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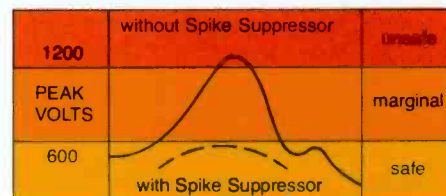
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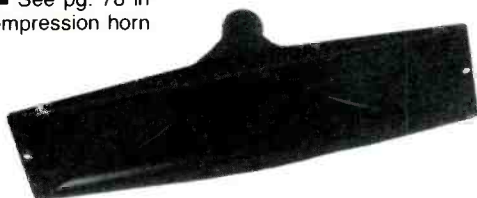


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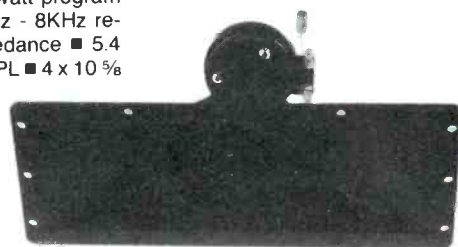
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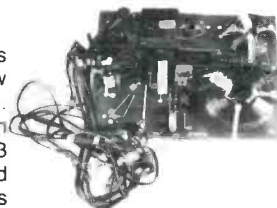
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The how-to magazine of electronics...

ELECTRONIC

Servicing & Technology

March 1984
Volume 4, No. 3



Graphics plotters give personal computer users the ability to draw schematics and detailed color graphics. See related story on page 6. (Photo courtesy of Hewlett-Packard)

8 Test your electronic knowledge

By Sam Wilson, ISCET test director

This month's questions relate to the various abbreviations used in electronics.

10 Fighting intermittents

By Kirk Vistain

The IM-1 is a monitor you can build to help make troubleshooting intermittent problems easier. This article will show you how.

20 VHS basics

By Steve Bowden

General operations of the basic VHS systems are explained in this article.

26 Troubleshooting with a signal level meter

Use a signal level meter to determine whether a poor picture or poor sound reproduction is caused by the TV set or a poor signal.

44 Continuing the discussion of π

By Sam Wilson, ISCET test director and NESDA technical publications director

The quantity π has a way of showing up in all manner of electronics calculations. This article shows how the constant of proportionality in the formula for inductive and capacitive reactance can be shown experimentally to contain π .

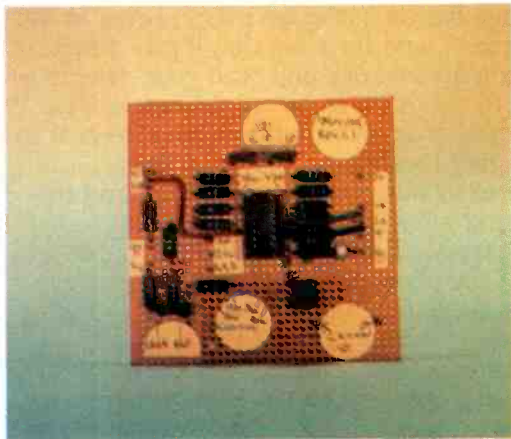
46 An introduction to digital logic gates

By Bernard Daien

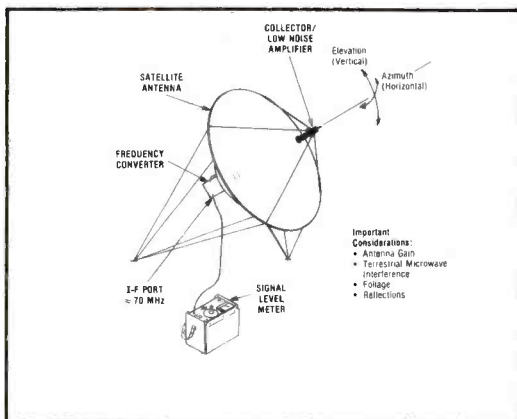
This article provides a simple overview of the basic digital logic gates for service technicians who may not be proficient in this area.

58 Toward better TV sound

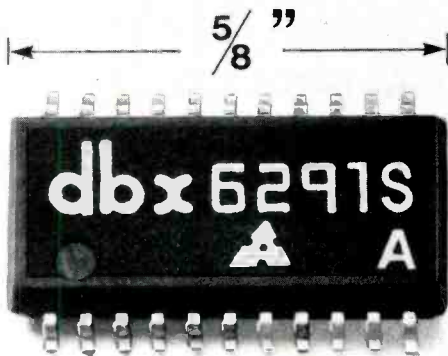
The dbx TV noise-reduction system is designed as a cost-effective technique to deliver a clean, noise-free audio signal through a noisy channel to the home.



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Next month...

Microcomputers. As an introduction to future coverage, this article describes the elements of a microcomputer and examines how they interact to perform the computing function.

But where can I get it serviced?

7:30 Wednesday morning, Jan. 11 at the Eastern Airlines terminal at Las Vegas' McCarran Airport was bedlam. Dozens of cabs and cars were spewing out hundreds of passengers.

What was the occasion for such a crowd of people at a small airport early in the morning in the middle of the week in January? Most of the passengers were flying home from the winter Consumer Electronics Show. They had been there either to exhibit electronic products that they manufacture or import, or to visit the exhibitors' booths with a view to contracting with the suppliers to sell their products at retail.

In all, a record number of people, something near 91,000 attended the show, which, according to Jack Wayman of the Electronic Industries Association, covered an area equivalent to 25 football fields. The size of the show and the huge number of attendees reflects the strength and growth of the electronics industry and makes quite a story in itself.

The story that fascinates most, though, is where that growth has taken place. Although there has been some growth in most areas, the growth in computers, (hardware and software), video games and telephones can best be described as explosive.

This doesn't mean that audio and video and all the traditional electronics have been displaced. They have not; they're thriving as well. But these new products are making quite a splash.

Servicing of these new products is a big question mark, though, and it'll probably be a while before it's resolved. And so many different organizations have so many, different philosophies. One attitude

was displayed by an executive of a Hong Kong manufacturer of telephones. When he told me he represented a telephone equipment vender and that their phones would sell for less than \$20 and eventually for less than \$10, I asked what owners would do about service when they break down. His instant answer was "Throw 'em away."

On the other hand, one telephone vender I spoke to a year ago has an exchange policy. Bring in the defective phone, and for a fee they'll give you a new or reconditioned one and send your defective unit along to the depot to be reconditioned. Still other manufacturers of high-ticket phones seem to be encouraging local service. At least one manufacturer of test equipment is in the process of introducing a line of telephone servicing test equipment, from a simple \$15 meter for in-home checking of the phone lines up to a full feature unit to test every function of telephones, including cordless.

Personal computer manufacturers are going through similar growing pains. They recognize that service is essential. Although many have established adequate servicing facilities and procedures, others are still scratching their heads as to how best to handle servicing.

The revolution and boom in electronics is exhilarating, and promises to continue for the foreseeable future, but in the headlong rush of sales, many gnawing questions, such as service, are still yet to be answered.

Nils Conrad Persson

ELECTRONIC Servicing & Technology

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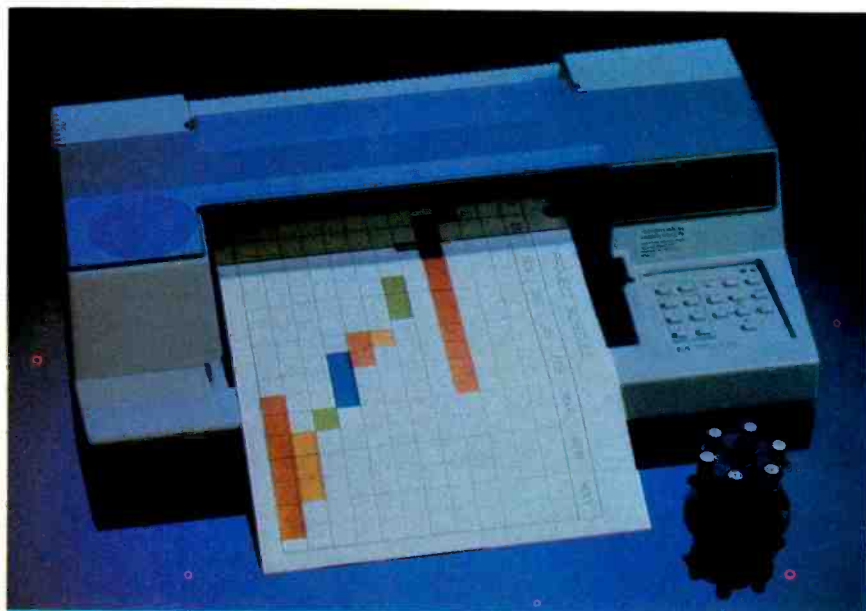
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A picture is worth a thousand bytes

Plotter brings graphics, schematic capability to personal computing



At a little more than \$1000, it's not exactly inexpensive; it's not a piece of computer equipment you will find in every home. But the HP 7470A graphics plotter from Hewlett-Packard is available at a price that makes it attractive to serious enthusiasts and hobbyists as well as to professionals who need plotting capability from their computers.

The plotter is capable of reproducing on paper, in two colors, just about any graphics that can be displayed on a computer display screen: bar graphs and pie charts among others. And for people who are involved in circuit design or modification, it will even reproduce schematic diagrams.

For readers who are currently involved with computer servicing, or who plan to service computers in the future, at least a passing familiarity with plotter technology might be found valuable in the

future because, according to a recent release from Hewlett-Packard, "The combination of broad compatibility, low price and readily available software should bring personal plotting within reach of a much broader range of personal computer users."

Greater sophistication and 6-pen capability may be found in the 7470A's more sophisticated companion, the 7475A at \$1895.

Both plotters are compatible with personal computers from Apple, IBM and many other vendors, including Hewlett-Packard.

Although both units can be used with many personal computers, they also can add high-quality graphics capability to instrument systems. Many smart instruments can record directly to HP plotters. Also, software is available to produce plotter graphics with an instrument through an external controller.

Graphics plotter provides personal computers with ability to draw schematic diagrams, plot detailed color graphics.

The HP 7475A plotter weighs 13.5 pounds and is 22.4"x14.5"x 5". It accepts 11"x17" (A3/B size) paper, 8½"x11" (A4/A) size paper or overhead transparency film. The 7475A draws at speeds up to 15 inches per second with 2g pen acceleration.

Plotting versatility is enhanced with intelligence features such as area-fill commands for presenting rectangles and circles as solids. Two interfaces can be specified—HP-IB (HP's enhanced version of the IEEE-488 bus) or RS-232-C—providing plotter compatibility with personal computers from HP, IBM, Apple, DEC, Commodore,

(Information and photos courtesy of Hewlett-Packard)

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Compaq and others. The plotters have a variety of built-in character sets, including ASCII, Japanese Katakana and several European sets.

An optional eavesdrop cable enables users to operate the HP 7475A in series with a terminal when using the RS-232-C interface, thus requiring only one serial computer port.

Pens are selected from the 6-pen carousel by either front-panel controls or program commands. When returned to the carousel, pens are capped automatically to prevent drying out. A variety of colors is available with pens of thick or thin line widths.

The plotter includes a damping mechanism to prevent pen damage; a pen slow-down control for special drawing conditions; and a "view" mode that stops plotting to allow a user to review the graph or chart being produced. Another feature rotates charts 90 degrees, making it easy to change a horizontal chart into a vertical format.

Software

To meet the administrative needs of scientific and engineering users, more than 10 independent software houses have developed packages for both the HP 7475A and the HP 7470A.

Software for Apple computers includes Apple Business Graphics, Chart-Master, GraphPower, and pfs:Graph. Software for the IBM PC includes Lotus 1-2-3, Boardroom Graphics, BPS Business Graphics, Business Graphic Systems, Chart-Master, Giraph, Graf-Talk, Graphwriter, GraphPlan, GraphPower and pfs:Graph. HP personal computers support HP plotters through third-party software packages as well as the various HP graphics presentation packages.

For those who want to do their own programming, the HP 7475A contains more than 50 HP-GL (Hewlett-Packard Graphics Language) commands covering pen movement, character selection, area fill and scaling.



Test your electronic knowledge

By Sam Wilson, IS CET test director

These questions are similar to questions used on various CET tests. All of the questions on the actual test are multiple choice, and a grade of 75% or better is required for passing. These questions relate to the various abbreviations used in electronics. (Answers on page 61.)

1. Which of the following would you expect to find in a phase-locked loop?

- A. a BFO
- B. a CPO
- C. a VCO
- D. None of the above.

2. In a superheterodyne receiver that has a diode detector, CW is demodulated with the help of

- A. a BFO
- B. a CPO
- C. a VCO
- D. None of the above.

3. Which of the following might be used as a power amplifier?

- A. UMOS
- B. VMOS
- C. WMOS
- D. XMOS.

4. A color TV receiver might be adjusted for proper color by the

- A. VITS signal
- B. VIRS signal.

5. Which of the following is a signal broadcast with FM stereo?

- A. VIRS
- B. REM
- C. ATR
- D. SCA.

6. A +5V regulated power supply is needed for

- A. CMOS
- B. ECL
- C. LCD
- D. TTL.

7. The section of the computer that interprets the program and performs arithmetic and logic is called the

- A. CUP
- B. PUC
- C. CPU
- D. PCU.

8. Which of the following is correct regarding CAD/CAM?

- A. It is related to calculations using digital and microprocessor components.
- B. It is related to design and manufacturing with the help of a computer.

9. In a series R-L circuit connected across an ac source, the product of the voltage across L and the current through L give the number of

- A. VARS
- B. PLRS
- C. PERS
- D. VALS.

10. The computer memory is loaded directly from a tape. To accomplish this, an I/O device takes control of the CPU for one or more memory cycles. This is called

- A. DAM
- B. DMA
- C. ADM
- D. MAD.



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Circle (6) on Reply Card

Fighting intermittents

By Kirk Vistain

How long have you been servicing audio? Five years? Ten years? If so, you can probably fix most problems without thinking too much about them. Stuff a transistor in here, tweak a coil there, a drop of oil on that squeaking take-up reel.

But, there is still one area that challenges apprentice and master alike, one exquisite little inconvenience that makes you wish you would have become a cook for the airlines—the intermittent. It happens at the customer's home or when you are not looking. It doesn't seem to happen when you are waiting for it.

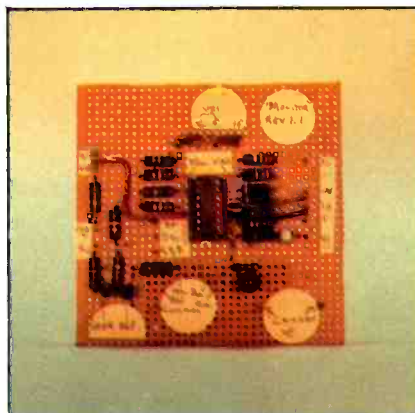
This article will present a project which, if completed, will give you another weapon in your arsenal. The IM-1 (Intermittent Monitor 1) is essentially an op-amp-based VOX (voice-operated switch) that controls a buzzer and LED. I have added several switchable enhancements, intended to optimize performance for use with audio equipment.

You can ask it to sum or subtract the two input channels (L&R). The flip of a switch selects peak or dip detection. A simple calibration procedure aligns levels using a built-in LED indicator that doubles as a visual alarm. Best of all, it is inexpensive and can be built with parts from the junk bin.

Circuit description

IM-1 had to meet these criteria:

- Simplicity of design
- Use of off-the-shelf components (preferably from the "junk box")
- Reliability
- Utility, not necessarily beauty



Prototype circuit board.



Front panel design with VR knobs removed for clarity.

IM-1 SPECIFICATIONS

Input Z:	150k Ω
Freq. response:	60-15kHz ± 3 dB at TP2 (peak detector)
Input sensitivity:	50mV for 3.6Vdc at TP2
I _a :	2.5mA (LED OFF), 20mA (LED ON)
Supply voltage:	± 9 V
V _{in} range, typical:	50mV-3Vrms

CHART 1. Performance of IM-1 prototype.

Figure 1 shows the results. The circuit uses a quad op-amp, type 324, a common package, electrically similar to the ubiquitous 741. It

is internally compensated, has good immunity to differential breakdown, and is inexpensive. Many car stereo booster/equalizers use a 324 as tone amp.

IC1a is an inverting amp with a gain of approximately four. IC1b can function as either a non-inverting or inverting stage, the mode being selected by the SUM/DIFF switch, SW1. Its gain is roughly the same as IC1a. The outputs of both stages are combined in VR2, the MIX control.

With SW1 set for DIFF, IC1a and IC1b are wired to simulate a differential amplifier, with the *out-of-phase* signals being mixed in VR2. The differential configuration is useful when testing stereo units, because the channels are automatically compared. Failures are detected as a *peak* across C3. More details follow in the user information section.

Set SW1 to SUM and the outputs are mixed *in phase*. A failure in either channel will be detected by the *dip* in voltage level across C3.

C2 keeps any residual dc offset out of IC1c, the inverting gain stage. Its output passes through rectifier D1 and charges C3. R7 functions as a bleed-down, providing the circuit with a time constant of 600mS. The dc voltage across the capacitor is proportional to the gain stage input. It is routed through SW3 to the comparator, IC1d. SW3 allows selection of PEAK or DIP detection. VR3, THRESHOLD, sets the voltage level at which the comparator will trip (go "high" or positive). An LED and switchable sounder provide audible and visual alarms.

The sounder can be almost any piezo buzzer. RS 273-060 from Radio Shack works fine. To further simplify the project, use dual 9V batteries instead of a line-operated power supply. Current drain is a low 2.5mA in standby,

and around 20mA when the alarm is triggered.

SW2 allows you to switch the input to the LED driver transistor, Q1, to sample either the comparator output (ALARM) or the peak detector (NULL). On NULL, the LED goes out when outputs from IC1a and IC1b are mixed equally. SW1 must be in the DIFF mode, and input voltage below 3Vrms.

Performance

Chart 1 contains the IM-1's performance figures. The input impedance is high enough that loading effects will be minimal for almost any signal point in audio equipment. The sensitivity control

makes it possible to monitor a wide range of voltages. The maximum voltage is 12Vrms. Beyond this point, differential input breakdown could damage the op-amp.

Construction methods

Circuit board

The monitor prototype is constructed on perfboard. If you plan on making several, an etched board is the way to go, but for one, the hand-wired version is quicker. I've included the PC pattern, along with the component layout, and front panel design for the prototype, in Figures 2, 3 and 4. If you decide to use the etched board, 1/8W resistors ought to fit nicely.

Larger ones will have to be mounted upright. Although not illustrated, the input jacks (RCA phono type) are mounted on the enclosure's rear, along with the buzzer.

An old cabinet, which I rescued from the garbage can, made a convenient enclosure. Because some holes had previously been drilled in it, I used a 3"x5" card as an overlay.

The circuitry is not critical, so the IM-1 should go together easily. If you lack experience wiring small devices and are unfamiliar with circuit board techniques, study previous issues of *ES&T* and other electronics magazines for help.

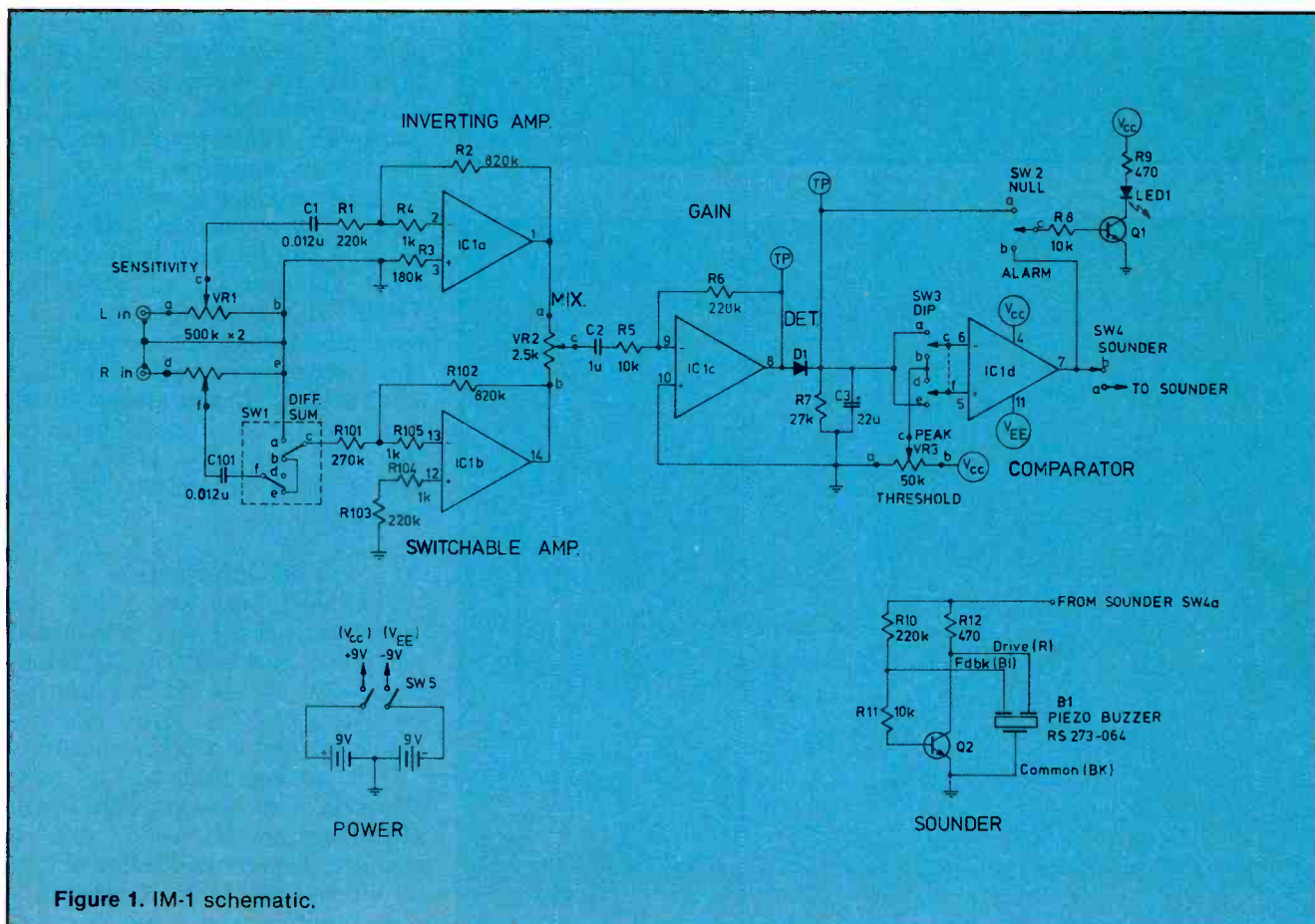
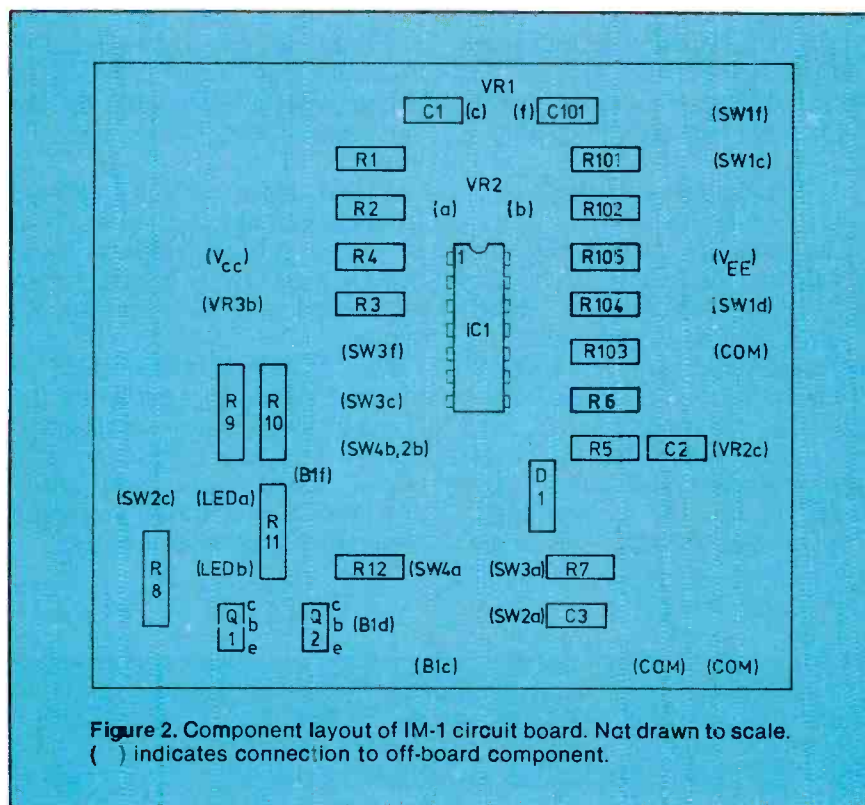


Figure 1. IM-1 schematic.



Parts

Parts substitutions are OK for the semiconductors, even the op-amp. Almost any silicon NPN signal transistor will suffice, and several other quad op-amp packages are available. C3, however, should be a tantalum electrolytic. Most of the aluminum ones I tried were too leaky, and decay time was not constant. This could result in false alarms. Stick with linear taper controls. Interpolation of settings is much easier that way.

Calibration

After assembly, you will have only to calibrate the threshold control. With a new set of batteries in the IM-1, connect a dc meter to the center terminal (c) of VR3. Adjust the pot until the voltage reads 5Vdc. Mark this as calibration point "*" on the front panel. Then turn the pot down to 3.5V, and mark this point S. Next, set the pot for 2V. This is point D. Calibration is now complete.

This procedure is optimized for input levels above 80mV. The IM-1 actually can be used with smaller input voltages by adjusting the THRESHOLD lower than the nominal settings. Be prepared to trade sensitivity for more critical level setting. If you always interpose an ac millivoltmeter between the IM-1 and the DUT, you'll seldom have to concern yourself with this.

User information

The IM-1 will not locate the defective part for you, and it also will not do any soldering or thinking. What it will do is patiently monitor a unit and give you a signal, when and if a failure occurs.

If it notices that one or both channels of an amp just quit, it will attract your attention with a sounder, so you can check it out. If an intermittent noise occurs in a unit, it will let you know. Coupled

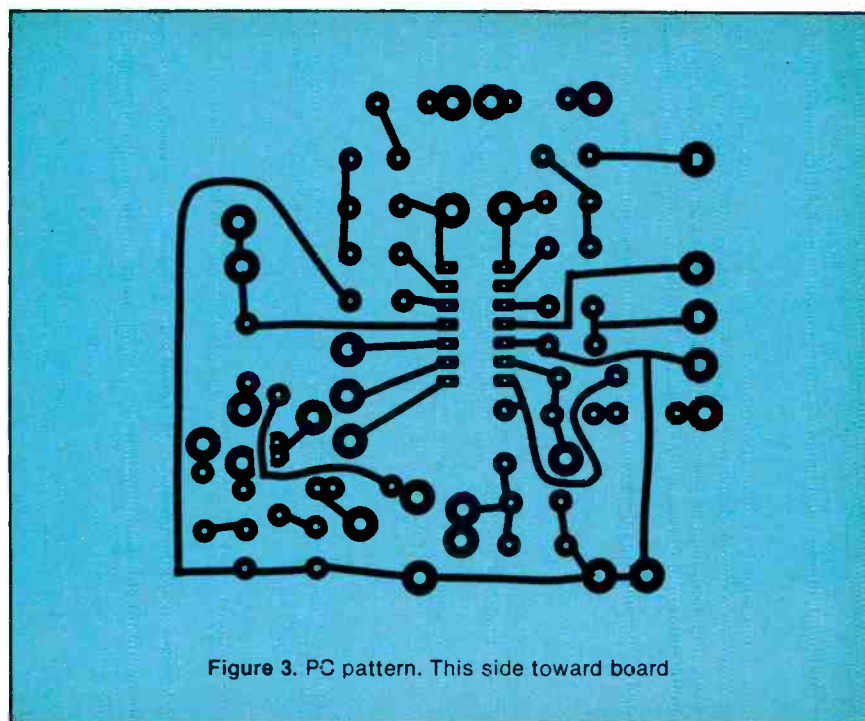


Figure 3. PC pattern. This side toward board

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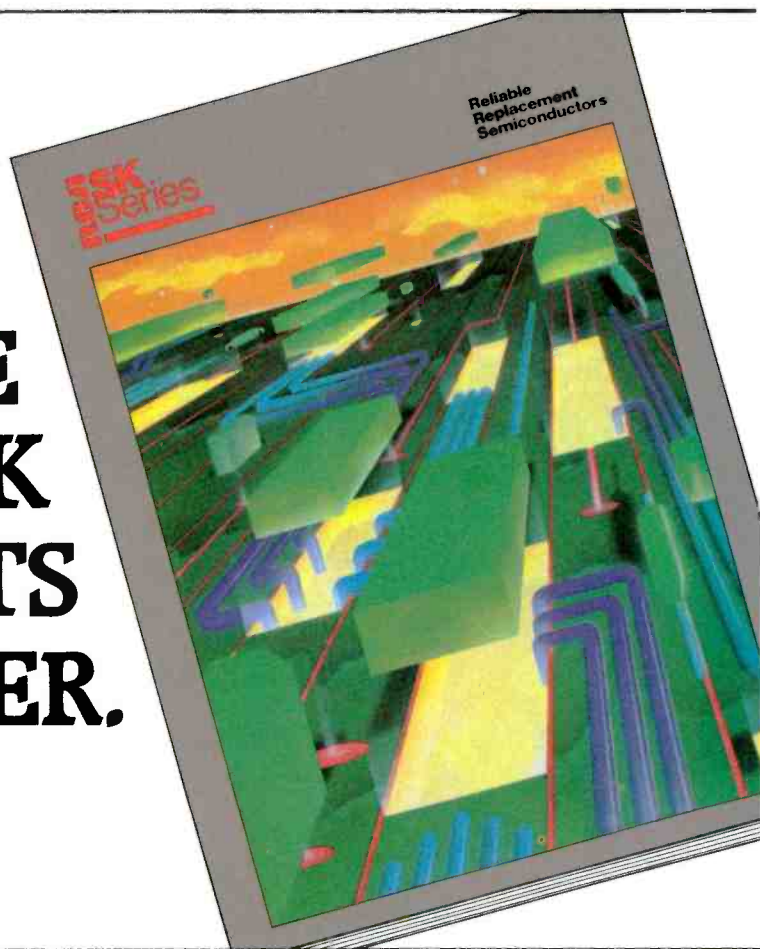
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Fighting intermittents

with other test equipment, it can monitor intermittent failures from the multiplex section of a receiver to the drive mechanism of a cassette deck.

Unaided, the IM-1 can handle input levels of 50mVrms to 3Vrms. To monitor at voltages outside this range, simply connect it to the output terminals of your ac millivoltmeter. This would make it possible to monitor anything from a phono cartridge's output to that of a power amplifier.

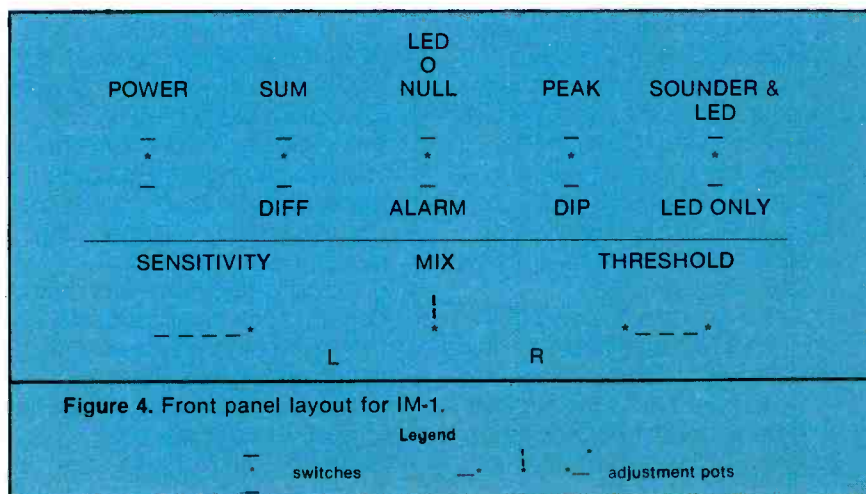
Detectable failures

The IM-1's flexibility accommodates analysis of several failure modes.

1. One or both channels cut out
2. One or both channels have spurious noise
3. One or both channels distorted

4. Intermittent speed irregularity in tape or phono, using wow and flutter meter
5. Intermittent multiplex operation (stereo receivers)

Figure 5 and Chart 2 summarize common hookups and switch settings for the IM-1. Practice will make you proficient at interconnecting the IM-1 to meet your par-



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SUGGESTED SWITCH SETTINGS

	SW1	SW3	VR2	VR3
SYMPTOM	SUM/DIFF	PEAK/DIP	MIX	THRESHOLD
ONE CH CUTS OUT	SUM	DIP	L or R	S
BOTH CH CUT OUT	SUM	DIP	MIX	S
ONE CH NOISY	SUM	PEAK	L or R	D
BOTH CH NOISY	SUM	PEAK	MIX	D
ONE CH DIST.	DIFF	PEAK	MIX	D

Chart 2. Switch settings for common types of failures. SW2 and SW4, the ALARM and SOUNDER switches (not shown) are set as desired.

ticular needs.

One thing you will have to do at the beginning of most test sessions is set SENSITIVITY and THRESHOLD levels. You will probably

find that doing it is quicker than reading about it.

Level setting

After connecting the DUT and

adjusting it for the desired output level, set up the IM-1 as follows:

1. SW1: SUM
2. SW2: ALARM
3. SW3: DIP
4. MIX: centered
5. THRESHOLD: * Calibration Point

Adjust the SENSITIVITY control until the LED just goes off. Then switch to DIFF, NULL, and use the MIX control to null the left and right channels, extinguishing the LED. The next step is to switch SW1, SW2, and SW3 to the desired mode. THRESHOLD should correspond to the S(UM)/D(IFF) switch position. In actual use, vary the THRESHOLD setting somewhat from the nominal settings for best results.

SUM mode

SUM is probably the most com-

Fighting intermittents

mon operating mode. It is especially useful if you do not know which channel is defective. Let's say a unit comes in with complaint #1. The owner really isn't sure which channel is bad. You run the device for several minutes and go through normal testing procedures. Everything seems OK. Because you have 20 other units in the log awaiting your services, you decide to cook this one on the back bench until it fails.

Referring to the hookup chart, feed a 1kHz sine wave into the unit, ahead of the suspected stage. When testing a receiver, I usually broadcast an FM mono signal as a source. Because you want to push the amp pretty hard, the IM-1 is connected to the speaker outputs through your ac millivoltmeter.

Adjust the DUT for desired output and perform the IM-1 level-setting procedure. Because the defective channel has not been isolated (the owner thought maybe both channels cut out), SW1 is set for SUM. You are expecting a drop in output so SW3 is set for DIP detection. Of course, you want both visual and audible alarms, so you switch SW2 and SW4 to ALARM and LED & SOUNDER, respectively.

To be safe, double check all settings by using the DUT balance control to shut down first one channel, then the other. IM-1 should trigger at both extremes of the control. If it does not, check the switches again and "tweak" levels if necessary. Keep input to the monitor below 3V.

DIFF mode

The DIFF mode compares channels and produces an output when they are different. Complaints of intermittent distortion on one channel are best tested in DIFF mode. SUM may not detect this problem unless the distortion is severe. Remember, DIFF cannot

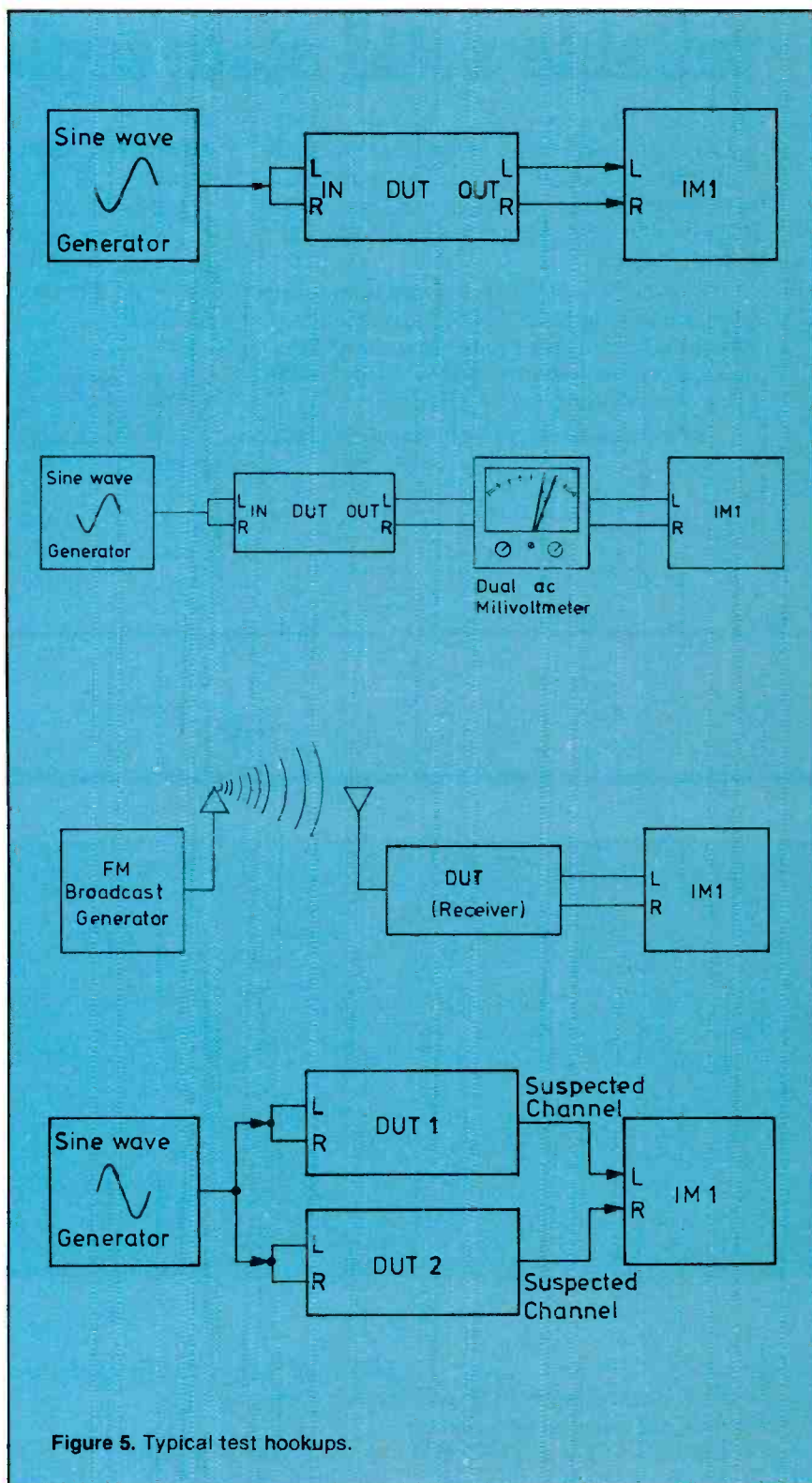


Figure 5. Typical test hookups.

discriminate between both channels dead and both channels on.

In DIFF, the C3 voltage will be low until the DUT fails. Then it will go high. DIFF amplifies *differences*. If the unit is fed the same signal to both channels, and DUT controls are adjusted for equal left and right output, they will cancel each other, as long as no failure occurs. Therefore, we have to set SW3 to PEAK.

Noise detection

One of the more vexing equipment failures is intermittent noise. IM-1 can be used in the SUM mode to detect it. In this case, the sensitivity control is turned up as high as practical without false trigger-

ing. SW3 is set for PEAK, and the THRESHOLD adjusted for as low a setting as possible. No signal is fed to the DUT, the selector switch is set for AUX or PHONO, depending on the expected failure, and volume control is turned wide open. If necessary, you can isolate the noisy stage in steps, by judicious selection of test points and DUT switch positions.

Two DUTs at once

If you know which channels are defective, you can monitor two units at once. Simply connect the bad channel from one device to the IM-1 left input. Use the IM-1 right channel for the other unit. Set levels, SUM the signals, and wait

for the alarm. This method requires that the same test signal be used with both units. Output levels at the test points should be roughly equal.

Unusual uses

Although it has two, the IM-1's inputs need not be used simultaneously. By turning the MIX control to one side, you have a simple VOX. I often use this mode if I know which channel is going to quit, or if I need to monitor the output of a test instrument, such as a wow and flutter meter, or distortion analyzer.

For example, a customer brought in his Pioneer RT 707, reel-to-reel tape deck. He claimed

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that, every now and then, the speed would suddenly change, then come back to normal after a couple of seconds. Apparently the problem was quite random.

Upon inspection, I noticed that tapping the speed control board would cause the symptom he mentioned. Isolating the cause to a flaky speed control pot, I cleaned it, then decided to burn-test the deck using a flutter meter and the IM-1.

The output of the flutter meter is a relatively low frequency (6-100Hz), so the SENSITIVITY control on the IM-1 had to be set quite high. To be certain the system was working, I "flanged" the reels to simulate failure. After eight continuous hours of testing, which cost only the time necessary to change reels at the end of the tape, I could be fairly sure the deck was OK. After six months, it still hasn't recurred.

A similar procedure allows you to monitor small changes in distortion, which would go unnoticed in the DIFF mode. The output of a THD meter contains distortion products produced by the DUT (along with hum and residual noise, which can be ignored for the sake of this description). By feeding the output to the IM-1, you can monitor the distortion level and trigger a warning signal if it exceeds a certain threshold. You must be careful to avoid reading hum, though.

Future uses

As it stands, the IM-1 is a useful addition to any audio test bench. But it is a simple device, with plenty of room for improvement. The elimination of capacitive coupling and a little more attention to correcting offset would improve frequency response down to dc. Adding a demodulator probe could extend performance into the RF spectrum. The use of BIFETs or

IM-1 PARTS LIST

IC1	LM324
Q1,2	2N3904
D1	1N4148
LED1	Any GP red LED
R1,6,10	103
R2,102	220k
R3	820k
R4,104,105	180k
R5,8,11	1k
R7	10k
R9,12	27k
R101	470
	270k
C1,101	.012μF
C2	1μF, aluminum elec.
	trolitic
C3	22μF, tantalum
SW1,3,5	Mini, DPDT, RS
	275-626 or eq.
SW2,4	Mini, SPDT, RS
	275-625 or eq.
VR1	500k, dual, linear
VR2	2.5k, linear
VR3	50k, linear
B1	Piezoelectric buzzer
	RS 273-064 or eq.

Misc.: Enclosure, perf-board (or etched board), battery holders, hookup wire, knobs, hardware, 9V batteries.

Notes: 1. All resistors 1/8W or larger, unless noted otherwise.
2. All capacitors in microfarads, 25WVdc, unless otherwise noted.

the addition of an extra couple of op-amps, configured as voltage followers, would raise the input impedance by a factor of 5 or 10.

Computer aided testing

The real fun would be to computerize testing. A simple microprocessor-based design could be integrated with the IM-1. The test program would monitor the IM-1 output and begin a voltage measurement procedure when triggered. Several probes, connected to strategic testpoints in the DUT, would be polled by the computer, in sequence, at the moment failure was detected. The results of the test could be saved in memory, to be recalled by the technician when convenient. You could let a unit burn-in, while you went out and enjoyed a lunch unhampered by worries about missing a once-in-every-seven-hours failure. I have already developed a system that will automatically measure and store one voltage, when failure occurs, so the idea is workable. A simple version of the computer-aided IM-1 should cost less than \$150.

Summary

The IM-1 makes troubleshooting intermittent problems a more reliable and fruitful procedure. It doesn't get tired of staring at a scope, or listening to speakers. It also does not go out for lunch just before the DUT quits.

Since using it at the shop, I wonder how I got along without it. The monitor has far more patience than I, so burn-in tests of eight or nine hours are easily accommodated. It helps reduce recalls. You diagnose and repair with more confidence. Customers who have had their units unsuccessfully serviced elsewhere are pleasantly surprised when the IM-1 helps pinpoint intermittent trouble previously missed.

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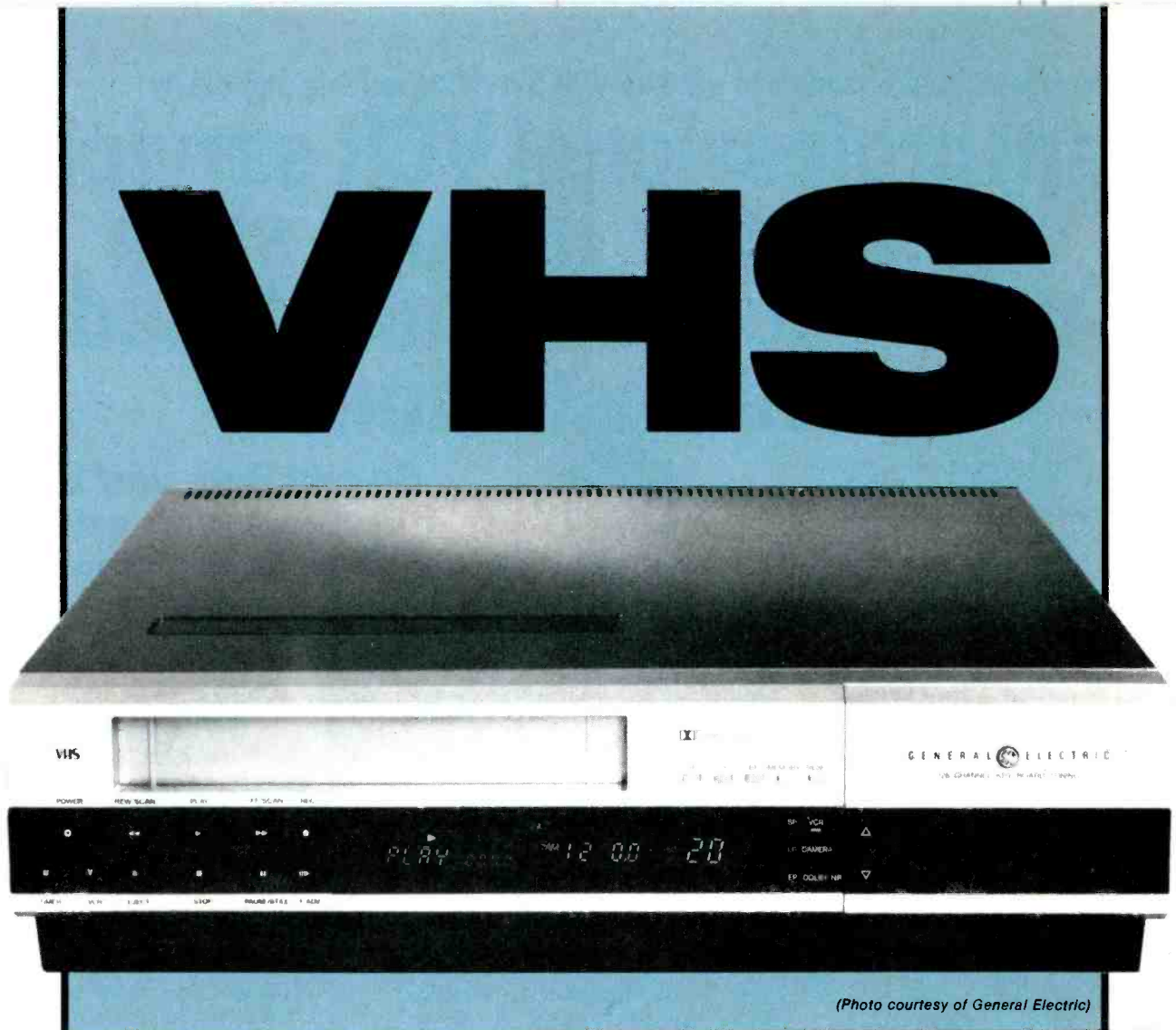
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videorecorder basics

By Steve Bowden

Lead-ins from both UHF and VHF antennas are connected to the VCR. When the TV/VCR switch is in the TV position, internal VCR switches route the VHF antenna signal to the color receiver antenna terminals. Thus, the television operates in the conventional way for broadcast programs. Note: If the TV/VCR switch is left accidentally in the VCR position, all VHF and UHF channels of the TV receiver will have no signals or very weak ones.

Each VCR has internal VHF and UHF tuners, and they are used to select the program that is recorded. Recordings can be made whether or not the program is monitored by a receiver. When the

switch is in the VCR position, the antenna lead-ins are connected to these internal tuners, while the VHF cable to the receiver is switched to the VCR's RF-converter output. The RF converter changes VCR video and audio into a Channel-3 or Channel-4 modulated carrier. Therefore, the receiver (after it is tuned to the proper channel 3 or 4) can monitor both picture and sound of the TV program that is being recorded.

In addition to UHF and VHF tuners, the VCR has IFs, AGC, AFT, video detector, sound IF and sound detector. These are similar to their counterparts in color-TV receivers. Of course, no vertical or horizontal sweep circuits are included.

Signal switching

Audio and composite-video signals coming from the output of the TV demodulator board are passed through the normally closed contacts of the external-input jacks and on to the appropriate board. If audio and video signals from an external source (a video camera or another VCR) are plugged into the video or audio input jack, the demodulator-board signal is disconnected automatically.

Audio and video recording

The audio signal is equalized and amplified before it reaches the audio head. A sample of the 67kHz bias signal and the audio are applied to the audio recording head, while stronger samples of this bias

are applied (without other signals) to the audio-erase and full-width erase heads, which remove any previous recordings.

The composite-video signal is divided into separate luminance and chrominance signals, with the luminance processed in the luminance-record system and the chroma processed in the chroma-record circuit.

A 3.4MHz carrier is frequency modulated by the luminance signal. Also, the 3.58MHz chroma signal is downconverted to 629kHz. Then the FM luminance and the 629kHz chroma signals are applied to the recording amplifier, and its output drives the two video heads in parallel.

No recording bias current is supplied to the video heads. The FM signal requires no bias, because its high amplitude drives the tape into saturation, and linearity is not necessary. In addition, the FM signal acts as bias for the 629kHz amplitude-modulated chroma signal. The video heads (located on the rotating-head assembly) record these separate signals on the tape as it is drawn around the cylinder.

Playback

During playback, each video head in alternate sequence receives from the tape its assigned one-vertical-field video signal. These head signals are separately amplified, but only one at a time is passed on the luminance-processing and chrominance-processing circuits. The luminance circuits demodulate the FM carrier, producing luminance video, while the chrominance system converts the 629kHz AM chroma signal back to 3.58MHz. Then the luminance and chrominance signals are combined in the video amplifier to recreate the original composite-video signal, which (along with the retrieved audio signal) is sent to the RF converter and on to the receiver. Therefore, the receiver can show the recorded picture and reproduce the accompanying sound.

Servo-control system

Servo circuits are shown near the bottom of Figure 1. A servo

can be called a closed-loop amplifier that electrically controls mechanical movements or rotations while monitoring and correcting the performance. This monitoring of the VCR rotational speed and phase is made possible by taking a feedback signal from

the motor and comparing it against a standard. If there is a discrepancy between the standard and the actual speed, the servo automatically corrects the speed (or phase).

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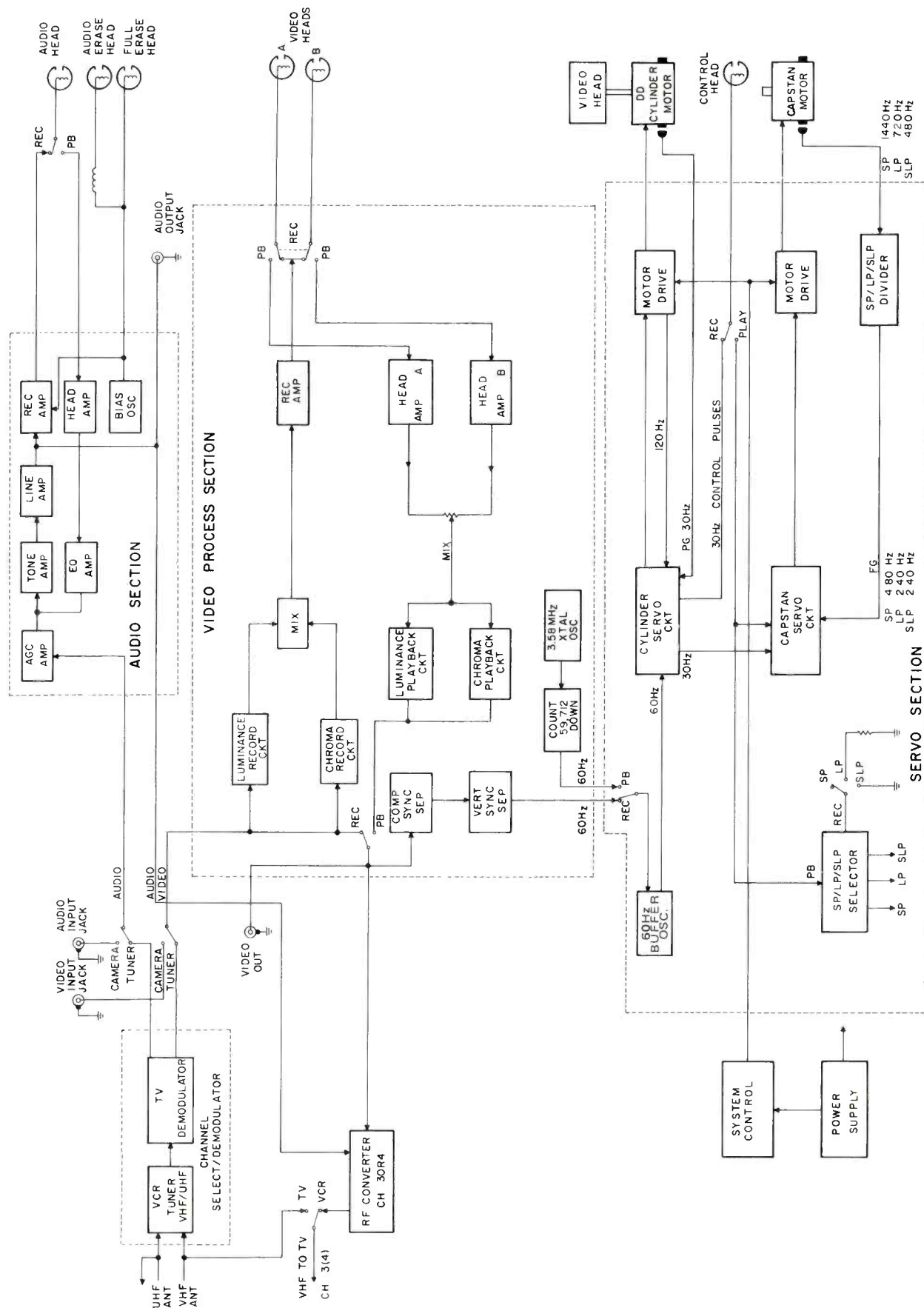


Figure 1

of the DD cylinder and motor, the cylinder must be rotated at 1800RPMs. Thus, each head records and plays one vertical field (262.5 horizontal lines) of each slant track. Also, vertical sync must be placed at the same point on each track, which is about 10 horizontal lines up from the bottom of the track. These are critical conditions that require servo-loop circuits for both *rotational speed* and *phase* of the DD cylinder.

For the *speed* loop, the feedback signal is a 240Hz square wave from the motor's main drive-coil signal. This square wave can be considered an FG (frequency generator) signal because the frequency varies in step with the head-cylinder rotation.

The *phase-loop* feedback signal is a 30Hz pulse-generator (PG) waveform coming from the head-cylinder

assembly. Two magnets are mounted opposite each other on the flywheel. One is polarized N-S, and the other is polarized S-N. As these magnets rotate above a stationary pickup coil, the coil produces alternate negative (A-head) and positive (B-head) pulses. Each pulse indicates that a video head is at the bottom of the tape ready to record another diagonal video track holding one vertical field of signal. Therefore, the PG pulses are the *feedback* signal that are phase-compared with the vertical-sync frequency of the incoming video signal. When any deviation from perfect phase occurs between the *feedback* pulses and the *standard* sync pulses, the circuit speeds up or slows down the DD head cylinder so the signals have the same phase.

During playback, a different

standard signal must be used. The 60Hz *reference* signal is produced by dividing the output of a 3.58MHz crystal oscillator by 59,712. PG pulses are the *feedback* signal also during playback.

These 30Hz PG pulses also indicate when the A or B head is contacting the tape. This is vital because the head with the positive-azimuth tilt must play all the diagonal one-field tracks that were recorded with positive tilt. In the same way, the negative-tilt head must play all the tracks previously recorded with a negative tilt. Also, the pulses indicate which playback-head is receiving the recorded signal, because the signal from the unused head is blanked to prevent pickup of extraneous noise.

Capstan servo operation

Vertical-sync pulses from the in-

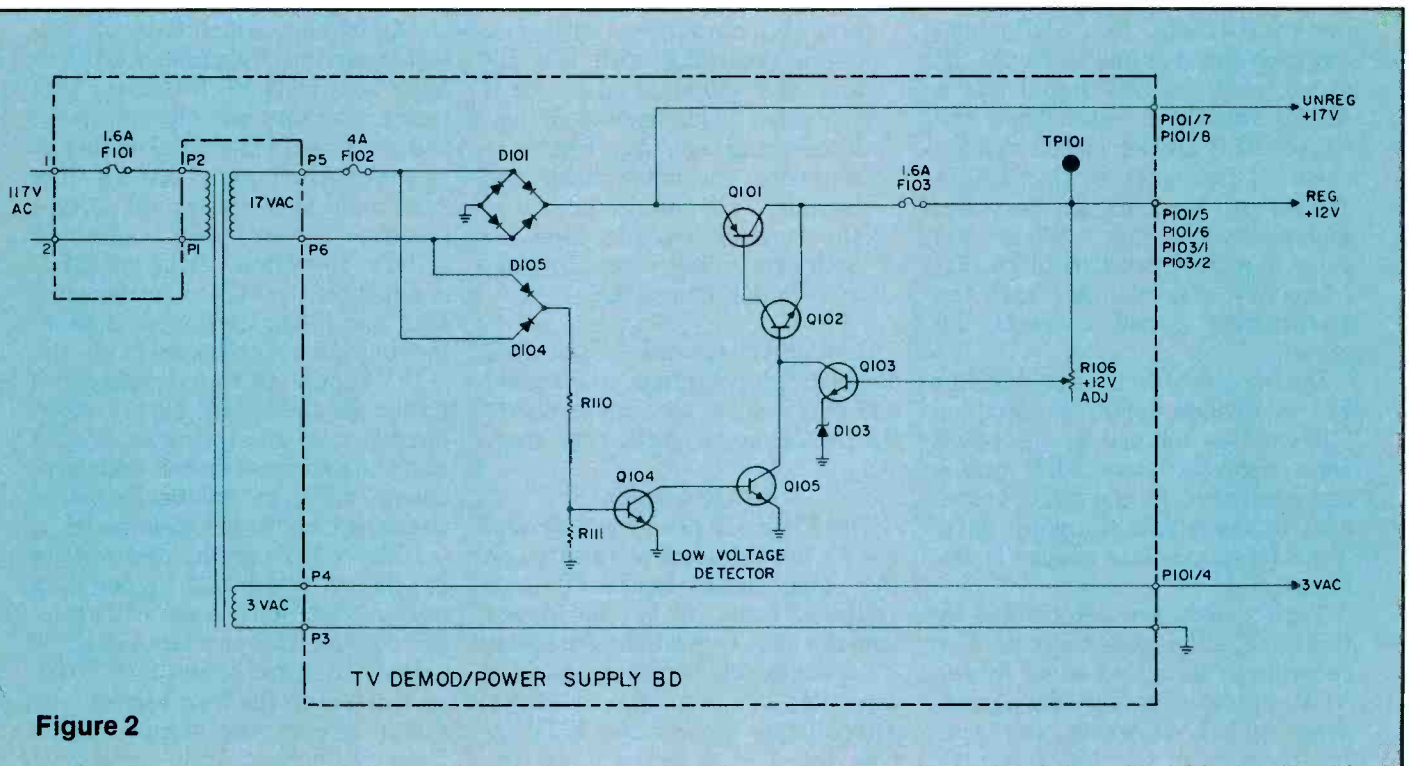


Figure 2

Figure 2. The power supply and the TV demodulator are located on the same circuit board.

Figure 1. (opposite page) A block diagram of a VHS videocassette recorder/player. Dotted lines enclose the video signal-processing section (top) and the servo-control section (bottom). The direct-drive (DD) head-cylinder motor and the capstan motor are speed- and phase-controlled by these servo circuits.

coming composite video are used to synchronize a 60Hz buffer oscillator. Output of the buffer is divided to 30Hz and then integrated to become the *reference* trapezoidal signal for the *phase* circuits of cylinder and capstan sampling gates. Also, these divider 30Hz square waves are recorded as pulses on the control track (they are used later during playback as the *feedback* signal for the capstan *phase* circuit). Because these 30Hz control-track pulses were derived from incoming vertical sync, minor adjustments of the tape movement can correct video-head-to-tape misalignments. A control is provided for these adjustments.

The approximate capstan-motor speed is maintained by *feedback* from the speed-sensor frequency generator (FG). This FG repetitive frequency is different for each speed mode. For standard play (SP), the capstan FG is 1440Hz. For long playing (LP), the tape speed is reduced to half, so the FG becomes 720Hz. For SLP mode the tape speed is one third the SP speed, and the FG signal has a 480Hz repetition rate. Then the SP/LP/SLP divider circuit divides each FG frequency so that 120Hz always is sent to the capstan motor-servo circuit. When the capstan-motor speed drifts, the FG frequency also changes and the motor-drive circuit corrects the speed.

During recording, the capstan FG is divided again to produce 30Hz pulses for use by the *phase* servo circuit. These 30Hz pulses are compared to the 30Hz trapezoid in the phase sampling gate. Therefore, absolute phase is obtained.

Tape speeds are determined by the SP/LP/SLP select circuit. For recording, the speed is set by the VCR operator using the speed-select switch. However, the tape-travel speed is selected automatically (by the 30Hz to 90Hz repetition rate of the control pulses) during playback.

Troubleshooting

Use this check list for troubleshooting a VHS VCR, following this sequence:

1. Switch power on.
2. Check the TV/VCR switch operation.
3. Check status of the timer switch (if the machine has one).
4. Check the DEW indicator.
5. Check the playback by using an expendable pre-recorded tape. Notice the head output, luminance and chroma outputs, and the RF converter input and output (by switching the TV/VCR switch and using the tuner).
6. Make a recording and check the quality on another machine. If the other machine shows a good picture, but the one being tested does not, the problem is in the playback circuit. If the other machine shows the same bad picture as the customer's machine does, the problem is in the recording circuit. Check the camera/tuner switch; check tuner operation; record with external video and audio signals and evaluate the results; scope the outputs of luminance and chrominance systems; check recording with SP, LP and SLP modes; and notice if the video heads need cleaning.
7. Record and then play, testing in sequence: the video heads and signals; all luminance and chrominance circuits used for both recording and playing; and the RF converter.

Demagnetize and clean the heads and tape guides, and record and play a short test and evaluate the performance as the final step.

Power supply

The Figure 2 power supply and the TV demodulator are located on the same circuit board. Two ac voltages come from the power transformer. One winding supplies 3Vac for the clock display, and the other has 17Vac for the rectifiers. Three fuses protect the 117V input, the 17V secondary and the +12V regulated dcV source. Bridge diode D101 supplies unregulated +17V for the cylinder motor, while transistors Q101, Q102 and Q103 regulate the +12Vdc main supply source.

When the power switch is turned on, a positive voltage through

R106 and Q103 base/collector junction applies forward bias to Q101, which conducts to raise the output voltage at TP101 up to +12V. Q103, Q102 and Q101 then operate to stabilize the +12V supply at whatever voltage is determined by the adjustment of R106.

The *low-voltage detector* is unusual because it eliminates the +12V supply when the line voltage is too low. In conjunction with the two grounded-anode diodes in D101, D104 and D105 are a bridge rectifier that has unfiltered output. In normal operation with correct line voltage, the R110/R111 voltage divider applies saturation bias to Q104. Of course, the collector-to-emitter path in Q104 becomes a low resistance that grounds the base of Q105, stopping all Q105 collector current. Therefore, Q105 does not remove the base voltage from Q102, and the regulator operates normally.

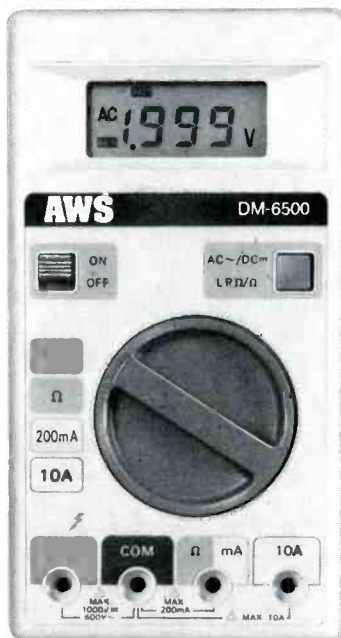
However, a line voltage of approximately 80V rms decreases the Q104 bias, which stops its collector current. This allows Q105 to have saturation forward bias (some resistors are not shown on the simplified schematic) so its collector/emitter path has a low resistance that shorts out Q102's positive forward bias, stopping Q102's operation. Without Q102 conduction, Q101 has no forward bias, and it becomes open, thus removing all dc voltage from the +12V supply. Of course, this elimination of the +12V supply stops operation of all electronic circuits and places a reset on the microprocessor, which automatically places the tape deck in the *stop* mode.

If the +17V unregulated voltage is present (it will test higher than normal) but there is no +12V supply voltage, the problem might be a short that has blown fuse F103, or a defect in the 5-transistor regulator circuit has stopped Q101 from conducting. An in-circuit test of all transistor junctions should prove whether or not a regulator transistor is the source of the voltage loss.

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A future article will cover signal processing in both recording and playing modes of operation.

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TROUBLE SHOOTING

with a signal level meter

The quality of a TV picture or an FM program is directly dependent on the level of the signal reaching the receiving set. A good strong signal produces, in a properly operating unit, clear crisp pictures and clean undistorted sound. Low signal level can result in poor picture and sound, or no output at all. A signal level meter, properly used, can determine if the reason for poor picture or sound reproduction is the fault of the set or a poor signal.

Essentially a tunable RF voltmeter, a signal level meter is an excellent tool for signal tracing, fault isolation and general troubleshooting in RF circuits. For example, on a TV service call, a measurement of the RF input signal level at the TV receiver will immediately verify whether the problem is within the TV set or outside the TV set (Figure 1). Measurements should be made for each channel that is normally received. This is an important first step if TV reception is served by a CATV (cable television) or MATV (master antenna television) system, because the owner normally is not responsible for the repairs if the problem is within the CATV or MATV distribution network. However, all equipment and cable for which the owner is responsible should be thoroughly checked. Likewise, a CATV or MATV service technician using a signal level

meter can verify that the problem indeed lies within the distribution system.

A signal level of at least 0dBmV is required for acceptable picture quality. In all but fringe reception areas, signal levels from an antenna lead-in should normally be considerably higher. Remember to use a 300 Ω to 75 Ω matching transformer when making signal level measurements at any 300 Ω circuit point. See Figure 2 for meter tuning considerations.

Low input signal level at the TV set could be caused by corroded antenna connections, a broken antenna, damaged lead-in or a defective or improperly installed splitter. Each device in the RF signal path could cause such a problem and should be checked. The conventional signal tracing technique consists of a series of measurements, usually starting with the input signal and following the signal path until the signal is lost (Figure 3). The device just before the loss of signal is then known to be defective. However, in home TV applications, you would probably wish to work in the opposite direction. Starting at the TV receiver and working toward the antenna, a series of measurements is made until the signal is found. The device just before the presence of signal is then known to be defective. This sequence delays climbing up to the antenna until

other possibilities are eliminated.

Of course, the half-splitting technique of troubleshooting applies and can often speed up fault isolation. Instead of measuring every point in the network, split the network in half and make a measurement. If the signal is missing, work toward the antenna (signal source), split the remainder in half and make another measurement. If the signal is present, work toward the TV set (signal termination), split the remainder in half and make another measurement. Continue half splitting until the fault is isolated to one device.

It is normal to observe some signal loss between the antenna and the TV receiver. Each cable, connector and other device (except an amplifier) causes signal attenuation. Also, it is normal for attenuation to be greater at higher frequencies. A little experience will tell you whether signal loss is normal or excessive.

MATV applications

MATV networks are used in many apartment buildings and motels. Such a network permits a single antenna (or antenna array) to serve many TV sets. It may also

Adapted from the B&K Precision Dynascan Corporation Instruction Manual for use with the models 425 and 430 signal level meters.

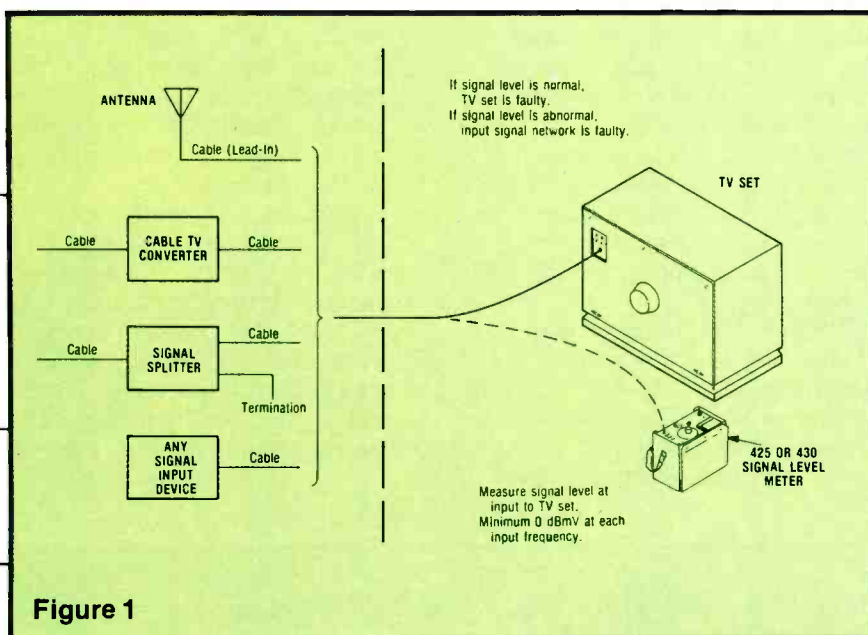


Figure 1: A signal level meter can be used for fault isolation by measuring the signal level at the TV input.

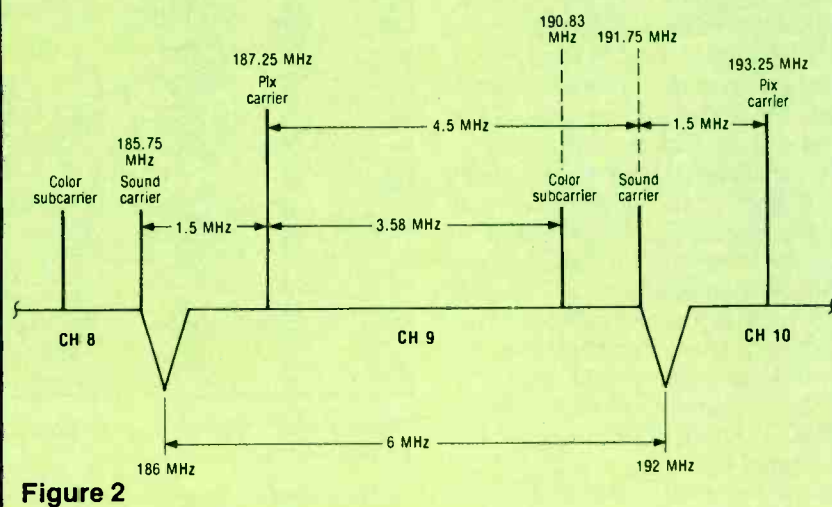


Figure 2

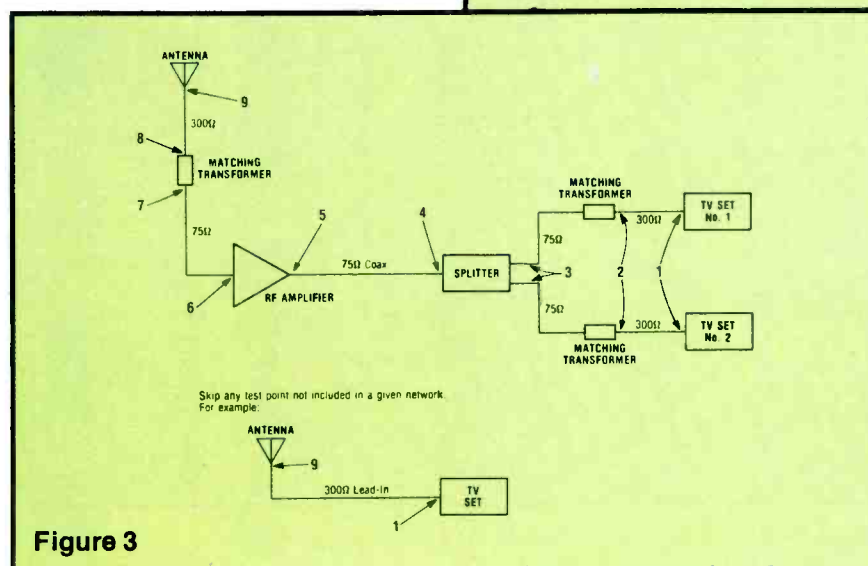


Figure 2: If the signal level of both picture carrier and sound carrier of composite TV signal are to be checked, they must be tuned separately on the meter.

Figure 3: A signal level meter may be used for signal tracing to determine where the problem is in a system.

include a satellite TV antenna and equipment for adding locally generated video (for example, a VTR, encoder and RF modulator for producing pay movies on motel TV). The equipment may vary widely from system to system, but it usually includes wideband RF amplifiers and 75 Ω feeder cables with taps to each apartment or room. Equalizers, splitters and bridgers are also common.

A signal level meter is indispensable in the installation, expansion, modification, troubleshooting and upkeep of an MATV system. Figure 4 illustrates some of the test points for troubleshooting an MATV system. Many of the same test points would be used for periodic level measurements to keep the system in peak operating condition. If adjustments are required, a signal level meter would be used to measure signal levels at each frequency used in the system. A signal level meter would also be used for selecting antenna locations and for aiming antennas.

A log of signal level readings can be valuable for MATV system maintenance. Readings taken at periodic intervals will indicate any gradual degradation of system performance, or possibly an impending failure. For troubleshooting, a list of reference signal levels will more rapidly isolate faults.

MATV applications include use of a signal level meter for checking coaxial cables, amplifiers and equalizers, antennas, satellite antennas, splitters, connectors and tape recorders.

CATV applications

CATV networks have many of the same characteristics as MATV networks, but usually on a much larger scale. CATV systems serve an entire community and may include several miles of coaxial cables with several cascaded amplifiers and equalizers.

Antennas, satellite antennas, locally generated video programming and possibly microwave relays gather video signals. A frequency converter or modulator at the head end of the system places the video onto RF carrier frequen-

cies. A low loss main trunk carries the RF signals from the head end to the community, where it branches out into medium loss feeder lines, and finally into high loss house drops. Inside the home, cable-ready TV receivers tune to the cable RF frequencies, or a converter adapts a standard TV receiver to accept all the RF cable frequencies.

A signal level meter is a primary tool for installing, maintaining and servicing CATV systems. The instrument is used in much the same way as described for MATV systems. Figure 5 illustrates some of

the test points in a CATV system. Normally, 75 Ω amplifiers and cables are used throughout the system. Frequent checks of the antennas, main trunk and feeder lines keep the system in peak operating condition.

Picture carrier levels from a cable TV system are typically +10 to +30dBmV at the TV receiver, and sound carriers are usually 6 to 15dB below the picture carriers. However, any picture carrier level above 0dBmV normally should provide a good quality picture. The more important check is that all

(continued on page 38)

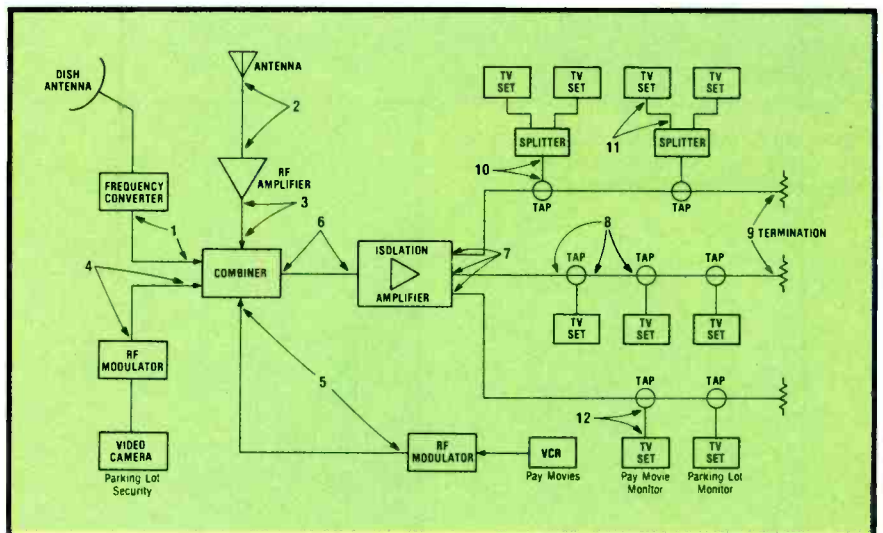


Figure 4: MATV system installation, expansion and troubleshooting procedures may be streamlined through the use of a signal level meter.

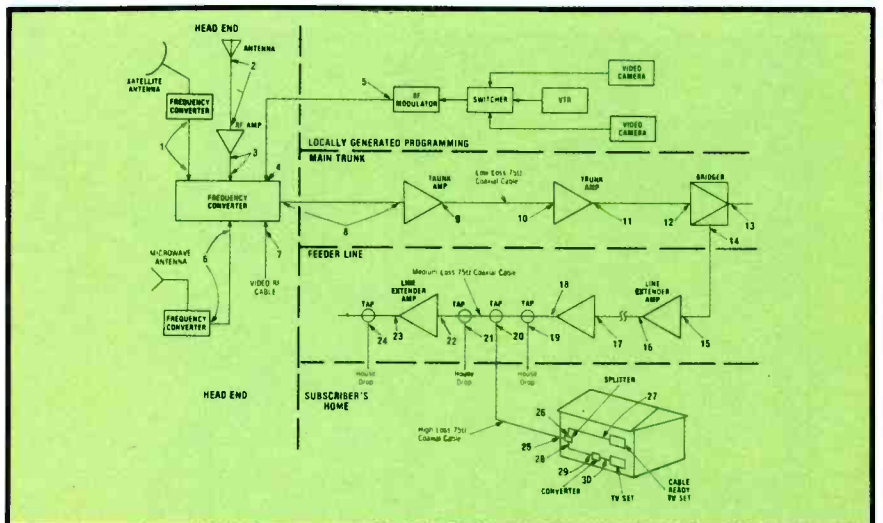
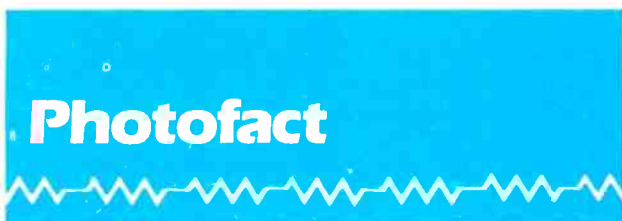


Figure 5: Signal level measurement is a valuable procedure in installation and maintenance of CATV systems.



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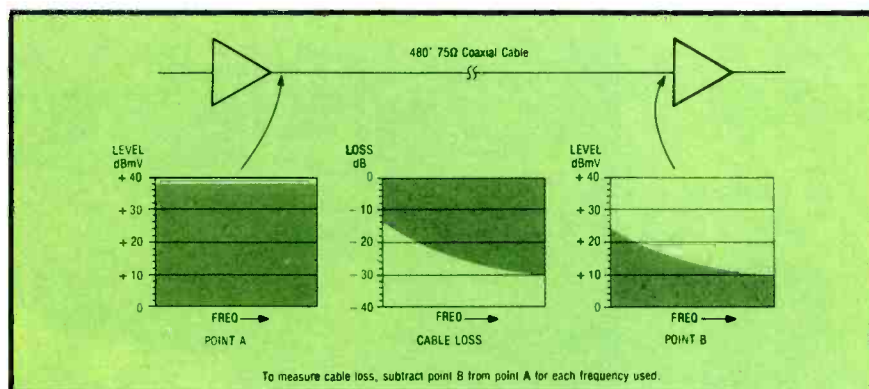


Figure 6: To measure cable loss, subtract the signal level reading at point B from the reading at point A.

channels should be received at approximately the same level. Abnormal levels could be caused by the converter, damage to the cable within the home, bad connectors or a problem in the cable system exterior to the home.

Coaxial cable measurements

One of the most common applications of a signal level meter is to measure the signal loss through a length of coaxial cable (Figure 6). All coaxial cables attenuate the RF signal; the longer the cable, the greater the attenuation. Attenuation also depends on the RF frequency being carried by the cable. Attenuation increases as frequency increases. If a band of frequencies is being carried by the cable, the high frequencies are attenuated more than the low frequencies, resulting in a non-linear frequency response.

To measure signal loss of a length of coaxial cable, measure the signal level of each RF frequency carried by the cable at the input and at the output. Subtract the difference between the readings to obtain signal loss for each frequency. Although the meter readings are in dBmV, the difference is in dB.

Coaxial cable properties

A coaxial cable has resistive, capacitive and inductive properties. The capacitive and inductive properties give the cable its characteristic impedance, which is 75Ω for most coaxial cable used in TV RF applications.

Attenuation is partially caused by the resistive property of the cable. Resistance is dependent primarily on the diameter of the center conductor and the conductivity of the material—solid copper, stranded aluminum, etc. Attenuation caused by resistance is directly proportional to the length of the cable, but is independent of frequency.

Attenuation is also caused by one of the capacitive properties of the cable—dielectric loss or dielectric leakage. Dielectric loss is dependent primarily on the type of dielectric used—polyethylene, Teflon, foam, etc. Dielectric loss is proportional to the length of the cable and increases with frequency, as in any capacitor.

Standard attenuation characteristics

The approximate attenuation for a given length of coaxial cable can be calculated. Tables of standard attenuation for various types of coaxial cables are available. These tables give the standard attenuation per 100 feet of cable at various frequencies. The standard attenuation per 100 feet for some of the most common 75Ω coaxial cables is listed in Table 1. A convenient rule to remember is that standard attenuation for RG-59/U coaxial cable is 6dB per 100 feet at channel 13 (216MHz) at 25°C.

In a coaxial cable, attenuation is proportional to the square root of the frequency. By this rule, the attenuation at channel 13 divided by the attenuation at channel 2 is pro-

portional to the square root of the frequency at channel 13 (216MHz) divided by the frequency at channel 2 (54MHz). 216MHz divided by 54MHz equals 4, and the square root of 4 is 2. Therefore, the loss at channel 13 will be twice that at channel 2. If the loss is 24dB at channel 13, the loss will be 12dB at channel 2. This relationship holds true regardless of the type of coaxial cable used, the length of the cable, or the temperature.

Effect of temperature

Changes in temperature greatly affect losses in a coaxial cable. Each 10°F variation in temperature causes about 1 percent change in cable attenuation at all frequencies. For an outdoor cable where seasonal temperatures may vary from 100°F to 0°F, this

ATTENUATION PER 100 FEET				
(Polyethylene dielectric)				
	RG-6A/U	RG-11A/U	RG-59/U	RG-58B/U
50MHz	1.8dB	1.5dB	2.7dB	
100MHz	2.9dB	2.15dB	4.0dB	
200MHz	4.3dB	3.2dB	5.7dB	
400MHz	6.5dB	4.7dB	8.5dB	
800MHz	8.3dB	6.0dB	10.8dB	

Table 1. Standard attenuation of popular 75Ω coaxial cables.

would cause a 10 percent change in attenuation. A 20dB loss at channel 13 at 100°F becomes 18dB at 0°F, and half that loss at Channel 2 changes from 10dB to 9dB. Not only does the signal level change, but the difference in signal level between high and low frequencies changes (not the ratio, but difference in dB). In a CATV system with long cable and many cascaded amplifiers, temperature changes cause significant changes in performance so that temperature compensation is essential. Standard attenuation tables list nominal attenuation at 25°C (77°F).

Practical cable checks

Because coaxial cable attenuation for any given length and type of coaxial cable, and at any given temperature, may be calculated,

the need for measurement with a signal level meter may be questioned. The calculations apply, of course, only if there is no defect in the cable, and if the connectors are installed properly, etc. Almost any abnormal coaxial cable condition will result in higher than normal attenuation. Signal level measurements can confirm the condition of the cable, detect any abnormal condition and locate the cause. Some specific examples follow.

Any damage to the cable such as a kink or flattened spot produces a change in the characteristic impedance at that point. This results in an impedance mismatch, standing waves (high VSWR), and a lower than normal output level at the end of the cable. If water has penetrated the cable, the dielectric constant will change, perhaps drastically. Attenuation would become much higher than the calculated value.

As previously explained, temperature affects attenuation. Measurements with a signal level meter can check the effectiveness of temperature compensation networks. Corroded or improperly installed connectors, broken stands in conductors and almost any other abnormal condition can be similarly identified and isolated with signal level measurements.

300Ω lead-in

Many of the principles that apply to coaxial cables also apply to 300Ω lead-in. Losses are proportional to

the length of the lead-in and are greater at higher frequencies. Signal level measurements should be made for all frequencies to be carried by the lead-in. Measurements may identify the need for low-loss lead-in, an RF amplifier, or a better antenna. Damaged lead-in will exhibit excessive attenuation. Remember to use a 300Ω to 75Ω matching transformer for all measurements.

Amplifier gain measurement

A signal level meter may be used to measure gain of an RF amplifier. To determine amplifier gain, measure the signal level of each RF frequency at the input and at the output of the amplifier. Subtract the difference between the readings to obtain the gain at each frequency. Although the meter readings are in dBmV, the difference is in dB.

Gain measurements are not always required. If the signal level and frequency response at the output of an amplifier is satisfactory, there is probably no need to check gain. If either is abnormal, separate checks of cable attenuation and amplifier gain (and the equalizer, if a separate unit) will isolate the defective item. Remember to terminate each item into the proper impedance or high VSWR will cause measurement error.

Equalization

When RF signals are carried by cables, amplifiers must be used to

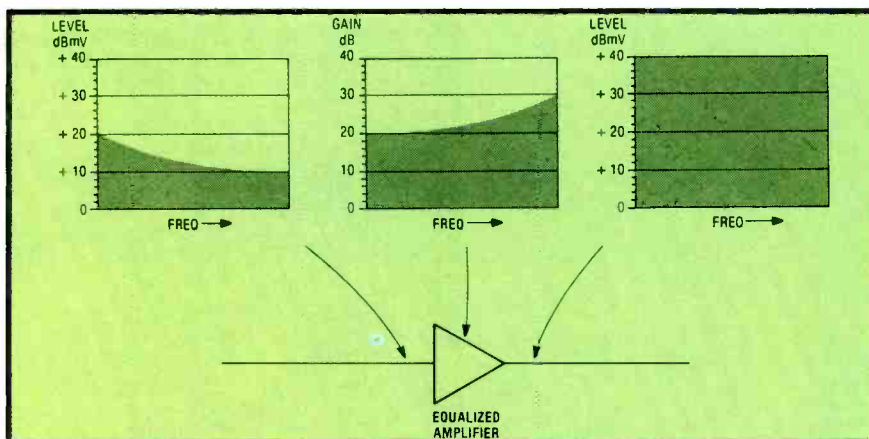


Figure 7: Amplifier gain may be determined by subtracting input level from output level at each frequency.

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offset cable attenuation and restore signals to a usable level. Typically, an amplifier is inserted in a CATV system (or any long coaxial cable installation) after each -20dB of cable attenuation. Naturally, the amplifier gain in such a case should be $+20\text{dB}$.

As previously noted, cable attenuation is non-linear; high frequencies are attenuated much more than low frequencies. Some sort of compensation must also be inserted to restore the high-frequency signals to the same level as the low-frequency signals. This is known as *cable equalization* or simply, *equalization*.

One method of including equalization is to use equalizing amplifiers (Figure 7). The gain of an equalizing amplifier is non-linear. In fact, its gain vs. frequency curve is the exact inverse of the cable attenuation curve; gain is highest at the highest frequency and lowest at the lowest frequency. If all frequencies are applied to a coaxial cable at the same level, all frequencies at the output of the equalized amplifier should also be at the same level.

A second method of including equalization is a separate equalizer at the output of an amplifier (Figure 8). In this case, the amplifier boosts all frequencies equally, then the equalizer attenuates the

lower frequency signals to match the level of the highest frequency. Again, the frequency response curve of the equalizer should be the exact inverse of the cable attenuation frequency response curve. Adjustable equalizers may be adjusted to include compensation for any non-linearity of the amplifier.

Bridging amplifiers and isolation amplifiers

Bridging amplifiers and isolation amplifiers are tested in the same

manner as single output amplifiers. The only difference is that they should have two or more outputs. Usually, all outputs should be at the same level, and all outputs should have the same frequency response.

Antenna amplifiers

Most of the same principles apply to antenna amplifiers as other RF amplifiers, except equalization. An antenna amplifier can compensate for lead-in loss, but cannot compensate for a weak signal at

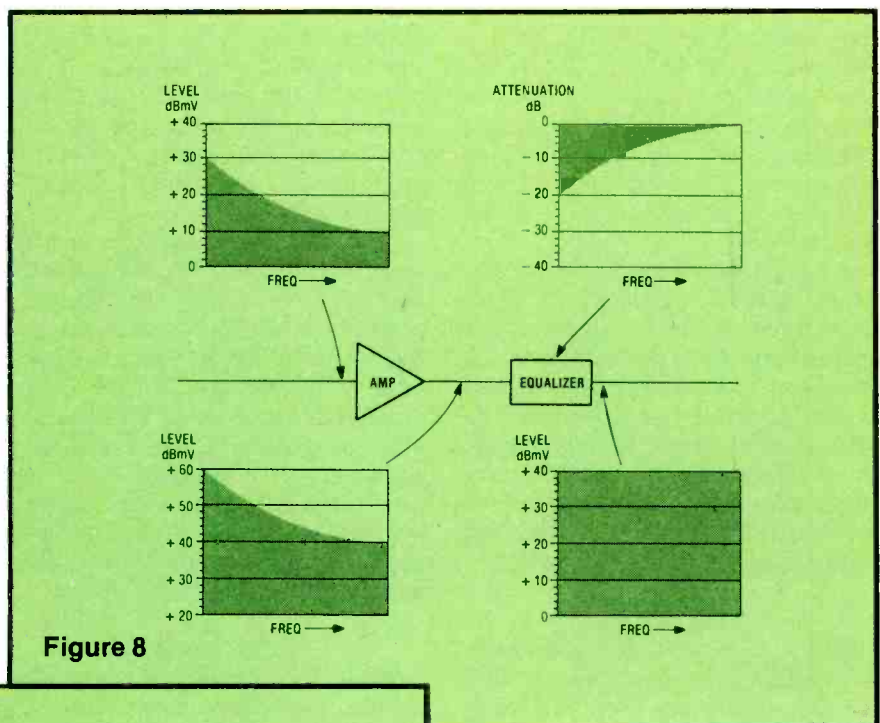


Figure 8

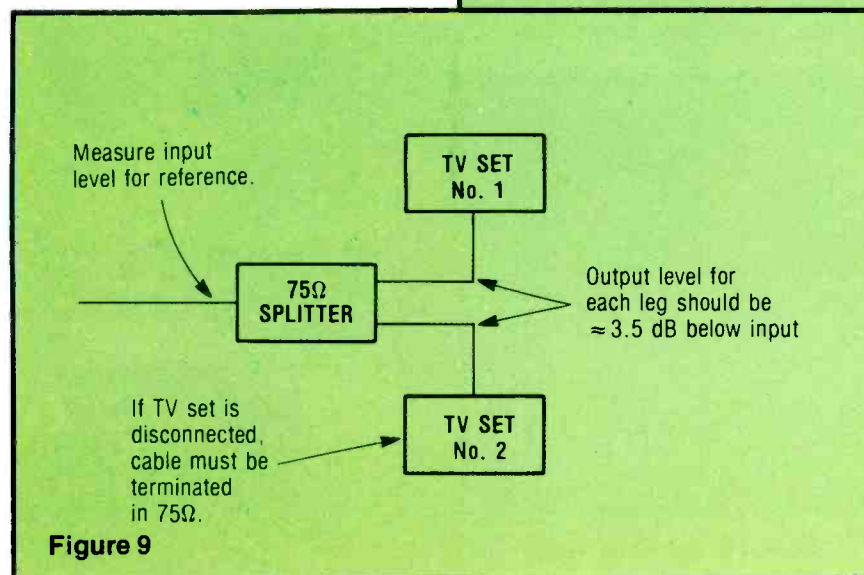


Figure 9

Figure 8: Equalizer response curve should be the inverse of the cable attenuation frequency response curve.

Figure 9: Measuring the effectiveness of a signal splitter.

Figure 10: Aiming of a TV or FM antenna may be optimized through the use of a signal level meter.

Figure 11: During installation of a satellite TVRO antenna, a signal level meter is valuable to aim the antenna for the strongest signal, to measure carrier-to-noise ratio and to measure the level of terrestrial microwave interference.

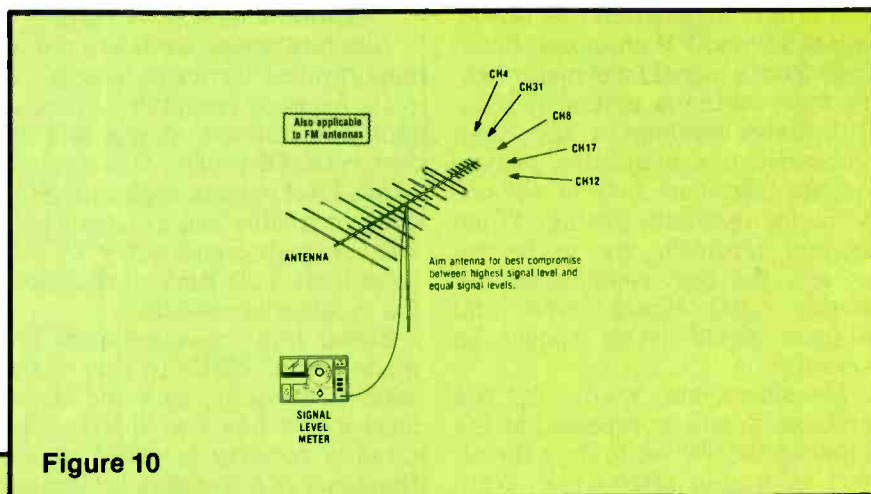


Figure 10

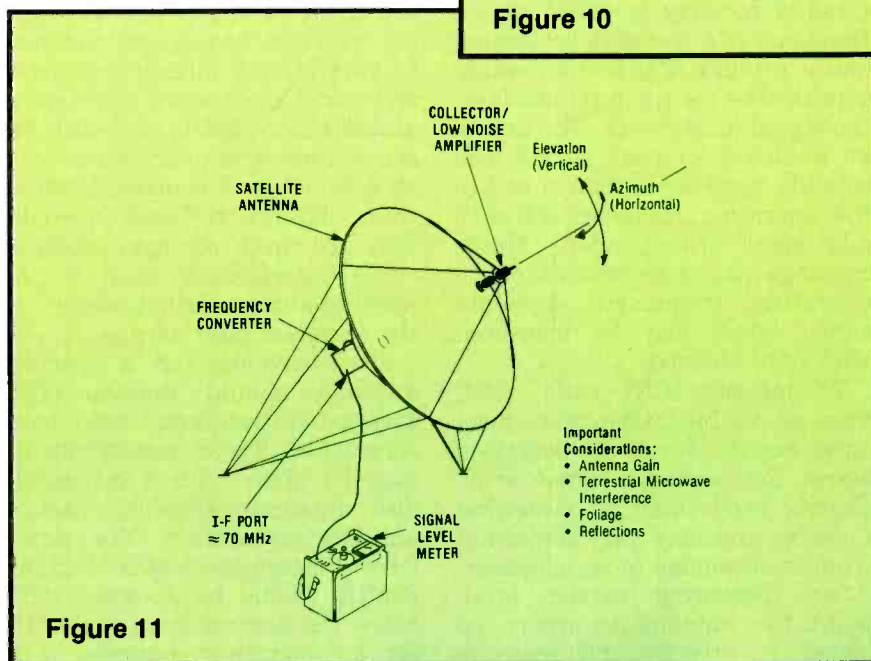


Figure 11

the antenna. If a weak signal is amplified, signal level and noise are both increased by the same proportion, and a snowy picture results.

Splitters

Splitters are used to split a signal into two paths. The splitter must also match impedances so that the input and both outputs are equal impedances. A splitter is a passive device, and thus its output power is always less than its input power. A good splitter should provide two equal level outputs, each of which is slightly less than half the input power (approximately -3.5dB). Measuring the input and output signal levels with a signal level meter quickly verifies

whether a signal splitter is good or defective (Figure 9).

A defective splitter will not provide the proper impedance match and output signal levels will be low, or output signal levels may be unequal. It is important that each leg of the splitter be terminated in its characteristic impedance. For example, a 75Ω splitter must be terminated in 75Ω; a 300Ω splitter must be terminated in 300Ω. If a leg of a splitter is temporarily unused, it should be terminated in a resistor. If there is no longer a need for the splitter, it should be removed to eliminate the half-power attenuation.

Connectors and adapters

Damaged, defective or improv-

erly installed connectors or adapters are often a source of abnormal signal loss. The amount of signal loss may be measured with a signal level meter. Good connectors and adapters should present less than 0.5dB insertion loss each. It is important to check loss at all frequencies of operation; losses tend to be higher as frequency increases. Some types of connectors present high insertion loss at UHF frequencies and are not suitable. Be sure the type of connector used is suitable for the application; check this by installing one of the connectors on a short piece of test cable and measuring insertion loss.

Connectors and adapters are normally part of a coaxial cable when it is checked. If an abnormal signal level is indicated, a technique is needed to determine whether the connectors, adapters or the cable is defective. A close visual inspection of connectors and adapters will often reveal damage or improper installation. Adapters are usually readily substituted with a new one and the measurement repeated. To isolate between cable and connectors, it may be necessary to replace the connectors, one at a time. Measurements should be repeated after each connector is replaced until the defective item is identified.

Antenna installation and servicing

A signal level meter is useful for

the proper installation and servicing of TV and FM antennas. Readings from a signal level meter help optimize antenna aiming (Figure 10). Meter readings, rather than imprecise and subjective picture quality judgment, become the criteria for optimum aiming. When several channels are to be received, the best compromise between equal signal levels and highest signal levels should be selected.

Measurements made at the antenna should be repeated at the input to the TV set to note the effect of lead-in attenuation. Note specifically signal levels at the highest frequencies used, because the highest frequencies will be more sharply attenuated. A need for low-loss lead-in, an antenna amplifier, or another method of improving signal level may be indicated.

Signal level readings can demonstrate the effectiveness of different antenna designs at the frequencies to be received. Signal level readings can also check the effectiveness of stacking antennas, or whether increasing antenna height will offset the lead-in loss sufficiently to improve picture quality.

Most of the tests and procedures mentioned for antenna installation also apply to antenna servicing and troubleshooting. A signal level meter will isolate the cause of poor performance, whether it is from damaged lead-in, corroded connections or broken antenna elements.

Satellite antenna applications

A signal level meter is indispensable for site selection, installation and servicing of satellite TV antennas (Figure 11). For example, it is obvious that a signal level meter would be used to aim a satellite antenna for strongest signal reception, both in elevation (vertical plane) and azimuth (horizontal plane). Other important uses for a signal level meter include confirmation of adequate signal level, carrier-to-noise ratio measurement and measurement of terrestrial microwave interference.

Antenna gain, C/N ratio

Absolute signal levels are not as important as carrier-to-noise (C/N) ratio for good reception. Antenna gain and antenna aiming will affect both. Of course, the absolute signal level must be high enough to overcome cable losses and still provide adequate signal at the TV set, so at least +20dBmV at the satellite receiver is desirable.

Signal level measurements are made at the 70MHz IF port of the satellite receiver, with the signal level meter tuned to 70MHz. The satellite receiver is tuned to the frequency of a transponder located on the satellite. The meter reading is peaked by the tuning controls on the signal level meter. The antenna is aimed for peak signal. The satellite receiver is then tuned to the operating frequency of each additional transponder. Meter readings may be repeated for each operating frequency. Absolute signal levels may be measured with AGC enabled.

To measure C/N ratio, AGC must be disabled. Otherwise, measure carrier level as described above for absolute signal level. Carrier levels may be somewhat unstable and may vary somewhat from transponder to transponder. After measuring carrier level, point the antenna to where no signal is present and measure noise level at each transponder frequency. For each frequency, subtract the noise level from the carrier level. The resulting figure

is the C/N ratio, which should be 8 to 15dB (minimum 8dB for satisfactory reception).

Terrestrial microwave interference

Terrestrial point-to-point microwave is the most common source of interference to satellite receivers. Satellite-to-ground television operates in the 3.7 to 4.2GHz frequency range. Terrestrial point-to-point microwave operates in the same frequency range, but the carrier frequencies are offset 10MHz. When the satellite receiver has down-converted to 70MHz, any interference from terrestrial microwave will appear at 60MHz or 80MHz (or both). Because terrestrial microwave carriers travel much shorter distances than satellite-to-earth signals, they are much stronger and can cause interference even if the satellite antenna is not pointed at the source of interference.

Site selection for a satellite antenna should include (C/I) carrier-to-interference ratio measurements. These measurements may be made with a collapsible dish antenna before the actual antenna installation. The signal level of interference at 60MHz and 80MHz should be at least 12dB below the carrier signal at 70MHz for all operating channels. It is often possible to locate the direction of interference by swinging around the antenna, or just its feedhorn assembly. Steps can then

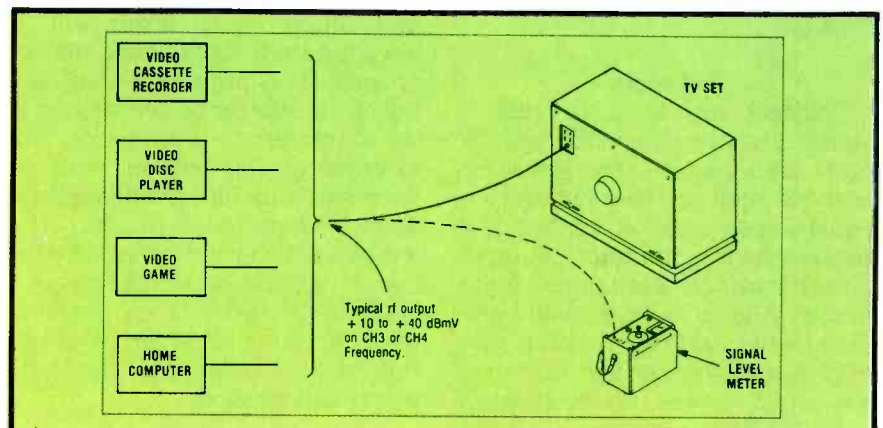


Figure 12: One step in the troubleshooting of video equipment is to check the output of the RF modulator.

be taken to locate the antenna to shield it from interference. All levels should be rechecked if a new location is chosen. Although buildings and foliage will block unwanted signals, they can also reflect them. Also, remember the seasonal change that can occur from foliage changes. Foliage that blocks unwanted signals in the summer may let them pass in the winter. The opposite can also occur. Summer foliage can cause reflections, and thus interference, that was not present when the system was installed in the winter months.

Other applications

Signal level meters have many other applications. Almost anywhere that RF signals of 50MHz to 450MHz (plus 470MHz to 810MHz for model 430) are used, the signal level meter may be used.

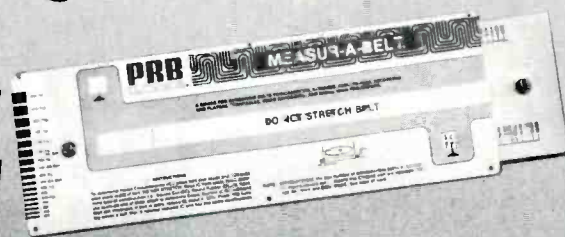
Many devices, such as VCRs, videodisc players, video games and home computers, include an RF modulator that permits the output to be fed into a TV set. Typically, these RF modulators provide a video modulated RF carrier on the Channel 3 or Channel 4 frequency. A signal level meter is useful for checking the RF modulator of such devices (Figure 12). Output level is usually not critical, but at least 0dBmV is needed for satisfactory picture quality.

The frequency bands of the signal level meters include frequencies used for amateur radio, aviation, land-mobile communications and radio navigation and may be used in such applications. Of course, the instrument's primary application is with video frequencies of 6MHz bandwidth, and some of its design characteristics reflect that application. When the instrument is used in non-video applications, the user should have a good understanding of the instrument's characteristics and the normal signal characteristics of the equipment under test. Such characteristics would include bandwidth, type of modulation, adjacent channel assignments, and the specific frequency assignment of the equipment under test.

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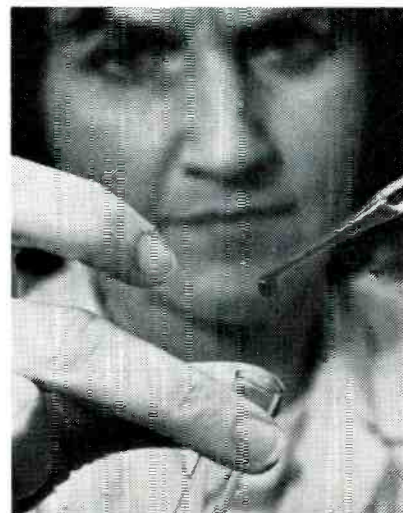
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Continuing the discussion of π

By Sam Wilson, ISCT test director, NESDA technical publications director

So far in this series you have learned that π gets into the electrical and electronic equations because sinusoidal waveforms can be considered to be rotating phasors. The position of the rotating phasor at any one time is directly related to its angular velocity (ω), and the elapsed time.

Always keep in mind that most of the equations in linear ac electronics are based on sinusoidal waveforms, but that does not place any serious limit on applications. By a relatively complicated mathematical process, *it can be shown that any waveform, no matter how complex, can be considered to be made up of combinations of pure sine waves.* In other words, the sine wave is the basis for all ac waveforms.

Every sinusoidal voltage and current waveform can be represented in the following form:

$$v = V_M \sin \omega t \pm \phi$$

and

$$i = I_M \sin \omega t \pm \phi$$

In these equations ϕ is a phase angle, which permits the waveform to be shifted to the right or left on the time axis.

Note the angular velocity (ω) in these equations. It is actually equal to $2\pi f$. The fact that π is included makes this discussion pertinent.

Before proceeding with the use of π in X_L and X_C , it is important to review a basic rule in mathematics. When two things are *directly proportional*, it means that whenever one increases, the other

also increases. If they are *inversely proportional*, one increases when the other one decreases. In mathematics if you want to say that A is proportional you write it as follows:

$$A \propto B$$

Whenever two things are proportional, they can be made equal by introducing the proper constant of proportionality. In the case of A and B just described, A can be made equal to B in the following manner:

$$A = kB$$

where k is the constant of proportionality.

A good example of this mathematical rule is used when you relate the amount of money you earn each week to the amount of time that you work. Let M equal the money and T equal the time, you would say that M is proportional to T:

$$M \propto T$$

According to the mathematical rule just described, this can be written as an equation with an equal sign when a constant of proportionality (k) is introduced. This is shown as:

$$M = kT$$

If you have ever worked, you certainly recognize that k must be the number of dollars per hour or

dollars for some period of time. The amount of money you make is equal to the dollars per hour times the number of hours that you work. Even if you had not guessed it, you could find the relationship of k simply by solving for k in the equation. This gives the following results:

$$k = M/T$$

In other words, the constant of proportionality involves the amount of money divided by time. With the above rule in mind, it is now possible to show why π is involved in the calculation of inductive reactance and capacitive reactance.

It is important to note that this is an *informal representation of the mathematics*. A *mathematics purist will find this approach objectionable*. Normally, equations for X_L and X_C are obtained by using integral calculus. Many readers may be unfamiliar with integral calculus so another technique will be used to explain the need for π .

A look at X_L

X_L is defined as the opposition that an inductor offers to the flow of alternating current. The most simple experiments in basic electricity will show that the amount of opposition (X_L) is directly proportional to the frequency and the inductance. If you increase either the inductance or the frequency of the sinusoidal waveform, the inductive reactance will increase. Write that as a simple relationship based on proportions:

$$X_L \propto fL$$

This proportion can be changed to an equation if the value of k can be determined:

$$X_L = k f L$$

therefore

$$k = X_L / fL$$

Experimentally measuring the value of X_L at several various frequencies would reveal that k is slightly greater than 6. Given a set of ideal conditions, it might be shown to be $6.28+$. Mathematically, it can be demonstrated that k is

in fact equal to 2π . Referring back to the phasor notation discussed previously (ES&T December 1983) this makes sense, because the angular velocity of the phasor is two times the frequency ($2\pi f$). Thus k has been calculated and we can write:

$$X_L = 2\pi fL$$

This is no different than the procedure used for finding k to be equal to dollars per hour in the previous example.

A similar example occurs with the simple ohms law. Experimenting with a simple dc circuit, you quickly learn that the amount of current (I) is directly equal to the applied voltage (V).

$$V \propto I$$

or,

$$V = kI$$

Solving for k ,

$$k = V/I$$

You can define k as being the amount of resistance (R) in a 1V, 1A circuit:

$$V = IR$$

You cannot argue with this procedure if you take the time to set up a simple experiment to test the relationship between the angular frequency and the inductance in a simple inductive circuit. Pure mathematicians will find this approach objectionable.

Looking at X_C

A simple experiment with a capacitor will show that the opposition of the capacitor offers to the flow of alternating current decreases as the angular velocity increases. In other words, the capacitive reactance (X_C) is inversely proportional to the angular velocity. Likewise, increasing the capacitance decreases the opposition to alternating current flow. Therefore, capacitance, like the angular velocity, is inversely

proportional to capacitor reactance. This can be written as a simple relationship:

$$X_C \propto 1/fC$$

This proportional relationship can be written as an equation by introducing the constant of proportionality.

$$X_C = (k) 1/fC$$

By proceeding as in the case of inductance it can be determined that $k = 1/2\pi$ and that therefore

$$X_C = 1/2\pi fC$$

Again, it is normal practice to use integral calculus to derive the equation for X_C , just as it is normally used for X_L . However, we are able to proceed with the proof given here simply because the units have already been defined, and we are merely attaching a physical meaning to these units.

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An introduction to

digital lo

By Bernard Daien

Although digital logic gates have been around for years, many technicians are not as proficient with them as they should be. Some never really were very interested in logic gates, and others have forgotten about them because of a lack of use. And, of course, logic gates have evolved, leaving technicians with a need for an update.

This article presents a direct and simple overview of the basic digital logic gates. The service technician will find it an easy way to review his electronic skills in the digital area.

Actually, this is a good time in electronics technology for service technicians to study logic gates, because some of the older logic gate families, such as resistor transistor logic (RTL), and diode transistor logic (DTL), have become obsolete and no longer require coverage, thus reducing the amount of effort needed.

Just switches

Although modern logic gates come in a wide variety of types with many different names, they are all just switches. Even though you may find gates with such names as "buffers" or "inverters," they are still only switches.

Basically, these switches come in two main types, as shown in the electrical switch circuit equivalents in Figure 1A and 1B. A third, more specialized variation is shown in Figure 1C. Figure 1A is a switch with its output in a single-pole, double-throw configuration. It has two possible outputs (tied to the positive power

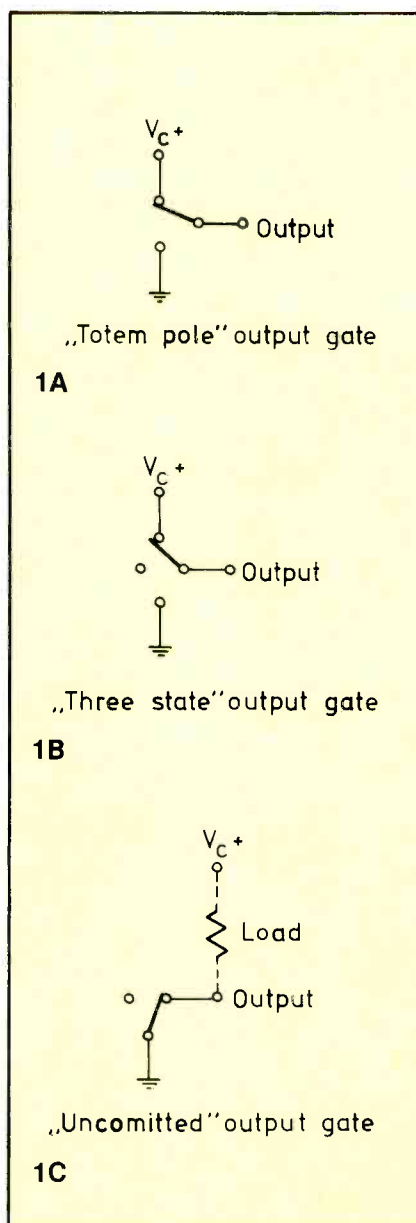


Figure 1. Equivalent circuits help to visualize how logic circuit elements operate.

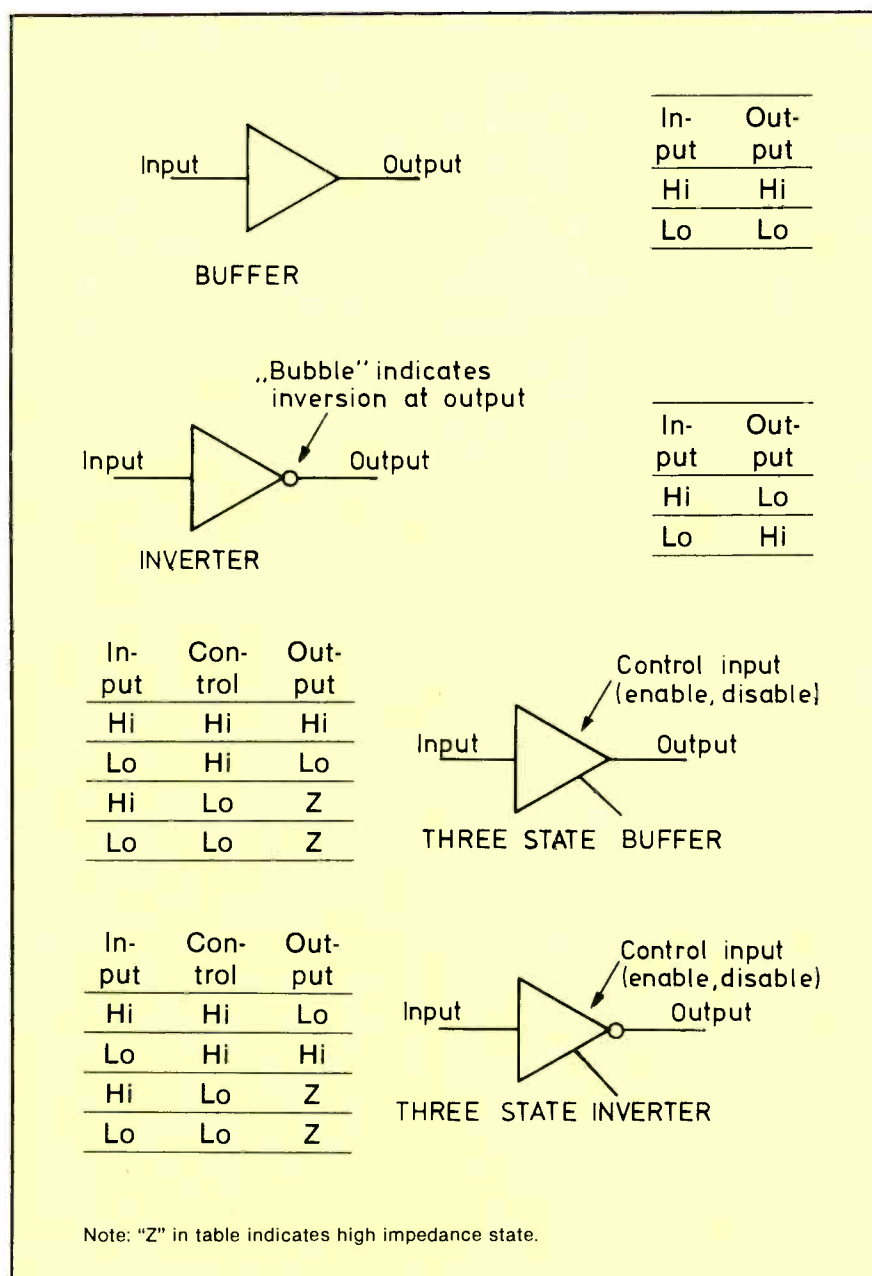
supply voltage, or ground). It is a complementary symmetry circuit, or a variation of it, known as a "Totem Pole."

Figure 1B is a switch with its output in a single-pole, triple-throw configuration. It is similar to the circuit in Figure 1A, except it has the added capability to also exhibit an open-circuit state, in which the output is connected neither to plus, nor to ground—but is simply connected to nothing. Logic gates using this circuit are called "three-state logic."

Figure 1C is a single-pole, double-throw output circuit, with one output position going to ground, and the other being essentially an open circuit. This configuration is known as the *uncommitted* configuration, because the output is not always committed to plus or to ground, but can be wired up to plus via an external load.

Most logic gates are strictly signal-handling circuits, not power-switching circuits. They come in many combinations, and are therefore in many ways similar to the older manual or solenoid-operated, rotary- and slide-type switches. Such switches came in a wide variety of configurations, with one or more wafers or decks. The more popular types were readily available, while less popular types were available on order, or could be assembled from kits. Of course they were bulky, costly, required mechanical actuation, and were slow. Modern computers, which required extremely fast, small, light, and inexpensive switches, sparked the evolution of

logic gates



integrated circuit logic switches (gates). Nevertheless, the logic "gate" is still only a solid-state "switch" with a new name.

Some symbols

Figure 2 illustrates some common logic gate symbols, along with their names. It should be noted that even though one of the circuits is labeled a "buffer," it is *not* a linear amplifier. The output of the buffer is in phase with its outputs. It is true that a switch can have appreciable gain; in this case, current gain (which also implies power gain). In digital systems, the input and output voltage levels are essentially the same, so only the current handling ability changes. Most logic gates require a relatively small input current to yield a higher output current. In that sense, the buffer is an amplifier, but so is the common magnetic relay.

The "inverter" works the same way, except that the output is out of phase with the input. Remember, digital logic has only two input states: "high" and "low" (also known respectively as "one" and "zero", or "true" and "false"). When the input state and the output state of a logic gate are opposite, the gate is said to have "inversion." (Inversion is frequently combined with other functions.)

Figure 2 also shows the standard symbol (indicating the input and output terminals) as used with differential amplifiers, operational amplifiers, inverters, buffers, and other similar devices, both analog and digital. The use of the little cir-

Figure 2. Some common logic device symbols and their input-output tables.

Most manufacturers do not even offer a single buffer or inverter in a package. The standard package is the hex package, with the resulting mass production bringing the cost down...

cle indicates an inversion. It should be noted that inversion may occur at the input or output of a logic gate, but with the multi-input logic gates to be examined later, this makes a difference. You cannot interchange the inversion symbol from input to output, on multi-input logic gates, without causing some significant changes in circuit logic operation. (In the case of a single input inverter, it does not make any difference.) This fact should be noted and remembered. Similarly, you cannot substitute one IC for another if the little inversion circles are not in the same place (at the input, or the output) on the schematic symbol, and the IC.

Next to the symbol for the buffer, and for the inverter, is a table, showing the state of the output for each input state. A corresponding table is also shown for the 3-state logic symbols.

The 3-state logic integrated logic gates have a single output terminal, and in the single input logic gates shown in Figure 2, only one signal input. They also have another input, sometimes called a "control" input, which controls whether the output is in the *active* state (a "high" or "low" condition), or in the *inactive* state. The inactive state is a high-impedance condition (an open circuit, connected to nothing). The corresponding table of inputs vs. outputs clearly shows this. The control input is sometimes labeled "disable," or "enable," since it is used to enable or disable the output, i.e., change from the active to an inactive state.

The control input may cause the output to be inactive when control is "high," or, depending on the particular type of IC used, the control input may have to be in the low state. There is no standardization of this particular function so do not assume that all 3-state logic circuits will have the input-vs.-output table as shown in Figure 2. Always examine the data sheet for the logic gate you are interested in to be sure.

More gates

Just as the simple mechanical switch can be assembled into multi-switch combinations, the solid-state logic gate can be combined. It is these more complex gates that offer the greatest advantages in size, weight and cost reductions. It is simple to put six gates into a single package, or to combine gates internally to provide a single gate with many inputs. Alternatively, you can buy a single IC package with several gates, each with several inputs.

The combinations are limited mainly by the number of pins available for use as inputs and outputs. If you stick to the lower cost packages, which have 14 pins in a standard dual-in-line package, a single gate requires one pin for output, one for ground, and one for power input, leaving 11 pins available as inputs. At the other extreme, with six buffers, you have six outputs, six inputs, one ground, and one common power input, totaling 14 pins. Alternatively, if you so desired, you could buy a package with two logic gates. You would then have two outputs, one ground pin and one power input pin, for a total of four. That would leave 10 pins available for inputs, or five pins per logic gate. Thus, you could have two 5-input logic gates in the 14-pin package. Actually, logic gates often come in duals (two per package), quads (four per package) and hexes (six per package), depending on the number of inputs. (It should be noted that many manufacturers also put out a low-cost, 16-pin package.)

The cost is not proportional to the number of gates; six gates in one package cost little more than one gate in a package. As a matter of fact, this is so self-evident that most manufacturers do not even offer a single buffer or inverter in a package. The standard package is the hex package, with the resulting mass production bringing the cost down still further. Simply use the number of inverters or buffers you need, and

ignore the rest. It should be noted, however, that it is bad practice to leave a logic gate with an open, or "floating" input. Unused inputs are always tied up to plus or down to ground, as the circuit permits. If connecting an unused input to the plus side of the power supply, it is considered desirable to put a 1000Ω resistor in series with the connection. (Sometimes two unused inputs are tied up to plus through a common resistor.) If you see such resistors in a logic circuit, you now know why they are there.

The buffer is widely used. One application is to increase "fanout." Fanout is the number of logic gates that can be driven by a single logic gate. If one logic gate can drive the inputs of 20 other logic gates, the fanout is said to be 20. Stated another way, the logic gate output can handle a total load of 20 other logic gates, and drive them all simultaneously. If you wanted to drive more than 20 other logic gates, you could use 19 logic gates and one buffer. The output of the buffer, in turn, could drive another 20 logic gates, for a total of 39 logic gates. Thus, buffers offer the capability of increasing fanout tremendously.

Often a 3-state buffer is used, in which case the control input on the 3-state buffer gives extra flexibility in isolating circuits. This is particularly useful in computers that use a bi-directional bus (a common practice). Of course, the inverter fills an obvious need, which does not require elaboration.

There are many other needs that cannot be filled with inverters or buffers. Figure 3A shows an AND gate symbol, its switch equivalent circuit, and the input-vs.-output table. It is called an AND gate because it must have all inputs high to get a high output (i.e., input A AND input B must be high). With a four input AND gate it would need to have input A, AND input B, AND input C, AND input D, all high to get a high-output state. AND gates are available with a built-in inverter on the output and are then called

NAND gates. Figure 3B shows the NAND gate symbol and its input/output table.

Figure 4A shows an OR gate symbol, its switch equivalent, and the input/output table. It is called an OR gate because input A, OR input B must be high in order for the output to go high. If it were a four-input OR gate, input A, OR input B, OR input C, OR input D would have to go high in order for the output to go high.

Figure 4B shows the NOR gate symbol, and its input/output table. The NOR gate is an OR gate with an inverter on the output.

As you can see, AND or OR gates are simply a number of switches connected in the series, or parallel configuration. The inverting function permits more flexibility, giving us the equivalent of normally open, or normally closed

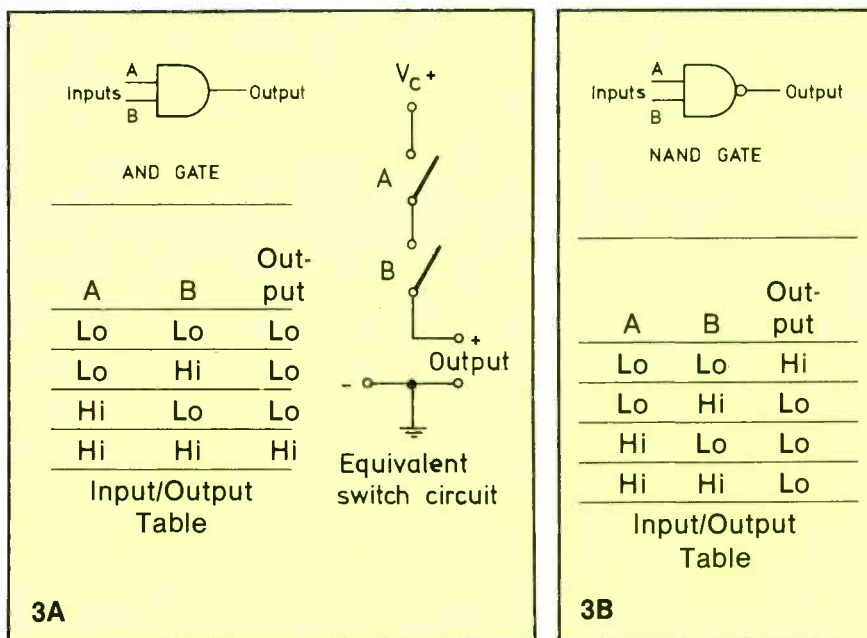


Figure 3. AND and NAND gates are multiple input, single output devices. All inputs must be "true" to generate an output. NAND gates provide inversion at the output.

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Logic gates can be used for other low power applications...uses are limited only by your imagination.

contacts. Because digital logic circuits require only two states, high or low, simple switches fulfill the requirements. Logic gates can be used for other low power applications, such as alarm systems. As a

matter of fact, their uses are limited only by your imagination.

Figure 5 is the circuit of a simple security alarm system using a single multi-input NOR gate, and a small relay (using a coil operating

with a few milliamperes of current) with a normally closed single contact output. If an open circuit occurs in any of the input lines (it becomes ungrounded) the output of the NOR gate goes low, the relay

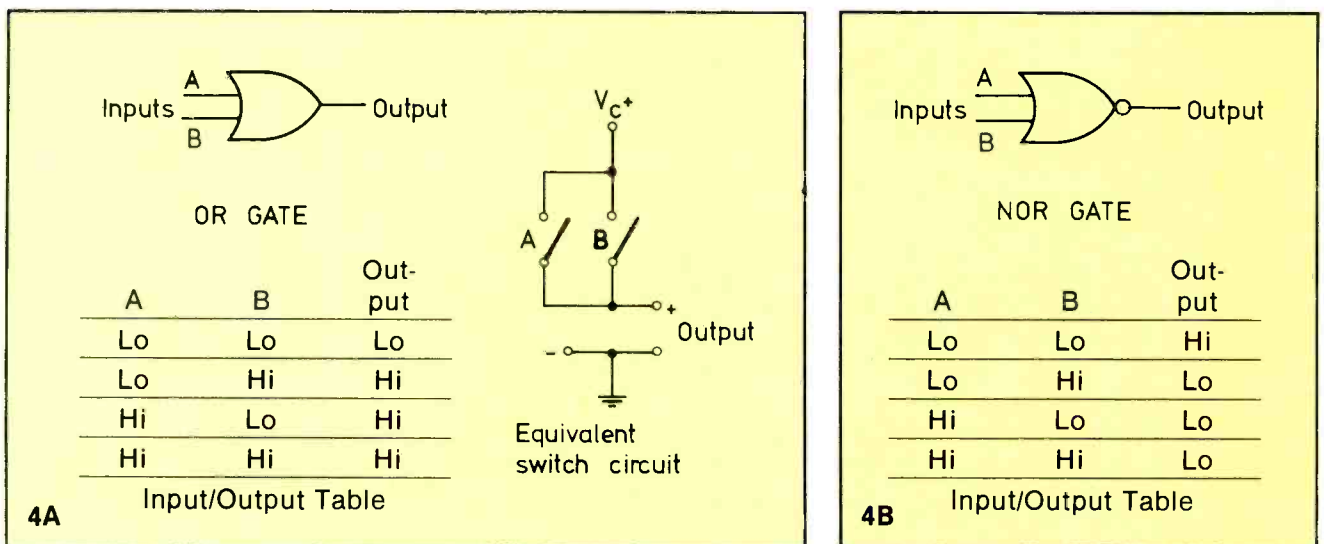


Figure 4. OR and NOR gates are also multiple-input, single-output devices. A signal at any input results in an output. A NOR gate provides inversion at the output.

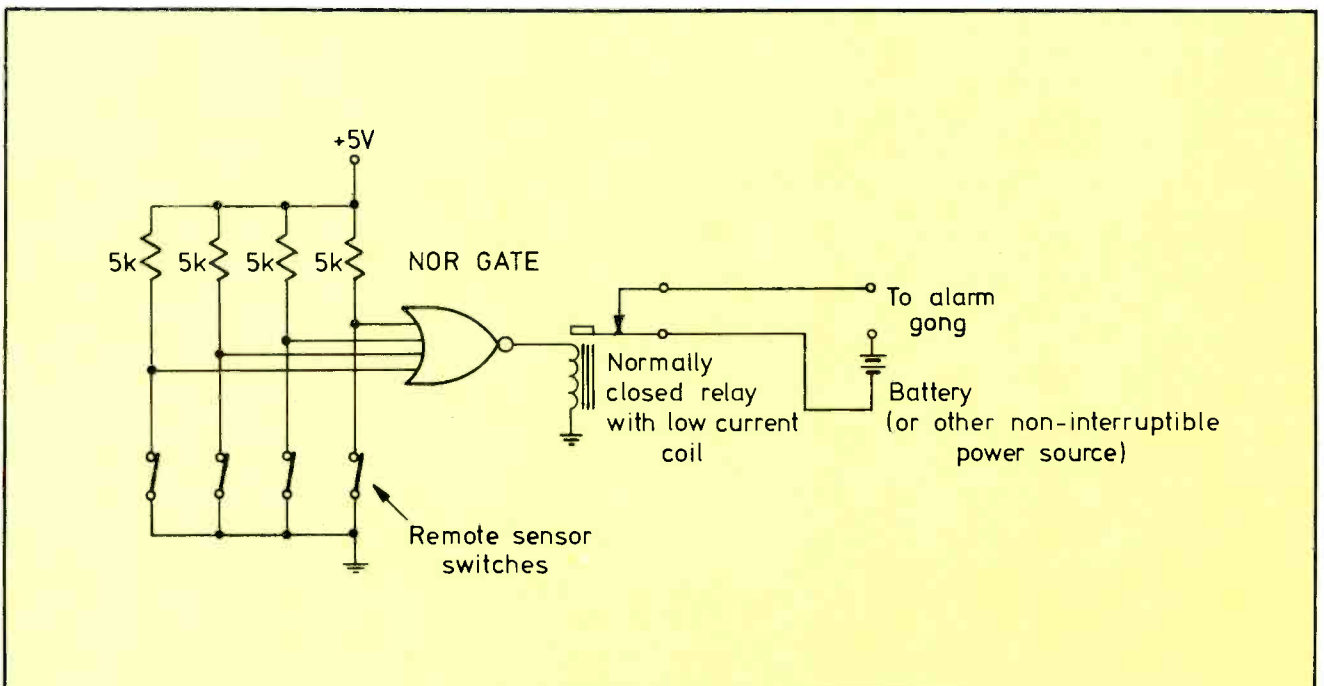


Figure 5. A NOR gate with a few other components forms the basis of an alarm system.

coil is de-energized, and the relay contact closes, setting off the alarm. The alarm should have its own source of power, such as a battery, to prevent disabling the alarm by opening a circuit breaker at the breaker box. The logic gate circuitry cannot be so disabled, because loss of power to the NOR gate will cause the relay contact to close. This circuit is shown to illustrate how a single logic gate, with a few resistors, can replace several conventional relays with increased reliability and reduced cost, size and weight, in practical applications involving signal level logic. In this case the logic consisted of several possible inputs from sensors, with the alarm sounding if one or more of the inputs is open circuited, or if the power is interrupted.

Logic gate families

There are several families of logic gates, but the vast majority of applications are handled by only two families, TTL (transistor-transistor logic), and CMOS (complementary metal oxide semiconductor). TTL circuits are made with silicon bipolar transistors. CMOS circuits are made with silicon field effect transistors (in the complementary symmetry configuration) using pairs with an N channel and a P channel FET.

There are some significant differences in these two families. TTL logic runs on a regulated +5V single power supply. CMOS runs on either a single supply of 4V to 18V, or a dual or "split" power source of ± 2 to ± 9 V, with less regulation than TTL. (CMOS has less need for voltage regulation than TTL). Normally, TTL requires that the voltage be regulated to plus or minus a quarter of a volt with low ripple, while CMOS tolerates poorer regulation and higher ripple without ill effects. Although TTL and CMOS are different, the logic symbols are the same, which can be quite confusing. The tip-off on a schematic can be found in the power source. If it has a regulated +5V source, it

is probably TTL. If it has other than a +5V supply or two supplies, (+ and -) it is CMOS. This is important, because the signal levels (input and output) can be quite different with TTL or CMOS, as you

will see shortly.

Figure 6 is a table comparing the input and output signal levels for TTL and CMOS. Note that the TTL signal levels are fixed, because TTL operates off a fixed

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These digital devices are now being incorporated into automobiles, consumer electronics, industrial electronics and more.

power source, while CMOS signal levels depend on the voltage of the power source. As a matter of fact, the voltage required to switch a CMOS circuit is approximately half of the supply voltage, with a recommended "forbidden zone." Thus, if the supply voltage is +10V, the switching point would be about +5V. But to be sure that clean switching occurs, the high state input voltage would be 7V, and the low input state would be 3V, leaving a forbidden zone of 4V (from 7V to 3V). Signal inputs from 7V up to the supply voltage of 10V are allowable for a "high" input. Low signal inputs can be from 3V down to zero. Inputs greater than the supply voltage or less than zero (ground), such as a negative input, are not permissible and may damage the CMOS IC. If the supply voltage is increased or decreased, the input required to cause switching will also change, since switching occurs at about 50 percent of the applied supply voltage when a single supply is used.

When two supplies are used, say $\pm 6V$, the input switching occurs at zero volts (the half voltage plus the forbidden zone). Thus, for balanced dual supplies, an input greater than a few volts plus is a high, while an input less than a few volts minus is a low. Note in this case that the input can go negative without damage, since the negative supply voltage is $-6V$. The maximum input signal in this case would be up to $+6V$ and down to $-6V$. The rule is, *With CMOS, the input voltage cannot exceed the most positive supply voltage, nor be less than the most negative supply voltage.* (This is important because CMOS inputs can be damaged more easily than TTL.) Another rule, when using a single supply with CMOS, is that the recommended high input should be 70 percent or more of the supply voltage, and that the recommended low input should be 30 percent or less of the supply voltage (but never greater than the power supply source).

Parameter	Logic Family	
	TTL	"B" CMOS
"High" Input, (minimum)	2.0V	70% of supply voltage
"Low" Input (maximum)	0.8V	30% of supply voltage

Figure 6. Input signals for TTL are fixed, while signals for CMOS vary, depending on power source voltage.

Other families of logic are in use, such as ECL (Emitter Coupled Logic), etc., but they are not used as widely as TTL or CMOS.

Now that you know about the input signals, you should be interested in some of the other facts about TTL and CMOS, so here are some of the more important ones. An ordinary TTL gate operates up to about a 20MHz rate, while CMOS is slower, running at 10MHz. TTL gates have about 10mW of power dissipation, while CMOS has only 0.01mW of dissipation, when operating at a low frequency. (The dissipation increases rapidly at high frequency due to increased current drain.) Nevertheless, reduced power drain is probably one of the chief advantages of CMOS. TTL has a typical fanout of 10 logic gates, while CMOS has a fanout of 50. This is because CMOS consists of FETs, which have a high input impedance (negligible input current) and therefore impose a light load on the driver.

Looking at output characteristics, TTL typically puts out 3.25V in the high state, and 0.3V in the low state. In the high state, the output current (source current) is about 8mA per gate. In the low state, the gate will accept (sink) 10mA from the load. CMOS, with the rather low supply voltage of 5V (so that a comparison to TTL can be made), has the following output characteristics: High output voltage is 4.9V, low output voltage is 0.1V. High-state output current (source) is about 200 μA , while low state current (sink) is about 500 μA . As you can see, CMOS is low-current logic, which explains the low-power dissipation. Because we are supposed to use logic gates for signal handling, the low power handling ability of CMOS is usually no problem, and when you consider the large number of gates in digital systems, the reduction in power dissipation affords a great advantage in terms of reducing the size, weight and cost of the power supply required.

by the system.

To sum up, TTL is faster than CMOS and handles more current. It also uses more power. CMOS is slower than TTL, uses less power, and has a larger output voltage swing at the same supply voltage. It also has a greater fanout.

A discussion on TTL and CMOS characteristics should include the information that while CMOS is generally available in two types: "A", (which is largely obsolete) and the newer "B" version, (both available in several operating temperature ranges), TTL is available in several types. TTL comes in *low power* and *high speed* versions. (The low power version is slower, while the high speed version uses more current.) In addition, TTL comes in a variety of temperature rated ranges: commercial, industrial and military. TTL has a wider variety of types to choose from because it is an older technology than CMOS, but in either case be careful about the type of logic gate you use. Usually the markings, along with the manufacturer's data sheet, will give you the needed information.

In any event, some data sheets or a data book put out by one of the logic gate manufacturers will aid in learning about the various technical terms applicable to logic gates. A discussion of data sheets and definitions brings up the subject of truth tables. The data sheet for a digital logic IC, along with the truth table, enables a technician to get all the working information needed in order to understand and use the device.

Several truth tables were presented earlier in this article, labeled "Input-vs.-Output Table." The truth table is simply a table that shows the output or outputs of the device, resulting from each combination of the inputs. As you now know, this is fairly straightforward, requiring only the amount of care that would be required in using any kind of table with several variables. (Some truth tables use "True" or "1" instead of "High," and "False" or "0"

instead of "Low."

Of course the truth table really becomes essential when you have a device with a great many inputs and more than one output. In such cases it is impossible to keep track of what happens to each output when a change occurs in the combination of inputs. You simply cannot do it in your head unless you're a genius. And you certainly can't remember such a table for any length of time. So the truth table becomes an essential tool when dealing with digital logic gates, with their multi-inputs, internal inverters, etc. With the aid of the data sheet and the truth table you can figure things out easily.

Because analog devices have different characteristics than digital switching devices, the specifications are also different. For example, in an analog amplifier we are interested in such things as distortion, gain, power output, etc. These things are of no interest to us in digital devices that all have a voltage gain close to unity, and put out a square wave as the ideal waveform, etc. The table shown in Figure 7 conveniently lists some of the most important specifications and their symbology. They are the part of the specifications you will see on digital data sheets and are almost self-explanatory after a little examination.

This article should be considered only as an introductory step toward your continued study of logic gates. These digital devices are now being incorporated into automobiles, consumer electronics, industrial electronics and more. It is no longer possible to avoid them, so why try? They are merely solid state switches, and by themselves, are quite simple. It is more difficult to design with them, but technicians seldom have to do original designs. Repairing circuitry that includes digital gates is easier than repairing a color TV. There is no 30kV high voltage problem, and no weak signal microvolt problem. You know exactly what the input and output voltage should be. That's a big

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Repairing circuitry that includes digital gates is easier than repairing a color TV.

Letter symbols

Characteristics

I_{IH}

Input current with a high level input

I_{OH}

Output current with a high level output

I_{IL}

Input current with a low level input

I_{OL}

Output current with a low level output

I_{OZ}

Output current of a 3 state device in the disabled state

V_{IH}

High level input voltage

V_{OH}

High level output voltage

V_{IL}

Low level input voltage

V_{OL}

Low level output voltage

I_{OS}

Short circuit output current

I_{CC}

Supply current, TTL

I_{DD}

Supply current, CMOS

Figure 7. A familiarity with some of the more important IC characteristics and symbols makes learning about them easier.

help. The waveforms are essentially square wave pulses, and you know what they should look like. Timing problems can get a bit sticky, but with modern scopes and their sophisticated triggering capabilities, that problem is greatly alleviated.

Obtain a manufacturers data book for TTL and another for

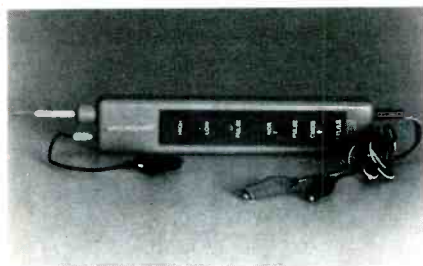
CMOS. (They are published by National Semiconductor, Motorola, Texas Instruments, Fairchild, RCA and others.) In a short time, you will become quite conversant with digital logic gates. They are easy to work with, and you will soon find yourself using them for a variety of work and hobby projects.

ES&T

Products

Digital logic probe

The digital logic probe from *Radio Shack* provides a fast way to peek inside TTL, LS and CMOS digital circuits. Color-coded LEDs indicate high, low or pulsed logic states up to 10MHz. Simultaneous tone output "frees" the eyes to speed up testing.



The digital logic probe can test all logic families and is overload and polarity protected. The minimum detectable pulse width is given as 50ns. A tested circuit provides power for 36-inch leads with clips. The probe comes with instructions and user's tips.

Circle (70) on Reply Card

Uninterruptible power supply

BITS Power Systems has announced two uninterruptible power supplies for critical computer applications requiring a totally dedicated, absolutely continuous and completely isolated source of electrical power. Unlike other systems that transfer the operating computer from the utility line to battery-derived power after a power outage, these units are always on-line. Utility line power is used only to maintain a full charge on the internal gel-type batteries.

Both units have visual, audible and remote alarm functions. The Bits Batstat battery monitor is standard. The standard full load backup time from internal batteries is 10 minutes. External 12V batteries may be plugged into the connector provided for extended backup time and automatic charging. Four standard grounded out-

put receptacles are provided. Model UPS-200 (200W) measures 5" x 13" x 16" and weighs 35 pounds. Model UPS-400 (400W) measures 6" x 16" x 18" and weighs 55 pounds.

Circle (71) on Reply Card

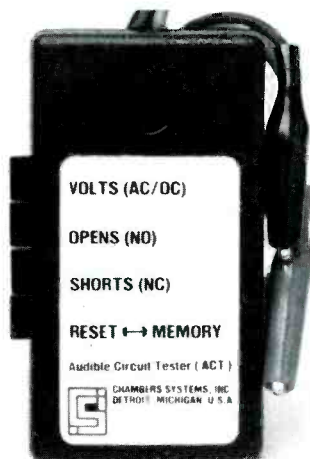
Oscilloscope

A 100MHz, dual channel, dual-time base oscilloscope has been introduced by *B&K-Precision/Dynascan*. The model 1580 100MHz oscilloscope has 5mV/div vertical sensitivity over the 100MHz bandwidth with 1mV/div vertical sensitivity to 50MHz in the X5 mode; V mode to display two signals unrelated in frequency; Z-axis input; channel 1 output; calibrated delayed sweep; X-Y operation; channel 2 invert; 20MHz bandwidth limiter; and variable trigger hold-off that permits stable observation of complex pulse trains. The user can select from 23 calibrated sweep time ranges.

Circle (72) on Reply Card

Circuit tester

An audible circuit tester available from *Chamber Systems* will discriminate between ac and dc voltages, check the polarity of voltage sources, and locate circuit problems such as shorts, opens and hard-to-find intermittents. The audio piercing tone indicator is

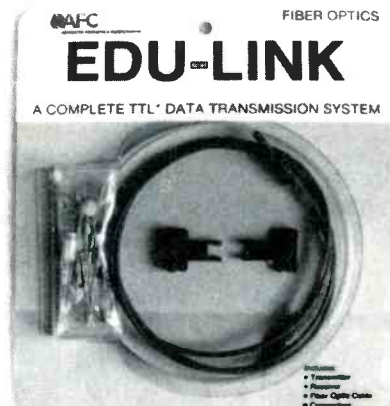


useful in noisy environments and allows the user to concentrate on the problem without looking at the tester or having it in the same location. Other features include a high-response memory, self-holding magnetic base and impact-resistant case.

Circle (73) on Reply Card

Fiber optics

The Edu-Link fiber-optic link system from *Advanced Fiberoptics* is a low-cost, TTL data transmission system, designed specifically as an educational tool. The Edu-Link package includes a transmitter, receiver, and a 1-meter length of preterminated



fiber-optic cable. This kit, being sold in unassembled format, demonstrates the principles of fiber-optic transmitter and receiver design. Complete instructions, theory of operation, and tutorial information are included.

Circle (74) on Reply Card

Wire stripper and cutter

A patented wire stripper and cutter designed for the professional and do-it-yourself installer has been introduced by *Multicore Solders*. The model 9MS is of tempered steel and has specially honed edges that cut wire cleanly, split plastic twin flex and strip insulation without nicking the wires.

The model 9MS is fitted with easy-grip plastic handles with a locking catch and a strong scissor spring for automatic opening after each operation.

Circle (75) on Reply Card

Soldering iron tip cleaner

Oxide Off from *TCS* is a specially prepared fine wire wool that cleans soldering iron tips. Deposits and oxidation are removed by wiping the tip on the wire wool. With this method, the soldering iron tip is not subjected to cooling or temperature shock, and the wire wool used is not springy so there is no danger of hot solder particles causing eye injuries or of solder bridges forming on PCBs.

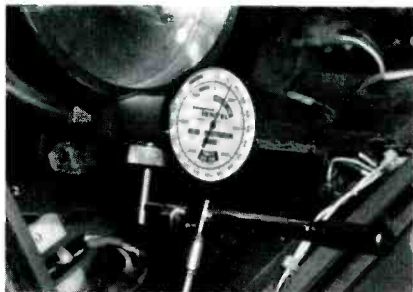
Oxide Off may be used to remove oxidation or deposits from

alligator clips, banana plugs, probes, tweezers or electrical contacts. When the wire wool is used up, simply cut it off with scissors, and pull up the next section of wool inside the container. Oxide Off is available in various models for stationary, semi-stationary, and mobile, bench-type work and production procedures.

Circle (76) on Reply Card

VCR maintenance

The *Tentel* head protrusion and eccentricity gauge HPG-1 allows anyone to monitor the amount of head tip wear (tip projection) and head drum run out. The gauge provides readings in both microns and ten-thousandths of an inch. The special patented measuring probe makes it impossible to harm the fragile video heads when used as directed.



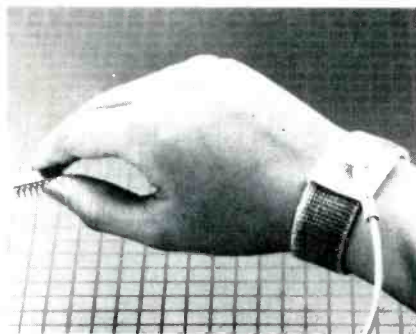
The HPG-1 has been designed for Beta, VHS and U-matic video recorders. The gauge allows operators, technicians and engineers to monitor head wear and provides a troubleshooting tool for head tip and head drum problem detection. The HPG-1 comes with a foam-lined carrying case for protection during storage or transport, and a 16-page set-up and troubleshooting guide that gives wear and protrusion data for common VCRs.

Circle (77) on Reply Card

Elastic wrist band

An elastic wrist band with a conductive path to ground for complete static protection is being introduced by *Charleswater Products*. The CP407 elastic wrist band has 3/4-inch-wide polyester fabric with hook and loop fasteners. It provides less than $10^3\Omega$ resistivity at the interior. The band comes in two color-coded sizes: brown for wrists up to 6 1/2 inches in diameter and blue for wrists up to 8 inches

in diameter. The wrist band is knitted with clean, conductive stainless steel inner threads and has a snap fastener on top that accepts the lightweight, coiled

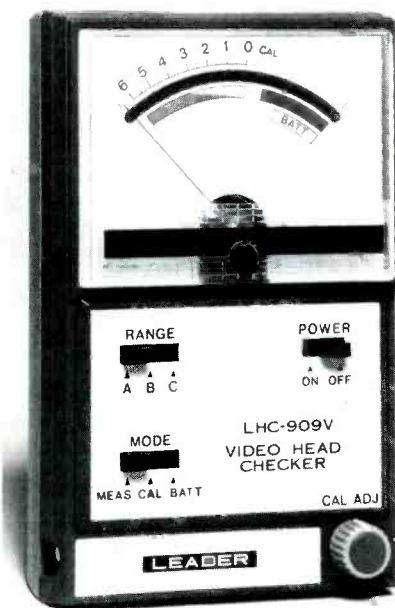


grounding strap. Molded with a built-in $1M\Omega$ resistor, straps come in 4-foot and 6-foot lengths with a combination banana plug and alligator clip.

Circle (78) on Reply Card

VTR head tester

The LHC-909B/V from *Leader Instruments* is designed for electronically checking videotape recorder head wear. Previously, head wear could only be determined by using a microscope to view abrasion. The LHC-909 measures the inductance of the video head



using a bridge-type inductance meter with a 1MHz test signal.

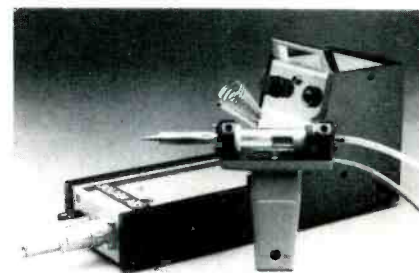
Three measurement ranges are available. The analog meter scale "7 to 0" indicates head wear. Typically, any reading below "0" indicates the heads require replacement, although the inductance range and acceptable head

wear tolerance should be specified by the VTR manufacturer. The instrument's battery operation and small size allows easy portability and requires minimum bench space. Two versions are available: the LHC-909B for Beta and U-matic VTRs and the LHC-909V for VHS types.

Circle (79) on Reply Card

Desoldering system

The desoldering system model SA-7 from *OK Industries* is a lightweight, pistol-grip-shaped desoldering iron that does not require shop air, but features a self-contained vacuum pump. Straight flow-through design prevents clogging, and the transparent solder



collector is easy to clean and replace. The unit also includes a built-in tip cleaning rod stored in the handle. The desoldering iron is designed with an IC controlled ceramic heater that allows adjustment of tip temperature for the widest variety of desoldering applications.

Circle (80) on Reply Card

Reference card

Programmers no longer have to translate the bits, codes and special conditions found in manufacturer-supplied reference guides and data books. This data has been completely restructured into a fully decoded format for fast programming, debugging and patching. A 2-sided, 2-color, full-page sheet made of lasting plastic, available from *Micro Logic Corporation*, covers conversion of instructions to and from hex, instruction descriptions, cycle time, addressing modes, flag codes, register map, memory map, pin-outs, ASCII, diagrams and cautionary notes. It is number 7 in the Micro Chart series and sells for \$5.95.

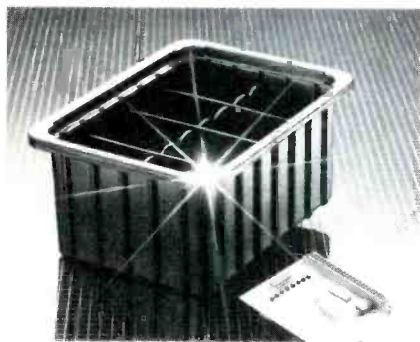
ES&T

Literature

A brochure that describes a wide range of tote boxes and parts bins for handling and storing static-sensitive devices is being offered by **Charleswater Products**. The 6-page brochure describes their line of standard and custom tote boxes and self-stacking parts bins. Resistant to most chemicals,

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conductive containers



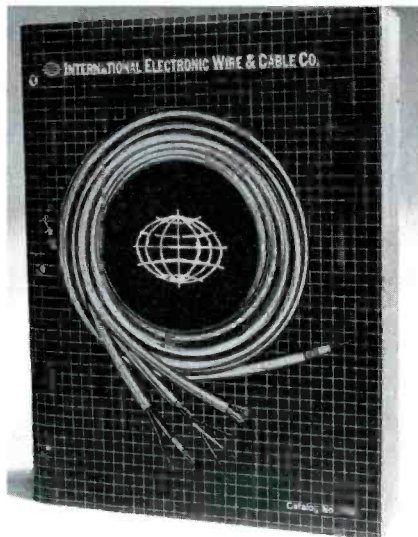
solvents and acids, these containers dissipate static charges instantly and provide a Faraday Cage to shield contents from electrostatic fields. Specifications and photographs are included for more than 14 standard products and numerous divider options.

Circle (90) on Reply Card

An 80-page catalog from **Lectronic Research Laboratories** describes new and reconditioned test equipment and components. Some of the manufacturers included are Ballantine, Boonton, General Radio, HP, L&N, Sierra and Tektronix. Also included are listings of electronic frequency converters; energy storage and vacuum capacitors; bridges; resistance, capacitance and inductance decades; dc and high-voltage power supplies, recorders, rotating power sources, vacuum relays and voltage regulators.

Circle (91) on Reply Card

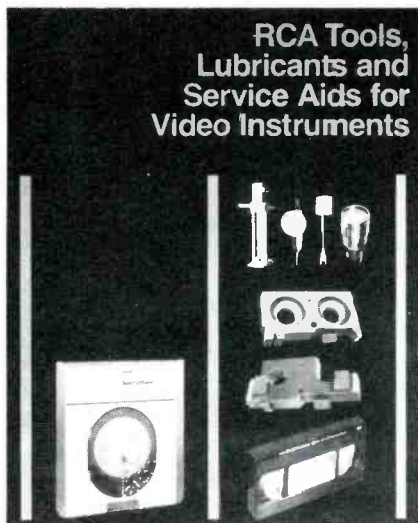
A 52-page catalog of electronic wire and cable products is available from **International Electronic Wire & Cable Company**, formerly known as Consumers Wire & Cable Company. The



catalog includes more than 1200 items for broadcast, television, stereo, citizen's band, cable, telephone, security, satellite and other technical, consumer and industrial applications.

Circle (92) on Reply Card

RCA Distributor and Special Products Division has revised its catalog of tools, lubricants and service aids for video instruments. The 24-page catalog includes tools, jigs, test tapes and discs, lubri-



cants, and other service aids designed for efficient and correct servicing of RCA video instruments. Many of these products are also useful in servicing instruments of other manufacturers.

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Toward better TV sound

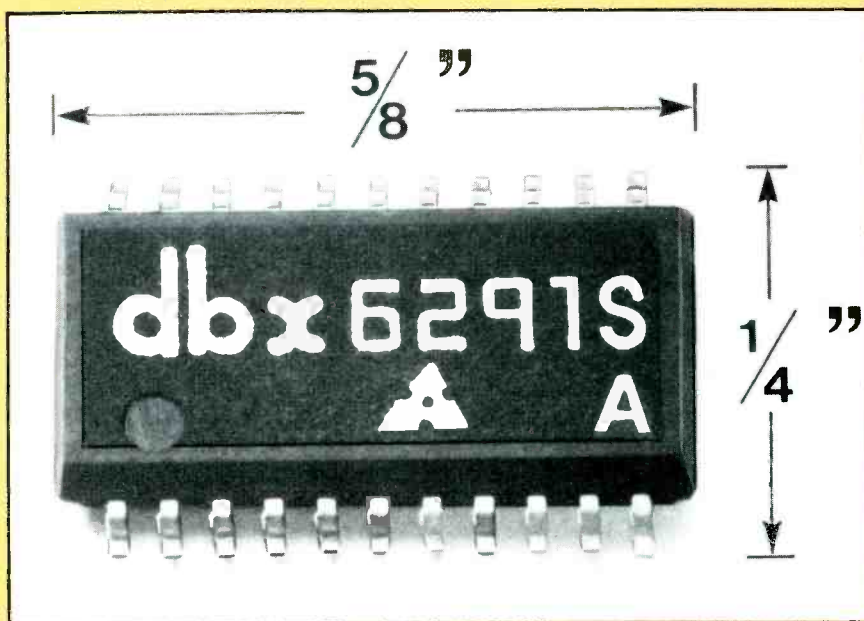
The electronics industry has taken a step closer toward high-quality stereo sound for television. This is good news for consumers if it is adopted by broadcasters, but it will eventually present a new challenge to electronics servicing technicians who will have to be prepared to deal with this new technology.

Culminating more than four years of testing and deliberation, the Electronic Industries Association's Multichannel TV Sound (MTS) subcommittee voted unanimously Dec. 22 to recommend the Zenith multichannel TV sound system with the dbx companding system for noise reduction as the standard for compatible TV stereo sound broadcasting. The EIA was to file its recommendation, together with test data, with the Federal Communications Commission by Jan. 30.

The dbx TV noise-reduction system is designed as a cost-effective technique to deliver a clean, noise-free audio signal through a noisy channel to the home. According to dbx, the system is capable of delivering consistent high-quality audio in the face of a variety of possible channel degradations, including hum, buzz and hiss.

According to the psychoacoustics of noise reduction, the ear functions like a spectrum analyzer, effectively dividing sounds into frequency bands, called "critical bands." In order to simultaneously mask a variety of possible noises occurring in different parts of the spectrum, it is necessary to keep signal levels high at all times relative to the noise level across the entire audio spectrum.

Two elements of the dbx system are keys to satisfying this con-



The companding noise-reduction circuit by dbx for the TV stereo sound system is contained within this $\frac{5}{8}$ "x $\frac{1}{4}$ " package.

straint: wideband compansion and spectral compansion. The 2:1:2 wideband compansion keeps overall signal levels high during transmission. The spectral compansion optimizes the spectrum that is transmitted. It is similar to a sophisticated, signal-controlled treble control hinged around 1000Hz. The range of control is a wide ± 25 dB at high frequencies, with accompanying peak slopes of 12dB per octave. Combined with the wideband compander and other elements, the resulting system has a wide range of independent gain/spectral tilt combinations, and can therefore deal with the broadest range of signal/noise spectral combinations, without overload or overmodulation.

System Description

The dbx system consists of an encoder at the TV station trans-

mitter end and a matching decoder in the consumer's TV set. The two are complementary in their operation.

As illustrated in Figure 1, the encoder performs five signal-conditioning functions:

1. Lowpass filtering to remove out-of-band signals;
2. Wideband compression to keep overall signal levels well above transmission-channel noise while avoiding over-modulation;
3. Spectral compression to maintain proper spectral balance in the transmission channel;
4. Static pre-emphasis to match overall spectral requirements imposed by the channel characteristics;
5. Pre-emphasized clipping to eliminate peak overshoots.

In the encoder, two independent rms-detector circuits monitor broadband signal level and high-frequency signal level, and adjust the wideband compression and spectral compression sections accordingly. Thus, the system can adjust the amplitude of the input signal for transmission of the most effective level, at the same time as it adjusts the input signal's spectral character for the greatest amount of masking. For a broad range of input signals, the encoder output remains within a narrow amplitude and spectral window, riding well above the noise at all frequencies, thereby masking it, while making full use of the channel's limited dynamic range.

At low and middle frequencies, where channel dynamic range is widest and where most of the primary signal energy is found, the

effective compression ratio is kept to 2:1, with relatively slow time constants. At high frequencies, where masking of noise components is especially critical, the effective compression ratio rises to 3:1, with faster time constants. Passive R/C networks limit the maximum amount of dynamic pre-emphasis to optimize the amount of audio processing at high frequencies. The use of rms-level detection allows for program-dependent time constants that act quickly when necessary, manipulating the audio inaudibly over the full compress/expand cycle.

The clipper operates on the compressed and pre-emphasized signal, eliminating any large, short-duration transients. The clipper prevents overmodulation of the channel on a transient basis while the wideband compressor

prevents overmodulation for the longer term.

The signal controlling the wideband compressor is gently band-limited to 100-3000Hz to reflect the ear's sensitivity. The dynamic-pre-emphasis control signal is bandlimited to the 4-9kHz range, so the spectral compander will concentrate on the part of the program material that most needs help. This control signal's low-end rolloff is sharp in order to selectively respond to high frequencies even in the face of the much stronger lower- and middle-frequency energy. Both detector circuits are rolled off toward the frequency extremes so that they ignore non-audio, out-of-band energies.

The decoder fully complements the encoder (see Figure 2). It restores proper spectral and amplitude dynamics to the signal, rendering channel noise inaudible in the process.

The decoder performs the following functions:

1. Wideband amplitude expansion: mirror image of the wideband compressor;
2. Spectral expansion: mirror image of the spectral compressor;
3. Static de-emphasis: mirror image of the static pre-emphasis.

The decoder's effective expansion ratios are 1:2 at low and middle frequencies, increasing to 1:3 at high frequencies. These match the compression ratios used in the encoder. Because the expanders track the compressors perfectly, the dynamic amplitude/frequency manipulation performed by the encoder is completely decoded within the consumer's TV set.

The rms-level detector circuits in the decoder are equivalent to those in the encoder and monitor virtually the same compressed signal. Because the encoder places the signal to be transmitted well above noise and artifacts in the transmission channel, the decoder detectors are never fooled into tracking anything but the compressed signal. Because the detectors in the encoder and decoder observe the same signal, truly complementary processing is ensured.

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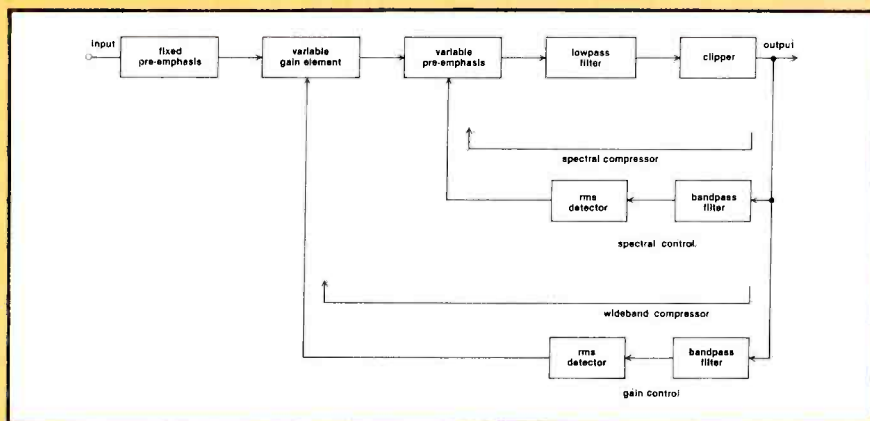


Figure 1. The encoder portion of the dbx noise-reduction system conditions the audio signal so it can be transmitted as a clean, noise-free signal through a noisy channel.

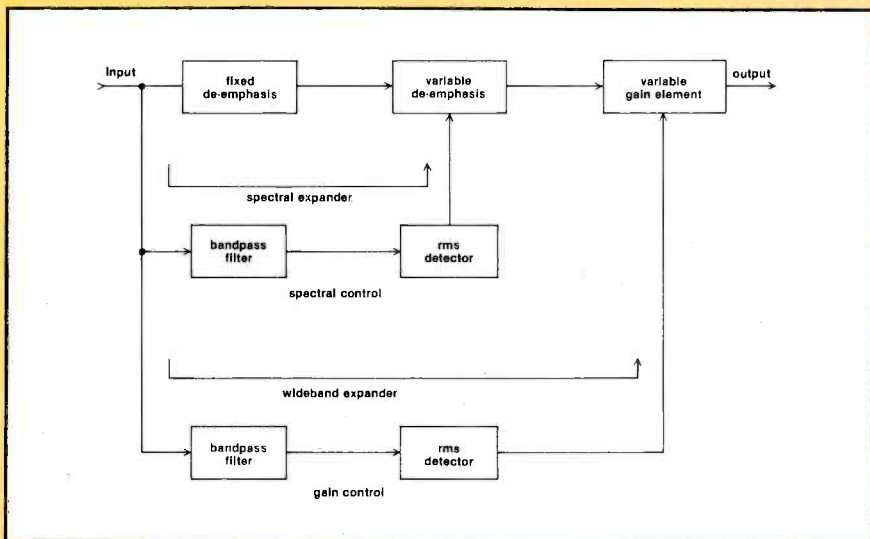


Figure 2. The decoder at the TV set restores proper spectral and amplitude dynamics to the signal without noise.

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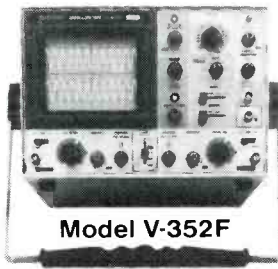
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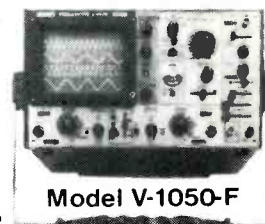


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Editor's note: Periodically *Electronic Servicing & Technology* features books dealing with subjects of interest to our readers. Please direct inquiries and orders to the publisher at the address given for each book, rather than to us.

Digital Audio Technology, by H. Nakajima, T. Doi, J. Fukuda, and A. Iga of Sony Corporation; **Tab Books; 320 pages; \$18.95 hardbound, \$11.95 paperback.**

This book discusses the latest developments in the science of audio recording and playback—the combination of two modern technologies: digital electronics as used in computers and satellite communications, and audio. Stereo recording and playback techniques are reviewed, and the basic principles of pulse code modulation are outlined. PCM equipment is described, and PCM is compared with other modulation techniques, including AM and FM.

The authors take an in-depth look at tape and disk recording systems, including the relationship between bandwidth and the wavelength actually recorded on the tape. They compare rotary and stationary head systems and suggest ways to solve recording density problems. The construction of PCM recorders and digital disks is also described. The authors discuss code error detection and correction, as well as PCM design and system standardization.

Published by Tab Books, Blue Ridge Summit, PA 17214.

Semiconductor Device Technology, by Malcolm E. Goodge; **Howard W. Sams & Company; 481 pages; \$34.95 hardbound.**

This engineering text covers modern semiconductor device fabrication, including manufacturing techniques, operation and performance. It helps designers

understand the behavior of these devices by explaining their properties, limitations and performance in measurable terms.

Devices covered include general-purpose and voltage-reference diodes, bipolar, and field-effect transistors. Specialized devices—including switching devices, devices used in signal generation, and optical devices—are grouped according to application. The author describes fundamental physical processes, using an atomic model to explain how materials are structured and how they interact. The major focus is on the construction and operation of each device and its typical terminal characteristics. The book is illustrated with figures, schematics and tables, and appendices cover network modeling, terminology, preferred component values, device numbering and coding, and much more.

Published by Howard W. Sams & Company, 4300 W. 62nd St., Indianapolis, IN 46268.

The Handbook of Electronic Safety Procedures, by Edward A. Lacy; **Tab Books; 288 pages; \$17.95 hardbound, \$10.95 paperback.**

This handbook covers the vital safety precautions and procedures needed by everyone who repairs, designs, installs or uses electronic equipment. It tells what hazards to avoid and what to do if an accident occurs.

Written in simple, non-technical language, this manual contains important information on topics ranging from chemicals that cause adverse reactions and how to safely use them, to how-tos for avoiding electric shock or radiation exposure, to ways to deal with everyday electronic situations with the least amount of risk. Topics covered include electric shock, static electricity and lightning. Radiation hazards are examined with pointers for working on color TVs, microwave ovens, radar and transmitters. Laser effects and safety precautions for working with these devices and facts on toxic or explosive chemicals found in aerosols, batteries, printed circuits and waveguides are included.

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Answers to quiz

(from page 8)

1. C The letters stand for Voltage Controlled Oscillator.
2. A You will find a Beat Frequency Oscillator in communications receivers.
3. B
4. B The Vertical Interval Reference Signal is used by some receivers to adjust color circuits.
5. D This signal can be used to get the music without the commercials.
6. D
7. C The Central Processing Unit does the number crunching in a computer.
8. B The letters stand for Computer Aided Design and Computer Aided Manufacturing.
9. A In a power triangle you have *true power*, *apparent power* and *reactive voltamperes* (or, VARS).
10. B The letters mean Direct Memory Access.

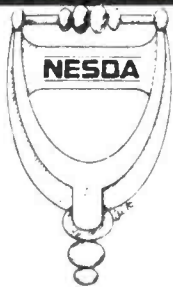
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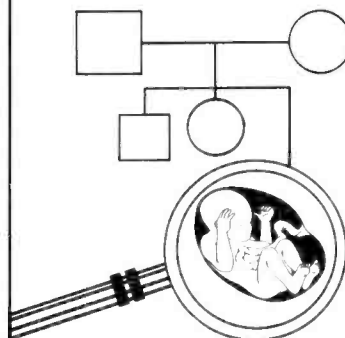
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For sale: B&K 520B transistor tester; B&K 470 picture tube rejuvenator; B&K 415 sweep marker generator, best offer. Send SASE for list of other equipment. *Hills TV, Box 160, Glen Ewen, Saskatchewan, Canada S0C 1C0.*

Needed: Webcor model EP2810-1B service manual, schematic and transformer PT 68P052; yoke for Sears model 528.40721407, PT M9103B. *Stuart Konarski, c/o Archer Brighton T.V., 4380 S. Archer, Chicago, IL 60632.*

Needed: Simpson V.O.M. model 260 in good condition. Also need sockets for B&K picture tube tester model 467, nos. 2, 3, 4, 5, 6, 7, 10 and 11. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235.*

For sale: RCA picture tube tester CR111-WT333A. Extra adapters and all manuals included. Excellent condition, hardly used, \$175. *R. Bailey, Box 274, R.D. 4 McKishen Road, Elmer, NJ 08318; 609-358-8853.*

For sale: B&K CRT restorer/tester model 467, \$300; B&K transistor tester model 520B, \$140; excellent condition with books and attachments. *J.L. Bachelor, 2538 Tam O'Shanter, Cleveland, TN 37311; 615-472-8726.*

For sale: Sencore model VA 48 video analyzer, \$800; Sencore SC60 scope, \$1200; Simpson model 465 autoranging digital multimeter, \$200. All equipment is like new with accessories and manuals. Send for complete listing. *Clarence G. McKee, 9516 Zion Road, Rives Jct., MI 49277; 517-569-3139.*

For sale: Nearly complete set of Ryder radio manuals. Price negotiable. *J.M. Knoble, Knoble's TV Service, 2303 Pleasant Valley Road, Fairmont, WV 26554; 304-366-1938.*

For sale: Tube caddy with 183 new tubes, \$120; Heathkit AA-1 audio analyzer, \$20. *Frank Beckerle, 313 Woodcrest Drive, Buffalo, NY 14220; 716-823-1571.*

Needed: Supremes TV-1, 2, 4 and R-7 volumes. *C.T. Huth, 130 Hunter St., Tiffin, OH 44883.*

Needed: Schematic and instruction manual for Hickok universal TV-FM alignment signal generator, model 610A. Will buy or copy and return. *John Brouzakis, R.D. 3, Box 602B, Charleroi, PA 15022; 412-483-3072.*

For sale: Sencore CB-42 citizen's band analyzer. Excellent condition with RFS-205, all cables and manuals in original box, \$575. *Shewmaker Electronics, P.O. Box 23342, Lexington, KY 40523; 606-273-1772.*

For sale: *Electronic Servicing* from December 1955 to the present, \$100 plus shipping. *Russell Brubaker, 2001 Temple Ave., Lancaster, PA 17603; 717-394-3185.*

For sale: Approximately 650 new receiving tubes, \$200 or best offer. Send SASE for list. *Bill Benish, East 10812 19th Ave., Spokane, WA 99206; 509-928-1050.*

For sale: Radio and TV schematics from the 1940s and 1950s. *Oak Hill Electronics, 1208 E. 24th St., Manistee, MI 49660.*

Wanted: Good used flybacks, Sony 1-439-185-15 (model KV1204-A) and Zenith b&w 95-3332-01 (model L162W). *M.B. Danish, P.O. Box 217, Aberdeen Proving Ground, MD 21005.*

Needed: Schematic and alignment instructions for Hallicrafters model SX110 receiver. Will pay for manual or its reproduction cost. *O.M. Brown, 6369 Lansdowne, St. Louis, MO 63109; 314-351-1707.*

Needed: RCA flyback #143732 or 1439242-501. Have new and used yokes, tubes, triplers, transistors, modules, etc. or state price. *Sam Applebaum, 148 Belvidere St., Springfield, MA 01108.*

For sale: B&K model 1472C 15MHz scope, dual trace with 2 10X probes and 1 reprobe; B&K 520B transistor checker; B&K 667 tube tester; B&K digital IC color generator; B&K model 801 capacitance checker. All equipment in excellent condition with all necessary manuals and leads. Money back guarantee; make reasonable offer. *Robert Knapp, P.O. Box 145, Lyndhurst, VA 22952.*

Wanted: ESR meter in good condition, reasonable. *Paul Capito, 637 W. 21st St., Erie, PA 16502.*

Needed: By the Alton, NH, fire department, service literature for Instalert EC-22, model EC-122 two-tone receiver manufactured by Electronics International, Philadelphia, PA. *Paul A. Todd, Box 54, Alton Bay, NH 03810; 603-875-3772.*

For sale: Parting out b&w chassis RCA KCS 169XA, 171, 175, 183; GE 15XB; Panasonic T126A, TR659; Satchell Carlson UX600. Color sets: Admiral K10, K19; Arvin 15-inch 60K34-12, GE 19CD; Motorola TS915, TS919; Sears 528.407203, 528.419405, 562.10423; Sony KV-1212. Also have 10 Heathkit boards, 85 series. *D.J. Aigula, 50 Fir Circle, Babbitt, MN 55706.*

For sale: Signal generator (Navy) AN/USM-27B, tube type. 6"x12"x8", 10 pounds. In good shape with tech. manual and schematics, asking \$70, shipping paid. *D. Test, P.O. Box 9064E, Newark, NJ 07104.*

For sale: B&K 1076 with cables and manuals, perfect working condition, \$110; Heath 5-inch oscilloscope, good condition with cables, \$110. *G. Barzily, 84-39 120th St., Jamaica, NY 11415; 212-847-7965.*

For sale: Heath H.D. 1250 grid dip meter, assembled and tested, never used. Will sacrifice for \$65 including UPS. Present listed price \$84.95 for kit only. *Thurston Electronic Service, 5738 U.S. 33 N., Fort Wayne, IN 46818.*

Needed: Used Hickok color bar generator, operable or inoperable OK; used Sencore FS fieldstrength meter, preferably operable. *Jim Shoemaker, 600 First St., Leechburg, PA 15656; 412-842-8321.*

Needed: Test jig Telematic-10J106 or Sylvania-CK3000 or RCA-10J106. Call or write with price and details. *Jim's TV, P.O. Box 23, Greenville, NY 12083; 518-966-4177.*

Needed: An RCA Radiola radio receiver model no. 1064, chassis no. B274. Need not be in working order, but all parts must be intact. *John G. Lefko, P.O. Box 782, Fairfield, CA 94533; 707-425-4578.*

Needed: New or good used color picture tube #370BYBT C01 or 370BYP22 with deflection yoke complete for Magnavox color TV model DG 40500 K02. *Max Emerson, 1923 N. Texas, Weslaco, TX 78596; 512-968-3913.*

Needed: Leads, probes, manual and set of knobs for Sylvania polymeter type 301, same for type 2212 polymeter except knobs. Also need a Sencore FE-20 multimeter. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235.*

For sale: 100 electronic books on TV and solid state, also Heath test equipment course, two large volumes with parts. All for \$240. *Daniel Seidler, 5827 S. Campbell Ave., Chicago, IL 60629.*

For sale: Sencore SC 60 oscilloscope (factory calibrated 11/83); VA 48 video analyzer with all probes and accessories, and SG 165 stereo analyzer. All equipment in like-new condition. Will sacrifice each piece for half price. *Dick Lopez, 10212 New Hampshire Ave., Silver Spring, MD 20903; 301-439-5333.*

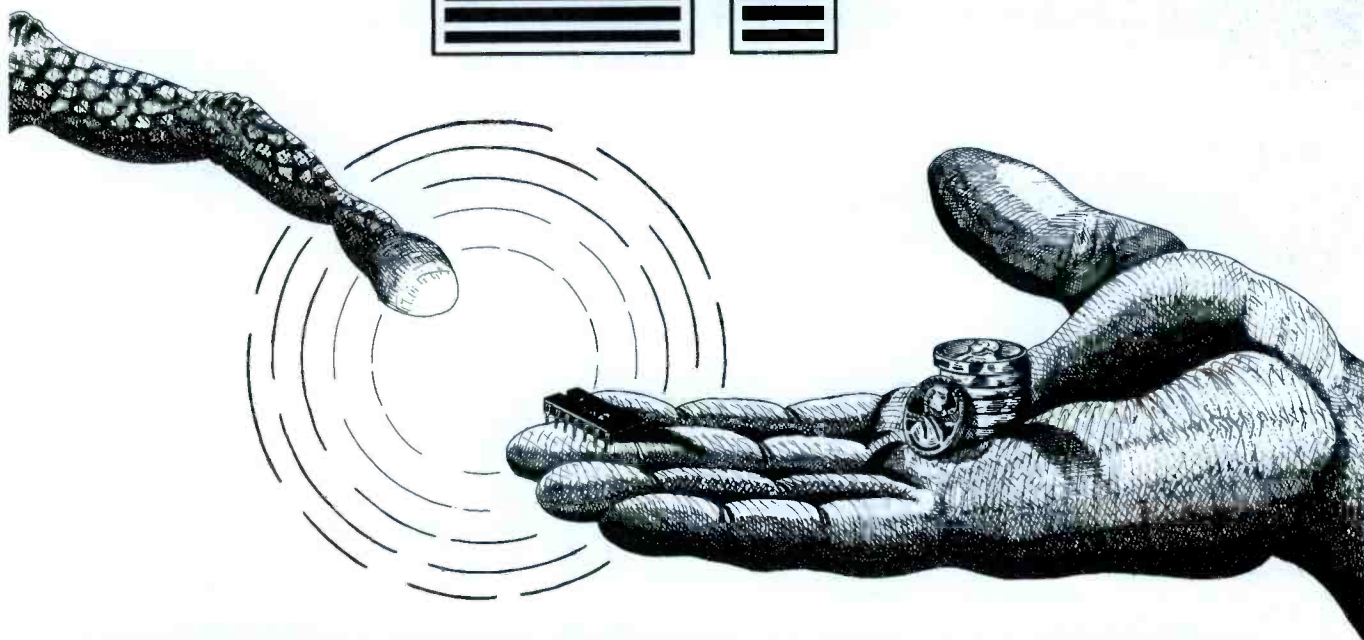
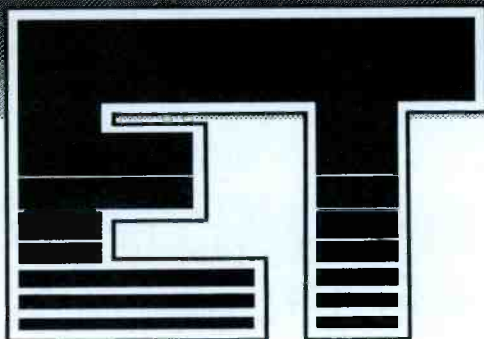
For sale: Sylvania CK3000 test jig, \$175; Sencore CR161 CRT tester, \$150; Sencore CR143 CRT tester, \$45; Conar 311 R/C tester, \$35. *George C. Pullen, 6722 Botetourt Drive, Ft. Washington, MD 20744; 301-449-7348.*

Wanted: Old Ryder manuals, radio not TV. *Jim Craft, 604 W. Michigan Ave., Jackson, MI 49201; 517-787-0077.*

Wanted: Video sound AGC board, part no. TNP 65122AZ for Panasonic CT 905. *J.E. Humphrey, 1006 E. 28th St., Los Angeles, CA 90011.*

Readers' Exchange listings are free and are limited to three items per month. "For sale" items must be used equipment sold by individuals, not companies. Send information to: Readers' Exchange, Electronic Servicing & Technology, P.O. Box 12901, Overland Park, KS 66212.

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