CALECTRO

semiconductor projects handbook

$1.00

Easy-to-follow instructions, parts list, drawings and information on how to build such interesting and useful devices as a Digital Thermometer, Frequency Counter, Digital Voltmeter and Universal C-MOS Decade Counter.

GC ELECTRONICS
DIVISION OF HYDROMETALS, INC.
ROCKFORD, ILLINOIS 61101 U.S.A.

GC ELECTRONICS

98-104

FORWARD

The Calectro Semiconductor Project Book consists of nine state-of-the-art projects; each intended to be of interest to the beginner as well as the experienced hobbyist. The projects selected are all of general interest, varying from a simple decade counter to a complex frequency generator.

Each project describes the theory of operation, as well as providing printed circuit board layouts, detailed drawings for suggested enclosures, and intended applications. If normal care in construction is followed, you should find many hours of enjoyment in building your own circuits and employing them in your own creative applications.

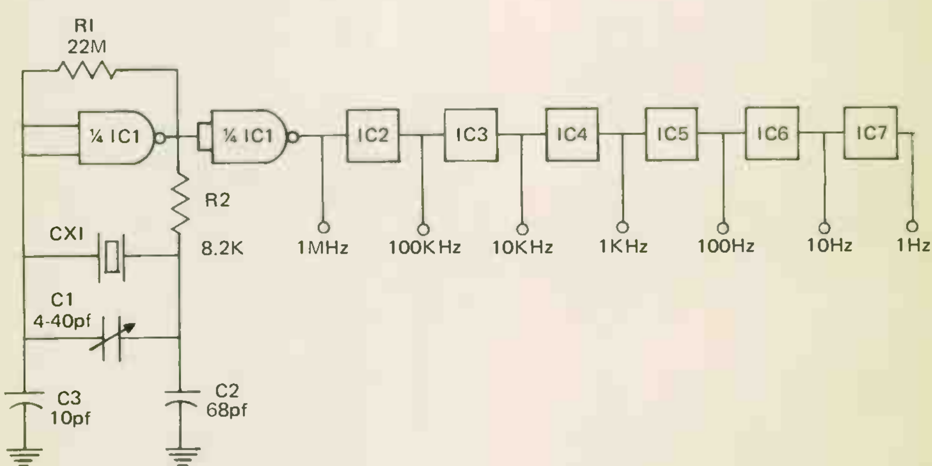
Edited by Gary S. Ebens

CONTENTS

CRYSTAL TIME BASE

This project provides various timing pulses which can be used whenever a clocking function is needed, such as the decade counter project. It will give you six different outputs starting at one cycle per second (1Hz) and increasing by multiples of 10 up to one million cycles per second (1MHz). The amplitude or voltage of the output will always equal the supply voltage, which can be varied between 4 and 15 volts. Accuracy of the time base is .005 of one percent. Once the temperature of the crystal is stabilized, C1 may be adjusted to compensate for the tolerance so that the 1MHz output is achieved. Referring to the schematic (Fig. 1); IC1, CX1 and their associated components make up the 1MHz oscillator. The output, which is a square wave, is fed into IC2, the first divide by 10 counter. The output of IC2 will be 100 KHz, which is in turn fed into IC3. This process of dividing by 10 continues until the 1hz output is achieved at the output of the sixth divide by 10 counter. In some applications it may be unnecessary to divide down to 1Hz. In these cases you may eliminate all J4-4029's not required without affecting the circuit performance.

Fig. 1 Schematic

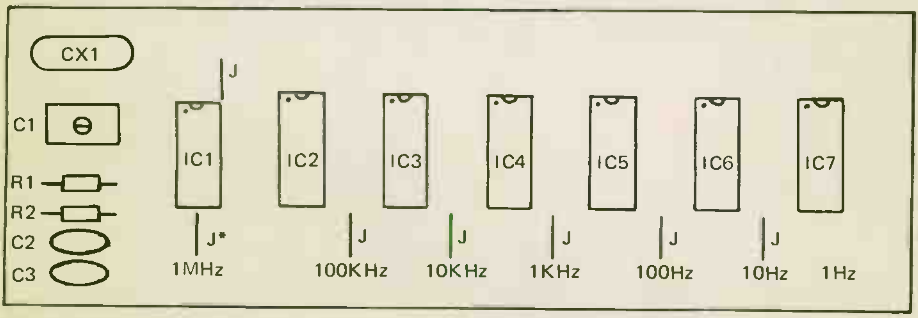


This project may be constructed on perforated board or perferably on a printed circuit board. The PC board may be produced by using our new J4-828 Lift-It kit and the layout supplied. (See page81)Figure 2 shows the component placement for the PC board. Install resistors R1 & R2, capacitors C1-C3, crystal CX1, and all jumpers prior to installing the I.C.'s. It would be advisable to use I.C. sockets although it isn't mandatory.

Be sure to follow C-MOS handling instructions before removing I.C.'s from display card. After the assembly is completed check to see that all components are installed correctly and that there are not any solder bridges.

If accuracy of greater than .005 of 1 per cent is desired, attach a frequency counter to the 1Mhz output and adjust C1 to obtain exactly 1Mhz.

Fig. 2 Component Layout



*=JUMPER WIRE

PARTS LIST

SYMBOL	DESCRIPTION	CALECTRO NO
IC1	Quad Nand Gate	J4-4011
IC2-7	Up/Down Counter	J4-4029

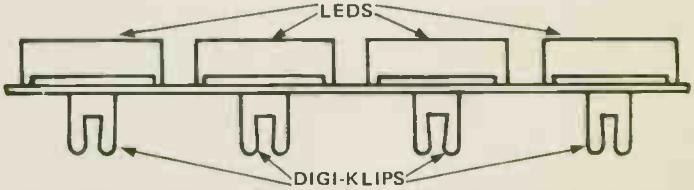
PARTS LIST (CONT.)

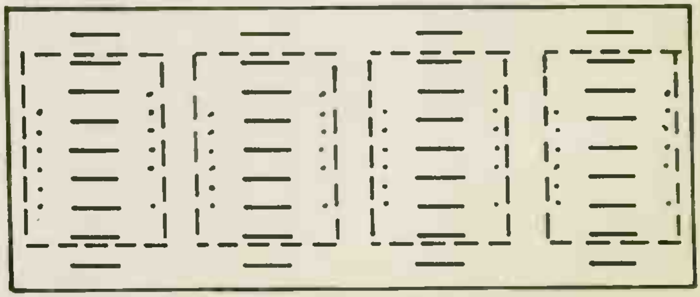
SYMBOL	DESCRIPTION	CALECTRO NO.
CX1	1 MHz Crystal	J4-1900
C1	4-40 pf Capacitor	A1-246
C2	68 pf Capacitor	A1-005
C3	10 pf Capacitor	A1-001
All resistors 1/2 watt 10% tolerance		
R1	22M (GC No.)	26-152
R2	8200	B1-395

CALECTRO C-MOS DECADE COUNTER

This project consists of a very versatile decade counter and LED readout, with the option of choosing between a .3 inch or .6 inch readout. The counter utilizes a J4-4029 pre-settable up/down; binary/BCD decade counter and a J4-4511 BCD to 7 segment decoder latch, and driver, both C-MOS devices. Either the J4-903 2/3" or J4-901 1/3" seven segment common cathode LED display can be used. J4-645 Digi-Klips greatly simplify construction, eliminating point to point wiring between PC board and readout, and providing means for display mounting. (Fig. 1)

Fig.1 Digi-Klip Layout





DIGI-KLIPS MOUNTED ON FOIL SIDE OF PC BOARD

This project can be built on perforated board (J4-616) or preferably the printed circuit boards may be produced by using our new J4-828 Lift-It kit and the supplied full size layouts (Fig. 3)(see pages 83,85,&87) The printed circuit layout for the display boards is shown for the mounting of six LED's. This can be expanded or reduced to meet whatever requirements you have.

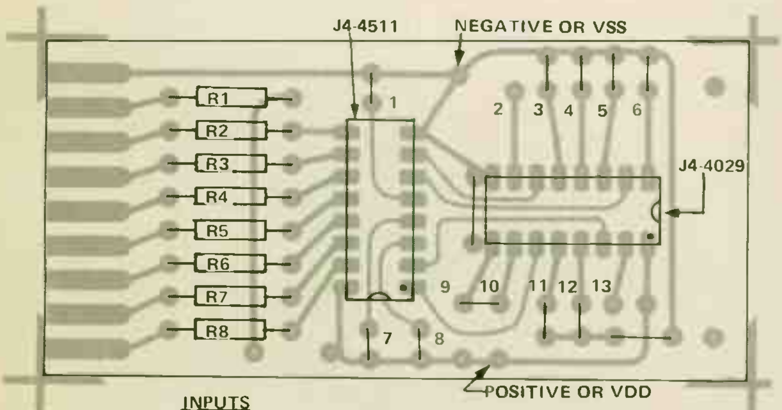
Figure 3 shows the component placement for the counter board. All jumpers and resistors should be installed prior to installing IC's. It would be advisable to use sockets for the IC's although it isn't mandatory. Be sure to follow C-MOS handling instructions when attaching IC's to the printed circuit board.

Values for resistors R1-R8 are determined by the voltage that is used. The counter can be operated from any voltage ranging between 3 and 15 volts DC.

The table below gives you values for three typical voltages. If voltages other than these three are to be used, set the value for R1-R8 so that there is approximately 10-15 mA flowing thru each segment of the LED.

VOLTAGE	VALUE FOR R1-R-8
5V	100 OHM
10V	470 OHM
15V	680 OHM

Fig.3 Component Layout



INPUTS

1. Latch Enable
2. Carry Out
3. Carry In
4. Jam Input No. 1
5. Jam Input No. 4
6. Preset Enable
7. Blanking
8. Lamp Test
9. Binary/Decade
10. Up/Down
11. Jam Input No. 2
12. Jam Input No. 3
13. Clock Input

Jumpers shown provide down count assuming there is a input to the clock.

The J4-4029 has various inputs which must be connected to either ground (low, Vss) or positive (high, Vdd) depending upon the operations you want it to perform. Binary counting is accomplished when the Binary/Decade input is "high"; the counter counts in the decade mode when the Binary/Decade input is low. For use with our 7 segment readouts this input should be "low". The counter counts "up" when the up/down input is "high". A "high" on the Carry In will inhibit the advancement of the counter. The Carry Out output may be left floating, (unconnected) when not in use, or must be connected to the Carry In input of next counter when more than one counter is used, (Fig.4). The four Jam Inputs are used to preset, or reset, the counter to any state. Jam Input #1 controls output Q1, Jam Input #2 controls output Q2, and etc. Input states of the Jam Inputs are transfered to their respective Q output when the Preset Enable is "high". Refer to Truth Table X for proper biasing of Jam Inputs to obtain desired display. All Jam Inputs must be tied "low" when not used.

The Preset Enable must be "low" while counting, and "high" when a reset or preset is desired.

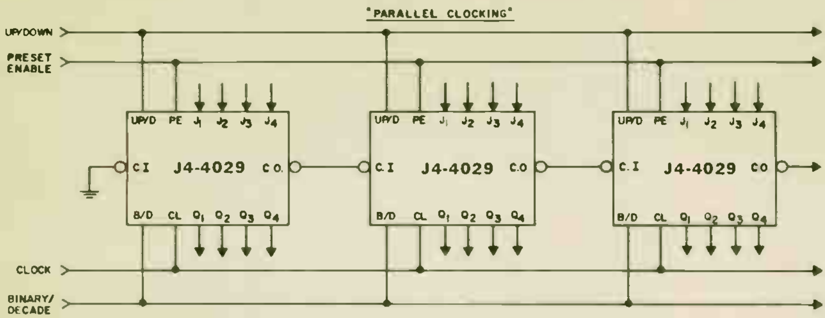
Table X

Jam Input 4	3	2	1	Display
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	Blank
1	0	1	1	Blank
1	1	0	0	Blank
1	1	0	1	Blank
1	1	1	0	Blank
1	1	1	1	Blank

Valid only when Preset Enable is high

1=positive
0=ground

Fig.4 Parallel Clocking



Note: Parallel Clocking must be used when switching the Up/Down mode during a 0 or 9 count.

The J4-4511 has three inputs which must be tied to either ground or positive. Referring to Truth Table Z the Latch Enable (LE) must be tied "low" to show the counting sequence on the display, a "high" on the LE will hold the last number shown on the display prior to trying LE "high". This is used in applications such as frequency counters and digital voltmeters where only the final count is desired. The Blanking Input ($\overline{BI}$) should be tied high. A "low" on the $\overline{BI}$ will shut off the display. This may be used in a "standby" condition to conserve power. Upon returning the $\overline{BI}$ to a "high" state the display will show the most recent information in the latches. The Lamp Test ($\overline{LT}$) is used only for that purpose, to test the LED's. It should be tied "high" normally. A "low" on the $\overline{LT}$ will display an eight on the LED. Remember, these three inputs to the J4-4511 only affect the display. They do not inhibit the internal counting functions of the I.C.'s.

Table Z

TRUTH TABLE

LE	$\overline{BI}$	$\overline{LT}$	D	C	B	A	a	b	c	d	e	f	g	Display
X	X	0	X	X	X	X	1	1	1	1	1	1	1	8
X	0	1	X	X	X	X	0	0	0	0	0	0	0	Blank
0	1	1	0	0	0	0	1	1	1	1	1	1	0	0
0	1	1	0	0	0	1	0	1	1	0	0	0	0	1
0	1	1	0	0	1	0	1	1	0	1	1	0	1	2
0	1	1	0	0	1	1	1	1	1	1	0	0	1	3
0	1	1	0	1	0	0	0	1	1	0	0	1	1	4
0	1	1	0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	0	1	1	1	1	1	1	0	0	0	0	7
0	1	1	1	0	0	0	1	1	1	1	1	1	1	8
0	1	1	1	0	0	1	1	1	1	0	0	1	1	9
0	1	1	1	0	1	0	0	0	0	0	0	0	0	Blank
0	1	1	1	0	1	1	0	0	0	0	0	0	0	Blank
0	1	1	1	1	0	0	0	0	0	0	0	0	0	Blank
0	1	1	1	1	0	1	0	0	0	0	0	0	0	Blank
0	1	1	1	1	1	0	0	0	0	0	0	0	0	Blank
0	1	1	1	1	1	1	0	0	0	0	0	0	0	Blank
1	1	1	X	X	X	X				*				*

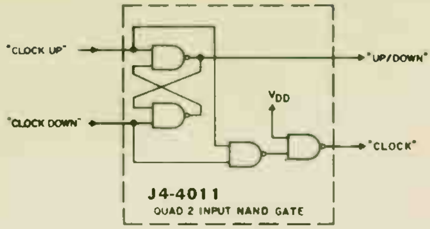
X ≡ Don't Care

*Depends on BCD code previously applied when LE = 0

Note: Display is blank for all illegal input codes (BCD > 1001).

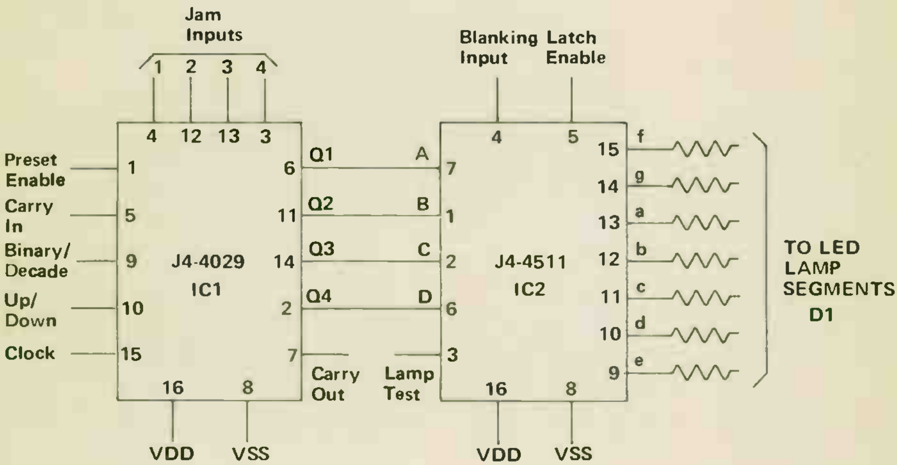
With the addition of J4-4011, inputs for both a "Clock Up" and a "Clock Down" can be easily realized as shown in Fig. 5. When using this configuration and counting "up" the "Clock Down" input must be maintained "high" and conversely when counting "down" the "Clock Up" input must be tied "high".

Fig.5



Conversion of "clock up", "clock down" input signals to "clock" and "up/down" input signals.

Schematic



PARTS LIST

SYMBOL	DESCRIPTION	CALECTRO NO.
IC1	Up/down counter	J4-4029
IC2	Decoder Driver	J4-4511
R1-8	Resistor	See text
D1	LED	J4-903 or J4-901
QTY.	MISCELLANEOUS	
1 pkg	Digi-Klips	J4-645
1	PC board	J4-604

SCA DECODER

How would you like to listen to music on your FM radio without any commercials; light classics or modern ballads without interruption, hour after hour?

These programs are transmitted on commercial FM stations every day. However, they are hidden in a special sub-carrier, mixed in with the commercial programming signal, and are undetected by your FM receiver.

The FCC has allowed FM broadcasters to transmit this subcarrier to stores, supermarkets, and businesses who are interested in a continuous flow of soft background music. The broadcaster rents the special decoder to the store. It's illegal for a commercial establishment to decode these programs without the consent of the broadcaster. However it is perfectly all right to listen to these programs privately for your own pleasure.

The sub-carrier is called an S.C.A. channel, and is usually a 67KHz FM modulated signal with a 14KHZ bandwidth. Some broadcasters use a 47 KHz carrier, provided they're not transmitting stereo.

Just a few years ago it would have required several tuned circuits and a fist full of transistors to build an S.C.A. decoder. Now, with the advent of the phase-lock loop circuit I.C., a decoder can be built with just one integrated circuit and its associated components.

Referring to the schematic (Fig. 1), J1 picks up the composite audio signal from your FM tuner. Here a high pass filter attenuates the low frequency components of the signal. The signal is then fed into the input of the phase-locked loop. The J4-1210 consists of a phase detector or comparator, a voltage controlled oscillator, an amplifier, and a low pass filter. (Fig. 2) The VCO is set to 67 KHz by the adjustment of R1. This frequency is then compared to the incoming frequency by the phase comparator. If there is a phase difference, indicating the incoming frequency is changing, the phase detector output voltage increases or decreases just enough to keep the oscillator frequency the same as the incoming frequency, preserving the locked condition. The changing output of the phase comparator is actually the demodulated audio signal. This signal is then amplified and passed through the internal low pass filter and the external three stage low pass filter to provide de-emphasis and attenuated the high frequency noise that often accompanies SCA transmission.

Fig.1 Schematic

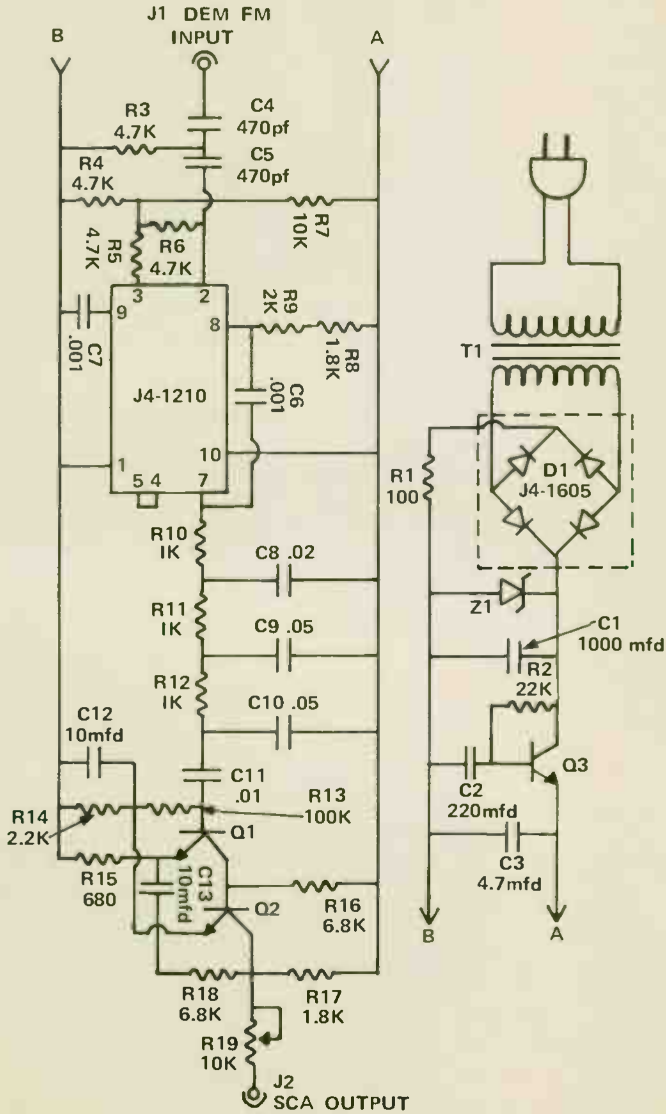
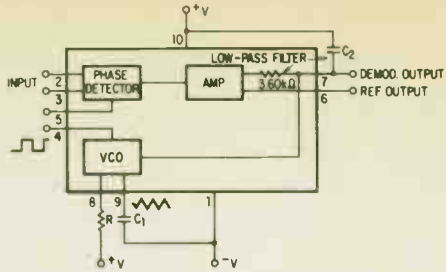


Fig.2



Since the output of the PLL is approximately 50mV this must be amplified again to achieve a output signal of significant amplitude to drive the inputs of the pre-amplifier of your stereo. Q1 , Q2 and their associated components provide this function.

This project may be built on perforated board (J4-616); or preferably the printed circuit board may be produced by using our new J4-828 Lift-It kit and the supplied full size layout Fig.4 (see page 89)

Referring to the component layout (Fig. 4) assemble all resistors and capacitors to the PC board first, followed by the semiconductors and integrated circuit. Be sure to observe polarities of all electrolytics. The center tap wire of transformer T1 may be clipped off. The PC board can be mounted in a H4-742 aluminum chassis box. It provides a very compact attractive enclosure and also provides very effective RF shielding. The chassis layout (Fig. 5) shows dimensions for mounting PC board, AC cord, and RCA jacks. Use 4-40 mounting hardware and 1/4" or 3/8" spacers for securing PC board to chassis. Use shielded cable between the PC board and the input and output jacks.

Fig.4 Component Layout

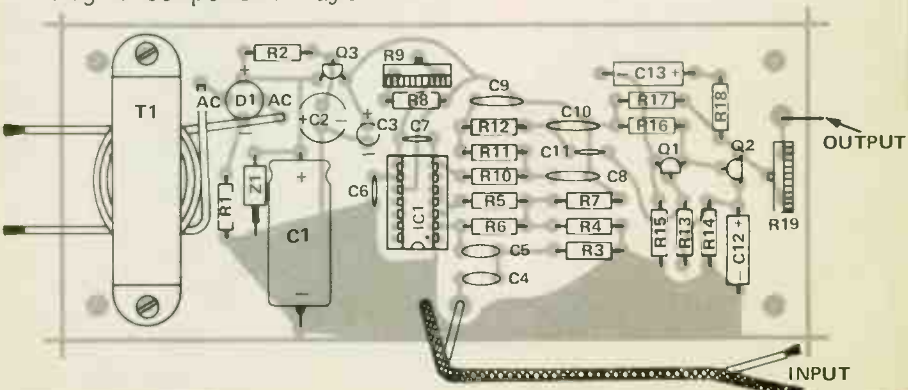
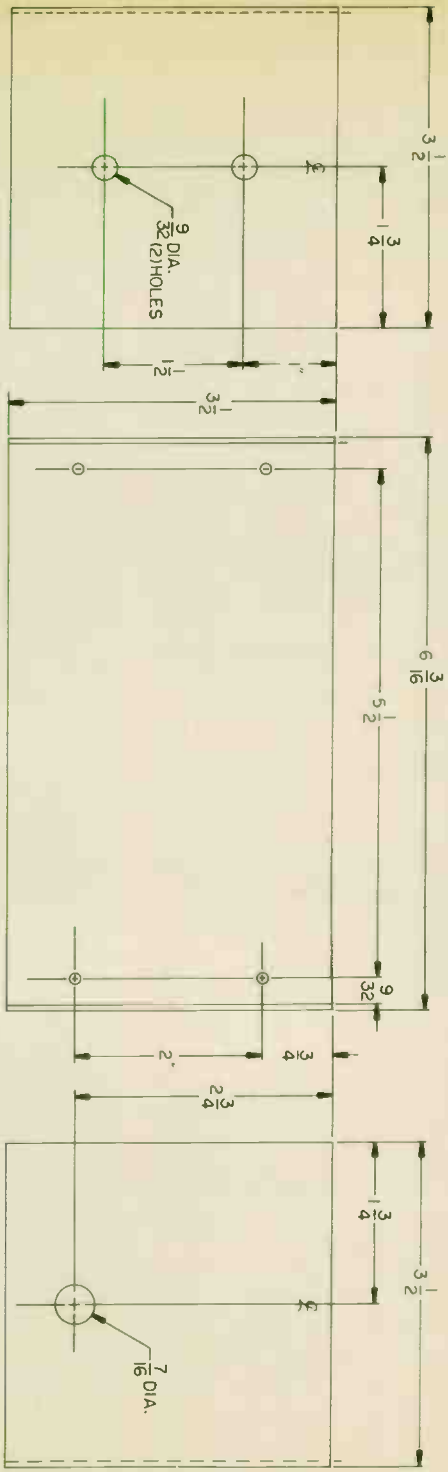
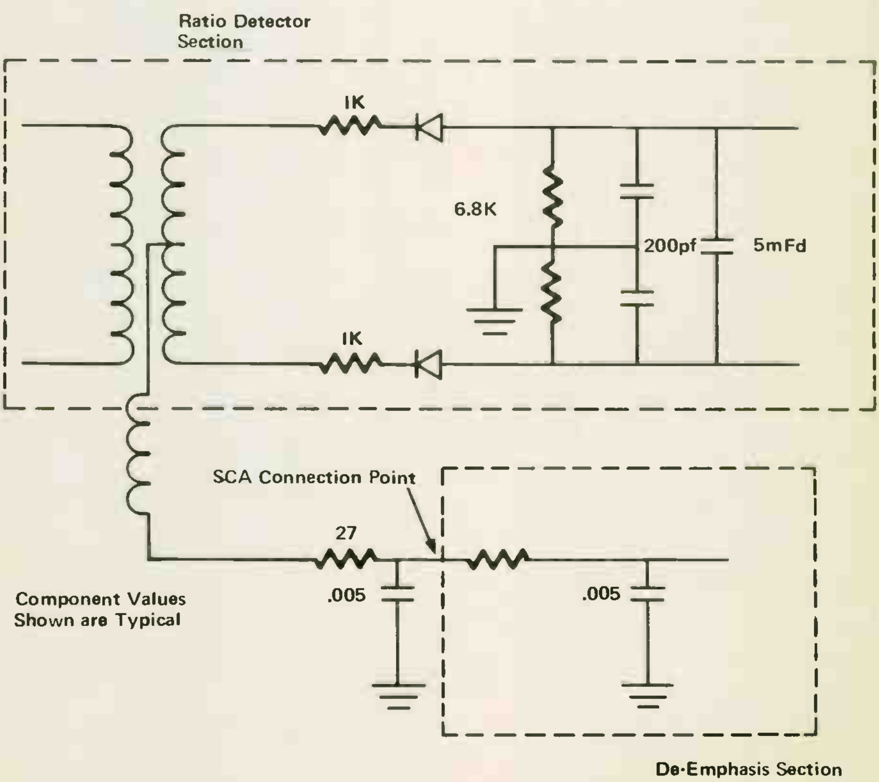


Fig.5
Chassis Layout



The input of the SCA adapter is connected to the tuner section after the ratio detector or discriminator and ahead of any de-emphasis circuitry. Fig. 6 shows a typical connection. Output of the adapter is connected to either the auxillary or tape monitor input on the rear of receiver or amplifier. Adjust potentiometers R9 and R19 to mid-point and plug SCA adapter into 120VAC outlet. Scan the FM dial. The regular FM broadcast may be picked up but it will sound very distorted. Once a SCA station is tuned in adjust R9 and R19 for maximum sound clarity. The most simple way to locate a SCA station would be to contact a local radio station and ask them at what frequency SCA is broadcast in your area.

Fig.6 Typical Hookup



PARTS LIST

SYMBOL	DESCRIPTION	CALECTRO NO.
D1	1.5 Amp Bridge	J4-1605
C1	1000 mfd 25 V Electrolytic	A1-133
C2	220 mfd 12 V Electrolytic	A1-113
C3	4.7 mfd 12 V Electrolytic	A1-103
C4, C5	470 pf	A1-013
C6, C7	.001 mfd	A1-026
C8	.02 mfd	A1-030
C9, C10	.05 mfd	A1-031
C11	.01 mfd	A1-029
C12, C13	10 mfd 12V Electrolytic	A1-104
IC1	Phase-locked loop IC	J4-1210
J1, J2	RCA Jack	F2-806
Q1, Q2	NPN Audio	J4-1644
Q3	Darlington Amp	J4-1634
All resistors 1/2 watt 10% tolerance		
R1	100 Ohms	B1-372
R2	22,000 Ohms	B1-400
R3-R6	4,700 Ohms	B1-392
R7	10,000 Ohms	B1-396
R8,R17	1,800 Ohms (G.C.Part No.)	26-052
R9	2K Trim Pot	B1-643
R10-R12	1,000 Ohms	B1-384
R13	100,000 Ohms	B1-408

PARTS LIST (CONT.)

SYMBOL	DESCRIPTION	CALECTRO NO.
R14	2,200 Ohms	B1-388
R15	680 Ohms (G.C. Part No.)	26-044
R16, R18	6,800 Ohms	B1-394
R19	10K Trim Pot	B1-644
T1	12.6 VCT Transformer	D1-750
Z1	12 V 1 W Zenier	J4-1622

MISCELLANEOUS

QTY.	DESCRIPTION	CALECTRO NO.
1	AC Cord	L3-717
1	Chassis	H4-742
1 Ass't.	Spacers	J4-846
1 Ass't.	Screws & Nuts	J4-834
1 Ass't.	Wire Connectors	L3-768
1	Audio Cable	Q4-250
1	Audio Cable	Q4-256
1	Hook-Up Wire	L3-641
1	IC Socket	F2-1002

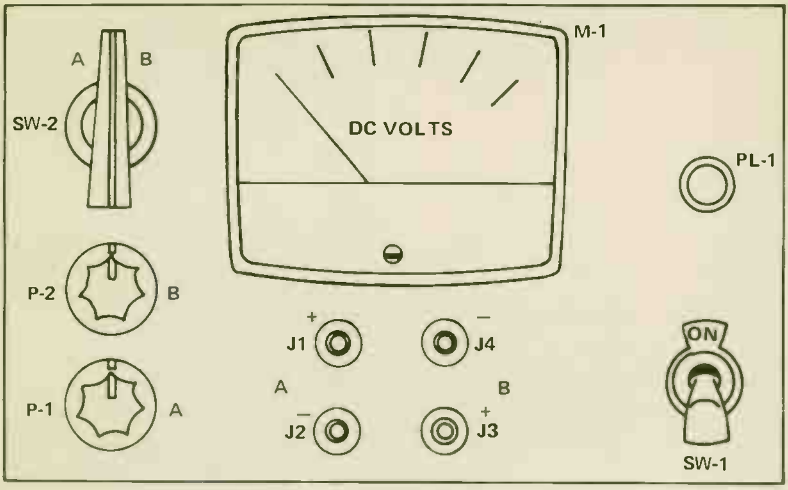
CALECTRO DUAL POWER SUPPLY

Need a dual power supply to power OP-AMP's or MOS shift registers or memories while you work with them on the bench? Build this dual regulated supply, featuring current limiting at 100mA. Two independent supplies, variable from 3 to 20 VDC are included in one cabinet, with a common switchable voltmeter. Because the supplies are separate, they may be used to power two different circuits or strapped to supply, for instance, +5V and -12V.

LAYOUT AND ASSEMBLY:

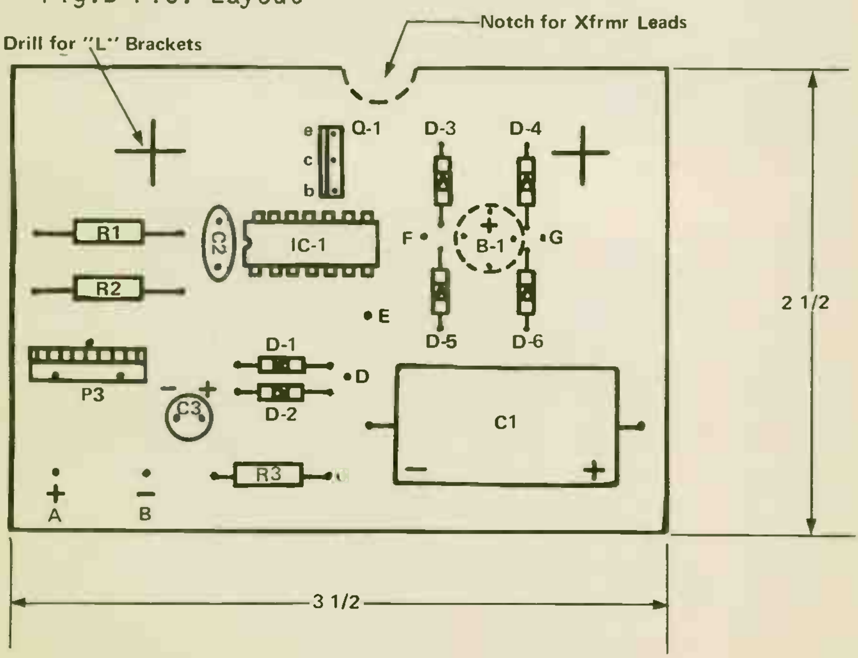
Refer to the illustrations. Layout and mount front panel parts first.

Fig.A Front Panel Layout



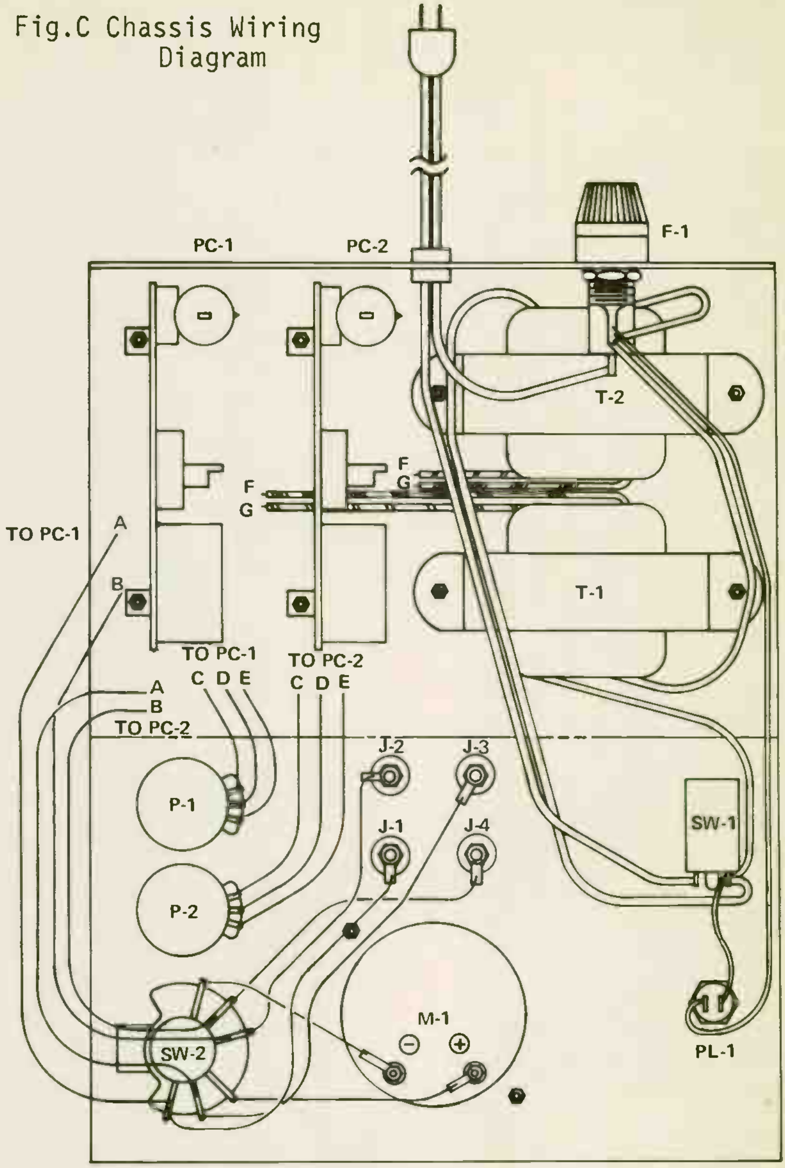
Load and solder the PC boards next (make your boards from the enclosed foil pattern). (Fig.5) (see page 91) Mount the L-brackets to the boards.

Fig.B P.C. Layout



Now position and drill for all bottom and rear chassis parts.

Fig.C Chassis Wiring Diagram



Mount all components except the PC boards. Cut and tape the red/yellow transformer leads. Wire and solder all connections except to PC boards. Allow enough wire length to reach the boards. Check your wiring carefully. Now solder all connections to the PC boards following the letter designations shown on the PC layout and chassis wiring diagram. Mount the PC boards to the chassis.

ADJUSTMENTS:

1) Set the green 10K OHM trimmer pots to mid range.

2) Set voltage - adjust pots P-1 and P-2 counterclockwise.

3) Put meter switch in position "A".

4) Apply power and turn on supply.

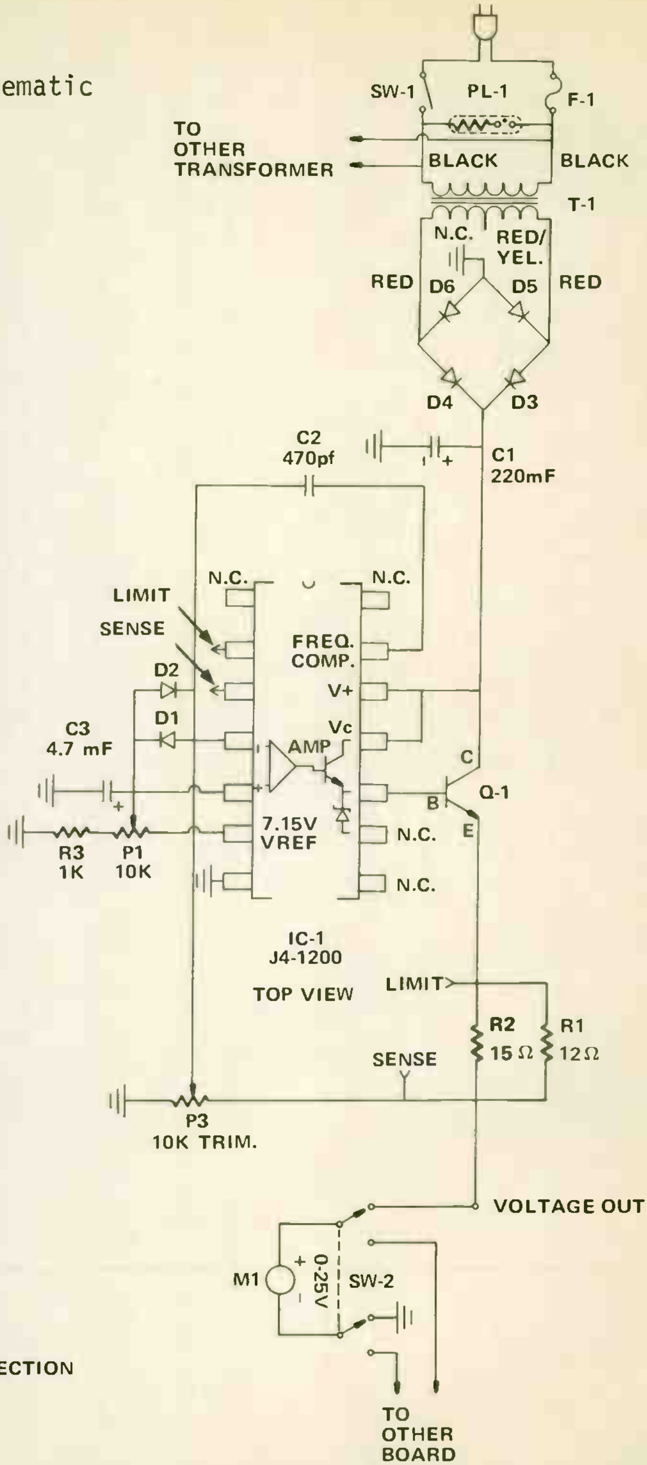
5) Adjust pot on board PC-1 for a meter reading of 3.0V. Do <u>not</u> turn pot to its full extremity.

6) Turn voltage adjust pot P-1 slowly clockwise. Voltage should increase to over 20V.

7) Set voltage with P-1 to 20V. Apply a 220 OHM 2W load resistor to J1 - J2. Voltage should not drop more than 0.5V.

8) Repeat steps 3 and 7 for position "B" and J3-J4.

Fig.D Schematic



N.C.=NO CONNECTION

USE:

For most applications, strap jacks J2 and J3 for "Common" or "ground" connections, using J1 for "+" and J4 for "-". Do not parallel the jacks. If you need more current, do the following: Move transistor Q-1 to the chassis, mounting it with a thermal washer and pad. Extend wire leads from the PC board to the transistor. Change R-1, -2 to smaller values (use 1 watt resistors). Current limiting takes place when the voltage across these resistors reaches 0.65V. For example, a pair of 3.3 OHM resistors for R-1, -2 will current-limit at 0.39A. Do not use smaller values than 3.3 OHM Make these changes for both boards.

PARTS LIST

SYMBOL	DESCRIPTION	CALECTRO NO.
J1, J2, J3, J4	Binding Posts, Pr.	F2-926
F-1	Fuse Holder	E2-495
PL-1	Pilot Lite	E2-420
SW-1	Switch	E2-119
M-1	Meter 0-25V	D1-923
P-1, P-2	Pots 10K	B1-683
SW-2	Rot. Sw.	E2-160
T-1, T-2	Xfrmrs	D1-752
PC-1, PC-2	P-C Boards	------
C-1	220mfd/50V	A1-155
Q-1	Tip 29 Xistor	J4-1649
P-3	10K Minipot	P-3
D-1, D-2	Diode IN 4148	J4-1610
B-1	Optional Bridge Rect. (Use in place of J4-1600's)	J4-1605
C-2	470 Pf	A1-013
IC-1	723C Reg. I-C	J4-1200
D-3, D-6	1N4001 Rect's	J4-1600
R-3	1K OHM 1/2W Res.	B1-384
R-1	12 OHM 1/2W Res.	26-002
R-2	15 OHM 1/2W Res.	B1-362
C-3	4.7 mfd. 12V Cap.	A1-103

QTY.	MISCELLANEOUS	
1	Chassis Box	H4-747
1	Line Cord	L3-717
1	Strain Relief	L3-770
1	Fuse, 1A	D2-127
2	Knobs	E2-705
1	Knob	E2-710
1	L-Brackets, Pkg	J4-641

SUPER CLOCK

Prior to the introduction of integrated circuits, construction of a digital clock would have been a hopelessly complicated task, requiring hundreds of parts and a maze of wiring. Then, in the early 60's as the first integrated circuits became available containing basic logic gates, counters and flip-flops, a digital clock could be constructed using just 12-15 IC's. As a result, many digital clock projects were published in the electronics magazines. However, with these 12-15 IC's you could build only a basic clock. And it cost in the neighborhood of seventy five dollars to purchase the parts.

Now with the introduction of large scale integration, digital clock circuitry has undergone a dramatic cost and size reduction. The J4-4900 L.S.I. integrated circuit contains all of the functions of those 12-15 IC's in just one 28 pin package, and thats just the beginning of the story.

In addition to the basic 6 digit clock, the "chip" contains a calendar which is alternately displayed, a 24 hour alarm, with 10 minute snooze delay, and a 10 hour timer.

Let's take these one at a time. The calendar is displayed for 2 seconds, then the time for 8 seconds. The date is displayed as two numbers; thus May 15 becomes 5 15. Once you set the correct date, the proper number of days are counted for each month. The calendar must be corrected only once every leap year when February contains 29 days instead of the usual 28 days.

The 24 hour alarm can be preset for any time A.M. or P.M. and will sound only at this time. Pressing the snooze switch shuts off the alarm for ten minutes after which it again sounds. Another switch turns off the alarm.

The 10 hour timer can be preset to any time interval of 1 minute - 9 hours 59 minutes. When the timer switch is activated, the timer counts down one minute at a time until it reaches zero. With the addition of the relay board of Fig.5 page 33 you can use the timer or the 24 hour alarm to turn on any device for a specified interval or to turn on the device after a preset time interval.

CONSTRUCTION

Constructing the digital clock is quite simple due to use of two circuit boards, one for the main circuit, and one for the six digit display. The full size patterns of figure 1 & figure 2 can be duplicated with the Calectro Lift-It kit, (Fig 6 & Fig 7). (See Pages 93 & 95) After you have etched and drilled both boards insert and solder all parts following the illustrations. Be certain that all diodes, IC's and transistors are correctly oriented before soldering them into place. It is strongly recommended that you use a socket for the clock chip, as the IC is susceptible to damage from static electricity. Carefully insert the IC into the socket after all parts have been mounted to the board and all connections made between the boards and the swtiches. Handle the clock chip by the ends, avoiding as much as possible touching the pins.

The many connections between the boards and the switches are letter coded. Example: point K on the main circuit board is connected to point K on the display board. You should have no trouble making these connections if you carefully follow the illustrations.

You can enclose the clock in any suitable case. We assembled ours in the Calectro H4-747 case which we trimmed down in height to give the clock a modern, low profile. Mount the display to the base of the cabinet with brackets and cover the display surface with clear or red transparent plastic. GC 22-294 rubylith is a flexible film which is ideal as contrast increasing filter for the display. However, since the film is flexible it will require a clear plastic backing of some type.

The relay board is not shown installed in the clock but if you wish to add this feature make the connections between this board and the main circuit board as shown and mount the relay board wherever convenient.

OPERATING INSTRUCTIONS

Referring to figure 3, setting any function is very simple. Just rotate the rotary switch to the desired function, push down the momentary hour/month switch and the hour digits will advance at one count per second. Release the button when the desired number is reached. Then depress the min./day switch until the desired number is displayed. Each function is independently set and will not affect any other setting. The other switches perform as labelled. Close the alarm switch and the alarm will sound at the preset time. Push the snooze button momentarily and the alarm ceases for 10 minutes. The 12/24 hour mode switch selects conventional 12 hour timing or the 24 hour format. The alternate/clock-only switch selects either the alternating time and calendar display or clock-only display. The timer switch actuates the timer countdown.

Well, there you have it. A digital clock that is much more than just a clock. We think that after you build it and check out the many features it contains, you will see why we call it the "Super Clock".

DIGITAL CLOCK PARTS LIST

SYMBOL	DESCRIPTION	CALECTRO NO.
R1	68 ohm	*26-020
R2	460 ohm	*26-042
R3, R8,R15-R29	22K ohm	B1-400
R4, R30	27K ohm	B1-401
R6, R7	1K ohm	B1-384
R9-R15	47 ohm	B1-368
R31	5.6K ohm	*26-066
R32	4.7K ohm	B1-392
R33	22 ohm	B1-365
R5	10K ohm	B1-396
C1	1000 uf. 25V	A1-133
C2	220 pf. silver mica	A1-008
C3	.01 uf. disc.	A1-066
D1, D6-D17	Silicon signal diode	J4-1610
D2, D3	Silicon diode	J4-1600
D4	9V zener diode	J4-1620
D5	12V zener diode	J4-1622
Q1	PNP power transistor	J4-1648
Q2	NPN transistor	J4-1628
Q3	NPN darlington trans.	J4-1634

IC1	7001 clock/calendar	J4-4900
IC2, IC3	Quad digit driver	J4-970
IC4	Hex digit driver	J4-971
SW1-SW3	SPST momentary switch	E2-140
SW4, SW5, SW7, SW8, SW6	SPST miniature toggle switch	E2-116
SW8	2 pole 5 position rotary switch	E2-163
DY1-DY6	.3" 7 segment display	J4-901
SP1	Miniature speaker	S2-215
SO1	28 pin IC socket	F2-1006
LED1, LED2	Light Emitting Diode	J4-940

MISCELLANEOUS

QTY.		
1	Hook-up wire	L3-633
1 Ass't.	Mounting Hardware	J4-834
1 Ass't.	Spacer assortment	J4-846
1	Rubylith film	*22-294
1	Line cord	L3-717
1	Blank copper board	J4-604
1	Knob	E2-705
1	Cabinet	H4-747

* Indicates GC part, not offered in Calectro

Relay Board Parts List

RY1	12Vdc relay	D1-967
Q4	NPN Darlington transistor	J4-1634
R31	100K ½ watt resistor	B1-408
R35	22K ½ watt resistor	B1-400
SO1, SO2	AC receptacle	F3-100

Fig.1 Component Placement Main Board

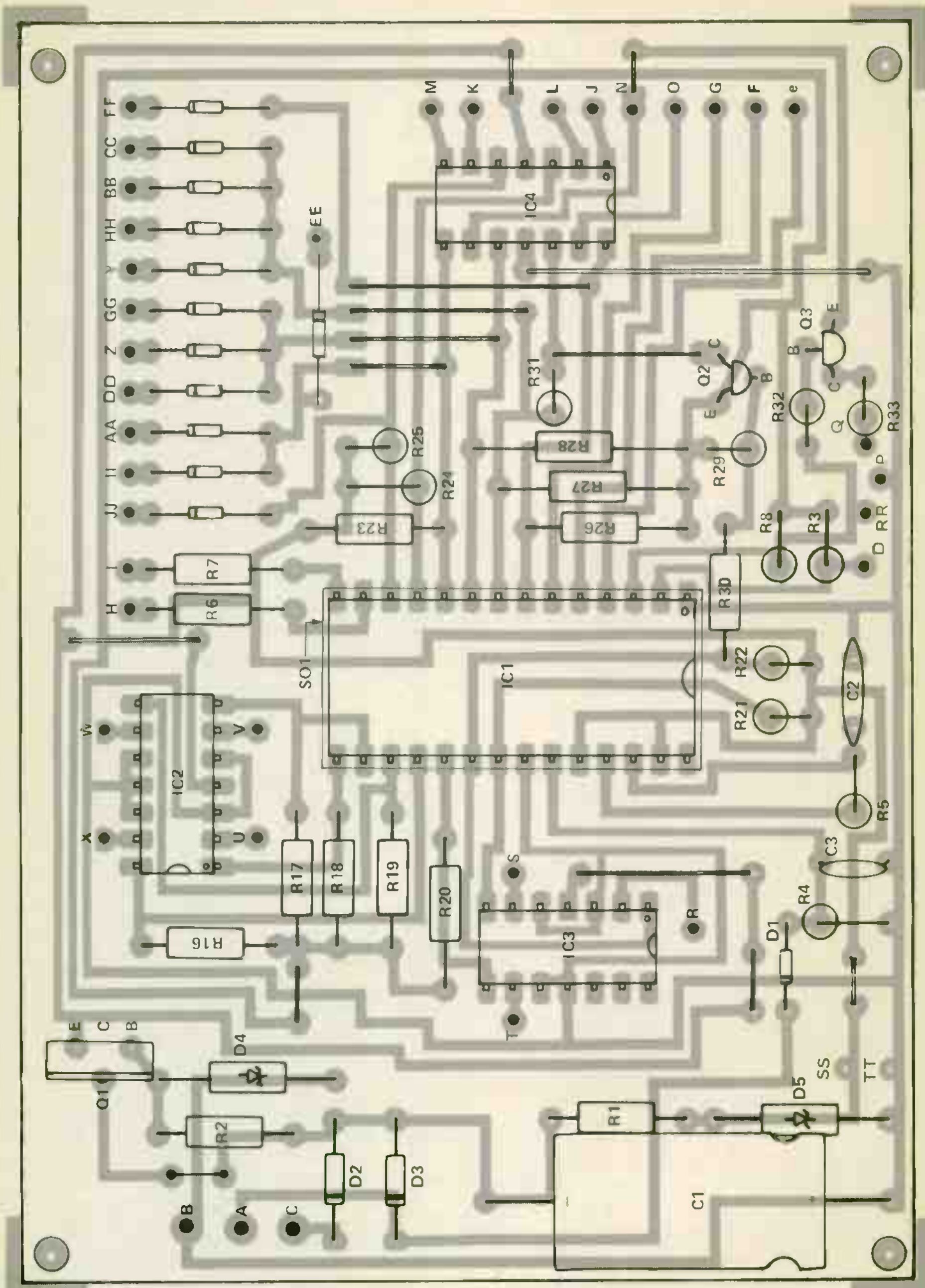
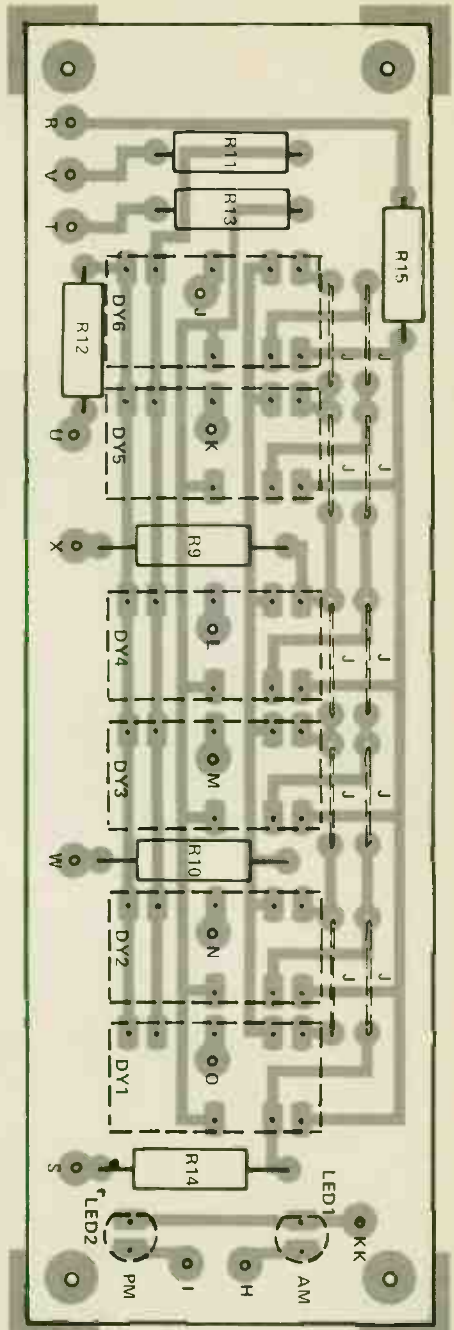


Fig.2 Component Placement
Display Board

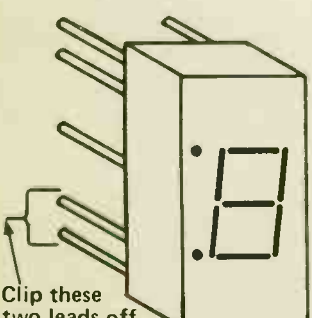
J=indicates jumper wire

Components shown by dotted lines are mounted to component side of board.

You will have to remove two leads from Displays before inserting them into board

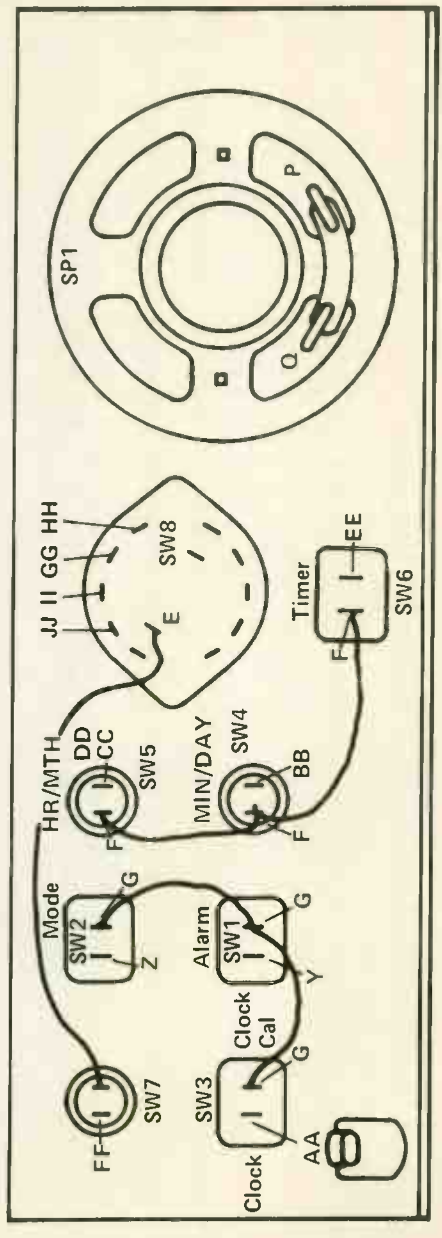


Digital Clock



Clip these two leads off before setting displays in board

Fig.3 Rear Panel Switch Connections



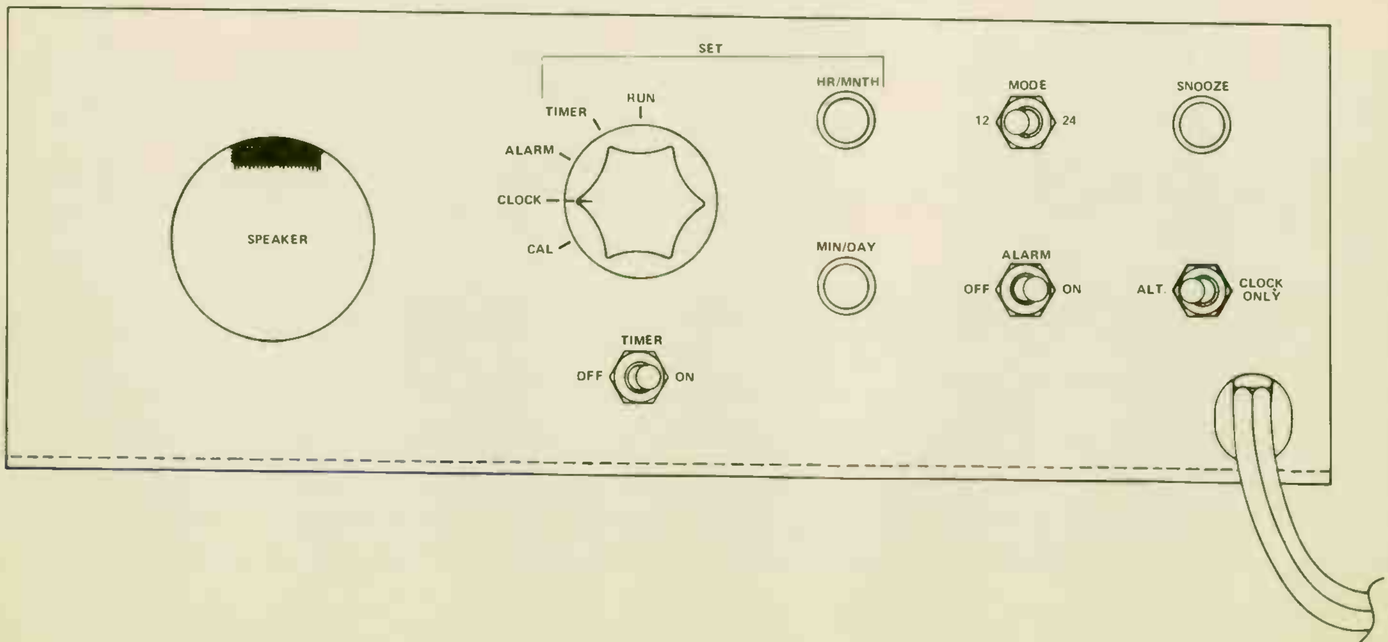


Fig.3 Rear Panel Functions

Fig.4 Assembly View of Clock

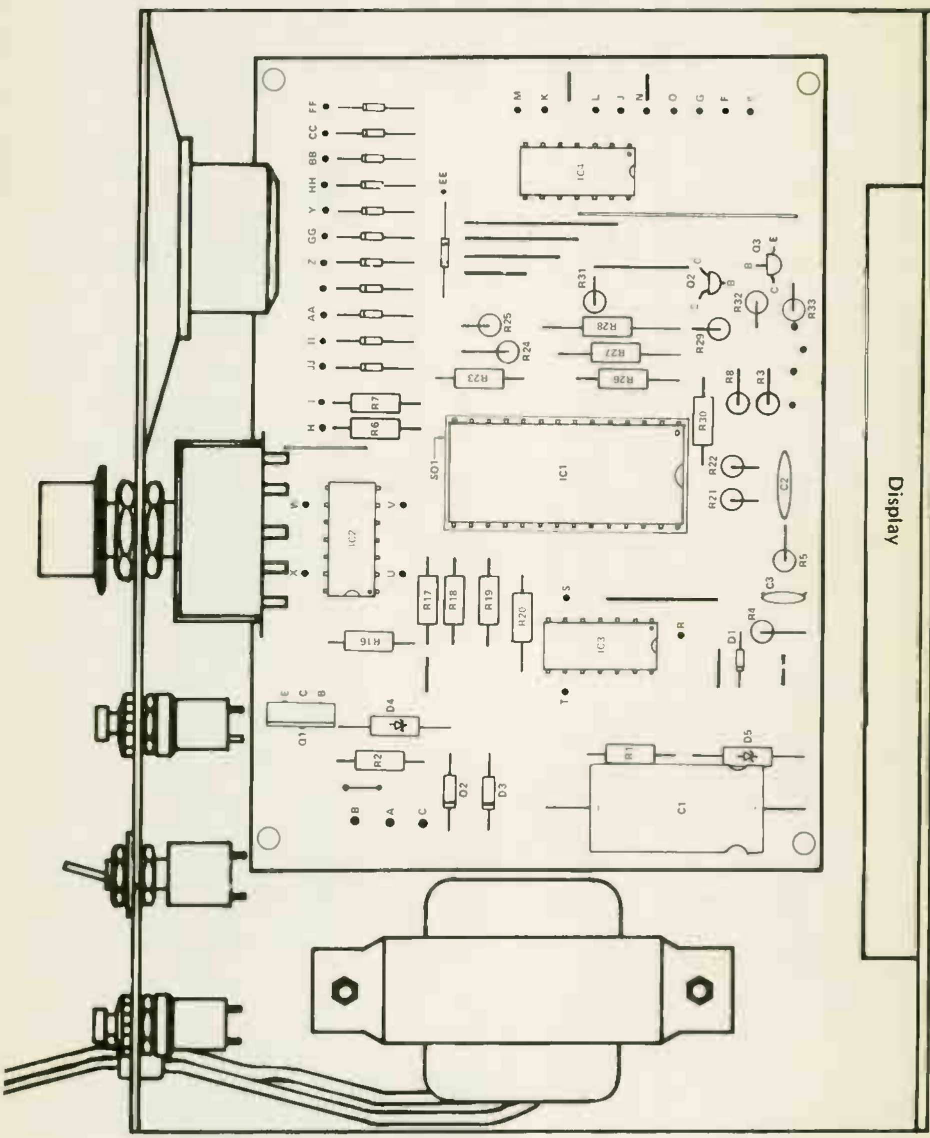
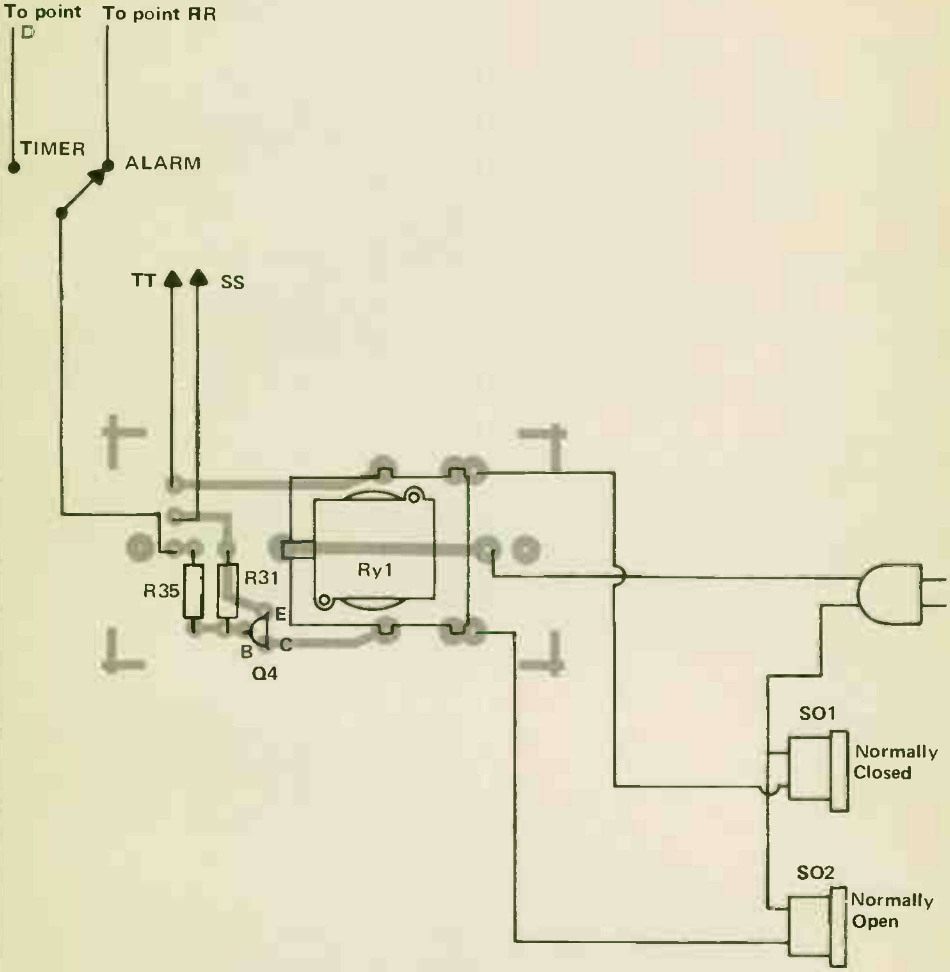
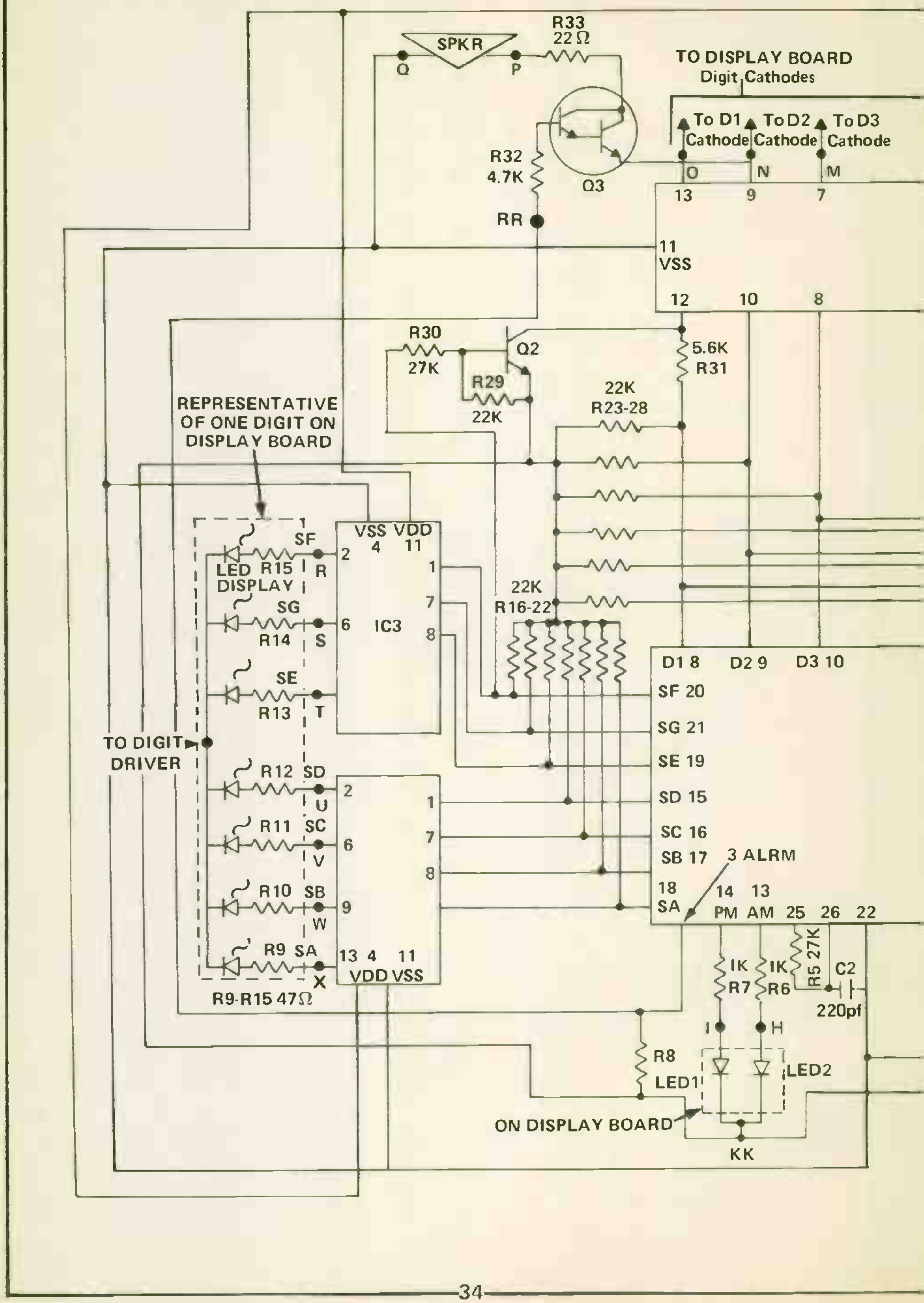


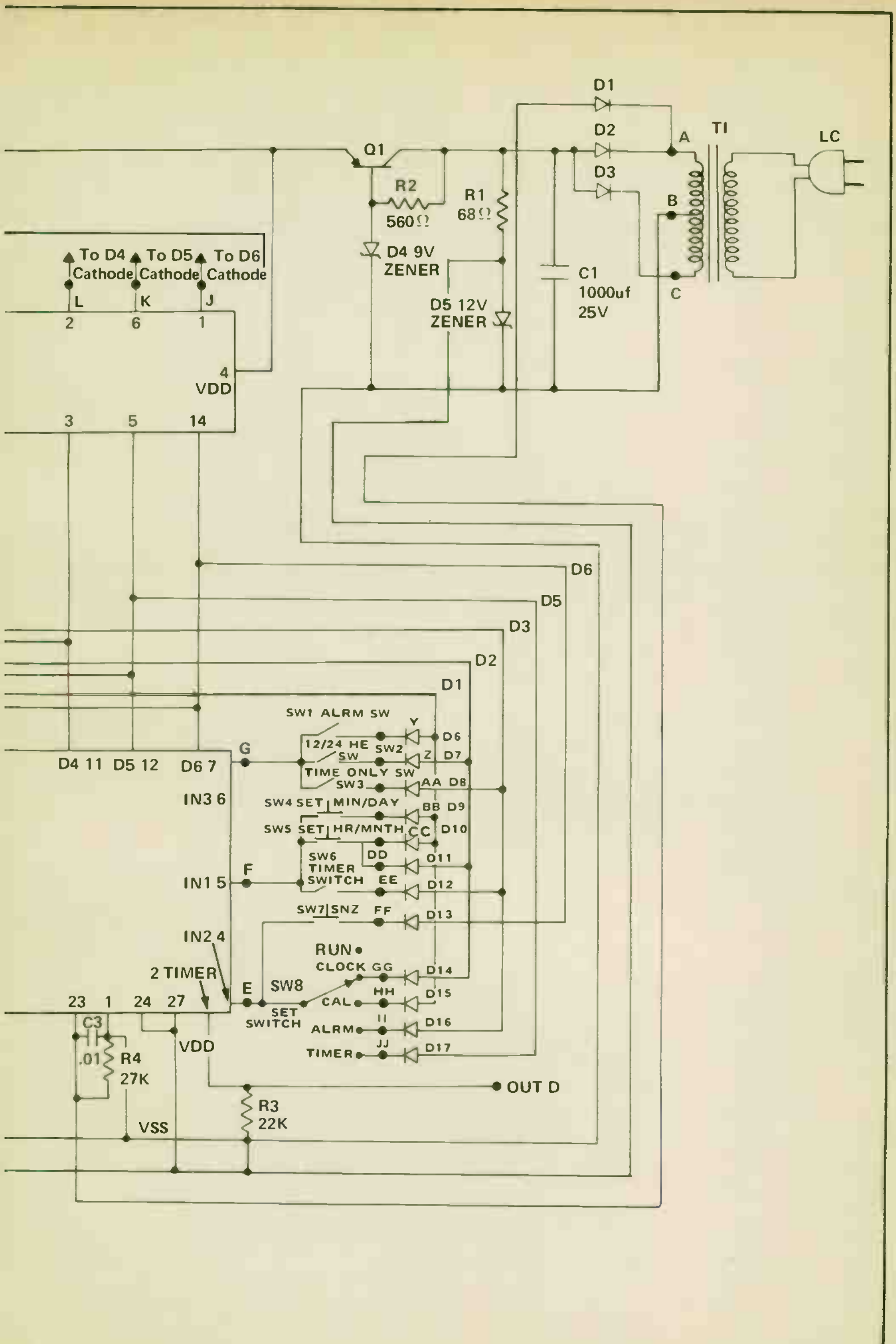
Fig.5 Relay Board Assembly



(See page 97 Fig.8
For full size P.C. pattern)

Fig.6 Schematic





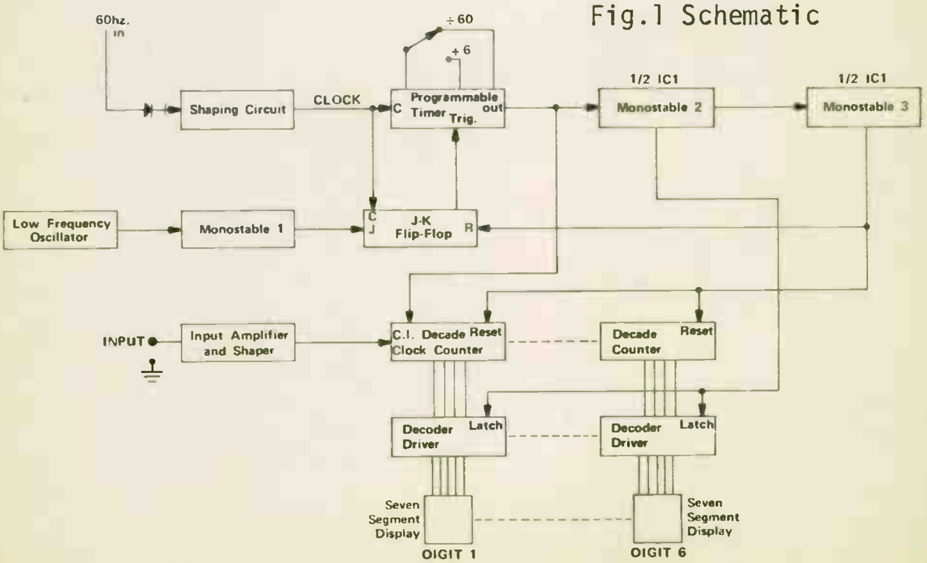
D1
D2
D3
A
TI
LC
Q1
R2
560Ω
R1
68Ω
B
C
D4 9V
ZENER
D5 12V
ZENER
C1
1000uf
25V
To D4 Cathode
To D5 Cathode
To D6 Cathode
L
K
J
2
6
1
4
VDD
3
5
14
D6
D5
D3
D2
D1
SW1 ALRM SW
12/24 HE SW
SW2
TIME ONLY SW
SW3
SW4 SET MIN/DAY
SW5 SET HR/MNTH
SW6 TIMER SWITCH
SW7 SNZ
RUN
CLOCK
CAL
ALRM
TIMER
SW8
SET SWITCH
Y
Z
AA
BB
CC
DD
EE
FF
GG
HH
II
JJ
D6
D7
D8
D9
D10
D11
D12
D13
D14
D15
D16
D17
G
F
E
D4 11
D5 12
D6 7
IN3 6
IN1 5
IN2 4
2 TIMER
23
1
24
27
C3
.01
R4
27K
VDD
VSS
R3
22K
OUT D

CALECTRO FREQUENCY COUNTER

The frequency counter is a recent addition to the range of test equipment available to the serviceman and hobbyist. This device, made possible with the introduction of digital integrated circuits provides a quick means of determining the true frequency of operation of any frequency source. This can be an invaluable aid in experimenting with and servicing audio, digital, and low frequency RF circuits. This article describes a low cost frequency counter you can build.

The frequency counter presented here is a six digit unit with a maximum count frequency of about three mhz. The accuracy of the counter is determined by that of the 60 hz line frequency since this is used as a timebase. Though not as stable as a crystal timebase, the line frequency is stated to be accurate to .03%, or three parts in ten thousand. Thus, when displaying a frequency of 10,000 hz. the last digit is accurate to ± 3 counts. If you require better accuracy, you can modify the circuit so that another more stable 60 hz source is inserted into D3 in place of the line frequency. However, this modification will be left to the discretion of the experimenter and will not be discussed further here. For most applications the line time base will prove more than adequate.

Fig.1 Schematic



Here, in brief form, is how the frequency counter operates. Referring to figure 1, the 60 hz line frequency is run into the shaping circuit where it is squared up for use as the clock input to the programmable timer and the J-K flip-flop. The low-frequency oscillator and monostable which feed into the J input of the J-K provide a short pulse about once every three seconds which changes the Q output of the J-K to a logic one, coincidently with the rising edge of the clock waveform, triggering the programmable timer.

The timer can be arranged to divide by any integer from 1 to 256; in this application it is set up to divide by 6 or 60, selectable from a switch on the front panel, providing timing intervals of 100 milliseconds and one second respectively. The output of the timer remains low for this interval, then resets to a high state. As long as the output of the timer is low the decade counters are enabled. They count the input frequency which first passes thru an amplifier and shaper. As the timer output resets, the counters are disabled, but whatever count they have reached remains at their outputs.

Upon the positive transition of the timer output, monostable 2 is activated producing a short inverted pulse which is applied to the latch inputs of the six decoder-drivers. This transfers the previous count which appears at the counter outputs and at the decoder/driver inputs to the decoder-driver outputs, and thus to the displays.

As monostable 2 resets, it triggers monostable 3 which produces another short pulse which resets the counters and the J-K flip-flop. The frequency counter is then in a reset state awaiting another pulse from the low frequency oscillator-monostable which will initiate another counting sequence. Thus, the frequency counter sums the incoming frequency once every three seconds, updating the display following each count.

With SW1 in the one second position the maximum displayable frequency is 999 kilohertz. Using the .1 second timebase the maximum count is limited to about 3 megahertz, due to the maximum toggle rate of the CMOS logic. Swl also selects the appropriate decimal point along with the proper LED labelled KHZ or MHZ.

CONSTRUCTION

The control circuitry as well as the input amplifier and shaper are contained on the main PC board, shown full size in Fig.9 (see page 99). A separate printed circuit board is required for each of the six decade counter-digit drivers. Fig.10 (see page 101)contains a full size pattern for these six boards. The pattern is repeated six times so that it can be etched on one 4½ x 6" copper board and then separated into the six individual boards, after etching.

The printed circuit board for the 6 2/3" displays is illustrated in the decade counter project presented elsewhere in this book. Refer to this article for the full size pattern and the component mounting illustrations. Connections between the display board and the six digit driver boards are greatly simplified by the use of Digi-Klips R as shown in the decade counter article.

After you have etched and drilled all of the printed circuit boards, insert and solder all components to the boards following the illustrations. Be especially careful that lead orientation is correct before soldering diodes, IC's, and transistors. Also, note that the tantalum and electrolytic capacitors must be mounted with their plus terminals oriented as in the illustrations. A word of caution about the CMOS ICs: handle these IC's by the body only, avoiding touching the pins as much as possible. Insert and solder the CMOS IC's after all other components have been soldered into place. It is also good practice to attach a clip lead from the tip of the soldering iron to the ground foil on the circuit board while soldering these IC's to the board. If you wish, the IC's can be mounted in sockets, eliminating the possibility of damage during soldering.

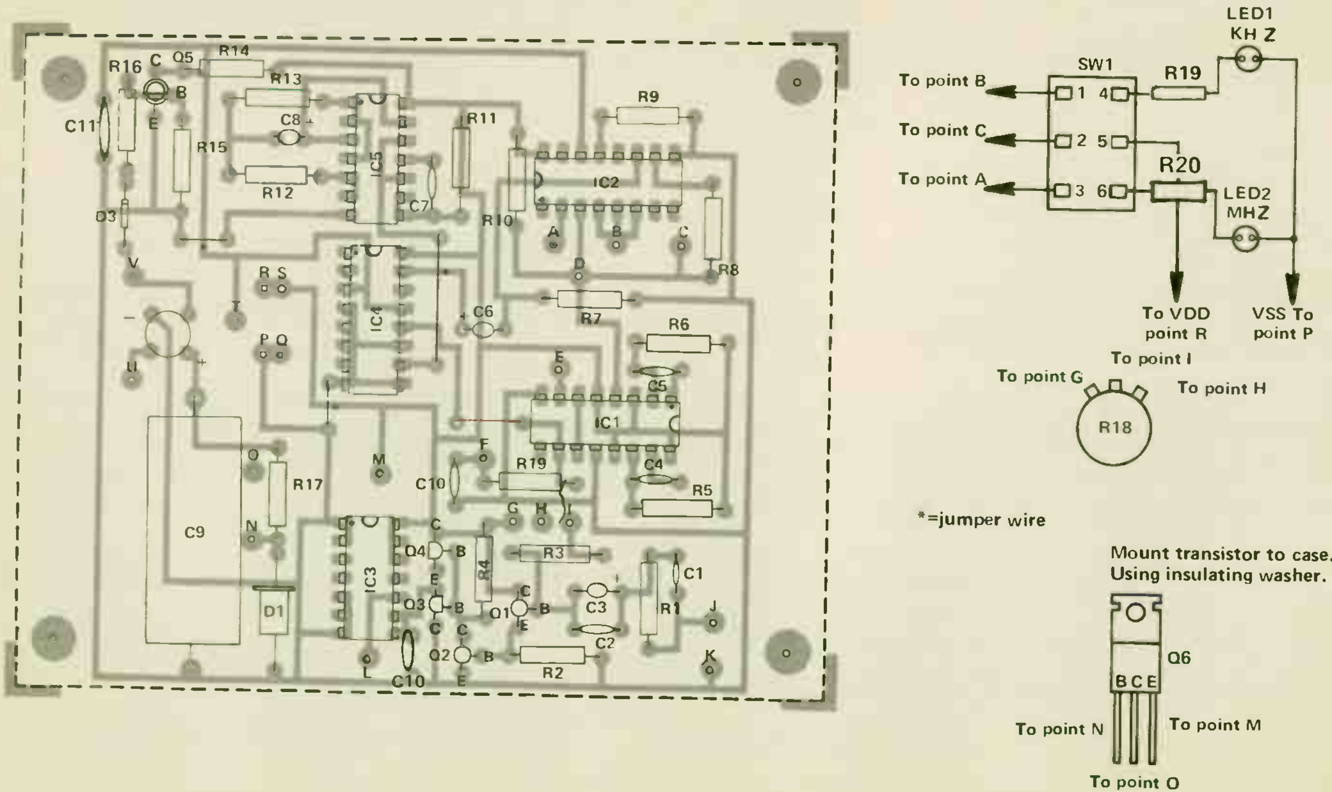
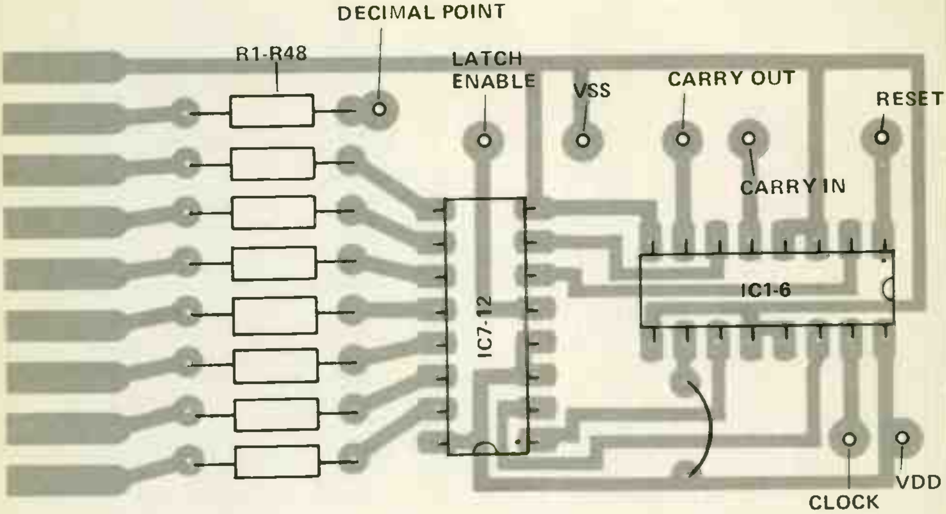


Fig.2 Main Board Component Diagram

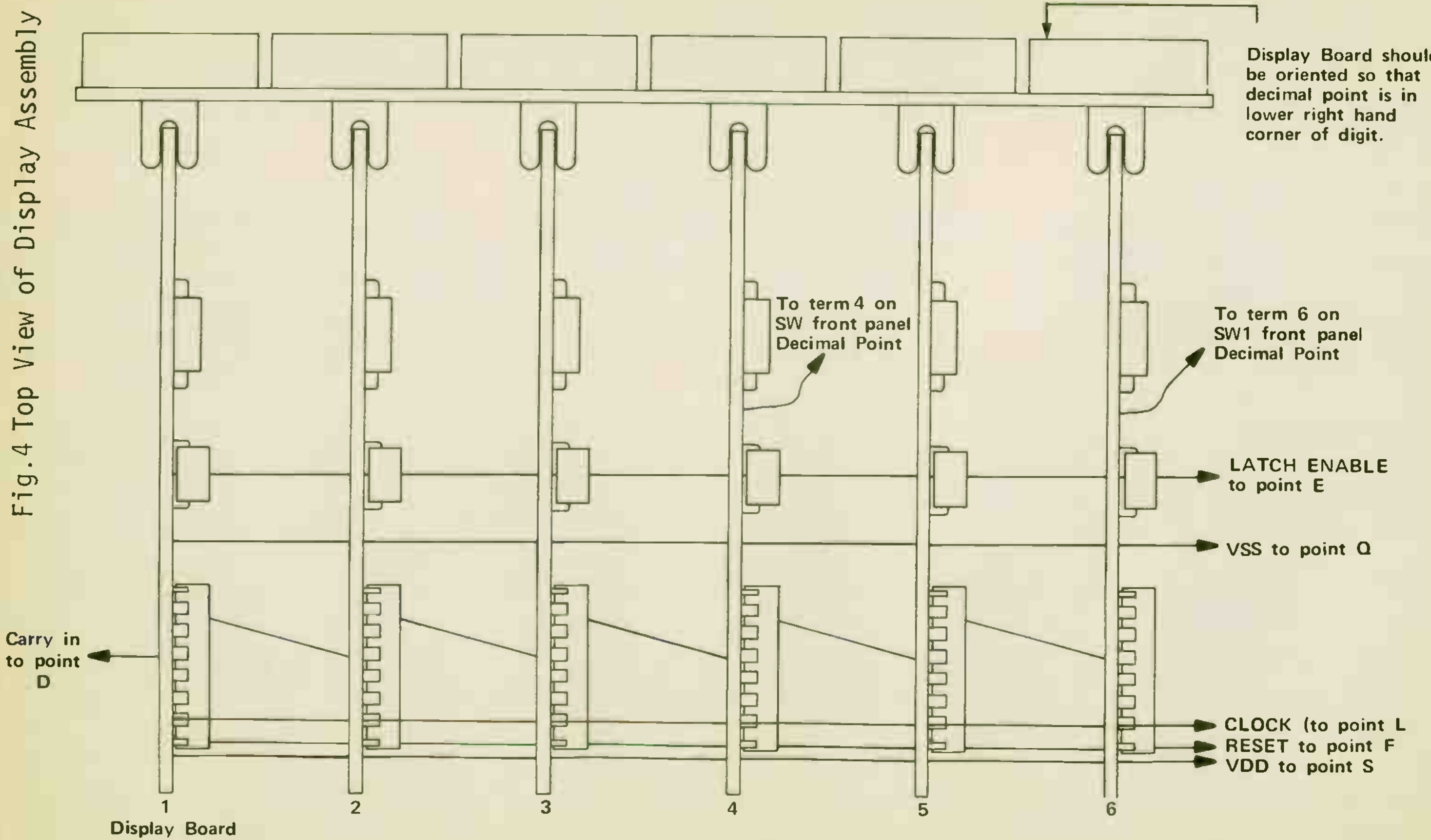
Fig.3 Component Mounting Digit Driver Board



(See fig. 10, page 101 for full size PC pattern)

After you have assembled the main circuit board, the six digit driver boards and the display board, plug the driver boards into the display board and connect the six boards as described here and illustrated in figure 4. Wire all latch enable terminals in parallel on the six boards. You can do this by feeding a bare wire thru each of the latch terminals, soldering the wire at each of the boards. Following this procedure wire all clock terminals together, Vss terminals, Vdd terminals, and reset terminals. Then connect the carry-out terminal of board 1 to the carry-in terminal on board 2; the carry-out terminal of board 2 to the carry-in terminal of board 3, etc., until you make the last connection between the carry-out terminal of board 5 and the carry-in terminal of board 6. All connections between the driver boards and the main board are also illustrated in figure 4.

Fig.4 Top View of Display Assembly



The frequency counter can be enclosed in any suitable case; we chose the Calectro H4-748 case. Figure 5 illustrates the assembly of the counter into this case. Make all connections between the power switch, the timebase switch, the LEDs, the transformer, and the input terminals as you assemble the counter into the case. A suggested front panel arrangement is shown in figure 6.

Fig.5 Frequency Counter Assembly

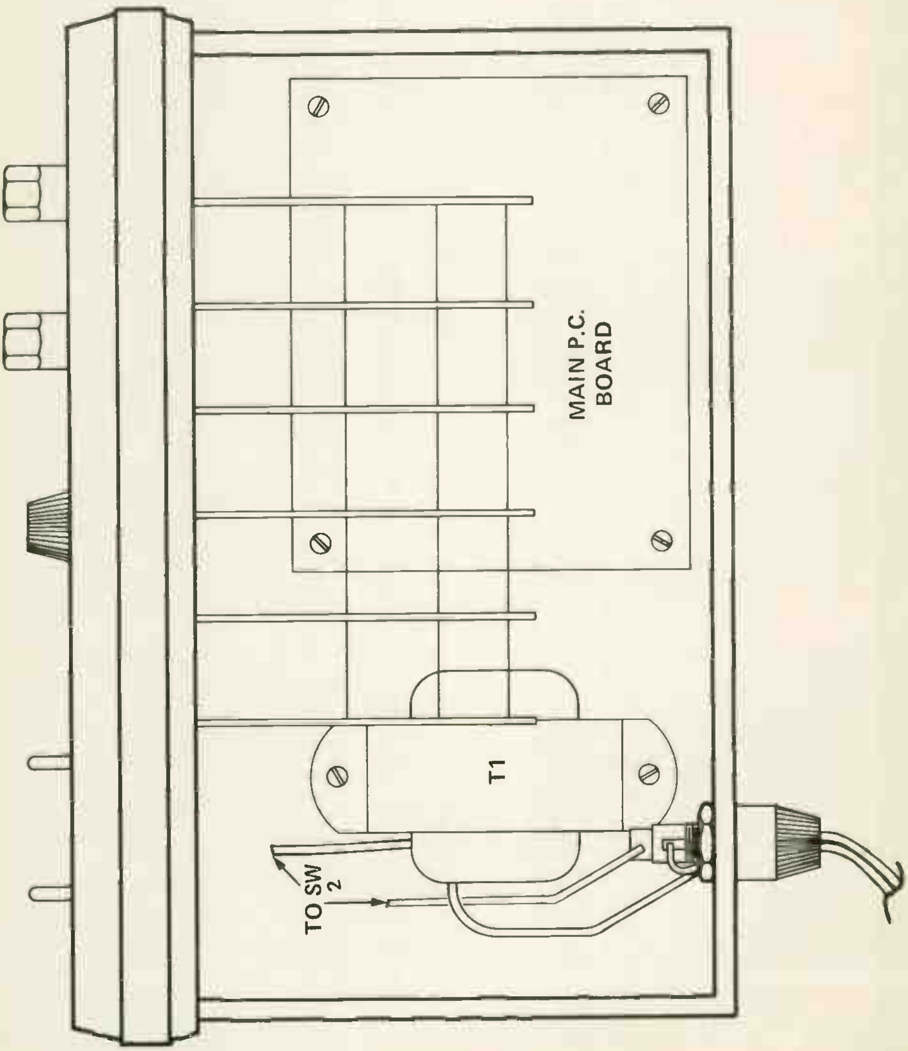
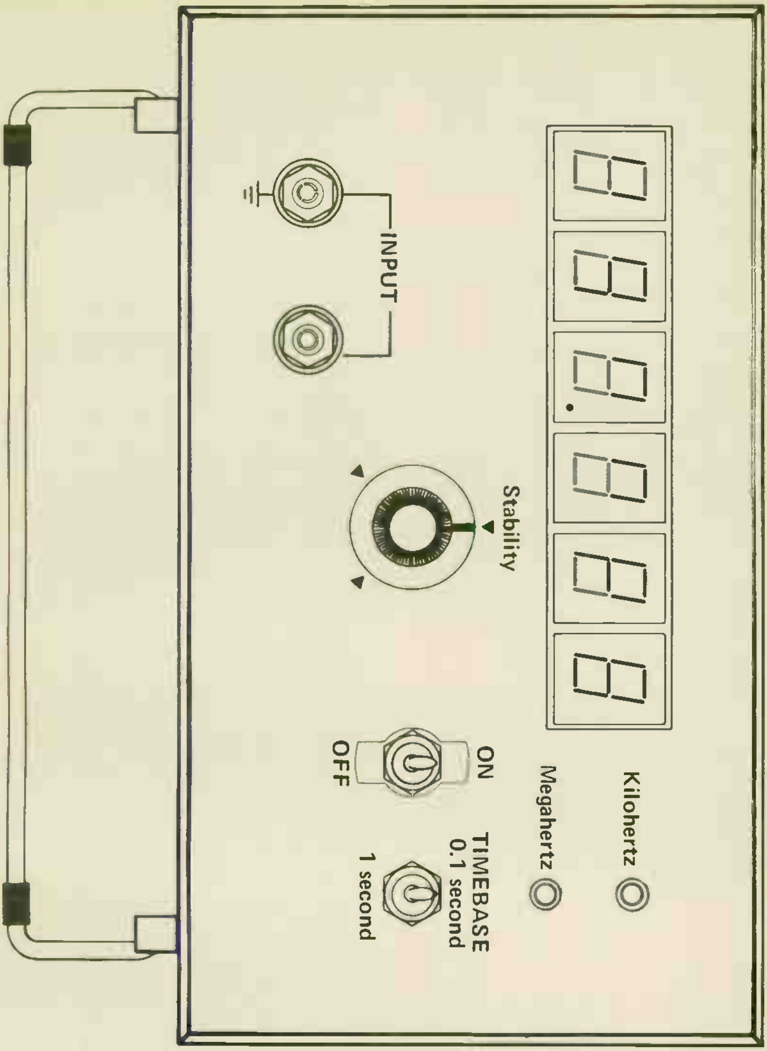
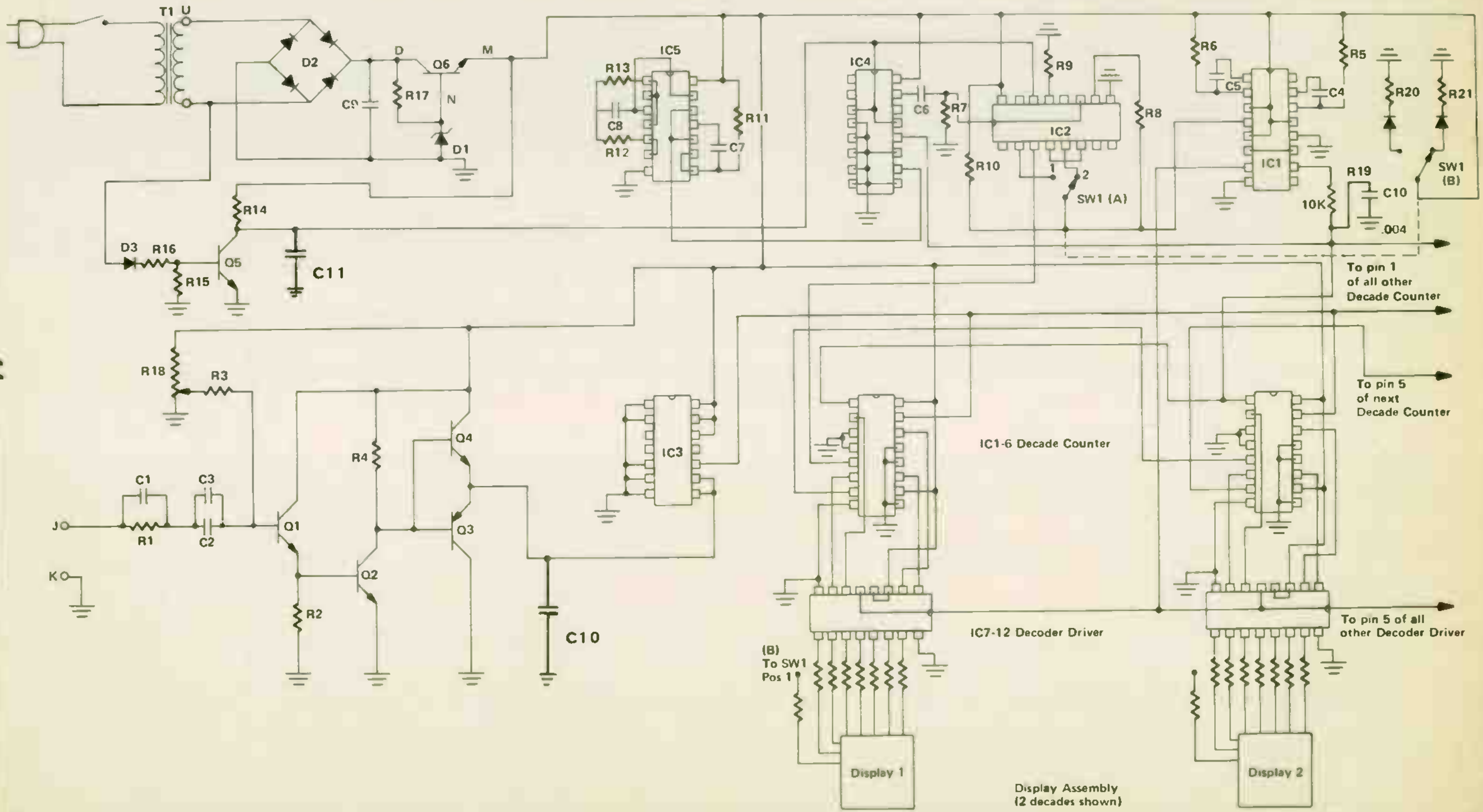


Fig.6 Finished Frequency Counter



No calibration is necessary after completion of the frequency counter. All that is required to check the proper functioning of the counter is some frequency source of known accuracy and stability. Connect this to the input of the counter and adjust R18 for a stable reading. The resultant measured frequency should be within the stated accuracy of the frequency source plus that of the frequency couner. The minimum input amplitude is approximately 200mv.

Figure 7 Schematic Diagram of Frequency Counter



FREQUENCY COUNTER

PARTS LIST

Main Board

SYMBOL	DESCRIPTION	CALECTRO NO.
R1,R3,R5,R6	100K All resistors	B1-408
R7,R11,R13,	½ watt	
R2,R9,R19,R20	1K	B1-384
R4	820	*26-046
R8	56K	*26-090
R10	5.6K	*26-066
B12	220K	B1-412
R14,R15	2.2K	B1-388
R16,R17	390	*26-038
R18	10K Potentiometer	B1-683
C1,C10	33pf silver mica	A1-003
C2,C11	.01 disc	A1-066
C3,C6	1 mfd tantalum	A1-304
C4,C5	.004 mfd mylar	A1-078
C7	.47 mfd tantalum	A1-302
C8	10 mfd tantalum	A1-308
C9	1000 mfd electrolytic	A1-133
Q1,Q2,Q5	NPN type 2N2222	J4-1628
Q3	PNP type MPSAS6	J4-1650
Q4	NPN type MPSAo6	J4-1651
D1	12V zener diode	J4-1622
D2	Full wave bridge	J4-1605
D3	Silicon signal diode	J4-1610
IC1	Dual monstable	J4-4098
IC2	Programmable timer	J4-1214
IC3	Quad Schmitt trigger	J4-4093
IC4	Dual J-K flip flop	J4-4027
IC5	Quad 2-input norgate	J4-4001

Decoder/Driver and Display Boards Parts List

R1-R48	390 ohm	*26-038
IC1-IC6	Decade counter	J4-4029
IC7-IC12	Decoder,driver,latch	J4-4511
Display 1-6	.6"7' segment LED display	J4-903
3 pkg	Digi-clips	J4-645

Chassis

T1	12V 2A Transformer	D1-747
LED1,LED2	Light emitting diode	J4-940
SW1	DPDT toggle switch	E2-133
SW2	SPST toggle switch	E2-130
BP1,BP2	Binding Posts	F2-926

MISCELLANEOUS

QTY.		
1	Aluminum Cabinet	H4-748
1	Rubylith filter	*22-294
1 Ass't.	Mounting Hardware	J4-834
1	Hookup wire	L3-633

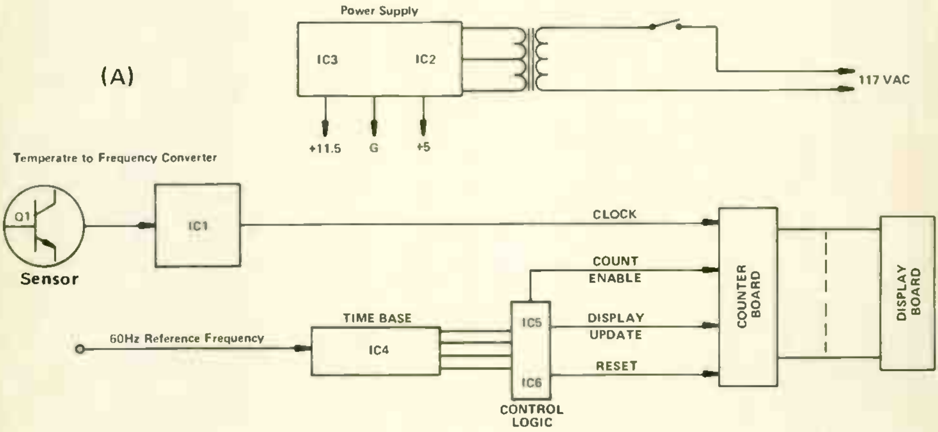
* = denotes GC no.: item not offered in Calectro

CALECTRO C-MOS DIGITAL THERMOMETER

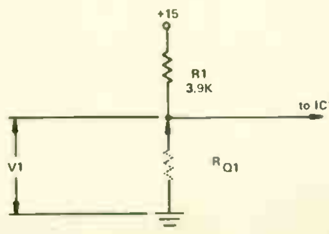
The advances in I.C. technology have made possible projects that a few years ago would have been staggering due to complexity and component count. The CALECTRO Digital Thermometer uses two discrete transistors and five diodes, all other functions being implemented by I.C.'s. The thermometer can be used to not only measure indoor or outdoor temperatures, but also to monitor other air or liquid temperatures from below 0°F to over a 100°F.

Fig. 1A, 1B, & 1C.

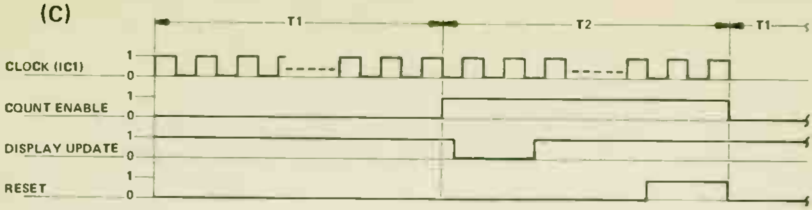
(A)



(B)



(C)



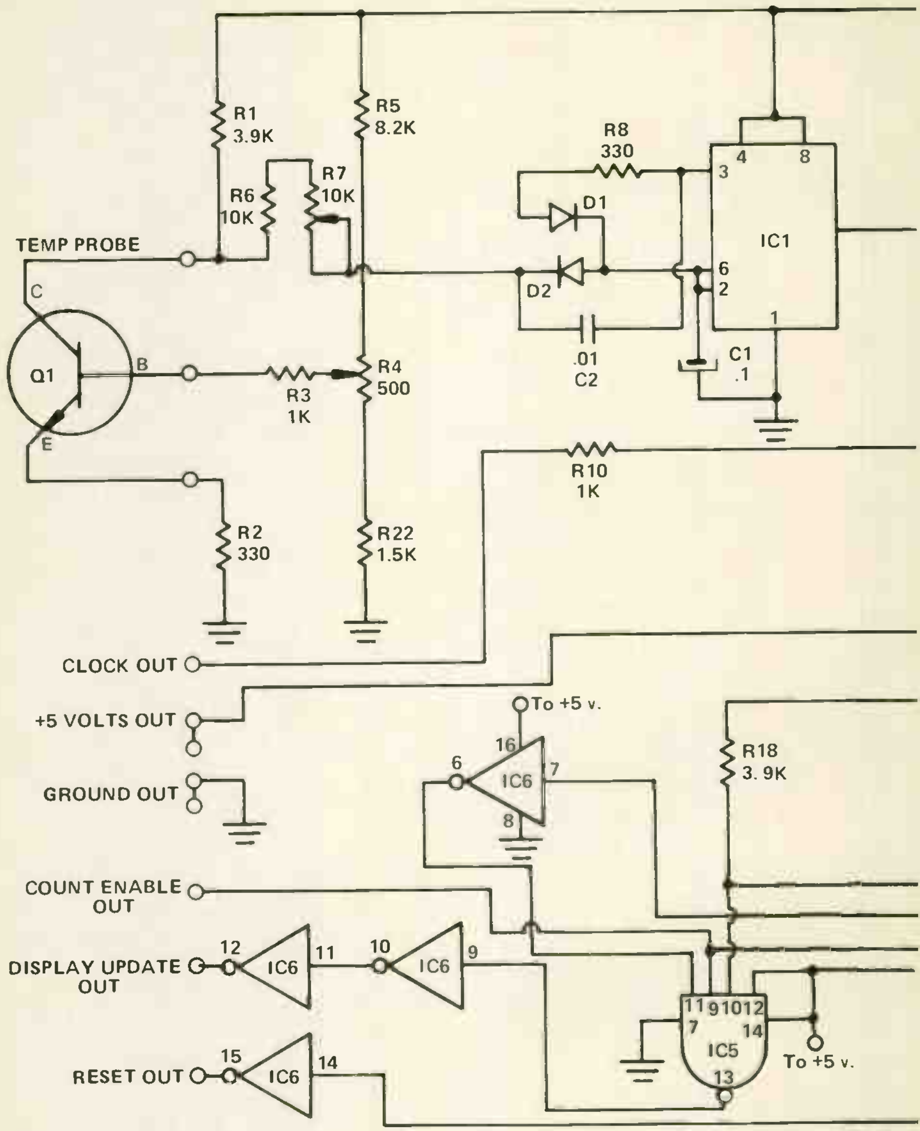
OPERATION:

The digital thermometer consists of six major sections (Fig. 1a.). A common drawback of all transistors is their change in beta with a change in temperature. This characteristic is used to produce the temperature sensing circuit for the thermometer. In Fig. 1b, RQ1 represents the effective series resistance of transistor, which forms a voltage divider with the 3.9K collector resistor. In Fig. 2, the trim-pots, R4 and R7, are used to match the response of Q1 to produce the desired temperature reading.

With an increase in temperature, the beta of Q1 also increases, causing Q1 to draw more current, thus decreasing the resistance R-Q1 (Fig. 1b.) and lowering the voltage V1. The relationship between V1 and temperature is very linear and makes an ideal sensor without resorting to a special and/or expensive thermistor. I.C.1 and its associated components form an oscillator whose frequency is determined by V1 (Fig. 1b.), and thus proportional to the temperature of Q1. If the output of I.C.1 (Fig. 1c.) is counted for a fixed period of time, t1, (Fig. 1c.) the total number of pulses for that period will represent the temperature. If the temperature increases, the frequency of I.C.1 increases, thus yielding a higher count during the fixed counting period, t1.

It is easy to see that the accuracy of the temperature measurement depends not only on the operation of Q1 and I.C.1, but on the stability of the fixed timing period, t1, i.e., if t1 were to vary for the same temperature, then a different number of pulses would be counted, giving different temperature readings. For this reason the time-

Fig.2 Main Board Schematic



World Radio History

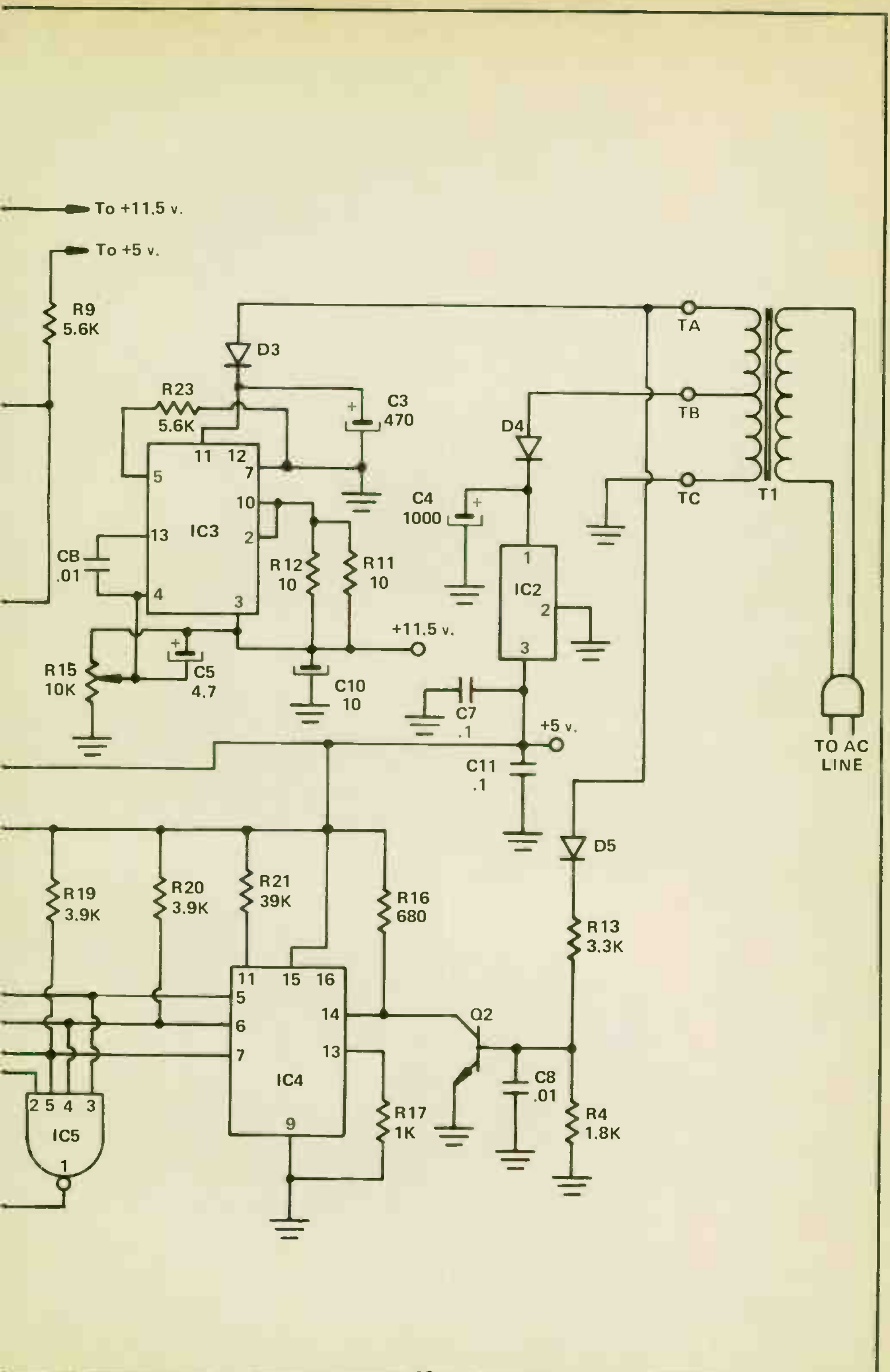
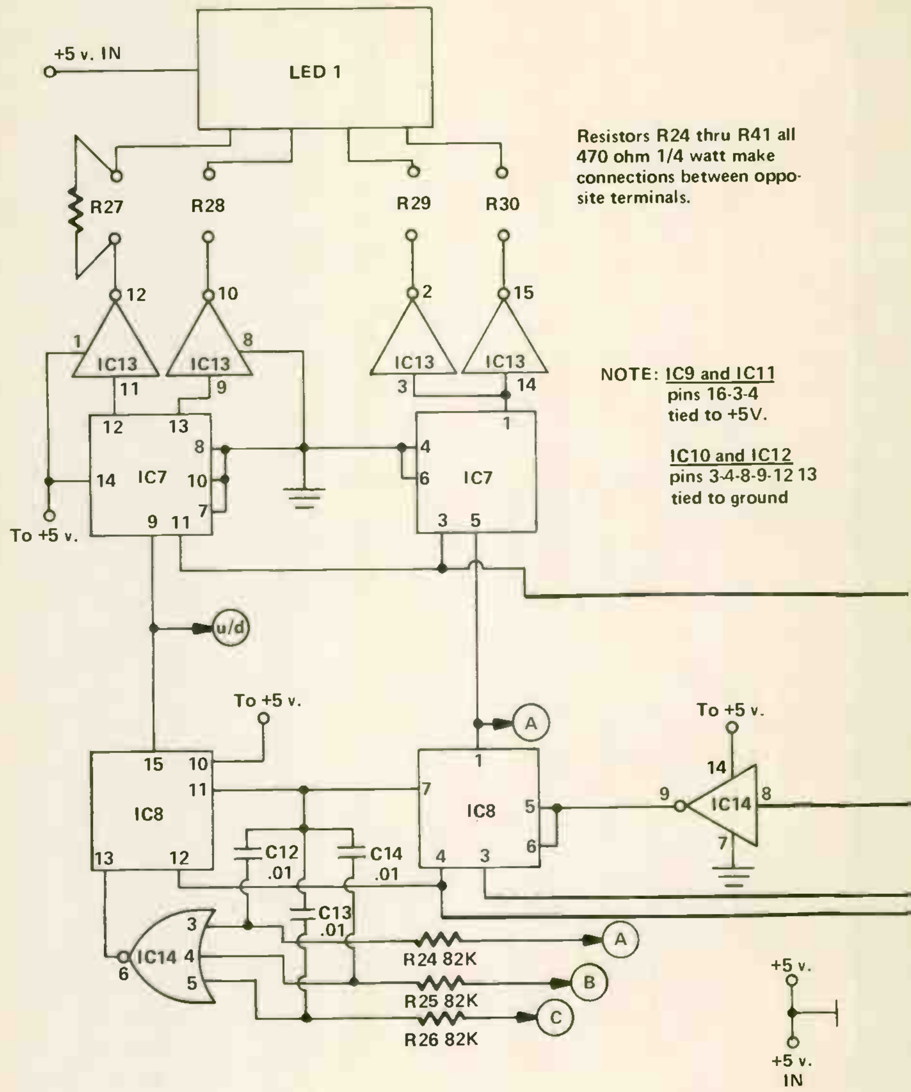

To +11.5 v.
To +5 v.
R9
5.6K
D3
R23
5.6K
C3
470
11 12
5
7
10
IC3
13
2
4
3
CB
.01
R12
10
R11
10
+11.5 v.
R15
10K
C5
4.7
C10
10
D4
C4
1000
IC2
1
2
3
C7
.1
+5 v.
C11
.1
TA
TB
TC
T1
TO AC
LINE
D5
R13
3.3K
R19
3.9K
R20
3.9K
R21
39K
R16
680
IC4
11 15 16
5
6
7
14
13
9
Q2
C8
.01
R17
1K
R4
1.8K
IC5
2 5 4 3
1

Fig.3 Counter & Display Board Schematic



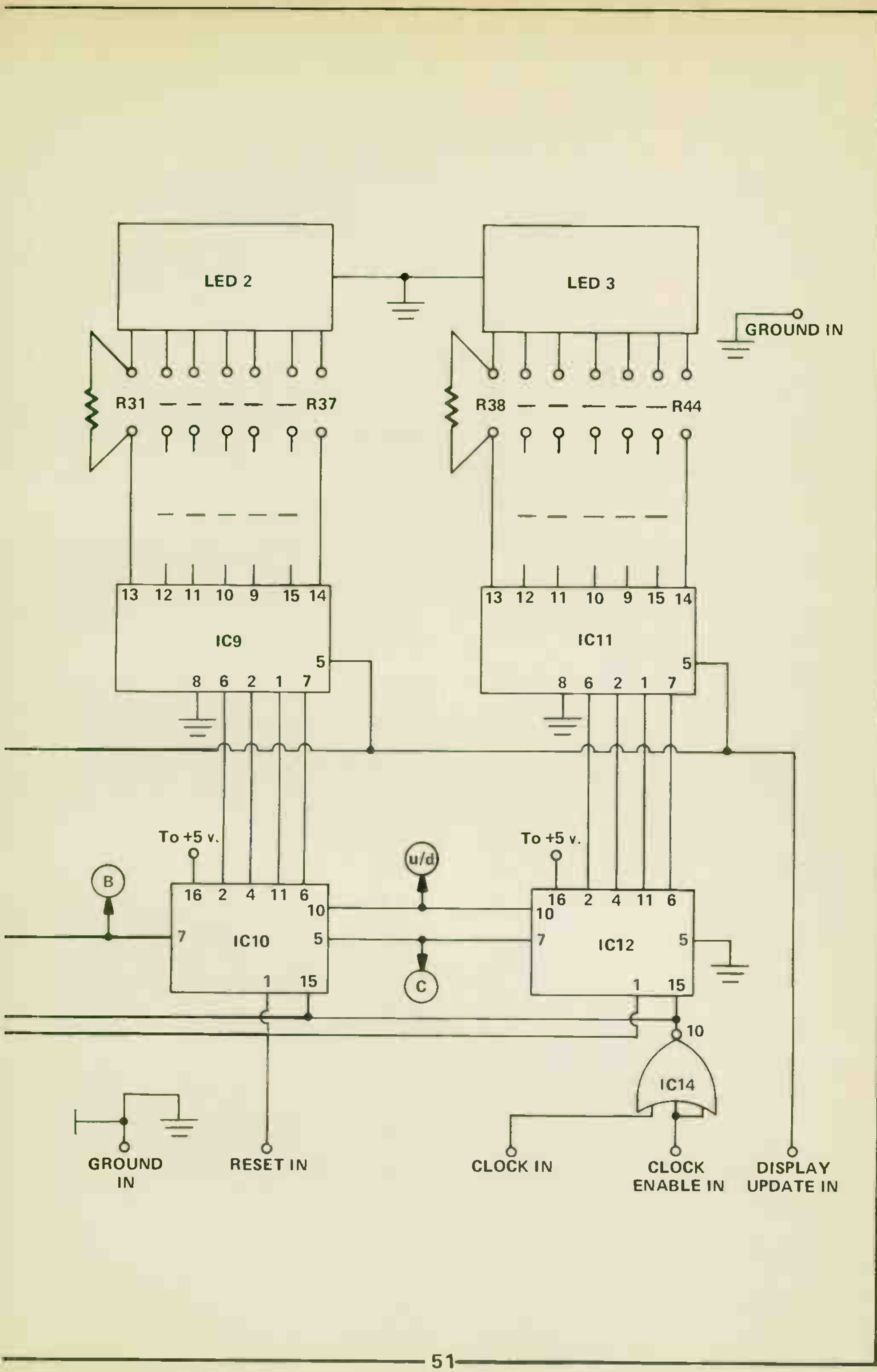

LED 2
LED 3
GROUND IN
R31
R37
R38
R44
13 12 11 10 9 15 14
IC9
5
8 6 2 1 7
13 12 11 10 9 15 14
IC11
5
8 6 2 1 7
To +5 v.
B
16 2 4 11 6
10
7
IC10
5
1 15
u/d
C
To +5 v.
16 2 4 11 6
10
7
IC12
5
1 15
10
IC14
GROUND IN
RESET IN
CLOCK IN
CLOCK ENABLE IN
DISPLAY UPDATE IN

Fig. 4 Component Side - Main Board

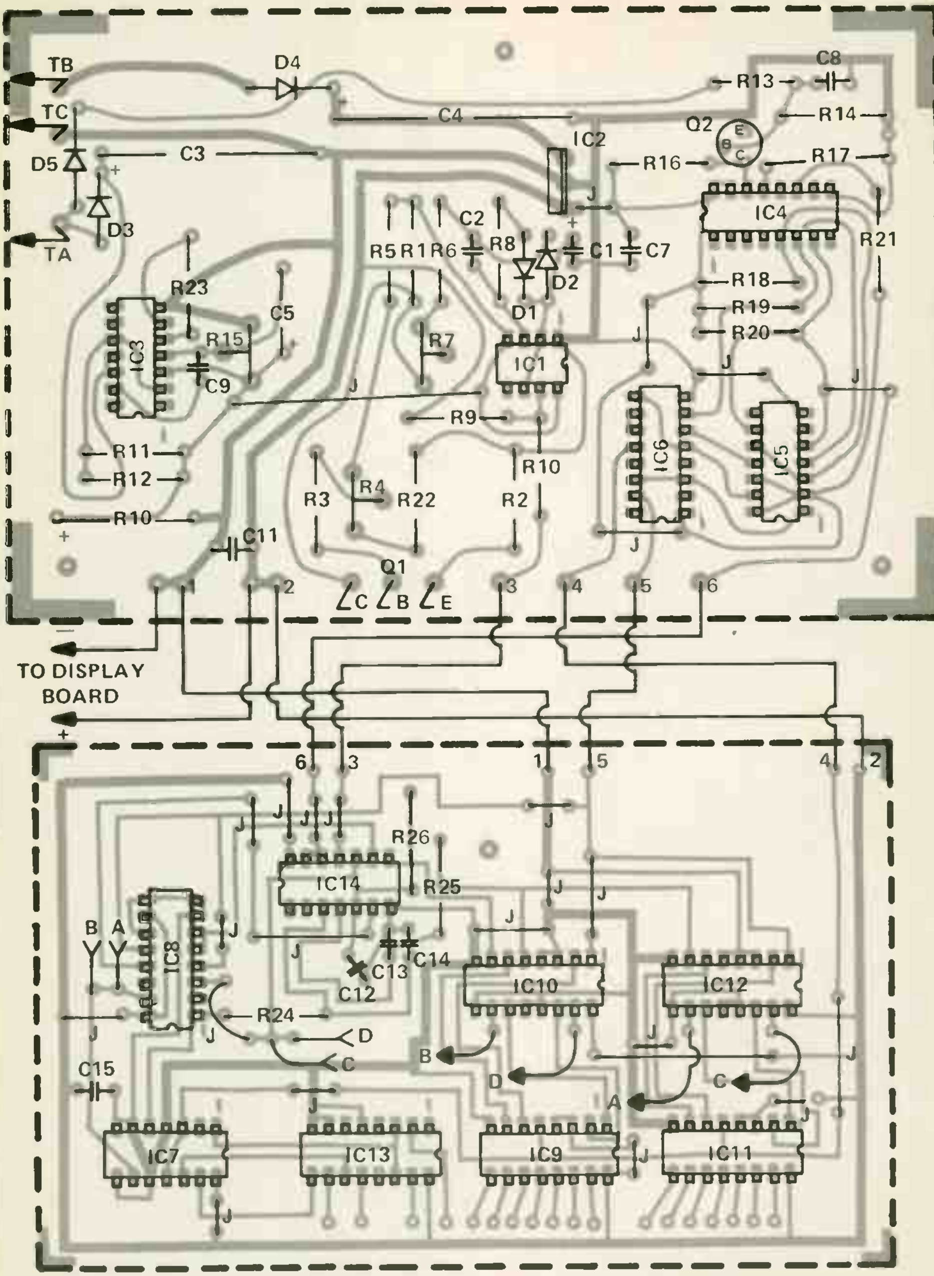
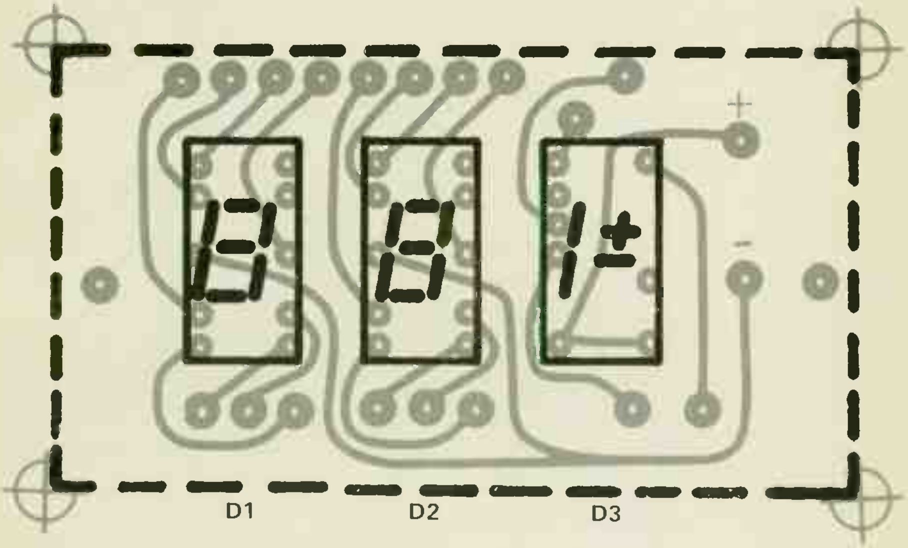


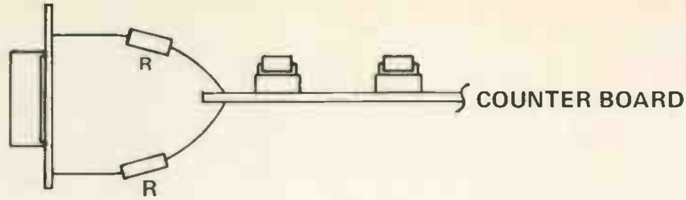
Fig. 5 Component Side - Counter Board

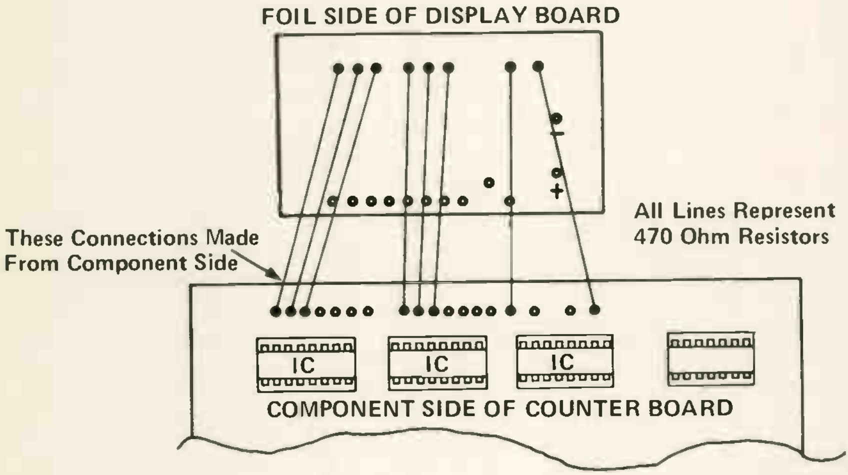
Fig. 6 Display Board Layout



base, I.C.2, is driven from the 60Hz power line frequency, which provides a stable and accurate reference for generating t1. In Fig. 1c the sequence of operation is shown. The I.C.1 output frequency (clock), which is dependent on temperature, is counted for the period t1 (count enable waveform). When the count enable goes to "1" (end of t1 and start of t2) the temperature information is held in the counters, and the output of I.C.1 has no further effect on the counting and display stages (I.C.6 to I.C.13). As period t2 starts, the "display update" line goes to "0" and the information in the counters is transferred to the L.E.D. displays. After the "display update" line returns to "1", (which stores the information until a "0" is again present on the "display update" the "reset" line goes to "1" which resets the counters and prepares them for the next period, t1. The lengths of periods t1 and t2 are each 1.07 seconds, which gives an updated temperature reading every 2.14 seconds.

Fig. 7 Display To Counter Board Hook-up





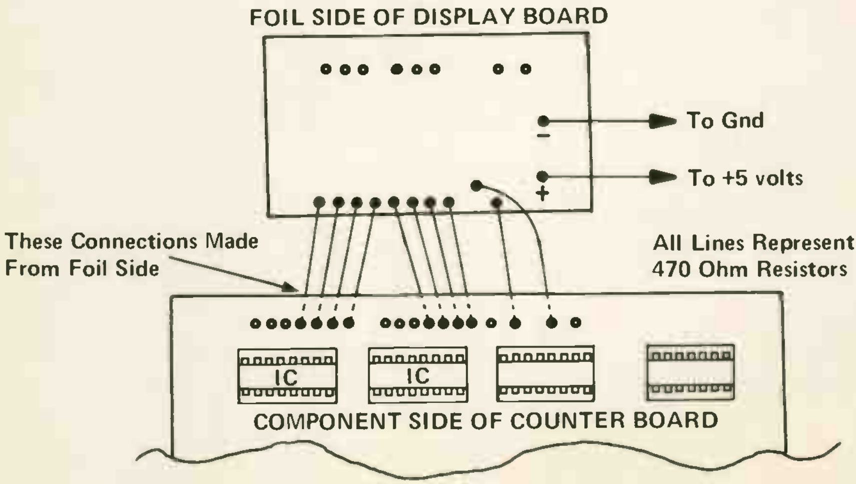


Fig. 8 Case Mounting

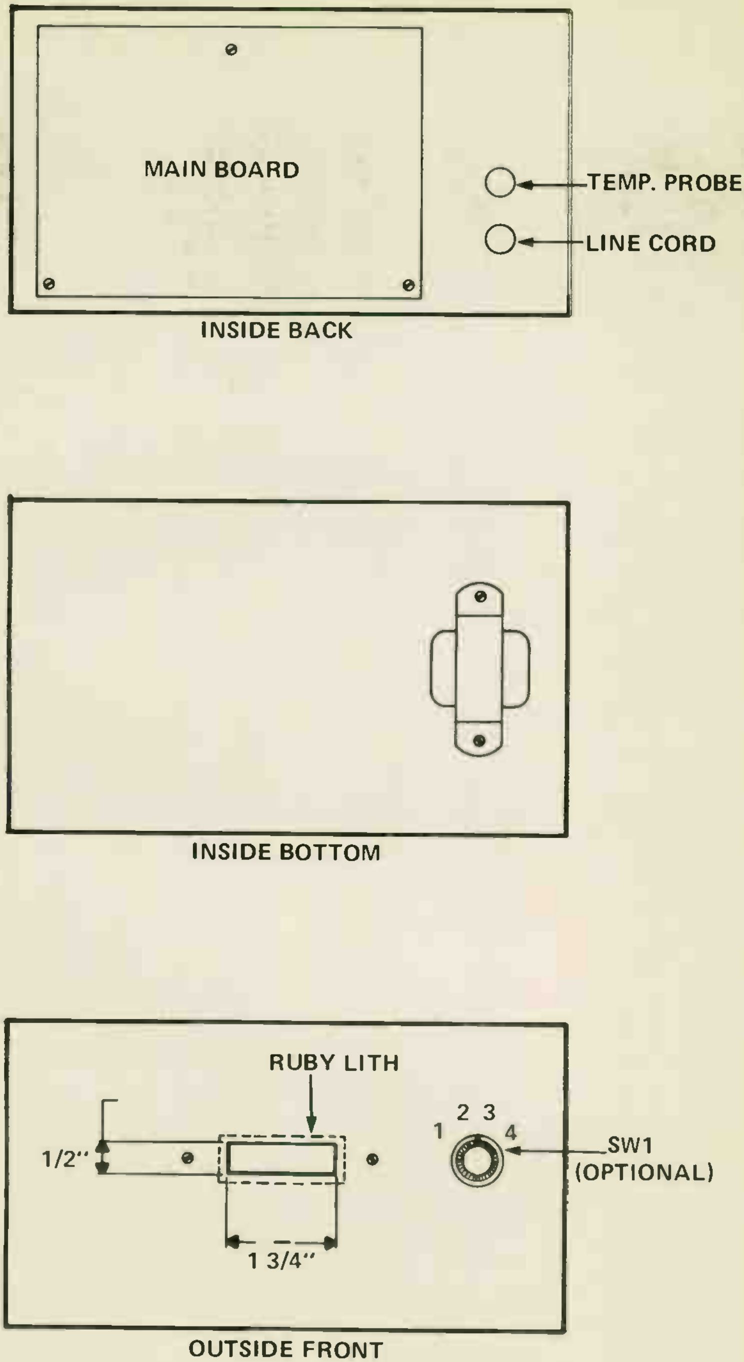
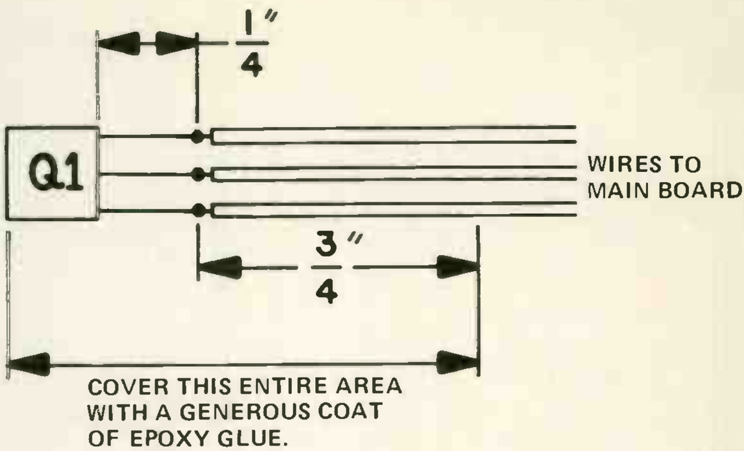


Fig. 9 Probe Construction



In order to obtain a (-) or "below zero" temperature readout, the up/down mode of the counters (I.C.10 and I.C.12) is used. At the start of the counting period, t1, the counters (I.C.10 and I.C. 12) start counting down from 200, i.e., 200, 199, 198, 197, etc. When the count reaches "0" the "minus sign" is turned off and the "plus sign" on, and the count continues "up", i.e., 1, 2, 3, 4, etc. If the probe (Q1) is in a cold environment the clock frequency (I.C.1) will be slow. If the temperature is -5^o, the counters will start counting down from 200 at the beginning of t1 (Fig. 1c). Period t1 will end when the counters have the information "05" at their output, the output of I.C.8 will be "0" and I.C.9 will be "-". At this time the display update line (Fig. 1c) will go "low" and transfer the information into I.C.7. I.C.9, I.C.11. This information will then be stored in these I.C.'s for the remainder for period t2 and the following t1.Since the L.E.D. readouts only display information that is stored in I.C.7, I.C.9, and I.C.11, only the final count will be displayed.

CONSTRUCTION:

Begin construction by making the P.C. boards. A full size foil layout for each P.C. board will be found starting on page 103 Figs. 11,12,& 13. The CALECTRO Lift-It Kit can be used for making your P.C. boards from these layouts. When the boards are drilled, insert parts according to Figs. 4, 5 and 6. Solder in all resistors, capacitors, and I.C.'s. Be sure to solder in the I.C.'s last.

Refer to Fig. 7 and connect the display board to the counter board. Figs.4 & 5 show interconnection between main and counter boards. The three P.C. boards can be mounted as shown in Fig. 8 or another suitable enclosure can be used.

After mounting is complete prepare the probe (Q1) by covering the transistor and its leads (fig. 9) with a coat of epoxy glue.

This is necessary for calibration procedure and if liquid temperatures are to be measured. Make sure the epoxy covers an inch of the lead wires past the solder connection to the transistor leads. Plug in the line cord and with a voltmeter, measure the voltage fromground to pin 3 of I.C.3. Use trim-pot R15 to set voltage to 11.5V. Then measure the voltage between ground and the base of Q1, set this voltage to 1.37 V with trim-pot R4. Turn trim-pot R7 to maximum resistance. Prepare two containers of water, one with cracked ice, the other with the water at 100 to 120°F. Place an accurate thermometer in the warm water to monitor its temperature. Place the probe (Q1) in the warm water and use R7 to set the temperature. Remove the probe and place it in the container of water and ice.

Use R4 to set the display temperature to +33. R7 and R4 will interact with each other so the above procedure will have to be repeated several times. When changing the probe from one container to the other allow a minute or so for it to stablize before setting R7 or R4. When this procedure is complete your digital thermometer is ready for use. If you desire to use more than one probe see Fig. 10 . This assembly may be built on a piece of perf-board and SW1 should have as many positions as probes desired. Remember to calibrate each probe. For Probe A use R4A and R7A, for probe B use R4B and R7B, etc.

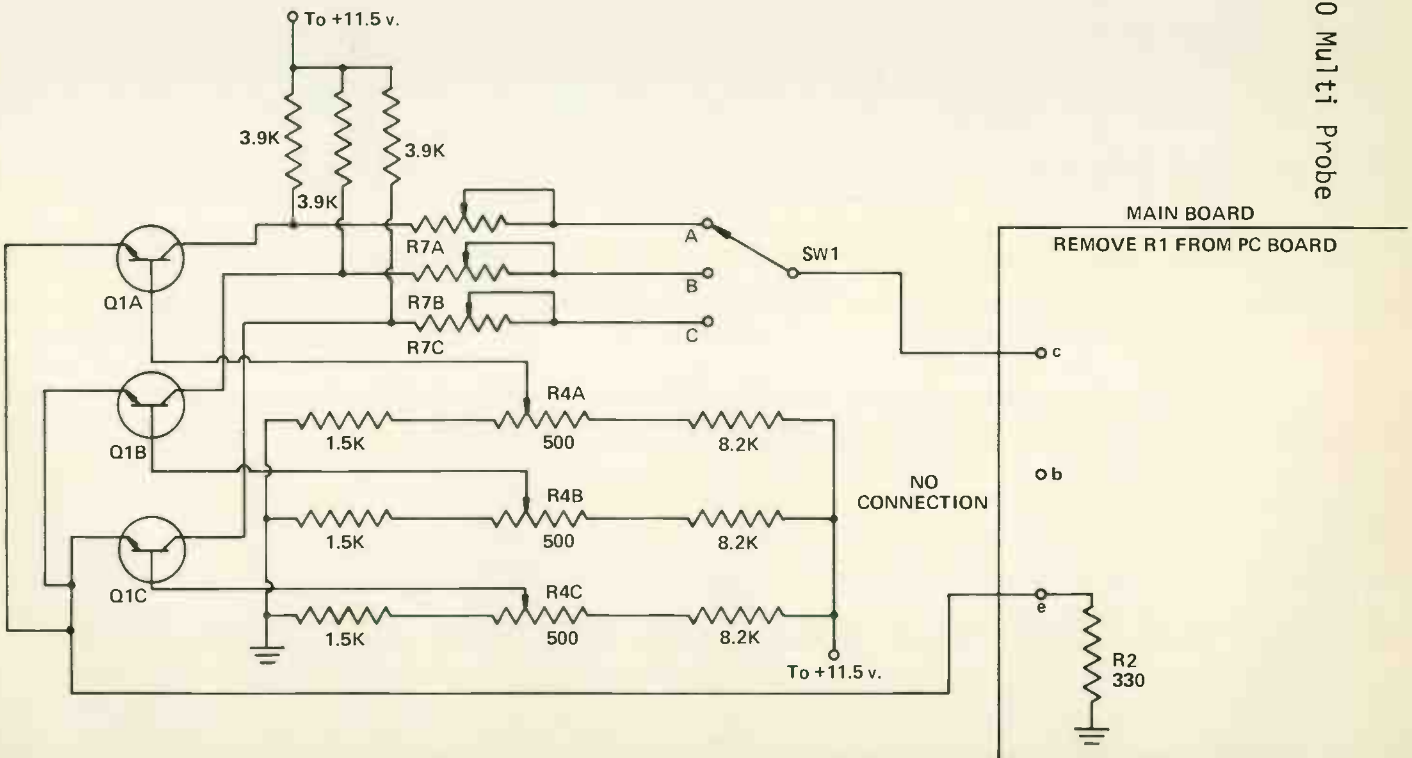


Fig. 10 Multi Probe

PARTS LIST

SYMBOL	DESCRIPTION	CALECTRO NO.
	MAIN BOARD	
IC1	Timer IC	J4-1555
IC2	5V.Regulator IC	J4-1201
IC3	Voltage Regulator IC	J4-1200
IC4	Timer Counter	J4-1214
IC5	NOR Gate	J4-4002
IC6	Hex Inverter	J4-4049
Q1	NPN Transistor	J4-1644
Q2	NPN Transistor	J4-1644
D1,2	Switching Diode	J4-1610
D3,4,5	Rectifier Diode	J4-1600
R1,18,19,20	3.9K ohm All	
R2,8	330 Resistors	B1-378
R3,10,17	1K ½ watt	B1-384
R4	500 pot unless	B1-642
R5	8.2K otherwise	B1-395
R6	10K noted.	B1-396
R7,15	10K pot	B1-644
R9,23	5.6K	23-066(GC)
R11,12	10	B1-360
R13	3.3K	B1-390
R14	1.8K	26-054(GC)
R16	680	26-044(GC)
R21	39K	26-110
R22	1.5K	B1-386
C1	.1mfd 35V.Tant.	A1-300
C2,6,8,9	.01 mfd disc.	A1-029
C3	470 mfd 25V.	A1-132
C4	1000 mfd 25V.	A1-133
C5	4.7 mfd 25V.	A1-126
C7,11	.1 mfd disc.	A1-032
C10	10 mfd 25V.	A1-127
T1	12.6V @ .5Amp	D1-746
	COUNTER BOARD	
IC7	D Flip-Flop	J4-4013
IC8	J-K Flip-Flop	J4-4027
IC9,11	Decoder-Driver	J4-4511
IC10,12	Counter	J4-4029
IC13	Hex Inverter	J4-4049
IC14	NOR, Inverter	J4-4000
R24,25,26	82K ohm	26-094(GC)
C12,13,14	.01 disc	A1-029
C15	.1 disc	A1-032

PARTS LIST

SYMBOL	DESCRIPTION	CALECTRO NO.
	DISPLAY BOARD	
LED1	± 1 LED Digit	J4-902
LED2, 3	7-Seg. LED	J4-903
R27 thru R44	470 ohm ¼ wt.	J4-975
	MISC. ITEMS	

Hardware, Case, Line Cord, Rubylith

DELUXE WAVEFORM GENERATOR

How would you like to build a deluxe waveform generator which produces six basic waveforms over a frequency range of 45Hz to 100Khz, and contains in addition, selectable AM or FM modulation of these waveforms. This generator produces sine, triangle, square, saw-tooth, ramp and pulse waveforms. These waveforms can be frequency or amplitude modulated by an internal 1Khz oscillator, capable of producing sine, triangle, and squarewave modulation waveforms. The generator should prove a valuable aid wherever a variable frequency signal source is needed.

The heart of the waveform generator is the J4-1213, an integrated circuit containing a voltage controlled oscillator that produces the six basic waveforms. It also contains a modulator which is capable of modulating the the oscillator output in accordance with the input to the modulator. The modulation input is provided either by a second identical I.C., which operates at a fixed 1Khz, or from an external source thru the external modulation inputs. Thus a variety of waveforms are available at the output of the generator, as shown in figure 8.

Power to the waveform generator is supplied by the voltage regulator, I.C.1, which provides a stable ripple-free 12V.

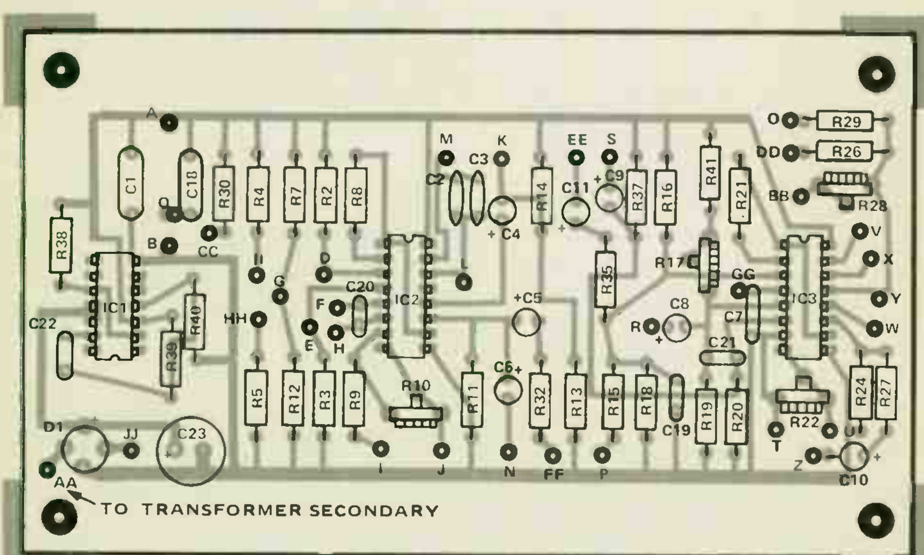
The generator is housed in the handsome new Calectro H4-748 cabinet, which lends a professional appearance to the completed unit.

CONSTRUCTION

The entire circuit is contained on the printed circuit board (see page 109 Fig. 14) simplifying construction. You can duplicate this board with the new Calectro LIFT-IT kit.

After etching and drilling the printed circuit board, insert and solder all components, carefully following the diagram in figure 1. Make special note of the polarity of the electrolytic capacitors and the orientation of the I.C.'s.

Fig.1 Component Layout



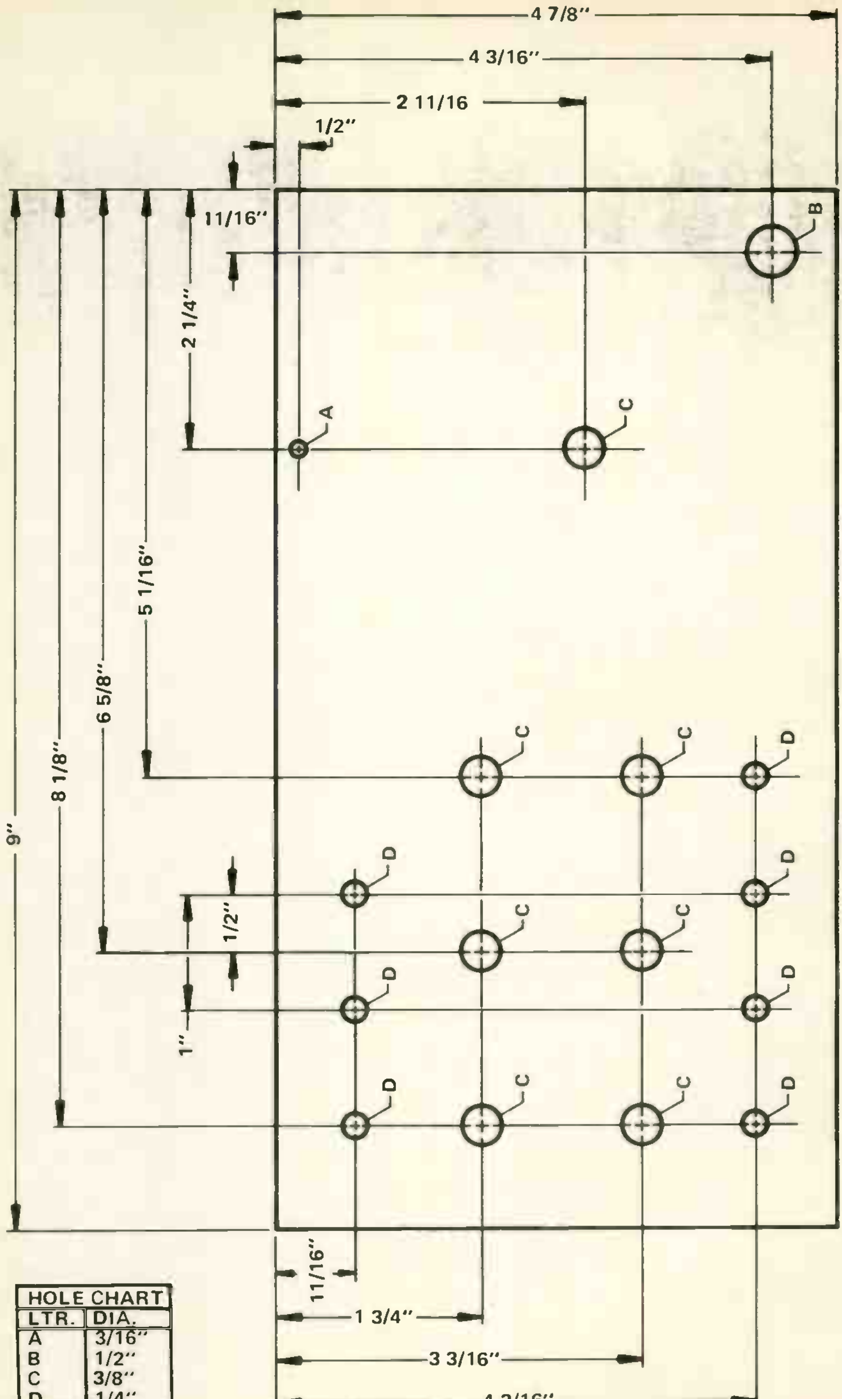


Fig.2 Front Panel Hole Locations

HOLE CHART	
LTR.	DIA.
A	3/16"
B	1/2"
C	3/8"
D	1/4"

Next punch or drill the front panel following figure 2. After completing this, label all functions as illustrated in figure 3. For best results use transfer-decal lettering available at office and art supply stores. Following figure 4 mount all switches, jacks, potentiometers and the LED to the front panel. Glue the LED into place after inserting it into the front panel. Then, still following figure 4 make all connections between front panel components as shown.

Fig.3 Front Panel

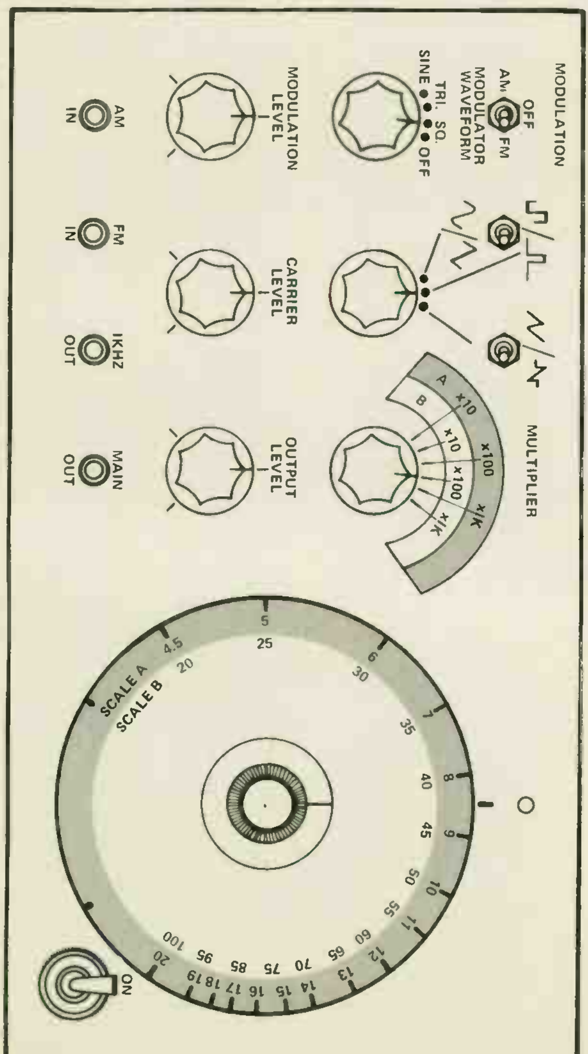


Fig.4 Front Panel Interconnection Wiring and Component Placement

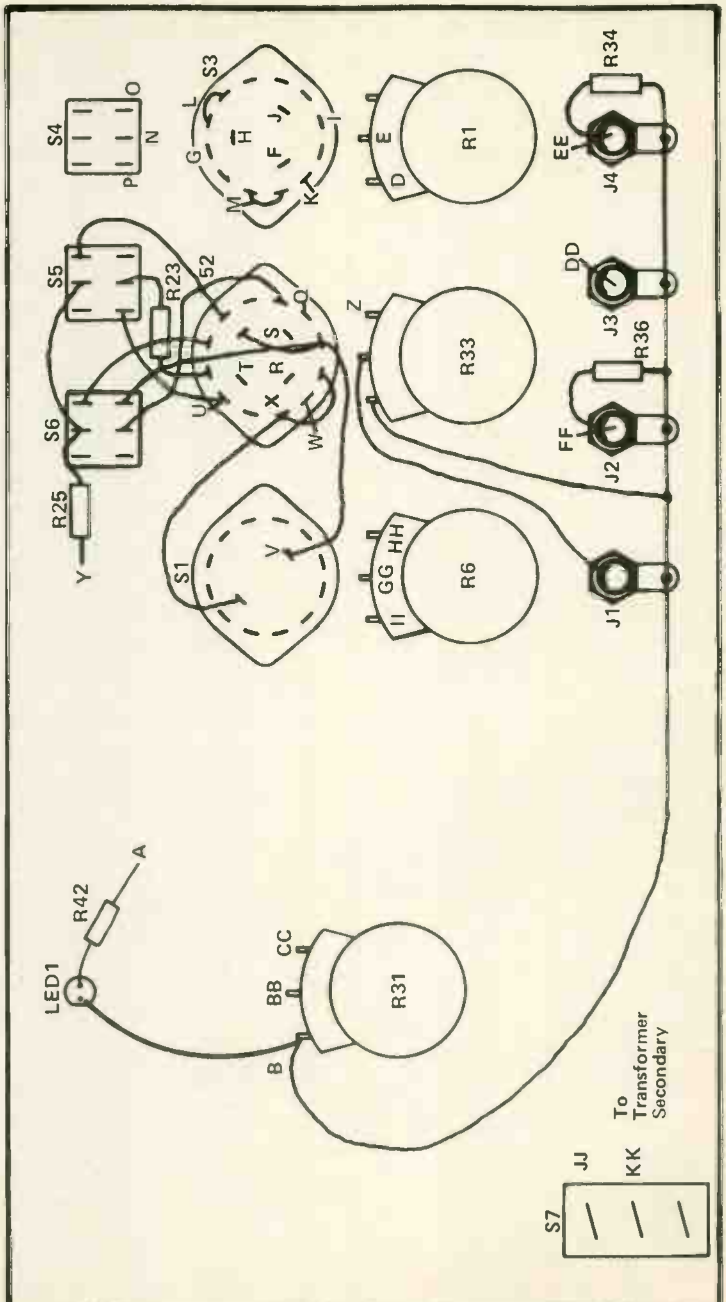


Fig.5 Capacitor Mounting
to Switch 1

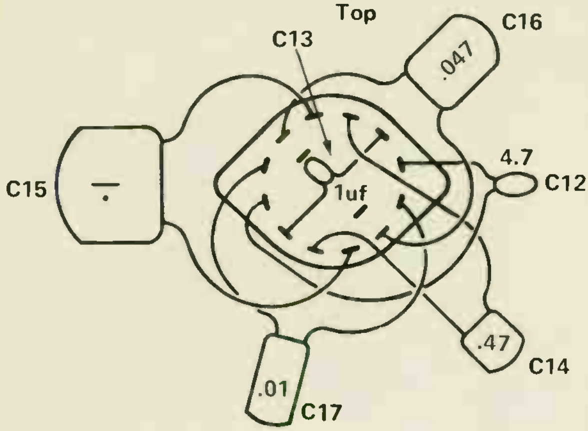


Figure 5 illustrates the mounting of capacitors to switch 1. Assemble and solder these capacitors to the switch as shown.

The connections between the front panel and circuit board are letter coded in figures 1 and 4. Example: connect point C on the circuit board to point C on the front panel. Make wires long enough so that the PC board can be mounted horizontally behind the front panel in the cabinet.

Drill the back panel of the cabinet and fasten the line cord and fuse holder as illustrated in figure 6. Drill the bottom panel to provide mounting holes for the PC board and transformer. Fasten the transformer to the bottom panel with machine screws. Then assemble the cabinet leaving the top panel off. Pass the PC board thru the front frame and make the connection between the board and the transformer.

Fig.6 Fuse Holder and Line Cord Mounting

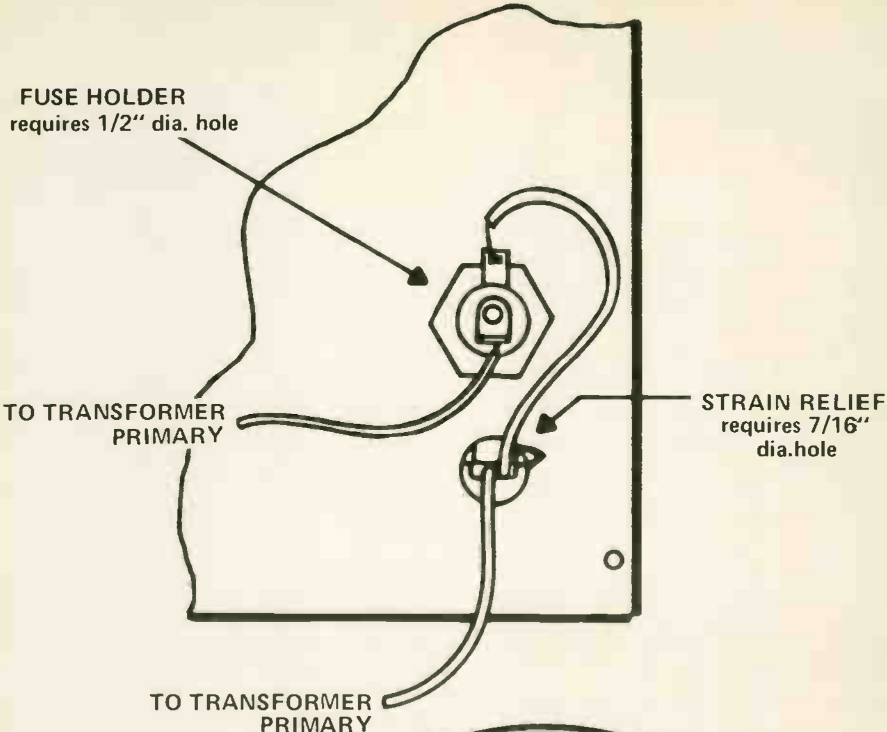
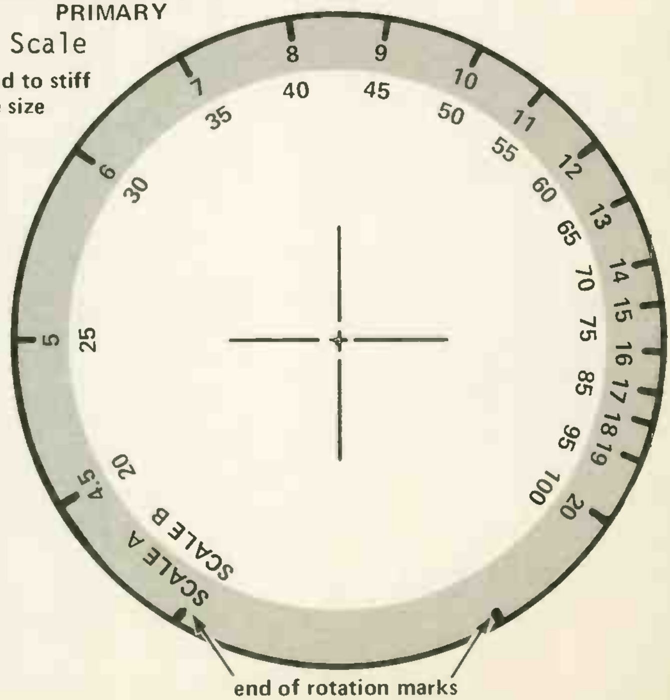


Fig.7 Dial Scale

cut out and bond to stiff backing of same size



Fasten the PC board down using machine screws and spacers. The front panel can now be fastened to the cabinet, and the one remaining connection made between the power switch and the xformer. Next, cut out the dial scale of figure 7, and glue it to a stiff backing such as cardboard or plastic. Cut the backing to the same size, then punch or drill a 3/8" hole in the center of the disc, indicated by the crossmarks. Glue a knob, Calectro E2-728, directly over the center hole, and after it dries mount the dial assembly on the front panel. This completes the assembly of the generator. All that remains is the calibration of the unit.

CALIBRATION PROCEDURE

Set all front panel controls as listed below:

Modulation waveform selector-OFF.

Modulation level--maximum (full C.W.).

Carrier waveform selector--sinewave.

Carrier level--maximum (full C.W.).

Frequency multiplier--X100 (A scale).

Output gain control--maximum (full C.W.).

Set frequency dial to 10 on the A scale. Connect an oscilloscope to the main output, and adjust R17 for a symmetrical waveform. Then adjust R22 for the most perfect sine waveform.

Now, using either a frequency counter or an oscilloscope adjust R28 until the output frequency is 1Khz.

Next move the oscilloscope connections to the 1Khz output and adjust R10 to obtain the best sinewave.

OPERATING INSTRUCTIONS

Operation of the generator is straight forward. If you wish to obtain an unmodulated waveform set modulation waveform selector to off. Select proper carrier waveform, and frequency multiplier. The output level control sets the output waveform amplitude and in addition, determines the phase of the waveform. At the extremes of rotation the waveform is shifted 180°.

Other control functions are explained below.

Carrier frequency multiplier--selects the frequency range of operation. Multiply the dial reading on the appropriate scale of frequency adjust by the selected multiplier. Note: the frequency ranges apply only to the symmetrical waveforms, sine, triangle, square and ramp. For the asymmetric waveforms (sawtooth and pulse) the actual frequency will be about one-half the frequency setting.

Carrier frequency adjust--varies the carrier output frequency over approximately a 5:1 range, for any given setting of the frequency multiplier.

Carrier waveform--selects one of 6 waveforms. This control consists of 2 toggle switches SW5 and SW6 and the rotary switch SW2. The selection of the proper waveform is illustrated on the front panel in figure 3. With the rotary switch in position 1, the toggle switch on the left selects either sine or triangle waveform. With the rotary switch in position 2 this toggle switch selects square or pulse waveform. With the rotary switch in position 3 the right hand toggle switch selects between sawtooth and ramp waveforms.

Carrier level control-controls the output amplitude.

Modulation level control-controls the modulation amplitude.

Output level controls the output amplitude.

Modulator waveform-selects between the three modulator waveforms.

Modulation switch-selects between internal AM or FM modulation. When using external modulation inputs or unmodulated mode this switch should be in the center-off position.

External modulation inputs-the carrier waveform may be FM or AM modulated by applying a signal to these inputs. A signal amplitude of 6V p-p is sufficient.

1Khz out-fixed 1Khz modulator output.

Main out-generator output connection providing modulated or unmodulated carrier output.

Fig.8 Waveforms Produced by Generator

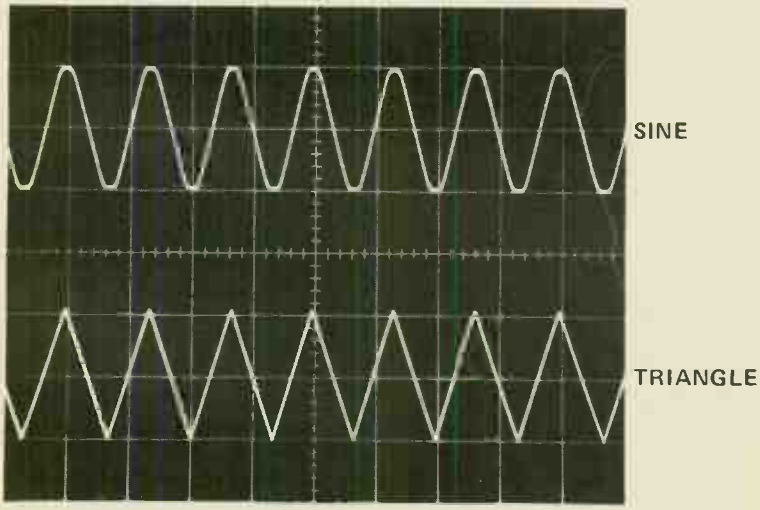
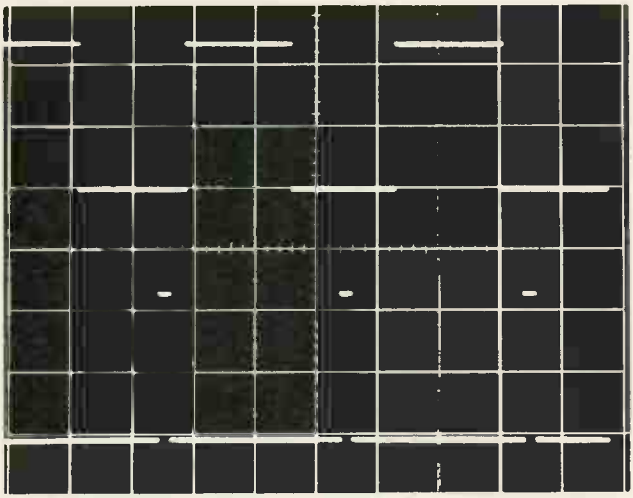
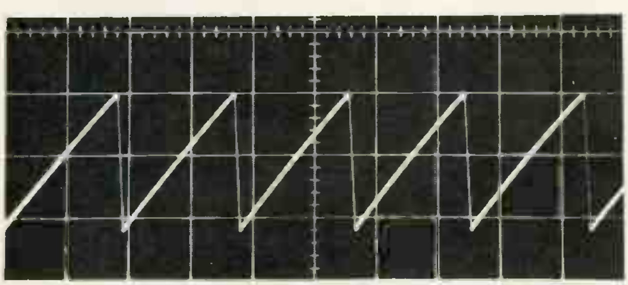


Fig.8 Waveforms Produced by Generator (Cont.)

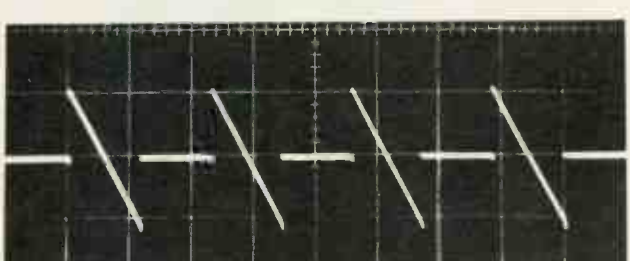


SQUARE

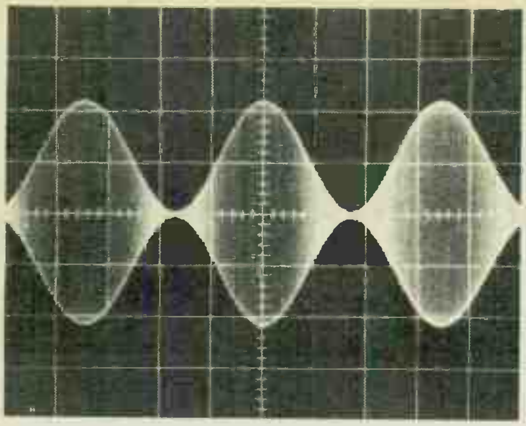
PULSE



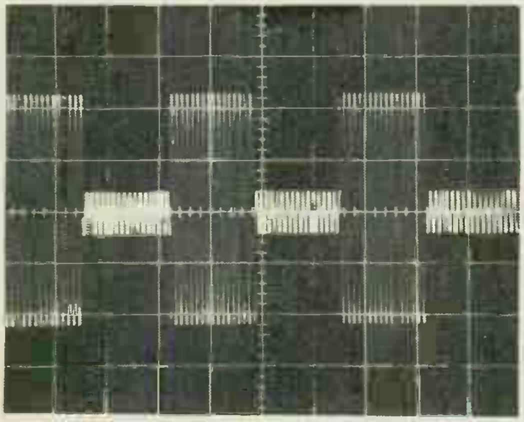
SAWTOOTH



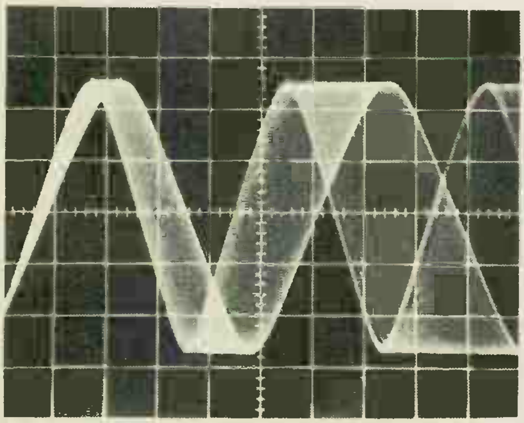
RAMP



SINEWAVE AM MODULATION

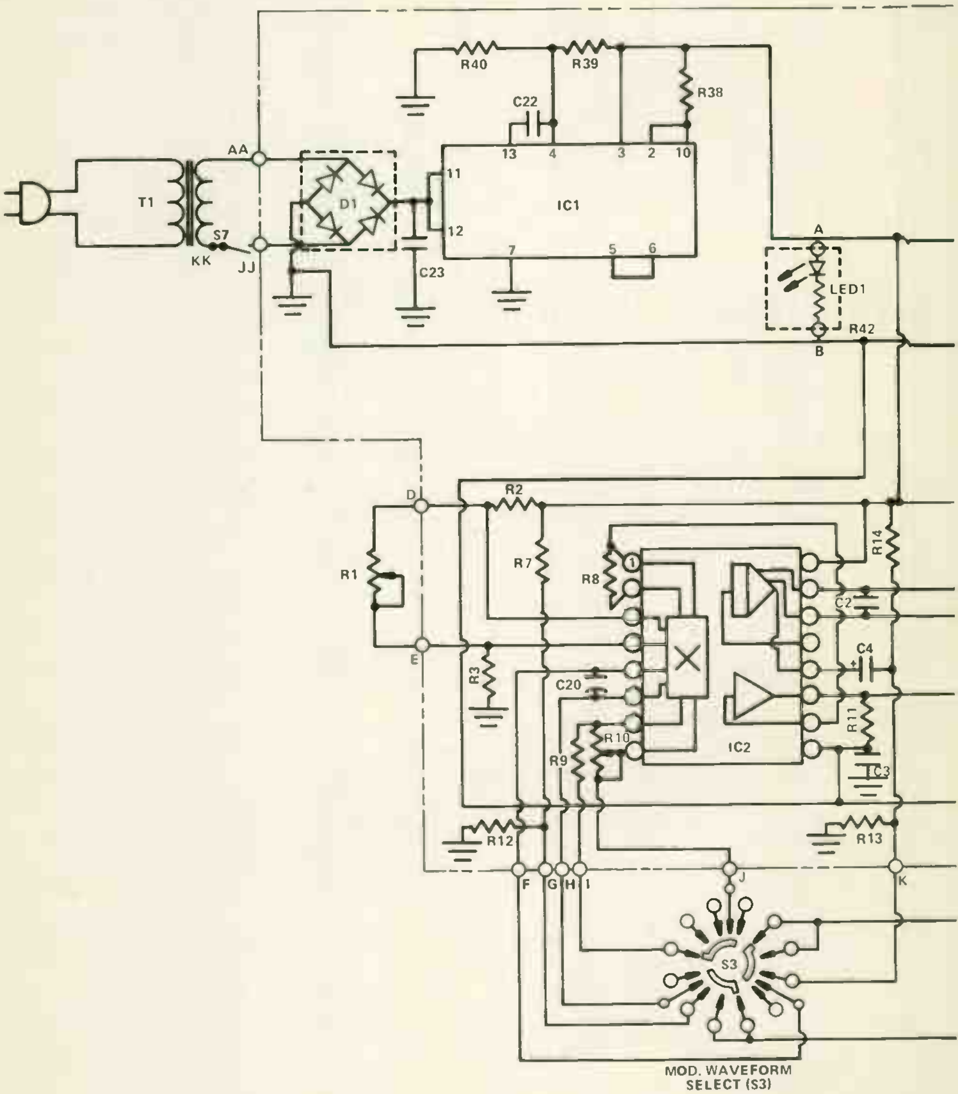


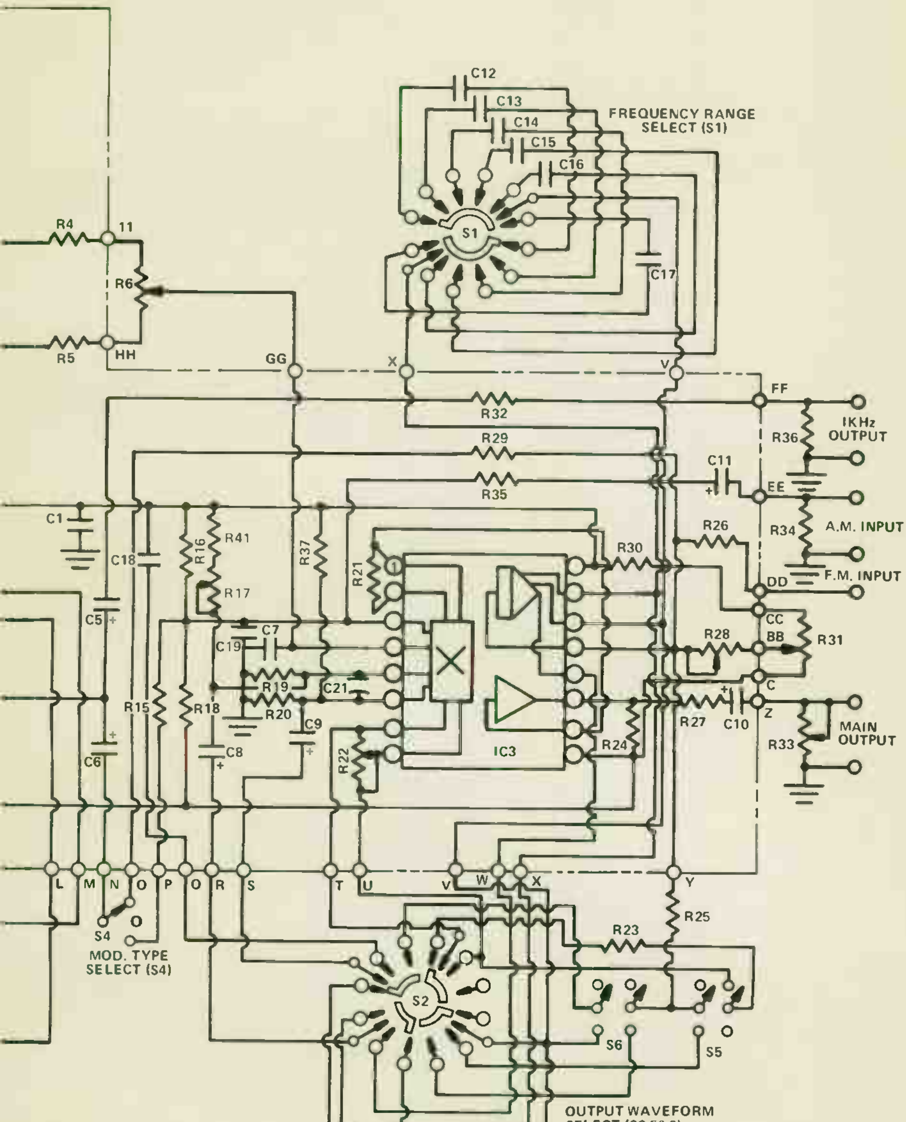
SQUAREWAVE AM MODUCATION



FM MODULATION

Fig.9 Schematic Diagram of Waveform Generator




C12
C13
C14
C15
C16
FREQUENCY RANGE SELECT (S1)
S1
C17
R4
11
R6
R5
HH
GG
X
V
FF
R32
R36
1KHz OUTPUT
R29
C11
R35
EE
C1
R34
A.M. INPUT
R26
R41
C18
R16
R37
R21
R30
F.M. INPUT
DD
R17
C5
CC
C7
R28
BB
R31
C19
R19
C21
C
R15
R18
R20
R27
C10
Z
MAIN OUTPUT
C9
C6
C8
R22
IC3
R24
R33
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
S4
MOD. TYPE SELECT (S4)
R25
R23
S2
S6
S5
OUTPUT WAVEFORM SELECT (S2,5&6)

PARTS LIST

WAVEFORM GENERATOR

SYMBOL	DESCRIPTION	CALECTRO NO.
R27, R32	560 Ohms	*26-042
R25, R42 R29	1K Ohms	B1-384
R9, R23	1.8K Ohms	*26-054
R24	3.3K Ohms	B1-390
R30, R26	3.9K Ohms	*26-062
R11, R35	5.6K Ohms	*26-066
R4, R5, R8, R15, R21	15K Ohms	B1-398
R2, R3, R16, R18	33K Ohms	B1-402
R7, R12, R13, R14, R19, R20, R34, R36, R37	100K Ohms	B1-408
R38	10 Ohms	B1-360
R39	4.7K Ohms	B1-392
R40	6.8K Ohms	B1-394
R41	68K	B1-406
R1, R6, R31	Linear Taper 5K Ohms	B1-680
R33	Audio Taper 5K Ohms	B1-681
R10, R22	Trimmer 10K Ohms	B1-644
R17	Trimmer 50K Ohms	B1-645
R28	Trimmer 2K Ohms	B1-643
C1, C18, C15, C2, C3	0.1 mfd-Mylar	A1-082
C7, C19	0.01 mfd-Mylar	A1-079
C4, C5, C6, C8, C9, C10, C11	10 mfd electro-lytic 12V	A1-105
C12	4.7 mfd tantalum	A1-306
C13	1 mfd tantalum	A1-304
C14	.47 mfd tantalum	A1-302
C16	.047 mfd Mylar	A1-081
C17	.01 mfd Mylar	A1-079
C20, C21	33 pF silver mica	A1-003
C22	100 pF silver mica	A1-006
C23	200 mfd electrolytic	A1-113
IC1	Voltage Regulator	J4-1200
IC2, IC3	Wave form generator	J4-1213
T1	12V transformer	D1-750
D1	Bridge Rectifier	J4-1605
LED1	Light emitting diode	
S1	2 pole 6 pos.	E2-169
S2	4 pole 3 pos.	E2-166
S3	3 pole 4 pos.	E2-168

SYMBOL	DESCRIPTION	CALECTRO NO.
S4	DPDT (Center off)	(Electro-craft)
S5, S6	DPDT Toggle	E2-118
S7	SPDT	E2-122
J4-J4	RCA Jacks	F2-806

MISCELLANEOUS

QTY.	DESCRIPTION	Calectro No.
1	Knob	E2-728
6	Knobs	E2-705
1	AC cord	L3-717
1	Cabinet	H4-748
1	Fuse holder	E2-495
1	Machine screw assortment	J4-835
1	Spacer assortment	J4-846
1	Hookup wire	L3-633

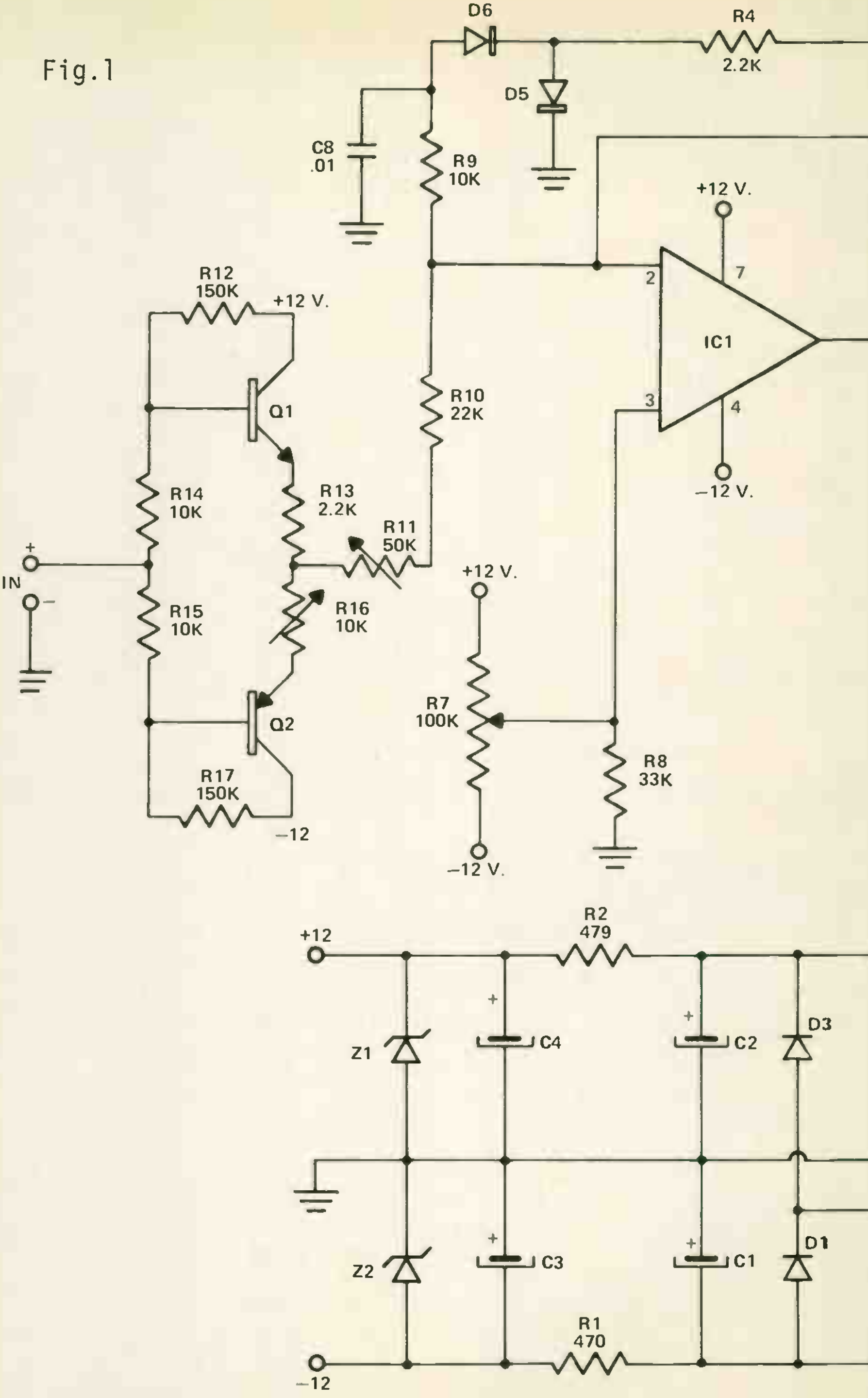
* GC Electronics Cat. No.

CALECTRO DVM

The CALECTRO DVM project will enable you to convert the CALECTRO FREQUENCY COUNTER to a digital voltmeter. This converter can also be used with most any commercially available frequency counter. If the CALECTRO FREQUENCY COUNTER is to be built for use with this project, then only three digits are needed.

Transistors Q1 and Q2 form an input buffer, which isolates the circuit under test from the input of IC1. IC1 and IC2 are used as a voltage controlled oscillator. The frequency of the ouput is dependent, and proportional to the input voltage.

Fig.1


D6
R4
2.2K
D5
C8
.01
R9
10K
+12 V.
7
2
IC1
3
4
–12 V.
R12
150K
+12 V.
Q1
R10
22K
R14
10K
R13
2.2K
R11
50K
+
IN
–
R15
10K
R16
10K
+12 V.
R7
100K
Q2
R8
33K
R17
150K
–12
–12 V.
R2
479
+12
Z1
C4
C2
D3
Z2
C3
C1
D1
R1
470
–12

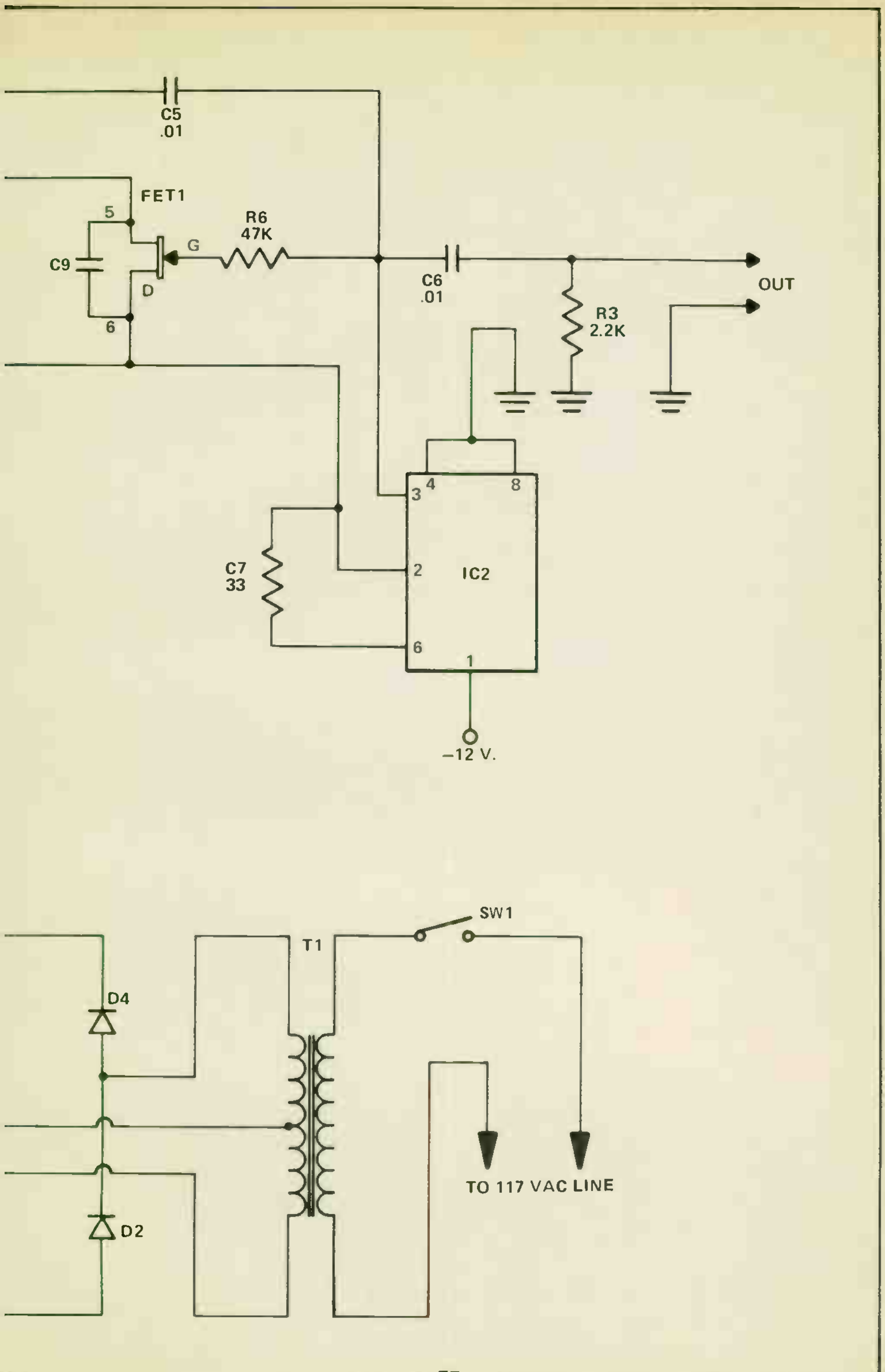
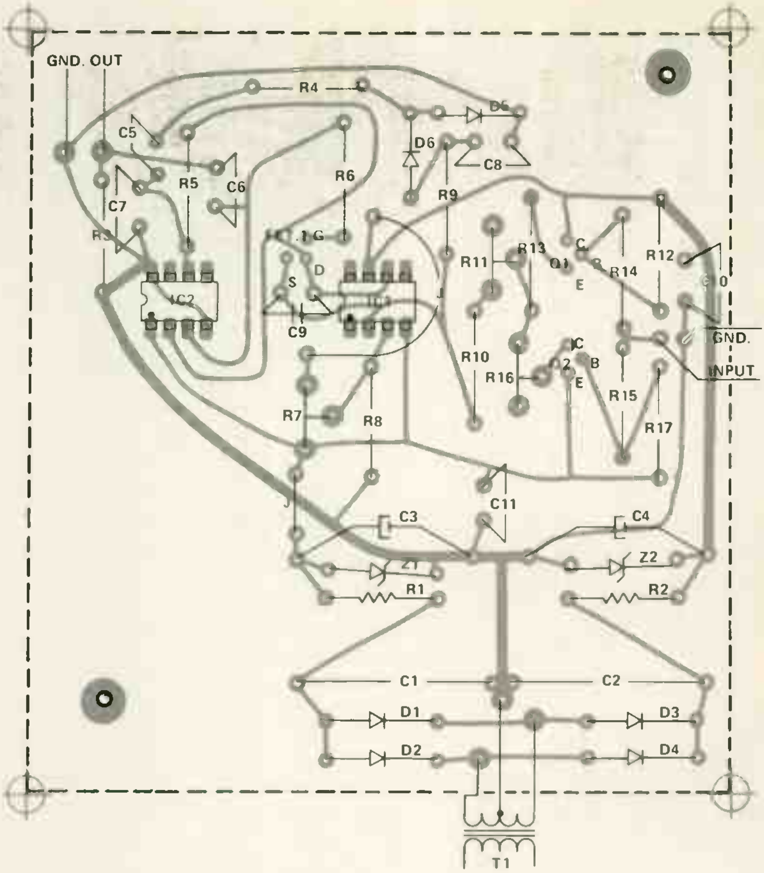
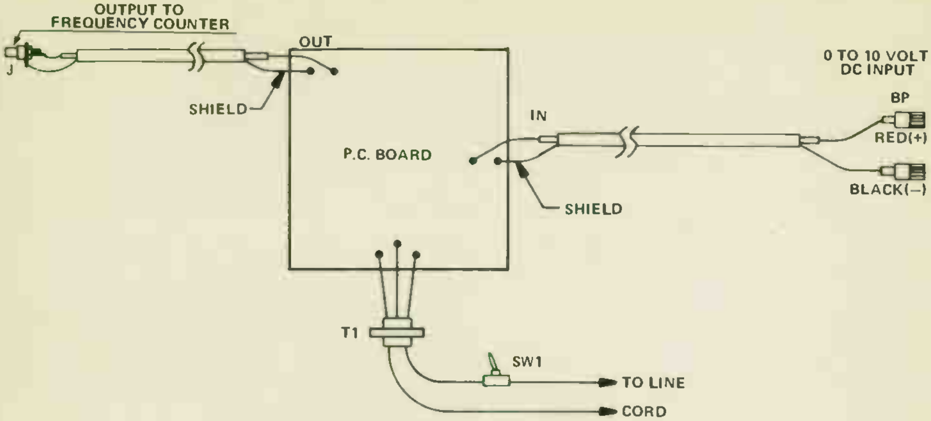

C5
.01
FET1
5
R6
47K
G
C9
D
6
C6
.01
OUT
R3
2.2K
3
4
8
C7
33
2
IC2
6
1
–12 V.
SW1
T1
D4
D2
TO 117 VAC LINE

Fig.2



Begin construction by making the PC board. The CALECTRO LIFT-IT kit can be used to duplicate the full size foil pattern. (see page 111 Fig. 15). After the board is drilled, insert and solder the components. Solder 8" of shielded cable to the input and output pads on the PC board and attach the transformer leads.

Fig.3



The assembly can be mounted in a chassis box as shown in Fig. 4.

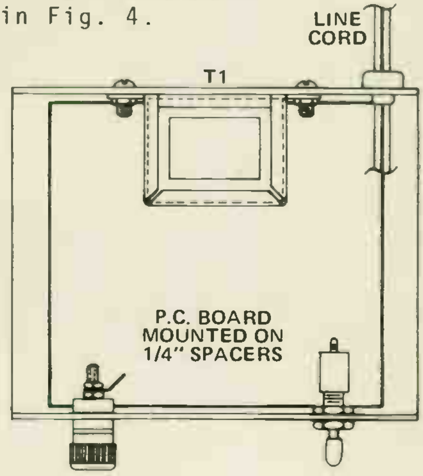
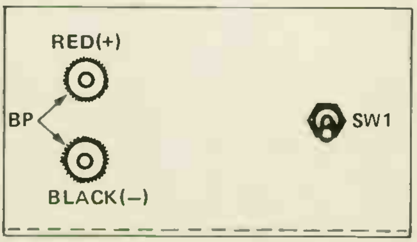


Fig.4



To calibrate the voltmeter connect the output to a frequency counter. Short the center terminal of R11 to ground, short the input jacks, and adjust R7 for a "zero" reading. As R7 is turned thru its range the value displayed on the frequency counter will decrease and stop at "zero".

The proper setting for R7 is just at the point where a zero count is obtained. Remove the connection between R11 and ground. Connect an accurate source of 10 volts DC to the input terminals and adjust R11 for a count of 100. This represents a reading of 10.0 volts. If greater voltage ranges are desired a resistive divider network can be used at the input terminals.

PARTS LIST

SYMBOL	DESCRIPTION	CALECTRO NO.
R1, 2	470 Ohm	B1-380
R3, 4, 13	2.2K	B1-388
R5	15K	B1-398
R6	47K	B1-404
R7	100K Trimpot	B1-646
R8	33K	B1-402
R9, 14, 15	10K	B1-396
R10	22K	B1-400
R11	50K Trimpot	B1-645
R12, R17	150K	B1-401
R16	10K Trimpot	B1-644
C1, 2	100/50V	A1-154
C3, 4	22/25V	A1-128
C5, 6, 8	.01 Disc	A1-092
C7	33pf	A1-003
C9	.005 Disc	A1-028
C10, 11	.1 Disc	A1-032
D1, 2, 3, 4	1A/50PIV Diode	J4-1600
D5, 6	Switching Diode	J4-1610
Q1	NPN Trans.	J4-1644
Q2	PNP Trans.	J4-1645
FET 1	N-Chan FET	J4-1710
IC1	OP-AMP (741)	J4-1215
IC2	Timer (555)	J4-1555
BP	Binding Posts	F2-926
J	RCA Jack	F2-806
T1	Transformer	D1-751
SW1	Power Switch	E2-116
	Chassis box	H4-746
Misc.	Mounting screws, line cord, spacers, test leads, & hook-up wire.	

Fig.2

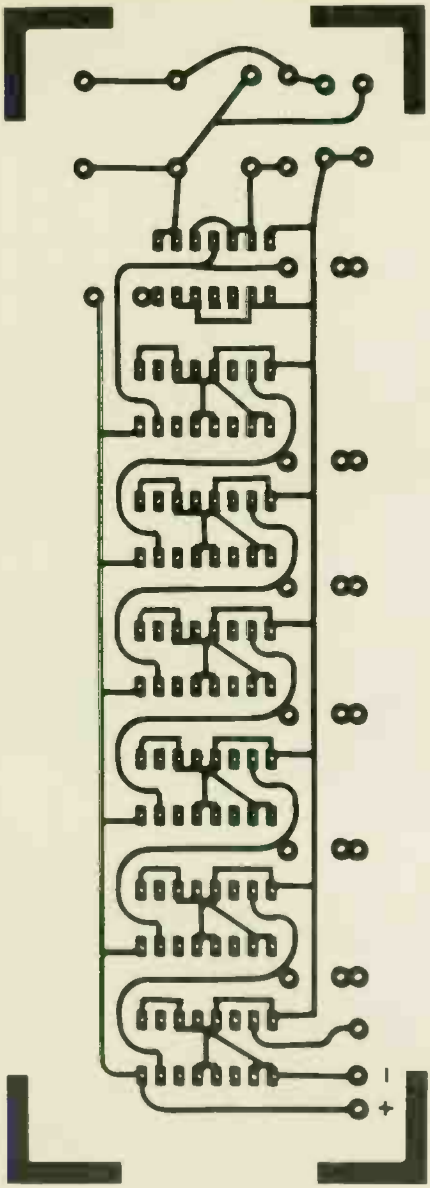


Fig.3

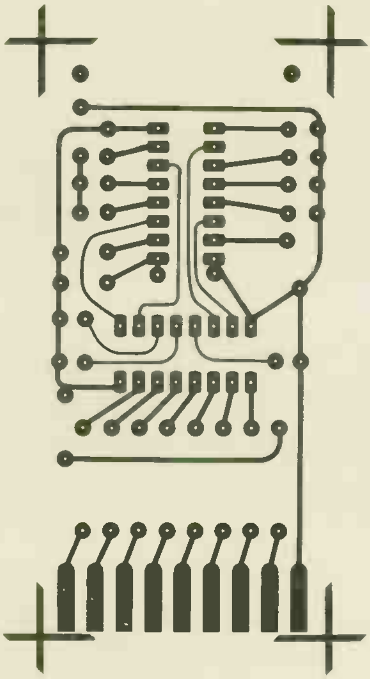


Fig.3

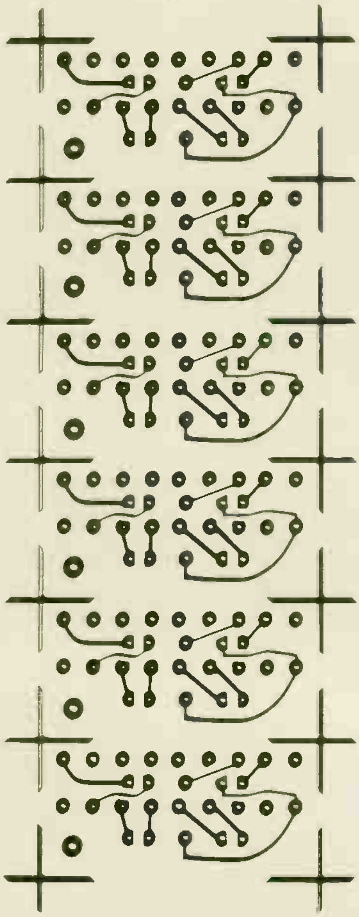


Fig.3

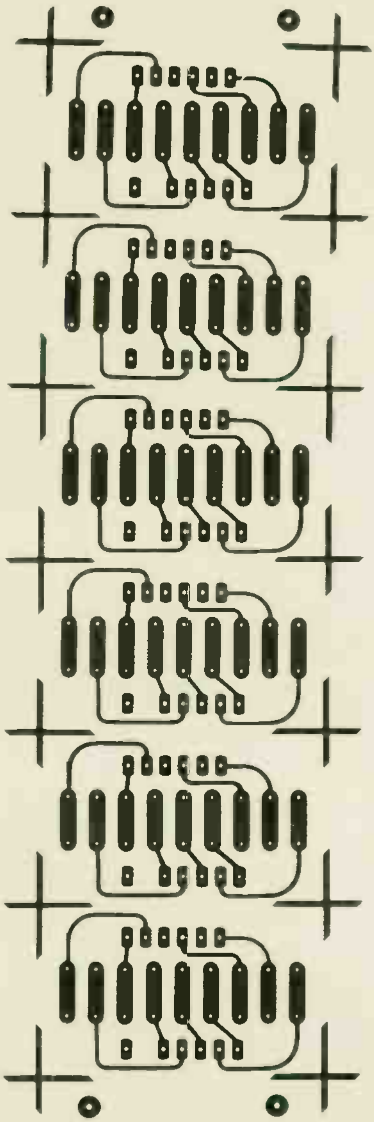


Fig.4

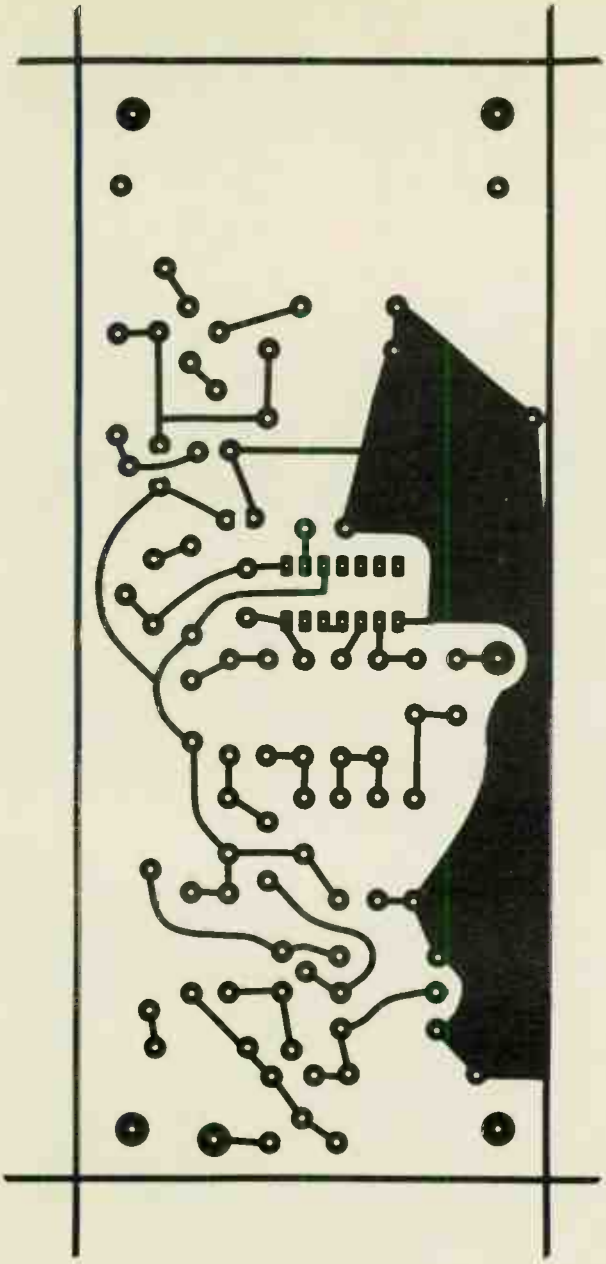


Fig.5

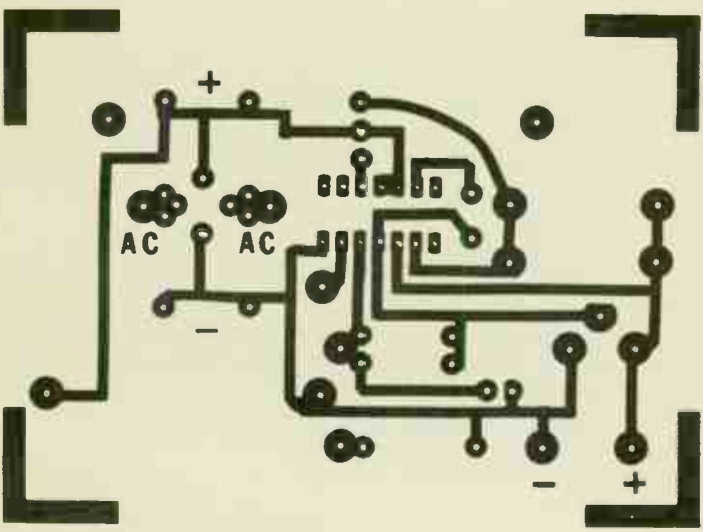


Fig.6

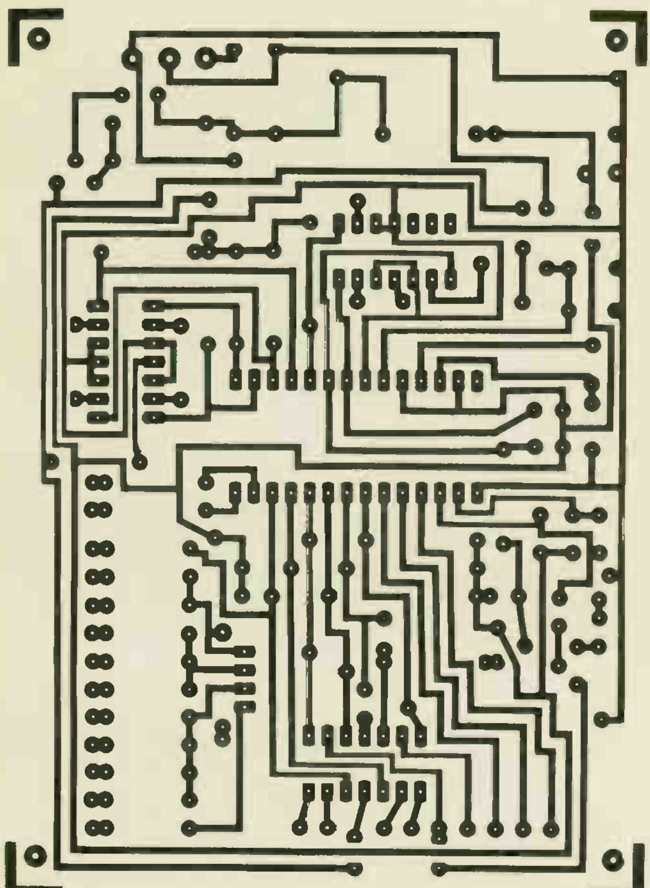


Fig.7

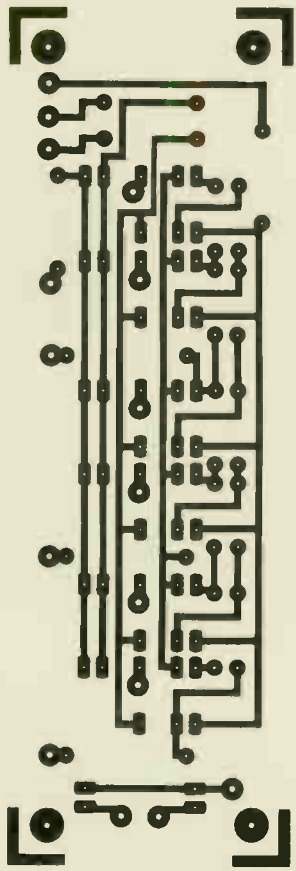


Fig.8

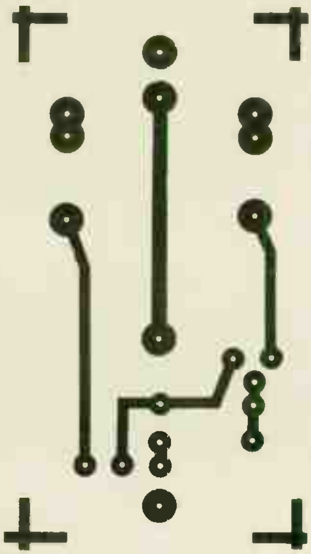


Fig.9

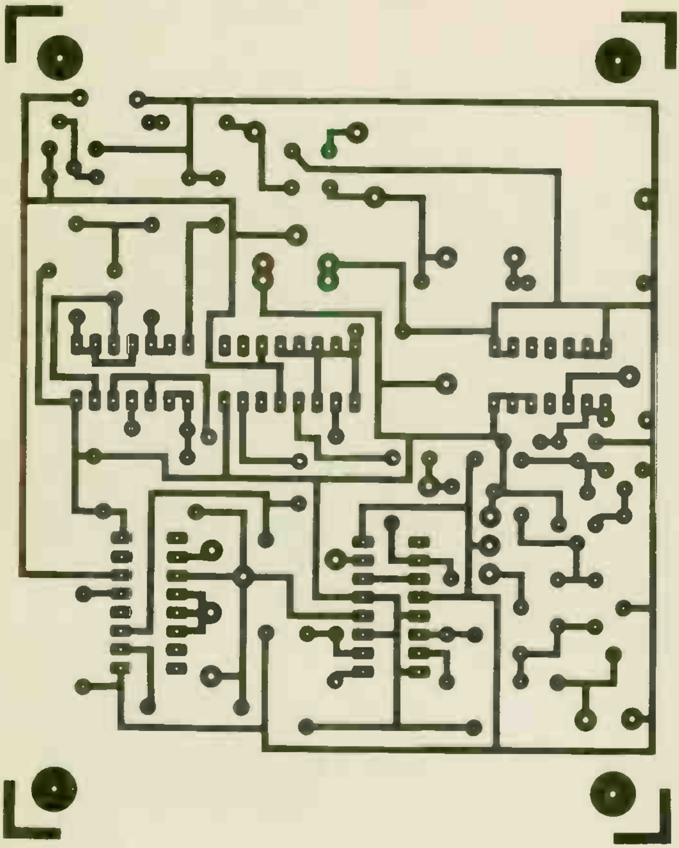


Fig.10

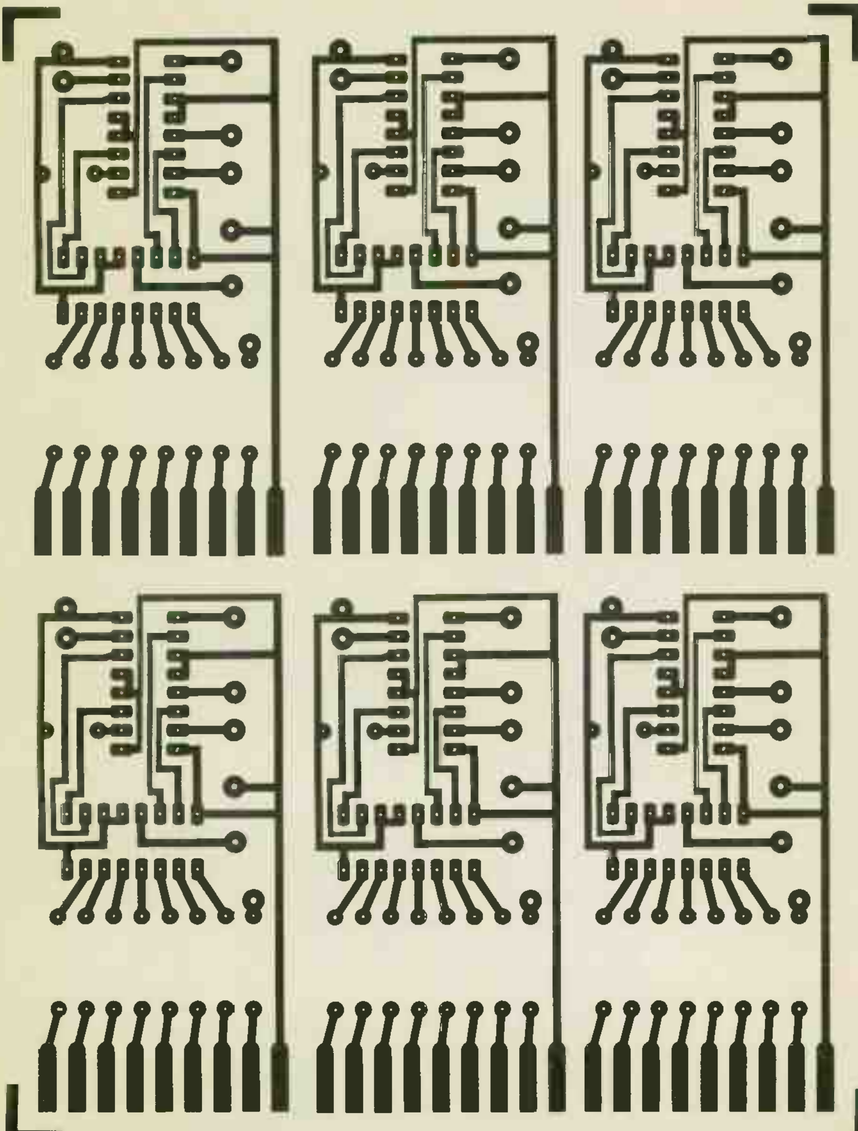


Fig.11

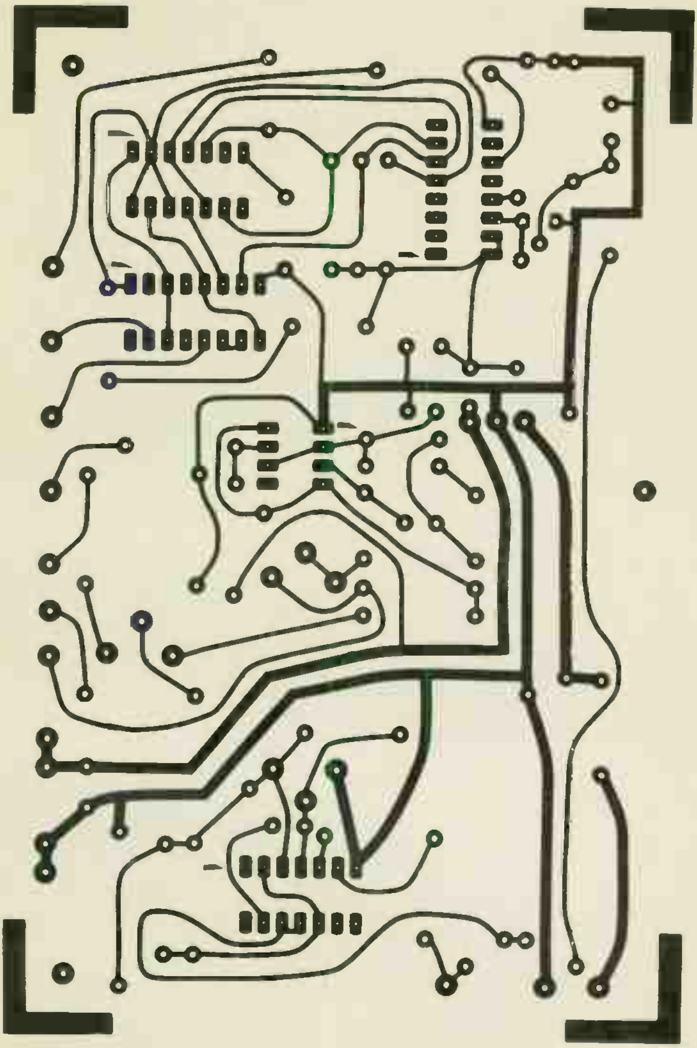


Fig.12

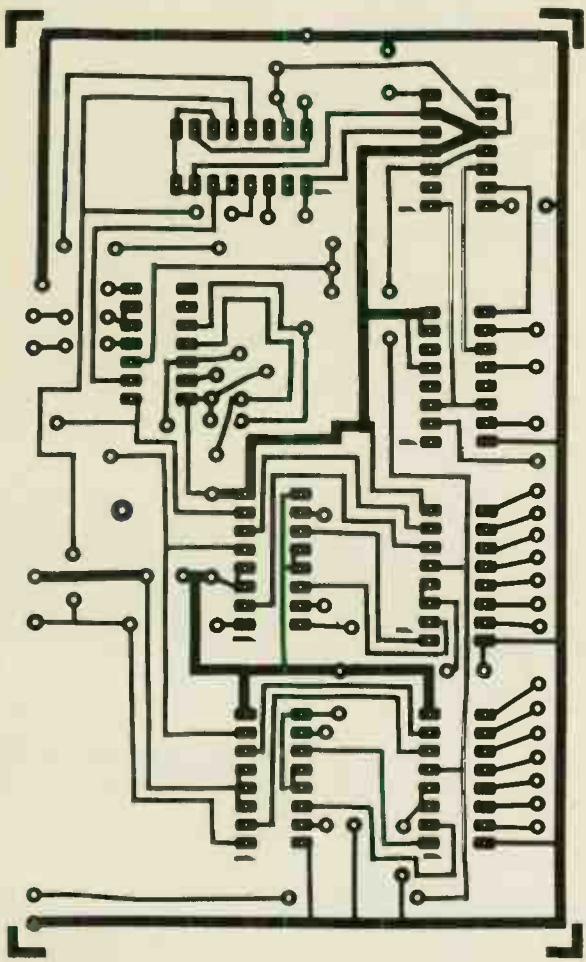


Fig.13

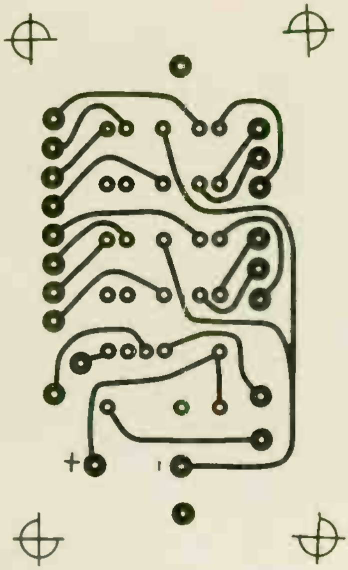


Fig.14

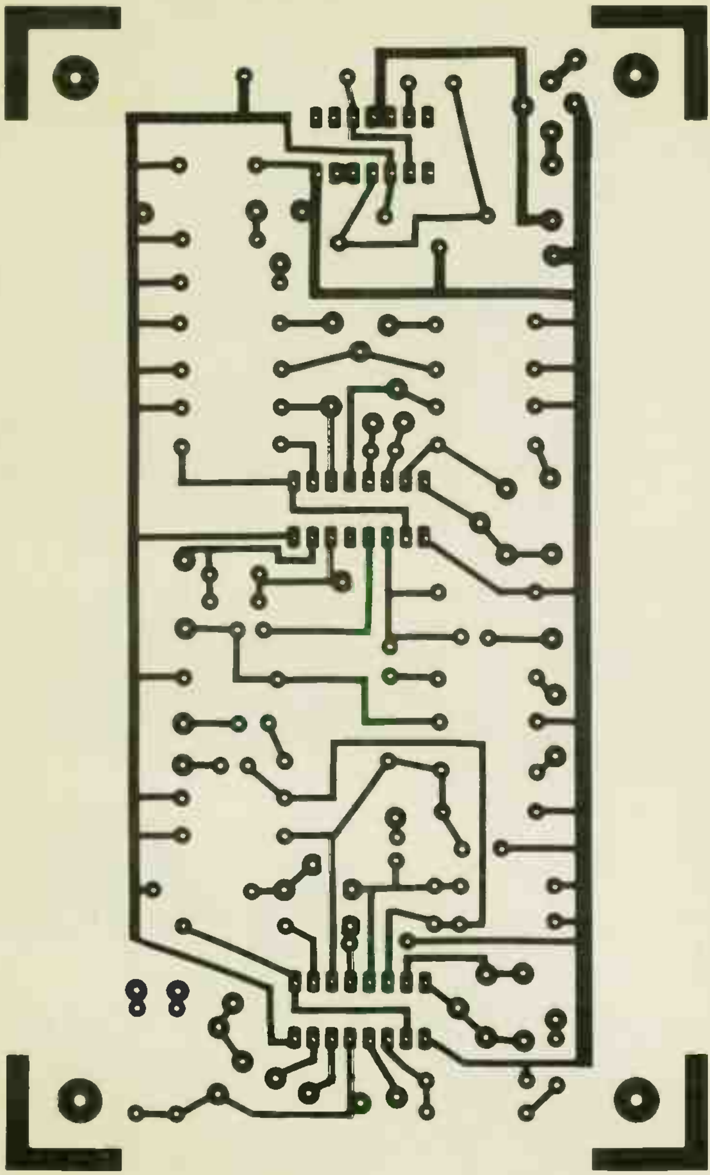
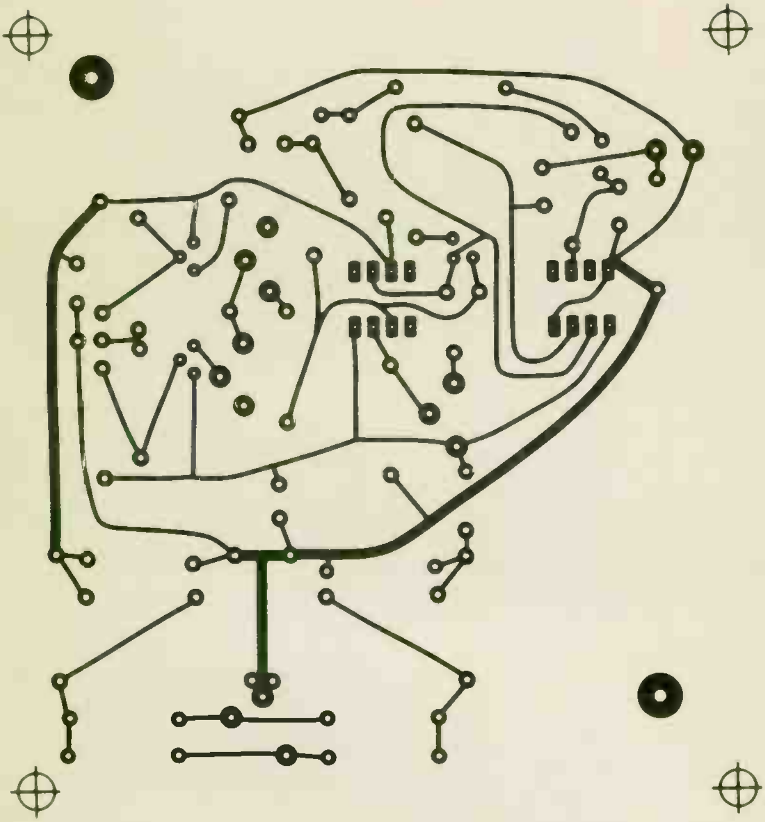


Fig.15



NOTES

NOTES

"LIFT-IT"

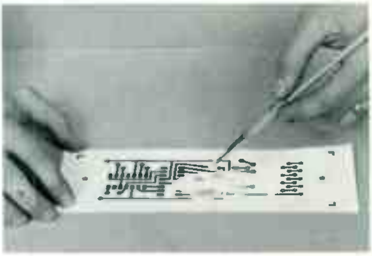
CAT. NO. J4-828

The new, positive approach to negatives for printed circuits

- Complete, illustrated instructions
- Transform your printed page circuit layout into an etched wiring pattern.

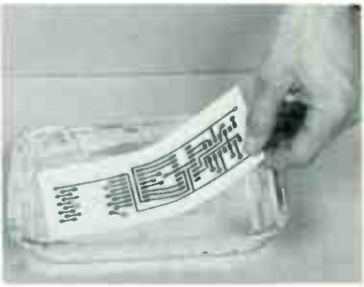
Steps to Remove P.C. Pattern from Printed Page

STEP 1. *Securing P.C. Pattern*



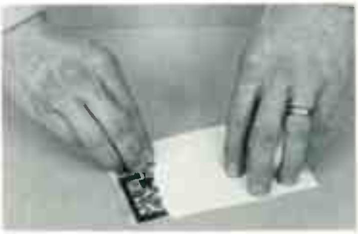
STEP 2. *Applying LIFT-IT*

STEP 3. *Removing Paper*



STEP 4. *Let Dry*

STEP 5. *Finishing The "Positive"*



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