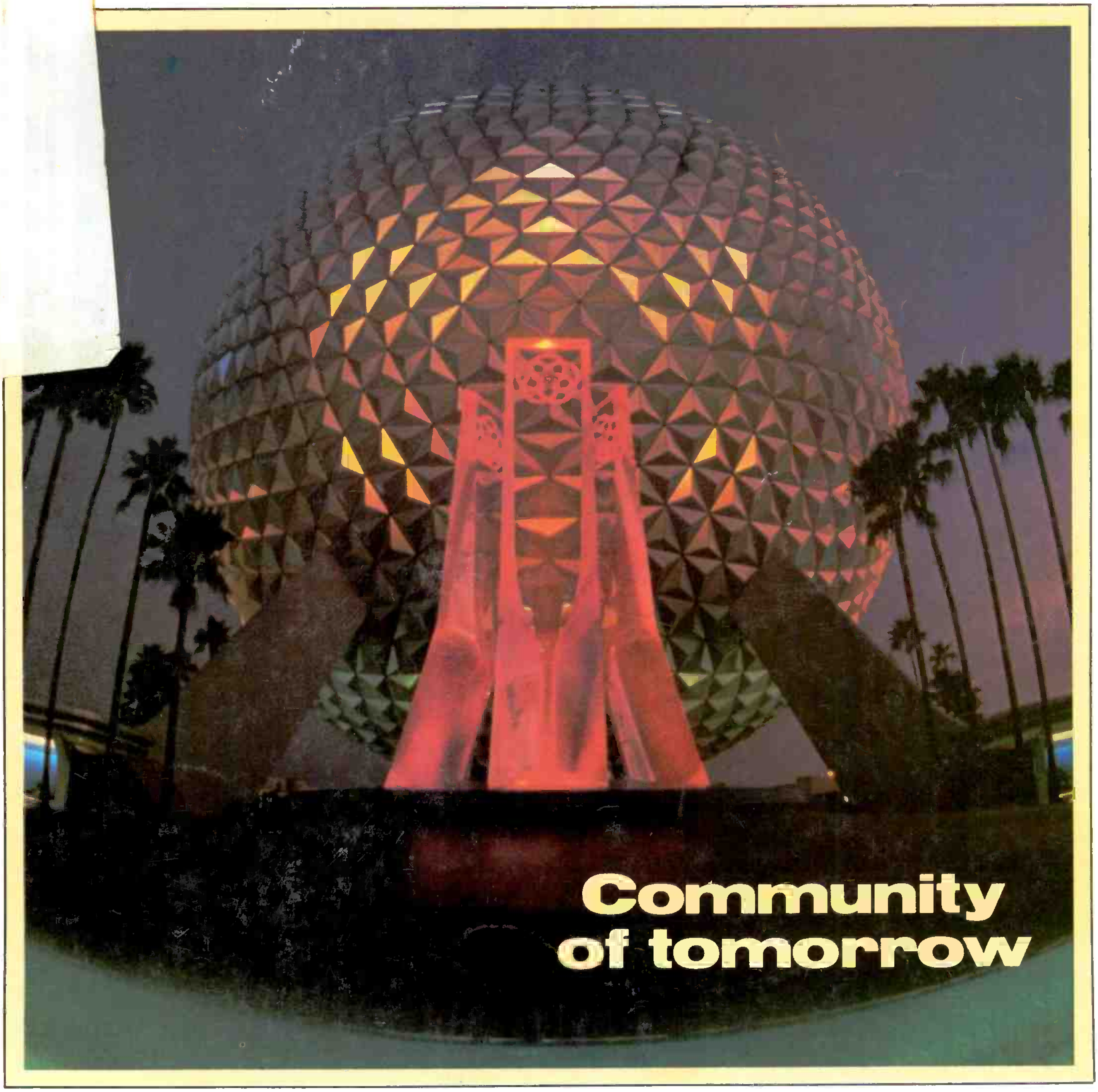
ELECTRONIC™

Servicing & Technology

AUGUST 1983/$2.25

Build your own logic probe

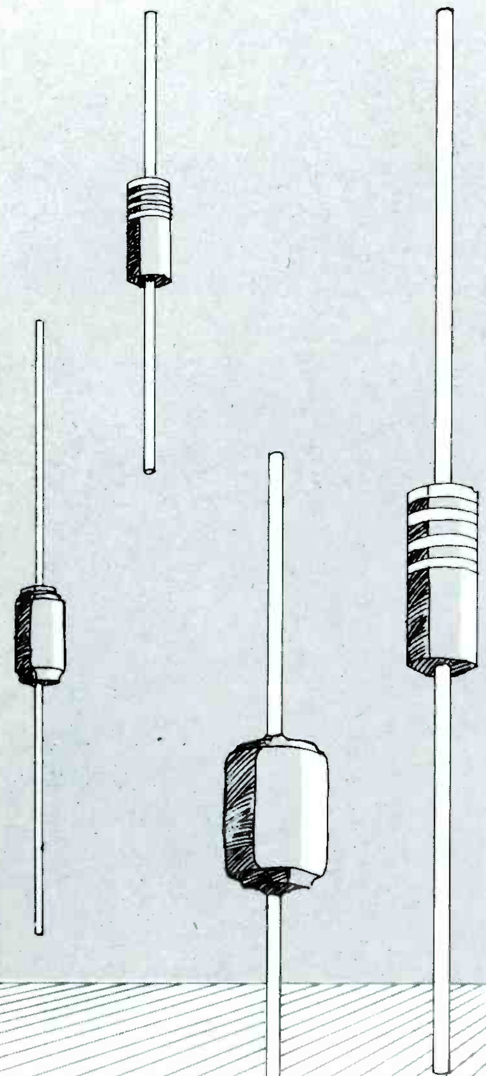
Setting up for audio servicing



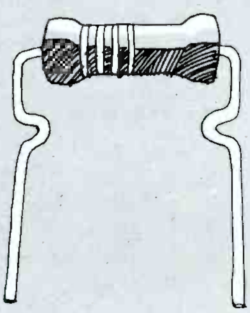
PTS CORPORATION
No. 9 in a series
Sylvania 02-37503

Module Update

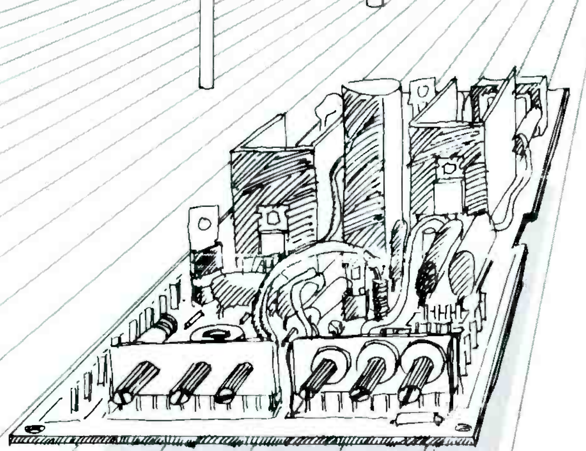
PTS automatically updates this deflection module to prevent vertical height problems, intermittent horizontal shutdown and component overheating.



A review of PTS' computerized service records of this deflection module revealed excessive failure rates of two capacitors. Automatic changes extend the capacitors service reducing vertical height problems and intermittent horizontal shutdown.



Three resistors were also identified for consistent part failure. Automatically changing two 68K, ½ watt resistors to 1 watt, and a 300 ohm, 2 watt to 270 ohm, 3 watt eliminated the overheating problem. Automatic updates are only one reason thousands of service technicians specify quality PTS rebuilt tuners and modules. You can also depend on complete overhaul, stringent testing in live chassis, fast service and nationwide availability.



You'll find PTS quality rebuilt modules with automatic updates at over 1,500 locations nationwide. For the name of the location nearest you and your free copy of the PTS Price and Technical Information Guide, use the reader response card or write: PTS Corporation, P.O. Box 272, Bloomington, IN 47402.

PTS™ **PTS CORPORATION**

Circle (1) on Reply Card

"Just one call shows you why MCM is . . .

THE ONLY ELECTRONIC PARTS COMPANY YOU'LL EVER NEED.

Your business depends on quality parts and quick, efficient service and delivery. That's why we at MCM try our best to meet your needs. We have over 4,000 electronic items in stock to let you get all the quality replacement parts you need in just one call. Our friendly salespeople take pride in knowing your business needs and giving the prompt, personal attention you deserve.

Our shipping department is fast and dependable. You can be sure that we'll ship exactly what you need right away. The parts are on their way to you within 24 hours.

Best of all, we won't make you pay more for our great service. Saving you money with some of the lowest prices in the industry is just part of what makes us your best choice.

Here is what some of our customers say about MCM:

"I appreciate your large stock of semiconductors and your quick service. I have a small business and your company has been of tremendous help."

"I have dealt with many companies in the past and your service is the finest of them all."

We know you'll feel the same when you've given us a call! Join our satisfied customers by calling for your **NEW FREE 96-PAGE MCM ELECTRONICS' SUMMER CATALOG #6. CALL TODAY TOLL FREE FOR YOUR COPY.**
1-800-543-4330
(in OHIO 1-800-762-4315).

mcm ELECTRONICS

RIGHT PARTS, RIGHT PRICE,
SHIPPED RIGHT AWAY.

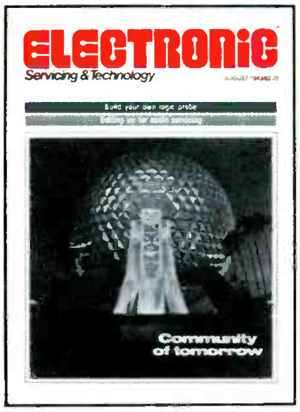
858 E. CONGRESS PARK DR. CENTERVILLE, OHIO 45459

Circle (4) on Reply Card

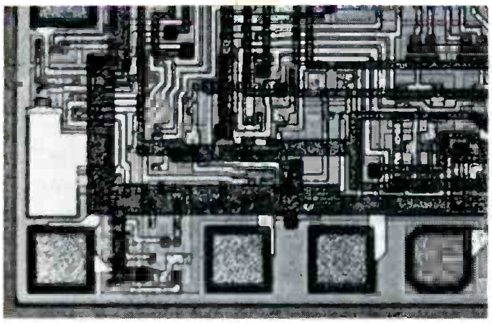
The how-to magazine of electronics...

ELECTRONIC Servicing & Technology

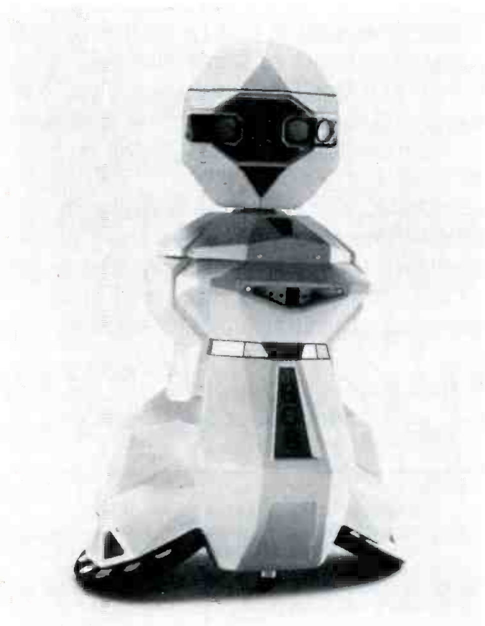
August 1983
Volume 3, No. 8



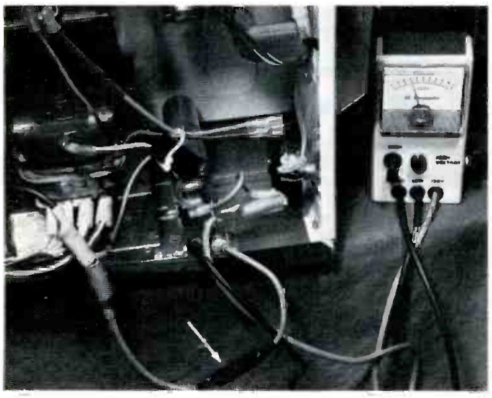
The 17-story geodesic sphere on the cover is Spaceship Earth, the landmark structure of Epcot Center in Orlando, FL. Epcot is a 260-acre example of how technology will change our lives in the near and far future. See article on page 40. *(Photo provided by Walt Disney Productions, © 1983.)*



Page 8



Page 42



Page 48

Departments

Next month...

How to service RCA CTC108 chassis. An experienced technician describes the circuit operation, methods for testing the basic circuits and common failures of this color receiver.

The new consumer electronics: more than TV

Another Consumer Electronics Show has come and gone. Perhaps it's pointless to write about it: For those of you who attended, no description is necessary; for those who didn't attend, no description is possible. Still, the magnitude of CES so staggers the imagination that there's some kind of compulsion to try to sum it up, to draw some kind of conclusions.

One conclusion is unavoidable. The electronics industry is healthy and dynamic. Traditional electronic products such as TV sets continue to sell in increasing numbers and TV manufacturers were at the show in force. In addition to that, more new products continue to be introduced at the show: digital audio disc players, computers, videogames and more.

The electronics industry is becoming increasingly a driving force in our society. Television, computers and other electronic marvels have changed the way we live more than we know. The new products constantly being introduced will have their impact, too.

One of the trends that was most apparent at this show was the trend toward personal ownership of telephones. Five years ago, virtually no one owned a telephone. Today anyone can go to a department store, discount store, convenience store or grocery store and buy a phone for ten bucks. More sophisticated phones that can dial themselves, answer themselves or allow the owner to walk around unfettered by a cord are available for a few dollars more. There were more than 100 companies listed in the CES directory as merchandisers of telephones.

That's only one aspect of what appears to be a greater trend – the trend toward total personal communication. Some of the new products allow you to forward telephone calls so that you can have your home phone direct incoming calls to any location you're going to visit. Another company offers a personal paging system so you can be sure to get all your messages immediately. General Electric has a system under development that will interface your home telephone with a mobile radio system so you can make and answer phone calls from your car without waiting forever to be assigned a mobile telephone frequency.

Already the central focus of attention in the home, the TV set will become even more so, and it will continue to serve even more functions. The progress of the utility of the TV screen has been remarkable to this point. Originally it was designed to receive TV broadcast programs. Then cable was added. Then video games, home computers, VCRs, videodiscs and satellites became sources of information to be displayed on the TV screen. But the electronics manufacturers aren't finished with the TV screen yet. Teletext is a reality in Europe now, and it will be in the United States soon. Manufacturers of home control systems plan to make the TV "intelligent" and use it to perform part of the control function and to display status information. No doubt there will be yet more uses.

The Summer Consumer Electronics Show in Chicago this past June was a circus – a busy place that defies description or interpretation. But much of the technology demonstrated there will in its season be woven into the fabric of our society.

Nils Conrad Persson

ELECTRONIC Servicing & Technology

Editorial, advertising and circulation correspondence should be addressed to: P.O. Box 12901, Overland Park, KS 66212-9981 (a suburb of Kansas City, MO); (913) 888-4664.

EDITORIAL
Bill Rhodes, *Editorial Director*
Nils Conrad Persson, *Editor*
Carl Babcoke, *Consumer Servicing Consultant*
Rhonda Wickham, *Managing Editor*
Tina Thorpe, *Associate Editor*
Brenda Wesierski, *Editorial Assistant*

ART
Kevin Callahan, *Art Director*
Kim Nettie, *Graphic Designer*

CIRCULATION
John C. Arnst, *Director*
Evelyn Rogers, *Manager*
Dee Manies, *Reader Correspondent*

ADMINISTRATION
R. J. Hancock, *President*
Cameron Bishop, *Publisher*
Eric Jacobson, *Associate Publisher*

ADVERTISING
Greg Garrison, *National Sales Manager*
Liz Turner, *Production Manager*
Robyn Kahn, *Marketing Coordinator*

Member, Audit Bureau of Circulation

Member, American Business Press

ELECTRONIC SERVICING & TECHNOLOGY (USPS 462-050) (with which is combined Electronic Technician/Dealer) is published monthly by Intertec Publishing Corp., 9221 Quivira Road, P.O. Box 12901, Overland Park, KS 66212-9981. Second Class Postage paid at Shawnee Mission, KS 66201. **Send Form 3579 to P.O. Box 12952, Overland Park, KS 66212-9981.**

ELECTRONIC SERVICING & TECHNOLOGY is the "how-to" magazine of electronics. It is edited for electronic professionals and enthusiasts who are interested in buying, building, installing and repairing home-entertainment electronic equipment (audio, video, microcomputers, electronic games, etc.).

SUBSCRIPTION PRICES: one year $15, two years $26, three years $34 in the USA and its possessions. Foreign countries: one year $20, two years $30, three years $40. Single copy price $2.25; back copies $3.00. Adjustment necessitated by subscription termination to single copy rate. Allow 6 to 8 weeks delivery for change of address. Allow 6 to 8 weeks for new subscriptions.

ISSN 0278-9922

INTERTEC PUBLISHING CORP.

Technology

AM stereo capability arrives

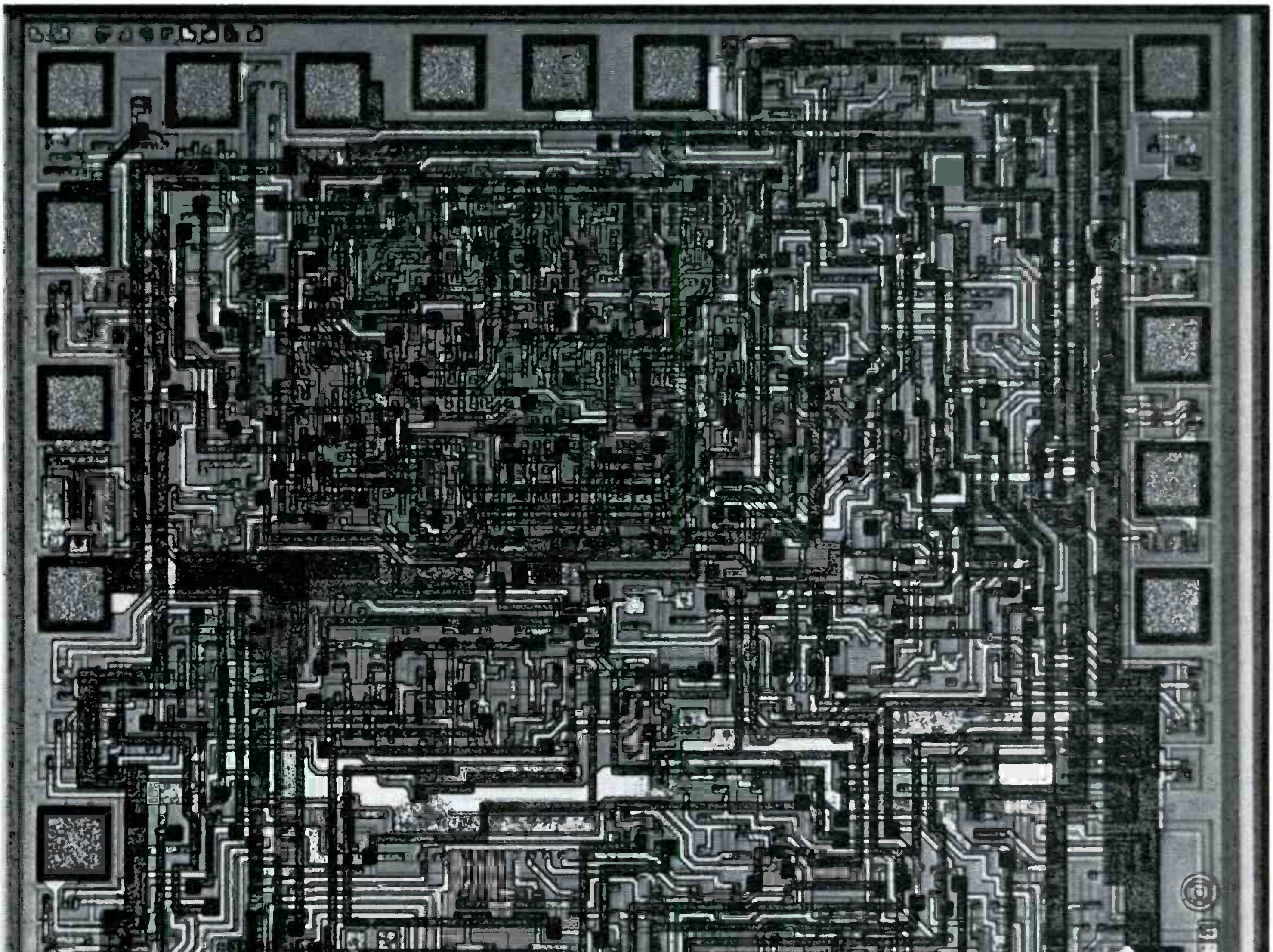
AM stereo is no longer just an idea for the future. Motorola's Semiconductor Products Sector has introduced an integrated AM-stereo decoder circuit designed for compatibility with the Motorola-developed C-QUAM AM stereo broadcasting system, and has geared up for volume sales to radio manufacturers.

Story and illustrations courtesy of Motorola.

C-QUAM means "compatible quadrature amplitude modulation," and the L + R and L − R signals are encoded by amplitude modulation of two carrier signals at the same frequency but 90° out of phase. The system is rendered compatible with mono by multiplying the signal by the cosine of the resulting phase angle.

The new decoder represents the heart of an AM stereo receiver and takes the place of the standard detector in a conventional AM radio. It accepts a 200mV RMS IF signal and puts out approximately 100-200mV of audio.

Figure 1 shows the essential components of the receiver. The output of an I detector, sensitive only to the in-phase signal, is compared to the output of an envelope



This photomicrograph shows the detailed circuits of Motorola's chip.

OMNITRON: AUGUST SPECIALS

NOTE: Must Use "ETD" Part #'s For Special Prices

SILICON RECTIFIER
100/$6.95 2.5 Amp/1000 PIV
#ETD-1

SOLDER (60/40 Rosin Core)
1 lb. - .062 dia. (regular size) $7.99 #ETD-2
1/2 Lb. (thinner size) $3.99 #ETD-3

SOLDER WICK 59¢
Solder Removal
⅛" Wide (Thick Type) #ETD-4

SANYO / **TOSHIBA**

2SC1308K #ETD-5B
TSC1-72B #ETD-5C
$1.49/50 up
$1.69 10-49

RG-59/U 75 OHM Co-Axial Cable Copper Braided Shield

#ETD-6
White or Black
$44.50/1000 ft.

F-59 Connector with Separate Ferrule
#ETD-7 10¢/100 lot

#ETD-8
Matching Transformer 75-300 Ohm
39¢ ea. Minimum 30

#ETD-9
2 Way - 75 Ohm Splitter
89¢ ea. Minimum 10

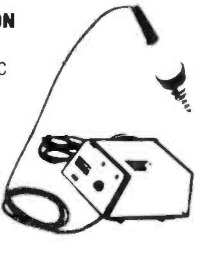
DIGITAL CAPACITANCE METER
0.1pF to 1999 MFD
Accuracy 0.5%, 3½ digit 0.5"
8 ranges full scale, 200pF to 2,000 MFD, 0.1pF resolution
Fuse protected, 1 yr. warranty
#ETD-11 $59.95

6.5 MHz Laboratory Oscilloscope
1 year warranty
very popular
$174.95
#ETD-12

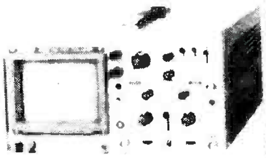
JERROLD 60 CHANNEL CORDLESS TV CONVERTER
MODEL DRX-3-105
#ETD-10
Call For Quantity Prices
$110.00 ea.

ADJUSTABLE-TEMPERATURE SOLDERING STATION
- Temperature 0°C to 750°C
- LED Indicators
- 50-B182-Replacement Tips $3.00 each

Model 50B-180
$49.95
#ETD-18



EICO 20 MHz DUAL TRACE SCOPE Model 482
Reg. $799.95
Our Price
$450.00 each
#ETD-19

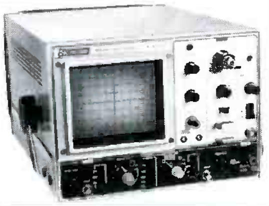


Features:
Dual Trace
- 5 mV/cm
- 5 mV/cm sensitivity.
- Automatic triggering.
- Add and subtract mode.
- Built in component tester.
- 17.5 nanosecond rise time.
- Includes 10:1/direct probes.
- Automatic selection of alternate or chop mode.

SPECIAL!

B&K PRECISION DYNASCAN CORPORATION
CRT RESTORER/ANALYZER
Model 467
#ETD-13
$412.00
Reg. $515.00

B&K PRECISION DYNASCAN CORPORATION
30 MHz Model 1479B
dual trace
5mV/div sensitivity
10:1/reference/direct probes included
$619.00
REG. $795.00 #ETD-16



B&K PRECISION DYNASCAN CORPORATION
10 MHz Model 1476
#ETD-17
$420.00
Reg. $525.00
dual trace
10mV/div sensitivity
video sync separators
includes probes

TUBES

70% + 10% OFF LIST

RCA SYLVANIA

TYPE	Our Price	Sugg List
1G3GTA 1B3GT	3.52	13.05
2AV2	2.79	10.15
2HA5	3.41	12.45
3A3C	3.40	12.60
3AT2A	3.56	12.80
3CU3A	4.38	16.05
3DB3 3CY3	3.93	14.40
3DJ3	3.81	13.95
3HA5 3BUB	3.62	13.25
5GH8A	4.03	14.75
5GJ7	3.34	12.20
5GS7	4.03	14.75
6AQ5A 6HG5	2.99	10.90
6BA11	4.40	16.10
6BK4C/6EL4A	6.29	23.30
6BL8 ECF80	2.70	9.80

TYPE	Our Price	Sugg List
6BQ5 EL84	3.56	13.00
6CA7 EL34	5.86	21.50
6CE3 6CD3	3.22	11.75
6CG3 6BW3	3.22	11.75
6CG7 6FQ7	2.67	9.70
6CG8A	3.90	14.25
6CJ3 6DW4B	3.22	11.75
6CW5 EL86	3.22	11.75
6EA8	3.52	12.85
6EH7/EF183	3.48	12.70
6EJ7/EF184	3.30	12.05
6GF7	4.64	17.00
6GH8A	2.69	9.95
6GJ7/ECF801	3.40	12.40
6HA5 6HM5	3.63	13.25
6HQ5	4.56	16.70

TYPE	Our Price	Sugg List
6HV5A	7.54	27.75
6J10 6Z10	5.32	19.50
6JA5	4.45	16.30
6JC5 6JB5 6HE5	4.19	15.35
6JC6A	3.91	14.30
6JE6C 6LQ6	7.07	26.20
6JS6C	6.36	23.20
6KD6	7.14	26.45
6KE8	5.44	19.95
6KT8	4.75	17.40
6KZ8	3.64	13.30
6L6GC	5.48	20.10
6LB6	6.80	25.20
6LE8	5.45	20.00
6LF6	7.44	27.55

TYPE	Our Price	Sugg List
6LR6	6.71	25.40
6LU8	4.51	16.50
6LX6	7.15	26.30
6U10	3.61	13.20
8CG7/8FQ7	2.66	9.70
12AU7A ECC82	2.76	10.05
12AX7A ECC83 7025	2.72	10.10
12BY7A/12BV7/12DQ7	3.22	11.75
12GN7A/12HG7	4.81	17.85
13GF7	4.70	17.25
13J10 13Z10	5.74	21.10
17CT3	3.22	11.75
17JZ8	3.75	13.70
19CG3	3.56	13.00

TYPE	Our Price	Sugg List
21HB5A	4.44	16.25
21LR8	4.44	16.25
21LU8	4.45	16.35
22KM6	6.71	25.40
23Z9	4.78	17.50
24JE6A 24LQ6	7.19	26.45
25CG3	3.14	11.45
25HX5	5.73	21.05
29KQ6	7.87	28.95
31JS6C	6.49	23.85
31LZ6	7.61	28.00
33GY7A	5.75	21.10
35LR6	6.88	25.30
36MC6	7.69	28.30
38HE7	6.48	24.00

FULL LINE IN STOCK

OMNITRON ELECTRONICS
770 Amsterdam Ave., New York, NY 10025
■ Write for FREE 112 page Catalog ■

SHIPPING CHARGES

For Orders	ADD
$25-100	$6.50
$100 - $500	$8.50
$500 - $750	$10.50
$750 - and up	$15.00
FOREIGN ORDERS —	$20.00

Send Purchase Order, Check, Money Order or C.O.D.

or Call Toll Free 800-223-0826
in NY STATE (212) 865-5580

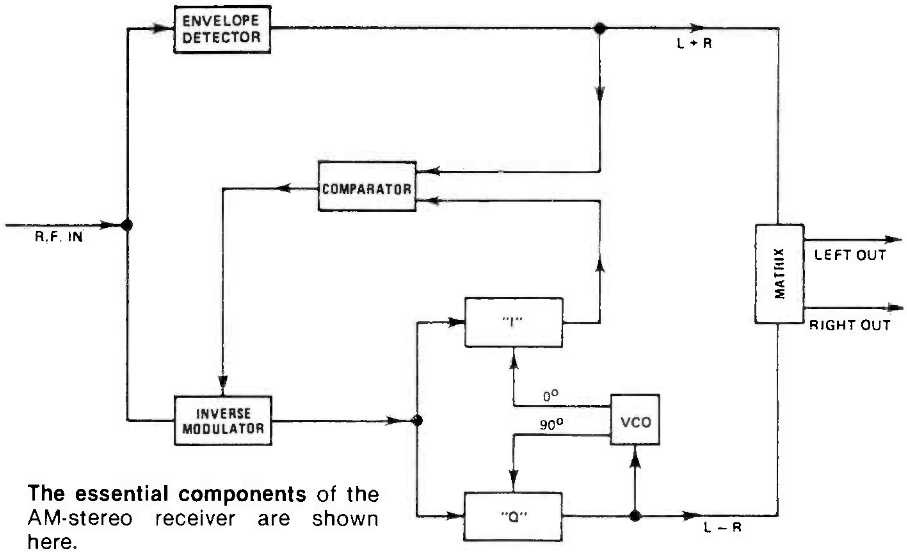
MASTER CARD • VISA

*NOTE: Must Use "ETD" Part #'s For Special Prices.

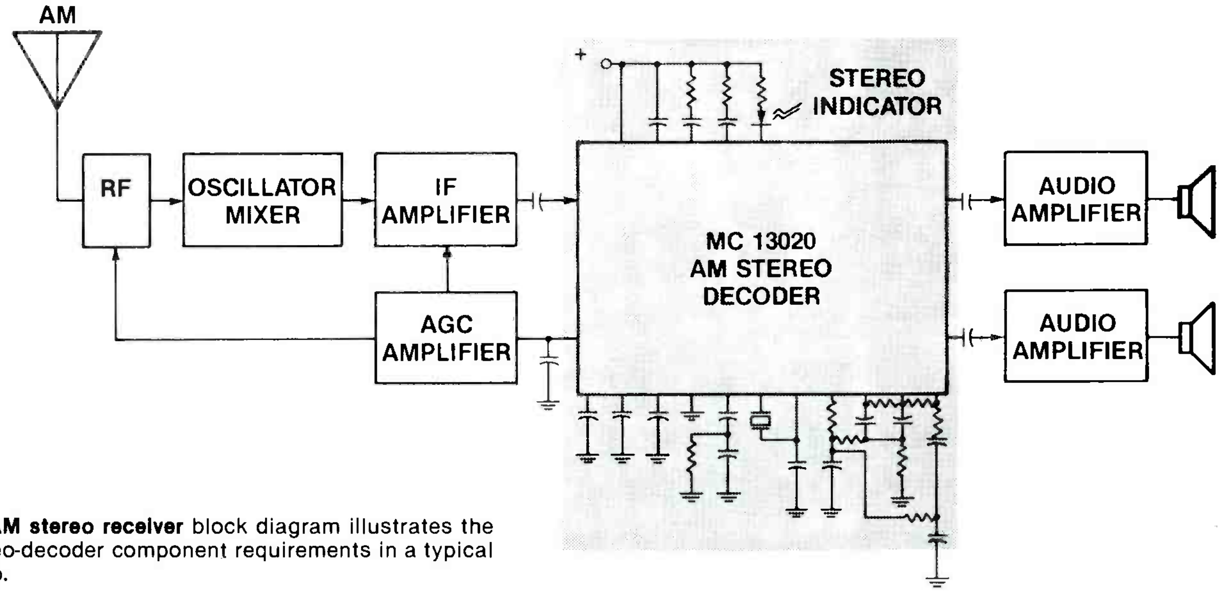
Circle (6) on Reply Card

detector sensitive to the vector sum of the two signals (that is, L + R). The difference is treated as an error signal to drive a variable gain controller governing both I and Q detectors. To make the envelope equal to I, the controller must divide the signal reaching these detectors by precisely the amount it has been multiplied by during transmission. The adjusted output of the Q detector is then fed to the decoder matrix along with the envelope detector output.

These functions have all been incorporated into an IC that also contains the pilot tone recognition circuit. The design of this circuit



The essential components of the AM-stereo receiver are shown here.



An AM stereo receiver block diagram illustrates the stereo-decoder component requirements in a typical radio.

has drawn heavily on Motorola's experience with car radios to provide positive, silent gating from stereo to mono and back as the signal strength changes.

Some important features of the decoder are

- full-wave envelope detection of L + R
- stereo mode permitted only when a signal is a valid stereo signal and signal conditions are good
- Few peripheral components required
- no adjustment or coils necessary

In addition to a small number of resistors and capacitors, the only other detector circuit component needed is an inexpensive ceramic resonator for the phase locked reference oscillator.

Other typical specifications of interest are:

- THD (total harmonic distortion) monaural — 0.5%
- THD stereo — 0.75%
- channel separation — 30dB
- stereo lockup time (on retuning) — 300ms
- adaptive pilot tone detection circuit — 1.5s
- L-R rejection in monaural mode — −50dB

The Motorola receiver chip requires no adjustment after installation. Because the required subsidiary circuits are minimal, Motorola expects that it will cost the manufacturer no more than $2.50 to $3.50 to add AM stereo to a radio already having FM stereo capability.

The added cost compared to a monaural AM radio will be substantially more because of the cost of the extra speaker and the stereo circuits. Furthermore, the typical AM stereo buyer will demand higher quality than that obtained in inexpensive AM-only receivers. Receiver manufacturers are likely to find that a major effect of the introduction of AM stereo is a shift from low-cost to middle- and top-of-the-line models.

To assist receiver manufacturers, Motorola has already conducted two AM Stereo Design Seminars, and Motorola engineers are ready to directly assist any manufacturer comtemplating the design of an AM stereo receiver based on the Motorola C-QUAM system. ES&T

From the folks who brought you the 2213/2215: the new 2235/2236.

Two new Tek 2200 Series oscilloscopes: Solid 100 MHz performance. And Integral scope/counter/timer/DMM.

The 2235 combines a complete 100 MHz feature set with refined performance, versatile triggering, and superior reliability. Its position independent trigger system provides stable triggering with such modes as Peak-to-Peak Auto, Normal, TV Field and TV Line trigger, and Single Sweep for observing transients and single shot events.

It offers multiple trigger sources, 10:1 variable holdoff range, excellent spot size and trace brightness, plus Tek's unequaled human engineering factors—all for just $1950* in a lightweight (13.5 lb.) package.

The 2236 adds to this an integral 100 MHz counter/timer/multimeter that makes its measurements through the scope's vertical, horizontal and triggering systems. It makes possible direct digital readout of Delay Time and Δ-Time to accuracies of 0.001%. The auto-ranging, floating, 5000-count DMM uses standard meter leads at side inputs.

Displayed operator prompts simplify set-up and increase your measurement confidence. Auto-ranging frequency, period, width and gated burst measurements are made push-button simple. Total price: just $2650.*

Scope. Three-year warranty.* Probes and expert advice. One toll-free call gets it all. You can order, or obtain literature, through the Tektronix National Marketing Center. Technical personnel will answer your questions and can expedite delivery. Direct orders also include operating and service manuals, 15-day return policy, and worldwide service.

Call toll-free: 1-800-426-2200, Extension 37.

In Oregon, call collect (503) 627-9000, Ext. 37.

Tektronix
COMMITTED TO EXCELLENCE

Circle (7) on Reply Card

*Price F.O.B. Beaverton, OR. Price subject to change. Three year warranty applies to 2000 Family Oscilloscopes purchased after 1/1/1983. Scopes are U.L. listed

Putting it all together

By Bud Izen

Set up an audio test bench for efficient audio servicing

With all the audio servicing equipment available today, how do you know what you need to get started in the audio servicing business? An article in the June issue listed 10 basic pieces of test equipment you need. These additional 17 fixtures and accessories will complete your audio test bench setup.

1. Test speakers

A decent set of bookshelf speakers will serve nicely for your purposes. Just about anything that sells for around $100/pair (retail list) or more should do. Different servicers have different feelings about this. Obviously the level of quality of the products you service will determine how much you will spend on monitor speakers. I think that as long as you are servicing mid-line equipment, it will not make much difference what speakers you use, providing you follow the above minimum. In any case, whatever you buy, make sure they can handle at least 50W continuously in order to avoid accidental destruction.

2. Test receiver

This falls into the same type of decision as with the test speakers. I suggest that you buy a receiver that costs at least $200 when new and that it be less than five years old. By doing this, you will be confident that any distortion you hear is coming from the unit under test and not from your test setup. Good sources for equipment such as this are garage sales, moving sales, classified ads and the used equipment departments of other service shops.

The test receiver must have certain inputs and oututs. It is necessary that the unit have magnetic-tape monitoring facilities (tape in and record out), an external antenna input, a magnetic phono input and a decent FM section (less than $2\mu V$ sensitivity). Another desirable feature is the presence of two sets of speaker outputs that are selectable via a front panel selector switch so that one or the other can be selected. The unit should also be equipped with a microphone input and a headphone jack, and the amplifier section should have sufficient wattage to drive the test speakers to a fairly loud level without distortion.

3. Turntable, cartridge, stylus force gauge and stylus inspection magnifier

These items may or may not be immediately necessary; it depends on whom you ask. I certainly think you should get them as soon as possible after you start performing audio service if you do not get them initially. The use of a turntable is the most convenient way to test the total operation of an amplifier. If a signal from an audio generator is used to do this, it may not tell the exact story, and you may be misled into thinking that nothing is wrong. This will rarely happen if you use music. Either a turntable or a record changer can be used for this purpose, and any unit that costs $100 or more when it was sold in the last few years will do fine. Use a magnetic cartridge with it, not a ceramic one. You will also need a good stylus force gauge for use when installing and/or adjusting cartridges. Finally you will need a stylus inspection magnifier to inspect styluses.

4. Soldering/desoldering station

A good means of soldering and desoldering is a necessity in all electronic repair work. Usually a smaller iron is handier in audio work because of the amount of printed-circuit work and high component density.

5. Miscellaneous chemicals and hand tools

A good source for chemicals is the GC Electronics catalog. Such things as lubricants, greases, cleaners, oils in extended-nozzle oilers and a variety of cements are especially handy on the audio bench. Print-Kote solvent is handy for getting at PC-board foils, while copper and silver print brush-applied conductors are nice for repairing broken foil connections. Super Glue and white glue are indispensable, as are good plastic-mending glues. Silicon heat-sink compound and a selection of mica insulators for driver, output and power supply transistors are necessities.

In the tool department, devices such as snap-ring pliers come in handy every so often, as do alignment tools, jeweler's screwdrivers, allen and hex-head wrenches, ISO-screwdrivers (available from Sony) for Japanese metric screws, small pliers and cutters, a small bench vise and a circuit-board holder to act as a third hand while soldering and/or glueing. The emphasis is on *small.* Nothing saves time and frustration like having the right tool when you need it. An assortment of small washers, screws, nuts, bolts, snap-rings, springs and miscellaneous hardware is indispensable.

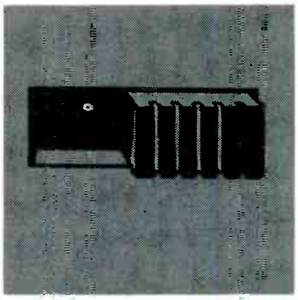
6. Turntable holder

This item is an absolute necessity. Its use allows you to work on a changer or turntable and see it cycle from underneath at the same time. A good source for this item is the GC Electronics catalog.

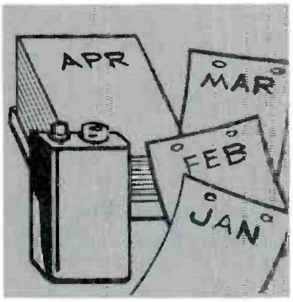
7. Head demagnetizer

This device is used to remove the residual magnetism that builds up

YOU SELECT FULL MANUAL
OR FULL AUTORANGING

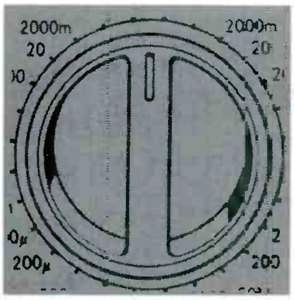


500 HOUR BATTERY LIFE



HIGH CONTRAST LCD
SHOWS MEASUREMENT
AND FUNCTION

0.25% dc volt accuracy
Continuity beeper
Diode test
Transient and overload protected
High energy fuse



EASY TO USE... RELIABLE
SINGLE-ROTARY
CONTROL SWITCH

OTHER NEW
DMM MODELS
PRICED
FROM
$75.00

New! A digital multimeter that lets you choose autoranging convenience or manual control

MODEL 2816
$150.00

To learn more about the 2816
and the complete line of new B&K-PRECISION
DMMs. see your local distributor or call
[1 312 889-9087].

B&K PRECISION DYNASCAN CORPORATION

6460 West Cortland Street • Chicago, Illinois 60635 • 312/889-9087

International Sales, 6460 W. Cortland St., Chicago, Illinois 60635
• Canadian Sales, Atlas Electronics, Ontario
South and Central American Sales, Empire Exporters, Plainview, NY 11803

Circle (8) on Reply Card

on record and playback heads, capstans and the metal area in the vicinity of tape deck heads. It is generally a low-cost item.

8. Bulk eraser

A bulk eraser is a medium-size, covered electromagnet, which is normally used to erase an entire tape at one time. It usually does a better job, and of course, a faster one, than the erase head circuitry of the average deck.

9. Electrical outlets

Because many devices need to be plugged in at the same time during a typical audio repair, sufficient ac outlets must be readily available. Usually this will not present a problem if an outlet strip is installed at the edge of the bench, behind the equipment.

10. Worklamp with optional magnifier

This is another priority item to deal with the high parts density of audio PC boards. I like to use a lamp with a built-in magnifier because it reduces eye strain. A side benefit of the lamps with built-in magnifiers is that they use fluorescent bulbs. These bulbs are cheaper to use in the long run and do not produce much heat. Cheaper lamps use incandescent bulbs. Standard bench lamps start at about $16, while magnifier lamps cost about $60.

11. Miscellaneous cables and adapters

I think that Switchcraft makes the finest audio connectors in the industry. They also offer a kit of standard audio adapters that can be stocked for resale, but should also be kept on hand for use when working with the occasional non-standard cord or input plug. I have never thought that saving money by buying lower-quality plugs, jacks and adapters was anything but false economy – they just don't hold up in day-to-day use.

12. Antenna

A good source of FM is necessary. Ordinarily, this signal can be split or tapped off the shop antenna or cable system.

13. Strobe

This small device is used to check the speed stability of turntable and changer motors. Variations are also available for checking reel-to-reel and cassette tape speeds. Usually you can order these items through your local distributor.

14. Roll-around carts

Roll-around carts are a great convenience in both audio and TV repair. If you are handy with woodworking tools or know someone who is, you can knock out quite a few of these over a weekend. Otherwise, you can purchase metal ones starting around $60. They will raise servicing efficiency the most if the unit to be worked on is placed on the roll-around cart and kept there while service is performed.

15. Electric drill and electric screwdriver

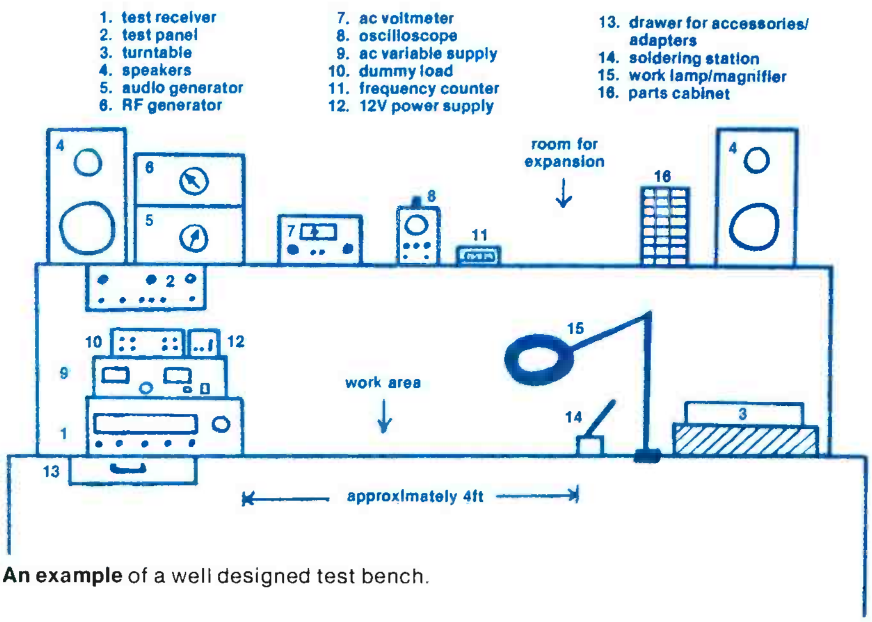
These tools are convenient for disassembly and reassembly. If you don't want to splurge for an electric screwdriver, at least purchase a manual automatic one. You will understand how useful and time-saving this item can be after you have taken apart your first guitar amplifier speaker cabinet using 20 or more long screws to hold the back on! The electric drill will also find a lot of applications.

16. Tape splicer

This inexpensive device can pay for itself many times over and rapidly in either dollars or good will, by using it to save customers' tapes that have been "eaten" by defective tape transport mechanisms. Some of the modern cassettes now in use are expensive, regardless of whether blank or pre-recorded. Most people are more than willing to spend a dollar or two for a minute of your time to repair a damaged tape and at least save most of the tape, if the only alternative is to throw the tape away. Also, you may want to perform this task as a good-will gesture in the hope of generating future business. The device itself was originally created for the reel-to-reel market, but there are versions out for cassette tape as well.

17. Tension gauges

These gadgets are necessary for the adjustment of take-up clutches, and rewind and fast-forward tension on tape drives. Different devices are required for each type of tape format. These are available from the OEM outlet and from other suppliers such as ORA. ES&T



An example of a well designed test bench.

Photofact

These Photofact folders for TV receivers have been released by Howard W. Sams & Co. since the last report in ES&T.

EMERSON	
ECE-140	2173-1
ECR-210	2175-1
B-120A	2177-1
EC-190	2178-1
GOLD STAR	
Chassis NT8X	2172-1
PANASONIC	
Chassis NMX-K8A	2178-2
PHILCO	
Chassis 09C201 (CQ4X)	2169-1
QUASAR	
Chassis GC111	2166-1
Chassis GC107	2167-1
Chassis ADC105,C105	2168-1
Chassis 5TS-629	2172-2
SAMPO	
Chassis C3-13A	2167-2
Chassis CS-13AS	2174-1
SANYO	
Chassis A2V-56000	2166-2
Chassis A4S-46000	2167-3
Chassis A2V-61000	2170-1
Chassis A2P-65000	2172-3
Chassis A2V-54000	2173-2
SEARS	
564.44310150/4360150/ 4360151/4410150	2169-2
564.40050250/51	2174-2
562.42111250	2175-2
564.43000250/51	2176-1
564.49000250/010251/020250/ 020251/030350/030351	2177-2
SHARP	
FF13602	2171-1
19G97	2176-2
FF19662,19G87	2178-3
13G45	2179-1
SONY	
Chassis SCC-442A-A/43A-A	2179-2
SYLVANIA	
Chassis 09C201	2171-2
TOSHIBA	
Chassis TAC8131	2173-3
WARDS	
GNB12314A/384A	2168-2
GGY16221A/229A	2170-2

Circle (9) on Reply Card

Readers' Exchange

Needed: Schematic and calibration instructions for a Knight model KG-620 vacuum-tube voltmeter. Will pay any reasonable price. *J. L. Wingfield, P.O. Box 685, Cedaredge, CO 81413.*

Needed: Horizontal output transformer, Sylvania part #241-0026 or suitable equivalent (ref. Sams 285-14). Will pay cost and shipping. *Dick's TV Service, 5620 Cranberry Place, Dayton, OH 45431; 1-513-256-8447.*

Needed: Chart to set up old, obsolete radio tubes on Eico 666 or Precision 910 tube testers. Will pay for copies. *Don Maurer, 29 S. 4th St., Lebanon, PA 17042.*

Needed: EMC model 802 signal tracer/generator; schematic and service manual for an EMC model 700 RF/AF crystal marker/generator, Sams Photofact SD-13; and Realistic Pro-52 or 53 scanner-monitor. *Caswell Davis Jr., 601 Delmar, Apt. 2, San Antonio, TX 78210; 1-512-532-9378.*

Needed: Schematic for Pride Electronics, DX 300 bilinear amplifier for ham bands. Will buy or copy and return. *Hector's TV Service, 3811 S. Manhattan Ave., Tampa, FL 33611; 1-813-831-4189.*

Needed: Original RCA advertising dog, Nipper (his master's voice). State condition and price; I will pay shipping. *Tom Pamula, 2017 Crestview Drive, Erie, PA 16509.*

Needed: Original service manuals for any Braun or Clairtone Braun radios and other audio products, in English or German. *Carleton Sarver, 256 W. 88th St., New York, NY 10024; 1-212-874-3529.*

Needed: Complete Delco auto radio, model 91BFP1 or 91BFM2. *Paul Capito, 637 W. 21 St., Erie, PA 16502.*

Needed: HV cup and socket for Panasonic television, model #CT 21P. *George Saylor, 2319 Parrish St., Philadelphia, PA 19130.*

Needed: Sencore LC53 capacitor analyzer. *Robert J. Blackwell, 2925 Riggs Ave., Baltimore, MD 21216.*

Needed: Two solenoids for Viewlex Mark I cassette-to-cassette duplicator. Viewlex part number is 58900ZO-01; Regdon #1786. *Albert J. Hopkins, Route 8, Box 700, Joplin, MO 64801.*

Needed: Back issues of **Electronic Servicing & Technology,** April 1983 and earlier. *NRC Satellite Receivers, Route 5, County U, Green Bay, WI 54303.*

Needed: Hallicrafters S-40, S-52 or S-77 receiver. *Fala Electronics, P.O. Box 04134-17, Milwaukee, WI 53204.*

Needed: Service manual/schematic copy for Great American Sound Company mod "Son of Ampzilla" stereo amplifier. *Haltectronics, P.O. Box 131, Five Forks, WV 26145.*

For sale: Sencore CG 169 deluxe color generator, $125. *Fred Washington, 4004 Prospect, Kansas City, MO 64130.*

For sale: Sencore meter FE149, $99; B&K capacitor checker, $29. *WSEP, 318 S.K., Sparta, WI 54656; 1-608-269-2392.*

For sale: RCA WR-508B mini chro-bar generator, $40; heath model IT-1121 semiconductor curve tracer, $60; and Amphenol CRT Commander model 855 CRT tester and rejuvenator, $50. plus postage. *C. A. Pontillo, 3104 Boulanger, Laredo, TX 78040.*

For sale: Tektronix time base plug-in model 5B40; used about 5 times; $200. *R. G. Electronics, 2784 Fairway Drive, Kelsevville, CA 95451; 1-707-279-1938.*

For sale: B&K 1077B TV analyst with manual, excellent; and B&K 707 tube tester, excellent; make offer. RCA color bar generator WR61B with manual, $20. *W. Wiebe, 1233 Benedict Court, San Leandro, CA 94577; 1-415-357-9888.*

For sale: Hitachi V-1050, 100MHz, dual-trace scope; Sencore VA48 TV analyzer; and Sencore PR57 ac Powerite. All less than 1½ years old; with manuals. Best offer. *Thomas LaPlante, 6221 Pine Tree Ave., Panama City Beach, FL 32407.*

For sale: Eico model 944 (factory-wired) yoke/flyback tester, $49; MFJ-721 CW/SSB audio filter, $39. Manuals with both items. Refund if not in A1 working condition. *John J. Augustine Jr., 530 N. 9th St., Reading, PA 19604; 1-215-373-4538.*

For sale: Simpson model 311 VTVM with 22M input-impedance, $65; RCA sine/square wave audio generator, type 504B/44D, $100; Dentron model MLA-2500 linear amplifier, $600. *William D. Schevtchuk, 1 Lois Ave., Clifton, NJ 07014; 1-201-471-3798.*

For sale: B&K solid-state model 415 sweep marker generator, $150. Used very little and in good condition, Instruction manual and lead included. *John F. Bogan, Johnny's TV & Radio Service, Route 1, Box 249, Jonesville, SC 29353.*

For sale: Used Seco LTV-12 dc power supplies; 10-15A, 115-120Vac in, 0-90Vdc out; variable and fused. Sold new for more than $150 each; asking $25 each now. Guaranteed to work. Also, repairs on other dc drives and PC boards for textile plants. *Edward J. Moore, Route 5 Union, SC 29379; 1-803-427-8284.*

For sale: Sencore CB repair system (CB-41, CB-42, NL-204 noise pulse simulator and PS-43 power supply) complete with tech data, $750. More than 235 Sams and Tab CB manuals included free. Also Sencore SG165 AM/FM stereo analyzer complete with tech data, $500. More than 50 Sams and Tab audio manuals included free. *David Skyberg, Sky's Electronics, P.O. Box 89, Glenns Ferry, ID 83623; 1-208-366-7909 (shop) or 366-2345 (home).*

For sale: Hundreds of television and radio tubes, some oldies and hard to find. Also books and parts, 80% and more off, plus postage. Close-out, retiring. *Kay TV, 644 Lincoln Ave., Maywood, NJ 07607.*

For sale: More than 200 old radio tubes, new; 1-14 series and #27-89 etc. Most factory boxed; send for listing. Also Sams 1-60 in binders, complete, $180. *Don's TV, 620 W. 4 St., Holton, KS 66436.*

For sale: Heathkit VOM model 1M-5338. Includes probes and manual and extra 50kV probe. New and very accurate. Asking half of kit price. *C. Gillow, P.O. Box 177, Springer, NM 87747; 1-505-483-2363.*

For sale: Simpson model 303 VTVM, $35; RCA model WR-64A color-bar/dot/crosshatch generator with booklet, $45; Weston model 664 ac volt/capacity meter, $30. All work great. *John Russo, 1057 Big Pine Drive, Santa Maria, CA 93454; 1-805-925-8773 (day) or 925-2173 (evening).*

For sale: Eico model 955 in-circuit capacitance tester and Scientific Devices digital capacitance tester (100pF-20,000MF, factory calibrated). Both testers used very little; $25 each, you pay shipping, or both for $50 postpaid. Manuals for both included. *W. James Tyger, Tyger's TV Service, R.D. #1, Commodore, PA 15729.*

For sale: B&K model 415 sweep generator, brand new and complete, $250. *Square TV, 128 Bala Ave., Bala Cynwyd, PA 19004; 1-215-664-6507.*

For sale: Heathkit EE-3401 microprocessor course and assembled ET-3400 computer trainer. Both like new; $180. *Frank Bekcerle, 313 Woodcrest Drive, Buffalo, NY 14220.*

For sale: Conar model 255 oscilloscope and assorted probes, $120; Sylvania CK 3000 test jig and adaptors, $275. You pay shipping. *J. R. Hinely, P.O. Box 119, Rincon, GA 31326; 1-913-826-5017 after 6 p.m.*

For sale: Heathkit IG-57A alignment generator, complete with manual, $100; 3M–Mincom 6500 recorder test set, no manual, $100; Hewlett-Packard 200CD audio oscillator, with manual, $100. *Walter H. Schwartz, Lakewood Drive, Route 1, Box 109C, Jefferson City, TN 37760; 1-615-475-8220.*

For sale: Sencore model SG165 AM/FM stereo analyzer; latest model; $450 or best offer. *Al D'Onofrio, 1523 Central Park Ave., Yonkers, NY 10710; 1-914-779-3057.*

Test your electronic knowledge

By Sam Wilson, ISCET test director

These questions are similar to questions used on the various CET tests. All questions on the actual CET test are multiple choice, and a grade of 75% or better is required for passing. These questions are related to the Associate Level test section called Tests and Measurements. The answers are given on page 58.

1. The voltmeter in Figure 1 has a resistance of 30K. Assuming there are no errors in the values shown, the voltmeter reading should be
   A. 5V.
   B. 6V.
   C. 10V.
   D. 11V.
   E. None of these answers is correct.

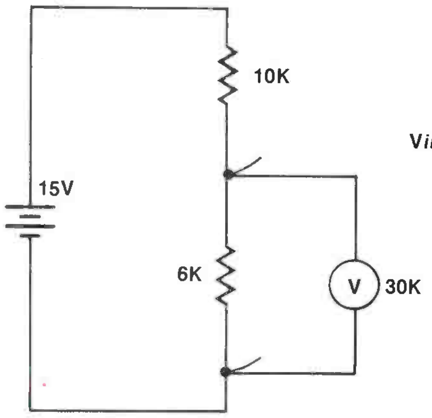


Figure 1

2. You are going to measure the base voltage of the Class A amplifier circuit in Figure 2. Your measurement is with respect to common. You should measure a
   A. positive voltage.
   B. negative voltage.

3. To measure the resistance of R_2 in the circuit of Figure 2 (with the power removed) you would use the
   A. low-power ohms scale.
   B. high-power ohms scale.

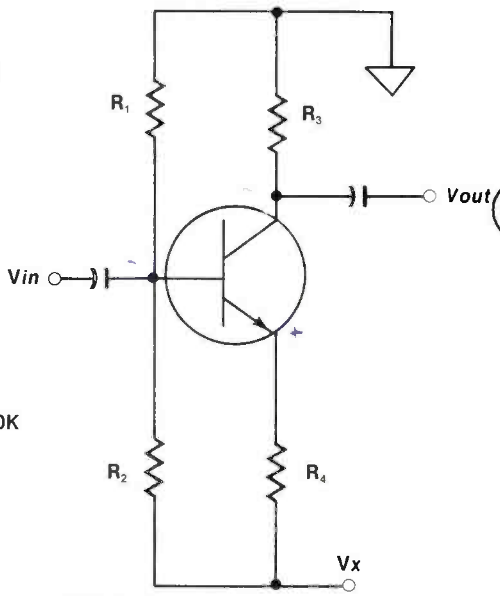


Figure 2

4. What is the frequency of the waveform in Figure 3?
   A. 100kHz
   B. 200kHz
   C. 666kHz
   D. 1MHz
   E. 2MHz

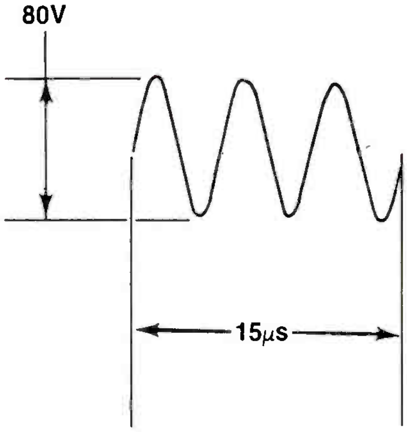


Figure 3

5. What is the RMS value of the sine wave voltage in Figure 3?
   A. 25.4V
   B. 28.3V
   C. 50.9V
   D. 56.6V

6. Is this statement correct? *The voltmeter in the circuit of Figure 4 should read 30V.*
   A. It is correct.
   B. It is not correct.

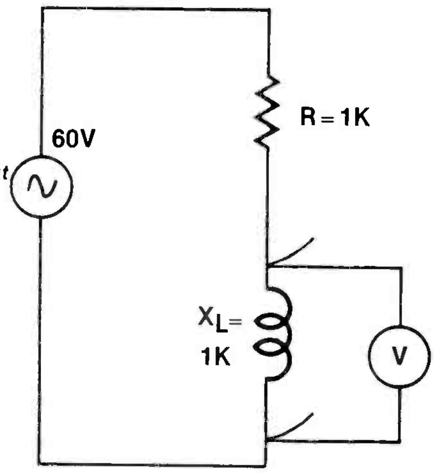


Figure 4

7. If the generator voltage in the circuit of Figure 4 is held constant, but the frequency is increased, then the voltmeter reading will
   A. increase.
   B. decrease.
   C. stay the same.

8. You can convert a single-trace oscilloscope to a dual-trace oscilloscope by using
   A. a vibrator.
   B. a push-pull amplifier.
   C. a Darlington amplifier.
   D. a ringing oscillator.
   E. an electronic switch.

9. The voltage waveform in Figure 5 is supposed to be a sine wave. The distorted waveshape shown is most likely to occur in
   A. a Darlington amplifier.
   B. a phase-shift oscillator.
   C. a push-pull amplifier.
   D. an overcoupled L-C network.
   E. None of these choices is correct.

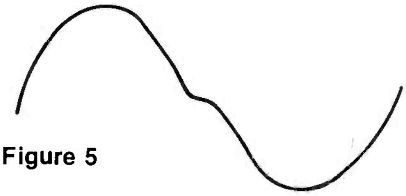


Figure 5

10. Figure 6a shows a coincidence circuit. Which of the combinations in Figure 6b will produce an outpulse pulse?

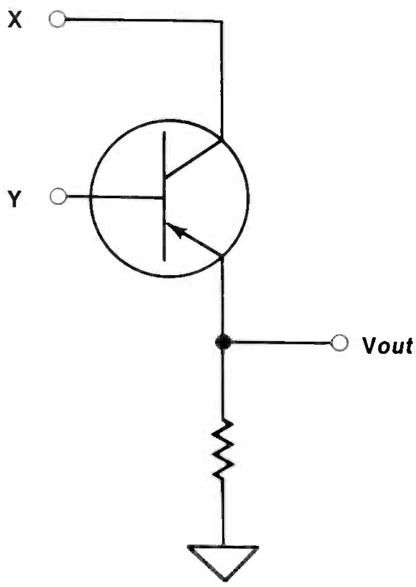


Figure 6a

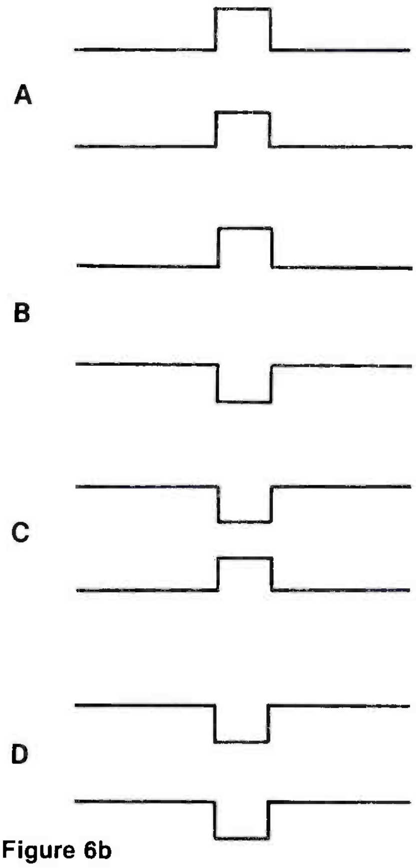


Figure 6b

The CET program

In 1965, the National Electronic Service Dealers Association (NESDA) developed the Certified Electronic Technician program. Since that time, it has become a highly accepted accomplishment.

The CET exam was originally developed for consumer electronics, but other options are now available or are being developed. Technicians who pass and show proof of four years of experience and/or schooling are awarded an internationally registered certificate, and many use the initials CET after their signatures.

A technician or student in electronics with less than four years of experience may apply for the Associate Level exam, which is administered by the Certification Administrator in his area. The exam is the basic electronic portion of the full CET exam.

For more information on the CET exam, contact ISCET, 2708 W. Berry St., Fort Worth, TX 76109. ES&T

How decibels got started

By Sam Wilson,
ISCET test director

The best way to understand decibels is to get a clear picture of logarithms in your mind. In this article, we will start with how decibels came about and one reason why they are used in electronics. Later in this series, the applications of decibels will be dealt with in more detail.

We are all a little bit spoiled by our calculators. It might be a good idea to work some problems the long way once in awhile just to keep the proper perspective on the wonders of mathematics. If you lived in the year 1600 there just simply was no help in working problems like

$$\frac{26491 \times 97938}{12504}, \text{ or } \sqrt[5]{(846)^3}.$$

Scientists at that time had no way out. If they wanted to work problems like that, the only way to do it was to sit down and work each problem long hand.

That's they way it was until 1614 when Lord John Napier, a member of the Scottish royalty, published his first paper on logarithms. Henry Briggs, an English mathematician who was editing Napier's paper, was able to make a very important advance in logarithms. Napier agreed with Briggs' variation so the two forms of logarithms were printed at nearly the same time.

The idea of logarithms is based on basic principles. When you multiply two numbers that have the same base, all you have to do is express the base with the sum of the exponents. Likewise, if you divide two numbers with the same base, the answer is the base with the exponents subtracted. For example,

$$10^3 \times 10^2 = 10^5, \text{ and}$$
$$10^8 \div 10^5 = 10^3.$$

Having studied electronics, you will probably remember the powers of 10 notations. They simplify the problem of working with micro units and mega units. But what about problems with numbers that are somewhere between these even multiples? Actually, any number can be expressed as 10 raised to some power, as shown in Table I.

Using this simple table, you can multiply 2 times 3 simply by multiplying the numbers expressed as powers of 10. So 2 x 3 =

$$10^{0.301} \times 10^{0.477} = 10^{0.778}$$
$$(0.301 + 0.477 = 0.778).$$

The answer ($10^{0.778}$) is actually the value of 6 expressed as a power of 10. Napier reasoned that it would be possible to make a table that contained all numbers expressed as some power of a base, and he used the base ϵ (epsilon). It was Briggs who suggested that 10 be used as the base.

When you are looking up a number in the logarithm table, what you are really looking for is

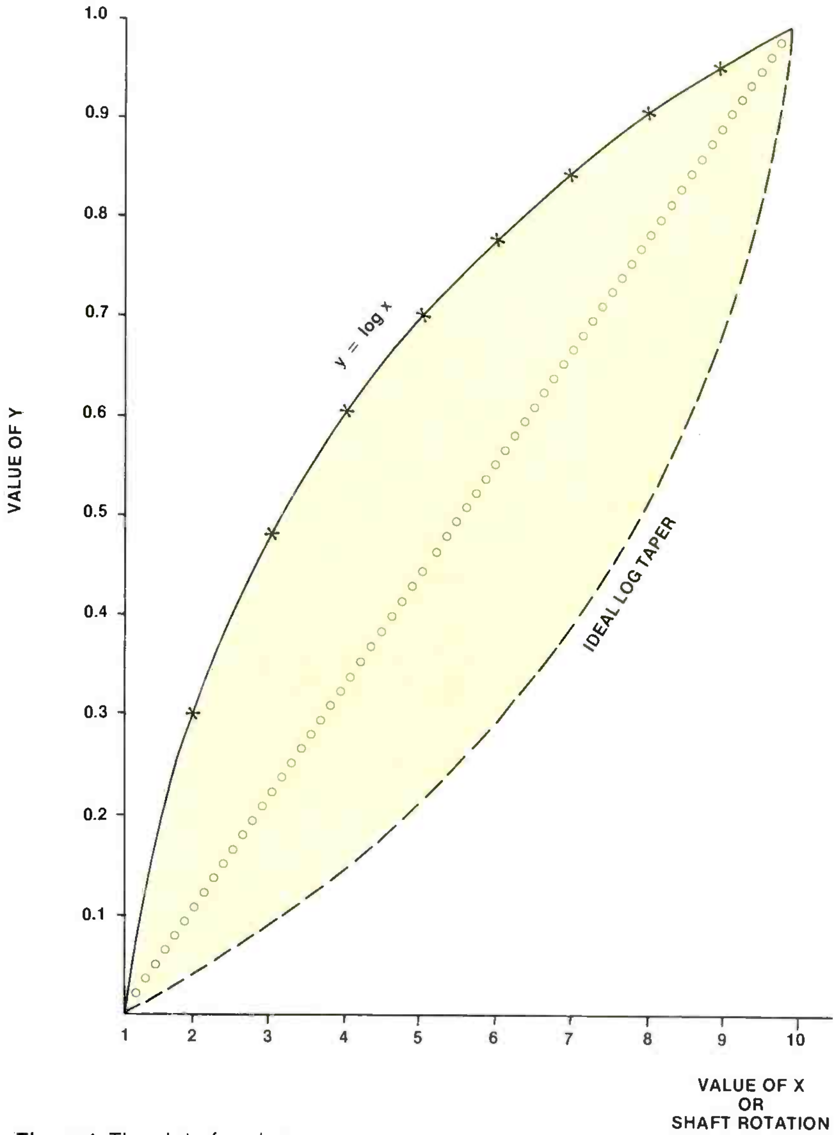


Figure 1. The plot of y = log x.

the power of 10 that represents that number. For example, in Table I the logarithm of 3 is 0.477.

After adding or subtracting the logarithms, you have to go back to the table to find which number corresponds to that logarithm. This is called finding the antilogarithm. In the sample problem 2 x 3 = 6, the antilog of 0.778 is 6.

As a second example, 8 ÷ 4 = 2 will be done with logarithms. The logarithm of 8 (0.903) minus the logarithm of 4 (0.602) equals the logarithm of 8 ÷ 4 (0.301). The antilog of 0.301 is 2.

This invention (if it can be called that) has had a great impact in the field of science. The first contribution was removing the drudgery from calculating the product of large numbers and the quotient of large numbers. Furthermore, it made it simple to raise any number to a power or take the root of any number.

It might be good practice for you to work the problem just done by finding the logarithms and the antilogs on your calculator or in a book of math tables. Then, follow along with this solution to the problem at the beginning of this article:

$$\frac{26491 \times 97938}{12504}$$

The logarithm solution is to take the log of 26491 (4.4230984) and add the log of 97938 (4.9909512) to get the log of 26491 x 97938 (9.4140496). Then subtract the log of 12504 (4.097049) to get the log of the answer (5.3170006). Log $^{-1}$ (or inv log) of 5.3170006 is 207491.65 – the answer to the problem.

If you work the problem out in the normal method on a calculator you will get the same answer, and you will get it more quickly than working it with logarithms, but try to imagine the tremendous significance of this in the days when there were no calculators.

The second problem given at the beginning of this article is almost as easy to work. It is only necessary to find the logarithm of 846; multiply it by 3/5 and take the antilog. Here again, the problem will be worked by using logarithms obtained from a calculator.

$$\sqrt[5]{(846)^3} = (846)^{3/5}$$
$$\text{Log } 846 = 2.927$$
$$2.927 \times 3/5 = 1.756$$

The antilog (or Log $^{-1}$) of 1.756 is 57.07 (answer).

There is another important aspect of logarithms to consider before delving into the idea of decibels. Figure 1 shows a graph made by plotting y = log x. For every value of x on the horizontal line, the logarithm of x has been calculated and plotted on the curve.

This curve has a significance that cuts across many branches of science, and the calculations in this article are an example of only one small aspect of its importance. The curve is also the graph for many technical functions. For example, there is an important basic law in biology called the Weber-Fechner Law that shows up on the curve. Simply stated, it says the amount of stimulus necessary to produce a response in a human being depends upon the amount of stimulus already present.

Note that between $x = 1$ and $x = 2$, the curve moves up very rapidly, but between $x = 9$ and $x = 10$, the rate at which the curve is moving up is much lower. Interpreting this in terms of the law, a small amount of stimulus at $x = 1$ would produce a large response (y), but the same amount of stimulus at $x = 9$ would produce much less response.

If you make a graph of the hearing response of the human ear, it will follow the curve shown in Figure 1.

TABLE I

NUMBER	EXPRESSED AS A POWER OF 10
1	$10^{0.}$
2	$10^{0.301}$
3	$10^{0.477}$
4	$10^{0.602}$
5	$10^{0.699}$
6	$10^{0.778}$
7	$10^{0.845}$
8	$10^{0.903}$
9	$10^{0.945}$

All numbers can be expressed as a power of 10.

By varying the brightness or volume along the dotted line, it appears to your eyes, or your ears, that equal changes occur for equal changes in rotation of the shaft. A very small rotation between 1 and 2 produces only a small change in output, but the great sensitivity of your eyes and ears is able to discern this. Likewise, between 9 and 10 a large amount of change is necessary to get your eyes and ears to respond by the same amount as they responded for the change between 1 and 2.

The curve drawn with circles indicates the actual response of your eyes and ears when you use a control with a logarithmic taper.

More recently in history, a great amount of work was done with the hard of hearing by Alexander Melville Bell and his son, Alexander Graham Bell. One of the problems they were faced with was being able to measure changes in sound volume. It was not enough to allow the person being tested to say "that's a little bit of change" or "that's a lot of change." Some quantitative value had to be assigned to the amount of change heard, so they used a logarithmic relationship, described by the equation:

Change in sound volume (in bels)

$$= \text{Log} \frac{SP_2}{SP_1}$$

where SP_2 is the greater sound power, and SP_1 is the lower sound power.

The unit for the change in volume was given as bels in honor of Alexander Graham Bell and his father for their work with the hard of hearing. This equation is accurate, but it turned out that the unit is too large for convenience. It would be more convenient to use units that are only 1/10 as large as a bel, and that is how the idea of the decibel came about. One decibel equals one-tenth of a bel. The equation for decibels is:

$$\text{decibels (dB)} = 10 \text{ Log} \frac{SP_2}{SP_1}$$

A person with good hearing can just barely hear the difference in sound volume represented by one decibel, under controlled conditions.

Decibels in electronics

The first practical applications of electronics were in communications. (The idea of sending messages back and forth was so important that the first large society of electronics engineers was called The Institute of Radio Engineering.)

The ultimate goal of radio communications was to produce a sound that could be heard and interpreted by a human being. If you were going to design amplifiers to be used for amplifying audio signals, and changes in these amplified signals had to match the response of the human ear, what would be the logical way to rate the amplifier? The answer is, of course, to use the same decibel rating as was used for rating the human hearing itself. By rating the amplifier gain in decibels, you would know how much an increase in the gain of the amplifier would produce in terms of hearing response.

A future article will discuss the difficulty involved in using decibels as a mesurement. For one thing, audio frequency is entwined with the response of the human ear, and that was not fully understood until a number of years after the use of decibels was established. Nevertheless, the method of rating amplifiers by dB gain has become firmly entrenched, and the basic equation is given as follows:

$$\text{dB gain} = 10 \text{ Log} \frac{P_2}{P_1}$$

where P_2 is the output power of the amplifier, and P_1 is the input power of the amplifier.

There are many practical applications for this equation. As an example, when amplifiers are cascaded, the decibel gain of the combination can be found by adding the decibel gains of each stage. Likewise, you can determine the decibel loss of a transmission line in an MATV system by adding the decibel losses of each drop along the line. ES&T

Feedback

Servicing myths

After reading Kirk Vistain's article, "Audio Servicing Myths," (April ES&T) I had to take exception to "myth 3"–the one about needing a distortion analyzer. He claims that any deviation from spec can be caught with a scope. As a Crown service center, we are required to have a distortion analyzer to make sure the amps we fix meet factory specs (distortion of 0.01% or better). Five times in the last two years, the analyzer has caught deviation that my Tektronix 465 missed. The solutions to the problems involved very minute things overlooked, but these amps would have gone out less than "factory perfect" without my analyzer.

I think that the customer who spends $1000 or more for a single power amp deserves better service than "myth 3" implies.

Steve Stoeckel
Charlotte, NC

Vistain's reply

Unfortunately, Mr. Stoeckel misread the section on distortion analyzers. Nowhere did I write that "any deviation from spec can be caught with a scope." If you'll just take a second to re-read it, Steve, I think you'll notice this time that I said the *gross* distortions (>3%), which *usually* occur due to amp failures, are easily observable on the scope.

The first sentence in "myth 3" states that THD analyzers are occasionally handy. As a matter of fact, I must thank you for helping me to prove the point. You state that your THD analyzer was needed only five times in two years. If I assume that my average production and yours are equal, that means you fix about 150 units per month, or 1800 per year. What that implies is, out of 3600 units, you needed the THD analyzer for 5 of them, or 0.14% of the time. In my book, that's occasional!

Kirk Vistain
West Chicago, IL

News

Explosive growth predicted for satellite TVRO stations

"At the present growth rate, sales of satellite receiving antennas have the potential of tripling in 1983," according to Peter Dalton, president of KLM Electronics. Reasons cited include growing public awareness of the advantages of interference-free satellite television, better design, mass production, lower prices, resistance of the market to a sluggish economy and the advent of direct-broadcast satellites.

Dalton thinks industry sales can triple again this year for several reasons. "The prime customers for satellite antennas are rural families who cannot get the three commercial networks and PBS off the air," he said. "Because of low population density, these families are not of interest to cable operators.

"These families appear less affected by today's economy than, say, steel or auto workers in more urban areas. Most important, they represent a new, unsaturated market of viewers who demand the same wide choice of entertainment urban viewers enjoy. Thus, earth stations sales are skyrocketing."

Dalton said the earth station boom has been boosted by growing consumer awareness of the availability and benefits of earth stations for satellite reception. "The dishes themselves, plus word of mouth, are their own best advertising," he said.

Other growth factors include new technology and design improvements, making antennas easier to install and use along with lower prices due to better designs and the onset of mass production. Design of signal receivers and dish-control mechanisms also has improved.

Sound procedures for troubleshooting amps

By Mannie Horowitz

Audio amplifiers built around solid-state devices such as bipolar transistors, field-effect transistors (FETs) and ICs are relatively durable and not prone to excessive breakdowns. However, defects do occur, and technicians should be acquainted with typical circuits, so they can cope with any repairs that are needed.

Basic transistorized circuits

Bipolar transistors dominate the amplifier field. Although these transistors can be wired in three basic configurations, the grounded-emitter type is the most common.

Figure 1 shows four biasing variations for a small-signal amplifier stage with the transistor biased for class-A operation. During class-A operation, collector/emitter current flows continuously, and the increase during positive signal peaks at the base equals the decrease during negative signal peaks. Therefore, the amplification is linear, and minimum distortion is produced.

One way to achieve approximately the optimum forward bias is to use bias-resistor values that produce a collector dc voltage of about half the supply voltage. This general rule can be used to evaluate correct or faulty operation during troubleshooting.

Normal voltage increases and

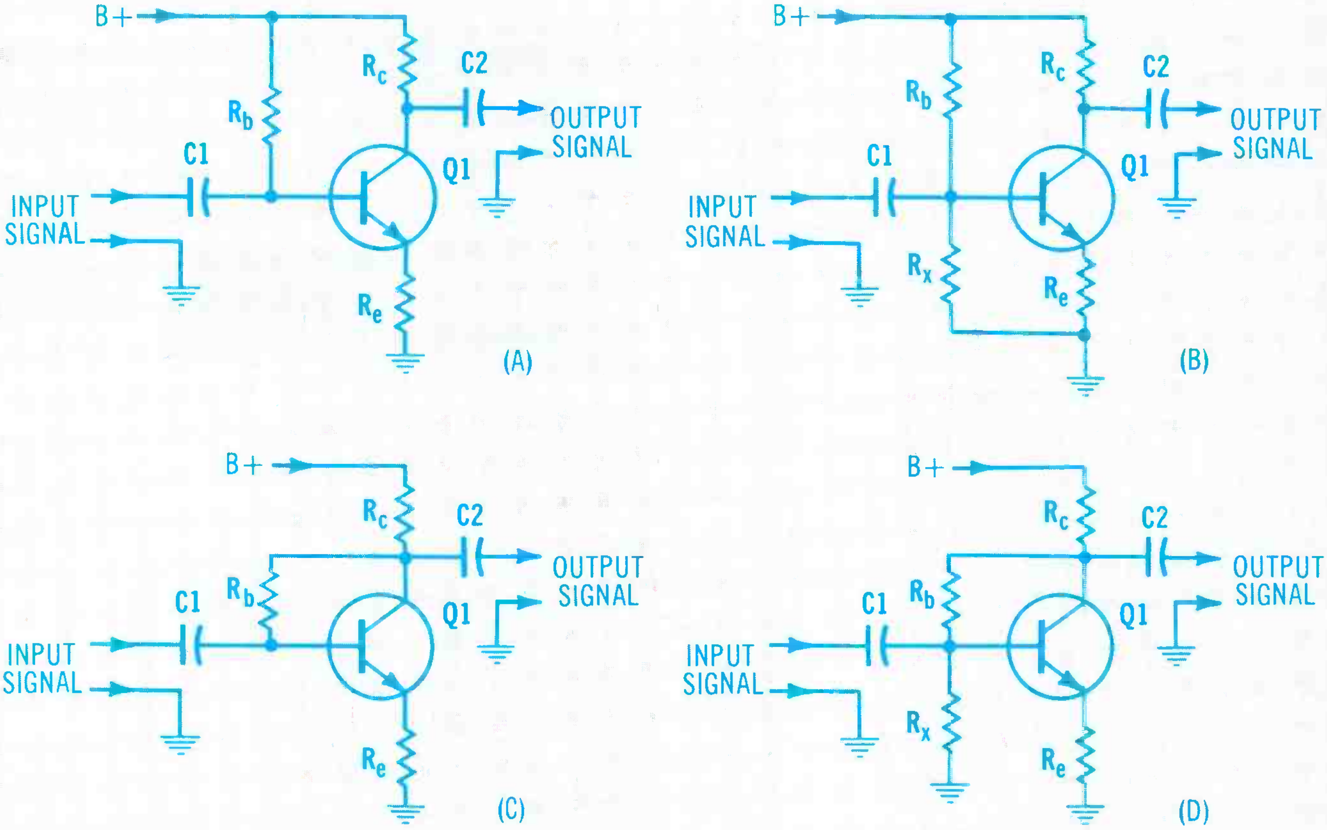


Figure 1. The only difference in these transistors' performances is stability, particularly with temperature variations. (A) A single base resistor connected to the power supply gives the least stable operation. Most of the stability is supplied by the emitter resistor. (B) The addition of a resistor from base to ground slightly improves the stability. (C) A single resistor connected from base to collector provides good stability against time and temperature. If the transistor draws excessive collector current, the collector voltage is reduced, which reduces the forward bias and decreases the collector current. (D) The best stability is obtained when a base-to-ground bias resistor is added to the base-to-collector principal bias resistor.

decreases of the ac base signal produce corresponding increases and decreases of the collector/emitter current, and this generates a varying voltage drop across the collector resistor. The varying collector voltage averages out to the same collector dc voltage obtained when the base signal voltage is zero, but these rapid variations pass through the C2 output capacitor and on to the next stage.

In Figure 1, any or all variations of resistor values or the transistor's condition affect the measured collector dc voltages. If the collector idling voltage almost equals the supply voltage, the collector is drawing insufficient current, perhaps because the value of R_b is too high, the R_e value is too high, or the resistance of R_x is too low. In circuits that previously operated correctly, the transistor base-to-emitter junction might have leakage, the collector might be open, or the resistance of R_c might have decreased.

At the other extreme, if the collector voltage is much lower than half the supply voltage, the resistance value of R_b might be too low, the R_e value might have decreased, R_x might have become open, R_c resistance might have increased, or the transistor has collector-to-emitter leakage.

The ratio of base resistors R_b and R_x determines the base-to-ground dc voltage, while the voltage drop across emitter resistor R_e is subtracted to yield the true base-to-emitter voltage, which partially determines the base-to-emitter current. Remember that the base current multiplied by the transistor beta is the collector current.

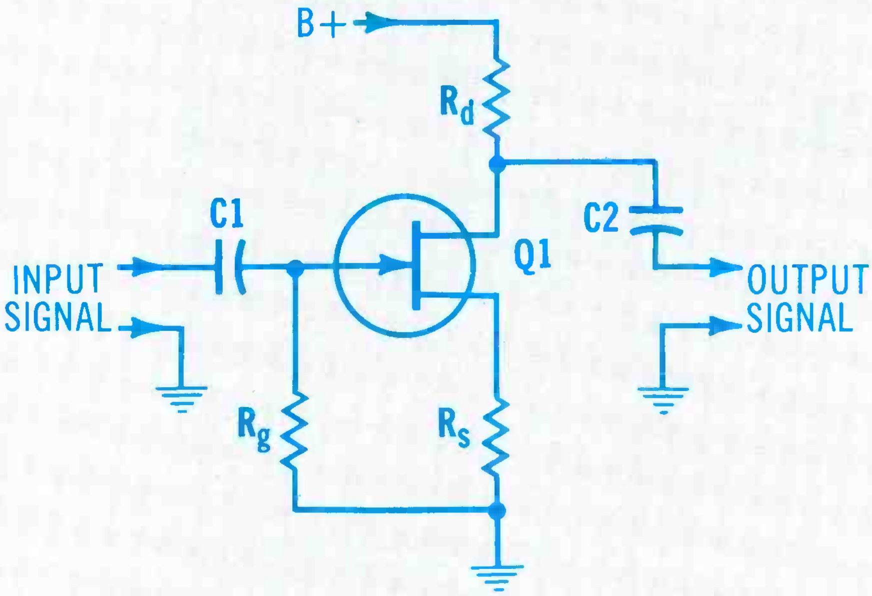


Figure 2. The schematic for one type of FET amplifier is similar to the previous ones using bipolar transistors.

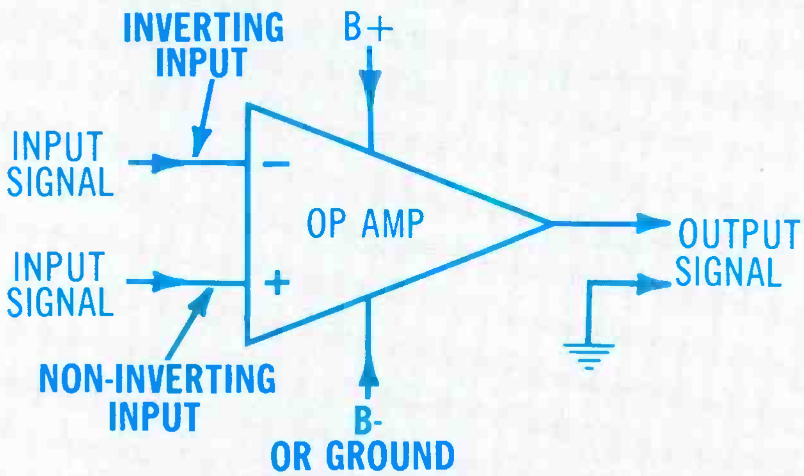


Figure 3. In most schematics, op-amp ICs are drawn as triangles with lead wires, as shown. Op-amps have high gain, two high-impedance inputs and a low-impedance output. They always should be operated with negative feedback applied. The amount of feedback determines the overall gain. Without feedback, the high-frequency response is unacceptable, because the curve begins to roll off below 100Hz.

When emitter resistor R_e is not bypassed, the base-to-collector gain is approximately equal to the ratio of R_e to R_c. Bypassing resistor R_e does increase the gain (by making the impedance almost zero), but the transistor's input resistance decreases so that in some cases the input signal is reduced by the added load. In an extreme example, bypassing the emitter does not increase the gain because the base signal is reduced by the lower load. (Usually, this effect is not found when the impedances are matched by coupling transformers.)

Therefore, you must suspect the components connected to the emitter and test them when the gain is too low or too high. Measure all resistors and substitute all capacitors. Also, negative feedback often is injected at an emitter, and the gain will appear substandard because of the feedback.

Capacitors C1 and C2 keep all steady dc voltage or current from traveling between the stages. Often electrolytic-type capacitors are used in transistor circuits (because of the lower impedances), and electrolytics are more susceptible to developing decreased capacitance. When the capacitance decreases, the reactance to low audio frequencies rises, thus the bass response is impaired. These capacitors should be the first components tested if the complaint is reduced bass response.

A small capacitance placed across R_e decreases the degeneration at high frequencies, so the effect is a high-frequency boost or increase. Therefore, if the emitter's R_e is supposed to be completely bypassed, a large electrolytic must be used. When an emitter electrolytic dries out internally, the gain is reduced noticeably. Also, the response might have a definite high-frequency boost because of the small remaining capacitance.

Other circuits

These Figure-1 circuits are called common-emitter or grounded-emitter types. The input signal is at the base, and the output signal is taken from the collector. To be picky about details, they should be called common emitter when the emitter has an unbypassed resistor. The emitter is a grounded or grounded-for-ac type if it is grounded directly or has an emitter resistor that is heavily bypassed to remove all signals.

Two other basic circuits are possible. Of course, the base in each must have the optimum forward bias relative to its own emitter, and the collector/emitter path must have sufficient voltage of the proper polarity. An emitter follower is formed when the input signal is connected to the base, the collector is connected to a supply voltage (if there is a collector resistor, the collector must be heavily bypassed to ground so there is no signal there), and the output signal is taken from an unbypassed emitter resistor. This connection greatly increases the input impedance, while the output impedance is low (hundreds of ohms). Gain for voltage is unity (approximately), but there is a power gain because of the large impedance difference. An emitter follower can function as an impedance-matching device.

Another circuit (rarely used) is called a common-base or grounded-for-signal base type. Input is to the emitter and its unbypassed resistor, while the output is taken from the collector. The input impedance is low, but the circuit can be advantageous when the effect of a step-up audio transformer is needed.

Most defects in single stages can be found by an analysis of the dc voltages, a resistance or voltage-drop test of the transistor junctions, and ohmmeter tests of all resistors.

FETs

FETs are available in many types. Some have insulated gates that should not draw current regardless of the bias polarity. Others have junction-type gates that normally operate without current, although an unwanted opposite-polarity dc voltage produces undesired gate current. In addition, many otherwise identical FETs are offered in a choice of P or N polarity.

Figure 2 shows the most common circuit. When power is applied, current flows through R_d

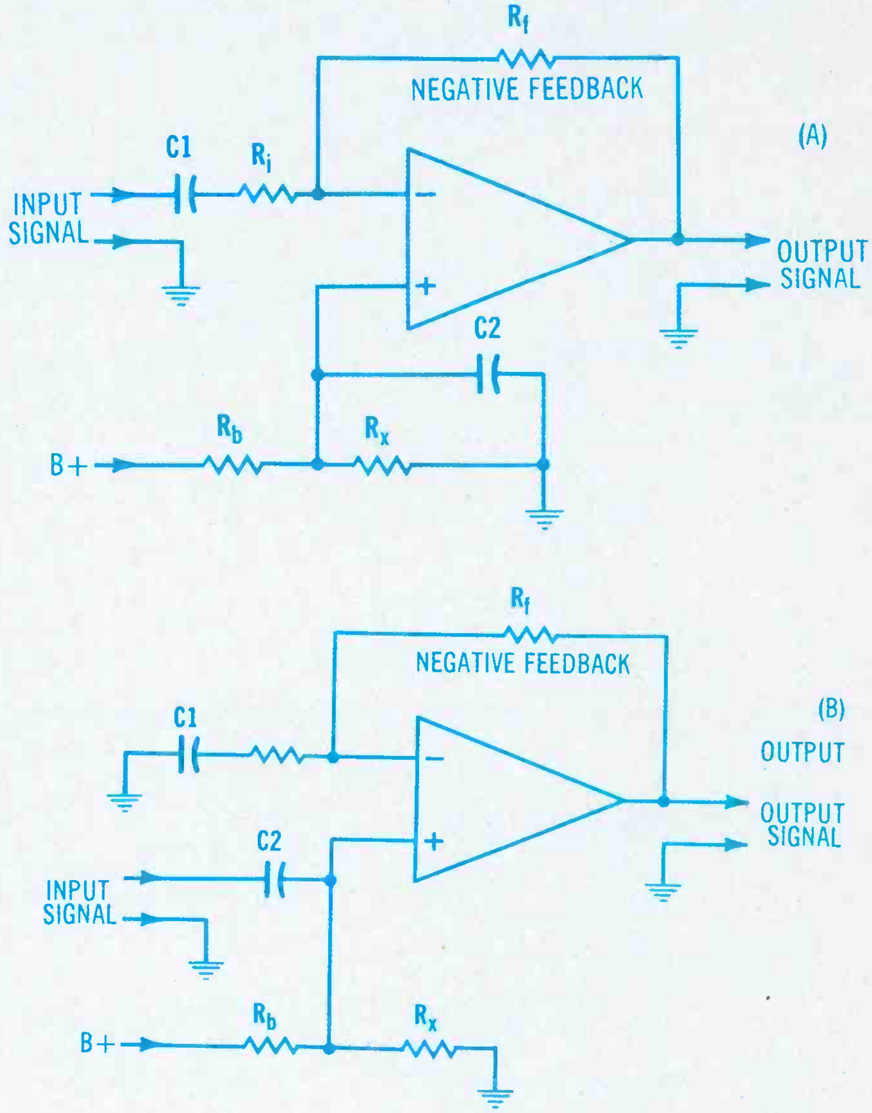


Figure 4. Op-amp ICs can be wired for inverting or non-inverting operation by choosing which input receives the signal. Feedback should be applied from the output to the minus input (which gives inversion). Both schematics have been modified for operation with a single power supply. The output pin must be precisely half the supply voltage, so the circuit must apply the same voltage to both input pins. (A) Inverting operation requires feeding both input and feedback signals to the minus input. The R_f resistor automatically applies the output dc voltage to the minus input. A voltage divider at the plus input must apply the same dc voltage as is present at the output. If the divider is adjustable, vary it until the output has precisely half the supply voltage. (B) For non-inverting, the input signal is applied to the plus input.

(FET drain resistor), the FET internal channel, and R_2 (FET source bias resistor) to ground. Therefore, voltage drop is generated across each resistance according to bias and the resistor values. The FET drain-to-source resistance varies with the signal voltage and bias applied between gate and ground. And the current that changes with the resistance produces a varying voltage drop (relative to ground) that is the amplified output signal.

As in the previous case of bipolar transistors, the drain voltage relative to ground should be approximately half the supply voltage in most circuits. The drain dc-voltage measurement, therefore, can be a quick and fairly accurate evaluation of the FET current.

Remember that the gates of all FETs are susceptible to short-circuit damage from static-electricity voltage. Observe all the industry-recommended safeguards when testing FETs or the circuits containing them.

Except when R_s is unbypassed and unusually large in value, the gain of an FET stage equals the transconductance (g_m) times the value of R_d.

In general, the effects of capacitance values are similar to those encountered with bipolar transistors. However, the C1 capacitance is not so critical because the gate-circuit impedance is much higher.

Op-amp ICs

Many ICs now are included in audio amplifiers. Some complete small amplifiers are in a single IC. Others have ICs containing operational-amplifiers to replace several discrete transistors.

A typical op-amp IC (Figure 3) has many bipolar transistors. Others have FET transistors as input amplifiers to provide a high input impedance, and bipolar transistors are used for the other internal stages.

Most op-amp ICs have two input pins and one output-signal pin. The two inputs are identical except for phase. One is marked with a plus sign and has the same plus phase as the output signal. The other has a minus sign, so a signal introduced there produces a 180° phase-inverted signal at the output pin. Obviously, the availability of both inverting and non-inverting modes extends the variety of circuits possible.

In addition to a signal output and two signal inputs, each conventional op-amp has pins for both B+ and B− power supplies, a ground pin, and two or more pins for external frequency-compensating components (sometimes required for better response or to stop internal oscillations). However, most schematics do not show power-supply pins; these are taken for granted. If a schematic does not show a pin or pins for dc power, refer to the IC specification sheet.

Figure 4 illustrates amplification with either inverting or non-inverting operation. Both circuits have gain-determining negative feedback applied to the inverting inputs. The resistance ratio of resistor R_f (feedback) to resistor R_i (input load) determines the overall gain. When there is need of a specific voltage gain, these resistors must be selected with care.

Incidentally, Figure 4 shows the op-amps operated from a single B+ supply. All true op-amps are designed to have identical dc voltages at the output and both inputs. When separate B+ B− supplies are connected, these three pins should have dc voltages within a few millivolts of zero. But, when a single B+ is applied, the

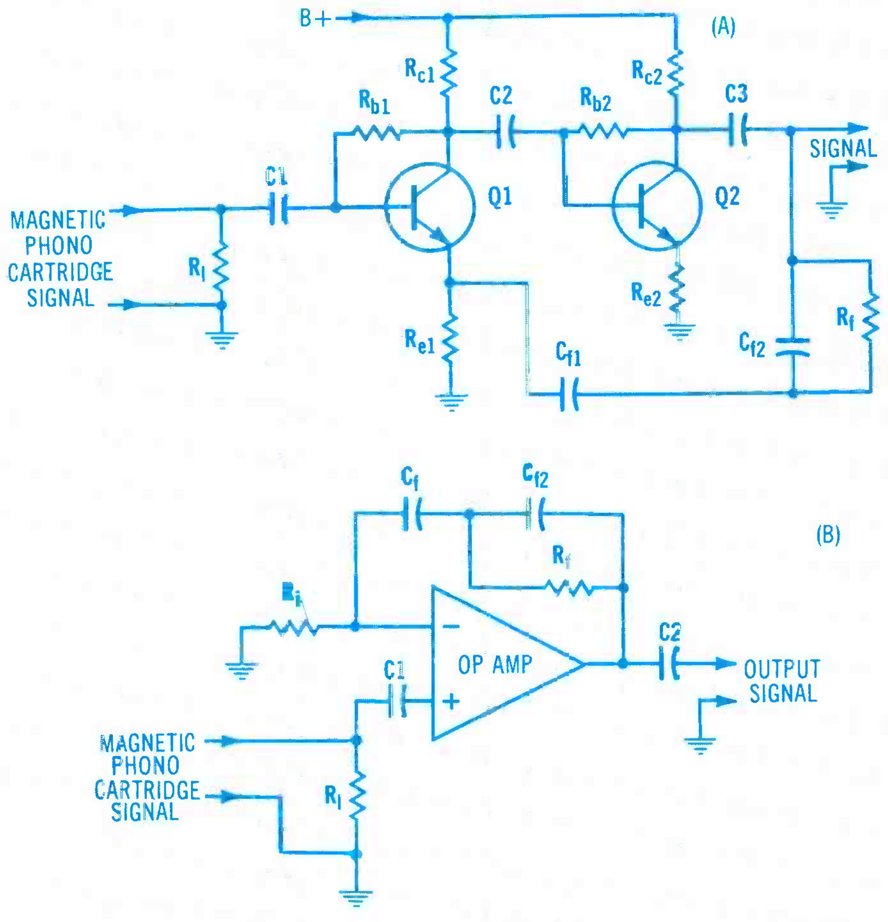


Figure 5. Preamplifiers can be designed for bipolar discrete transistors or a single op-amp. In both cases, the required bass-boost and treble decrease is accomplished by C_{f1}, R_f and C_{f2} in the feedback path. (A) Two bipolar transistors are required for a preamplifier. (B) An op-amp IC can provide the same performance, but some ICs contribute excessive noise. The type must be selected with care. Both B+ and B− supplies are required for this schematic.

output pin should measure to ground almost exactly half the supply voltage. In that case, the circuit must supply this same voltage to both inputs. Also, input and output coupling capacitors must be used – a practice that is not recommended for digital-pulse operation. Therefore, single supply operation is used only for audio signals.

Of course, ICs do not have zippers that allow technicians to trace signals or measure voltages inside. ICs must be considered black boxes that are tested by verifying proper dc voltages and signals at the appropriate pins and by measuring the various supply voltages. If the supply voltages and the input signals are correct, a lack of output signal indicates an IC that needs replacement.

Phono preamplifiers

Circuits shown previously were designed for flat frequency response. In other words, the gain did not vary with frequency over the desired ranges. But many preamplifiers must have certain frequency responses that are complementary to other non-flat responses earlier in the system. There are two major types: phonograph preamplifiers for magnetic cartridges and tape-player preamps. The major difference between the two is the exact frequency responses and the amount of compensation in decibels.

The two preamplifiers in Figure 5 perform the same functions, but one uses discrete bipolar transistors while the other has one op-amp IC.

Except for the values of components in the negative-feedback path, each circuit would have flat response. The values of C_{fl} and R_f present a higher impedance to lower frequencies than to higher frequencies. The feedback-path response produces an opposite response in the amplifier, so these two components provide bass boost (generally less than 1000Hz). Paralleled across R_f is a capacitor (smaller value than that of C_{fl}) that increases the feedback at high frequencies, thus reducing the response of the amplifier at high frequencies (generally above 1000Hz).

In both circuits, R_i is the input-load resistance whose value must be chosen according to the cartridge or tape head that is connected there.

Other response filters

Scratch and rumble filters (Figure 6) are two frequency-discriminating circuits that are sometimes added to minimize other shortcomings of an audio system.

Scratch filters are 2-stage, low-pass R/C filters that ideally have a high-frequency rolloff of 12dB per octave. Pink noise is more offensive to human ears when the sound system has excellent high-frequency response (such noise is masked at lower frquencies), so if a record has noise but no appreciable overtones of music, much of the noise is eliminated by a scratch filter, although no musical harmonics are lost.

Today's records do not have enough surface noise to require such a drastic remedy, so scratch filters are not included in modern amplifiers. If a scratch filter ever is needed, there are better circuits available, including some tuned circuits or active electronic filters.

Rumble filters reduce the extremely low audio frequencies, perhaps in the 5Hz to 20Hz range. Rumble is a sound like thunder that originates in phonograph turntables, usually in the support or thrust bearing. Slight irregularities allow the turntable to move up and down erratically, causing a rumbling noise. The best preventative is a better turntable, but a rumble filter (sometimes called a subsonic filter) can minimize the rumble without removing too much of the desired low frequencies in the music. Again, better circuits apply feedback around the filter, or some use active electronic filters.

Tone controls

Treble and bass tone controls are not required to provide overall flat response in the amplifier

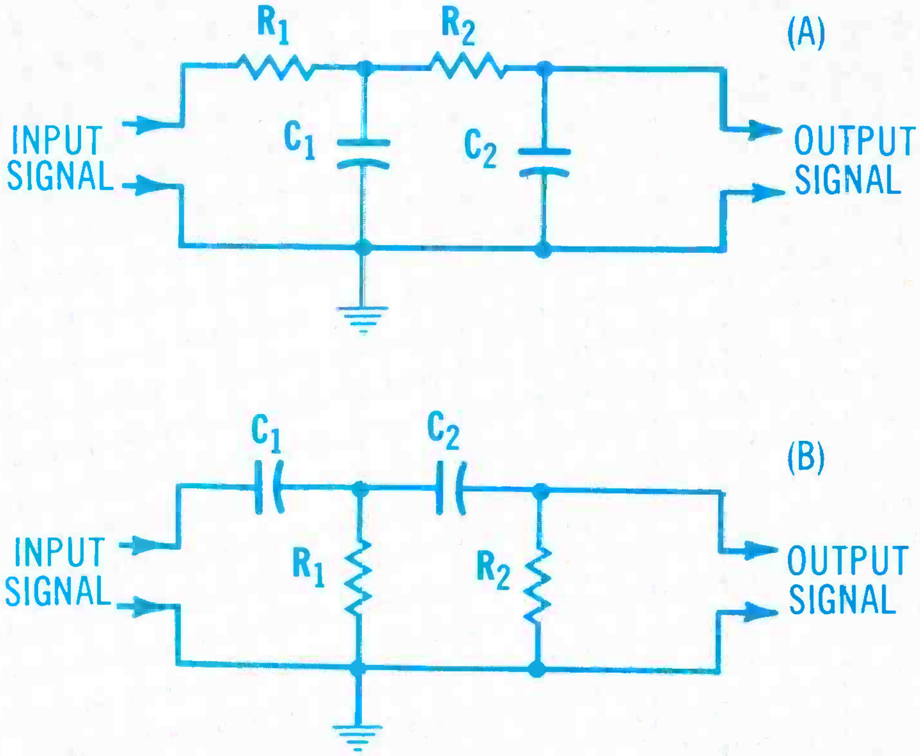


Figure 6. Scratch and rumble filters can be added to phonograph systems to minimize certain problems. (A) A low-pass scratch filter usually provides high attenuation to all frequencies above about 5kHz. (B) A high-pass rumble filter minimizes subsonic rumbling noises that originate in the turntable.

system, but they are useful options that compensate for the preferences of individual listeners. In addition, they are useful for minimizing the effects of poor speakers or other inferior listening conditions.

Most tone controls give a fixed loss to all frequencies and then remove the loss at selected frequencies to give the illusion that those frequencies have been boosted. At maximum-boost control settings, the response at both ends of the audio band is increased at a 6dB-per-octave rate, which usually is satisfactory. However, when a control is rotated to reduce the boosting, a *shelf* is formed. With bass boost, for example, an intermediate boost setting might provide the same boost at both 40Hz and 200Hz. Unfortunately, this gives a booming sound to male voices and does not provide enough increase for the low bass frequencies. These circuits are better than nothing, but they leave much room for improvement.

Baxendall circuits eliminate the shelving limitation by varying the turnover frequency up and down in step with the amount of cut or boost. No shelves are formed at any settings.

Figure 7 shows a Baxendall circuit modified for use with a transistor (original designs had one tube for each). Actually, there are two bass actions (one for boosting and another for decreasing) and two treble functions (one boosting and one for treble decreasing). For example, when the bass control is rotated to the *cut* position, small capacitance C_2 is in series between the incoming signal and Q1's base (via R4 and C6). Therefore, the C_2 small capacitance attenuates the low frequencies. At the same time, the bass control shortens C_3 (which under different conditions will give bass boosting). Therefore, the negative feedback path between the Q1 collector and the Q1 base has flat response over the audio band. The addition of the C_2 bass cut and the feedback's flat response is a bass cut at 6dB per octave.

When the bass control is rotated to the *boost* side, C_2 is shorted. This permits the incoming signal to reach the Q1 base without response change. At the same time, the Q1 collector signal passes through C_5 and R_2 without response change to C_3. However, C_3 has a small capacitance that passes only middle and high frequencies through R_4 and C_6 to the Q1 base. This amplifies the bass frequencies but allows little amplification for middle and high frequencies to give bass boost.

Intermediate settings of the controls produce an unbalanced amount of boost and cut. For example, a partial rotation of the bass control toward boost might produce 25% cut (by C_2) and 75% boost (from C_3) for 50% of overall bass boost.

Treble adjustments operate in the same general way except C_4 can function for both boost and cut. Resistor R_4 is added to prevent the bass wiring from loading the treble circuit.

Notice that the capacitances of C_1, C_5, C_6 and C_7 must be large enough to pass the entire audio range without significant loss.

Troubleshooting a Baxendall circuit should not be difficult after you understand the operation. Defects of capacitors and resistors will allow some functions but not others, and the symptoms should point to the area that has the defect. Anything that eliminates the Q1 gain should produce weak sound and little variation of response when the controls are rotated.

Remember the tendency of controls to become noisy and erratic with age. Cleaning the carbon element can provide temporary improvement, but replacement is recommended.

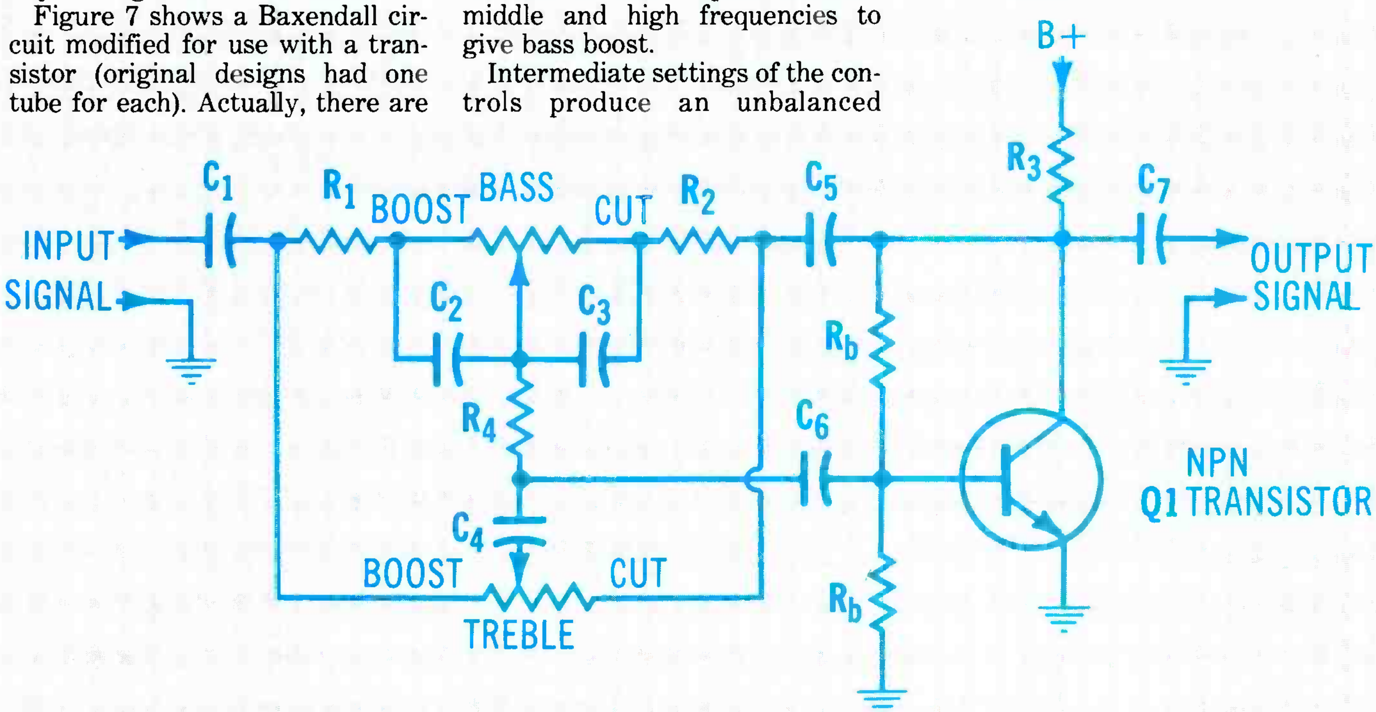


Figure 7. Baxendall-type bass and treble controls can provide excellent operation, gaiving variable roll-off operation without any shelving when the boost or cut is less than maximum.

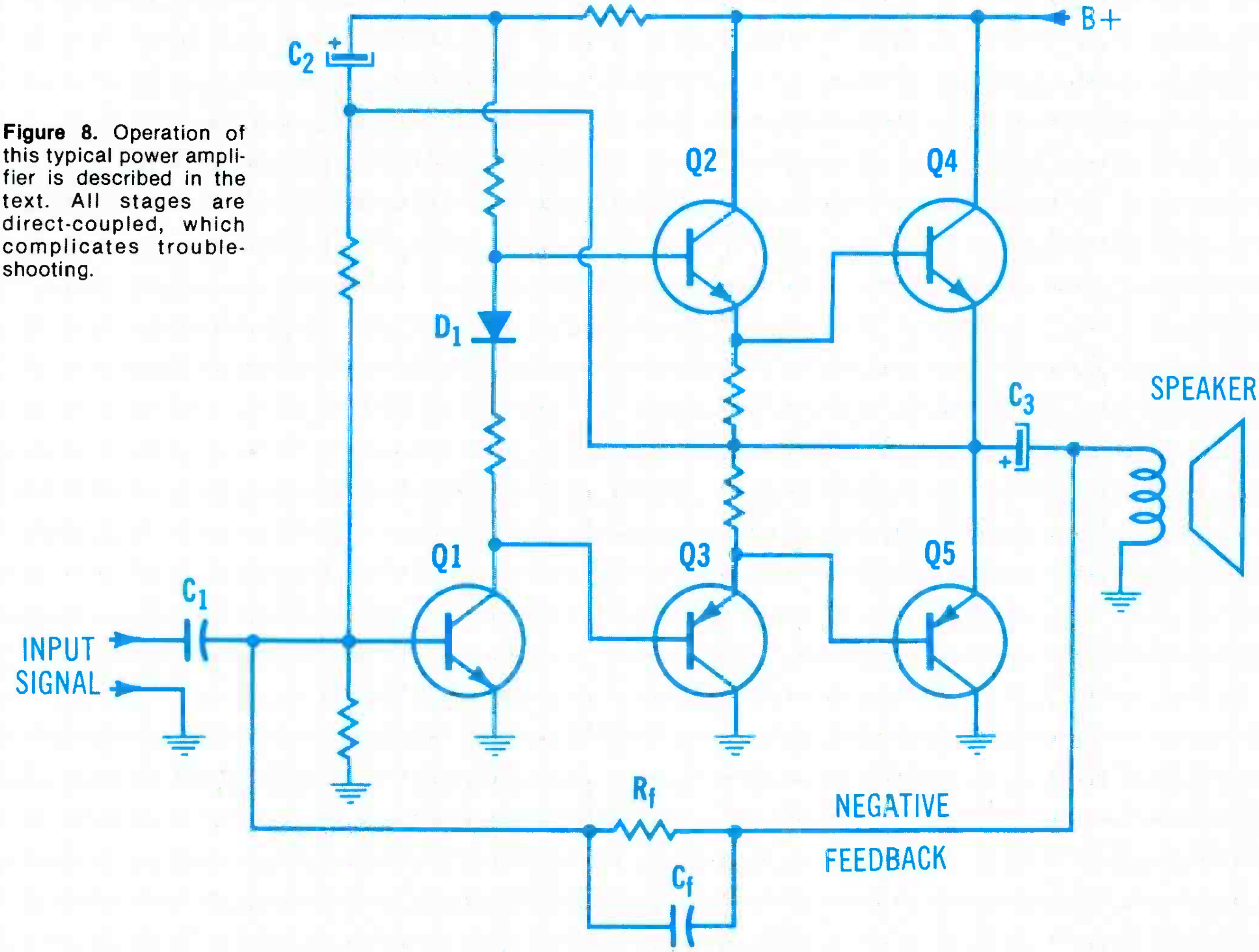


Figure 8. Operation of this typical power amplifier is described in the text. All stages are direct-coupled, which complicates troubleshooting.

Power amplifiers

Power amplifiers are designed in many ways, but the most common circuit is shown in Figure 8. Q1 is direct coupled to the bases of Q2 and Q3, while the emitters of Q2 and Q3 are direct coupled to the bases of Q3 and Q4. Notice that Q2 and Q4 are NPN polarity types while Q3 and Q5 are PNP types. A positive signal peak at the Q1 collector produces increased current in Q2 and Q4 but decreased current in Q3 and Q5. Negative signal peaks reverse this action. Therefore, the output transistors operate in push-pull with Class-B bias. Negative feedback is provided by R_f and C_f between the output signal and the input signal at the base of Q1.

Direct-coupled stages are more difficult to troubleshoot than are those with individual stages separated by coupling capacitors. For example, a defect that changed a Q1 dc voltage also would produce a much larger change in the voltages and currents of Q4 and Q5.

There is one quick test that provides much information: Measure the dc voltage at the Q4 and Q5 emitters. A normal reading is approximately half the supply voltage; deviations of more than about 10% indicate a defect.

Usually the failures in this circuit are large or catastrophic, such as complete opens or shorts. Therefore, the first tests should be resistance checks made with an ohmmeter.

If a power transistor with a mica insulator needs replacement, be sure to apply sufficient silicone grease to the transistor, insulator and chassis or heat sink, or the new transistor can run hot and eventually fail.

Comments

Poor frequency response usually is caused by defects in resistors or capacitors. An open (or nearly open) coupling capacitor greatly reduces the low-frequency response while sometimes passing the extreme high frequencies, although the sound also will be weak. Collector resistors that have higher-than-specified resistances can reduce the high-frequency response.

In Figure 8, one of the few defects capable of increasing the overall gain is an open (or increased ressistance) F_f feedback resistor. Also, minor distortion can be caused by an open C_2 bootstrapping capacitor, a shorted D_1 bias diode or a bias change at Q1. Major distortion might be caused by an open Q2, Q3, Q4 or Q5, leakage in C_3 coupling capacitor, an open in almost any resistor, or a leaky C_1 input capacitor.

Signal tracing a power amplifier often is not productive. First tests should include in-circuit junction tests of all transistors, dc-voltage analysis at all transistors and supply voltages, and a series of resistance tests. ES&T

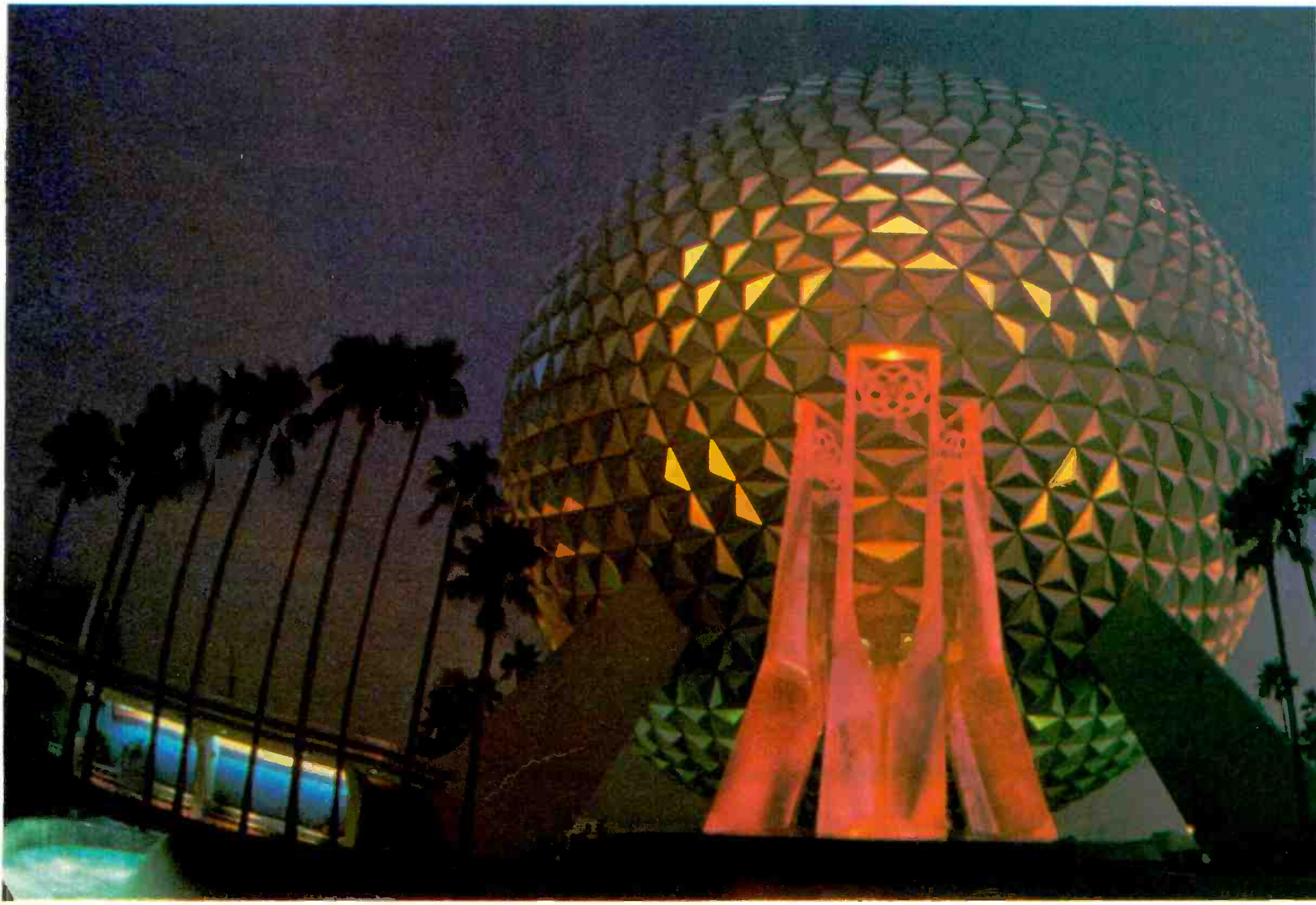
Community of tomorrow

By Rhonda Wickham,
managing editor

"The Jetsons," a cartoon series that has entertained children for years, evolved as a product of a creative person's imaginative impression of some future society. The plot of the cartoon revolves around the *average,* everyday life of George Jetson, his wife, Jane, and their children, Judy and Elroy, in a space-age society.

What seems to be anything but average is the total automation of their home. Front doors slide open when they sense the approach of warm-bodied creatures. Chairs pop out of the floor to seat guests at the push of a button. A conveyor belt carries people from room to room or gives the pet dog, Astro, his constitutional. Audio-video display units similar to present-day televisions are used for interhome and interoffice communications. Housecleaning chores are performed by a programmed robot named Rosie. A panel of buttons on a long wall is designated as the kitchen. Food and drinks are prepared exactly as requested by the hungry boarder and magically appear on a conveyor belt.

When the Jetson's automated home first appeared on television in the 1960s, their entire society must have seemed too far-fetched and "Star Trekian" to ever become a reality. However, after only a couple of decades, we have seen



many of these luxuries appear in stores and homes. What once seemed like space-age wizardry, such as audio and video presentations via laser beam, remote control of home devices and robotics, is now upon us. A product that might have been a mere seed in someone's imagination or a gross prototype in someone's garage in the early '60s has become a very real part of our society. And with use comes the need for servicing, so many of these devices are appearing on workbenches of technicians across the country.

Prototype of tomorrow

Where do we go from here? The home electronics industry has blossomed and yielded incredible fruits in the last five years, but the season is far from over. Many more fruits are left to be ripened.

An example of what society might look like in our lifetime is on display at the Epcot Center in Orlando, FL. Epcot, which translates into Experimental Prototype Community of Tomorrow, is 260 acres devoted to what outer realms man's imagination can take him to. This same type of imagination has made such electronic brainstorms as the radio and television practical realities. Epcot Center invites guests to look at these developments in an area called Future World.

Future World

The six major pavilions and exhibit areas of Future World are designed to present the themes of communications, energy, transportation, agriculture, imagination and technology.

Spaceship Earth, the symbol of Epcot Center (see front cover) towers over the pavilions. Spaceship Earth is a shining geodesic sphere anchored on 15ft-high legs and rises a total of 180ft. A ride-through attraction spiraling through the 17-story interior of the geosphere introduces visitors to the story of man's progress through communications advancements. From the first images painted on cave walls to computers with electronic pathways capable of taking you to the very edge of space, you'll see how communications has survived and grown through the ages.

At the hub of Future World is CommuniCore, two crecent-shaped buildings where guests can use a variety of advanced-design electronic devices for entertainment and information purposes, including a touch-sensitive videodisc system that provides instant audio-visual information on specific attractions throughout Epcot. Guests can converse with computers, cast opinions on current issues, select and preview travel plans via videodisc and have hands-on experience with products of the year 2000 and beyond.

Surrounding CommuniCore are four separate theme pavilions, including World of Motion, shaped like a giant wheel six stories high; Universe of Energy, a pyramid-shaped building with rooftop solar cells that can generate up to 70,000W of dc power; The Land, with six acres under one roof devoted to leading-edge agricultural methods and land use; and Journey into Imagination, with two truncated glass pyramids shaping the exterior and an interior where guests explore a fantasy world of creativity and participate in creative experiences using electronic devices.

All theme pavilions have ride-through attractions, some involving elaborately constructed scenes of historical events and the use of life-like figures. In World of Motion, for example, a used-chariot salesman in ancient Rome is busily slashing prices–in Roman numerals. Elsewhere, the first traffic jam involving the automobile is depicted.

In Universe of Energy, visitors will ride in 97-passenger "theater cars" powered by solar energy through a prehistoric diorama illustrating the billion-year formation of fossil fuels. In The Land, a boat ride journeys through the different food-growing regions of the world and through greenhouses where lush crops are being grown in imaginative new ways.

Future World pavilions also explore themes through demonstrations, participatory experiences, theatrical productions, unique motion pictures and hundreds of elaborate special effects that employ state-of-the-art technologies and projection techniques.

Although it is a little intimidating to admit that the electronics industry could have such a major impact on our society, the fact remains that it is shaping the future. In your communities and your very homes, you can see the influence of modern electronics in your television and home computer and the convenience of your garage door opener and microwave oven. Imagine what you will soon see. Many of the products that are now in developmental or prototype form may soon make the Jetsons seem as antiquated as the Flintstones. ES&T

(Photo provided by Walt Disney Productions, © 1983.)

Home Control System, under development by GE, allows the homeowner to control all major elements of the home environment conveniently and automatically while at home or away.

The electronic home

By Conrad Persson, editor

Home has become the host to a number of electronic devices. There's the television, the stereo, the portable tape recorder and the calculator you use to balance the checkbook and figure your taxes. Associated with the television is the video game. (Doesn't everybody have one?) The microwave oven cooks electronically. Telephones, which we take entirely for granted, are among our most valuable electronic tools.

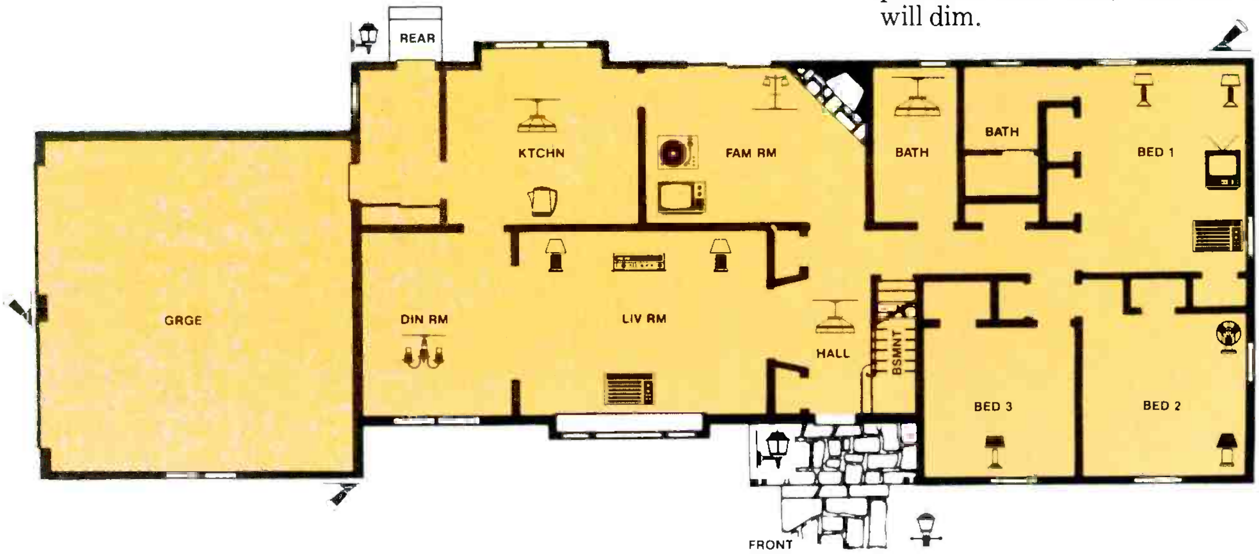
These are just a few of the many home electronic devices available today. There is no end of electronic entertainment devices, security devices and control devices, and the electronics industry continues to churn them out in awesome numbers while inventing more.

Control in the electronic home

Until recently, each of the electrical/electronic devices in the home has acted as a separate entity, with the house wiring system as the only common bond. Now, through the magic of electronics, that common bond has become not only an electrical distribution system, but a message distribution system, allowing a central operator, human or computer, to control any piece of equipment that derives its power from the house wiring.

Several of these control systems already exist, and others are being developed. A small electronic package is plugged into the house wiring outlet at each point where a device is to be controlled. The electrical appliance (lamp, stereo, television, etc.) to be controlled is plugged into a receptacle on the electronic package.

Each of these electronic control packages has a unique "address" and may be controlled from a panel that is installed at a central location: the kitchen or master bedroom, for example. Let's say you're in the kitchen, where the control panel is located, and you want to turn on a lamp in the living room. You simply touch the button on the control panel that corresonds to that lamp's control package and the light in the living room comes on. Too bright? Press the button on the central control panel marked "dim," and the lamp will dim.



An application planning sheet helps the homeowner plan a control system using elements of the BSR system X-10.

Computer control

A microcomputer in the control panel allows you to program the operation of your appliances. You can preset the control panel to turn any of the appliances on or off at any time of any day. Most of these systems allow more than an adequate number of on/off cycles for each appliance on any day.

With a system like this, you can program your lights to come on before you come home on those dark winter nights. Or on hot summer days, you can have the room air conditioner come on a half hour before you walk in the door. Why not have the electric coffee percolator perk your coffee so it's ready when you get up? The possibilities are endless.

The security module

With all of this control capability, home security suddenly becomes more effective. If you place sensors at all doors and windows and tie them into the central control panel, when an intruder opens a door or a window, all the lights (or any you have preselected) come on and the tape recorder (if you have set it up) comes on with a recording of a barking dog. There are even interface devices that will dial the police or any other number you choose and deliver a message that your house is being broken into.

The MicRobot

BSR has been marketing home control devices for several years. It has just introduced the X-10 MicRobot, a combination of hardware and software that gives a computer or television the power to control everything electrical in the home.

The first MicRobot-type product is currently being manufactured on a private-label basis for Mattel Electronics' new Aquarius home-computer system. Mattel calls this new peripheral the Aquarius Command Console, and it is cosmetically designed to match the Aquarius.

In the near future, BSR intends to introduce a series of MicRobots under the BSR label for other popular computer systems, including the major personal computers and home computers.

"Some people have characterized

Let your phones do the dialing

Superphone model 7800 has two lines, can forward calls, dial a number for you, let you make conference calls, tell you the day, date and time, and will wake you up.

Once the exclusive province of Ma Bell, the telephone has now become the business of dozens of manufacturers and hundreds of merchandisers. You can now go to almost any store and buy a "throw-away" phone for about ten bucks. If you want something more reliable and feature laden, you can buy phones that dial themselves, phones that answer themselves, phones that forward calls, and more. And of course if you're interested in walking around unfettered by a cord, you can get one of the newer cordless phones and do your calling from the poolside or patio.

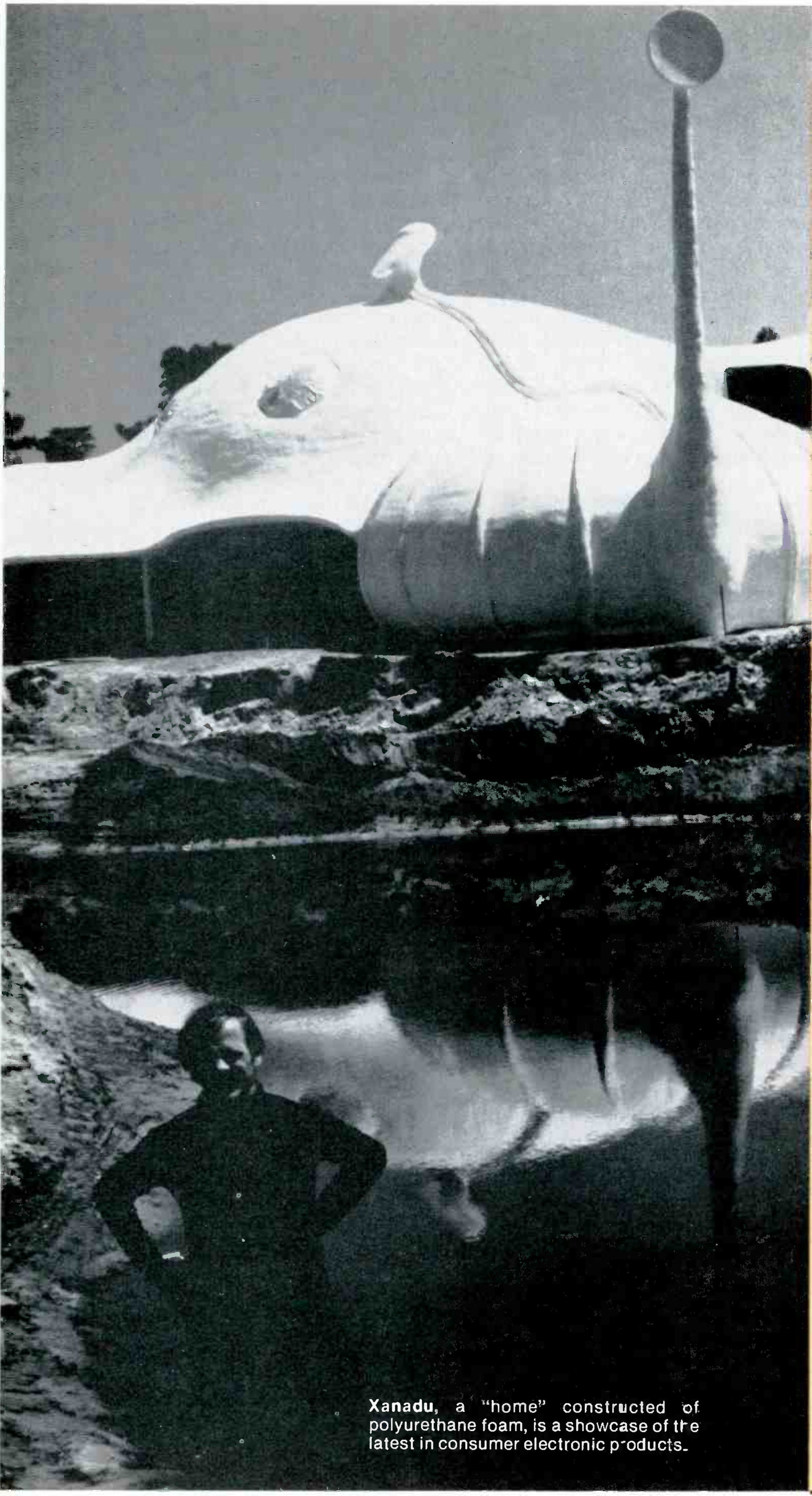
Superphone

One example of these remarkable new telephones is the Superphone model 7800, said to be the only 2-line feature phone in the industry and which offers built-in programmable call diversion. At the user's option, call diversion (or call-forwarding) can be performed in several ways. For example, the phone can be programmed to divert all incoming calls to a local or a long-distance number or only those during a particular time period. Another option is to establish a series of up to eight numbers in a sequential time frame and the 7800 will route calls to the proper number at the proper time.

Another one-of-a-kind feature is the ability for hands-free dialing by the *superdial* or electronic-answer-detect. In this mode, the user leaves the handset on the hook, dials a desired number, presses *redial* and lets the 7800 do the work. Superphone selects an unused line, *Superdials*, and then signals with a tone when the other party has answered. If the line is busy, the 7800 will call every minute for 16 minutes, yet leaves your line free for incoming calls. If there is no answer, it tries 3 times then quits.

Superphone also features *auto-pause,* which lets you dial a network system (i.e., Sprint, MCI...) in 1-step dialing.

Other features include 64-number memory (14 digits per memory), 3-way conference calls, a 6-function calculator, a large time/date/day display and a call-to-wake alarm. It also has a switch to select either, touch-tone or rotary signal mode.



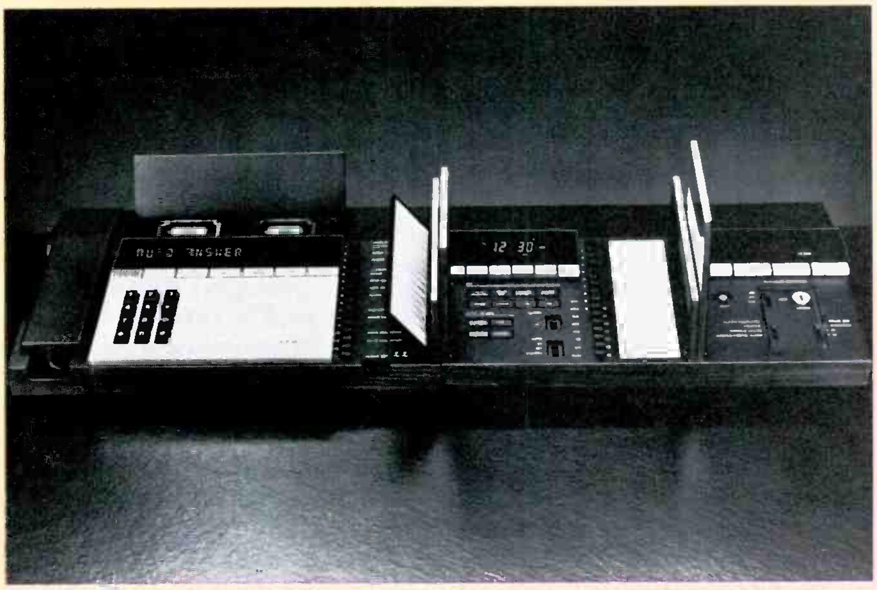
Xanadu, a "home" constructed of polyurethane foam, is a showcase of the latest in consumer electronic products.

There's no place like foam

Developments in electronic technology will make homes in America far more livable, functional and secure, according to futurist architect Roy Mason, designer of "Xanadu," an electronically "intelligent" display home in Orlando, FL. The home, constructed of energy-efficient polyurethane foam, is designed to consume one-fourth the energy required to heat and cool a conventional house of similar size.

This permanent exhibit of the latest consumer electronic products on the market or in development features advanced microcomputers, electronically generated visual arts, innovative appliances, electronic games, audio/video systems, interactive videodisc players and "robutlers." An exponent of architronics (the blending of architectural design and electronics), Mason credits technology for "opening up new vistas in human habitats and lifestyles."

To demonstrate the point, he showcased the Anova Master



The nervous system of Xanadu consists of this combination of Telephone Center, appliance/lighting Control Center, and Protection Center.

System, a unique set of integrated component centers that will combine communications, appliance/lighting control and personal/property protection at the 6000ft² foam dome house.

Developed by Anova Electronics, the "smart" system can warn residents of an intrusion while simultaneously switching on lights and stereo music and automatically dialing police or neighbors.

"We see Anova's product as the nervous system of Xanadu," Mason points out. "It will be an extension of the microcomputer-based 'house brain,' but will operate independently–in this case off the ac wiring of our display house through proprietary Auto-Link technology pioneered by Anova.

"Most importantly, the product will be available on the market in a matter of weeks and at an affordable price," adds Mason. "This is why we selected it for Xanadu, as we are seeking to combine a glimpse of tomorrow with practical application today."

Other features at Xanadu include:

- The "sensorium," a family room that Mason calls the electronic hearth, containing a wall-sized TV screen connected to a 2-way cable system. Also, there are several video-game consoles, educational computer terminals and systems for electronically generating visual art.
- Work and school stations in which each family member has a soundproof kiosk and computer terminal, looking to the day when working at home will be commonplace and education but a step away.
- Kitchen computers programmed to provide diet plans based on age, weight, height and activity levels. They also maintain records of food stocks and prepare shopping lists.
- Future plans call for an "Autochef," a combination refrigerator and microwave unit that moves pre-prepared meals from storage to microwave oven and on to the dining room without human handling.

the home computer as a solution in search of a problem," says Peter Lesser, general manager of the BSR X-10 division. "Computers in the home have been suffering from a lack of things to do around the house, and an X-10 MicRobot will finally give a home computer a thoroughly useful in-home job to do. The BSR MicRobot will retail for less than $75 with the ability to add on as many X-10 modules as required."

A concept with even greater potential than the MicRobot for computers is the MicRobot for TV sets or cable TV set-top converters.

According to Lesser, "As much as 70% of a U.S. consumer's leisure time is spent in front of a TV screen. It makes sense, therefore, to let consumers control their homes from in front of the TV set using its hand-held, remote-control unit. In effect, a MicRobot can be built into the TV set or cable converter, or it can be attached to the set like a TV game or computer. BSR can demonstrate a TV control system today, and we are now engaged in discussions with major TV manufactures to determine the best way to proceed."

Lesser notes that a major European TV manufacturer has already decided to build an X-10 controller into its top models and will introduce the system in Europe this September.

"Ultimately, a TV screen will be the central home entertainment, computing and control medium," Lesser observes. "Perhaps there will not even be a separate television and computer but rather one system that does it all. In any event, System X-10 will be there controlling everything electric."

Simple to use

The BSR X-10 MicRobot is a small computer peripheral that is actually a self-contained microcomputer itself. It incorporates a microprocessor and memory backed up by a battery that can sustain it without ac power for more than 100 hours of use. The MicRobot sends signals over the ac wiring to X-10 modules controlling lights and appliances throughout the house.

The MicRobot has two cords; one plugs into the cassette port of a home computer such as the Mattel Aquarius, and the other plugs into a standard 120V wall outlet. The software is on a cartridge just like a videogame except, instead of playing a game, this cartridge gives you the power to automatically control virtually every electrical device in a home.

In vivid color, the software system graphically steps you through every room in your home on the video screen as you select each light, appliance or home entertainment product you wish to control. The screen also displays the outside of your home so you can set outside convenience or security lights to go on and off automatically or operate them instantly.

The computer screen prompts the user every step of the way. The user responds and makes selections, using only three adjacent keys on the computer keyboard or using a simple joystick connected to the computer. As the user makes selections, the information is sent to the MicRobot and recorded in its memory. When the user has finished setting up the personalized home control system, the MicRobot may be unplugged from the computer and will send commands over the power cord, which remains plugged in. At this point, the home computer system is free to be used for other purposes.

BSR introduced System X-10 four years ago, and since that introduction, these X-10 features have been added:

- *timer*—for automatic, programmed control of your lights and appliances
- *telephone responder/controller*—to control your home from any phone
- *burglar alarm interface/controller*—to light up your home when the burglar alarm is tripped
- *thermostat set-back controller*—to save energy by cutting back central heating and air-conditioning automatically

Electronics everywhere

There is no question that electronics is transforming the home. The question that remains is to what degree will this transformation take place. Already we have the capability for instant access to almost every kind of information anywhere in the world. We can control the home environment in ways undreamed of a few years ago. We have electronic video games and electronic tutors, and it looks like it won't be long before we have robots that can do useful tasks around the house. The "electronic home" is no longer the "home of the future." It is the home of the present. It is here.

A robot companion

Androbot has introduced B.O.B. (Brains On Board), a personal robot designed to entertain, to communicate and to be a useful addition to the home environment.

B.O.B.'s on-board "native intelligence" derives from Intel 8086 microprocessors combined with 3 megabytes of memory capacity. B.O.B. will navigate a living space and talk in a human-like voice, randomly choosing more than 100 stored words and phrases. Infrared sensors attract B.O.B. to humans, whom he may follow at will; in the process, he'll avoid inanimate objects in his path via his ultrasonic sensing devices. One additional feature of note: B.O.B. can retrieve a beer or soft drink from an optional AndroFridge, and bring it to wherever his master may be waiting.

What's more, equipped with an exclusive Androbus system, B.O.B. has nearly limitless potential for expansion, both through add-ons to his existing electronic brain, as well as through user-created and commercially available software.

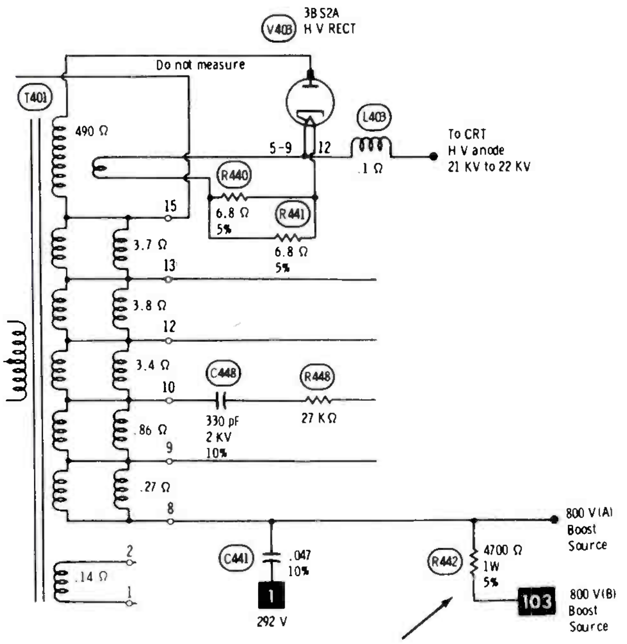
In the future, B.O.B. has the potential for being not only a charming companion, but also an indispensable "multi-tasking" computer on wheels. B.O.B. may sound a wake-up call and coax late sleepers out of bed in the morning; watch over the house, take phone messages and respond to emergencies while the family is away at work or school; and entertain them in the evening after a long day with a recitation from Byron, Keats or Shelley.

Troubleshooting Tips

Sound but no raster
Penney's model 685-2849
(Photofact 1451-1)

Normal sound and no trace of a raster usually indicates a loss of horizontal or high voltage, but the high voltage checked within tolerance. Perhaps a video problem was removing the raster and picture. (Actually, the color receiver was a Toshiba model C312 with a TAC-7630 chassis, but no Photofact was listed for it. A technician friend told me the Penney's model had the same schematic with a different physical layout.)

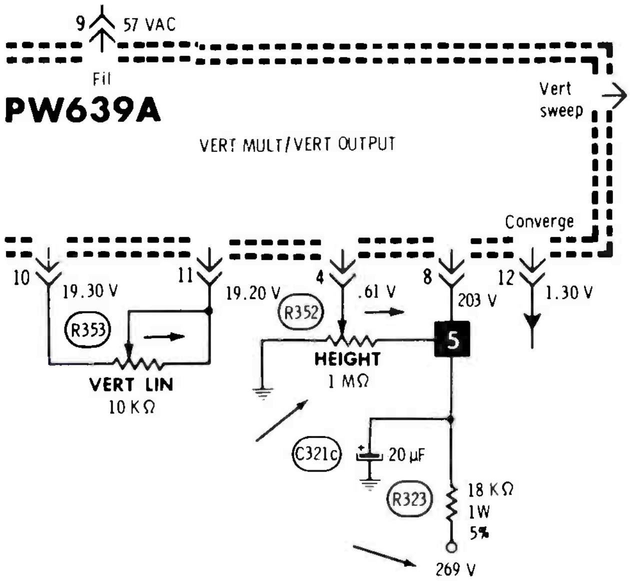
After testing a few major dc voltages and replacing the video output tube, I was surprised to find +239V at *both* ends of the screen controls. Of



course, +800V of boosted-B voltage should be at the *high* ends of these controls. The boosted-B supply comes through R442, so it was tested and found burned open. A new R442 restored the boosted-B voltage, but the screen remained dark until a new 10BQ5 video tube was installed (the old one had been plugged back in earlier when a new one did not help).

Unfortunately, the screen showed only one horizontal line; there was no vertical sweep. Resistance tests in the vertical circuit found an open R352 vertical-height control. However, the control had been replaced before, and this was cause for suspicion. Before installing a new control, I tested the voltage coming to the control. It was +800V instead of the correct +269V. I disassembled the receiver and began tracing the wiring. Finally, I found where the wire from the control had been moved from the +269V supply to the B-boost supply, apparently by the same technician who had installed the height control. After I restored the B+ wiring and installed a proper height control, the raster had normal height that could be adjusted for good linearity, but the raster contained no video at all. Replacement of the 10KR8 video tube brought back the picture.

While tuning all active channels, I found the channels were erratic, indicating that the tuner contacts needed cleaning. For the third time, I disassembled



the machine, cleaned the tuner, and reassembled everything. All channels now were stable, and the fine tuning operated smoothly and correctly.

The many disassembling and assembling operations, however, had broken the age-hardened insulation on the high-voltage cable, so I replaced this wire.

After so many different problems, I was not too surprised to find the ac-interlock was intermittent. After the power cable was replaced, the color receiver finally operated correctly.

It is unusual to find so many defects – both natural and technician-caused – but a good technician should be able to find them by following standard diagnostic procedures.

Phillip M. Jones, CET
Martinsville, WV

Have you solved a difficult troubleshooting problem? Send your solution to:
Troubleshooting Tips
Electronic Servicing & Technology
P.O. Box 12901
Overland Park, KS 66212

The magnetron: a key to microwave oven servicing

By Homer L. Davidson

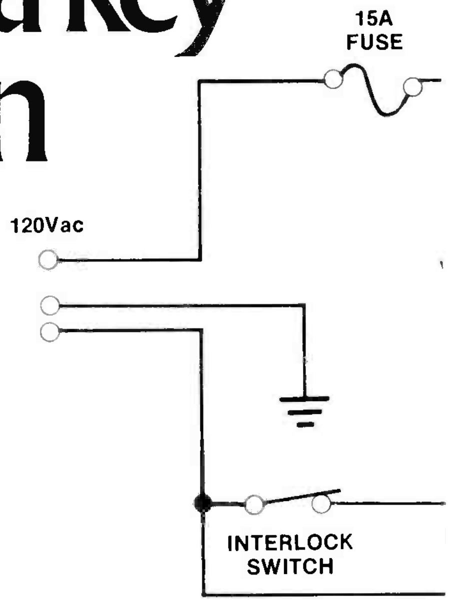


Figure 1. The primary step in servicing a microwave oven is determining if the problem is caused by the magnetron or some other part of the circuit. A leaky diode or high-voltage capacitor may cause the absence of high voltage at the filament terminals of the magnetron.

The microwave oven circuit is relatively simple and reliable in operation. Like any other electromechanical device, however, microwave ovens occasionally malfunction. Servicing the microwave oven is not as complicated as it might seem. Determining when to replace the expensive magnetron tube, an important aspect of servicing these appliances, is thoroughly discussed in this article.

Isolating the problem

The first step in servicing a microwave oven is to determine if the magnetron is defective or if the trouble lies elsewhere in the circuit (Figure 1). Take voltage and current readings at the magnetron terminals. When proper voltage and current measurements are found at the magnetron terminals, but the oven does not produce any heat, it is likely that the magnetron is defective.

The magnetron may have low emission resulting in slow or no cooking. An indication of low emission is a low value of current to the magnetron.

Overcooking or burning may also be caused by a defective magnetron (Figure 2). In this case, a high current reading may be found. Often, the thermal switch will open intermittently and shut down the oven. The cooking process will start up again after the magnetron cools down.

Arcing inside the oven cavity may be caused by a buildup of grease in the waveguide area. Burning or arcing of the waveguide cover may be the result of the collection of grease on the top side of the cover, or may be caused by a defective magnetron. Food particles near the antenna element of the magnetron may cause arcing.

A dead condition or repeated blowing of the 15A fuse may result from a leaky or shorted magnetron. In order to properly test for this, filament or heater leads must be removed from the magnetron. This isolates the magnetron from the high-voltage circuit and eliminates the possibility of confusing a leaky magnetron with a leaky diode capacitor in the voltage circuit.

Always pull the power cord and discharge the high voltage capactior before attempting any kind of test in the oven (Figure 3).

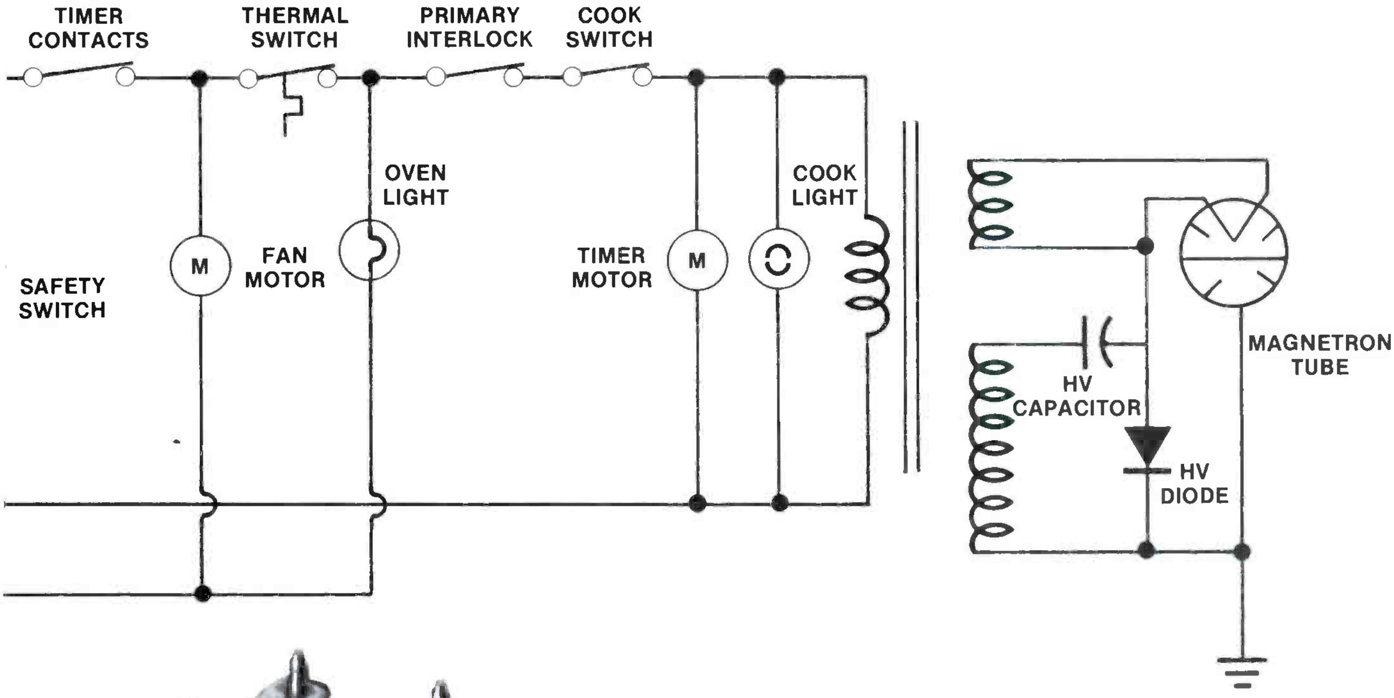
Resistance measurements

With all cables removed from the heater terminals, a correct leakage test can be made. Measure the resistance between one heater terminal and the chassis. The anode terminal or the body of the magnetron is at ground potential in all microwave ovens. The resistance between filament and chassis ground using the high megohm scale should read infinite. Replace any magnetron with a lower resistance measurement.

Check the continuity of the filament or heater terminals using the low ohm scale. Usually this measurement is less than 1Ω. With a digital ohmmeter, the reading may be less than 0.01Ω. High resistance or no measurement indicates the heater is open internally. Always remove the filament transformer leads for this test, or you may measure the low resistance of the transformer winding.

Some oven manufacturers recommend that troubleshooting of the high-voltage section be performed by measuring resistances instead of voltage and current. The resistance across the high-voltage diode terminals should measure above 10MΩ. Sometimes a 10MΩ resistor is included in the circuit or is built right in the diode component to provide a leakage path for the high voltage after the oven is shut down. Remove all leads from one side of the high-voltage capacitor to measure its resistance. The resistance reading across the capacitor terminals should be infinite.

The high-voltage transformer windings may be checked with the ohmmeter. A reading less than 1Ω should be found across the filament or heater winding. You may find a separate filament transformer in some microwave ovens. The high-voltage winding feeding the voltage doubler circuit may be more than 50Ω. Most microwave oven servicing data does not include normal resistance values of the transformer winding. It's wise to take the transformer resistance measurements of a nor-



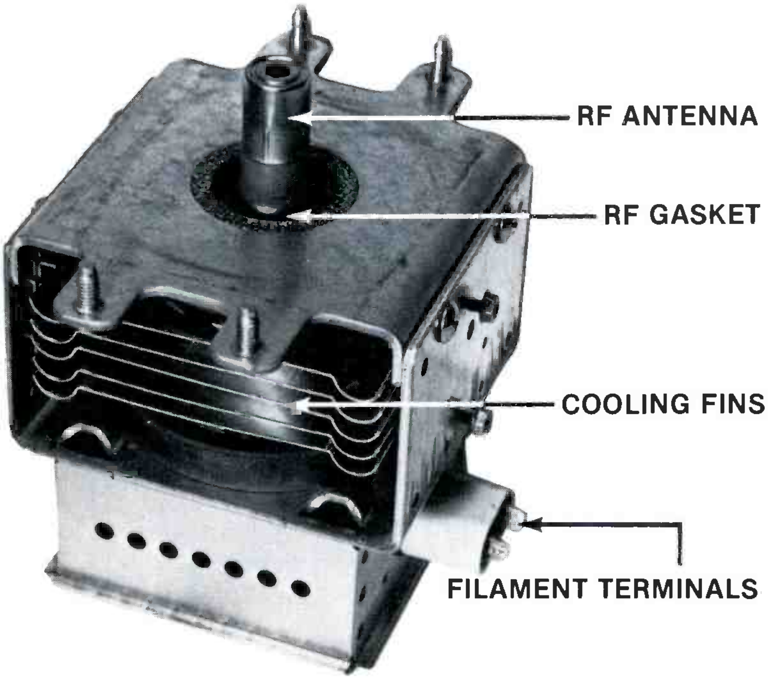


Figure 2. A defective magnetron may cause overcooking or burning of food. When the magnetron becomes too hot, the terminal switch opens up, shutting down the high-voltage circuits.

mal oven and record them upon the schematic for future reference.

High voltage and current tests

Several safety precautions should be observed when taking high-voltage measurements within the oven circuits: Use only a high-voltage voltmeter with a 5kV range, do not use the regular VTVM or bench VOM in high-voltage tests (the VTVM may be used only with a high-voltage probe), connect the instrument terminals with clip leads and do not hold the meter in your hands.

A TV high-voltage probe may be used for high-voltage indication (the dc voltage applied to the magnetron may be from 1800V to 4500V). Lay the probe on the bench and clip the terminals into the high-voltage circuit. The meter ground lead will clip to the high-voltage negative side at the heater terminals with the positive probe

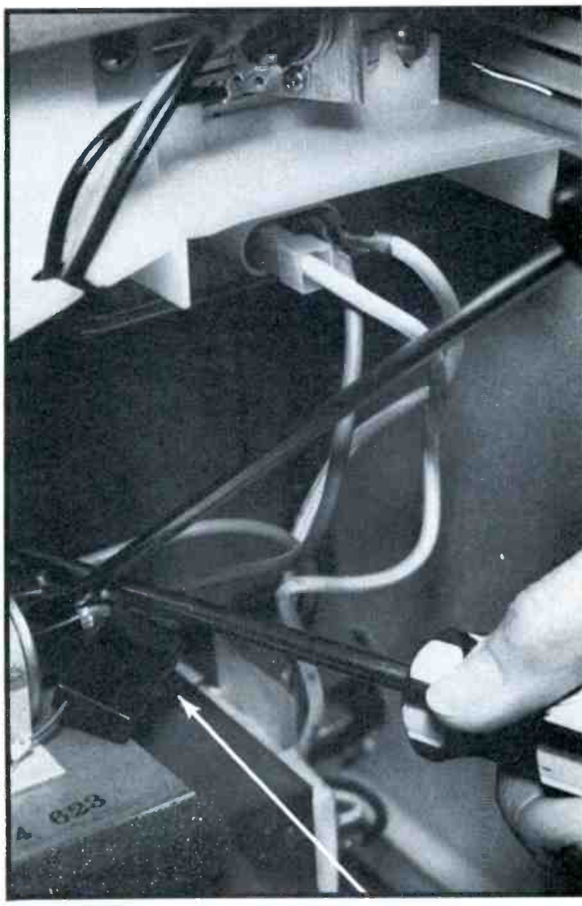


Figure 3. Always pull the power cord and discharge the high-voltage capacitor before attempting to make any kind of tests in the oven. (Arrow indicates high-voltage diode.)

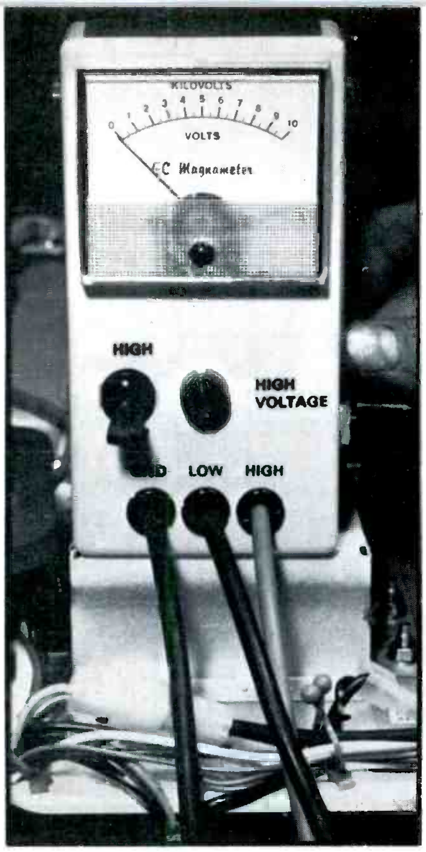


Figure 4. The GC Magnameter is an ideal high-voltage and current meter for servicing microwave high-voltage circuits. Besides measuring current and voltage, the meter has a switch to discharge the high-voltage capacitor.

clipped to chassis ground.

The ideal high-voltage and current meter for microwave circuits is the Magnameter by GC Electronics (Figure 4). This meter may be clipped into the high-voltage circuit for correct voltage and current measurements. A 10Ω resistor with insulated clips is included for current tests. Pushing back on the meter lever switch provides a method for discharging the high-voltage capacitor when the oven is turned off.

The meter is well insulated and may be placed on top of or beside the oven for high-voltage measurements. Although the meter movement is small, it gives an indication of when high voltage is applied and if the tube is drawing current. Replace the magnetron when the high voltage at the heater terminals is correct, but low or no current is measured.

The Magnameter is easily connected to the high-voltage circuit. Clip the red lead to the heater terminals or the high side of the high-voltage diode. Connect the black lead to chassis ground. Remove the ground lead of the high-voltage diode and insert the insulated 10Ω resistor in series. Clip the green lead to the positive terminal of the diode (Figure 5). Double check all connecting cables before turning the oven on.

When high voltage is present, the red light on the meter will light, and the meter indicator will give the reading. Simply flip the switch down for current tests. An open heater or lack of emission from the magnetron will be indicated by low or no current measurement. If the symptom was burning food or excessive temperature, the meter may indicate a higher than normal current reading.

It is possible to check the current draw of the magnetron without a high-voltage or current meter. To do this, clip a 10Ω, 10W resistor in series with the high-voltage diode and chassis ground (Figure 6). You may find that some older ovens already have this resistor in the high-voltage circuit.

Next, clip the negative lead of a regular VOM to the chassis with the positive lead to the top side of the resistor. Switch the meter to the 100Vdc scale. Prepare the oven for a cook test. A 2.5 to 5V

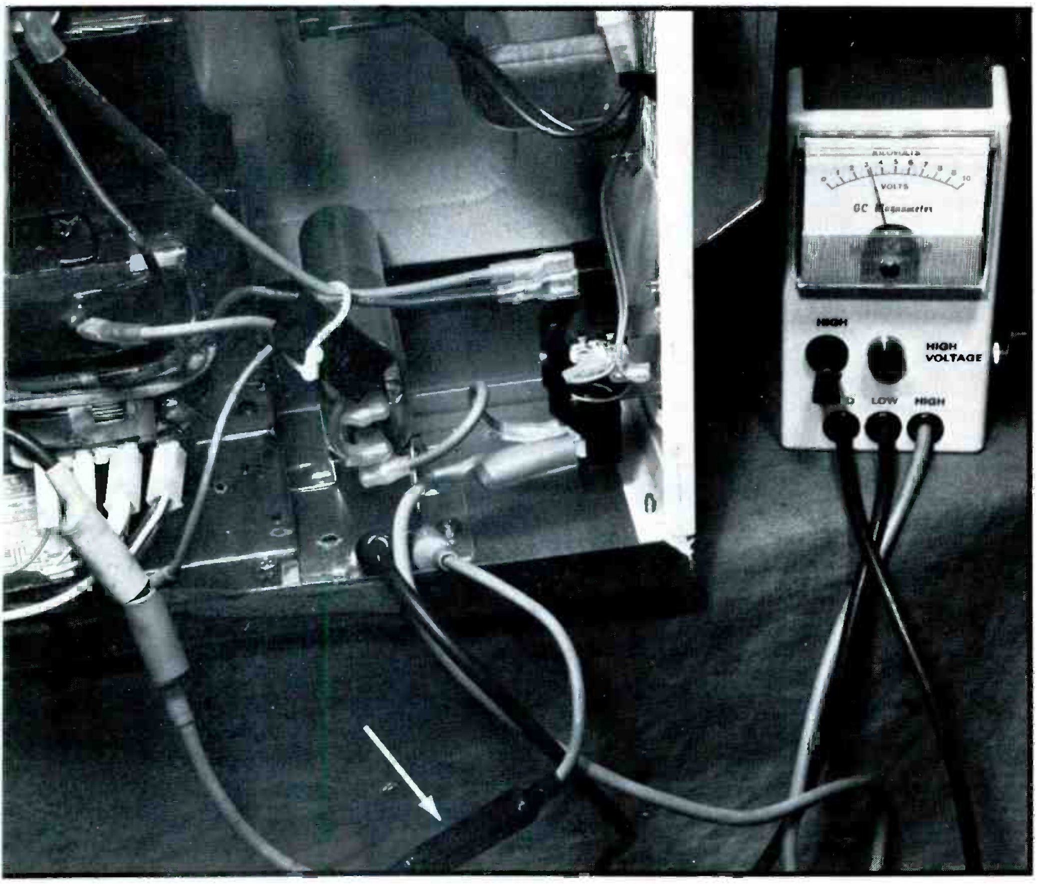


Figure 5. The Magnameter is clipped into the circuit with large insulated alligator clips. Remove the grounded end of the diode and insert a 10Ω resistor (indicated by arrow) in series for current tests.

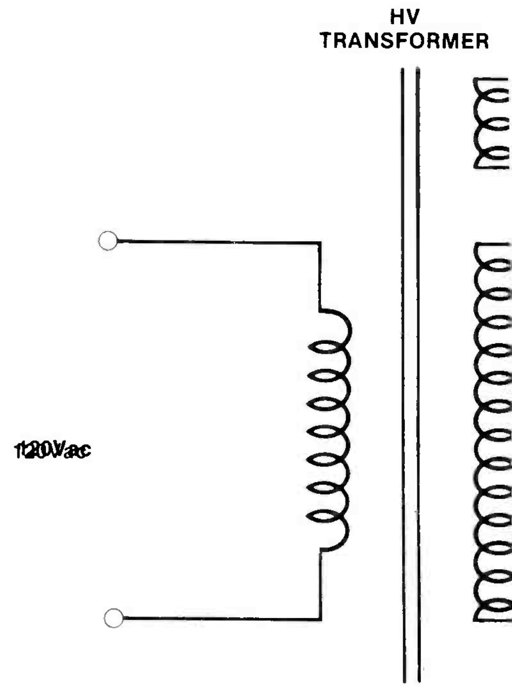


Figure 6. Without a high-voltage meter, you may check current of the magnetron by inserting a 10Ω, 10W resistor in series with the diode. Now measure the voltage across the resistor and chassis ground. A normal oven develops a voltage of 2.5V to 5V across the resistor.

measurement across the resistor indicates a normal range of current draw. For instance, a Sharp microwave oven with correct high voltage and pulling 300mA of current gave a 2.75Vdc reading. A magnetron with low emission may read below 1Vdc. A leaky magnetron may cause a voltage measurement above 6Vdc.

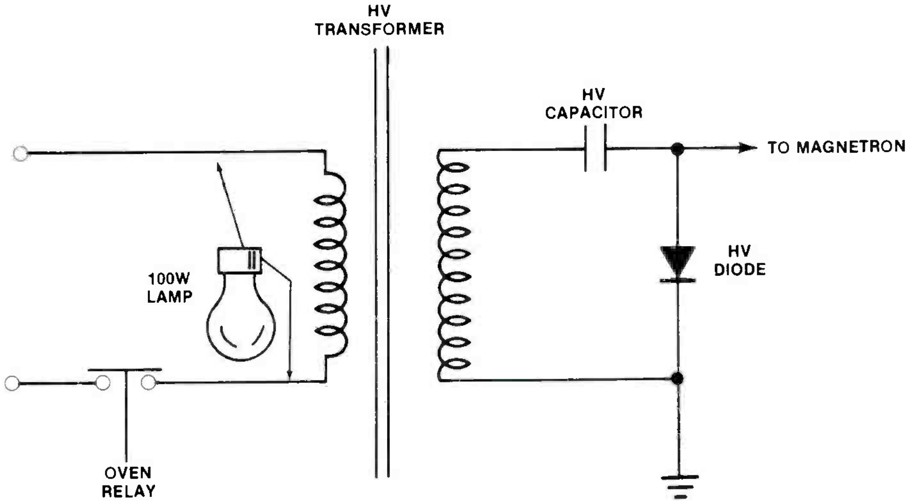


Figure 7. Monitor the power-line voltage across the primary winding of the high-voltage transformer with a voltmeter or 100W light bulb. When the bulb or voltmeter indicates power-line voltage, you may assume all low-voltage circuits are normal.

No operation at all

When the oven fails to operate altogether, a leaky diode, high voltage capacitor or magnetron may be the reason, drawing enough current to cause the 15A fuse to open. In this case, monitor the voltage (120Vac) at the primary winding of the high-voltage transformer. Clip a voltmeter or 100W lightbulb across the primary terminals (Figure 7).

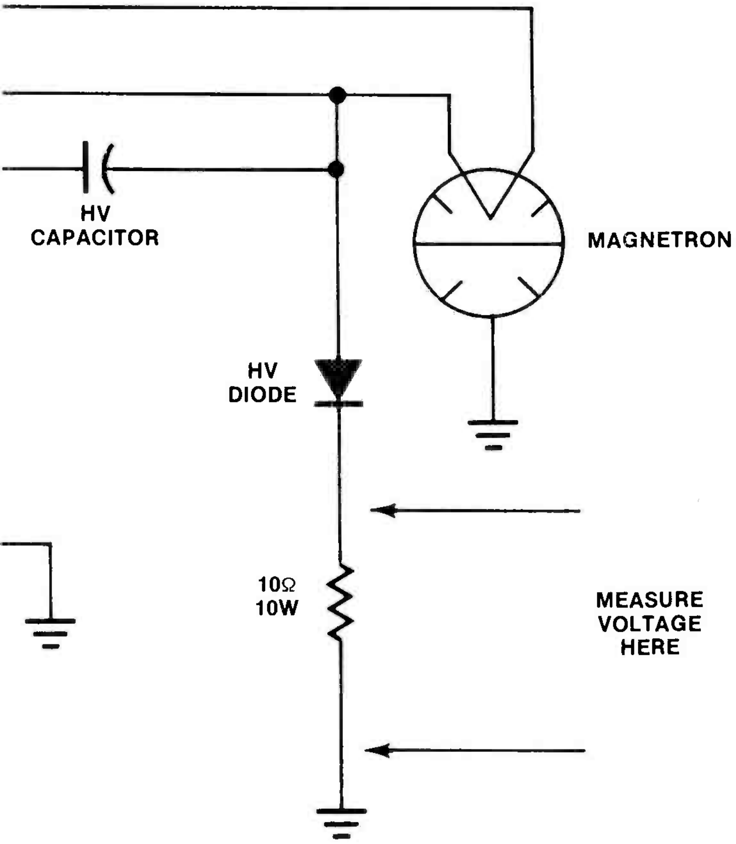
If the lamp lights up or the meter shows that normal power-line voltage is present, you may assume that the low-voltage components are functioning correctly.

The next step is to measure high-voltage and current at the magnetron terminals. Proper high voltage at the heater terminals, accompanied by current measurement, indicates a defective magnetron. If low or no high voltage is measured, suspect a defective high-voltage capacitor or diode. Discharge the capacitor and measure resistance.

Only accessories operate

When a no-heat-or-cooking condition exists but the lights and fan operate, suspect improper high voltage applied to the magnetron, or a defective magnetron. Check the oven with a water cook test. Measure the high voltage and current of the magnetron, and monitor the power line voltage at the primary winding of the power transformer. The absence of high voltage may indicate a defective high-voltage capacitor or diode. Replace the magnetron when the high voltage is normal but no current is drawn.

In some ovens, you may measure high voltage at the high-voltage diode, but find that there is no voltage at the heater terminals of the magnetron. Carefully check the oven schematic. I encountered this condition in a Quasar model MQ5520TW and suspected that the variable power switch terminals were open (Figure 8). A tap on the variable power switch started the oven operating. Replacement of the variable power switch restored normal operation.



Oven quits after five minutes

Suspect a defective magnetron or thermal switch when the oven quits operating after several minutes of operation. The magnetron may become leaky or open up. A defective thermal switch may have burned terminals or it may open up if the magnetron becomes excessively warm.

You may monitor this condition by connecting a 100W bulb or a voltmeter across the primary winding of the power transformer.

When the oven shuts down, if the bulb goes out or the meter drops to zero, you know that power is no longer being applied to the transformer. The oven may

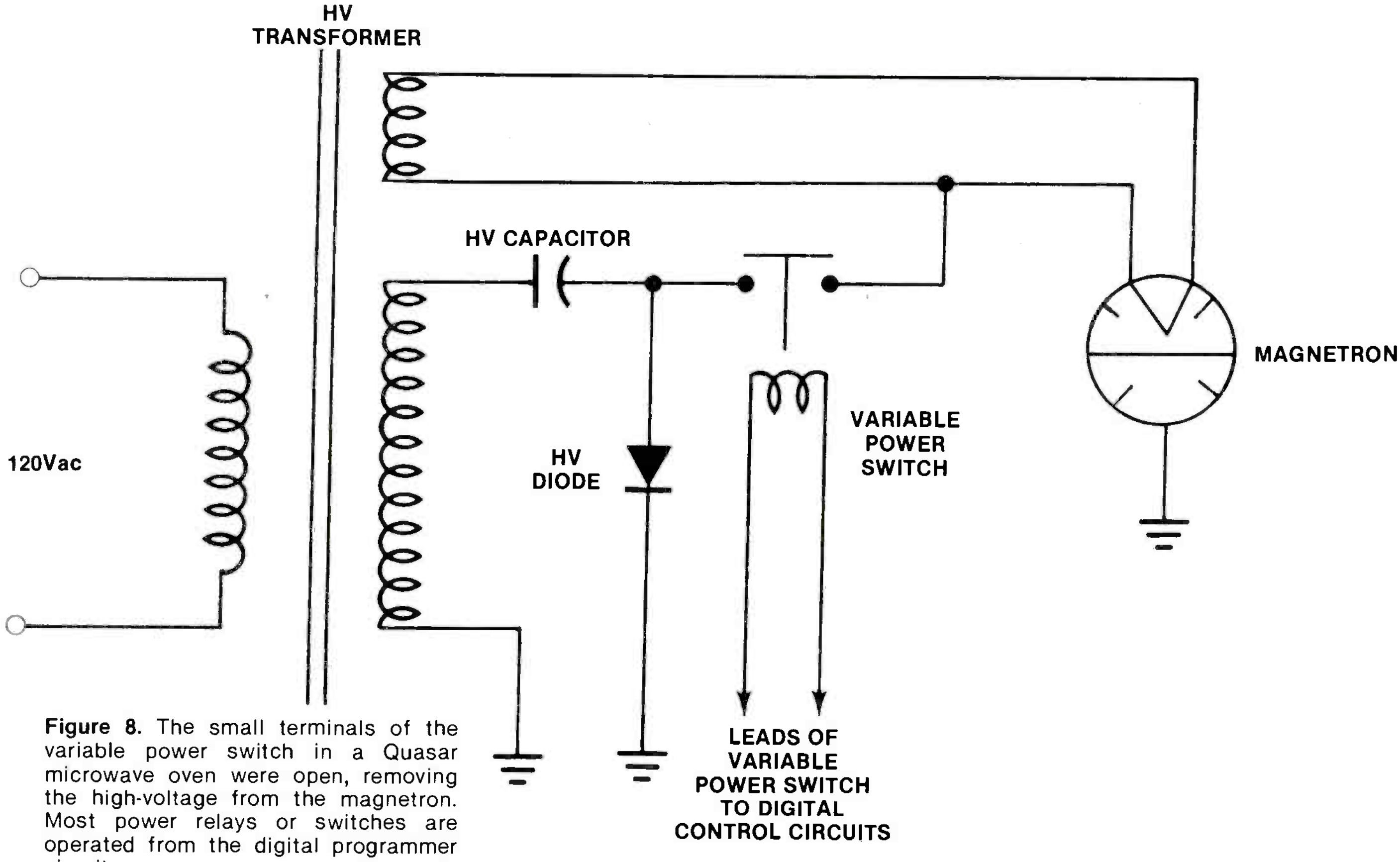


Figure 8. The small terminals of the variable power switch in a Quasar microwave oven were open, removing the high-voltage from the magnetron. Most power relays or switches are operated from the digital programmer circuits.

begin to operate once again after the magnetron cools down. Connect the 100W bulb across the thermal switch terminals. If the light comes on when the oven shuts down, suspect a defective switch or an overheated magnetron (Figure 9.) If the intermittent shutdown is accompanied by excessive magnetron current draw, replace the magnetron.

If the thermal switch is suspected, pull the power cord, discharge the high-voltage capacitor, and measure the resistance of the thermal switch. A normal switch will measure zero resistance. A measurement of as little as 5Ω between the thermal switch terminals may produce intermittent heat or cooking conditions. Replace the thermal switch if it's defective.

A defective fan

A Sharp R7704 model would stop functioning after cooking for 3 to 10 minutes. After a period of time, the oven would start up and shut down once again. The thermal switch in this case was functioning properly, opening when it became too hot. When the magnetron cooled down, the thermal switch closed, and the oven would start to cook. The cause of this problem was a little out of the ordinary. A broken motor field connection caused the fan to malfunction. This in turn caused overheating, and consequent opening, of the thermal switch.

Intermittent operation

If cooking is slow or erratic, suspect a defective magnetron. Monitor the high voltage and current to determine if the magnetron is at fault of if the problem lies elsewhere in the circuitry. Both high voltage and current should come up within 3 or 4 seconds. If the current reading is erratic, replace the magnetron.

Slow and intermittent cooking was a symptom in a K-Mart SKR-9505A model. The cable connection and filament terminals were

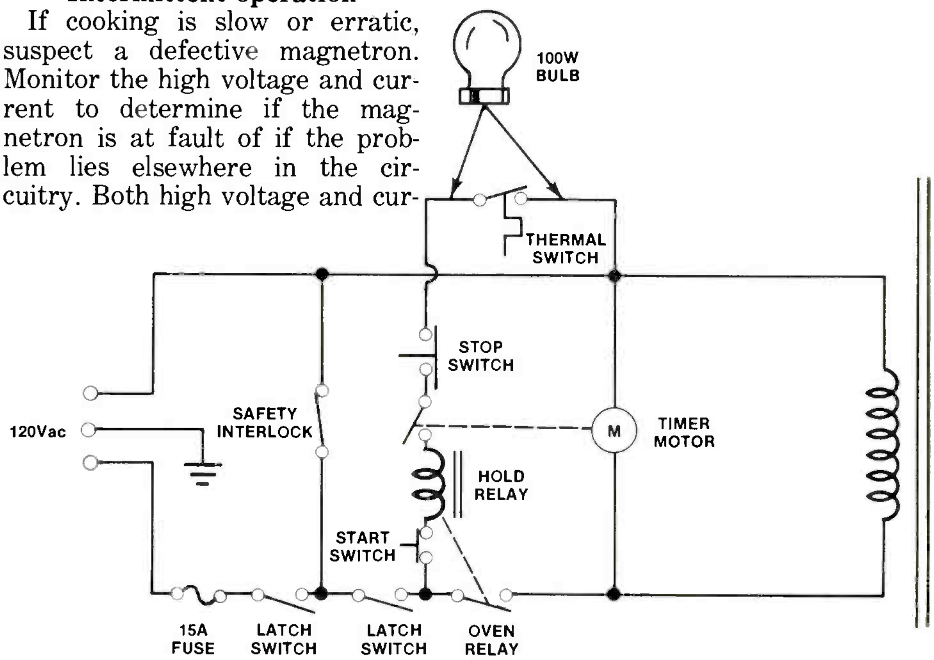


Figure 9. With a 100W bulb clipped across the thermal switch terminals, you can tell when the switch contacts open up. A defective magnetron or switch may cause the light to come on.

inspected and signs of overheating (Figure 9). The connections were cleaned up and soldered to the heater or filament terminals, which solved the problem. In some cases, burned or overheated cables are the cause of the problem and must be replaced. Poorly crimped transformer leads are another possible cause of erratic cooking.

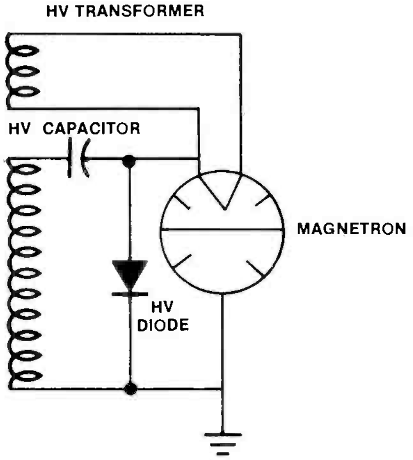
Improper cooking

When the oven appears to run hot and burns food, a common cause is a defective magnetron. Replace the magnetron if the oven appears red hot in only a few minutes. Double check the magnetron with an excessively high current measurement and check the thermal switch for burned contacts.

Hot spots in the oven may be caused by a defective stirrer motor or turntable. In a Sharp R-7600 model, improper cooking resulted from a cracked turntable bushing, which caused intermittent rotation of the food. When the oven takes too long to cook in the owner's home but appears normal in the shop with a water cook test, suspect low power-line voltage in the home. You may find the oven operating from an extension cord when it should be operated from a separate power outlet.

Sparks or arcing

A defective magnetron may cause arcing in the oven cavity. Check the waveguide cover for burned areas. Excessive grease on top of the cover or a defective magnetron may cause the cover to burn. Remove the cover and notice



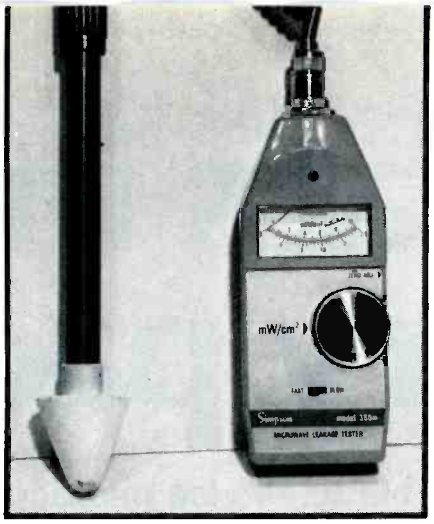


Figure 10. After replacing the magnetron, always check for leakage around the magnetron and wave guide assembly. Check all vents and around the door for possible leakage. There are several good microwave leakage survey testers on the market, including the Simpson 380M model shown here.

if arcing still occurs. If the arcing persists, replace the magnetron.

Excessive arcing inside the magnetron may be caused by a cracked or broken glass seal of the antenna area. A leaky or open filament of the magnetron may produce internal arcing. If arcing appears to occur within the magnetron, the high-voltage transformer secondary winding or other high-voltage components may be damaged, so the oven should be turned off. Replace the metal gasket around the magnetron antenna area if arcing has occurred around it.

Removing the magnetron

When the magnetron is determined to be defective, discharge the high-voltage capacitor before attempting to remove it. Be careful; you may have to remove several components, including the fan motor assembly, before the magnetron is free. Disconnect all wire leads and mark down where each cable goes. Remove the wire leads from the thermal switch. In most ovens, the new magnetron does not come with a new thermal switch, so the old thermal switch must be installed on the new magnetron, unless it is defective.

Remove the four mounting nuts that hold the magnetron to the waveguide area. (In some ovens, only two mounting bolts are found.) Use socket wrenches rather than pliers to remove these nuts, and be extremely careful when using metal tools around the magnetron. These magnets are very strong and may pull the metal tool out of your hands, breaking the top glass seal of the tube. The magnetron assembly is heavy and should be held up from the bottom while removing the remaining nuts by hand.

Lower the magnetron to clear the waveguide assembly. You may have to tip the tube up a little to remove it from the waveguide area. When mounted, the antenna assembly of the magnetron protrudes through the waveguide assembly. Check the condition of the RF metal gasket–it may be needed for the new tube.

Installing the new magnetron

The new magnetron may be installed in the reverse order of removal. Check the magnetron to make certain it bears the right part number. Sometimes the oven manufacturer has substituted another magnetron for the original part. Check to make sure the RF gasket is in place.

Inspect the new magnetron for damaged outside areas. If the vent area is bent upward due to damage during shipping, do not install the magnetron. All cooling fins should be equally spaced and should not show signs of being crushed. Damage such as this might cause arcing internally. Check for a cracked glass seal.

Replace all wires and cables, and double check the heater or filament clip-on connections. Replace the connections if signs of overheating are found. These contact clips will arc and burn if a poor contact is made, causing erratic oven operation. You may solder the clips in place after cleaning up all contact areas, when the connections are not readily available.

Leakage tests

After the magnetron is installed and the oven is cooking with a water test, check for RF leakage around the magnetron and waveguide covers. Go slowly over these areas with a qualified, government-approved leakage survey meter (Figure 10). Check all vents and intake areas for leakage before replacing the metal cover, and check for RF leakage around the door areas. ES&T

What's in the mystery package?

You may be able to service microcomputer-based products even if you don't know anything about microprocessors.

By John Shepler

Editor's note

People frequently use the terms microcomputer and microprocessor interchangeably. Although this is not strictly correct, it is not a serious problem, as long as everyone knows the ground rules.

The microcomputer era was spawned when Intel manufactured the first **microprocessor,** *a computer central processing unit (CPU) on a single, tiny IC chip. By itself, the microprocessor is of little value. Add some memory in which to store a program, some more memory in which to store data, and some input/output (I/O) circuitry to connect to the outside world, and you have a* **microcomputer.**

Some microcomputers are made up by interconnecting a packaged microprocessor, memory packages and I/O circuitry on a printed-circuit board. Advanced technology now makes it possible to fabricate the processor (CPU), the memory and the I/O on a single IC chip and seal it into a single IC package with only one set of pins.

Strictly speaking, then, it is only correct to call the product **microprocessor-based** *when referring to a product in which the CPU is fabricated by itself on an IC chip and packaged by itself in an IC package. On the other hand, whether the controlling portion of the product is a microcomputer on a chip or a microcomputer made up of several ICs, it is always correct to refer to the product as microcomputer-based.*

There's nothing magical about a microcomputer. Products that contain microcomputers can be confusing and difficult to service, though. Troubleshooting these small computers-on-a-chip requires some new philosophies and perhaps a small investment in books and test equipment. These are some tips about how to pick a microcomputer's brain without spending a lot of money.

Why microcomputer-based products are different

Microcomputer circuits are as different from CMOS and TTL digital logic circuits as logic circuits are from audio amplifiers. They're all electronic circuits that obey strict rules, yet something is different about microcomputers: The circuit functions are controlled by instructions rather than wires. This gives manufacturers great flexibility in small packages, but because the instruction codes for the product are usually considered a trade secret, the service technician is often in the dark about what's going on in the system.

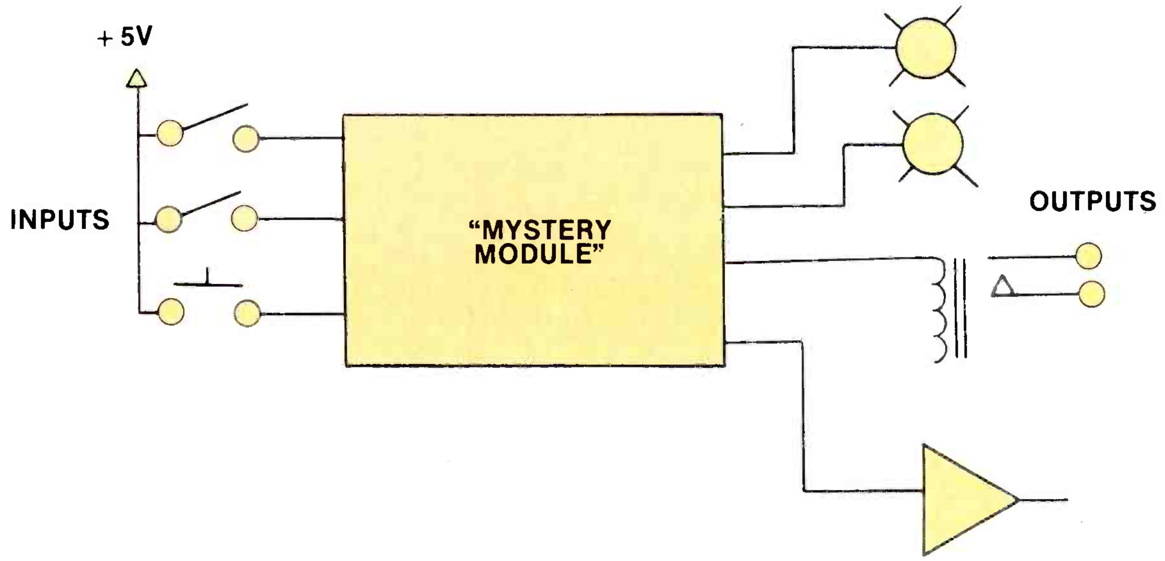
When servicing a microcomputer-based product, you're pretty much at the mercy of the manufacturer. The documentation you obtain may go into great detail about the signals present at different points in the circuit. Some products even have built-in test functions that help to pinpoint faulty components. On the other hand, some products may have only a simple instruction book or nothing at all.

Because microcomputers (frequently shortened to *micros*) are being designed into everything from meat scales to typewriters, it can be profitable to have a few general troubleshooting techniques available for those times that you can't get complete service data.

How to approach a microcomputer circuit

No microcomputer can do a job all by itself. Some of the cheaper calculators have specially designed chips that need only a bare minimum of components, but even these need a keyboard, display and power source. A larger product, such as a microwave oven, home computer or industrial temperature controller, will often have many ICs and passive components for functions such as signal conditioning.

These parts will show up on a schematic even if the microcom-



You can troubleshoot a microcomputer-based product without knowing anything about the micro. Use the mystery-module approach.

puter is shown only as a block. Because all micros need access to electrical signals such as switches and lights, you can use these components to trace the circuit action.

Troubleshooting tips

The simplest microcomputer circuits use a single-chip processor that has the instructions and computing circuitry sealed within the chip. Connecting pins are used for power and for input and output signals.

If all else fails, you can use the "mystery module" approach. This assumes that you have no information about the processor itself, but can use a schematic to determine the nature of the inputs and outputs. If no schematic is available, you can get the same information by tracing the foil runs on the circuit board. Many consumer products are simple enough to allow this approach.

Unless the circuit was damaged by a lightning surge on the power line, the processor chip will probably work. Most failures will be in power-supply components, interface circuits or mechanical devices such as switches or relays.

First, determine if the power supply is working. TTL and NMOS micros run on +5Vdc and a larger system can use several amps of current. CMOS micros can run on 5 to 15V at much lower currents.

If you can identify the manufacturer and number of the micro, you can check data sheets for the required voltages and pin numbers. Otherwise, other circuit clues such as capacitor voltage ratings and voltage regulator numbers will provide suggestions. The supply must be reasonably well regulated and low in ripple. The common 3-terminal regulator chips are widely used in microcomputer circuits.

Next, test the inputs with a voltmeter or scope. Switches should provide the logic-level voltage changes when they are activated. A low signal should be near 0V, and a high level should be near the micro power-supply level. These signals must be traceable all the way to the micro pins.

Some micros contain analog-to-digital (A/D) converters on board and have varying dc voltages on their pins. Other micros may have external converters. An A/D converter is useful for measuring sensors such as thermistors and photocells.

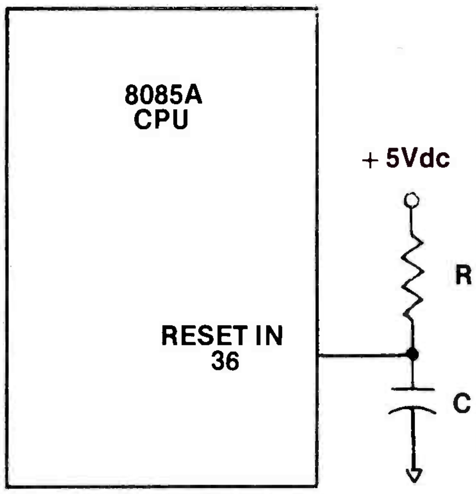
The opposite of an A/D converter is the digital-to-analog (D/A) converter. These are used to develop control voltages for motor speed controls, or they can be used to produce musical notes or test signals.

Output drivers such as power transistors and triacs are more likely to fail than are ICs. You can test these by tracing their drive signals back to the micro. A scope will show whether there is any activity on that line as the inputs are activated. You can confirm that the output driver is working by forcing its input high or low and seeing that the output is activated. *If you do this, be extremely careful that whatever is turned on will not create a dangerous situation. When you bypass the micro, you also bypass any protective logic for the system.*

If all inputs test ok with an ohmmeter and show logic-level changes, and the outputs are all functional, the trouble must be in the brain itself. However, the fault may still not be the microprocessor IC.

Most micros have a clock oscillator that requires a crystal or RC network external to the chip. Your scope can show if there is any activity on those pins. However, don't expect a perfect square wave. If a healthy oscillation is detected, the clock is probably running.

Another support circuit for the micro is the power-up circuit. This can be as simple as a resistor and capacitor, or it may be as elaborate as an external comparator and voltage reference. The purpose of the power-up reset circuit is to keep the micro on hold until its power supply has time to stabilize. A few milliseconds after power is applied to the circuit, the capacitor charges above the reset threshold and processor operation begins. A failure in this circuit can keep the microprocessor stopped even if normal power is present.



If the power-up reset circuit fails, the microprocessor may remain stopped even if normal power is present.

Where to find data

You can see that proper service data is important when tackling a tough microprocessor service problem. A complete schematic and test procedure can save hours of detective work. However, there are going to be many situations in which you have little to go on besides your general knowledge of how a microprocessor works.

You can build a valuable library of microprocessor data books by attending manufacturers' trade shows and seminars or if necessary, by purchasing the most useful books for a few dollars. These manuals will give you a complete description of how each pin on the micro operates. They also provide timing charts and diagrams for various operations.

Because most engineers use these manuals as design references, you may find the suggested circuits used in products that you are servicing. Whatever you invest in microcomputer information is bound to be repaid many times over in future service jobs. ES&T

Testing the CPU

The Central Processing Unit (CPU) is the brain of any computer circuit. A single-chip microcomputer has the CPU, memory and I/O logic integrated on a single IC. Other general-purpose micros such as the INTEL 8085 have only a power CPU within the chip. The INTEL 8080/8085 family of microprocessors is commonly used in small computers and industrial products. You can test an 8085 CPU without knowing anything about the circuit.

Take a look at the pinout of the 8085A microprocessor. Power is supplied as +5Vdc to the VCC pin 40. Power-supply ground is pin 20. Other micros may need more than a single supply voltage.

The crystal clock is connected to pins 1 and 2, but a better place to observe the clock signal is at pin 37, which is CLK(OUT). The scope signal at this point will be a logic-level square wave with a frequency that is one-half the frequency of the crystal. The clock oscillator and divider are on the 8085 chip.

The RESET line, pin 36, is active low. If you measure a voltage near 0Vdc at this pin, the IC may be ok but the microprocessor will not be executing a program. Check the external power-up components to find the failure.

The 8085A microprocessor is in a 40-pin, dual-in-line package (DIP). You can check it without knowing what's inside.

Pin 3 is a RESET OUT line and is high whenever pin 36 is low. This pin is used to reset other chips on the circuit board.

Pins 29 and 33 are status lines that tell what is going on in the mind of the CPU. If both these pins are low at the same time, the processor has executed a HALT instruction and has stopped running. If the micro is reading and writing data normally, the status lines will show varying logic patterns.

The read and write lines are pin 32 ($\overline{\text{READ}}$) and pin 31 ($\overline{\text{WRITE}}$). These lines are active low and should be toggling from the low to the high logic levels if a program is running.

The lines labeled A or AD are the address and address/data lines. These lines are grouped into buses to transfer data between memory chips, input ports, output ports, converters and the CPU. You should see activity on any of the address/data lines that are connected in the system. If a line is always high or low, either the CPU is faulty or some other chip or short circuit is loading the line. You can test for faults by removing power and testing each trace with an ohmmeter. If a low resistance is detected, try removing the chips one at a time if they are socketed.

A lighted magnifying lens is a handy tool for densely packed circuit boards. With a large lens, you can see tiny pieces of solder or metal chips that are shorting the traces.

The pin marked ALE (pin 30) is the Address Latch Enable. Some of the pins on the 8085 are shared between the address and data lines. This signal is used to distinguish the two. It should show a short positive pulse every few microseconds if the program is running.

A good scope is essential for microcomputer work. You probably have something suitable if you do any TV or industrial servicing. A 20 or 30MHz dual-trace scope with triggered sweep will allow you to observe the necessary signals.

The IO/M line designates whether the instruction being executed is in the group related to I/O or memory operations. Because it is possible to do I/O operations with the memory instructions, you cannot depend on this line being high. However, in order to fetch instructions, the line must go low every few microseconds.

The HOLD line is used for direct memory operations that are used for floppy-disc storage. In many control applications, this line will be grounded. If HOLD (pin 39) ever goes high, the microprocessor essentially goes to sleep and allows other hardware to take control of the buses. HLDA (pin 38) will also be true after HOLD goes true. This pin is used to tell the DMA controller that the hold condition has been acknowledged.

The interrupt lines, RST 5.5, 6.5, 7.5, INTR and TRAP, are used to force the processor to do some special function on demand. Normally, these lines will be low. When any interrupt goes high, normal program operation will cease, and the micro will perform an "interrupt service routine."

Typical uses for interrupts are to count clock pulses or strobe detectors for keyboards. In any case, none of these lines should remain high for more than a few milliseconds. If an interrupt line shorts high, it can appear that the CPU has failed. The $\overline{\text{INTA}}$ line (pin 11) should be high unless INTR (pin 10) is high, in which case $\overline{\text{INTA}}$ should be low. INTR and $\overline{\text{INTA}}$ work together like HOLD and HLDA.

The SID and SOD lines were intended for serial communications purposes, but they may also be used to read sensors and trigger logic. You will need to determine what circuitry is connected to these lines to tell what signals should be present.

The final pin on the CPU is the READY line (pin 35), which is most often used to accommodate slower memories. In most systems, this pin will be tied high. If not, it should be high most of the time. Periodic low pulses may be detected if a slow memory chip is tied into the system. If READY is shorted low, CPU operation will be suspended.

ES&T

Answers to quiz

(from page 18)

1. *A* The parallel resistance of the meter and 6K resistor is 5K. So 5/15, or one-third of the supply voltage will be across the resistor-voltmeter combination.
2. *B* In this circuit, the collector is at 0V (common) and the emitter is at a negative voltage (V_X). The base voltage is between the negative emitter voltage and 0V.
3. *A* You want to avoid forward biasing the emitter-base junction.
4. *B* One cycle occurs in 5μs. $F = 1/(5 \times 10^{-6}) = 200{,}000Hz = 200kHz$
5. *B* The peak value is 40V. RMS volts = 0.707 x peak volts = 0.707 x 40 = 28.3V.
6. *A* When a technician misses this question, it is usually because he or she is trying to read too much into it.
7. *A* Increasing the frequency causes the X_L to increase, so the voltage across the inductor also increases.
8. *E*
9. *C* The problem shown is called *crossover distortion*. Push-pull transistor amplifiers are forward biased to prevent this condition.
10. *D*

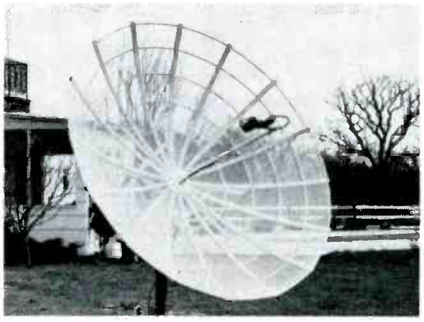
Products

Earth station systems

A new line of integrated satellite TV earth-station systems for residential or commercial use, the *Conifer* "system DE-2001," includes all essential components (antenna with motor drive, LNA with automatic polarity control, receiver and cable).

The 12ft polar-mount antenna, model AN-1200 features an expanded aluminum reflector surface supported by aircraft-grade aluminum alloy framing. Because the expanded aluminum has a 55% open area, it is less vulnerable to high winds than solid-material antennas. The TVRO receiver, model RC-2001, is a self-contained unit with channel and audio tuning, LNA polarity control, inverted video and scan tune.

Circle (75) on Reply Card



CRT adaptor kit

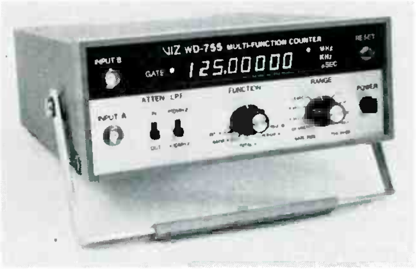
The CA28 from *Dandy Manufacturing* allows you to test more than 1000 picture tubes, including the new inline and 1-gun types, without purchasing any other adaptors. If your tester is the cleaner/restorer type or the rejuvinate type, you can use the function on your present machine on any tube from 9in to 26in.

You just look up the number of the picture to be restored in the instruction manual and follow the pin connection guide provided.

Circle (76) on Reply Card

Multi-counter

The *Viz* model WD-755, 125MHz multifunction counter is capable of frequency, period, totalize, ratio and time interval measurements. A combination of CMOS, TTL, low-power Schottky and LSI technology have been used to keep power consumption and cost low.

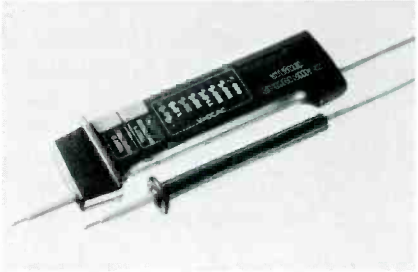


Features include an 8-digit LED display with leading zeroes blanked, automatic input triggering level, switchable attenuator, selectable low-pass filter and rear-panel BNC clock input/output connector.

Circle (77) on Reply Card

Electronic probes

Steinel America has introduced two electronic probes with multi-



ple functions for circuit-board testing and various home uses.

The Multi Check will detect the presence of current and determine voltage, polarity and continuity. The Combi Check, designed specifically for professional applications, offers a self-checking circuit to verify accurate operation and both visual and audio signals when circuit faults are located, in addition to the functions found in the Multi Check model.

Circle (78) on Reply Card

Magnetic head/disc cleaner

A new magnetic head/disc cleaner, developed by *Chemtronics*, removes accumulated oxides, smoke, film, dust, oils and other abrasive contaminants in and around magnetic heads/discs, drives and similar devices.

An aerosol spray solvent, it is safe for use on plastics, rubber, elastomers and film. It is non-flammable and non-conductive, and is ideal for cleaning cassettes, reel-to-reel, audio and video systems, magnetic disc memory systems, dictating equipment and telephone answering equipment. It is also useful for cleaning motion-picture cameras and projectors.

Circle (79) on Reply Card

CRT analyzer and restorer

Sencore's new model-CR70 Beam Builder CRT analyzer and restorer will test all CRTs with only six adapters. Conventional CRT testers rely on the adapter to match both the mechanical and electrical characteristics of the CRT to the tester, resulting in many mechanically identical adapters that are wired differently. A conventional CRT tester would require 64 different

adapters to test all the CRTs tested by the six CR70 adapters.

The CR70 also features a *CRT Type* switch that allows it to work with scope CRTs and projection CRTs, as well as standard video and computer display CRTs.

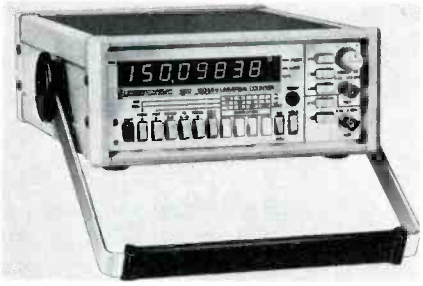
Circle (81) on Reply Card

Universal counter

A new 175MHz, 8-digit, universal counter from *B&K-Precision* provides frequency, period, frequency ratio, time interval and totalize measurements. Model 1822 measures frequencies from 5Hz to 175MHz.

The period mode can be used to accurately measure low frequencies from 5Hz to 2MHz. In the frequency ratio mode, frequencies of two input signals are compared and their ratio displayed. The time interval mode measures the elapsed interval (in microseconds or milliseconds) from a selected edge of one input signal to a

Marketplace



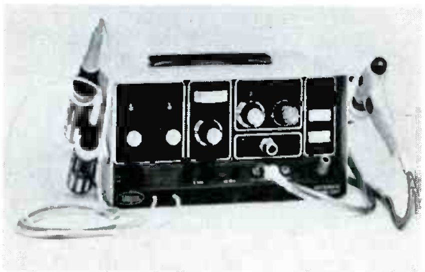
selected edge of another. The totalize mode counts individual events from 0 to 99,999,999 plus overflow LED.

Circle (82) on Reply Card

PC-board repair unit

A self-contained, portable Extensive Care Unit that incorporates the features necessary for repair and rework of PC boards and electronic assemblies is available from *Ungar*.

The model 4900 repair/rework station is equipped with two variable-temperature soldering irons, a variable power supply, a

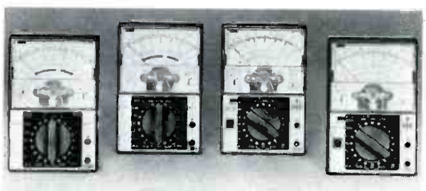


variable-temperature desoldering system, a variable-speed motor and accessories for deburring, polishing, drilling, milling and other machining operations.

Circle (83) on Reply Card

Drop-proof multimeters

The *A.W. Sperry Instruments* "DP" series of Drop-Proof



Multimeters is made up of four different pocket-size multimeters designed to withstand everyday rough usage. Models DP-300, 306, 310 and 316 all feature shock-absorbing PC-board mounting, taut-band meter, low 25Ω and 30Ω mid-scales, low 0.3Vdc scale and a built-in bench prop/handle.

Circle (84) on Reply Card

Fused eyeletting system

Pace's PFP-30 fused eyeletting system permits field repair of damaged or missing plated-thru holes and terminals on PCBs with factory quality. The system per-

mits the installation of a variety of hot-fused eyelets and funnelets for a broad range of setting conditions. It also eliminates the solder "blowout" problems associated with typical eyletting techniques.

Circle (85) on reply card

Static control system

Stanley-Vidmar has developed an anti-static cabinet system and work station to protect MOS and other sensitive electronic components from damage caused by electrostatic discharge (ESD).

The system's three components (a conductive cabinet, conductive workbench unit and conductive bins) combine to create a controlled, ESD-safe environment. The conductive cabinet is permanently grounded, using a 1MΩ resistor grounding cord, and is equipped with special lock-in/lock-out latches on each drawer that dissipate operator-induced charges in less than 0.06s, before retrieving or handling parts.

Circle (80) on Reply Card

Quasar replacement flyback

Thordarson has introduced a new color flyback replacement for the Motorola/Quasar unit, part number 2470809B08. According to the manufacturer, it is the only company currently making this exact replacement part.

Circle (90) on Reply Card

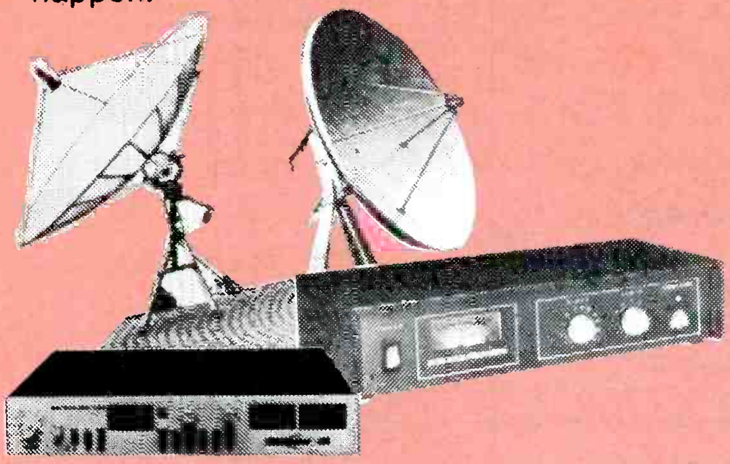
ES&T

An Invitation

THIS IS YOUR INVITATION TO GROW!
Backed up by the most complete reliable and saleable product line to hit the streets yet. Satellite Systems from Triton.

WE'RE LOOKING
We're proud to have some of the best satellite dealers in the country on our rolls. They're quality dealers with a strong commitment to customers, sales and service. And we're looking for a few more. But not just anyone. Because we know that to grow, we have to place our confidence and total resources behind the best. And that's who we want.

WE GIVE
When you deal with Triton, you're dealing with a company that not only stands behind the product, but drives customers to you. With an ongoing series of promotions to make customers come to you for Triton products. With fast product delivery. With a lead generation system that assures lead processing in 24 hours. And with total commitment to you that includes a TOLL FREE line to every department of our company. It lets you go one-on-one with the people that can and do make things happen.



WE LISTEN
What we've heard is that you are a businessman. So in order for us to be more successful we have to give you what you need for your success - like factory backed warranties. Extremely reliable products designed and built to give customer satisfaction for years to come. Systems design assistance on single, multiple and commercial receiver systems. Research and development to provide systems for your future. Solid marketing and management aids. We're out to give it all. And all you have to do is say "YES"

WE'RE READY
If you think you're ready, we're ready to talk and perform. After all we're no ordinary satellite systems distributor. And we'll prove it to you with profit opportunities you won't get anywhere else. With systems that are quick and easy to install. And a technical staff not usually found in this industry. GIVE US A CALL NOW. WE WANT YOU TO BE A PART OF THE NEXT DOMINANT FORCE IN SATELLITE SYSTEMS TODAY.

OUR SERVICES INCLUDE:
•ROOF MOUNTABLE SYSTEMS•PORTABLE DOWNLINK•TURNKEY SMATV HEAD ENDS •BROADCAST SYSTEMS•STOCK & COMMODITIES SYSTEMS•CONSUMER FINANCING

A PRODUCT LINE THAT INCLUDES:
- HOME TVRO SYSTEMS
- COMMERCIAL TVRO SYSTEMS
- MULTIPLE BEAM ANTENNAS
- 6, 8, 10 AND 13 FT. ANTENNAS MADE OF FIBERGLASS SPUN & STAMPED ALUMINUM & STEEL & EXTRUDED ALUMINUM MESH
- STEREO PROCESSORS
- SURVEY ANTENNAS
- PROGRAMABLE DRIVES
- MODULATORS
- ELECTRONIC FEED HORNS
- POWER DIVIDERS
- FERRITE DEVICES
- MICROWAVE RELAYS
- OUTDOOR HOUSINGS
- TEST SETS

REPRESENTING:
- ANTENNA TECHNOLOGY CORP.
- ARUNTA ENGINEERING
- AVANTEK
- BLONDER TONGUE LABS
- BOWMAN INDUSTRIES, INC.
- DX ANTENNA
- ECLIPSE TDF CORP.
- GILLASPIE & ASSOCIATES
- KLM
- LULY
- QUOTRADER
- SATELLITE SYSTEMS
- SOUTH RIVER METAL PROD.
- TRITON

Opportunity does knock twice...

TRITON MARKETING CORP.
EST. 1979

679 REMSEN AVE., BROOKLYN, N.Y. 11236
CALL 1-800-221-6535
IN NY; 212-345-8000

Circle (21) on Reply Card

Opportunity knocks.

The professional world of the Electronics Service Dealer is rough. That's why we're working so hard to make it easier for you to operate a cost effective business. **NESDA** offers substantial savings on bank-card and insurance rates, business contacts, technical and management certification, **and that's just the beginning.**

Our members are kept informed about industry developments, and are offered the most comprehensive managerial and technical training programs available. **Opportunity knocks. Don't let it pass you by.**

For more information about the National Electronics Service Dealers Association, write to: NESDA, 2708 W. Berry St., Ft. Worth, TX 76109.

NAME ____________________

FIRM NAME ____________________

FIRM ADDRESS ____________________ Member of State ☐ Local ☐ Assn.

CITY ____________ STATE ________ ZIP ________ PHONE ____________

Classified

Advertising rates in the Classified Section are 50 cents per word, each insertion, and must be accompanied by payment to insure publication.

Each initial or abbreviation counts a full word.

Minimum classified charge $10.00.

For ads on which replies are sent to us for forwarding (blind ads), there is an additional charge of $3.00 per insertion to cover department number, processing of replies, and mailing costs.

Classified columns are not open to advertising of any products regularly produced by manufacturers unless used and no longer owned by the manufacturer or distributor.

FOR SALE

FREE **THE GREAT ELECTRONIC THINGS & IDEAS BOOK!** HUNDREDS OF UNUSUAL PARTS, GADGETS & IDEA ITEMS, UNAVAILABLE IN STORES OR CATALOGS ANYWHERE! Bargain prices on everything! New items in every Issue! Rush postcard for your copy! ETCO ELECTRONICS Dept. 311 Plattsburgh, N.Y. 12901.

Circle (23) on Reply Card

TUBES FOR TV AND RADIO—35¢ ea. Washington TV Service, 1330 E. Florence Ave., Los Angeles, CA 90001. 1-83-12t

COMPLETE JERROLD WIRELESS REMOTE/DE-SCRAMBLER—full warranty, $159.00. Complete Oak descramblers, full warranty, $169. Trap/filters in line type, $49, 2 min. installation, SG613 transistors, only $6.99. Original Toshiba 2SC1172B, only $1.99 with hardware. 100/450, 80/480, 200/300, 40/450, 25 1st only $1 each mixed or single lot. Super special while they last 800-860 41 each safety caps Zenith type, 10 lot only $2.50. Bulk 2SC1172B only 50 lot, $1.69. Redcoat Electronics, 104-20—68th Drive, Forest Hills, NY 11374, (212) 459-5088. 5-83-tfn

CABLE CONVERTERS, DECODERS. Free catalog! APS, POB 263, Newport, RI 02840. 6-83-12t

COLOR PICTURE TUBES direct from manufacturer. Prices from $55 to $75 exchange. One year warranty. Send your old tube ups to ATOLL Color Tubes, 6425 West Irving Park, Chicago, Illinois 60634. Phone: 312-545-6667. We also sell equipment for rebuilding CRT's. 6-83-3t

SUBSCRIPTION TV MANUAL, covers all three major scrambling systems, only $12.95. Includes theory, circuits,. waveforms and trouble shooting hints. Save your VIDEO GAME CARTRIDGES on EPROM with our EPROM duplicator. Plans $9.95. Catalogue $2.00, refundable. RANDOM ACCESS, Box 41770A, Phoenix, AZ 85080. 8-83-tfn

2SC1172B's, 50 LOTS—$1.69; 2SC1308K's, original Sanyos, 50 lots—$1.99; Cheater cords, 25 lots—35¢; pol- and non-polarized. 1,000 ft. reels of RG 59 U. Coax Cable—$39/roll. Minimum order $75. Redcoat Electronics, 104-20 68th Drive, Forest Hills, NY 11375, 212-459-5088. 10-82-tfn

ELECTRONIC SURPLUS: CLOSEOUTS, LIQUIDATIONS! Parts, equipment stereo, industrial educational. Amazing values! Fascinating items unavailable in stores or catalogs anywhere. Unusual FREE catalog ETCO-011, Box 762, Plattsburgh, NY 12901. 6-78-tfn

SCRAMBLED TELEVISION, encoding/decoding. New book. Theory/circuits, $9.95 plus $1 shipping. Workshop, Box 393ES, Dept. E, Bethpage, NY 11714. 7-80-tfn

SPRING SPECIALS on Popular Electrolytics—40/450V—75¢; 80/450V—85¢; 100/450V—95¢ 200/300V—$1.05. Quantity 20 lot only. Minimum order of $50. SUPER SPECIALS. Bulk Zenith safety capacitors 800-860, 12 lot only $2.50 each. REDCOAT ELECTRONICS, 104-20 68th Drive, Forest Hills, NY 11375, 212-459-5088. 10-82-tfn

REPLACEMENT COLOR YOKES-DEALERS ONLY. Zenith 95-2501-2532-2887 etc. $22.95. Magnavox 361380-1 etc. $24.95. Sylvania $24.95. American-made fuses in bulk-example 3AG 2 regular price .23 each our price .12 each. Factory packaged GE transistors at discounts. Example GE-20 regular price $1.10 our price .65. Request circular on your letterhead. David Sims Enterprises, Inc., 665 East Jericho Tpke., Huntington Sta., NY 11746, 800-645-5030, NY State (516) 549-3925-1592. 10-82-tfn

TUBES—Receiving, Industrial and Semi-conductors, factory boxed. Free price list. Low; low prices. **TRANSLETERONIC INC.,** 1365-39th Street, Brooklyn, NY 11218E, 800-221-5802, 212-633-2800. 5-82-tfn

TV TROUBLE ANALYSIS TIPS. Over 300 symptoms/remedies by circuit area; tough ones over the years. Save time and money. Send $12.50 to CHAN TV, 8151 Grandview Rd., Chanhassen, MN 55317. 5-82-tfn

PRINTED CIRCUIT boards from your sketch or artwork. Affordable prices. Also fun kit projects. Free details. DANOCINTHS INC. Dept. ES, Box 261, Westland, MI 48185. 5-81-tfn

SONY-PANASONIC-RCA-ZENITH-EXACT REPLACEMENT PARTS-LARGE INVENTORIES-SEND PART OR MODEL NUMBERS-WILL UPS OR COD-GREEN TELERADIO DISTRIBUTORS, 172 SUNRISE HIGHWAY, ROCKVILLE CENTRE, NY 11570. 5-82-tfn

AUTOMOBILE RADIO and tape replacement parts: Delco, Chrysler, Philco-Ford, Motorola, Panasonic and many others. Large inventory. Laran Electronics, Inc., 3768 Boston Road, Bronx, NY 10469. (212) 881-9600, out of New York State (800) 223-8314. 5-79-tf

INDIVIDUAL PHOTOFACT FOLDERS (not sets) under #1200. First class postpaid $3.00. Loeb, 414 Chestnut Lane, East Meadow, NY, 11554. 6-83-3t

FOR SALE (CONT.)

ATTENTION TECH/SHOP OWNERS—Profits getting smaller with increasing cost of parts? Take advantage of our buying power and huge inventory on well known electronic products and replacement parts. Prices below dealer cost. Write for information. United Services Assoc., Old Grand Union Shopping Ctr., Rt. 9W, Stony Point, N.Y. 10980, 914-942-2173. 7-83-tfn

CB RADIO BOOKS, kits, modifications. Catalog $1.00 refundable. APS, POB 263, Newport, RI 02840. 6-83-12t

FOR SALE: Picture tube rebuilding equipment plus accessories—never used, reasonable offer. Alberto Barreiro, 1317 Jeanette Way, South Hampton, PA 18966, 1-215-322-8618. 8-83-1t

ADAPTER CABLES for Sylvania Check-a-Color CK 1500X Rig, Transverter, matching Cords, other updating equipment. A. Johnston's Electronics, 14 Waldwick Court, Toms River, N.J. 08757 8-83-1t

"OVER 2000 factory boxed receiving tubes, 80% off list. Shipping paid on orders over 20 tubes. Inquiries SASE. Lark Electronics, Box 5, Jacksonburg, WV 26377" 8-83-1t

FOR SALE: SAMS Photofact Library, 1-1899, $1000.00 including 7 file cabinets. Heathkit Yoke Flyback Tester, $65.00. Mark IV—C Subber, $65.00. Elenco Digital Color Generator, $50.00. EICO 667 Tube Trans Tester $150.00. EICO Yoke Flyback Tester, $60.00 (NEW). All Good Shape. Jim Goodman, Area Code 615 763-2166. 8-83-1t

RCA PARTS OVERSTOCK, modules-tubes-parts, in original boxes, cheap, for complete list of parts, write or call. Clermont Video, 629 Cinti-Batavia Pike, Cinti, Ohio 45244, (513) 528-4422. 8-83-1t

QUITTING BUSINESS sale! Sams 600-current $2000, test jig $350, tube tester $200, sweep/marker $250, Sencore VA48 $1100, test pattern generator $100, HV power supply $100. Will sell entire lot at discount. Rizor, Box 723, Walden, Co. 80480. Ph: 303-723-8459. 8-83-1t

ONCE-IN-A-LIFETIME SALE! If you're considering expansion or entry into the TV repair business, don't let this one pass you by! I'm selling over $10,000 worth of top-of-the-line B & K test equipment, office equipment, literature, Sams, parts inventory, and electronic laboratory equipment for an asking price of only $6,000. If it has to do with TV repair, I have at least one of it and in some cases, two. For all practical purposes this equipment has seen so little use, that it must be considered brand new. Some items still in original crates. This is a PACKAGE DEAL only, no piecemeal please. However, no reasonable offer will be refused. 1-713-487-3350. 8-83-1t

WANTED

WANTED FOR CASH: 50, 53, 6AF6, 6HU8, 304TL, 4CX1000A, 4-1000A, all transmitting, special purpose tubes of Eimac/Varian. DCO, Inc., 10 Schuyler Avenue, North Arlington, New Jersey 07032. Toll Free (800) 526-1270. 5-82-tfn

TELEVISION SERVICE SHOP in Florida or California. Call or write ATOLL TV, 6425 West Irving Park, Chicago, IL 60634; Ph. 312-545-6667. 6-83-3t

WANTED: NEW & OLD stock of parts for tube type radios; transformers, caps, knobs, etc. Also want Rider's manuals. Send list and price wanted. Antique Radio & Tube Co., 1725 W. University. Tempe, AZ 85281. 8-83-1t

BUSINESS OPPORTUNITIES

DEALERS EARN EXTRA PROFIT selling cable TV converters, Video accessories and other great items in our brand new dealer catalog. Request a FREE copy on your letterhead. ETCO. Wholesale Division, Dept. 535, Box 840, Champlain, NY 12919. 9-82-12t

BUSINESS OPPORTUNITIES

NORWALK, CALIFORNIA ESTABLISHED TV AND STEREO SERVICE AND SALES very busy money maker, excellent location, low rent, very good lease, 2300 square feet, 10 minutes to beaches and Los Angeles. $40,000 includes inventory, large enough for living quarters, owner retiring, phone 213-863-1919. 11-82-tfn

ESTABLISHED TV SERVICE and Repair shop. Florida Gold Coast. Name, inventory, equipment, Sams, customers & truck. $20,000.00 takes all. Owner retiring. Florida TV Headquarters, 520 SW 6th Ave., Hallandale, Fla 33009. 305-458-3824. 7-83-2t

TV TUNER REBUILDING BUSINESS, LOS ANGELES, CALIFORNIA 23 years same location, other interests, requires sale very reasonable, (213) 342-4745. 7-83-tfn

EARN HIGH PROFITS servicing ATARI VIDEO **GAMES.** Easy to follow technical manual and schematics for the beginner or expert technician only $29.95. Also we carry a complete parts inventory. Send $2.00 for the catalog. J WILLIAM ELECTRONICS, POB 133, Horseheads, NY 14845. 8-83-1t

SATELLITE TV BREAKTHROUGH in prices now brings systems within the reach of many. Opportunities abound that can provide you with $2000-5000 a month income in this fascinating business. Your demonstrations will draw crowds, startup costs only about $2000-2500. Free information on request. Also, complete installation/system secrets $7.50. J-Tronics, Box 5105-D, Arlington, Va. 22205.

HIGH PROFITS—LOW INVESTMENT: with our CRT rebuilding equipment. Complete training and technical assistance. Guaranteed result. Atoll Television, 6425 W. Irving Park, Chicago, Illinois 60634; PH 312-545-6667. 8-83-3t

RAMPART SECURITY SYSTEMS DEALERS' sales are booming. The Rampart Franchise Program offers ENORMOUS PROFIT POTENTIAL PLUS EXCITING RESIDUAL INCOME. Our success and reputation are a result of a total business format approach for the EXPLODING alarm market. Product, marketing and management training with complete backup has made success a reality for over 70 dealers. No experience necessary just a strong desire to succeed. Investment only $15,000 backed by inventory. Call Bob Pollack (800) 523-8002 or write RAMPART INDUSTRIES, INC., 1 Oxford Valley, Suite 317, Langhorne, PA 19047. 8-83-tfn

LEARN TO REPAIR HOME VIDEO GAMES IN YOUR OWN SHOP! Did you know that more than 9 million HOME VIDEO games have been sold? Now you can learn to repair! Atari, Coleco, Intellivision, or Atari 400/800 computers in your own shop. Our courses are taught on VIDEO TAPE (Beta or VHS) and come with a manual containing all the necessary technical information you will need to do repairs. For more information or to order, call: Electronic Institute (800) 221-0834 (outside N.Y.) or (212) 377-0369 (in N.Y.) Customized live in shop training courses are also available, call for more information and price schedules. 7-83-tfn

To get more information...

on items advertised or described in this publication, use the Reader Service Card.

As a free service for our readers, we forward your inquiry to the product's manufacturer. Reader Service Card is pre-addressed.

Advertisers' Index

CEI Consolidated Electronics, Inc.

2SC1172B
HORIZONTAL OUTPUT TRANSISTOR
SIMILAR TO ECG® 238

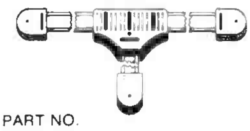
ALSO REPLACES:

ECG 165	C1875	D350
C1172B	C1893	D368
C1174	C1922	D627
C1295	C1942	D649
C1413A	C1894	D380
C1309	D200	D663
C1358	D201	D869
C1454	D348	D870

ECG is a registered trademark

$1.79 100-UP **$1.95** 10-99

FM DIPOLE ANTENNA



PART NO. **TA-3**

85¢ (1-9) **49¢** 10 OR MORE

TV GAME SWITCH
- RCA jack type input
- Easy to install
- 300 Ohm input

PART NO. **CE 483**

$2.35 (1-9)

$1.85 (10 & UP)

FREE T-SHIRT
w/$150 ORDER
REG. $7.95 ea.

E.T.
ELECTRONIC TECHNICIAN

PLEASE SPECIFY SIZE WHEN ORDERING. MEN'S S,M,L,XL

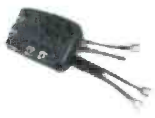
PUSH ON BALUN
300 Ohm twin lead to push on "F" type connector with built-in matching transformer

PART NO. **CE405** 99¢ (1-9) 89¢ (10 OR MORE)

YOUR COMPLETE ELECTRONIC PARTS SOURCE!

300 OHM SPLITTER
300 Ohm twin lead to UHF, VHF, and FM

PART NO. **SPL-300**



$1.40 (1-9) **$1.15** (10 OR MORE)

CARBON FIBER RECORD CLEANER BRUSH
- Cleans off even the finest dust particles
- Over 1 million conductive carbon fibers

PART NO. **CE 488** $4.85 (1-9) $3.95 (10-49)

SUPER SPECIALS
MINIMUM 10 pcs.

M51515 BL	$2.75
TA7205AP	.93
UPC 1025	$1.95
2 SD 313	.37
2 SD 424	$3.25

AC ADAPTOR
4 Way Universal Plug
Converts 120 VAC to 6,7.5, 9 VDC. 300 mA. 4-way Universal Plug.

PART NO. **AC-453** $3.99 (1-9) $3.59 (10 OR MORE)

CASSETTE HEAD CLEANER
- Wet type
- Includes cleaning solution

PART NO. **CE 390**

$3.89 (1-9) $3.55 10 OR MORE

FREE CATALOG

FOR MORE INFO CIRCLE OUR NUMBER ON THE SERVICE INFORMATION CARD

ALL STYLI ARE INDIVIDUALLY BOXED READY FOR DISPLAY

Ⓐ **ADC QLM 30 MKIII Replacement Magnetic Cartridge w/Stylus**
- 3.5 gm. tracking • 7 mil. conical tip
- 1.5 MV output • 50-18K frequency response

PART NO. **CE 487** $5.95 1-9 $4.95 10-UP

Ⓑ **SHURE M93 Replacement Magnetic Cartridge w/Stylus**
- Response 20 Hz-20 kHz • Tracking 1½-3 grams.
- Output 6.2 mV

PART NO. **CE 437** $7.95 1-9 $7.50 10-UP

Ⓒ **PICKERING V15-AT2 Replacement Cartridge w/Stylus**
- 7 mil. conical stylus • Tracking: 2-4 grams
- Output: 7 mV

PART NO. **V15-AT2** $7.95 1-9 $7.25 10-UP

Ⓓ **ADC K8 Replacement Stylus** — PART NO. **ADC K8** $5.60 1-9 $5.15 10-UP

Ⓔ **SHURE M44-7 Replacement Stylus** — PART NO. **N-44** $3.75 1-9 $3.50 10-UP

Ⓕ **Shure M74, M75, M81 Replacement Stylus** — PART NO. **N-75** $3.75 1-9 $3.50 10-UP

Ⓖ **SHURE M93, M91 Replacement Stylus** — PART NO. **N-91** $3.90 1-9 $3.65 10-UP

Ⓗ **PICKERING V15-AT2 Replacement Stylus** — PART NO. **V-15** $3.90 1-9 $3.50 10-UP

MINIMUM $10 ORDER
NO MIXED QUANTITIES

CONSOLIDATED ELECTRONICS INCORPORATED

MasterCard VISA

1-800-543-3568 NATIONAL WATS

1-800-762-3412 OHIO WATS

705 WATERVLIET AVE., DAYTON, OHIO 45420

IN DAYTON, OHIO CALL (513) 252-5662

CALL TOLL FREE TODAY!

TELEX NO. 288-229

Circle (24) on Reply Card

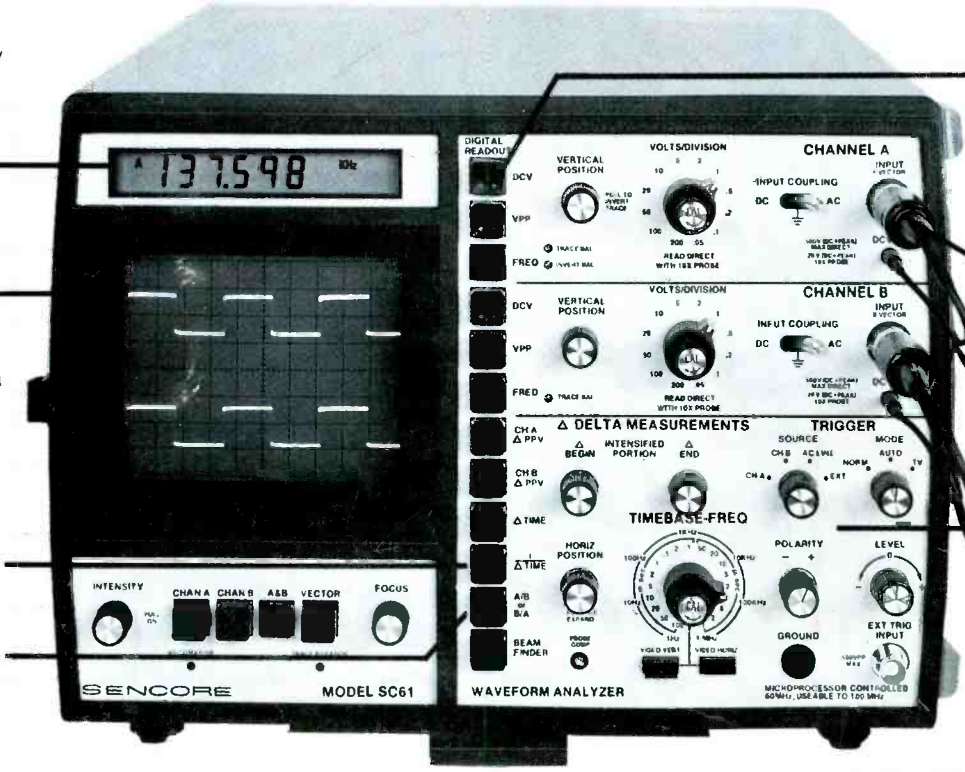
Double Your Troubleshooting and Testing Productivity . . . Or Your Money Back!

Six-digit readout: Automatically tracks every CRT test. We call it digital autotracking. It's patent pending.

Bright dual-trace CRT: 60 MHz (– 3 dB); 100 MHz (– 12 dB).

Delta PPV, Time, Freq: Measure any part of a waveform for PPV, time or frequency using Delta measurements. Just dial in the waveform section you want to measure and push.

Simplify Freq ratio tests: Automatically compare input/output ratio of multiply/divide stages from 1:1 to 1:999,999 with the push of a button.



Autotracking DCV, PPV, Freq: Measure DCV to .5%; PPV to 2%; freq. to .001%. Just push a button for either Channel A or B.

One probe input: One-probe input per channel for all measurements - digital and scope - with 5 mV to 2000 V measuring range. (2 lo-cap probes provided.)

Super sync: ECL provides rock-solid sync trigger circuits with only 4 controls; includes TV sync separators for video work.

U.S. Patent Pending
Financing Available

The first scope with push button digital readout. If you use general purpose oscilloscopes for troubleshooting or testing, we can double your present productivity with the SC61 Waveform Analyzer, the first instrument to turn every conventional scope measurement into an automatic digital readout.

No more graticule counting. Connect only one probe to view any waveform to 100 MHz. Then, just push a button to read DCV, PPV, frequency and time — automatically!

There are no graticules to count or calculations to make, which speeds every measurement.

The digital readout is from 10 to 10,000 times more accurate as well.

Plus you have everything you want to know about a test point, at the push of a button, which speeds troubleshooting tremendously.

A special Delta function even lets you intensify parts of a waveform and digitally measure the PPV, time or frequency for just that waveform section.

And it's neat. No more tangled leads, piles of probes or dangling cords. The SC61 is an entire test station in one unit.

The one and only. There are other scopes with digital readout, but none of them completely automate every conventional scope measurement so you can automatically analyze any waveform without counting one single graticule. Totally automatic waveform analyzing at the push of a button. It will make all the difference in your productivity.

Double your productivity. When we say the SC61 will double your productivity, we're being conservative. We've seen cases of three, four, even ten time increases in productivity with this first-of-its-kind, automated oscilloscope. Every situation is different, however, so try the SC61 and judge for yourself. Here's our offer.

Money back guarantee. If the SC61 does not at least double your productivity during the first thirty days, you may return it for a full refund, including freight both ways.

Call today. Get the entire SC61 Waveform Analyzer story. Call toll-free today, and ask for our eight page color brochure. It could be the most productive call you make this year!

Phone Toll-Free
1-800-843-3338
Alaska, Hawaii, Canada and South Dakota call collect (605) 339-0100

SENCORE
3200 Sencore Drive, Sioux Falls, SD 57107

For Information Circle (2) on Reply Card
For Demonstration Circle (3) on Reply Card