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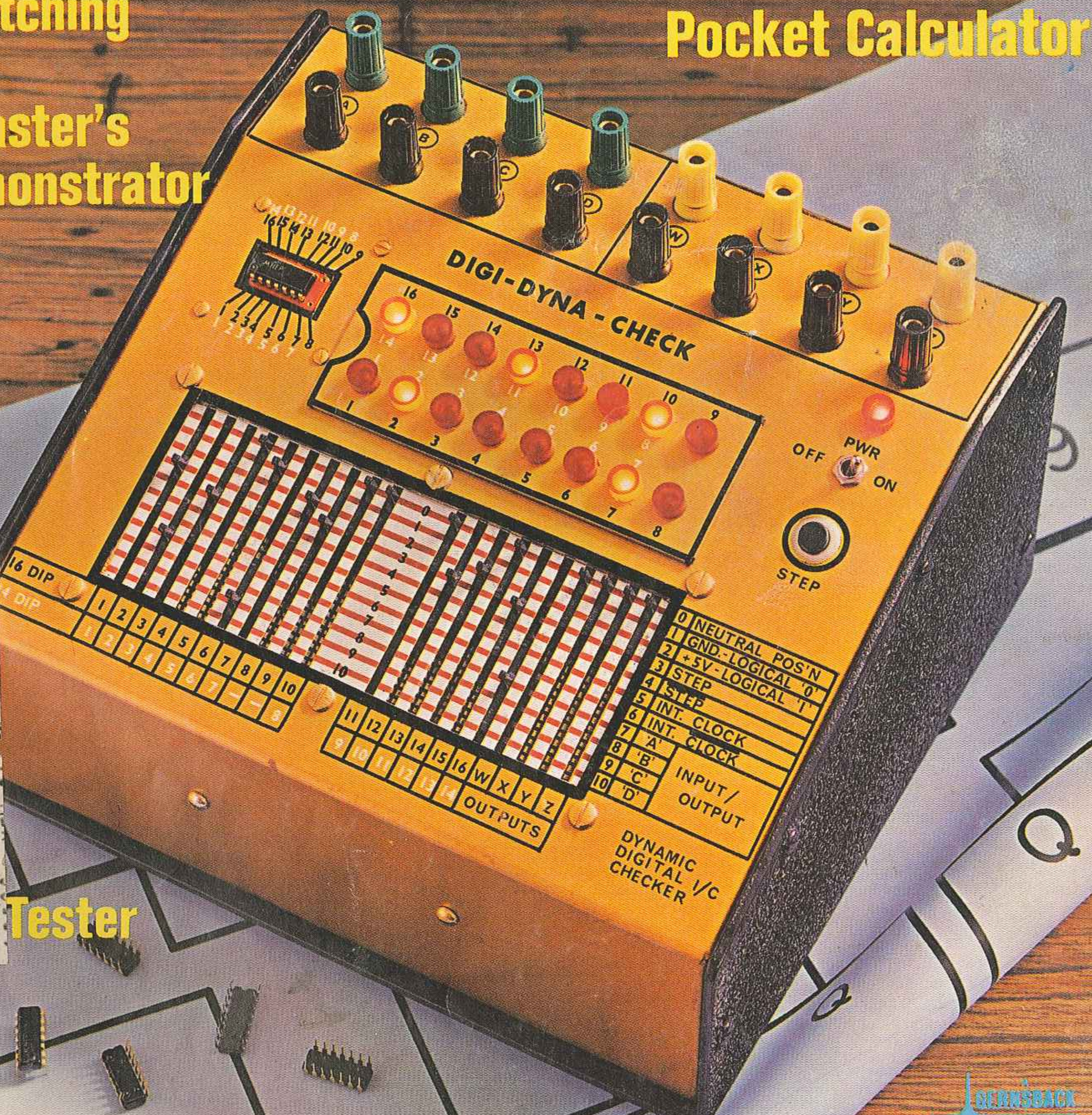


Bu... Di... Tester

GERNSBACK PUBLICATION

Here's that piece of dream test equipment that can tell you if a digital logic IC is good or bad—section by section

Build R-E's Digital IC Tester

by JACK CAZES

HAVE YOU EVER WISHED YOU HAD A fast, easy way to test the surplus digital IC's in your spare parts collection? Have you wanted to check an IC *in-circuit,* under actual operating conditions? Wouldn't it be great to be able to monitor the logic states at several points on a digital circuit board . . . even supply power to the board from an external source?

The DIGI-DYNA-CHECK is a truly dynamic digital integrated circuit checker that can be used to test digital IC's under actual operating conditions; it can be made to perform just as though it were functioning in an actual circuit. Tests can be performed both in- and out-of-circuit. A 5-volt regulated supply, capable of delivering up to 1 amp, is available within the DIGI-DYNA-CHECK to "fire up" fifteen or more IC's on a circuit board via an adapter cable with its miniature IC connecting clip.

An internal "bounceless" pushbutton, mounted on the front panel, can be used to advance counters, dividers, shift registers, etc., one step at a time. If desired, such IC's can be put through their paces automatically at a rate suitable for observing with an oscilloscope. This automatic mode of operation is available via an internal 50-kHz conditioned clock with complementary outputs.

Connections to "the outside world", ie., to equipment external to the DIGI-DYNA-CHECK, such as a scope, other voltage sources, oscillators, etc., are easily made via eight 5-way binding posts mounted on the front panel. Any internal or externally available function can be patched to any pin or combination of pins on the integrated circuit under test by means of the matrix programmer in the DIGI-DYNA-CHECK."

The heart of the checker is a 20-slider by 10-position matrix switch that is used to program the internal and/or external functions and logic levels for the IC under test. Another article will describe, in great detail, the programming and test procedures employed for a variety of digital integrated circuit types.

A schematic of the matrix switch used in the DIGI-DYNA-CHECK is in Fig. 1. It shows the connections between the various functions and the pins of the IC being tested. Basically, it consists of twenty 10-position slide switches mounted together in a single frame, with corresponding positions on all switches wired together. Thus, when two or more *sliders* are in the same *position,* they are connected internally. Additionally, each *slider* has a "home" or neutral *position* (no connection to any other slider).

The first sixteen *sliders* are connected to the correspondingly numbered pins of a 16-pin DIP (see Fig. 2) IC test socket and to sixteen lamp-driver assemblies used to monitor logic levels present at all sixteen IC pins *simultaneously*. The remaining four *sliders*, marked **W, X, Y,** and **Z** in Fig. 1, are wired to four similarly marked 5-way binding posts. Six of the matrix *positions* are connected internally to ground (logical **0**), +5 volts (logical **1**), the two complementary "step" functions, and the two complementary "clock" functions. The remaining four matrix *positions* are brought out to 5-way binding posts marked **A, B, C,** and **D.** This provides a 4 X 4 matrix (**ABCD** by **WXYZ**) that can be used for making a variety of special test connections, both internal and external to the DIGI-DYNA-CHECK.

Two power supplies are built into the checker. A regulated, highly filtered 5-volt supply capable of delivering up to 1 amp, continuously, is used to power the internal step and clock circuits (Fig. 4), and to supply V_{cc} and logic **1** level voltage to the integrated circuit under test. The regulated supply can also be used to provide power to a board containing many IC's for in-circuit tests. A filtered, but unregulated 5-volt supply provides power to the lamps and their associated driver circuits. This is shown in Fig. 5.

The stepping circuit is merely an electronic contact bounce eliminator. Solid metal switch contacts are inherently noisy and must be conditioned when used with high-speed solid-state circuits. An s.p.d.t. momentary pushbutton switch (S22 in Fig. 6) is connected to a basic NAND gate memory circuit. In the position shown, the output of ICl-a is at logical **0** level, while that of IC1-b is a logical **1.** Noisy, multiple contacts with **C,** as the switch moves toward **B,** has no effect on the outputs; the gates cannot change state until gate 1-a input is at **0** level. This occurs only at the time when the switch first contacts B. The output of IC1-a then swithces over to **1** and output of IC1-b switches over to **0.** Once these levels have been established in the manner described, they are not affected by further "make" and "break" movements of the switch (contact bounce) at **B.** Complementary outputs are available from this circuit. The STEP output is initially at logical **0** and produces a fast rise transition to logical **1** and then rapidly back to **0** when the pushbutton is depressed and released. The converse is true for the STEP (called NOT STEP) output. Both of these complementary functions are useful for testing digital IC's.

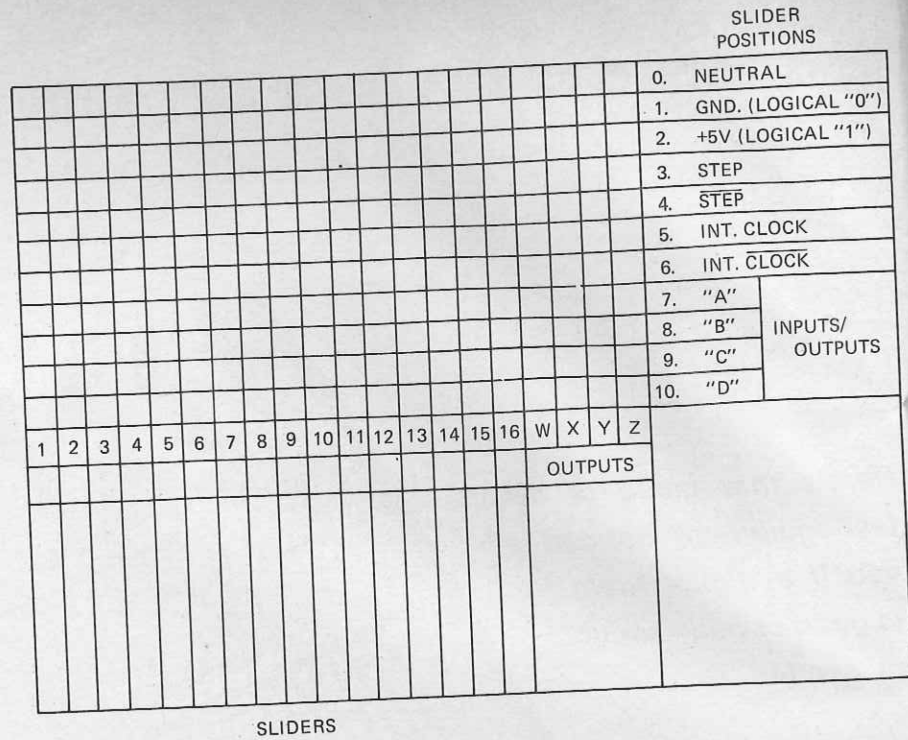
The clock circuit shown in Fig. 4 is an astable multivibrator made up of the two remaining NAND gates of IC1 (an SN-7400). The values of the gate input-sinking resistors (R8, R9, and R10) were chosen to maintain the gate input levels near the logic threshold. In this way, as C2 and C3 charge and discharge, the gate input levels oscillate above and below the threshold level. This results in the gate outputs oscillating in a complementary manner. The frequency of oscillation is determined primarily by the values of C2 and C3 according to the equation

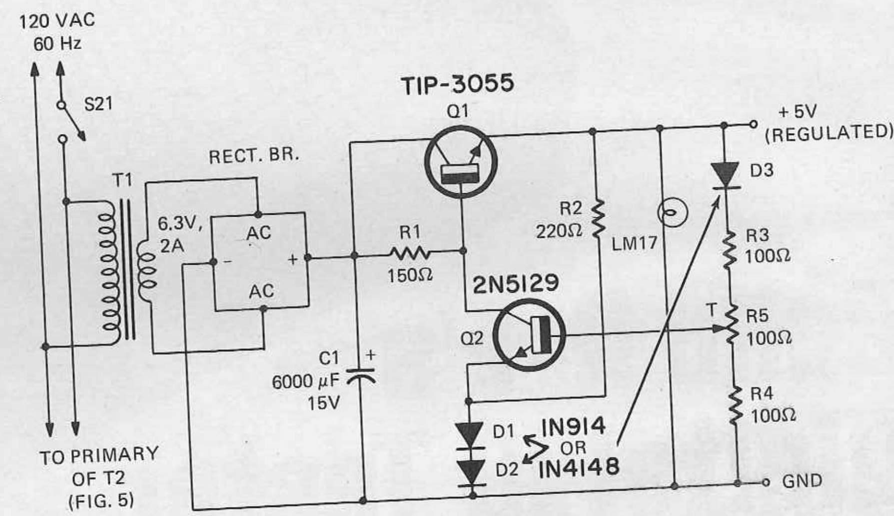
$$\text{Frequency} = \frac{1}{2(R8 + R9) \cdot C}$$

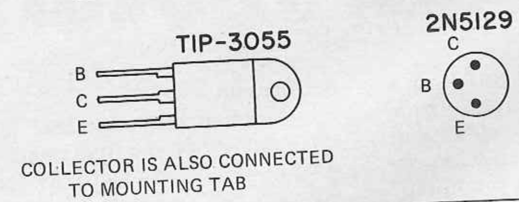
where C = C2 = C3 and R9 = R10. The component values shown in Fig. 4 result in a frequency of approximately 50 kHz. Some fine adjustment can be made by varying R8. A pair of transistor amplifiers (Q3 and Q4) is used at the complementary outputs to provide more than adequate power to drive sev-

PARTS LIST

All resistors ½-watt 10% unless noted
R1—150 ohms
R2—220 ohms
R3, R4—100 ohms
R5—100 ohms, Trimpot
R6, R7, R8, R9, R10, R12, R14—100 ohms, ¼ watt
R11, R13, R15 thru R30—22,000 ohms, ¼ watt
C1—6000 μF, 15V, electrolytic
C2, C3—0.01 μF, 100V
C4—1000 μF, 15V, electrolytic
D1, D2, D3—1N914 or 1N4148
D4, D5—1N4001 or similar (1A, 50V)
Rectifier Bridge—full wave, 1A, 100V PIV
IC1—SN-7400 (quad 2-input NAND gates)
BP1 thru BP16—5-way binding posts, insulated
LM1 thru LM7—4V, 50mA miniature lamp assembly
Q1—TIP-3055
Q2 thru Q36—2N5129
Matrix Switch (S1 thru S20)—20-pole 10-position (Part C10-42A, Cherry Electric Co., 1650 Old Deerfield Road, Highland Park, Ill. 60035)
S21—spst miniature toggle
S22—spdt miniature toggle
Miscellaneous parts:
16-pin DIP test sockets (2)
16-pin DIP test plug
16-pin DIP test clip
16-lead ribbon cable (2½ feet)
PC board
Perf board with 0.1-inch hole spacing
Heat sink for TIP-3055 transistor
Case







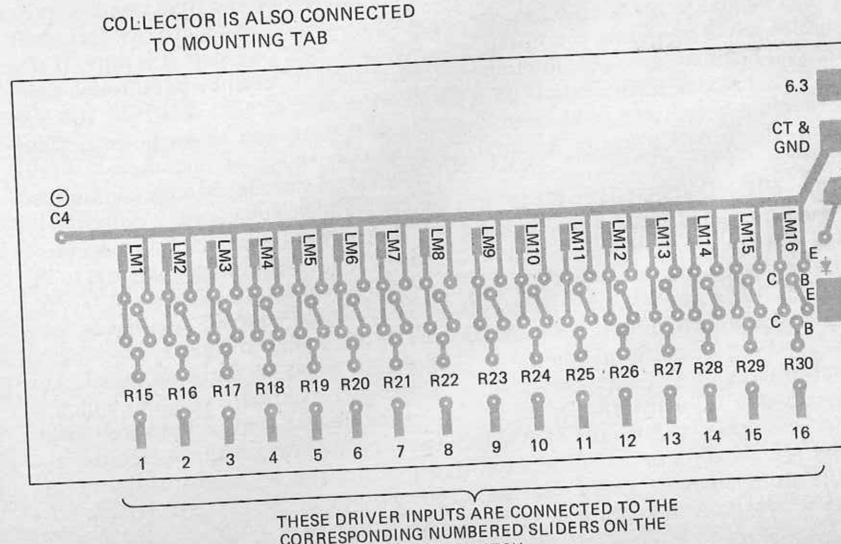
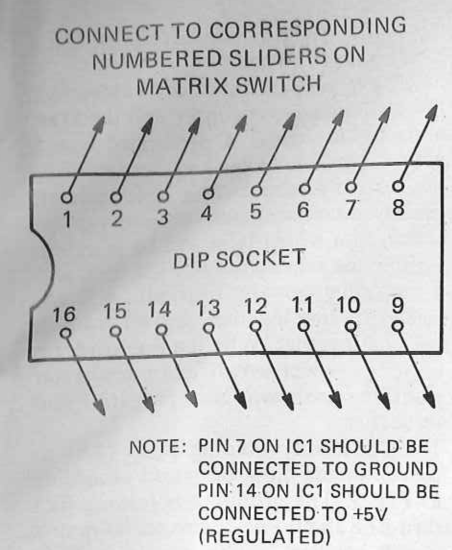
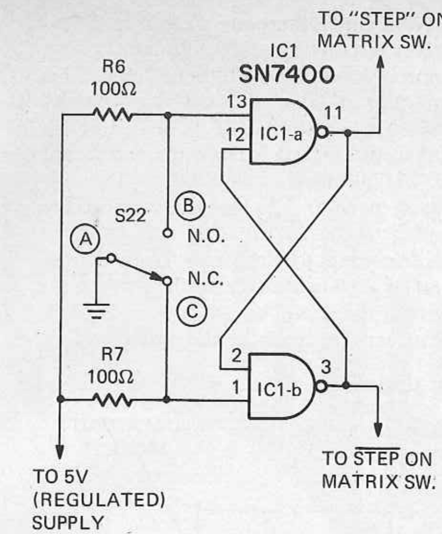
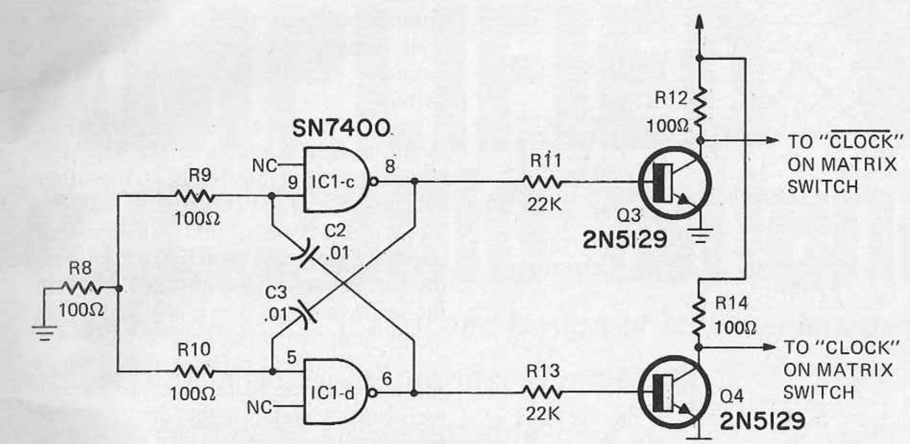
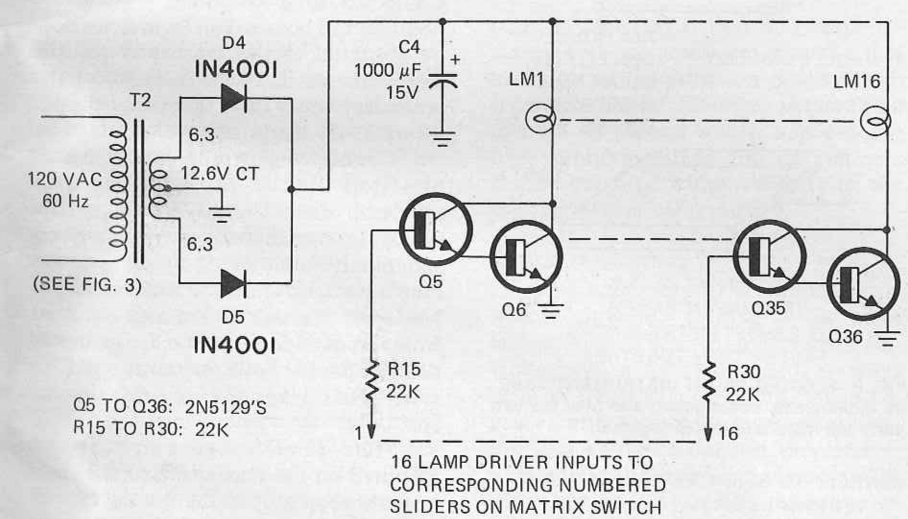


FIG. 1 (top)—MATRIX SWITCH layout. See cover photo for 14- and 16-pin DIP settings. FIG. 3—POWER SUPPLY for 5 volts regulated to step and clock circuits and the IC under test. FIG. 7-b (right)—PARTS LAYOUT for lamp-driver board. The C-B-E terminals at right are for Q35 and Q36. Transistor pairs Q5—Q6 through Q33—Q34 are positioned from left to right.









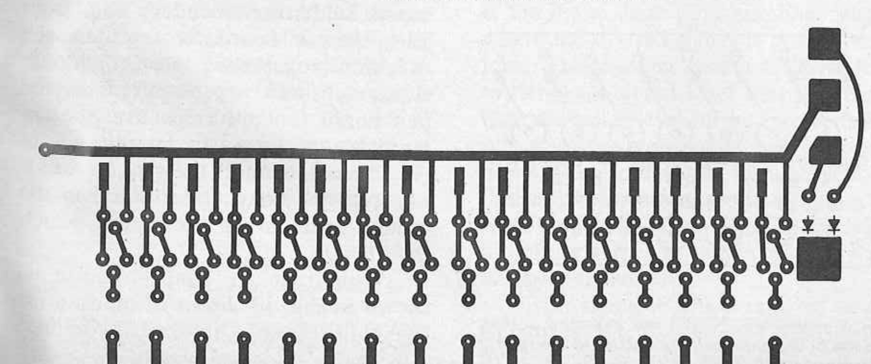


FIG. 2 (top left)—IC SOCKET TERMINALS are wired to matrix switches on instrument panel. FIG. 4 (second from top)—INTERNAL CLOCK is a free-running multivibrator. FIG. 5 (third from top)—LAMP DRIVERS are Darlington pairs to reduce loading on IC under test. FIG. 6 (top right)—STEP SWITCH with electronics added to eliminate effects of contact bounce. FIG. 7-a (left)—FOIL PATTERN for lamp driver. Enlarge so foil is 7½ inches across at widest point.

eral IC loads simultaneously. This is especially important where in-circuit testing is to be performed on a board that contains a multiplicity of IC's.

Sixteen lamp readouts continuously monitor the logic condition simultaneously at all pins of an IC under test. A voltage level above approximately 1.4 volts will cause a lamp to turn on, indicating a logical **1** level. Darlington-pair transistor amplifiers are employed as lamp drivers so that the IC under test cannot be overloaded by the lamp monitors. The selection of 1.4 volts as the threshold level permits the lamps to indicate properly logic levels for most RTL, DTL, TTL, and MOS digital integrated circuits. However, see the second article in this series for special precautions involving RTL IC tests. The lamp-driver circuits are shown in Fig. 5.

Mechanical construction

The author's prototype of the DIGI-DYNA-CHECK was assembled in the home-made sloping-front aluminum case shown in Fig. 8. Although case design and front-panel layout are not essential to the proper functioning of the tester, the arrangement shown offers convenience in use. Alternatively, a commercially available box of any design can be used, provided it is large enough to house all of the components.

Drill and punch the front panel to accept those components that will be mounted directly to it. These include the DIP test socket, the matrix switch, the readout lamps, pilot lamp and power switch, step button, and the 5-way binding posts. Rectangular openings can be cut out either with a nibbling tool or with a Bernz cutter. Several holes will also have to be drilled in the rear apron of the case to accommodate the line cord with its strain relief bushing, the two power transformers, and two pairs of L-brackets for the two circuit boards containing the lamp drivers, the 5-volt supplies, and the STEP and CLOCK circuits. The case can now be painted and lettering applied. Dry-transfer letters are particularly well suited for this job. It makes the checker more convenient to use if two different colors are used to number the test socket, lamp readouts, and matrix sliders to differentiate between the leads of 14-pin and 16-pin DIP integrated circuits as shown in the cover photo.

All components except the two circuit boards can now be mounted in the case.

Wiring the tester

The two circuit boards should be prepared and wired first. Then put them aside until all other wiring has been completed. Either copper-clad PC boards or perforated board construction can be used, as wiring layout is not critical. The foil pattern in Fig. 7-a corresponds to the schematic for the lamp drivers. Since there are sixteen identical driver circuits involved, the handwiring approach would be tedious here. This foil pattern also includes the unregulated 5-volt supply of Fig. 5. The ac input to this board is from the secondary of T2, mounted at one end of the rear apron next to T1. Do not connect the power to this board until it is ready to be mounted to the case. Connect one end of a 16-lead cable to the sixteen inputs of the driver circuits on this board. Number the leads at the other end of this cable. They will be connected later to the matrix switch.

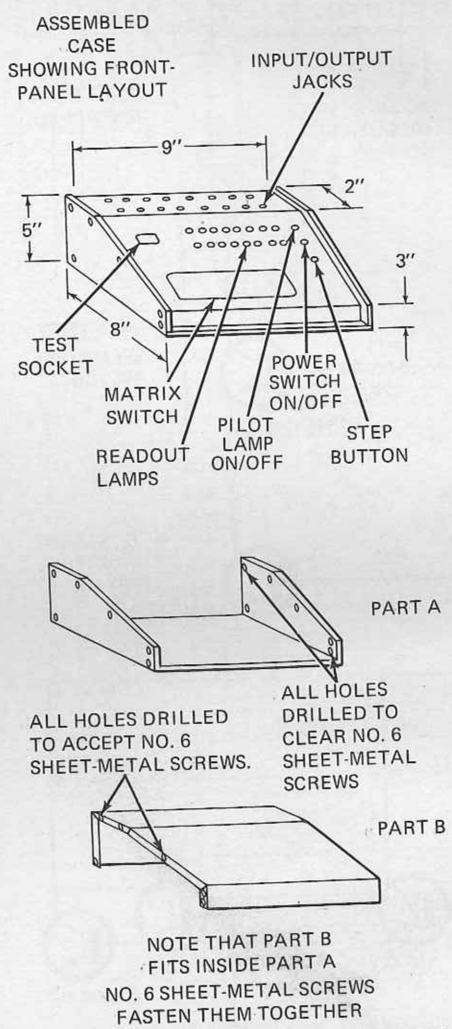


FIG. 8—SLOPING-FRONT INSTRUMENT CASE, its dimensions, construction and how the two parts are fitted and joined together.

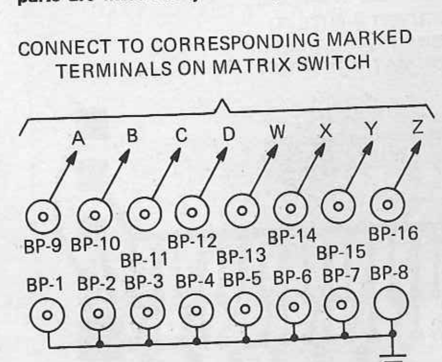


FIG. 9—BINDING POSTS are mounted across the top of the case and connected to the matrix circuitry as indicated.

Next, prepare the board containing the regulated 5-volt supply and the STEP and CLOCK circuits. A perforated board with 0.1 inch hole spacings was used in the author's model. This hole spacing readily accommodates the pins on the socket into which IC-1 will be inserted. Follow the schematics in Figs. 2, 3, and 4, making certain that all +5-volt points are tied together, and all grounds are tied together. Wire the line cord, pilot lamp, power switch, and transformer primaries as shown. Now plug IC-1 into its socket.

The 5-way binding posts (BP1 to BP16) should now be wired according to Fig. 9. The ground bus joining BP1 thru BP8 should be connected to matrix switch *position* 1. The remaining eight binding posts can then be connected to their respective *sliders* (**W** thru **Z**) and *positions* (**A** thru **D**) on the matrix switch.

Connect one end of a 16-lead cable to the sixteen contacts of the DIP test socket. Number the leads at the other end of the cable to correspond with the socket contacts. This end will be wired later to the matrix switch together with the correspondingly numbered leads on the cable that was previously connected to the lamp driver board.

Wire the miniature lamps (mounted on the front panel) to the sixteen output pads on the driver board. One lead from each lamp should be connected to a common +5-volt tie point on the board. This board can now be mounted to the rear apron of the case with two L-brackets. Connect the secondary leads from T2 to the proper locations on the board.

Connect the two 16-conductor cables (from the DIP test socket and from the lamp driver board) to the matrix switch. Be sure that all leads go to correspondingly numbered *sliders* on the matrix switch. Thus, the lead from pin No. 1 on the test socket and the lead from input No. 1 on the lamp driver board should both be connected to *slider* No. 1 on the matrix switch, etc.

The perf-board can now be mounted on the rear apron of the case, just above and parallel to the driver board. Solder the secondary leads from T1 to the perf-board. Now, connect the +5-volt (regulated), ground, clock, clock, step, and step outputs from the perf-board to their respective *position* terminals on the matrix board.

Finally, connect the ground terminal from the lamp driver board to the ground terminal on the matrix switch (*position* 1).

Construct an adapter cable as shown in Fig. 10. This will be used for in-circuit testing of integrated circuits.

(continued on page 85)

AMPLIFIED car radio antennas

by GARY K. JOHNSON*

A description of the theory and design of active antennas with technical details of the first commercial development of an active antenna.

AT THE HIGH FREQUENCY ENGINEERING Institute of the Technical University of Munich, West Germany, experiments to integrate antennas with transistors have led to the development of a new type of transistorized receiving antenna. The director of this Institute, Prof. Dr. H. H. Meinke, prefers to describe the invention as an "*Active Antenna*". Active antennas have smaller dimensions and a better signal-to-noise ratio than (conventional) passive antennas of the same bandwidth. This article should give you a better understanding of how active antennas work.

The basic concept of active-antenna design is to combine an active device (transistor) with an electrically short antenna. This concept gives a completely new dimension to the design of radiating structures and makes it possible to create extremely small antennas. The sensitivity limit of a receiving system depends on the noise produced in the first amplifying stage as well as how the antenna system, including lead-in and transformation circuits, is matched to the first amplifier stage. With an active antenna the first transistor in the receiving system is integrated with the antenna's elements. In this way a natural match between the first amplifying stage and the antenna can be obtained without disturbing the passive transmission parts.

*Corning Glass Works, Electronic Research Laboratory.

This article was written with the cooperation of Prof. Dr. H. Meinke and Dr. H. Lindenmeier. Prof. Meinke is the Director of the High Frequency Engineering Institute of the Technical University of Munich, West Germany. Dr. Lindenmeier is a Scientific Assistant in the same Institute.

Noise matching

The sensitivity of a receiving system is ultimately limited by its noise temperature (signal-to-noise ratio). Antenna gain, a figure of merit, is not a decisive factor in a receiving system because, with low noise level, amplification can easily be done in the receiver without any natural limitations. The most critical point in a receiving system is the input stage (first amplifier stage) where the desired signal is at its lowest level. The antenna system must be able to deliver a signal level that is greater than the noise level of the receiver's input stage as well as its own internal noise. Therefore, signal-to-noise ratio is the main factor limiting the reception of weak signals and consequently the most important factor to be considered with an antenna system.

The signal-to-noise ratio of a receiving system is primarily determined by three main noise sources:

1. **Antenna noise:** The passive antenna receives noise out of the surrounding space. This external atmospheric noise can be expressed as a noise temperature T_A.

2. **Inter-network noise:** This is the network between the passive antenna and the input terminals of the first amplifying stage. This network has two effects:

    a. The signal is decreased by attenuation since resistance in transmission lines and matching networks is unavoidable.

    b. This resistance in transmission lines and the matching circuits is an additional source of noise.

3. **Amplifier or transistor noise:** The first amplifier stage creates an internally generated noise. Transistor noise can be expressed as a noise temperature T_T.

The total system noise temperature would be simple to define if the only noise sources were in the receiver. Since there are three main sources of noise in a receiving system, the total noise is described by a total system noise temperature (T_S) in relation to the exit terminal of the passive antenna.

To reduce noise and increase the

new lit

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free for the asking. Turn to the Reader Service card on page 111 and circle the numbers of the items you want. Then mail the postage-paid card.

SCIENCE, OPTICS & ELECTRONICS CATALOG, *No. 722,* lists 4,000 unusual bargains for hobbyists, experimenters, science and crafts enthusiasts, students, gardeners and workshop buffs. Everything from air pollution testing equipment to zoom binoculars, illustrated with charts and diagrams, including tools, games, puzzles, rockets, microscopes, telescopes, photographic attachments, black-light equipment, lighting products, and kits for youngsters to use for science-fair projects.—**Edmund Scientific Co.,** 380 Edscrop Bldg., Barrington, N.J. 08007.

Circle 45 on reader service card

OSCILLOSCOPES CATALOG, *No. 5, 7/71,* a 14-page test equipment booklet presents the line of oscilloscopes and a curve tracer. These scopes, with built-in TV field and line triggering, find special application in TV service. Single-trace, dual-trace, and dual-beam scopes are shown. Fully illustrated. List of Field Engineering offices where technical assistance may be obtained.—**Tektronix, Inc.,** P.O. Box 500, Beaverton, Ore. 97005.

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TECHNIQUES FOR REPAIRING ELECTRONIC ASSEMBLIES, *Bulletin No. 700-005.* Most recent booklet in the series concerns "Notations on Solder Joint Removal, Conformal Coating Removal, Component Lead Forming". Highlighted are applications and illustrated procedures for the removal of specific types of solder joints and conformal coatings. This 24-page booklet is fully illustrated with photos and diagrams. Request on company letterhead.—**Pace Inc.,** 9329 Fraser St., Silver Spring, Md. 20910.

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REPLACEMENT COMPONENTS CATALOG, *No. 100, 1972.* This fully illustrated 68-page catalog of replacement components for radio and TV includes resistors, fusing devices, circuit breakers, sockets, convergence controls, service accessories, electronic chemicals, audio cables, adapters for hi-fi and cassette tape recorders, battery holders and prototype kit components. Available free to qualified distributors, service technicians and experimenters.—**Workman Electronic Products, Inc.,** Box 3828, Sarasota, Fla. 33578.

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Write direct to the manufacturers for information on item listed below:

REPLACEMENT PARTS CATALOG, four pages on solid-state replacement and renewal parts for color TV receivers including SOLID-TUBES, cartridges and multipliers. Lists solid state SOLID-TUBE high voltage rectifiers, focus rectifiers and damper diodes, silicon and selenium focus cartridges, diagrams showing dimensional drawings and socket connections for SOLID-TUBE solid state replacements of vacuum tubes with maximum ratings for pulse rectifier service.—**Electronic Devices, Inc. (EDI),** 21 Gray Oaks Ave., Yonkers, N.Y. 10710.

ELECTRONICS CATALOG, *1971.* 10,000 items described in this 64-page general catalog. Included are batteries, capacitors, controls, resistors, semiconductors, switches and timers plus new security systems, cassette recorders and cassette recording tapes. Available from authorized distributors.—**Mallory Distributor Products Co., Div. P. R. Mallory & Co.,** 101 South Parker, Indianapolis, Ind. 46201. **R-E**

IC TESTER
(continued from page 36)

Testing

Plug the Digi-Dyna-Check into a 120-volt, 60-Hz supply and turn on the power switch. Adjust R5 on the perfboard to obtain *exactly* 5 volts at the output of the regulated power supply. This should be measured with a VTVM, an FET input voltmeter, or other similar high input-impedance device. With all matrix *sliders* in the neutral *position,* only the pilot lamp should be on. Move *sliders* 1 thru 20 to *position* 1 (ground). None of the lamps should light. All IC test socket pins and binding posts **W** thru **Z** should be shorted together and at ground level. (Check with an ohmmeter). Move all *sliders* to *position* 2 (+5V). All sixteen readouts should be on. All DIP test socket pins and binding posts W thru Z should be at +5-volts. Move all *sliders* to *position* 3 (Step). All socket pins should be at logical **0** together with binding posts **W** thru **Z.** Depressing the STEP button should cause all lamps to turn on and bring all socket pins and binding posts **W** thru **Z** to logical **1.** Releasing the STEP button should return everything to their initial states. Move all *sliders* to *position* 4 (Step). Everything should behave as the inverse of that described for position 3. Move all *sliders* to *position* 5 (Clock). All lamps should glow at half brilliance due to the 50% duty cycle of the square wave clock output. A 50 kHz square wave should be present at all DIP test socket pins and at binding posts **W** thru **Z.** With all *sliders* at *position* 6 (Clock) you should see the inverse of that observed for position 5. Wave forms in positions 5 and 6 can be observed with a scope at binding posts W thru Z. Moving any of the *sliders* to any of the four *positions* 7 thru 10 should connect their corresponding circuits to binding posts A thru D, respectively.

If everything described here checks out A-OK, you're ready to use your Digi-Dyna-Check to check IC's. **R-E**

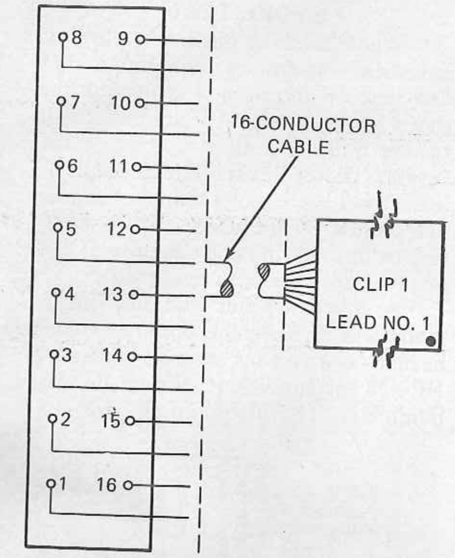

FIG. 10—ADAPTER CABLE consists of 16-pin plug and clamp and is used for in-circuit testing of DIP-type integrated circuits.

BUILD A SOLID-STATE LASER

Our June cover feature presents complete construction details of a solid-state laser. It's both easy and inexpensive to build. If you've been waiting for a low-cost low-power "safe" laser to experiment with you won't want to miss the June issue of **Radio-Electronics.**