tax help, games, various types of educational programs—the list is endless—are and can be available—and can be displayed on a quite basic computer CRT terminal.

What does this mean for you? Start looking to those companies looking for dealers or service. Some industry spokesmen feel the 1981 sales of under $10,000 dollar computers could reach $10 billion. That's a lot of sales—it rivals television—and someone has to sell and service them. I do not think the organization to handle it exists today. Learn to understand small computers, keep an eye on the opportunities that will arise. Although the average home will not treat its computer as a computer, but will use it to have access to information, it is going to be a tremendous factor in consumer electronics during the early 80's.

Sincerely,



Two New Portable Instruments From Simpson

Compare the Specs! Compare the Price!

MODEL 454 3" DUAL TRACE TRIGGERED SWEEP SCOPE

- DC to 15 MHz bandwidth, 5 mV/div. sensitivity, 100 nsec/div. (X5) to .5 sec/div. sweep range
- Differential amplifiers provide stable, clean waveforms
- Voltage calibrated vertical and horizontal input attenuators
- 100 KHz chopping rate for low-speed waveforms
- Alternate mode automatically selected on high sweeps
- 24 nsec rise time, 0.5 V P-P calibrator
- Displays CH A, B, A and B, A + B, A − B, X and Y
- External, CH A or CH B triggering, TV sync
- Compact 4-5/8 x 9-7/8 x 13-1/4", weighs 13 lbs.
- Two low-cap. X1/X10 probes included

MODEL 420 FUNCTION GENERATOR

- Provides sine wave, triangle wave, square wave and DC voltage output
- Fixed TTL output drives up to 10 TTL loads
- Wide frequency coverage of 0.1 Hz to 1 MHz in 7 ranges
- Voltage-controlled generator input for sweep signals
- Continuously variable DC offset control with convenient Off position
- Model 420D provides full day's operation on batteries*, and it can also be recharged overnight. The instrument can be operated from AC line voltage without the batteries installed. *Batteries not supplied.
- Compact 2.7 x 8.4 x 9" unit matches our DMM styling
- Adjustable tilt-view handle

Simpson
INSTRUMENTS THAT STAY ACCURATE

SIMPSON ELECTRIC COMPANY
853 Dundee Avenue, Elgin, Illinois 60120
(312) 697-2260 • Cable SIMELCO • Telex 72-2416
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KATY INDUSTRIES
ELECTRICAL EQUIPMENT AND PRODUCTS GROUP

Circle No. 107 on Reader Inquiry Card

MOST TV MANUFACTURERS COMMITTED TO VIDEO DISCS. Over 87% of the TV industry, based on market share has now adopted a video disc system. According to Television Digest the situation stacks up this way: (CED is RCA's system, LV is the Philips-MCA Laservision system and VHD is the Matsushita system.)

Rank	Brand	Share	Disc System	VCR
1.	RCA..........	21.0%	CED	VHS
2.	Zenith.......	20.5%	CED	Beta
3.	GE...........	7.5%	VHD	VHS
4.	Sears........	7.5%	CED	Beta
5.	Magnavox.....	7.0%	LV	VHS
6.	Sony.........	6.5%	u	Beta
7.	Quasar.......	5.0%	VHD	VHS
8.	Sylvania.....	4.0%	LV	VHS
9.	Mont. Ward...	2.25%	CED	VHS
10.	Panasonic....	2.0%	VHD	VHS
11.	Sanyo........	2.0%	CED	Beta
12.	Hitachi......	1.7%	CED	VHS
13.	Penney.......	1.5%	CED*	VHS
14.	Sharp........	1.5%	CED	VHS
15.	Philco.......	1.2%	LV	VHS
16.	MGA..........	1.0%	u	VHS
17.	C. Mathes....	1.0%	u	VHS
18.	Toshiba......	1.0%	CED	Beta
19.	JVC..........	n.a.	VHD	VHS
20.	Gold Star....	n.a.	LV	VHS
21.	Advent.......	n.a.	LV	Beta
22.	Pioneer......	0	LV	--
23.	Radio Shack..	0	CED	--
24.	Fisher.......	0	LV	Beta
25.	Sansui.......	0	VHD**	--
26.	Samsung......	n.a.	LV	VHS

System	No. Brands	Color Mkt. %
CED	10	59.0
LV	8	13.2
VHD	5	15.0
unknown	--	12.8

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*To sell RCA brand at start. **May adopt CED.

Circle No. 108 on Reader Inquiry Card →

"Here's great news for electronics enthusiasts on small budgets.

Now you can take home a Fluke DMM for $125*."

Whether you're just starting out in electronics or moving up from an analog VOM to a digital multimeter, you'll be smart to make sure that you're getting your money's worth.

In your search for a basic-performance DMM, be sure to consider the new D 800 from Fluke. Priced at only $125,* this dependable six-function handheld DMM is available now at select electronics supply stores throughout the U.S.

The D 800 offers 0.5% basic dc accuracy (five times better than analog voltmeters), a razor-sharp 3½-digit LCD readout, unsurpassed overload protection, and true, one-hand operation.

This hard-working basic measurement multimeter is designed from the inside out for long life and reliability. All D 800 specifications are traceable to the National Bureau of Standards.

As part of Fluke's new Series D line of low-cost digital multimeters, the D 800 carries a limited one-year parts and labor warranty and comes complete with the battery, and safety-designed test leads.

Ask your supplier about the D 800, then compare it feature-for-feature with any other low-cost DMM. You'll find that for only $125,* there's never been more multimeter than the new D 800 from Fluke.

From the world leader in DMM's. Now we've designed one for you.

*Suggested U.S. list price

If your dealer doesn't carry Series D Multimeters yet, call this number. We'll be happy to tell you who does. 1-800-426-9182

FLUKE

SERVICE SEMINAR

MAGNAVOX

Color TV Chassis T809—Schematic Error, make the following correction to the T809 Color TV Chassis schematic in service manual 7358, Section 4.1. Locate the regulator module section on the schematic and change pin 4 (shown at upper left corner of module block) to read pin 14. Pin 14 on the regulator module connects to W4 and W6 on the mother board. Pin 4 (located at lower right corner of regulator module block) connects to TP6 on the mother board.

RCA

Color TV Chassis 14CTC53F, No color—incorrect voltage on V4A (2nd chroma band pass amp.). To correct: Replace R22 (390 ohm 1/2 w resistor) resistor—may have changed value. Emmet Mefford, CET, Fontana, CA.
Color TV Chassis CTC90, Horizontal bars in video—two jagged hum bars about 8 inches apart rolling slowly upward on screen. To correct: Replace T201 (27 volt) start up transformer. Roger Varn, Massillon, OH.

SANYO

Color TV Chassis 31C38, Insufficient vertical height—picture shrunk at bottom of screen. To correct: Replace defective capacitor C259, 47 mfd @ 16 volts. Calvin Detherow, Little Rock, AR.

SHARP

B&W TV Chassis 3K-73B, No audio, no raster—R709 overheating. To correct: Repair broken tap on horizontal hold coil (or replace). Also replace R709, horizontal output, and horizontal osc. transistor. Kenneth D. Simmons, Sr., Gravel Ridge, AR.

SYLVANIA

Color TV Chassis D19, Blooming occurs when color control is turned up—To correct: Replace L609 (choke) open. Poor linear top stretch, bottom full but could use more height—To correct: Replace C328 (.027 mfd capacitor) shorted. **Chassis E08,** Tripler shorting out every few days or weeks—To correct: Replace R996 (330 ohm resistor) up in value. **Chassis E48-3,** Remote keeps running and skipping all channels, also snowy on all channels—To correct: Q1201 shorted. Replacing stops it from running and skipping channels. Q86 shorted, replacing it eliminated snow. Charlie Boudreau, Providence, RI.

A Super TV Pattern Generator
Here's a kink that may prove valuable if you need a NTSC or other expensive or not readily available pattern for video testing. We cannot vouch for the absolute quality of the signal after it is processed by a home, VCR but it should be very useful, Editor.

There is nothing better than genuine signals from a station for thoroughly testing a TV receiver. The problem always is that the desired signals are not available when needed. So the serviceman has to resort to signal generators that give usable patterns.

Generators that provide reasonably good test signals are expensive. One such generator sells for $1195. The cost of generators that duplicate the standard color on the air test signals could be prohibitive. Signals desired are: chroma at RF, IF, and video frequencies; circular test pattern; VITs; dot pattern; cross-hatch; and vertical and horizontal. Output should be variable into 75 and 300 ohm lines.

Believe it or not, there is an excellent solution available to a large number of shops! The instrument is the videocassette recorder which has become so popular! Just borrow your home unit and you can with a little ingenuity, pipe the signal to the shop.

You will need a recorder tape. Until such time that one becomes available on the market your own can be made. Set the recorder to go on when the desired test patterns are on the air. You can ascertain this from cooperative station engineers. You may even be able to go to a TV station as I have done, and make a tape. Use your recorder's counter to index the particular pattern. That will take care of your chroma and VITs information. Hook the recorder up to yours or a borrowed dot and cross-hatch generator for those signals mainly used for convergence. Audio, etc. can also be included.

Some of the later model recorders have a freeze frame which is an obvious advantage.

Output of some of these recorders have a switchable converter accessible in the back or bottom for two different channels. Choose the channel that has the least amount of interference. The signal level on several of the units I have checked is in the neighborhood of 2000 microvolts into 75 ohms. If you actually need more signal, just add a TV line amplifier in the line. If you do this, you may then need an attenuator pad, which can also be used for the IF frequencies. The recorder generally has a line input and output at video and audio frequencies. Use these for testing the video and audio stages of the TV.

There is no output available for testing the IF stages direct but this is easily handled. Until some manufacturer can produce a converter to be plugged into the back of the recorder, you must provide for that signal yourself. The specific signal level should be high enough for testing all IF stages. If it is, then by using a standard attenuator pad various desirable signal levels can be obtained. One solution which will give between 25,000 microvolts and .1 volt is to take a regular TV tuner, preferably transistorized, and match it to the output of the recorder both as to frequency and impedance. This item with suitable power can be mounted in a small box. Batteries will last for lots of testing. The IF output from the tuner is then available for IF testing.

Since vertical and horizontal signals are not available from the direct video line output, they can be obtained if desired by inserting a small signal diode in series with the IF output and loaded to ground by a 10,000 ohm resistor. The polarity of the diode will determine the positive or negative sync. I have not found this necessary since these particular signals are strong enough in the IF output signal and the set's second detector will provide the correct signal.

I've been very pleased with the results and find the videocassette recorder a terrific, versatile test instrument! E. E. Comstock, Rt. 2, Box 28, Point Washington, FL. ETD

BULLETIN BOARD

A new catalog of **hard-to-find tools** for electronic assembly and precision mechanics is offered free by *Jensen Tools Inc.* It features 15 pages of test equipment and contains more than 2,000 tools of interest to field engineers, technicians, instrument mechanics, locksmiths, watchmakers, and electronic hobbyists. Major categories covered are: Test equipment, micro-tools, soldering equipment, tweezers, screwdrivers, cutters, drafting supplies, power tools and a complete line of tool kits and tool cases. Many of the tools are illustrated with full-color photography.
Circle No. 128 on Reader Inquiry Card

The new *Antler* line of **professional and business 2-way antennas** are shown in a dealer catalogue just published. The color catalogue details over 50 mobile models ranging from 30-896MHz including the wide variety of mounts available. The catalogue is sectionalized into frequency classifications as an aid to ordering. Frequency ranges covered are 30-50MHz, 130-174MHz and 450-896MHz. Repeater type antennas from 108-896 MHz are shown in a special section. Each section pictures the variety of mounts and antenna variations available in the particular frequency range. Complete mechanical and electronic specifications are also included. A special catalogue section is devoted to popular accessories, whips and replacement parts.
Circle No. 129 on Reader Inquiry Card

Sylvania **high voltage components** are described in a six page two-color brochure recently available from *GTE.* The components, used as replacements in color television sets, are part of the Sylvania ECG semiconductor line. The brochure is designed to provide comprehensive product data to electronic parts distributors, service dealers and technicians. It contains sections on high voltage multipliers including a variety of tripler and quadrupler devices, high voltage rectifiers and resistive divider/focus assemblies. Circuit diagrams and package outlines are also given. Thirty-one Sylvania solid-state devices are cross referenced in the brochure to 615 industry part numbers listed in alphanumeric order. Copies of the brochure and information on all ECG semiconductors are available from Sylvania distributors.
Circle No. 130 on Reader Inquiry Card

An optoelectronics data manual containing extensive application information on **opto emitters, receivers and couplers, and fiber optics products** has just been published by *Motorola.* The catalog is divided into two major sections of Opto and Fiber Optics which include product data sheets, general information, and specifications.
Circle No. 131 on Reader Inquiry Card

Litton Security Products has recently revised the **Terminus® Product Guide** to include all of the current Terminus products. The section on applications has been greatly expanded, giving the potential user a far better idea about how Terminus can solve many different problems related to intrusion detection. The Product Guide covers the operation of the Terminus Shock Detection System, the product line, window protection, wall protection, and wiring specifications. Contact Litton Security Products for a copy of the **Terminus Product Guide.** ET/D
Circle No. 132 on Reader Inquiry Card

RCA kicks in a $10 discount on the Sidekick.

The RCA Sidekick. It's the rugged, large-capacity case for carrying the RCA Parts you need most for in-home TV servicing.

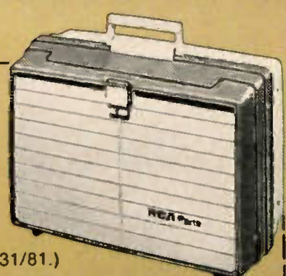
Now — for a limited time only — you can get your RCA Sidekick at a special $10 discount from participating RCA Parts Distributors.

Only the Sidekick offers you these useful features:

- Space for 164 RCA standardized parts boxes.
- Five pull-out drawers including storage bin for tools, manuals and drop cloth.
- No-spill lock feature that keeps drawers in place.
- Rugged ABS plastic construction, riveted for extra strength and durability.

The RCA Sidekick makes in-home TV servicing faster and easier because it "organizes" your inventory and eliminates the need for separate kits for different TV chassis. Take this coupon to your participating RCA Parts Distributor today. You'll get $10 off the price of the sensational RCA Sidekick.

This coupon worth $10



toward purchase of one RCA 1F6200 Sidekick Carrying Case.

Dealer: Present this coupon to a participating RCA Parts Distributor for $10 discount credit toward purchase of one RCA Sidekick Case. Offer not valid where prohibited. Limit: One $10 discount per customer. (Offer expires 5/31/81.)

Distributor: See separate instructions and limitations for honoring this discount coupon.

Dealer Name ____________________

Street ____________________

City ____________ State ______ Zip ______

RCA Distributor and Special Products Division

SECURITY VIEWPOINT

Let's face it. The American consumer has not yet responded to the need for residential security to the extent that many in this industry feel that he should have.

Industry leaders have cited consumer ignorance as a major roadblock to the successful implementation of residential security on a large scale basis.

And for the most part, they have been correct. I doubt that the average citizen is aware that in the four year period from 1973 to 1976, the *average* annual victim rate was better than four ouf of every hundred homes. Or that over 7% of all the families in America were burglarized last year; or that 10 out of 100 homes are vandalized; or that 2 out of every 100 families has their automobile stolen—the list could go on and on.

Studies conducted in 1979 showed that only one security system was sold for every thirty-seven burglaries that occured. This works out roughly to represent a burglary victim market penetration of only 2.7%. the logical question is why is this figure so low?

It has been my experience that a good portion of the blame be placed on the alarm dealer! Many alarm dealers are having a love affair with electronic technology. They seem determined to sell only the 'latest state-of-the-art equipment. Unfortunately, many times this equipment is very sophisticated in design and as a result, the prospect walks away feeling alienated and confused.

Since the prospect can't understand the equipment, instead of gaining a sense of being protected by it he often feels intimidated by it instead.

Many of the new 'super-security systems' are also costly. I've heard of more than one sale that went down the drain when the final estimate was presented. And here is where the tradgedly lies. In reality, these high priced, super systems are really only called for in about 4-5% of the homes you may be asked to secure. The other 95% of the homes only need protection at entry points.

You as an alarm dealer have to learn to determine what level of protection the prospect needs and wants. No one system is suitable for each home you attempt to secure.

You have got to adopt a multiple approach in order to make this business a success. If you have been selling the 'super-systems', all well and good. Keep that program for the 5% of your clients who actually require that degree of protection. For the vast, untapped other 95%, learn to sell every customer a level of protection they can afford.

Think about it. Every time you or anyone else in this industry sells the client on the *concept of security* but loses the actual sale because of price, you have lost a lot more than just that one customer.

Initially you have lost your credibility on the level of security you recommended. Additionally, you have lost your credibility as a spokesman for your industry; you have also iost any future referrals from the potential customer had you conducted business with him.

I don't want to belabor the point, yet I can't stress it enough. The American consumer is taking a long hard look at residential security.

I recently had the opportunity to attend the N.H.M.A. show in Chicago. While there, I talked to many company representatives involved in home security. The majority of them conceded that the residential market was having its share of problems. At the show last year, there was 52 exhibitors of 'home security' products. This year that figure dropped to 42. Enough said.

Conventional, 'one approach' one-system methods have not done the job. By being fair, and most importantly, by being flexible in your approach, 1981 can shape up as a year of success and fulfillment.

Ray Allegrezza

Alarm Systems

Design and Sources of Supply

An alarm system for maximum effectiveness at reasonable cost must be designed as carefully as a MATV or sound system. John Sanger is well qualified to explain system design, operating a company that both sells and installs systems and sell equipment to and advises do-it-yourselfers. This is the first of several articles on system design and bidding.

by John Sanger

Designing an alarm system need not be a traumatic experience. A basic knowledge of equipment and sources of supply will minimize design problems. Before a decision can be made about *what* equipment will be used, it should be determined *where* it will be used. And, before that determination can be made, there should be a fundamental understanding of the three major components in an alarm system: a detection device, a processing (control) unit, and an annunciator.

A detection device does just what the name implies, it detects something: a door opening, glass breaking, vibration, pressure, movement, sound, or temperature—to name a few. The selection of the correct detection device is crucial to the proper operation of the system. False alarms that require repeated service calls can quickly erode the profit made on the alarm sale. The rationale for selecting certain devices for specific applications will become apparent when individual detectors are discussed later.

The processing unit, commonly referred to as a control box, is the electronic or electro-mechanical brain of the system. Sophisticated electronic control devices developed over the past ten years have been a boon to the alarm industry. They are easier to install and perform a wider variety of functions at a cost-effective price. The purpose of the processing unit is to receive a signal from a detector and respond. The selection of the proper control unit will depend on two things: (1) the number and types of detectors used, and (2) the functions required of the system by the customer.

The processed alarm signal from the control device is sent to an annunciator. The signal can be announced visually, audibly, or both. Bells and sirens are the most common forms of annunciation, although strobe lights are gaining popularity. Annunciation may take the form of a pre-recorded message played on a telephone tape dialer or an electronic signal sent to a monitoring center.

The Building Survey

The first step in designing a system is to survey the building to be protected. While walking through, and *around*, the building, careful and detailed notes should be made. Diagrams of the building and/or individual rooms will prove helpful when the designer begins planning a proposed system.

Answering the following questions will provide the system designer with enough information to design an efficient and economical system for the customer and a profitable one for the installer. The comments noted in parentheses following the questions indicate the rationale behind the questions.

1. How many doors—interior and exterior? Type/construction? Location? (General information to determine best detection devices.)

2. How many windows? Type/construction? Location: (General information.)

3. Is there enough room in the attic or above the suspended ceiling to work? (If not, wireless RF equipment may have to be used for part of the system.)

4. What type of roof? Hip? Gable? Location and type of vents? (Gable ends with vents are ideal for mounting siren speakers. Soffit vents can be used for speakers if the vents are accessible.)

5. What is the interior and exterior wall construction? Hollow? Solid? (Space protection devices should be mounted on vibration free walls. Hollow walls can be used for concealing wire.)

6. Where will the control box be located? Is ac power convenient? (Helps to plan wire runs to detectors, annunciators, and power supply.)

7. Will flourescent lights be on when the alarm is in use? (Flourescent lights may affect microwave units.)

8. Is there a remote controlled television? (Ultrasonic units may affect the operation of the television.)

9. Will pets—or anything else that moves—be left in the building when the alarm is on? (Motion detectors detect movement—regardless of *what* moved. Passive infared detectors sense heat changes, and animals give off body heat.)

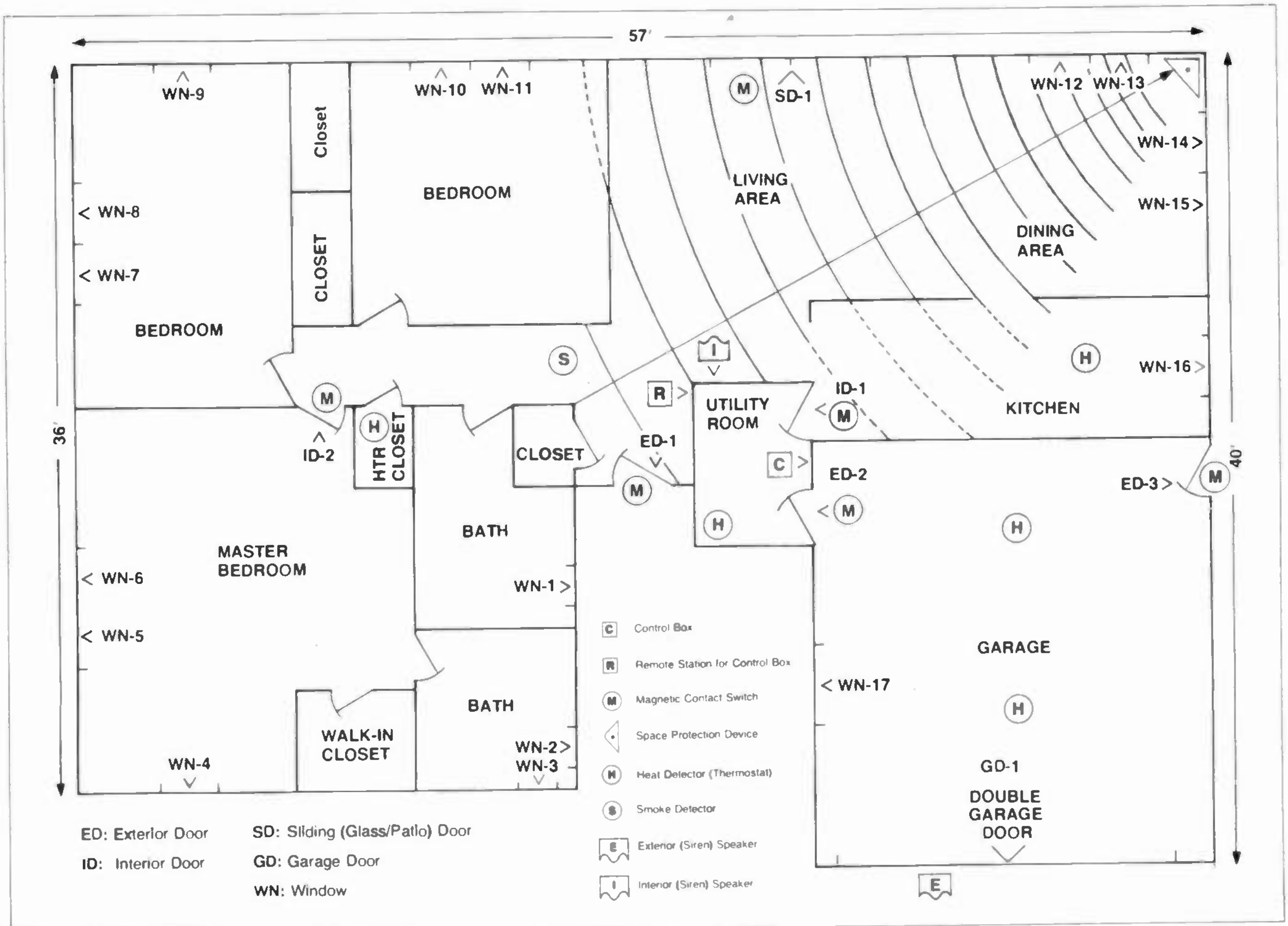


Fig. 1. The floor plan of a house showing a typical residential security installation.

10. Does the customer want to use the alarm when at home? Away from home? Both? (In other words, should an interior zone be used to shunt some detectors while leaving perimeter detectors on?)

11. Does the temperature in the building drop below 40 degrees Farenheit or exceed 120 degrees Farenheit under normal circumstances? (Extreme temperatures, especially for prolonged periods, may affect batteries and/or other items of equipment.)

12. Are neighbors close enough to hear a bell or siren? (If not, should a tape or digital dialer be used to notify the authorities?)

13. Would a strobe light be visible to neighbors or a passing patrol car? (Strobes help pinpoint the location of the alarm, especially at night.)

14. Can the system be expanded without major modification or replacing the control unit? (Keep in mind the potential for future sales: heat and smoke detectors for a fire system, or adding extra zones, or connecting an automatic dialer.)

Fig. 2 Nel-Tech's LKC-50 control has a wide variety of functions. It is useful in many residential systems and some commercial systems. It provides good protection at an affordable price.

What Sensors to Use?

The second step in designing the system is determining what will be protected and the specific detection devices needed. Doors are an obvious choice for protection since approximately eighty percent of all burglaries occur through a door, with over fifty percent occurring through a front door.

A basic perimeter alarm system should include all exterior doors. The doors are easily protected by using magnetic contact switches. Moreover, recessed magnetic contact switches remove the possibility of defeating the system by tampering, and, since they are totally concealed, they do not detract from the room's decor.

Protecting windows is a debatable issue—one that each installer must resolve for himself. There are positive aspects to each argument. Protecting each window with foil tape or glass breakage detectors (*not* vibration contacts) assures that entry will be detected immediately. Foiling windows is a time consuming process and can quickly increase the price of a system due to the labor involved. The foil tape is inexpensive, the labor is not. Glass breakage detectors have limitations if the window consists of several small panes. Asthetics come into play as well. The customer might object to the appearance of the foil tape.

If an intruder gains access through an unprotected window, he will most likely leave through a door—especially if he is carrying a large or heavy object. In that case, he would be detected leaving instead of entering, minimizing the loss, but not preventing it. An alternative to protecting each window is to make an interior (*trap*) zone. The installation of concealed magnetic contact switches on one or more interior doors, or the use of a space protection device covering an area where an intruder is likely to pass, in lieu of protecting each window, will reduce the time required to install the system and, therefore, reduce the cost of the system to the customer. Once inside, it is likely that an intruder will enter several rooms, and, upon opening a protected door or moving into an area covered by a space protection device, he will activate the system. Master bedroom and walk-in closet doors are excellent choices for interior trap zones using magnetic contact switches; central hallways, for space protection devices.

Installation of recessed magnetic contact switches is a relatively simple procedure when using a 1/4 × 30″ drill bit and drilling straight up into the attic. If, however, space protection devices are to be used, care must be exercised in the selection and placement of such devices.

Ultrasonic motion detectors have a range of approximately 25 × 20 feet, depending on the temperature, humidity, shape of the room, and objects in the room. They are susceptible to air currents (from heaters and air conditioners) and certain high frequency noises (such as ringing telephones and hissing radiators).

Microwave units are available in many different ranges, up to 300 feet. For most applications, a range of seventy-five feet or less is adequate. Placement of the unit is critical since its waves will penetrate most nonmetallic materials. Therefore, a unit aimed at a window or thin wall will "see" movement on the other side. Microwaves, for the most part, tend to be more stable than ultrasonics and are not affected as much by temperature changes and air currents. They may, however, "see" fluorescent lights. Strict adherence to the manufacturer's instructions will eliminate most placement problems.

Passive infared (PIR) detection devices are gaining in popularity with many alarm installers. They detect rapid changes in temperature within the protective zones—of which there are several. The unit will detect the infared radiation (body heat) of an intruder the instant he enters the protection pattern. Again, careful placement is required. Avoid placing the unit where it will be exposed to direct infared radiation—sunlight and car headlights are two common sources. Incandescent bulbs are a potential problem. For example, if a table lamp, controlled by a timer, is in view of the PIR device, as soon as the light bulb turns on and heats up, the PIR will sense the change in temperature and cause an alarm.

There are many different types of detectors available; too many to enumerate in this article. Reading the "Security Products" section and contacting the manufacturers of security products who advertise in *ET/D* will provide the installer with invaluable product information.

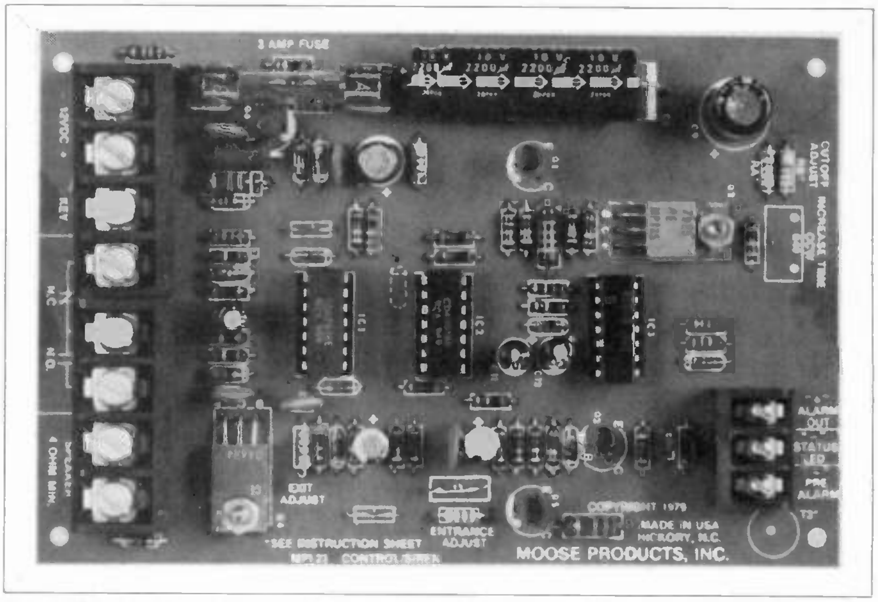


Fig. 3 There are some instances when a system, especially the control, seems to require building from scratch. The Moose MPI-23 control (PC board) had numerous features that will allow the system designer to actually construct his own control box without it becoming expensive.

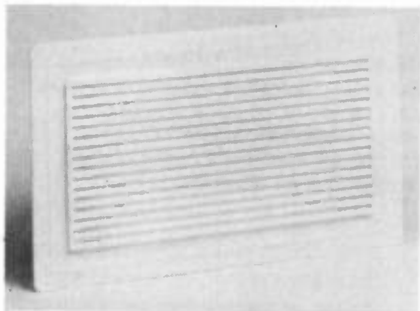


Fig. 4 Moose Products' MPI-16 speaker adds a nice (and professional) touch to an installation. The attractive 15 watt speaker can be used without detracting from the decor of a home or office and can be surface or flush mounted.

The Control Unit

The third step in designing an alarm system is the selection of a control unit, one that will accept the detectors in the system and meet the requirements of the customer. There are many excellent controls on the market. We, at Sanger and Son Incorporated's Security Division, have found that four control units will fulfill the needs of ninety percent of our installations.

Our most popular control is Solfan's Model 1200. It has an entry/exit delay, built-in siren driver, automatic cut-off and re-arm, and comes with a rechargeable gel cell. The 1200 will accept two "slave" microwaves (which are less expensive than stand-alone units) and has a normally closed delay circuit, a normally open instant circuit, and a normally open twenty-four hour panic circuit. The siren driver is capable of powering two thirty-watt speakers and the unit has normally open and normally closed dry contacts (to use for auxillary annunciation devices such as telephone dialers and strobe lights). The control is housed in an attractive plastic cabinet which may be surface or flush mounted. Arming and disarming the system is accomplished by entering a code on the digital keypad.

Another popular control is Nel-Tech's LKC-50, which has a built-in digital keypad for arming and disarming plus slide switches to select

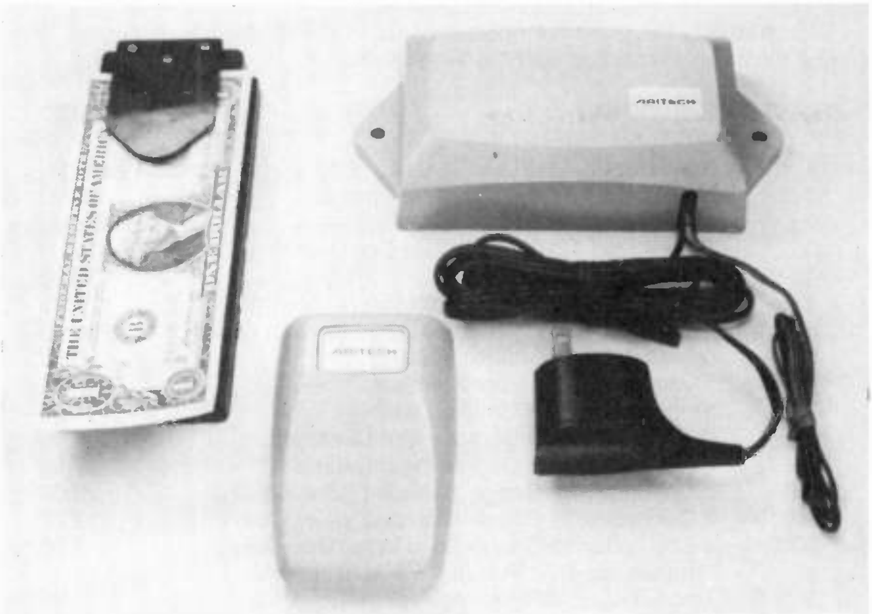


Fig. 5 Utilization of wireless equipment makes some installations less difficult. A cash drawer transmitter, portable transmitter, and single channel receiver (left to right) used in conjunction with a tape or digital dialer would make an effective silent hold-up alarm.

an instant or delay mode and to control an interior zone. Additional digital remote stations may be added to the system. A combination of normally open and normally closed burglary and fire/panic circuits are standard features. It has a charging circuit to allow the use of a rechargeable gel cell. In alarm, the unit provides voltage output for a siren driver or strobe light. Also, the LKC-50 has adjustable timing circuits for entry and exit delays and alarm cut-off.

PLC's 515 series of controls are designed to use two-wire remote key stations instead of the usual four-wire stations—making installation simpler. Two separate burglary zones plus fire and panic circuits make the 515 series very versatile. Separate voltage outputs for burglary and fire/panic and constant 6vdc and 12vdc outputs are provided.

Moose Products' MPI-23 control is a printed circuit board that does not come in an enclosure, allowing the installer to literally build his own control box. It is 12vdc powered and accepts both normally open and normally closed devices. The MPI-23 is armed and disarmed via a two-position (on/off) maintained switch. Its built-in siren driver and timing circuits make it adaptable to numerous installations.

In addition to the four primary controls listed above, two new controls are available from Moose Products: the MPI-330 and MPI-335. Both new controls show a lot of promise because of size (they fit a double-gang electrical box), appearance (attractive face plate), and operation (a variety of functions).

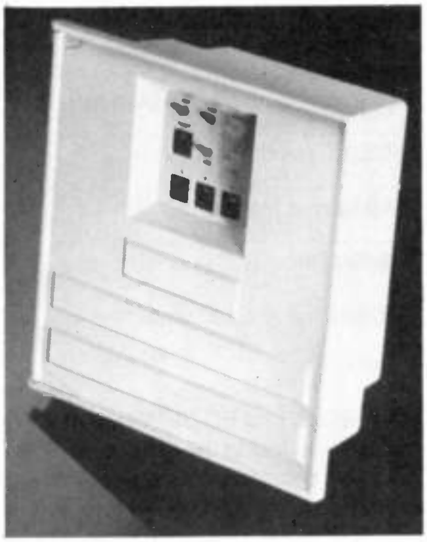


Fig. 7 Solfan's Model 1200 control unit contains features that make it very cost-effective for residential alarm systems. Ease of installation and simplicity of use are key features.

The system designer should determine what features are standard and which ones will have to be added to the control unit he is considering. Siren drivers, cut-off timers, and standby power supplies (batteries) are the most common items added to a control.

The Alarm

The fourth step in the design process is determining what the system will *do* once in an alarm condition—that is, after it has been "tripped." A local alarm is one that just makes noise. But, what kind of noise? A bell? A siren?

Fig. 6 Wireless transmitters can be installed in a matter of minutes–greatly reducing the installation time required. Although equipment costs will be greater when using wireless equipment, the savings in labor will more than make up for the higher costs.

To my way of thinking, bells are less desirable than sirens. Sirens get attention. A good siren driver, powered by twelve volts or more, connected to a thirty-watt speaker can be ear-splitting. Besides, speakers are usually easier to install and require less maintenance than bells, especially if the speaker can be mounted inside an attic vent.

As long as we are making noise outside the building why not make noise *inside* the building? After all, we want the intruder to be fully aware of the fact that he has been detected. Keep in mind that the primary function of an alarm is to make noise and, in so doing, cause the intruder to flee—hopefully, empty-handed. The Moose MPI-16, a speaker of 15 watts, has an excellent application as an interior siren speaker. It can be flush or surface mounted, it comes in walnut brown or ivory white, and, best of all, it does not look like a speaker. Once in place, it appears to be an *air vent.*

Other annunciators include strobe lights as well as tape and digital telephone dialers, which are frequently used in conjunction with bells or sirens. An alarm system that relies solely on a tape or digital dialer (a "silent" alarm) has one potentially serious problem: it assumes that there will be an *immediate* response to the alarm by the police or other persons—which may not be a valid assumption. If in doubt, make noise.

Specifying and Purchasing

The final step is to order the equipment needed for the installation. There are hundreds of security and fire equipment manufacturers and

Fig. 8 The addition of a "panic button" to an alarm system will make the system more versatile, and, may help close the sale. The convenience of a portable panic button, such as Transcience's PT-1, is a good selling feature–especially to women.

This chart lists the equipment necessary to install the proposed system and the costs associated with the installation.

QUANTITY	EQUIPMENT	COST
1	Nel-Tech LKC-50 Control Unit	$100.00
1	Nel-Tech 6R3 Digital Remote Station	20.00
1	Basler 12vac Transformer	5.00
1	Powersonic 12vdc-1.5ah Gel Cell Battery	19.00
1	Adcor SD-1 Siren Driver	10.00
1	Solfan 3250 Microwave with RP-70 Antenna	125.00
6	Sentrol 1078 Recessed Magnetic Contact Switch	21.00
1	Moose MPI-30 Exterior Speaker	30.00
1	Moose MPI-16 Interior Speaker	12.50
1	Smokeguard B1R Smoke Detector	24.00
2	Fire-Lite 41 - 130 Degree Heat Detector	5.00
3	Fire-Lite 42 - 200 Degree Heat Detector	7.50
1000′	2 Conductor/22 Gauge Stranded Wire, Clear	20.00
250′	2 Conductor/18 Gauge Stranded Wire, Clear	12.75
50′	4 Conductor/22 Gauge Solid Wire, Gray Jacket	5.00
1	Transcience PT-I Portable Panic Transmitter	19.50
1	Transcience SCR-12 Receiver	37.00

Equipment Cost	$473.25
Miscellaneous Hardware (3%)	14.20
Total Equipment Cost	$487.45
Estimated Labor Cost (14 Manhours @ $15.00/hour)	$210.00
Total System Cost	$697.45
Add Profit Margin (30%)	$209.24
Retail Price to Customer	906.69*

*Sales tax not included.

distributors across the country. Generally, it is advisable for a small dealer/installer to utilize the services of a distributor. Having a wide variety of products in stock, the distributor can be a valuable asset to the alarm installer by assisting him in selecting the proper equipment for a particular job. Locating several dependable distributors who offer good service and competitive prices can alleviate many of the problems associated with equipment purchases.

Equipment manufacturers are an asset to the installer as well. Their technical staffs will assist the installer in solving unusual problems, and most have toll free telephone numbers.

Some security consultants will provide specialized services to small alarm dealers/installers. Although there is a stipend for the consultant's services, he will probably save money for the dealer in the long run. As a regular matter of business, the consultant is aware of technological changes in the industry; he knows products and applications as well as sources of supply. Services and fees will vary from consultant to consultant and it would be wise to locate one who specializes in systems design.

A Typical System

The floorplan shows a typical three-bedroom house with a two-car garage. There are three solid exterior doors (ED-1, ED-2, and ED-3). Although door ED-3 is inside the garage, it should be considered as part of the perimeter of the building. Also on the exterior of the house are an overhead garage door (GD-1) and a sliding glass door (SD-1). The perimeter of the building contains sixteen vertical sliding windows (WN-1 to WN-16) and one stationary window (WN-17).

The proposed intrusion alarm system should include recessed magnetic contact switches on all exterior doors (ED-1, ED-2, ED-3 and SD-1), except the overhead garage door (GD-1), in the perimeter zone. The interior trap zone should include recessed magnetic contact switches on two interior doors (ID-1 and ID-2) and a microwave intrusion detector located in the dining area. For this particular system, the windows will not be protected. Should an intruder gain access through a window, he will probably be detected by one of the two protected interior doors or by the space protection device—which covers the living and dining areas and parts of the kitchen and hallway.

For the purpose of illustration, let us assume the use of a Nel-Tech LKC-50 control panel. The system can be armed or disarmed from the digital keypad on the control box or from the remote keypad located in the entry hall. An adjustable entry/exit delay circuit allows all of the alarm's functions to be controlled from *inside* the house. (The specific functions of the LKC-50 were noted earlier.)

An exterior speaker should be mounted so that it will be heard by the greatest number of people. In this case it is mounted in the front of the house, preferably inside a gable vent. The interior speaker should be mounted in a central location inside the house.

Adding a fire alarm system to the intrusion system is a relatively simple matter. One smoke detector located in the hallway and five heat detectors (garage, kitchen, utility room and

Continued on page 55

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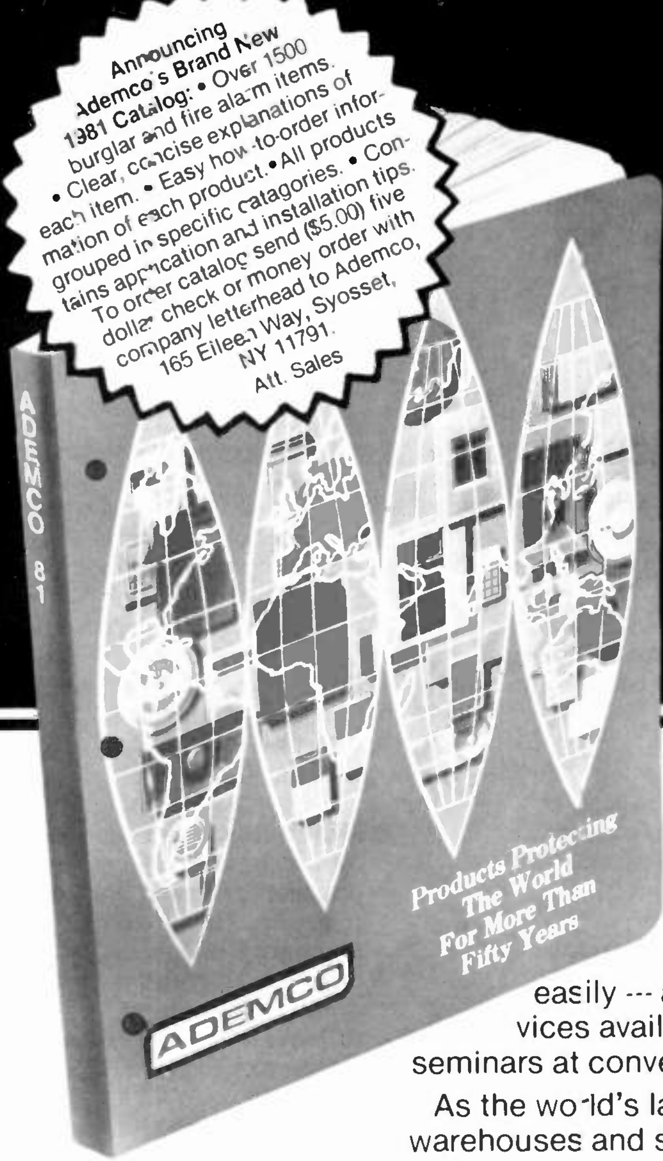

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CET Test Preparation Quiz

Part III

How did you do on the last two quizzes? Here's another to test your memory and knowledge on amplifiers, ac, and other things you haven't thought of lately

by Frank R. Egner CET

If you have worked the electronic quizzes in previous issues of ET/D, you've probable discovered that you have become rusty in some areas of electronic fundamentals. But don't be discouraged. Most technicians find that they become rusty in many areas over a period of time. If you make a true effort to answer the quiz, and then look up the solutions in text references for questions missed, you'll be surprised at how it will refresh your previous knowledge.

If you are not yet a Certified Electronic Technician, why not use some of your spare time to review and study your electronic fundamentals to get ready for the CET exam? You'll be proud to be a CET because it is evidence of your electronic knowledge and ability. It is hoped that these electronic quizzes will help you get ready for the test. If you'd like further information on the CET program, contact ISCET or ETA-I. The addresses have been in ET/D quite regularly. Also do not forget that NATESA has its own consumer electronics oriented certification program.

This quiz is similar to previous quizzes and is intended to provide a thought-provoking review of electronic concepts. Some questions may seem easy and others more difficult, but none are intended to be "trick" questions. The answers are available to check your solution, but shouldn't be looked at until you've made your best effort on the quiz.

1. The power factor (pf) of an ac circuit is equal to:
   a. The sine of reactance divided by resistance.
   b. Real power minus reactive power
   c. The cosine of the phase angle.
   d. Voltage times current divided by reactance.

2. An ac circuit has an applied voltage of 75 volts, a current of 50 milliamps, and a power factor (pf) of 0.85. The power being dissipated is approximately:
   a. 3.75 watts.
   b. 31.9 watts.
   c. 3.2 watts.
   d. 0.32 watts

3. An ac voltmeter measures the line voltage at 115vac. The ac average voltage is:
   a. Ov.
   b. 103.5v.
   c. 115v.
   d. 161v.

4. Moving the plates of a capacitor closer together will:
   a. Decrease its reactance.
   b. Decrease its capacitance.
   c. Increase its ac opposition.
   d. Increase its breakdown voltage.

5. Amplifier gain decreases to half power at high frequencies because:
   a. Coupling capacitors have too little capacitance.
   b. The reactance of the shunt capacitance decreases.
   c. The reactance of the series inductance decreases.
   d. By-pass capacitors are too low in value.

6. A tuned circuit in a radio receiver uses an inductor with a movable powdered-iron core. Turning the core further into the coil will:
   a. Lower the inductance.
   b. Raise the resonant frequency.
   c. Reduce its reactance.
   d. Decrease the frequency of resonance.

7. The input impedance of a common emitter transistor amplifier:
   a. Varies inversely to transistor current.
   b. Decreases as transistor current decreases.
   c. Is constant for each type transistor.
   d. Increases proportionally as current increases.

8. A zener diode is connected as a shunt regulator. Under this condition:
   a. Zener resistance decreases as input voltage decreases.
   b. Zener current varies directly as load current varies.
   c. Zener resistance increases as load current increases.

continued on page 35

CET Quiz

continued from page 26

d. Zener resistance is constant at its rated voltage.

9. Signal inversion between input and output is a normal condition for which transistor configuration?
   a. Common emitter amplifier.
   b. Common base amplifier.
   c. Common collector amplifier.
   d. More than one but not all of the above.

10. At what frequency will the reactance of a 0.01 microfarad capacitor be equal to a resistor of 10K ohms?
    a. 160 KHz (Approx).
    b. 16 KHz (Approx).
    c. 1.6 KHz (Approx).
    d. None of these

11. A series-resonant circuit is connected in parallel with a load. The circuit will function as a:
    a. Low-pass filter.
    b. High-pass filter.
    c. Band-pass filter.
    d. Band-stop filter.

12. A 2KHz squarewave is applied to an RC coupling circuit in which R = 10K and C = 0.001 microfarads. The output waveform, if taken across R, will be:
    a. A squarewave with minimum distortion.
    b. A distorted rectangular waveform.
    c. A differentiated waveform.
    d. Shifted in phase by nearly 90 degrees.

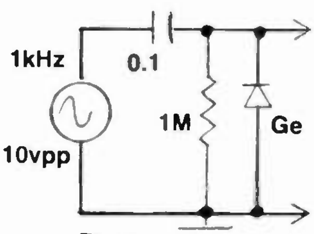

Fig. 1

13. The output of the circuit in figure 1, as measured with an oscilloscope on dc input will be:
    a. Positive half cycles only, about 5 volts peak.
    b. Negative half cycles only, about 5 volts peak.
    c. A full sinewave, centered on −5 volts dc.
    d. A full sinewave, centered on +5 volts dc.

14. The circuit of figure 1 could be identified as a:
    a. Negative dc restorer circuit.
    b. Positive clamper to a zero volt level.
    c. Shunt positive limiter.
    d. Shunt negative limiter.

15. The transistor amplifier configuration that provides no current gain is the:
    a. Common base amplifier.
    b. Emitter follower amplifier.
    c. Common emitter amplifier.
    d. Common collector amplifier.

16. A series resistance-inductance (RL) circuit has an output taken across the resistor. This circuit could be used as a:
    a. Low-pass filter.
    b. High-pass filter.
    c. Band-pass filter.
    d. Band-stop filter.

17. Kirchhoff's voltage law states that in all circuits:
    a. The algebraic sum of all voltage drops and rises is equal to zero.
    b. The algebraic sum of all loop voltages equals zero.
    c. Both a and b are true.
    d. Neither a nor b is true.

18. The dc input of a calibrated oscilloscope has an impedance of 1 megohm, shunted by 35 picofarads. The scope is connected across one of two series connected 500K ohm resistors across a 20 volt dc source. Using the 2v/div range, the trace will deflect about:
    a. 4 divisions.
    b. 5 divisions.
    c. 4.5 divisions.
    d. 3.6 divisions.

19. An iron-core transformer, having a 1:1 turns-ratio, would most likely be used for:
    a. Impedance matching.
    b. Voltage regulation.
    c. Safety precautions.
    d. Current regulation.

20. In figure 2, the most likely indication of a shorted capacitor CE would be:
    a. An excessive amount of gain.
    b. A decrease in voltage gain.
    c. An improvement in signal linearity.
    d. Increased amplifier bandwidth.

21. In figure 2, the most likely indication of a shorted capacitor CE would be:
    a. A change in the Q1 operating point.
    b. A complete loss of voltage gain.
    c. An improvement in signal linearity.
    d. A decrease in amplifier bandwidth.

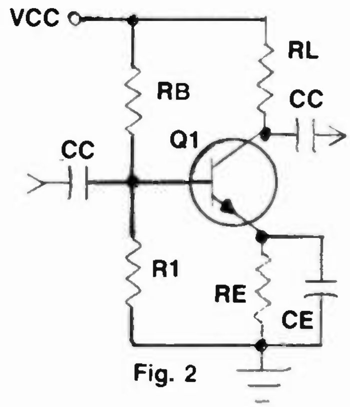

Fig. 2

22. In figure 2 the input and output signals are in phase. This could be an indication that:
    a. Q1 is shorted E to B.
    b. Q1 is shorted C to E.
    c. Q1 is shorted B to C.
    d. This is normal for this configuration.

23. In the circuit of figure 3, increasing the generator frequency will:
    a. Decrease the resistor voltage.
    b. Decrease the circuit phase single.
    c. Increase the power dissipation.
    d. Reduce the inductor voltage.

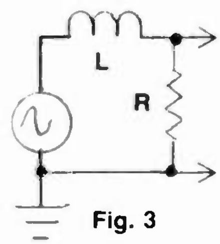

Fig. 3

24. In figure 3 the generator frequency is such that reactance and resistance are equal. Then:
    a. The phase angle is 45 degrees.
    b. Inductor voltage plus resistor voltage is greater than the generator voltage.
    c. The inductor current is greater than resistor current.
    d. More than one but not all the above are correct.

25. In figure 3, inserting an iron core in the coil will:
    a. Decrease the inductor voltage.
    b. Increase the resistor voltage.
    c. Decrease the power dissipation.
    d. Increase the circuit current.

You'll find the solution on page 55.

An Intrusion and Fire Alarm System

Another Design Problem

Basic to your ability to sell and install security systems is an understanding of overall system design. You must set up an adequate, perhaps expandable, system for a reasonable price. Here's a concrete design example.

by James A. Ross *

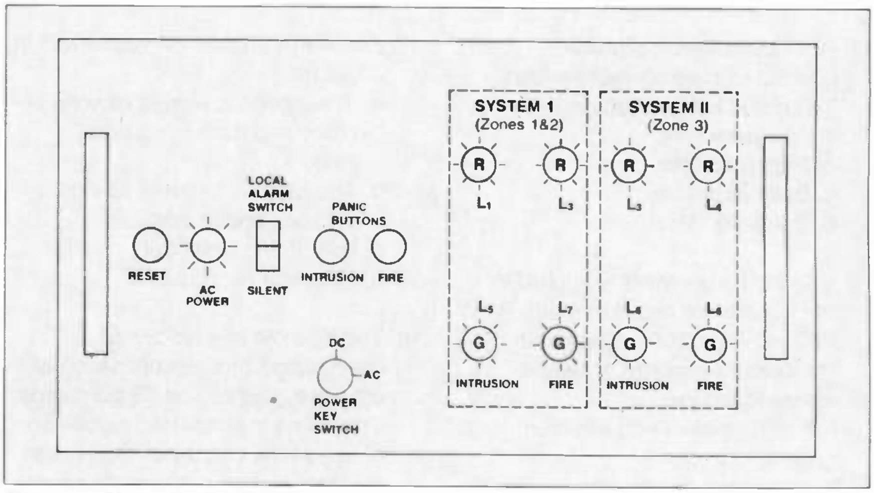

Figure 1 Master Control Panel

The first step in any design problem is to determine what is to be accomplished. (I know that this sounds silly because it is so obvious, but I have seen countless examples of waste in government programs due to the failure to specify real, necessary goals at the outset.) In this case our principal goal was the development of a demonstration model of an intrusion and fire alarm system for use as an instructional aid. We determined that desireable features of our system were:

1. Several zones for intrusion detection.
2. Smoke and heat sensors.
3. Master control panel with status indicator lights.
4. Local alarms for intrusion and fire.
5. Remote alarms via telephone dialer for intrusion and fire.
6. Backup power in case of loss of ac.

Also, because it is a demonstration system intended to be used as an instructional aid, it should be mounted in an enclosure which can be wheeled from storage into the classroom as needed. As far as possible, components which are to be demonstrated whould be located high enough so that they can be seen from the back rows of the classroom.

As in any design problem, after listing the goals, it is necessary to take stock of what resources we have available, and constraints which might cause us to modify our goals. In this case we had the following equipment available:

Rockland model 515 Residential Panel
Rockland model 562 Commercial Panel
Rockland model 500 Telephone Dialer
Ademco model 632D Smoke Detector
Heat Sensor
Magnetic Switches
Dialer Programmer
Solid State Siren
Buzzer

In addition to the hardware listed, and far more important, we had the capabilities of the designer, Bob Kroll, who combines theoretical knowledge with practical, hands-on experience. The single most important constraint was the budget—the entire project was limited to $50 of new expenditures. Because of a shortage of classroom space in the school, we were forced to design a portable system which meant that a large part of the budget had to be used for lumber, hinges, etc., leaving very little

* *At the outset, I wish to give thanks to Robert T. Kroll, a friend and former student at Capitol Institute of Technology. Bob assisted with the development of the Electronic Security Seminar at Capitol Tech by using various donated equipment in the design of the system which is described in this article. Thanks to his talents and hard work the college has a working model of a modern intrusion and fire alarm system.*

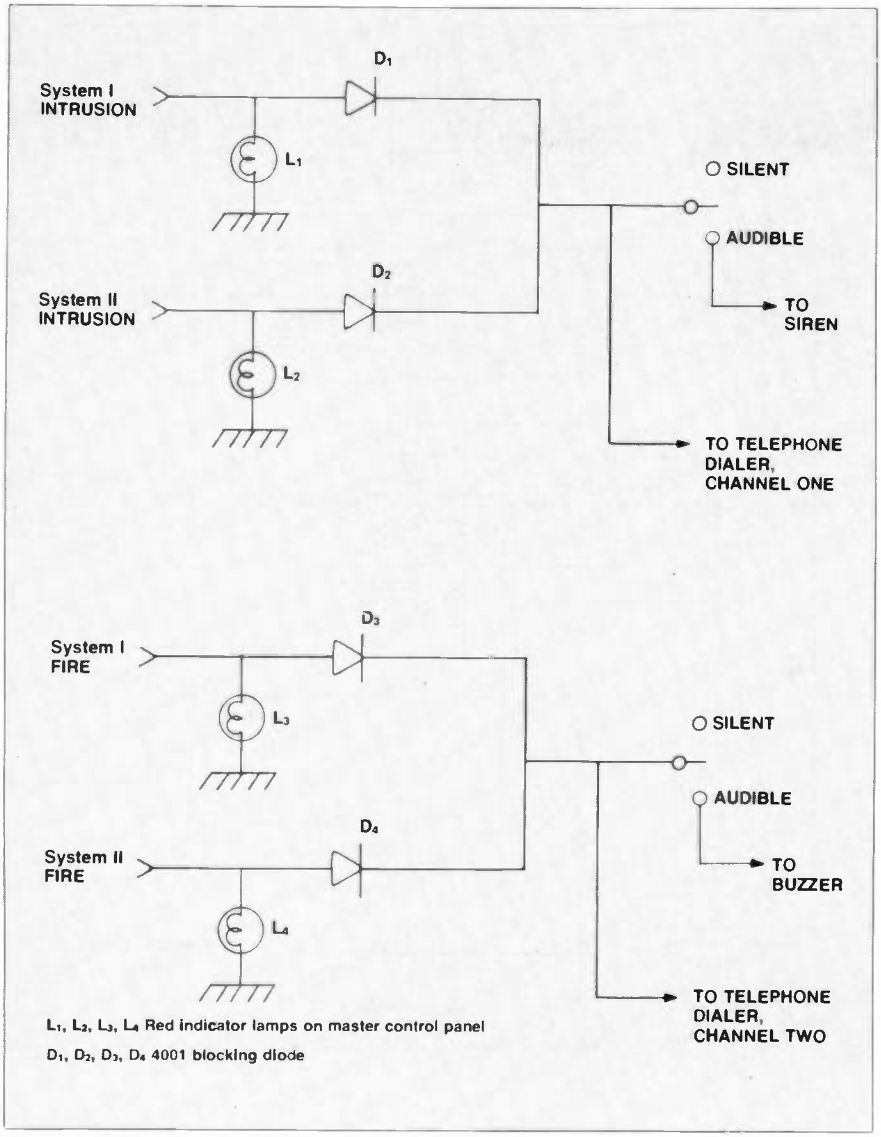

Figure 2 Interconnect Circuitry

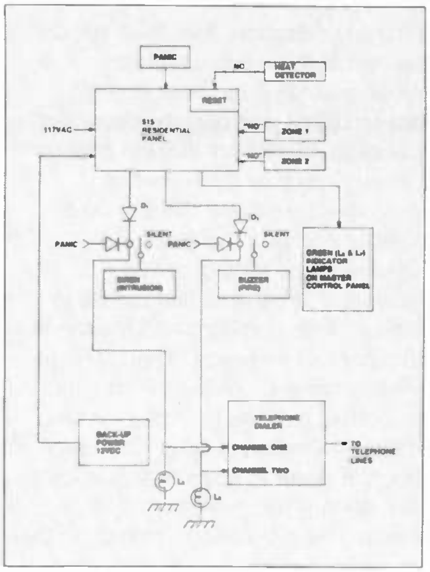

Figure 3 System I

for wiring, battery, master panel, status indicator lights, etc.

Equipment Characteristics

In the demonstration unit the master control panel is located at the top front for maximum visibility in the classroom; however, in an actual installation this panel would be located in the security office. Keep in mind that this panel is one which we added because we wished to demonstrate a greater capability than that of either the 515 residential panel or the 562 commercial panel. Also, we wanted to demonstrate that it is possible to combine commercially available units using simple binary logic circuits made of inexpensive components. A drawing of the face of the master control panel is shown in Figure 1. The reset switch controls the smoke detector and intrusion circuits of the 515 residential panel. The lamp marked "AC Power" glows when ac power is available for use whether the unit is being powered by either ac or dc. The silent alarm switch disconnects the heat and smoke buzzer and the intrusion alarm siren. With these disconnected, fire or intrusion would activate the appropriate channel of the dialer, but there would be no local alarm sounded. The panic buttons on the master control panel will activate the intrusion alarm or the fire alarm. Again, control over the local alarms is maintained by the local alarm switch. If it is in the silent position, the appropriate channel of the dialer will be activated by the panic button, but no local alarm will sound.

The status indicator lights are located on the right side of the master control panel. The lower lights are green and indicate which systems are activated, and operating properly. The red lights on the upper level indicate an alarm condition. The intrusion circuit for zones 1 and 2 can be reset by the reset button on the master control panel, but System II must be reset within the 562 control panel because it has no provision for remote reset. Also, if any intrusion circuit has been activated by any of the panic buttons, it must be reset within its own control panel (515 for zones 1 and 2 and 562 for zone 3). The smoke detector will reset itself after activation and the heat sensor used had to be replaced after activation.

The 515 residential control panel has provision for input from two zones for intrusion detection and one for heat detection, and the 562 commercial control panel accommodates input for only one zone of intrusion detection and the smoke detector. (The commercial panels are less complex because they are mostly sold to small retail stores which usually have a much simpler layout than a home.) The panels used will accept inputs which are normally open ("NO") or normally closed ("NC"). In our application zones 1 and 2 are "NC", and zone 3 is "NO." The heat and smoke detectors are "NO."

The model 500 dialer is a two channel device, providing two different reactions depending on whether it is activated by an intrusion or by smoke/fire. Channel one of the dialer is activated by an intrusion alarm, and channel two is activated by a fire alarm. This dialer will accept inputs including a dry (no voltage) closure and from 5-12 vdc, depending on the setting of the function switch. One important feature of this dialer is that channel two has automatic priority over channel one so that if a fire occurred during transmission of the intrusion message, the dialer would switch to its channel two response. Upon activation of channel one intrusion detection, the dialer will dial the first of three programmed telephone numbers (from one to eleven digits) and play the recorded message, then it will dial the second number and play the recorded message, then it will dial the third number and play the recorded message, and turn itself "OFF." Activation of channel two results in dialing those numbers and playing the channel two message. There are, of course, several options which could be added, but one standard feature latches an indicator light "ON" each time the dialer is activated. This tells you, even if you have not been reached by a telephone message, that the dialer had been activated since it was set.

System Operation

This system incorporates two standard panels, one master control panel, a telephone dialer, a buzzer fire alarm, and a siren intrusion alarm. The two standard panels are connected to the master control panel and the alarm system with simple "OR" gates as shown in Figure 2. As you can see, the master control panel indicator lamps will indicate whether System I or System 2 has been triggered, but the alarm circuitry will be activated if either System I or System II has been triggered. The block diagram for System I is shown in Figure 3 and the block diagram for System II is shown in Figure 4. Note that several panic buttons can be used in the system in addition to the ones shown by connecting them in parallel to the "NO" inputs to System II. The master control panel will indicate which zones are "ON" with green lights L_5, L_7, L_6, and L_8; and will indicate alarm status with red lights L_1, L_3, L_2, and L_4. Most of the elements of the system can be powered by a wide range of dc voltages so that 24 vdc from the 117 vac power supply is acceptable as well as 12 vdc from the back-up lead-acid automobile battery. Only the siren driver might be damaged by higher than 12 v input, so it is protected with a 7812 voltage regulator. No false alarms have ever been generated when changing from ac to dc or from dc to ac.

Special Considerations

Before connecting to phone lines, you should be familiar with applicable Federal laws and local telephone tariffs. Also, in some areas it is illegal to have a dialer dial the police directly.

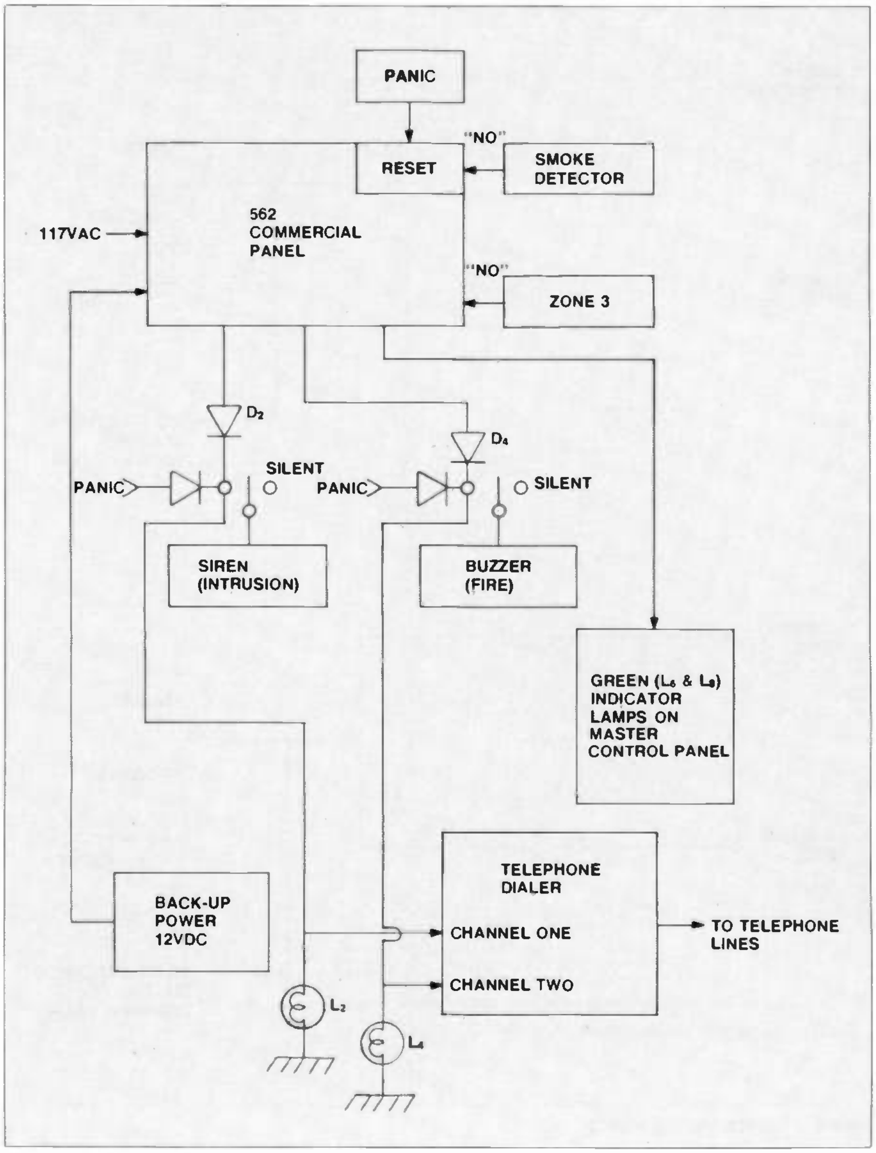

Figure 4 System II

If the dialer is dialing the owner of a business, the message can be very simple, e.g., "Intruder"; but if a central station is being called, the message will have to include the identity of the firm, and its address as well as the type of emergency. You will probably use the same telephone numbers for both fire and intrusion, but the messages will be different. Also, you should check local laws regarding sirens because in some places you are required to include a timed automatic cutoff.

The system described uses normally closed circuits for zone 1 and zone 2, and a normally open circuit for zone 3. In a practical application zone 1 and zone 2 might be in the same building with zone 1 an office area open 9-5 and zone 2 a manufacturing area open 7-3. Having different zones allows for activation of one without the other.

Zone 3 obviously could be another building, used only occasionally, so it requires separate circuitry. However, zone 3, with its normally open inputs from sensors might just be something entirely different. Recall that zone 1 and zone 2 are normally closed inputs. That means each one is a string of low-resistance door switches, window tape, break-wire across skylights, etc. Both of these zones are providing perimeter protection only, and the best use of zone 3 might be to provide area protection in both the office area and the manufacturing area. In other words, zone 3 could be both zone 1 and zone 2.

How would this work? Simple. When the last person leaves for the night, he activates zone 3 with inputs from several sensors throughout the building. These sensors will all be connected in parallel at the "NO" input to the 562 panel. (This requires something that installers don't like—a "home run", or conductor pair run from each sensor back to the panel.) The sensors can be point sensors like mat switches, line sensors like infrared beams or trip wires, area sensors like passive infrared motion detectors, or microwave or ultrasonic doppler motion detectors, or many others.

The advantage of connecting an area protection system as zone 3 is that it will generate an alarm even if the intruder has beaten the perimeter sensing system.

Conclusion

The system described is a very simple one, but I am sure that you can appreciate how complex it must seem to someone who does not work with electronics technology. Friends who work in this field tell me that their biggest problem is to find competent installers. They say that 90% of their service calls are to correct errors made in installation.

If you have any questions about this system or about this technology, please contact me c/o Electronic Technician/Dealer. ET/D

AC Theory and Reactive Networks, Part I*

All about AC

An adequate knowledge of basics can be of great help in understanding unfamiliar new circuitry and troubleshooting if in the absence of adequate service data. Here is a review of all the ac theory you once learned but have forgotten.

by Stan Prentiss

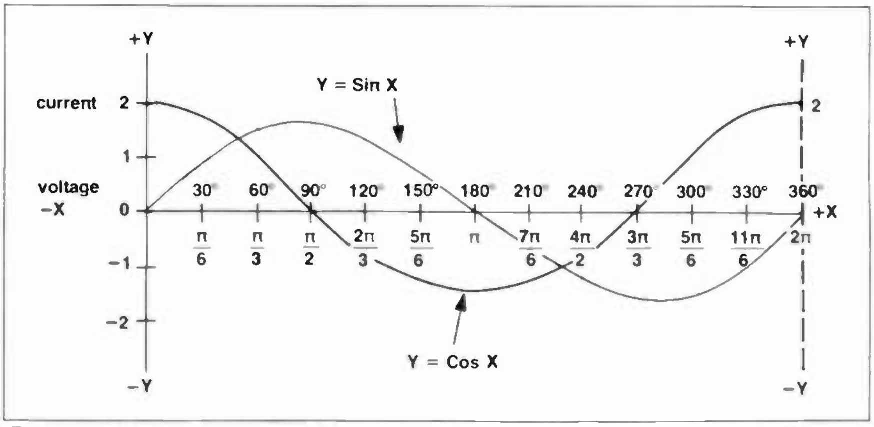

Fig. 1a A single cycle of alternating current (sinewave) showing y as (f) x for both sine and cosine functions. π always equals 180°. An example also of current leading voltage in a capacitive circuit.

Inductors, capacitors, transformers, and coupling-shaping networks, together with voltage dividers, form a very large segment of all electronics. Dc voltage and current are the motivators and operators for every conceivable simple network. In this you will see that capacitors and inductors have certain effects on both direct current and alternating current in signal transmission/reception. That is the elementary difference between plain electricity and the more sophisticated electronics. Both come from the Greek word elektron, meaning amber . . . And amber, when rubbed with certain fabrics and other materials, attract light particles of wood just as a comb will attract paper. Later, it was discovered by Ben Franklin and others that there are both positive and negative electricity that attract unlikes and repel likes, and these are now called electrons and protons, for negative and positive charges. In semiconductors, the charge carriers are currently identified as electrons and holes (a lack of electrons). As a further refinement, electricity can be considered in terms of work; and work means power . . . P = EI. Electronics uses this energy and power to deliver or receive information by wires, circuits, air, space, through the oceans, or by special radiation such as laser beams. As money is a medium of exchange, so electronics is a method of intelligence transmission. Satellites, radio, CB, 2-way communication and television are the world's outstanding examples.

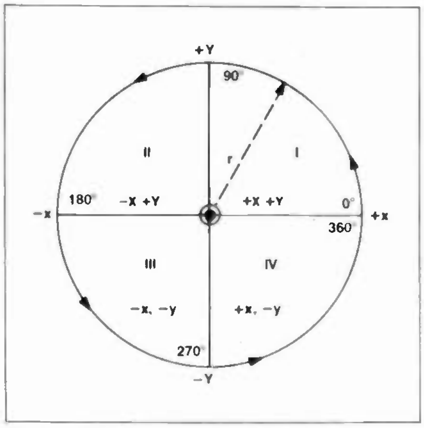

Fig. 1b The four quadrants and their positive and negative coordinates.

Alternating current

Almost all of the house or manufacturing current used in America today is delivered to us as alternating current (ac); and most electrical audio and video energy we hear and see arrives at receiver decoding circuits also as sinusoidal information in the form of signals whose waveshapes alternate above and below a zero reference line that is

from an unpublished book "Today's Electronics–Electronics for Troubleshooting," by Stan Prentiss

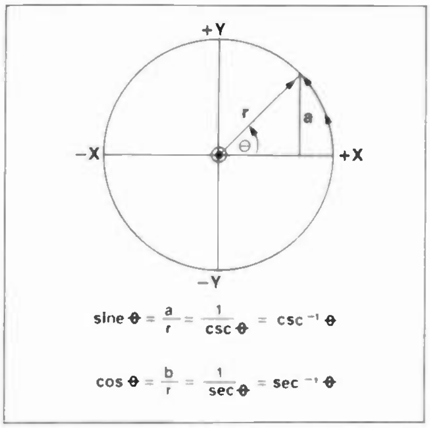

Fig. 2 Radius vector rotating about its (0) origin generates a unit of angular velocity.

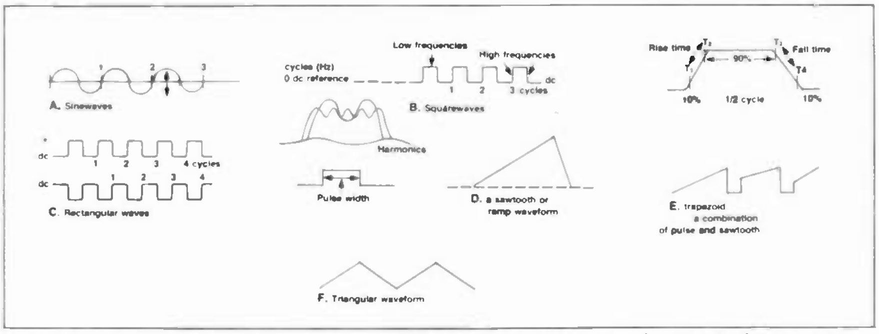

Fig. 3 Sine, square, pulse, ramp, trapezoidal and triangular waveforms all play a part in signal processing.

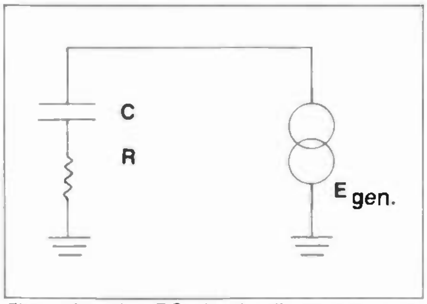

Fig. 4 A series RC circuit will charge and discharge at its RC time constant.

often referred to dc, to differentiate from positive or negative, or as simply a starting point. In Figure 1a, this alternation or sinusoid is drawn in the shape of a sinusoidal waveform, or what we commonly refer to as a sinewave. There are, of course, square, rectangular, triangular, sawtooth, trapezoidal waveshapes of all sizes and time durations, and we will discuss these also; but our main concern at the moment is with the all important sinewave, because that's the foundation for everything that follows.

This sinewave travels through an arc of 360 degrees, marked off in 30-degree sections (increments). As you see, it is also described in terms of radians where circular arc lengths are equal to the circle's radius. As you may remember from trigonometry, there are 57.295 degrees in one 360/2π radian, and π radians amount to 180 degrees. Any angle, of course, can be converted from degrees to radians by putting it over 180 degrees and producing the answer as a fraction of π radians. For instance 20°/180° = π /9 radians. The rest of the degree-radian table in Fig. 1a is calculated in exactly the same manner. Fig. 1b illustrates the counterclockwise travel route the sinewave travels beginning at 0 degrees and continuing through 360 degrees. As it passes through each quadrant, the signs for the X and Y coordinates change as shown. The sine (y = sin X) and cos (y = cos X) are identical except there is a 90-degree phase difference between the two . . . a most important relationship when the normal quadrature (90-degree) phase angle between current and voltage in inductive and capacitive reactances is considered. The two single cycles of alternations in Fig. 1a, of course, are dual curve plots of the same sine and cosine functions—the sine curve beginning and ending at zero, and the cosine curve being a unit mark identified at Y point 2 as one fourth cycle advanced over the sine function. Shortly you will see that one of these curves can represent voltage and the other current as we come to grips with reactances. Were we discussing pure resistances, the sine and cosine alternations would be superimposed on one another, since across pure resistances, current and voltage are always in phase.

The angular velocity of such a sine/cosine wave is also worth knowing because it represents the speed with which the radius vector r is turning about the center origin to generate the angle theta. With repetitive rotation, angular velocity is ordinarily measured in radians/second (radians per second), and this amounts to a repetition rate, or an established (constant) frequency. So the angle theta can now be expressed as a function of time and the number of radians the radius vector must pass in any period of time. Therefore, two fundamental ac equations have been developed that you must remember for all time—and never forget!

1. ω (the angular velocity in radians/sec) = 2 f, or 2 × 3.1416f where π (3.1416) is derived from dividing 180°/57.295° in 1 radian, with the sweep through an angle or 360 degrees every 1/f seconds, or 2 radians.

2. θ = ω t . . . representing the complete angle resulting from rotating a radius in t seconds at an angular velocity of radians. So θ could also equal 2 π ft.

In alternating current, the tangent, cotangent, secant, and cosecant functions are not used because, although they represent periodic events, their curves are not continuous throughout an entire cycle. However, in vectors such applications are essential.

In Figure 2, the sine and cosine of θ and their inverses—the secant and cosecant—are illustrated along with a unit of angular velocity. If you want to know the Y value at any point in either Figures 1 or 2, it amounts to: θY = r sin θ . . . since Y is proportional at all times to the sine of the angle times the length of the radius vector.

Waveforms

Of course, every video and audio waveform—be it voltage or current—is not simply a perfect sinewave: far from it! There must be variations, and these can be produced by changing amplitude (height) as well as frequency (duration), so that each pulse or curve of current can develop a voltage across some resistance/impedance viewable on a video screen or audible through a loudspeaker. As this article unfolds, you will learn how one waveshape can generate another waveshape that's related, but totally different, just because certain reactances at specific frequencies behave the way they do.

There are subsonic frequencies below about 20 or 30 Hz (Hertz), sonic frequencies between about 30 Hz and 15,000 Hz that can be heard by those with excellent hearing (others only hear to about 12 kHz), and supersonic frequencies above 15 kHz that animals may hear for a period, but then lose. By contrast, the eye

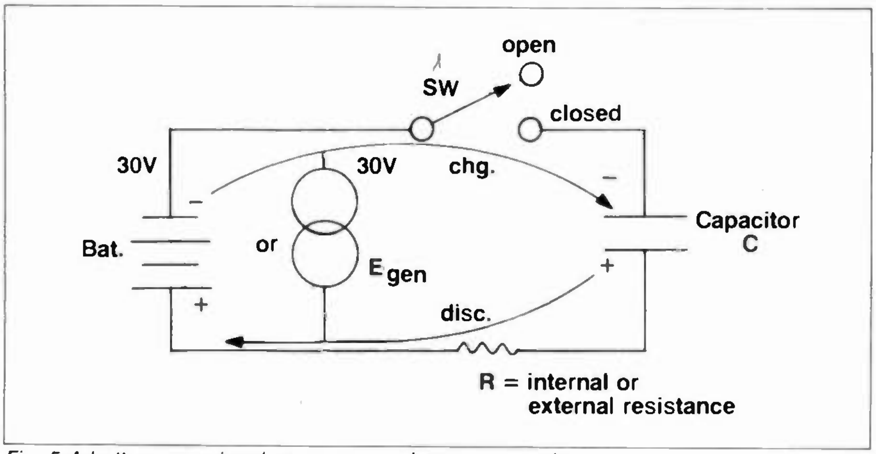

Fig. 5 A battery or a signal source may charge a capacitor

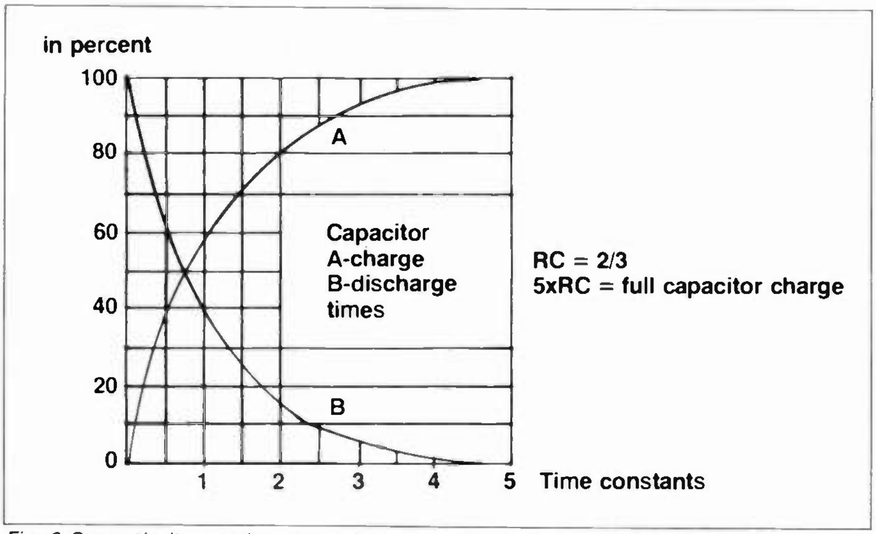

Fig. 6 Current/voltage value curves in exponential A, charge, and B, discharge, RC times of capacitors.

can easily see frequencies much lower than 15 cycles and, indeed, even millions of Hz (cycles), if it is properly presented in some sort of visible trace. The color spectrum, for instance is between 400 and 700 nanometers, and this translates roughly to between 3×10^{14} and 3×10^{15} Hz, an astonishing range since the nanometer is equal to one billionth of a meter, or 1/25,000,000 of an inch. So 400 nanometers amounts to 1/62,500 of an inch, while 700 nanometers become 1/31,500 inch. Obviously, the higher the frequency, the shorter the wavelength. At 460 nanometers we see blue, green at 500, yellow around 590, orange at 600, and red from 630 to 780 nanometers. Of course, red, blue, and green then combine to form white which, in Y additive, R-Y, B-Y, G-Y, color television is known as luminance and contains the lower frequencies constituting the black and white fine detail in the small areas of all color pictures.

Sinewaves, that you initially became familiar with in Figures 1 and 2 bear repeating. But if these are to carry information, they will vary both in frequency and amplitude, and their reproduction must faithfully reflect that same information broadcast or otherwise generated from some other network or transmitter. A pure sinewave of several cycles is illustrated in Figure 3A. The waveform amounts to three complete cycles rotating about a 0 or dc reference and extending from some negative to some positive amplitude. The positive portion has a positive peak amplitude, and the negative portion a negative peak amplitude. The two halves then combine their peak amplitudes (×2) to form what is known as peak-to-peak (p-p); and peak is 1.414 × the rms (root mean square) value, which simply means that an rms sinewave will always do the same work (power) a dc voltage of proportional magnitude will. So rms × 1.414 × 2 equals peak-to-peak . . . the ac reading of every service type oscilloscope ever invented.

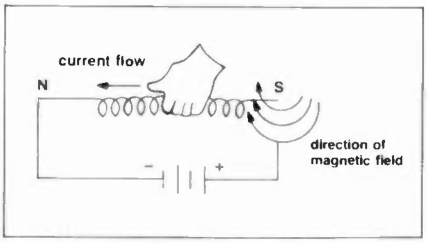

Fig. 7 An air core coil when held in the left hand, shows direction of both current flow and magnetic field.

Square waves (Figure 3B) are simply many sinewaves of odd-numbered harmonics whose rise and fall times (between the 10 and 90 percent points) are directly proportional to the quantity of these harmonics. With more harmonics, the higher the frequencies and the sharper the rise and fall times. Low frequencies form the top of each pulse, and high frequencies form the sides. Such waveforms are very useful in testing various types of circuits between rates of less than 1 Hz to many megahertz (MHz). This is especially true of audio and digital systems where faithful reproduction is essential to accurately recover transmitted intelligence. (Compensation used in video systems will not always do a square wave complete justice.) A square wave is so named because it has a 50 percent duty cycle—It's on half the time and off the other half(ór positive half the time and negative the other half.)

Rectangular waves (Figure 3C), however, are usually off or on more than half their duty cycle and this can be determined by multiplying their pulse duration (d) by repetitive rate (t) times 100. A pulse of .2 microsecond duration repeated once each microsecond, would have a duty cycle of 0.2 × 1 × 100, or 20 percent. Rectangular waves can show distortion too, but their main use is for trigger and synchronizing circuits in any digital or analog system where close tolerance sync is required.

Sawtooth or ramp waveforms (Figure 3D) are next and when combined with rectangular pulses they form a trapezoid. Unlike pulse and square waves, sawtooth waveforms are made up of a fundamental (original frequency) and both odd and even (2,3,4,5) harmonics. They are used as deflection currents in large inductances such as TV yokes and a ramp as an internal means of deflection in a sweep generator. Any sync system can find use for a

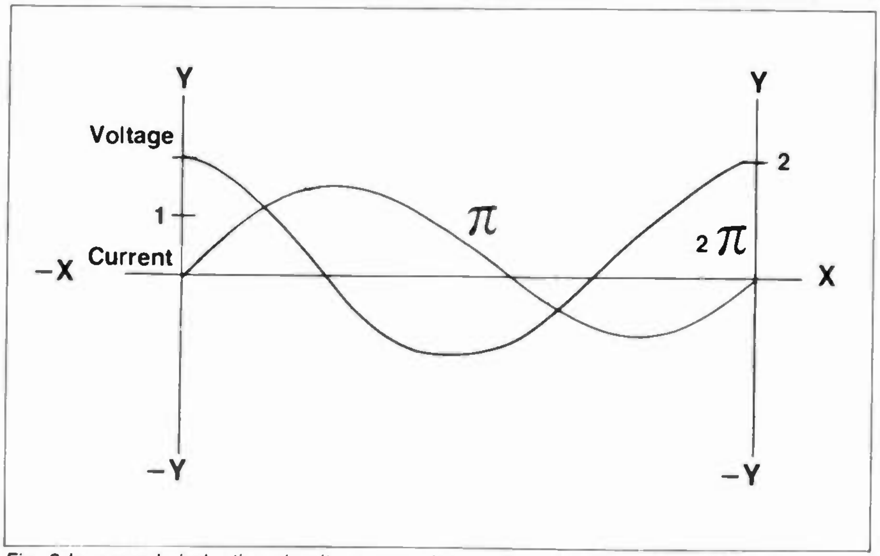

Fig. 8 In a purely inductive circuit, current lags voltage by 90°—or voltage leads current by 90°.

sawtooth when the rise times are quite slow and the fall times not especially abrupt. This is sort of a lazy waveform, but it can produce considerable driving power and may be made extremely linear (where voltage and current are proportional).

The trapezoid, shown next to the sawtooth in 3E, is also useful in deflection driving systems where the power outputs are vacuum tubes. Deflection coils with higher impedances have both inductance and resistance, and both a rectangular (for inductance) and sawtooth (for resistance) must be combined to drive such subsystems successfully. In solid state deflection systems with their lower, largely current-driven impedances, a rectangular wave swinging from near dc to some fairly high power supply level is sufficient. Here, coil dc resistance is negligible.

A triangular waveform (Figure 3F) is the final waveshape that will be considered now. The odd harmonics of this waveform begin at 9, then 25, 49, etc., are spaced far apart, and are not periodically regular. However, a triangle of voltage is useful in low frequency situations where harmonic distortion is easily seen, while high frequency oscillations can also be read on both rising and trailing slopes of the waveform. Crossover distortion—around the zero conduction point of push-pull amplifiers—can also be recognized using a triangular wave, as well as high and low frequency rolloff.

Capacitors

You know that dc currents and voltages power electrical circuits while alternating or digital energy supplies

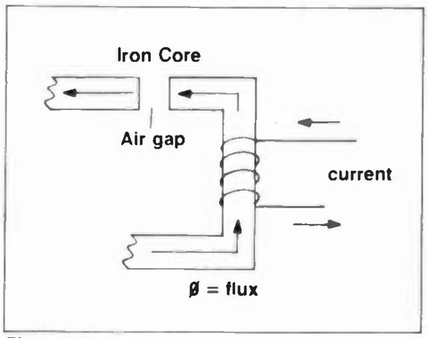

Fig. 10 A magnetic circuit, complete with flux, external windings and current, and air gap.

information, the components that have so much to do with these procedures need intensive explanation. For if you know precisely what capacitors (and inductors) do in electronics, much of the remainder is easy. Usually, the inductor is selected initially for explanation because its operations are somehwat easier to follow. But while your attention is fresh at the beginning of this discussion, let's consider capacitors and capacitance first. Inductors then may follow as both individual units and in combination with resistors and capacitors, forming complete RLC circuits.

A capacitor is any pair of conductors separated by an insulator called a dielectric . . . and the insulator may be polyethylene, mica, ceramic, foil, paper, , or even air, etc. Capacitance is the charge a capacitor will accept and store until such charge either leaks off or the capacitor is discharged. A capacitor has a value of 1 farad when 1 volt/sec. produces a current of 1 ampere. Its charge Q in coulombs (6.28×10^{18} electrons) is proportional to its capacitance and the

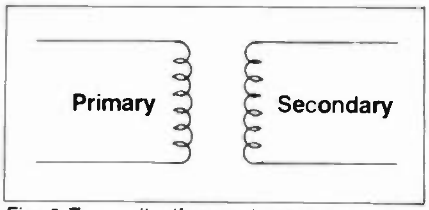

Fig. 9 Two coils, if wound correctly and spaced properly, form a very useful transformer.

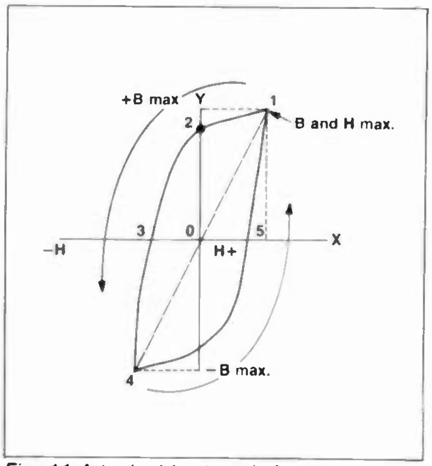

Fig. 11 A typical hysteresis loop.

voltage applied across it.

$Q = CE$, $C = Q/E$, $E = Q/C$

where C is capacitance in farads, and E is the applied voltage. One µF (microfarad) is 10^{-6} farad, and one pF (picofarad) is 10^{-12} farad. The term mF stands for (10^{-3}) millifarads; we now use only the symbol "µ" (mu) for micro and µµF is now pF. Energy stored in the charge across any capacitor amounts to W (joules in watt-seconds) and the following equations:

$W = 1/2\ (QE)$, $Q^2/2C$, or $1/2\ (CE^2)$

All are derived from the original $Q = CE$ identity in the paragraph above. Any parallel plate capacitor and its capacitance may be computed in inches by another equation:

$C = AK/4.45g$

where A is the area of one plate, K is the dielectric constant (found in certain tables; 1 for air), and g is the measurement (in inches) between plates.

A capacitor is a memory retention element that accepts and stores a charge until, by some, means it is discharged. The plates of any capacitor are the storage shelves for charges of electrons and the potential

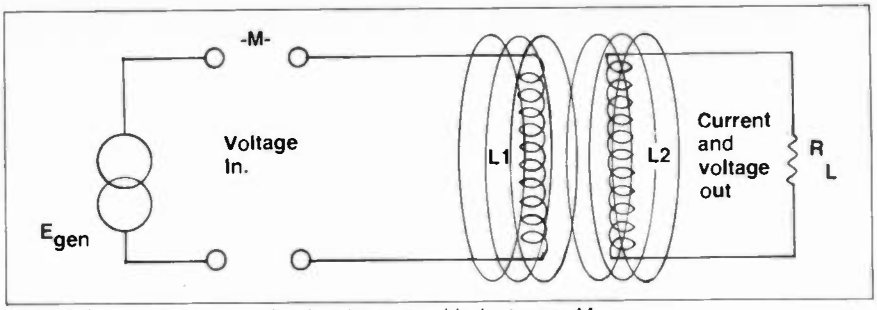

Fig. 12 Two coils in proximity develop mutual inductance, M.

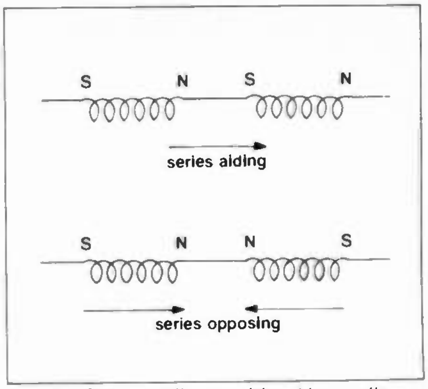

Fig. 13 Series aiding and bucking coils are used for a variety of purposes.

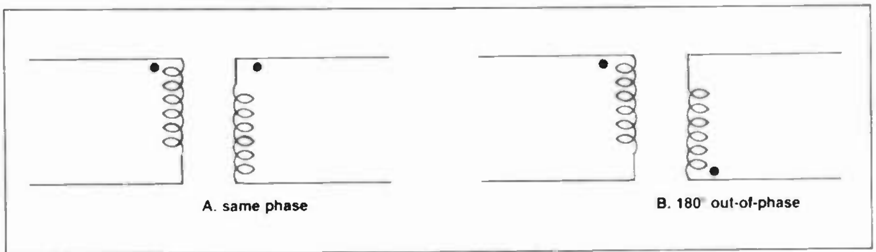

Fig. 14 A phase shift of 0° or 180° induced by different winding starts.

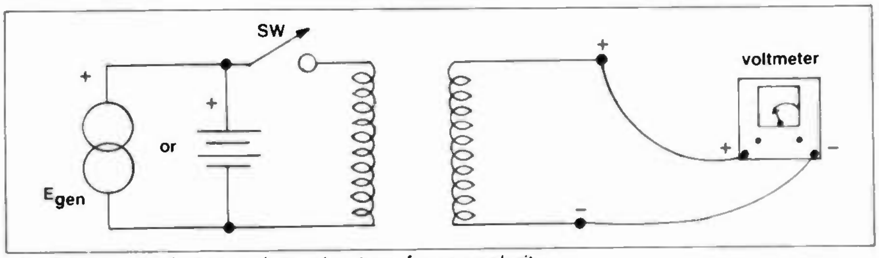

Fig. 15 An experiment to determine transformer polarity.

between plates across the dielectric is called an electrostatic field. The charge on any capacitor will be determined by the potential applied and the size, or surface area, of the two plates and the dielectric. An expensive, well-constructed capacitor may hold its charge almost indefinitely, but a cheap one, or one of very large value, will permit its charge to leak off in proportion to its size, dielectric, and quality. A resistor in series with the capacitor (Figure 4) may provide a timed period of charge and discharge that can become valuable in waveshaping, determining tube and transistor amplifier frequency characteristics, and audio sound compensation.

Capacitors are used frequently in both dc and ac circuits, where their behavior is often quite different because of steady state and the rising and falling levels of signal generation. But in both instances, the capacitor is charged and discharged and will react accordingly to surrounding circuit components and the charging source. Also, its use in both types of circuits differ and therefore, logically, so do its characteristics. In dc power circuits, for instance, large capacitances are needed to filter ripple, and therefore these have internal materials of aluminum, tantalum, etc., while high-frequency ac coupling capacitors may be ceramic, mica, polyethylene, or any other similar high quality dielectric. Capacitors also have both ac and dc potential ratings that many seem either not to understand or to ignore, but these ratings should be considered before particular capacitors are used in certain circuits. A 400V dc-rated capacitor, for instance, might well operate in a 600V ac circuit, but suffer a breakdown if the ac-dc voltage applied is reversed. In another instance, a large, somewhat leaky capacitor might be used as a bypass to remove the degenerative effect of an emitter resistor. But the leakage might also shunt the emitter resistor, negating its self-bias, so that circuit parameters would immediately be upset.

Charge & discharge

When any capacitor is charged to store electrical energy, there must be voltage applied to its plates. Figure 5 shows a condition where either a battery or voltage generator is in position to charge a capacitor to its partial or complete potential, depending on the time allotted. With the switch open, of course, no voltage can get to the capacitor, and neither capacitor plate is charged. When the switch closes, however, electrons flow from the battery's negative terminal to the nearer capacitor plate, delivering a negative (an excess of electrons) charge. When this occurs, all electrons on the capacitor's positive terminal are attracted to the battery's positive plate, causing an absence of electrons (holes in a semiconductor), resulting in (a less negative) positive potential. And, although there is current flow to and from the plates of the capacitor, no current flows through it because the dielectric (insulator) between its plates prevents current passage.

Nonetheless, the charge and discharge cycle makes it appear as though it does and in practical electronics we say capacitors couple one circuit to another, implying continuous current flow. There is now a voltage across this capacitor that reaches 63 percent of its fully charged state in a certain time. This time is the product of its internal or external resistance in ohms times its capacitance in farads and equals the elapsed time in t seconds:

$$t = RC$$

And this is known as the time constant of a capacitor. Interestingly enough, since current and voltage across any capacitor vary inversely, during the 63-percent charge time, the current is decreasing by 37 percent. Since capacitors charge, they must also discharge, and the same rules apply here, except the RC time constant begins at, say, 100 percent charge and reduces to zero. So as shown in Figure 6, the charge part of the time constant is exponential, as is

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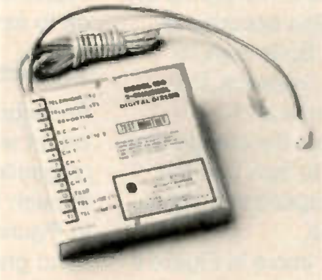

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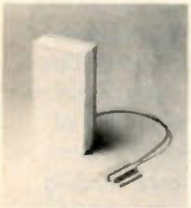

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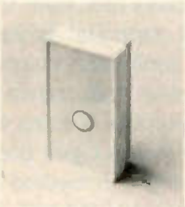

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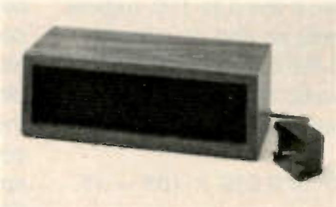

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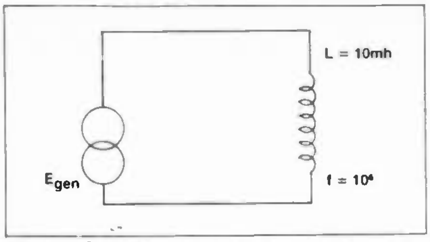

Fig. 16 Coils have ac reactance, depending on frequency.

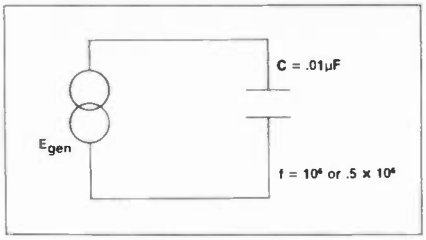

Fig. 17 Capacitors have reactance inversely proportional to frequency.

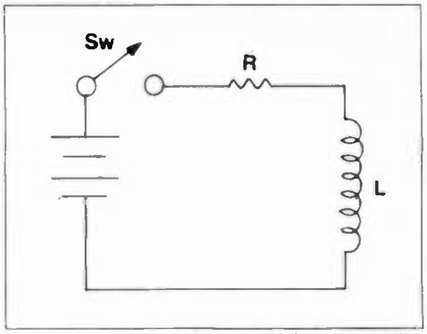

Fig. 18 A coil in a dc circuit charges and discharges exponentially just like a capacitor.

the discharge portion. In five time constants, the capacitor is fully charged and current stops flowing. As you see, current and voltage across any capacitor are precisely the inverse of one another: when current is maximum there is little or no voltage, and when current is minimum there is maximum voltage. So go back to Figure 1 and remember that in a capacitor, current leads the voltage since, during charge time, a voltage is built up across the capacitor that actually bucks the battery voltage. This voltage may be calculated from the equation:

$$e = E(1 - \varepsilon^{-t/RC})$$

where ε equals the base of natural logarithms (2.718)

t equals charge time in seconds
E is the battery voltage
r amounts to resistance in ohms
C is the capacitance in farads

Suppose, for instance, you had a 0.01 μf capacitor you were going to charge in 3 microseconds, a battery voltage of 20V, and a series resistance of 100 ohms. The numbers in the equation would now look like this:

$e = 20(1\text{-}2.718^{-3} \times 10^{-6}/10^{2} \times 0.01 \times 10^{-6})$
$e = 20(1\text{-}2.718^{-3} \times 10^{-6}/10^{-6})$
$e = 20(1\text{-}2.718^{-3})$ or $E = 20(1\text{-}\varepsilon^{3})$.

So natural log E(2.718) to the negative 3 can be looked up in the E^{-x} tables, or you can find the log of 1/3 × log 2.718.
Either way,
$e = 20(1\text{-}0.0498) = 20 \times .9502 = 19V$,
and the capacitor is so charged. As the capacitor charges, it may also be discharged, and here we return to current. If the capacitor is fully charged, its discharge current will amount to:
$i = -E/R\varepsilon^{-tRC}$, simply an Ohm's law $E = IR$
equation with the natural log and time constants added along with time.

Don't forget, you are still learning the dc functions of a capacitor! The ac portion is yet to come . . .

With no resistance in the circuit, the capacitor may instantly charge with a current surge; and the smaller the value of resistance, the shorter time the capacitor takes to fully charge. Inversely, the larger the resistance the greater the charge time because of smaller current flow. So in switch-operated circuits, for instance, the smaller the capacitance and resistance, the shorter the charge time until current ceases to flow and the voltage across the capacitor is equal to the battery voltage.

The time constant curve in Figure 6 is also as useful as it is decorative. For instance, a series resistor of 1,000 ohms and a 0.015 μF capacitor, could have what voltages and currents in 22 microseconds? If the 0 to 100 vertical scale represents ac and dc currents voltages, and the 0 to 5 horizontal scale is in classic time constants, the equations would amount to this:

$T = RC = 10^{3} \times 0.015 \times 10^{-6} = 15$ μsec
$TC = 22/15 = 1.47$

So the universal curve reads 1.47 time constants on A, the voltage at E = 77%, and current B (inversely) I = 23% let E = millivolts or microvolts, too, if you like, while I can be amps, milliamperes, or microamperes. The percentages you read out can apply to anything, as long as you stick to equivalent values of volts and currents, or even apples and oranges—if they can charge and discharge with some numerical resistance. Just remember that volts and amps vary inversely as they build or disperse energy, and the combination of the two on a 0 to 100 percent scale must always add up to 100.

At this point in this discussion we have a choice—continue on with capacitors in ac circuits, or introduce inductors, carry them through dc and simple ac circuits, and then combine inductors and capacitors in interactive ac circuits. The latter seems the better choice since capacitors and inductors are both reactances in ac circuits and their dual operations can best be explained together. So we'll now move on to simple inductors.

Inductors

An inductor can be any small or large coil of wire that produces an electro-magnetic field when current passes through it. The famous left hand rule in Figure 7 shows that when your left hand grasps such a coil with the thumb extended, both the direction of electron flow is established as well as the path (pointing of the fingers) of the surrounding magnetic field. A compass held near the conductor will point north just as your thumb does and verify both magnetic and current direction. Inductance is determined by the number of turns of wire, type of core (many types besides air), turns spacing and method of core winding, diameter of the coil, and the ratio of diameter to coil length. The greater the diameter of a coil, the larger its inductance.

As current increases through any coil, the magnetic flux about the individual turns expands and cuts adjacent turns. The effect is to induce current to flow in the opposite direction, building up a voltage (Lenz's law) that opposes the original current flow. Translated, this means that (Figure 8) current in an inductor lags the voltage by 90 degrees. Also, a decrease in current flow through an inductor induces another voltage that opposes this second change of current. As you will see later, an inductor is very useful as a choke in ac filter circuits to oppose ripple, and can be counted on to produce a large spike of reactive voltage whenever its electromagnetic field is suddenly collapsed and/or its current reversed. Two coils placed near one another can form a transformer (Figure 9) another useful device whose magnetic flux makes possible excellent circuit coupling without dc voltage interaction and also convenient impedance matching.

Cores and reactance

The core of a coil or transformer is actually a magnetic circuit that passes flux, and this flux depends on MMF—magnetomotive force (equivalent of electrical EMF electromotive force) and also the reluctance (analogous to electrical resistance) internally contained. The equation for such magnetic reaction is very similar to $E = IR$ Ohm's law except for the terminology:

$F = \phi R$; $\phi = F/R$; $R = F/\phi$ . . . a group of similar equalities, where F is the magnetomotive force in gilberts; ϕ (Phi) is the total number of lines of flux (Maxwells); and R is the reluctance of 1 cm^3 of air (or a vacuum). Such reluctance may be added in series or parallel, just like resistances. In Figure 10 is an illustration of such a magnetic circuit having all the elements of flux, external current (though windings), the iron core, and an air gap. The magnetomotive force F then can have a new relationship:

$$F = 4 /\pi\ 10\ (NI) = 1.257\ NI$$

where N is the number of wire turns, and I is the current in amperes. We may now also speak of the number of $lines/in^2$ or $lines/cm^2$ in terms of flux density, B. so that:

$B = \phi/A$; $A = \phi/B$; or $\phi = BA$.

"A" being the cross sectional iron core in in^2 or cm^2 through which the magnetic path passes.

The magnetizing force H is now identified as the magnetomotive force F in gilberts/cm. divided by the length of the path in centimeters:

$$H = F/L$$

Coil inductance is also proportional to its core permeability, and permeability μ is flux density in gauss B divided by the magnetizing force H in oersteds:

$$\mu = B/H,$$

Flux, of course, is equivalent to conductivity in electrical circuits, but varies with generated flux.

Skin effect is confined to ac systems (not dc), and is a term used to describe the contraction of flux at the center of a coil (or wire) and its expansion about the perimeter with varying current amplitudes. Consequently, wire impedance will be greater within the conductor than on its surface, so ac, naturally, will take the path of least resistance and follow the outer coil path. This effect is especially noticeable at high energy rates because inductive reactance is always proportional to frequency.

Radiation loss is another high frequency consideration that can become serious at upper megahertz and gigahertz frequencies.

Eddy current losses occur when coils are subject to a varying magnetic field—and since each conductor is cut by lines of flux, differences in potential result in a number of auxiliary currents being developed that serve no useful purpose. Unfortunately, they produce both heating and additional resistance which must be made up by added energy applied to the inductor.

Dc resistance of any coil is resistance measured with an ohmmeter and results from the type of material (copper, aluminum), length and diameter, and the effects of temperature.

A coil has an inductance of 1 henry

when a change of 1 ampere/sec. of current produces a back emf (electromotive force) of 1 volt.

Hysteresis

For some strange reason, hysteresis arises as the biggest goblin in simple magnetics. Once and for all, it is just a power loss in magnetic material; and this power loss is illustrated by the peanut-shaped curve in Figure 11. Very simply put, flux density B and magnetizing force H increase from 0 to positive peak 1 then decrease, with hysteresis following the curved path from 1 to 3, passing zero magnetizing force point 2, called the remanent flux density, and reaching 3, where the residual magnetism amounts to zero. The magnetizing force goes negative, to point 4—equivalent to point 1, but 1/2 cycle later—and then begins its increase toward maximum value, with the hysteresis curve continuing from 4 to 5 and then back to 1. The dotted line between points 1 and 4 is the B (flux density), H (magnetizing force) route and is the normal magnetizing direction.

Mutual inductance

When two coils are placed together so their magnetic fields are joined, a flux common to both loops is generated called mutual inductance (Figure 12). This mutual inductance M depends on the coils relative positions (to one another), their permeability ($\mu = B/H$), and the inductance of each coil. If two coils are coupled either tightly or loosely, they develop a coefficient of coupling called k, which is usually about 0.5 or less (except for power) and is a constant.

$$k = M\sqrt{L_1L_2}$$

with M standing for mutal inductance and L_1 and L_2 the primary and secondary of the two coils which now amounts to a transformer. Of course, if you know k, and the inductances of L_1 and L_2, mutual inductance is reasonably easy to find—just a little algebra:

$k^2 = M^2/L_1L_2$, then $M^2 = k^2L_1L_2$ or $M = k\sqrt{L_1L_2}$

and then L_1, for instance could be found as easily as L_2:

$L_1 = M^2/k^2L_2$ etc., if the other values are known. similarly, $L_2 = M^2/k^2L_1$.

The maximum value of k by the way, is 1 . . . so that when flux from one coil cuts all turns of the other, unity coupling has been achieved, and this is when k equals 1.

Aiding and bucking

Coils in working circuits are often tapped for impedance matching, separated for filtering and transformer action, placed in series and parallel for specific resonances, and in shunt (across one another) to construct transmission lines, and produce certain phase shifts. In a series aiding situation, (Figure 13) the north and south poles of each coil are connected to one another, and therefore flux produced in each coil combines with the other so both together produce an inductance total of:

$$L_t = L_1 + L_2 + 2L_{mutual}$$

But in the windings of these coils are series bucking, the total inductance is then less than either coil, and flux lines are consequently reduced. The total of the two still add, but the mutual inductance of the coils is now subtractive, so the equation looks like this:

$$L_t = L_1 + L_2 - 2L_{mutual}$$

Of course such coils may be placed in parallel for both series adding and bucking, and the equations would amount to the same as series resistors except, of course, the addition of L_m to each term. For instance aiding amounts to:

$$1/L_t = 1/L_1 + L_m + 1/L_2 + L_m$$

while opposing is: $1/L_t = 1/L_1\text{-}L_m + 1/L_2\text{-}L_m$

Such coils, naturally, can also be separated and used in different ways to change phase in transformers, and can be identified schematically by placement of the dots. If the dots are as shown in Figure C, 14A, the coils and flux are aiding, and there is no phase change but in Figure 14B, the voltages of the *unloaded* secondary are 180 degrees out of phase with the primary and, therefore, the output is inverse. Usually, most transformers *are* wound so that the polarities of their primaries and secondaries differ, and if dots are not shown on the transformer schematic, you may assume a phase difference of π or

180 degrees. If there is any doubt as to polarities, a signal generator or battery can be inserted in the primary half of a transformer and a dc voltmeter across the secondary Figure 15. If, when the switch is closed—and this has to be the case for *instantaneous* voltage from the battery—the meter kicks positive, the two coils are wound from the same starting point and the resulting voltage is *in phase*. If the voltmeter pegs, or goes upscale only when its polarity is reversed, then the secondary windings are in opposition and there is a 180-degree phase change. Switch SW is needed because steady state batteries cannot produce a coil interchange of flux after initial turn on; only alternating voltages can.

Reactance and Time Constants

The temptation at this point is continue immediately with transformers, and leave other coil knowledge for the combined circuits, but this could become confusing, especially since capacitive reactance has already been treated separately. So we'll work through the remaining inductive characteristics before considering the subject of *real* transformers, rather than simply the set of unleaded, air-core coils.

Inductive reactance, therefore, is the electromotive force (emf) opposition that builds up within a coil to oppose the flow of alternating current. To sound slightly sophisticated, it amounts to:

$e = L\,di/dt$ or $L\Delta i/\Delta t$

where L is the inductance and di or Δi and dt or Δt mean the rate change of current with respect to time. Calculated with inductance, they produce the value of the counter—*emf* developed across the inductance. The triangular symbol, of course, is called *delta*, and represents a larger increment than the differential di/dt. The instantaneous value (in ac) of this current is:

$i = I_m \sin\omega t$ (where $\omega = 2\pi f$, or 6.28 × frequency)

The instantaneous value (in ac) of the voltage is:

$e = \omega L I_m \cos\omega t$ (I_m = maximum current at that instant)

So, by now, you can begin to pull together the sine alternation and the cosine alternation, and mentally visualize the current—because of the resulting counter emf-actually *lagging* the voltage in a purely inductive circuit by 90 degrees. And, because of the counter emf, current is *choked* and physically reduced in magnitude. The opposition to this current flow at differing frequencies is called *inductive reactance* and results in the equation:

$X_L + \omega L$ or $2\pi fL$ since $\omega = 2\pi f$

In Figure 16 for instance, if a generator is pumping in a sinewave at a frequency of 1MHz, and the coil value is 10 millihenrys (mH), the inductive reactance at that frequency would be:

$X_L = 6.28 \times 10^6 \times 10 \times 10^{-3} = 62.8 \times 10^3$ or 62,800 ohms at 500KHz—half the frequency—the reactance of this coil would decrease to:

$X_L = 6.28 \times .5 \times 10^6 \times 10 \times 10^{-3}$ or 31,400 ohms, exactly half.

The capacitive equation (Figure 17) is: $X_c = 1/2\ fC = 1/6.28 \times 10^6 \times 0.01 \times$

10^{-6} = 1/.0628 = 15.9 ohms
but X_c = 1/2fC at 500kHz amounts to

$X_c = 1/6.28 \times .5 \times 10^6 \times 0.01 \times 10^{-6}$ = 1/0.314 = 31.9 ohms and this is just about double the reactance as the frequency decreases by half. So we can truthfully say that the reactance of a capacitor changes precisely opposite to that of an inductor with changes in frequency. Such opposing reactions are highly useful in maximum power transfer (impedance matching), filters, waveshaping, and resonant circuits, etc. Now, with inductors and capacitors having different responses under similar circumstances, additional methods are needed to calculate what their reactive impedances and phase angles are going to be as alternating currents and their driving voltages change.

Time constants for the inductor have considerable similarities to those for capacitors, and both can use the same charge-discharge curve (Figure 6). However, an electromotive force is present to oppose current changes, and therefore we think of inductors in terms of current rather than voltage. Both charge and discharge equations follow the capacitor's rules (Figure 18), except that resistance R is now on the top portion of the exponent with the L below, whereas in the capacitor, both R and C (RC) were below the exponential line and divided into time t. The natural log to the base E continues to be used as does the usual voltage and resistance. So in dc circuits, the equations look like this:

$i = E/R(1 \cdot \varepsilon^{-Rt/L})$

with i in current (amps), t in seconds (after the switch is closed), inductance L in henrys, dc volts in E, and total circuit resistance in R (ohms). Here, time constant T is the time in seconds from the moment the switch is closed until current has risen to 63 percent of its full value and amounts to the equation:

$T = L/R$

where L is the inductance in henrys and R the resistance in ohms. An inductance of 15 mH, for instance, might have circuit resistance of 1K ohms. So the time would be:

$T = 15 \times 10^{-3}/10^3 = 15 \times 10^{-6}$ or 15 microseconds.

If we wanted to know the current through such an inductor with E representing 20V:

$i = 20V/10^3\ (1\text{-}\varepsilon^{-Rt/L})$ and $^{-Rt/L} = -10^3 \times$
$\times\ 15 \times 10^{-615} \times 10^{-3}$
$i = 20 \times 10^{-3}\ (1\text{-}\varepsilon^{-1})$
$i = 20 \times 10^{-3}(1\ 0.3679)$
$i = 20 \times 10^{-3}(0.6321) = 12.642$ milliamperes

That, being the charge circuit, the discharge equation is simply:

$i = E/R(\varepsilon^{-Rt/L},)$

and, of course, the calculations are done in exactly the same way except there is no subtraction of the natural log product from 1. Surprisingly, the charge and discharge curves are spoken of as transients, because such an electrical action would be a one-time occurrence and not ordinarily repetitions.

To be continued

Brush up on your trigonometry. Next month we'll discuss vectors and get into complex circuits of resistance, capacitance and inductance, things you haven't thought of lately. **ETD**

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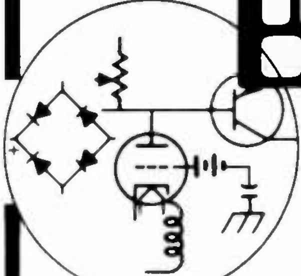

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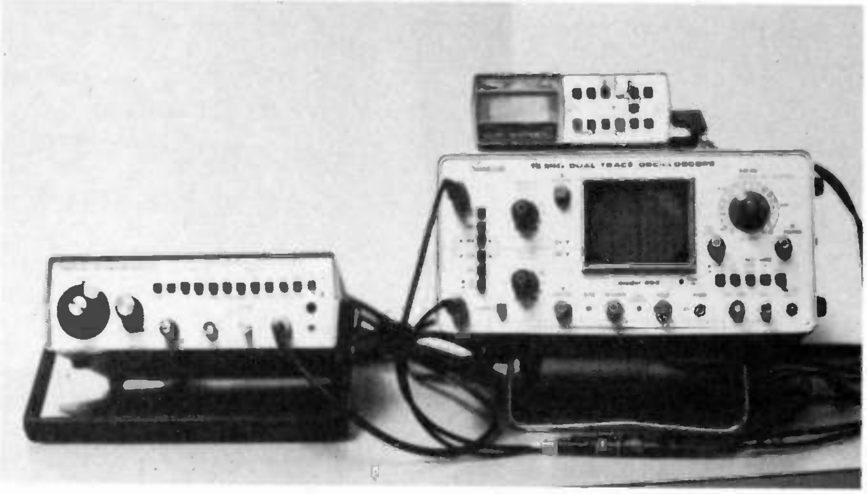
TEST INSTRUMENT REPORT

Featured in this month's Test Instrument Report are 3 pieces of quality equipment from Simpson that could help equip a starting shop or one that is already operating on a relatively tight budget. The three are the Model 467 3 1/2 DMM, the Model 420 Function Generator, and the Model 454 15MHz Dual-Trace Oscilloscope. The Model 467 incorporates some unique features not found in most other DMM's. The most unique of these features is the combination digital and analog display using an LCD bargraph. The bargraph reading corresponds to the numerical reading in both the ac/dc volts and ac/dc ma functions. The bargraph reading will follow changes in varying inputs and will display 110% of



Simpson's Models 420, 454, and 467.
For more information circle No 150 on the reader service card.

Simpson's 420, 454 and 467

Reasonably Priced Trio

by Peter B. Credit

the range selected. Another unique feature of the 467 is that the pulse detection mode will give visual and/or audible indication (buzzer sound) of either negative or positive pulses and logic states. The dc and ac voltage range of the Model 467 is 200mv to 1000mv with a reported accuracy of ±0.1% of input ±1 count on dc and ±1.5% of input +5 counts on ac (20-40Hz).

The resistance range is 200Ω to 20MΩ with a reported accuracy of ±0.25%)up to 2000KΩ). The dc current range is 200µa to 2000ma with an accuracy of ±0.5% of input +1 count except the 200 ma and 2000ma ranges which it is said to be ±0.75% of input +1 count. The 20K, 200K, and 2000K ranges have an open circuit voltage of approximately 0.45v, with enables in-circuit resistance measurements to be made without turning on semiconductor junctions. The other ranges have an open circuit voltage of approximately 2.4v, which will turn on semiconductor junctions for in-circuit testing. I found the Model 467 pleasant to operate due to its versatility and the unique combination of the analog and digital display. The price of the 467 is $239.00.

Next is the Model 420 function generator that provides sine wave, triangular wave, and square wave output, plus TTL, covering a frequency range of 0.1Hz to 1MHz in seven ranges. The output of the 420 is stated to be 20v p-p open circuit and 10v p-p into 600 ohms (both checked out) with a dial accuracy of ±3% full scale (1Hz to 100kHz), ±5% full scale overall. The fixed TTL compatible output will drive up to 10 TTL loads with an approximate rise/fall time of less than 25 nsec.

The output impedance of the Model 420 is 600 ohms ±5%, and the power requirements are 120/220/240 vac for the A model and 4 "C" sized batteries for the D model. Some applications of the 420 include: digital circuit design, communications and telemetry equipment, sound and vibration analysis, high fidelity equipment, signal transducers, control and information display systems, production testing and instrument repair or calibration, some of which are thoroughly covered in the operators manual. The compact size and weight (3 lbs) of the 420 would be very convenient for field servicing. The price of the Model 420 is $175.00 for the A model, and $210.00 for the D model. Completing the trio of test instruments this month is the Simpson Model 454 3″, 15MHz dual trace oscilloscope. The vertical and horizontal sensitivity of the 454 is 5mv/div to 10v/div calibrated in 11 steps; accuracy is said to be ±5%. Maximum input voltage for both ac and dc is 250v dc+ ac peak. With the X10 probe it is 500v (to 1kHz). Features include dual vertical inputs that permit simultaneous viewing of two waveforms plus differential amplifiers from inputs through deflection stages that provide common mode noise rejection for stable waveforms. The 454 displays channel A, channel B, A and B, A plus B, and A minus B. A chopping rate of 100kHz is also provided for low speed waveforms along with triggering–external, channel A or channel B with TV sync position. The 454 has a 24 µsec rise time for display of digital pulses and fast sweeps. I like the compactness of the 454 (4-5/8 × 9-7/8 × 13-1/4″) and its weight (13 lbs) and also the pushbutton operation. The only exception I noted to the overall ease of operation was the tightness of the tim/div knob which I thought could have been easier to turn. The 454 is supplied with two low capacitance X1/X10 probes and operator's manual. The price of the Model 454 is $675.00. ET/D

SECURITY PRODUCTS

Radar Alarm System

Circle No. 134 on Reader Inquiry Card

Seeker Security Systems, Inc. has announced a new radar burglar system, the Seeker I. The basic system consists of a control unit, sensor, siren, ni-cad battery, panic button and hardware for installation. Features of the Seeker I system include false alarm protection, selectable alarm mode, test feature and exit and entry delays. The range of the basic Seeker I system is said to be adjustable from six to forty feet with a 100 foot sensor being optional. Stand-by power is available by way of a ni-cad battery package which is supplied.

Microwave Alarm System

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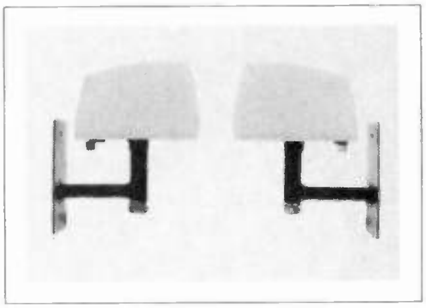
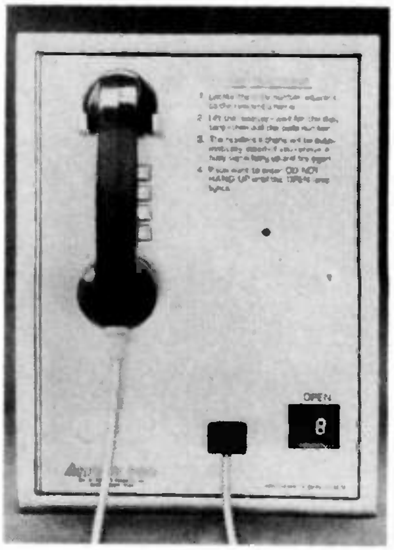
NJR Corporation has announced a new indoor/outdoor microwave span alarm system. The NJF4017 is designed for indoor/outdoor periphery protection and reportedly will cover a range of 200 feet. The transmitter and receiver produce a sharp beam that is said to be stable against vibration, noise, wind, fog, rain, snow, dust or extreme temperature change. The system operates on 12 volts dc and has wall or optional pole mount brackets. The units can be mounted to walls, fence posts, or any stable structure. Integral "gunsights" permit rapid alignment without the use of special equipment. Special circuits automatically compensate for background and environmental conditions, therefore eliminating field sensitivity adjustments.



Telephone Security System

Circle No. 136 on Reader Inquiry Card

Trigon Electronics has announced its telephone entry system, the Trigon 600, which is designed to operate solely through the use of standard telephone circuitry for voice path. Successful operation of the Trigon system requires only the use of existing telephone lines and standard telephone components. By eliminating the task of wiring a building for an intercom system, the Trigon 600 has overcome what was previously considered to be the major drawback in the installation of a limited access security system. The only installation necessary for the Trigon 600 is a single unit at each area of entry. Installation and programming can reportedly be completed in as little as three hours because no intercom wiring within the building is necessary. By using existing telephone lines, many locations are feasible. A visitor simply dials the desired resident's two or three digit code. The resident then touches or dials a single digit on his telephone, which releases the security gate and allows the guest to enter. Touch tone operation enables the entire procedure to take place within seconds. Emergency numbers such as the police and fire departments can be programmed into the unit. The postman has a special switch which insures inside mail delivery. The apartment manager is able to allow maintenance people onto the premises or talk to prospective residents from a distance. The Trigon 600 is reportedly the only telephone security system that can be completely programmed and verified from the exterior of the unit. A special "Times Up" feature emits an audible warning before the telephone automatically disconnects, which limits all calls to less than three minutes. The system's unique front panel display feature allows complete operation of the unit from the external keyboard and verification of the stored telephone numbers on a front display panel. It also has a microprocessor with an associated memory, which gives the system the programmed intelligence to perform automatic dialing of up to 580 telephones. The Trigon telephone entry security system comes with a 5-year service warranty, and is registered with the Federal Communications Commission.



Ultrasonic Intrusion Detectors

Circle No. 137 on Reader Inquiry Card

The *Alarm Device Mfg. Co.* has introduced two new ultrasonic intrusion detectors, Models 750 and 754. Both models contain independently adjustable swivel transducers which allow you to aim and shape the pattern of protection to fit the coverage area. The No. 750 has one pair of transducers which cover 450 sq ft, while the No. 754 has two pairs covering 900 sq ft. Each unit is available in 6 and 12vdc versions and can be powered by many Ademco controls. A 12vac model is available in each unit complete with built-in battery and plug-in transformer. Both units can be mounted on walls, ceilings or in corners. With a switched voltage provided over two wires from an Ademco control, the Nos. 750 and 754 can both provide alarm memory, night LED disable, silent relay, and day transmitter shut off functions. Alarm memory allows for quick area intrusion identification by simply illuminating the LED's on those detectors in only the affected areas. The night LED disable engages by cutting a single jumper and disengaging the walk test LED. The silent relay permits the user to silence the alarm relay during the day while maintaining a visual indication of the walk test LED. By cutting a pair of jumpers, the transmitter can be shut off automatically whenever the control panel is disarmed. ETD

Electronic quiz solution.

1. c	6. d	11. d	16. a	21. c
2. c	7. a	12. c	17. b	22. c
3. b	8. c	13. d	18. a	23. a
4. a	9. a	14. b	19. c	24. d
5. b	10. c	15. a	20. a	25. c

You should have missed no more than 6 questions to make 75%. If you missed more, you could use some reviewing of electronic fundamentals. **ETD**

ALARM SYSTEMS

continued from page 24

heater closet) will provide good protection.

The inclusion of a wireless panic system adds the final touch to the overall protection system. A portable RF transmitter and receiver connected to the twenty-four hour fire/panic circuit in the LKC-50 control are all that are required for the panic system.

The system just described is not what one would consider elaborate; it is a typical residential system. Numerous items of equipment could be added to effect a higher level of security. For example, the windows could be protected with foil tape or glass breakage detectors or a telephone tape dialer could be added. The cost to the customer for protecting all of the windows would be between $250.00 and $350,00; adding a telephone tape dialer would be an additional $200.00.

The system price to the customer assumes that the system will be *sold* to the customer. Should the dealer decide to *lease* the system, he must decide how much to charge for installation and how much the monthly lease fee will be. In general, it is better for small dealers to *sell* systems. There are ways to be competitive with the large alarm companies on a leasing and monitoring basis. However, space does not permit a complete discussion of the potential—both good and bad—for entering the lease/monitor market. **ETD**

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