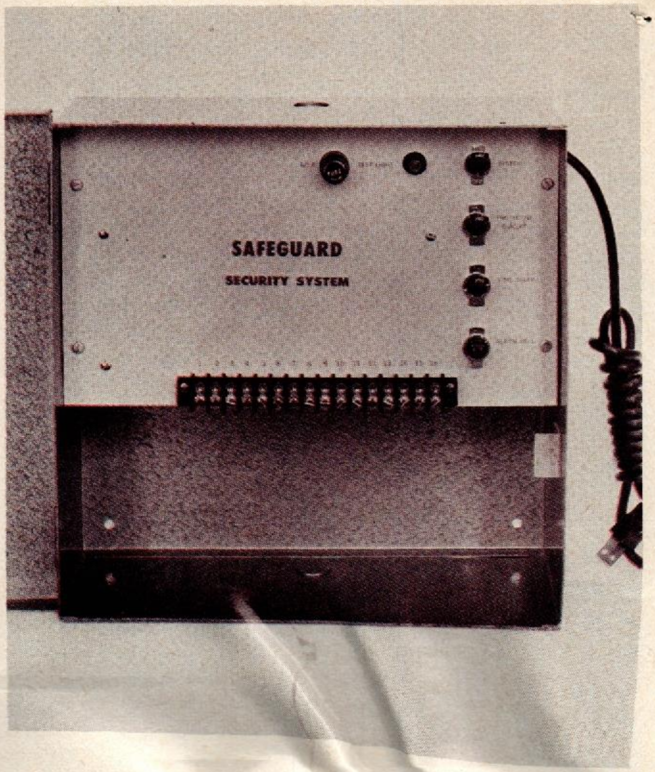
BEAT THE BURGLAR!



Build This Electronic Security System

Protect yourself and your property with this versatile multi-featured security system.

C. D. WADSWORTH

THE SOLID-STATE SYSTEM DESCRIBED here provides all the features and versatility of the most advanced security systems in the $500.00 to $800.00 category at a parts cost that should not exceed $65.00.

Special features of this security system include:

System test light that turns on any time the protective circuit is broken. Prevents false alarms—automatically indicates any tampering with circuit.

Automatic exit time delay. Just turn the system on; now you have three minutes before it activates the protective circuit. This eliminates the outside keylock switch (which is hard to install) and there is nothing outside to be picked or tampered with.

Automatic accessory control to provide house power to turn on lights, siren, or other accessories.

Automatic entrance time delay. When you enter the building, just walk to the master control and turn the system off. There is an adjustable time delay of 10 to 45 seconds before the alarm sounds. You set this re-entry time to suit your needs—it's fully adjustable.

Day-Night circuit to switch in or out part of the alarm circuit to suit your changing needs.

Entrance-Exit time delay turn-off. This single switch eliminates the time delays so you get immediate response (alarm) when an intruder breaks in—to protect you while at home.

Automatic alarm turn-off. 8 to 10 minutes after the alarm starts it shuts itself off and automatically resets itself (just in case the burglar returns). This could be a very attractive feature for your neighbors if you decided to leave home for two

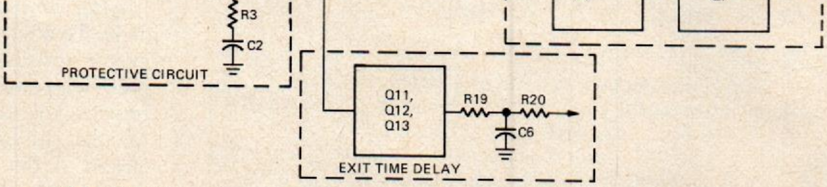


FIG. 1—BLOCK DIAGRAM DIVIDES the circuit up into its functioning sections, shows what transistors belong in each, and indicates connections to protective switches.

IC3, by way of Q3, eliminates an undesirable condition that results when pin 2 of IC3 is at a potential of 0 volts or less.

Construction

When constructing the thermometer be sure to include ceramic bypass capacitors for the power supply. The case should be made of metal and connected to the system ground. If the voltage regulator, IC9, is bolted directly to the chassis, with only a layer of silicone grease intervening, it will eliminate the need for a heatsink. Due to the many IC's used, it will probably be most convenient to use a PC board. The foil pattern is shown in Fig. 4 and the component overlay is shown in Fig. 5.

Two-conductor shielded cable, such as Belden No. 9452, is used to connect the thermistor to the rest of the circuitry. The shield should be connected to ground, while the two central conductors connect the thermistor to the positive supply and to R11. Use a 3- or 5-prong DIN plug-and-socket set with the shielded cable. Do not substitute for RT1, a 30K Fenwal UUT43JI precision thermistor. Use 5% resistors for R11 and R12; these two resistors, along with R13 and R14, were chosen especially to complement the thermistor. The combination provides the most linear voltage-vs.-temperature response over the 0°-to-99°F range, as shown in Fig. 6.

The thermistor assembly should be weatherproofed against environmental extremes. First insulate the exposed thermistor leads with heat-shrinkable tubing, then use Epoxy cement to seal any remaining areas where water could seep in. Since the thermistor is only 0.1-inch in diameter and thus relatively fragile, it should be mounted safely. For example, it could be put into a small plastic pill bottle, in which numerous large air holes have been punched. When mounting the thermistor outdoors, place it where summer sun and winter ice cannot damage it.

The power transformer for the thermometer is a 16-volt center-tapped 400 mA unit. If you cannot find a similar transformer, you can order one directly from the company listed in the parts list. Capacitors C11 and C14 should be polystyrene types to assure low leakage, high stability and precise capacitance values. Finally, the display pinouts are for Litronix DL-747's; others can be used, but the pin connections may be different.

PARTS LIST

All resistors ¼ watt, 5% unless noted.

R1—75 ohms, 1 watt
R2, R4—120,000 ohms
R3—470,000 ohms
R5, R15, R17—1000 ohms
R6—47,000 ohms
R7—56,000 ohms
R8, R19—4700 ohms
R9—10,000 ohms
R10, R12—33,000 ohms
R11—18,000 ohms
R13—3900 ohms
R14—1000-ohm multiturn trimmer
R16—27,000 ohms
R18—560,000 ohms
R20—2700 ohms
R21, R22—2400 ohms
R23-R36—180 ohms
RT1—30,000 ohms precision thermistor (Fenwal UUT43J1. Write to: Customer Service, Fenwal Electronics, Framingham, MA 01701, for name and address of their distributor in your area.)
C1, C2—1500 μF, 35 volt, electrolytic
C3, C4—100 μF, 16 volt, electrolytic
C5-C9—0.1 μF, ceramic
C10, C11—1000 pF, polystyrene
C12—75-480 pF trimmer (Arco 466)
C13—30 pF, polystyrene
C14—0.47 μF, polystyrene
C15—150 pF, polystyrene
C16—1 μF, paper
C17—2.2 μF, 15 volt, tantalum
C18—.01 μF, ceramic
C19—470 pF, ceramic
D1-D4—IN4002
D5—IN4734A, 5.6 volt, 1 watt
D6-D9—IN914
IC1, IC3—LM311 voltage comparator
IC2—LM301A op-amp
IC4—555 timer
IC5, IC6—74190 synchronous up/down counter with mode control
IC7, IC8—7447A BCD-to-seven segment decoder/driver
IC9—LM309K voltage regulator, 5 volt
F1—¼ amp
J1—3-pin DIN jack
P1—DIN plug
Q1, Q3, Q4—2N3904
Q2—2N4393
S1—SPST toggle
T1—16 volt, center-tapped, 400 mA (Signal No. 241-4-16. Available from Signal Transformer, 1 Junius St., Brooklyn, NY 11212. $3.70 each, plus postage.)
DIS 1, DIS 2—DL-747 (Litronix seven-segment display.)
Misc.—Case, 2-conductor shielded cable (Belden No. 9452 or equal), miscellaneous hardware.

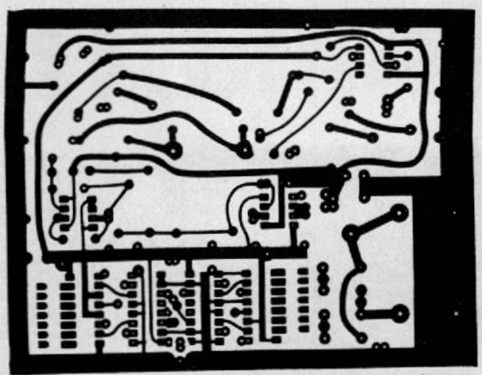
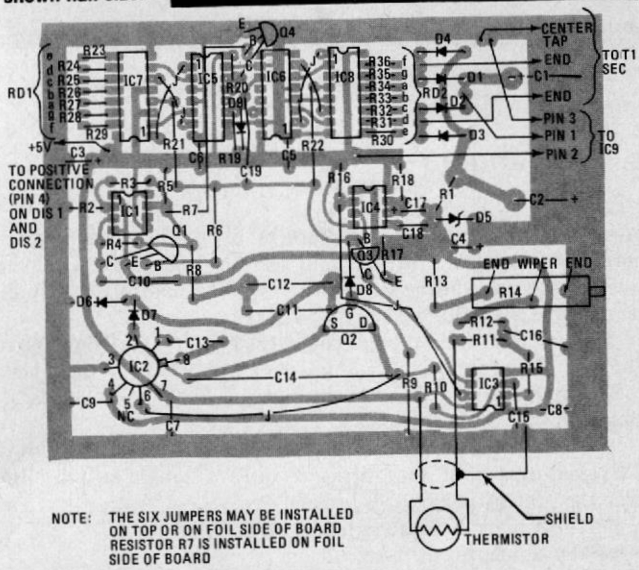


FIG. 4—FOIL PATTERN, shown half size.



NOTE: THE SIX JUMPERS MAY BE INSTALLED ON TOP OR ON FOIL SIDE OF BOARD RESISTOR R7 IS INSTALLED ON FOIL SIDE OF BOARD

FIG. 5—COMPONENT PLACEMENT diagram.

Calibration

After construction, only the circuit calibration remains to be done. To adjust R14, use a 287K 1% metal-film resistor. Thermistor resistance at 0°F is theoretically 288K ±1.5%; the precision resistor is a very close match. By using the precision resistor, you can obtain an accurate 0°F temperature reference for the calibration. Connect the precision resistor into the circuit at the point where RT1 would normally be inserted. Apply power to the thermometer, and connect a high-imped-

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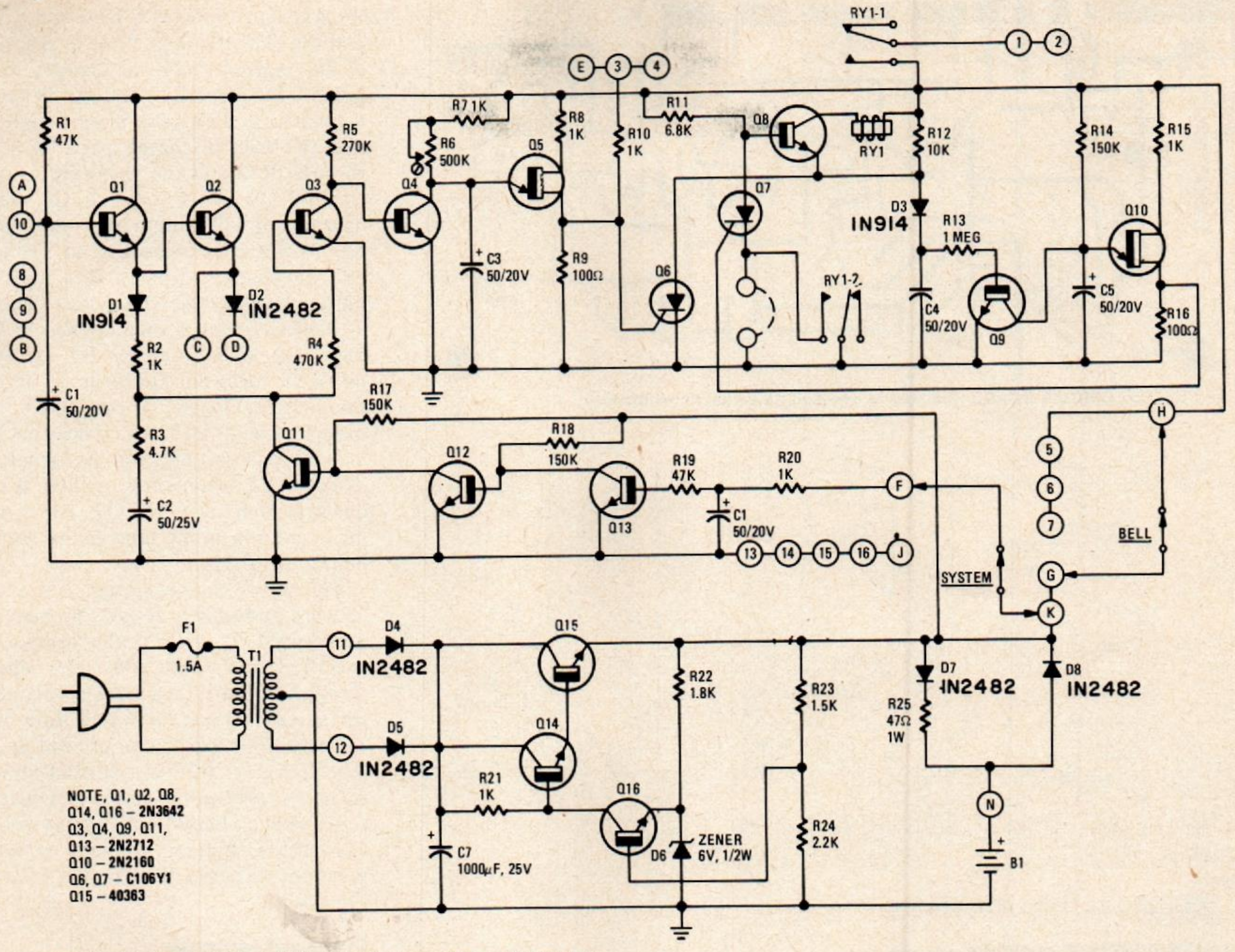


FIG. 2—COMPLETE CIRCUIT DIAGRAM of the Safeguard Security System.

PARTS LIST

All resistors are ¼-watt, 10%, unless noted.
R1, R19—47,000 ohms
R2, R7, R8, R10, R15, R20, R21—1,000 ohms
R3—4,700 ohms
R4—470,000 ohms
R5—270,000 ohms
R6—500,000-ohm, ¼ W, vertical-mount subminiature trimmer (Mallory MTC 55L1 or equal)
R9, R16—100 ohms
R11-6,800 ohms
R12—10,000 ohms
R13—1 megohm
R14, R17, R18—150,000 ohms
R22—1,800 ohms
R23—1,500 ohms
R24—2,200 ohms
R25—47 ohms, 1W
C1, C2, C3, C4, C5, C6—50 μF, 20V
C7—1,000 μF, 25V
D1, D3—1N914
D2, D4, D5, D7, D8—1N2482, 1A, 200 PIV
D6—Zener, 6V, ½ W, 10%
Q1, Q2, Q8, Q14, Q16—2N3642
Q3, Q4, Q9, Q11, Q12, Q13—2N2712
Q5, Q10—2N2160
Q6, Q7—C106Y1 (G-E)
Q15—40363 (RCA)
B1—batteries, (3) 4.5V alkaline rechargeable (RCA VS1563)
F1—fuse, 1.5A
RY1—Relay, DPDT, 12V DC, PC board mount (Potter Brumfield R10-E2-Y2)
L1—10V DC (Eldema ICE 5913)
Misc.—16-connector terminal strip (Cinch 16-140-Y), four SPDT toggle switches, metal spacers, panel, grommets, battery clips, key lock, metal cabinet.

Note: The following items are available from Electronic Products Co., Box 160412, Sacramento, CA 95816: Circuit board No. 627, $9.20.
Complete kit of all parts, circuit board, panel, metal cabinet and instructions. No. 627K, $65.00 plus postage for 10 lbs.

weeks and the alarm tripped while you were gone.

Automatic stand-by power in case the normal house power is interrupted for any reason. Rechargeable batteries are a feature and the recharging circuitry is built in and fully automatic.

Provision for fire sensors and panic button.

How it works

The block diagram of Fig. 1 shows the functions of the various parts of the circuit. The complete schematic appears in Fig. 2.

When protective circuit switches (Fig. 1) are closed, the base of Q1 is held at ground potential and the transistor remains off. When the protective circuit is broken, the bias provided by R1 turns on Q1 and charges C2 through R2 and R3. The only discharge path for C2 is through R3, R4, and the base-emitter junction of Q3. This causes Q3 to turn on, bringing the base of Q4 to ground potential and turning Q4 off. With Q4 off C3 (Fig. 2) is allowed to charge through R6 and R7 to the point where unijunction transistor Q5 fires and turns on SCR Q6. The R-C time constant of R6R7/C3 is the re-entry time delay.

The exit time delay is provided by the system switch (closed when system is off) which charges C6. Transistors Q11, Q12, and Q13 hold C2 at ground potential until C6 discharges through R19 and the base-emitter junction of Q13.

The 10-minute alarm turn-off works as follows: Transistor Q8 is held "on" by R11. However, relay RY1 cannot turn on because the emitter of Q8 does not have a complete path to ground until SCR Q6 is turned on. When Q6 turns on, RY1 acti-

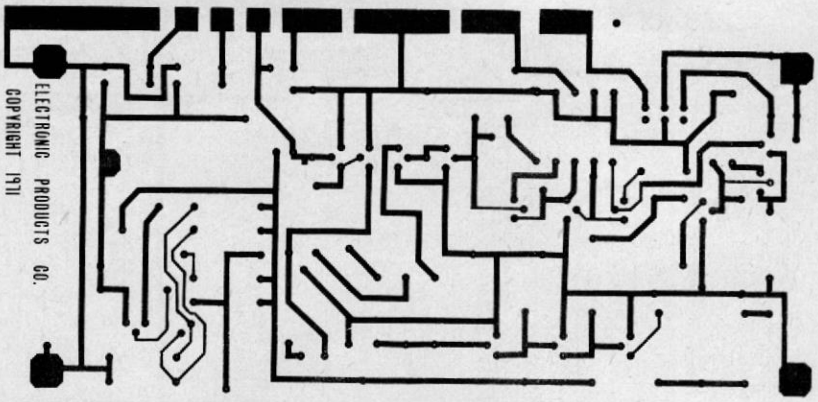


FIG. 3—PRINTED CIRCUIT BOARD, reduced to one-half its actual dimensions.

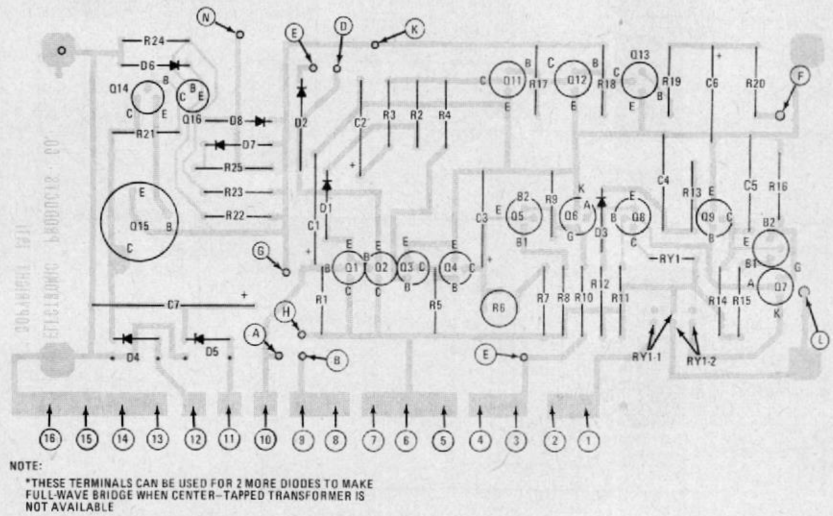


FIG. 4—COMPONENT PLACEMENT diagram.

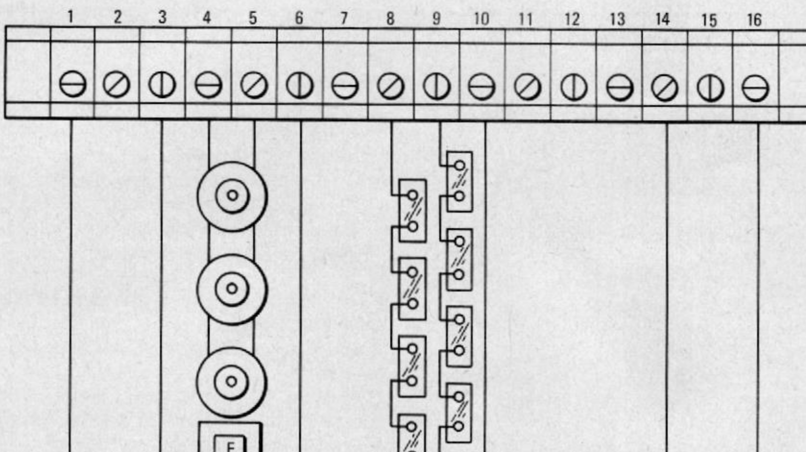


FIG. 5—THE TERMINAL STRIP. Numbers along top match circled numbers in schematic.

vates closing switches RY1-1 and RY1-2, and the alarm sounds. Prior to activation of Q6, capacitor C4 was charged to full potential through R12 and D3. When Q6 activates, it also back-biases diode D3 and the only discharge path for C4 is through R13 and the base-emitter junction of Q9. With Q9 on, C5 cannot charge and will remain at ground potential. When C4 has discharged, Q9 turns off. C5 charges through R14 and fires unijunction Q10 which triggers the SCR 7. Negative bias is then applied to Q8's base through Q7 and RY1-2. Q8 turns off, RY1 turns off, Q6 turns off because there is no longer a conductive path except through R12, which does not pass enough current to keep it turned on. When RY1 deactivates, switch RY1-2 opens, which turns off Q7. All components are now in the same active state as before the alarm.

The power supply design is straightforward and easy to follow. No heat sink is required for Q15 if the components specified are used. Batteries charge through D7 until their voltage is equal to the supply voltage, at which time diode D7 becomes back-biased, preventing further charging. R25 is a current-limiting resistor to protect the batteries. Diode D7 remains back-biased until supply voltage falls below battery voltage, at which point the batteries then supply power to the circuit.

Putting it together

Construction is straightforward and parts layout is not critical except in the SCR gate circuit, in which leads should be kept as short as possible. If you plan to etch and drill your own circuit board, the layout and parts placement are shown in Fig. 3 and Fig. 4.

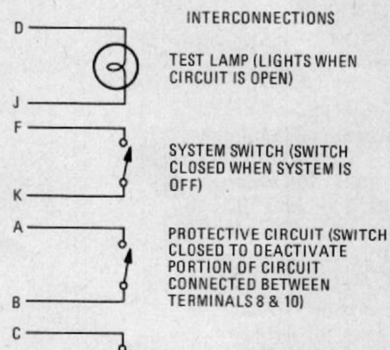
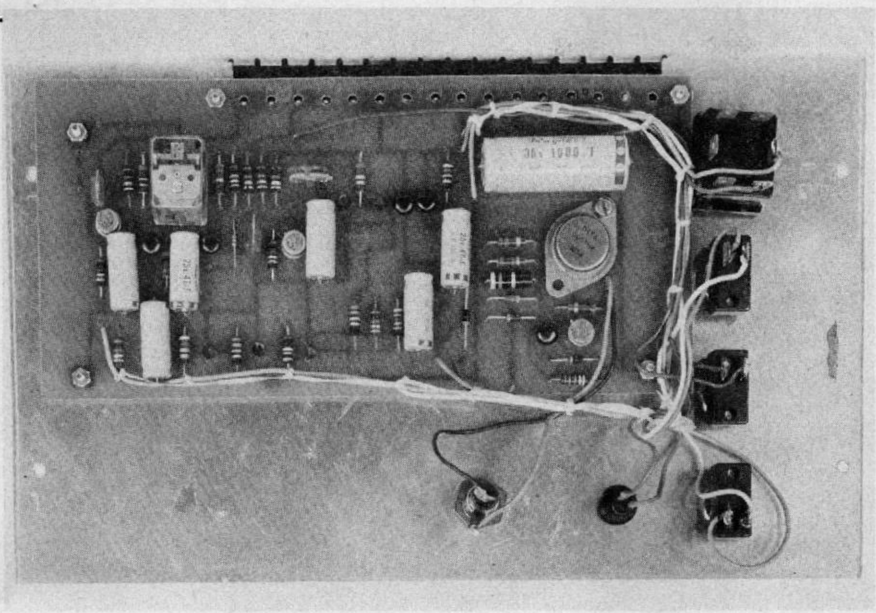
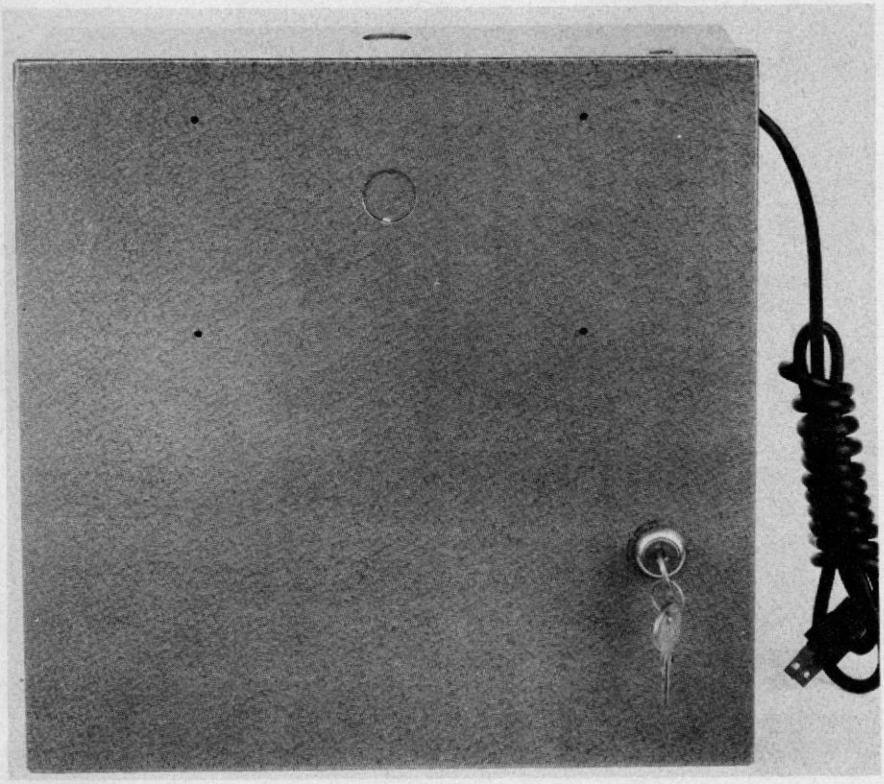


FIG. 6—INTERCONNECTIONS to items on panel. Letters match those on schematic.



REAR VIEW OF CONTROL PANEL shows circuit board and switches. Terminal strip is mounted on bottom edge of PC board.



THE ELECTRONIC SECURITY SYSTEM is housed within a steel enclosure. A key lock prevents tampering.

Insert resistors and capacitors in board and solder, then insert diodes and transistors and solder. This helps prevent excessive heat on the semiconductors. Next, connect the terminal strip to the foil side of the printed circuit board with 4-40 machine screws. Use one 4-40 nut and three washers as spacers between the terminal strip and the printed-circuit board so the ends of the leads on the terminal strip do not quite pass through the board. The metal leads on the terminal strip can now be soldered to the printed-circuit board.

The numbered locations on the schematic correspond with the pin numbers of the terminal strip (Fig. 5) and the printed circuit board layout. The lettered locations on the schematic and the printed circuit board layout are the interconnections for the test lamp, fuse, and switches and are detailed in Fig. 6.

Connect wires for the switches, fuse, and light to the printed circuit board, mount the board on the back of the metal panel, using 4-40 machine screws and two 4-40 nuts as spacers. Check to be sure that no leads from printed-circuit board or the terminal strip touch the metal panel. Mount the fuse, light and switches, dress wires around edge of printed-circuit board and connect to appropriate points. Mount transformer in cabinet with the center tap of the transformer secondary going to cabinet ground.

The connections for the various sensors to the terminal strip are detailed in Fig. 5. Remember when checking this system out, capacitor C2 must become fully discharged between tests. So you must turn the SYSTEM switch on between tests and wait the full 3 minutes (exit time) before the next test. Turning the BELL switch off will *not* discharge C2. Unless you turn the SYSTEM switch off and then back on you may get a false alarm.

Special Note: The time before the alarm turns itself off may be reduced or increased by changing the value of R13 and to some extent by changing the value of R14. Experiments with R13 show it can be increased to 5 megohms providing the beta of Q9 (the particular 2N2712 you use for this function) is not drastically different from normal for this unit.

For accessory control (house lights, siren, etc.) connect a 12-volt relay to terminals 2 and 15. **R-E**

Students to learn programming with hand-held calculators

A course for teaching fundamental programming with small calculators to students in high school was described to the recent annual conference of the National Council of Teachers of Mathematics by speakers from Texas Instruments.

Designed by the University of Denver Mathematics Laboratory and oriented to a series of motivational activity lessons, the course materials have been tested with both teachers and students. The format allows a teacher to move the students into simple straightforward programming quickly. They then proceed to advanced program techniques involving conditional and unconditional transfers, loops and subroutines. At each of these points the teacher selects applications or problem situations at various mathematical levels, to help the students understand the concepts covered.

The great advantage of the hand-held calculator as a learning tool is that it is readily available to teachers and students who would otherwise have to wait, after writing programs, for access to larger computers. Also, the initial and continuing costs for a computer-based course would be orders of magnitude greater than for one that uses calculators.

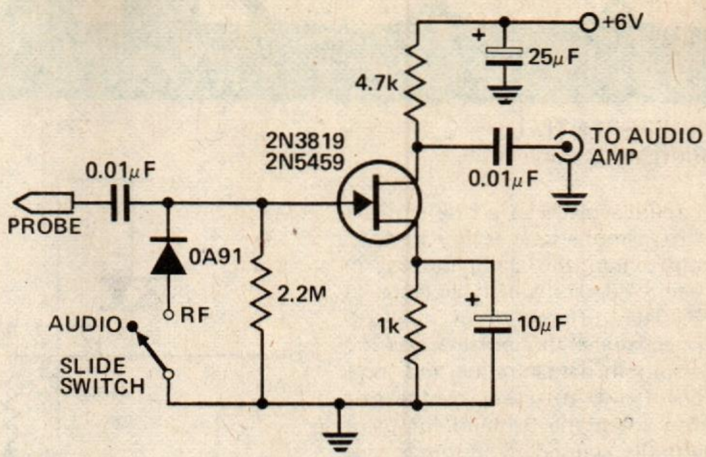
The course will be available late in 1977. Contact your local TI dealer or write: TI, Box 5012, Dallas, TX 75222

tech-tips

AUDIO-RF SIGNAL TRACER PRE-AMP

This economical signal tracer is very useful for servicing and alignment work in receivers and low power transmitters. It is easily constructed on a small piece of matrix board which can be mounted inside a commercially-available probe case or homemade probe. The slide switch can be mounted on the probe housing. A miniature toggle switch could be used as a substitute.

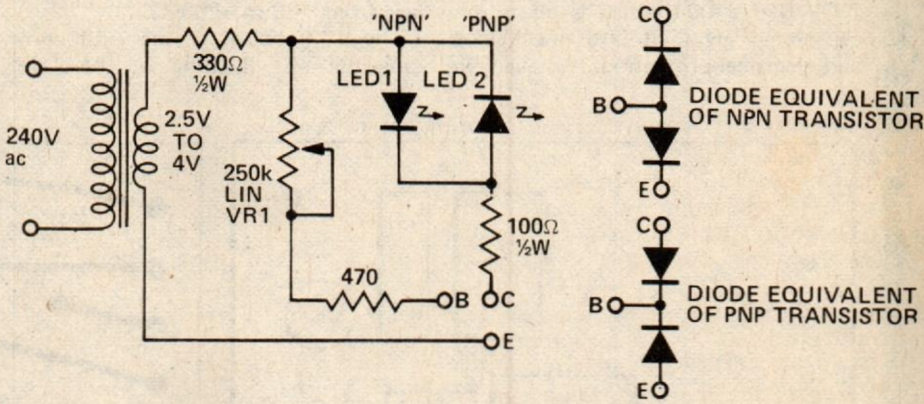
When switched to RF, the modulation on any signal is detected by the diode and amplified by the FET. A twin-core shielded lead can be used to connect it to an amplifier and to feed 6 volts to it.



GO/NO-GO DIODE/TRANSISTOR CHECKER

A diode can be checked by connecting it between C and E. If LED 1 lights the diode is OK and its anode is connected to C. If LED 2 lights its cathode is connected to C. If both light it is a short circuit suitable only as a link!

To check transistors with known pin connections, set VR1 at maximum resistance and connect the transistor. Advance VR1 until one LED lights. If LED 1 lights it is NPN, PNP if LED 2 lights. If both light you have a three-legged link. If neither light you have a three-legged fuse!



To check transistor connections, if unknown, short two of its leads together and check as for a diode making note of which lead/leads respond as anodes. Short two other leads together and do it again. Refer to diagrams above.

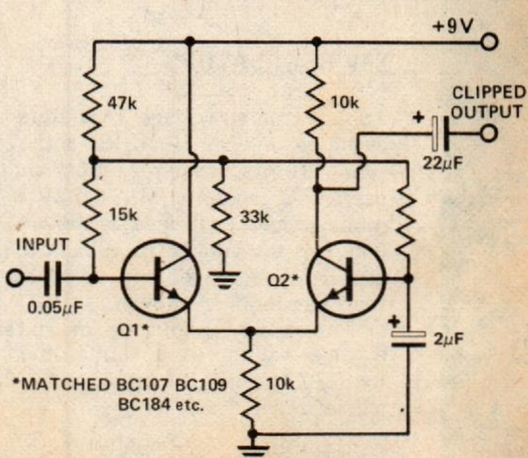
TINNING WITH SOLDER WICK

Do not discard the lengths of solder saturated solder wick. Further use can be made of them to plate printed-circuit boards by pre-tinning the joints, prior to inserting components and soldering.

The simple operation is as follows – place the saturated solder wick on the printed board and apply a heated soldering iron to melt the solder in the wick. At the same time, move the wick and iron along sections or joints requiring tinner. A neat plated copper print will result.

PRECISE AUDIO CLIPPER

A differential amplifier makes an excellent audio clipper and can provide precise, symmetrical clipping. The circuit shown commences clipping at an input of 100 mV. The output commences clipping at ±3 V. Matching Q7 and Q2 is necessary for good symmetrical clipping, however, if some asymmetry can be tolerated this need not be done.



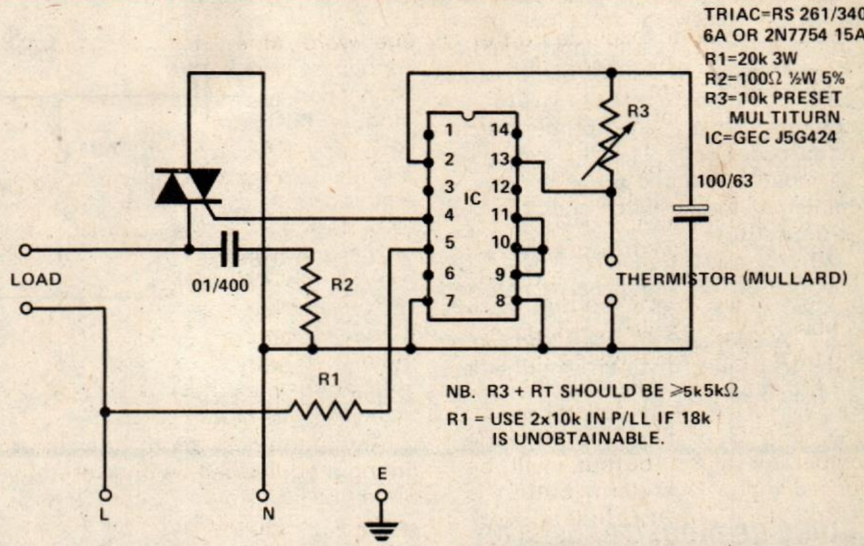
tech-tips

LOW DIFFERENTIAL THERMOSTAT

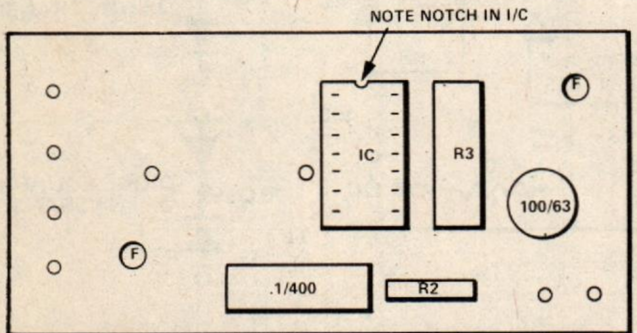
This circuit evolved as a result of the need for a more satisfactory method of controlling the temperature in our paint heaters which operate at 170°F. The differential of conventional mechanical thermostats was too wide, both in actual rating and in % accuracy, so that severe overheating occurred when the demand for paint momentarily lapsed. The result was poor finish and in a number of cases the destruction of the thermometer (at approx £10 a time).

The introduction of the new thermostat completely eliminated the problem. The circuit consists of a GEC J5G424 Zero Voltage Switch in IC form together with a Mullard 2322 640 90004 which is plastic encapsulated. giving it both mechanical and electrical protection. It is available in four sizes with a temperature coverage from −30 to +200°C.

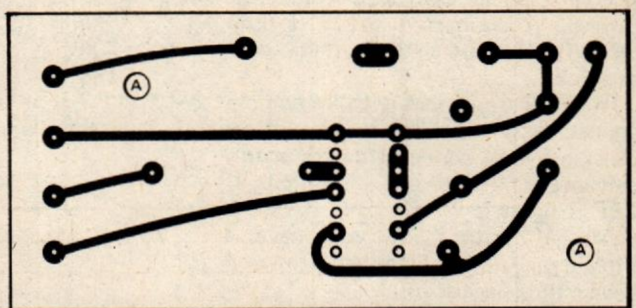
The RC network, 0.1mF + 100ohms, prevents self latching of the Triac. The J5G424 is, by nature of its design free of RFI. The type of Triac employed will depend on the loading. We were using 6 and 15 amp loads.



NOTE NOTCH IN I/C



ACTUAL SIZE F= FIXING HOLES



ACTUAL SIZE

This pcb is available from Ramar or Crofton (see Ad. index) for 76p including VAT & P and P.

30V REGULATORS

Three-terminal voltage regulators are available in 5,9,12,15,18 and 24V types. If you require a 30V supply use a 24V regulator with a 6.2V zener diode in the earth lead as shown.This increases the volatge to 30V. A 0.1μF capacitor should be connected across the zener diode as shown.

The zener should be of suitable wattage rating. In a similar manner for 27V use a 3.3V zener or for 33V a 9.1V zener.