MITS

kit electronic calculators

1440 MANUAL

$3.00

1440 MANUAL

MITS®

Micro Instrumentation & Telemetry Systems, Inc.

2016 San Mateo NE, Albuquerque, New Mexico 87110 505 - 266-2330

The MITS Model 1440 Calculator is the finest low-cost, six-function electronic calculator available today. The few short hours you spend assembling your kit will result in the satisfaction of owning a quality instrument which will serve you a lifetime.

Many convenient features of the 1440 calculator simplify its operational capacity while still allowing an outstanding range of flexibility. The square, square root, and memory keys distinguish the 1440 from any other unit with a comparable price; while a constant capability, a simplified "math" entry system, fifteen highly legible light-emitting diode readouts, and a powerful computed decimal system all combine to provide the 1440 owner with the highest quality performance attainable by the modern calculator industry.

The calculator has two internal provisions which allow for growth. A fully electronic programming unit may be added to the basic module (through built-in interfacing) to provide computer capability at a small additional cost, and the combination of its equally compatible printer gives the user a full range output capacity.

The central computational portion of the 1440 contains six large-scale integrated (LSI) circuits. Each IC plugs into its high-quality, low-profile socket to ease construction complexity and increase maintainability. The printed circuit boards used in the calculator are the finest manufactured in the United States and can be easily soldered by someone with no prior soldering experience, while one normal and three regulated power supplies allow operation of the unit under even under the most adverse voltage variations.

Rigid engineering standards, small size, and light weight construction make the unit truly portable, and the modern, streamlined styling will grace any decor.

The technical introductory section which immediately follows, provides the most comprehensive data on Theory of Operation (with complete schematics and logic diagrams) covering the electronic principles of the 1440's design.

Using reasonable care, the Step-by-Step Assembly instructions (Section II) will permit even the most inexperienced kit builder to construct the 1440 without difficulty; and the final section, covering Applications, will familiarize the owner with the usage of the 1440 through typical problems and examples.

Before beginning construction, please read the accompanying booklet entitled "Assembly Hints", for information on components, tools, soldering and service, paying particular attention to the section on soldering, as 90% of all service repairs are due to poor soldering techniques, then check your kit against the parts list enclosed and begin the actual assembly.

1440 THEORY OF OPERATION

GENERAL DESCRIPTION

The Model 1440 Calculator uses state-of-the-art MOS/LSI (Metal oxides substrate/large scale integration, MSI (medium scale integration, SSI (small scale integration), and discrete semiconductor circuitry. The calculator consists of three major areas: input, central processing unit (CPU), and output.

The input consists of an array of switches housed in the keyboard. Closing one of the switches causes a "Start" signal to be generated, and the unit responds accordingly.

The Central Processing Unit consists of 6 MOS/LSI chips, which are the heart of the calculator. These chips store the data and the internal control programs, make the calculations, and provide the output section with results.

The output section receives the data from the CPU, changes its format, and shifts the level of the signals to one suitable for driving the display.

The following sections provide more extensive details on each of these functions.

KEYBOARD

The keyboard consists of an X-Y matrix of normally open single-pole, single-throw switches. The switch is designed for minimum bounce with a contact resistance less than 1 k ohm. The X-Y matrix consists of 4X lines and 8Y lines giving a maximum possible combination of 32 functions (the 1440 uses 24 positions).

The "CLEAR", "CLEAR ENTRY", and "decimal set" switches are not in the matrix, but are level indicating switches.

The constant multiplier/divisor switch is the single-pole single-throw mechanical latching type, and it is also a level indicating switch.

CENTRAL PROCESSING UNIT

INPUT CHIP - 7014 IC

The Input Chip receives figures and command inputs from the keyboard by scanning an input switch matrix to detect keyboard activity and generates a suitable time delay to eliminate contact bounce. A six bit control ROM address for the initial instruction of a microprogrammed sequence is transmitted serially to the Control Chip. The Input Chip retains the BCD figure during entry until it is transferred by instruction to the Register Chip. The Input Chip locks out new keyboard inputs when the Control ROM is busy.

REGISTER CHIP - 5001 IC2

The Register Chip is composed of three 16 digit shift registers, one auxillary 4 bit shift register, and selection gating logic (SEL gates). The three 16 digit registers are (1) the Accumulator Register - A REG., (2) the Input Register - I REG., and (3) the Multiplier/Quotient Register - Q REG. Each of these registers has individual clear capability and right or left shift capability. The Input Register is used to receive keyboard figures and is one input to the adder on the Arithmetic Chip while retaining the result of any arithmetic operation for display. The Multiplier/Quotient register is used for storage and manipulation of operands during multiplication and division.

ARITHMETIC CHIP - 7002 IC3

The Arithmetic Chip contains the full BCD Adder/Subtractor with their complementing units and Sign and Overflow flip-flops. It also contains a Digit Timing Register and synchronization circuits for the keyboard-generated "Clear" function. Selection gates driven by ROM micro-operations determine the data paths entering the Arithmetic Chip from the Accumulator and Input Registers. The significant tests performed on the Arithmetic Chip are for sign and overflow conditions and/or contents of the individual register digits. The results of the arithmetic operations are carried out up to 14 digits of sums, products, and quotients.

CONTROL LOGIC CHIP - 5013 IC4

The Control Logic Chip contains the central control for the operation of micro-programmed sequences. This control logic consists of: Point Position Registers (stores the position at which the decimal point is being displayed); Digit Storage Register (1 digit - reconciles arithmetic result to the displayed decimal point position); Iteration Counter (4 bits - determines the correct time for transfer of BCD figures from the Input Chip to the Input Register, examines multiplier digit during multiplication, and generates quotient digits during division); Cycle Counter (4 bits - tallies the number of digits already calculated during multiplication or division).

CONTROL ROM (READ ONLY MEMORY) CHIP - 7006 IC5

The Control ROM Chip contains the read only memory unit which issues the basic control sequences to operate the calculator. A portion of each word specifies the ROM address of the next program step, receiving the initial address for any micro-programmed sequence from the Input Chip. A programmed sequence is terminated when address zero is selected.

OUTPUT CHIP - 5005 IC6

The Output Chip supplies the BCD signals for the digit display, decimal point, and indicator selection signals. The data is made available to all displays at once. The selection signals start at D7 and proceed sequentially to D0. Then the alternate display circuit causes the output chip to provide data for D13 through D8. Strobes D5 through D0 occur again with the alternate display directing the strobes to D13 through D8. The decimal point is displayed only in one of the lower 7 positions, and leading zeros are suppressed until the decimal point position is reached.

ALTERNATE DISPLAY CIRCUIT

The Alternate Display Circuit generates the signals which allow all 14 digits of a computation to be displayed at once. It consists of IC9 (SN7490), and IC 10, IC 11 (SN7402), IC 12 (SN7472).

DTO is a timing pulse used to determine the lenght of time that the circuit is in a given state. This pulse is counted by the decade counter (IC 9). The circuit is stable for 8 counts during which the lower 8 digits are displayed. All displays are shut off during the next two counts, and during those two counts the M6 and M7 signals are sent to the 5005 chip preparing it for the upper six digits. The upper and lower select flip-flop (IC 10) changes state to allow data to be routed to the upper six displays.

During the next six counts, the upper 6 digits are displayed. All displays are shut off for the next 4 counts. During this time, M6 and M7 return the Output Chip to the lower half data and the flip-flop is reset to select the lower half of the display and the process repeats.

CLOCK

A clock is incorporated to provide a timing base for calculator operations which must operate in a sequenced manner. The clock frequency determines the rate at which the calculator performs operations (within the constraints of the operating requirements of the CPU). The LSI's are designed to operate at a maximum clock frequency of 200KHz providing an adequate delay margin while still giving extremely fast operation.

G1, G2, and G3 are two input NAND gates (see IC7 with the left most gate being gate 1). If either of the inputs to a NAND gate are low, the output is high. If BOTH inputs are high, the output is low. Assume the output of G1 is low, G2 is high, and G3 is low; this is an unstable condition since the low input to G1 should force the output of G1 high. When G1 output goes high, it starts charging C1 in the opposite direction, while holding the output of G2 high. When the capacitor charges sufficiently, it will allow the output of G2 to go low. This forces G3 output high and G1 output low. Once again the capacitor must change its voltage polarity, and the cycle is complete. The time it takes to charge and discharge the capacitor determines the "on" and "off" time of the output wave form.

G4 acts as an inverter which drives the DTL to MOS interface buffer. The output for the interface buffer is a square wave of 0V to -14V amplitude with less than 100 nsec rise and fall time. This is the reference clock that synchronizes all six chips of the CPU.

OUTPUT

As indicated in the Output Chip description, the data to be presented to the display is in a BCD format consisting of 4 bits per digit. However, the display requires a 7 bit-per-digit word. The transformation from BCD to 7 segment data is made in chip SN7447 (IC8). The power supply for this IC is shifted to -3 and -8 volts by zener diode D6 and resistor R67 to increase its drive to the buffer transistors. The output is -8V for the particular segment to be lighted and is -3V for the segments to be turned off. The SN7447 has outputs that are inverted from its input signals. An example of this conversion is given below.

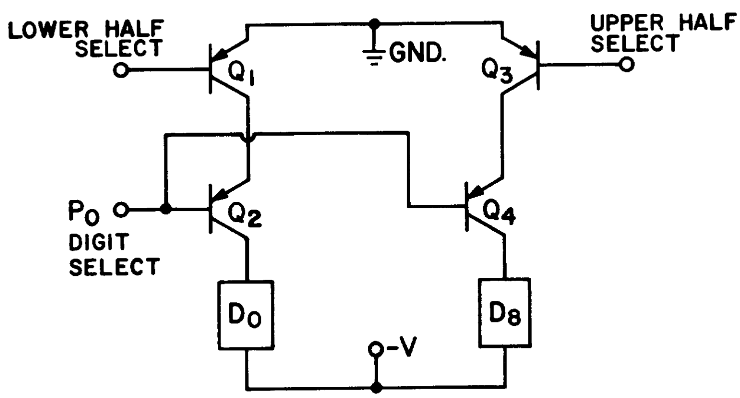
> Let B1 = 0, B2 = 0, B4 = -5V, B8 = -5V. Then A = -5V, B = -5V, C = -5V, D = -5V, E = 0V, F = 0V, G = -5V. This means that segments A, B, C, D, and G are on and E and F are off.

LIGHT EMITTING DIODE (LED) DRIVE CIRCUITS

The L.E.D. requires 3.4V at an average current of 4ma per segment to obtain adequate brightness. Since each digit is on for only 1/20 of each display period, it is necessary to put 80ma peak through each segment to get the equivalent brightness of 4ma average current. The SN7447 is able to supply only 40ma and; therefore, 7 buffer transistors are included. Each transistor operates as an emitter-follower with a resistor to limit base current into the SN7447. The signal at the base is pulled to ground potential by the 10KΩ resistor when the transistor is off and is approximately -4.1 volts when the transistor is on and segment current if flowing, while the collector resistor limits the segment current to about 80ma peak current. The SN7447 is able to supply only 40ma and; therefore, 7 driver stages are included.

DIGIT SELECT CIRCUIT

As stated in the description of Output Chip, the same position-select pulses occur twice: once when in the lower half of the display and once in the upper half of the display. In order to determine which position is being lit (position 1 or 8 for example), it is necessary to set up an AND condition of the strobe and the upper and lower half select signals. This is accomplished by a series connection of two transistors. A simplified schematic is given below:



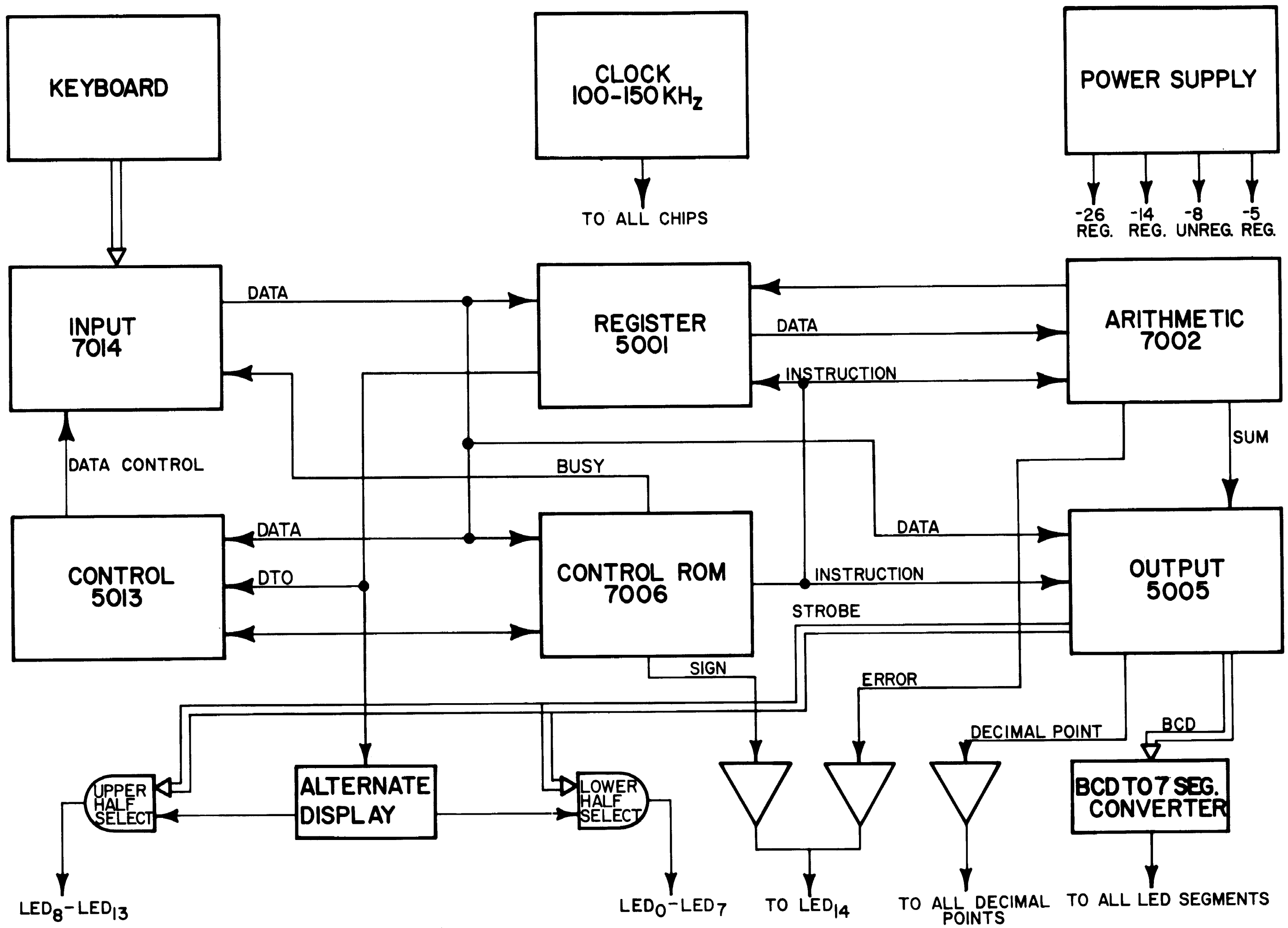
If Po is low, it will try to turn on both Q2 and Q4. When LOWER HALF goes low, Q1 will come on. This completes a current path from ground to -V through Q1, Q2 and the L.E.D. (turning on Do) while there is no complete path through Q3 and Q4 (leaving D8 off). When UPPER HALF goes low, the reverse situation is true. Note also that if Po is high, then Q2 and Q4 are both off, and, regardless of the condition of Q1 and Q2, neither L.E.D. will be on.

CONSTANT, SIGN, AND ERROR INDICATOR CIRCUIT

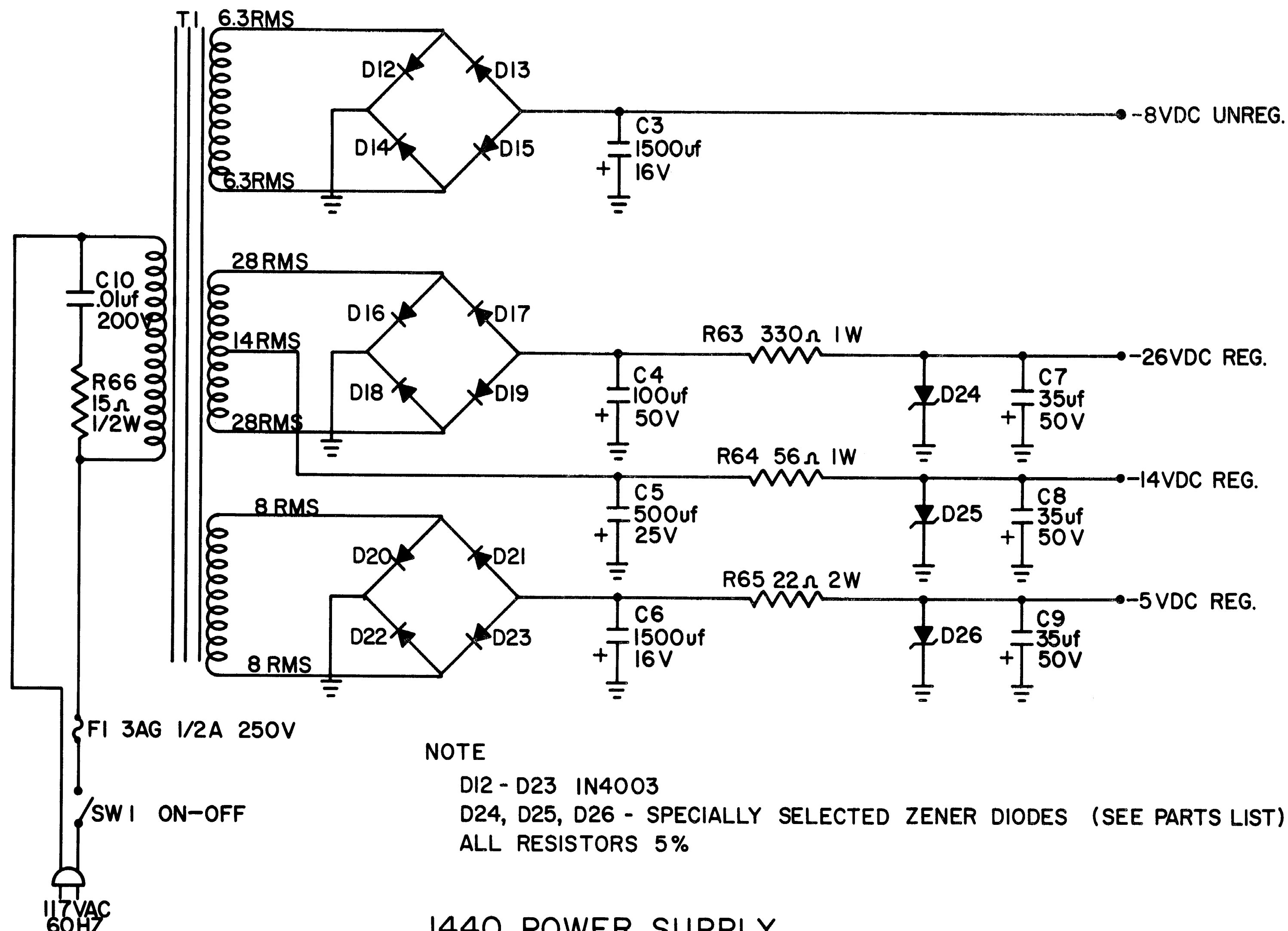
The negative sign for the 1440 calculator is segment A. The calculator generates a low level output when a negative sign is to be displayed. This signal is buffered to increase the current level to drive the L.E.D. while diode D3 isolates segment F from the negative sign signal.

The constant indication and function are generated by a switch closure to -8V which causes segments D, E, and G to be lighted. This also causes Q12 to turn on raising its collector toward ground and thus the required signal to the 7014 LSI chip. Diode D4 isolates segments A and F from the constant switch.

When an error has occurred, it is necessary to light segments A, D,E,F and G. The error signal from the calculator is also a low level output. This signal turns on Q11 allowing current to flow directly from segment F as the forward biasing diodes D3 and D4 allow current to flow in segments A,D,E and G.



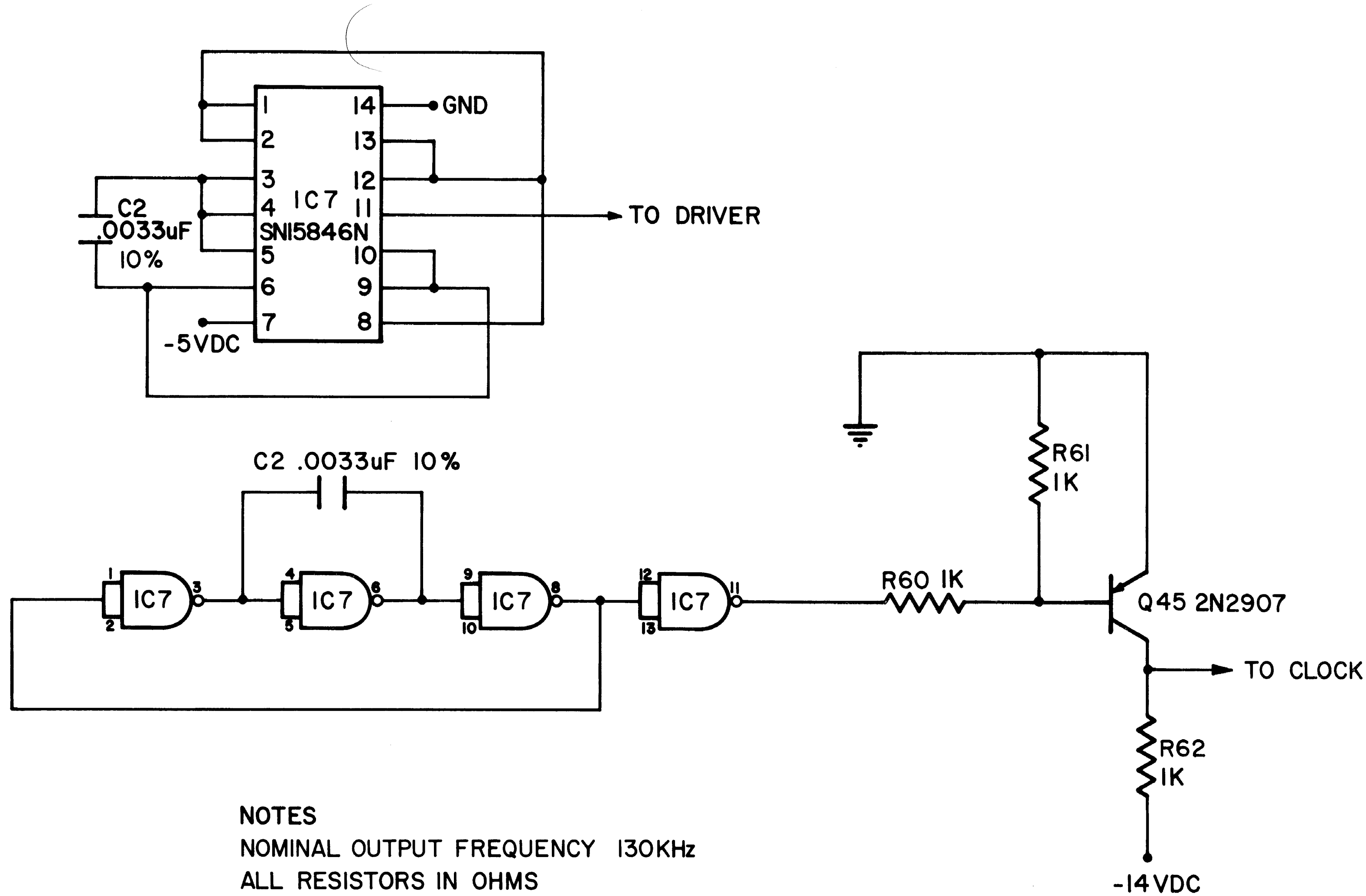
1440 BLOCK DIAGRAM



NOTE

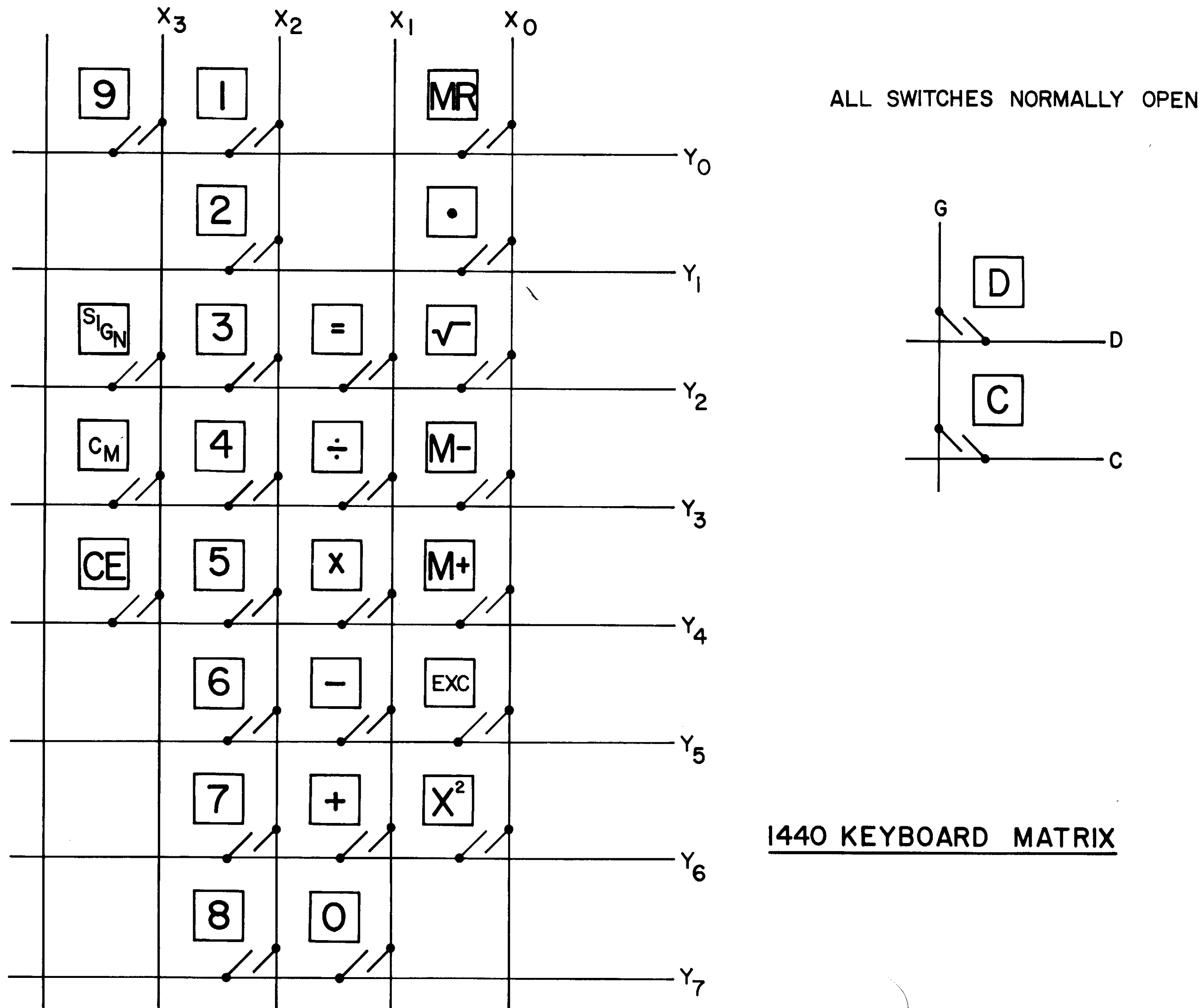
D12 - D23 IN4003
D24, D25, D26 - SPECIALLY SELECTED ZENER DIODES (SEE PARTS LIST)
ALL RESISTORS 5%

1440 POWER SUPPLY

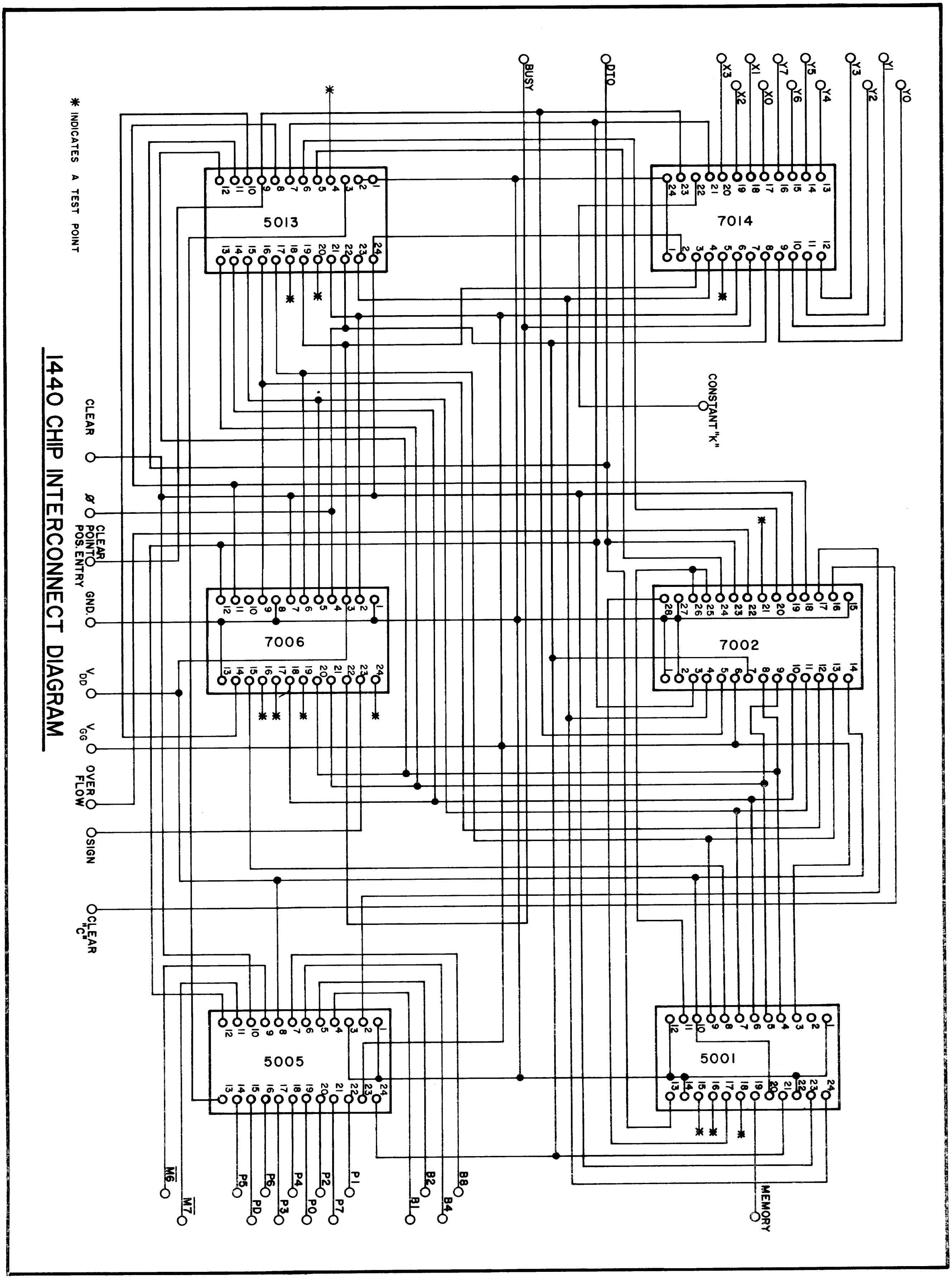


NOTES
NOMINAL OUTPUT FREQUENCY 130KHz
ALL RESISTORS IN OHMS
ALL RESISTORS 1/2W, 5%

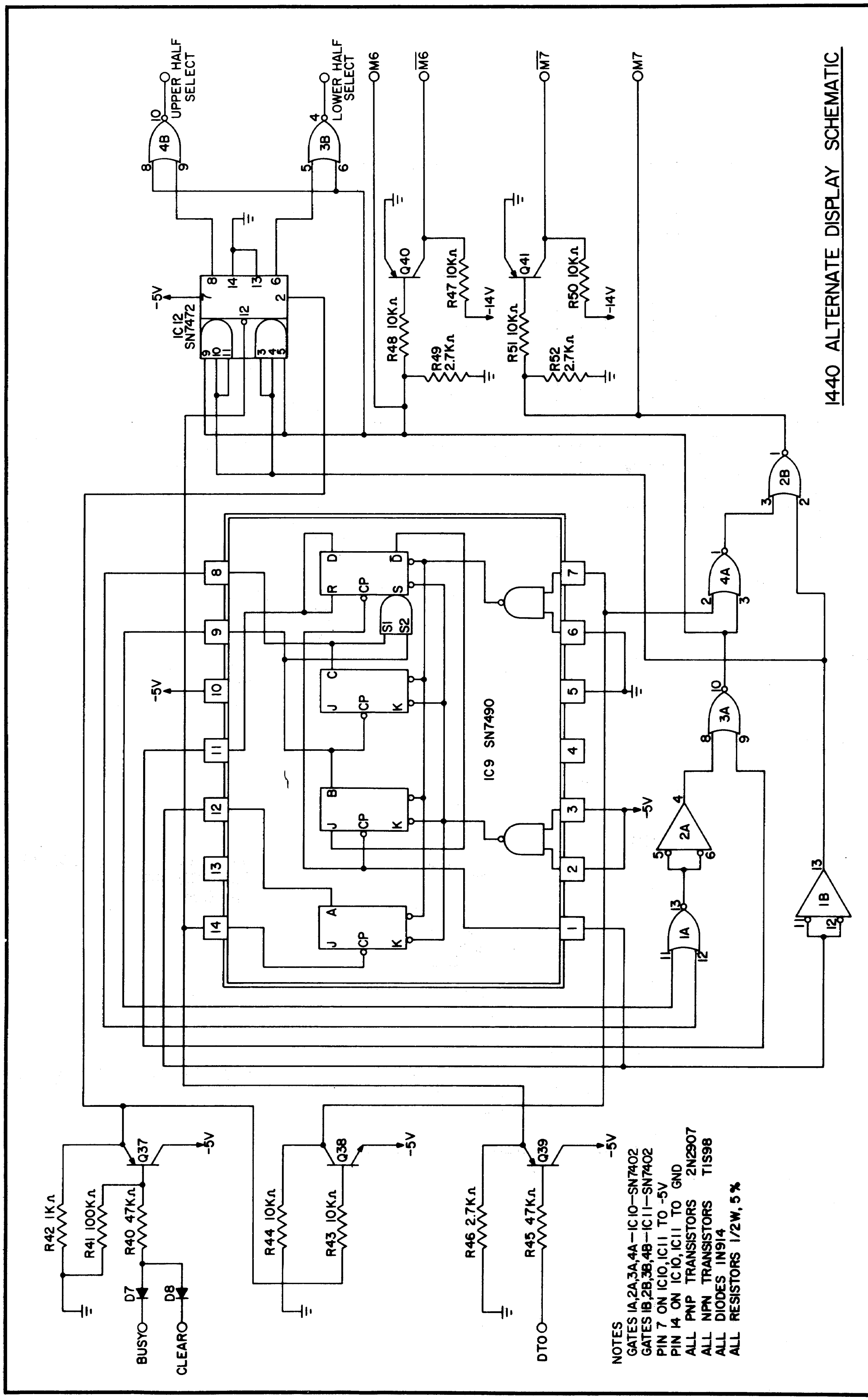
1440 CLOCK

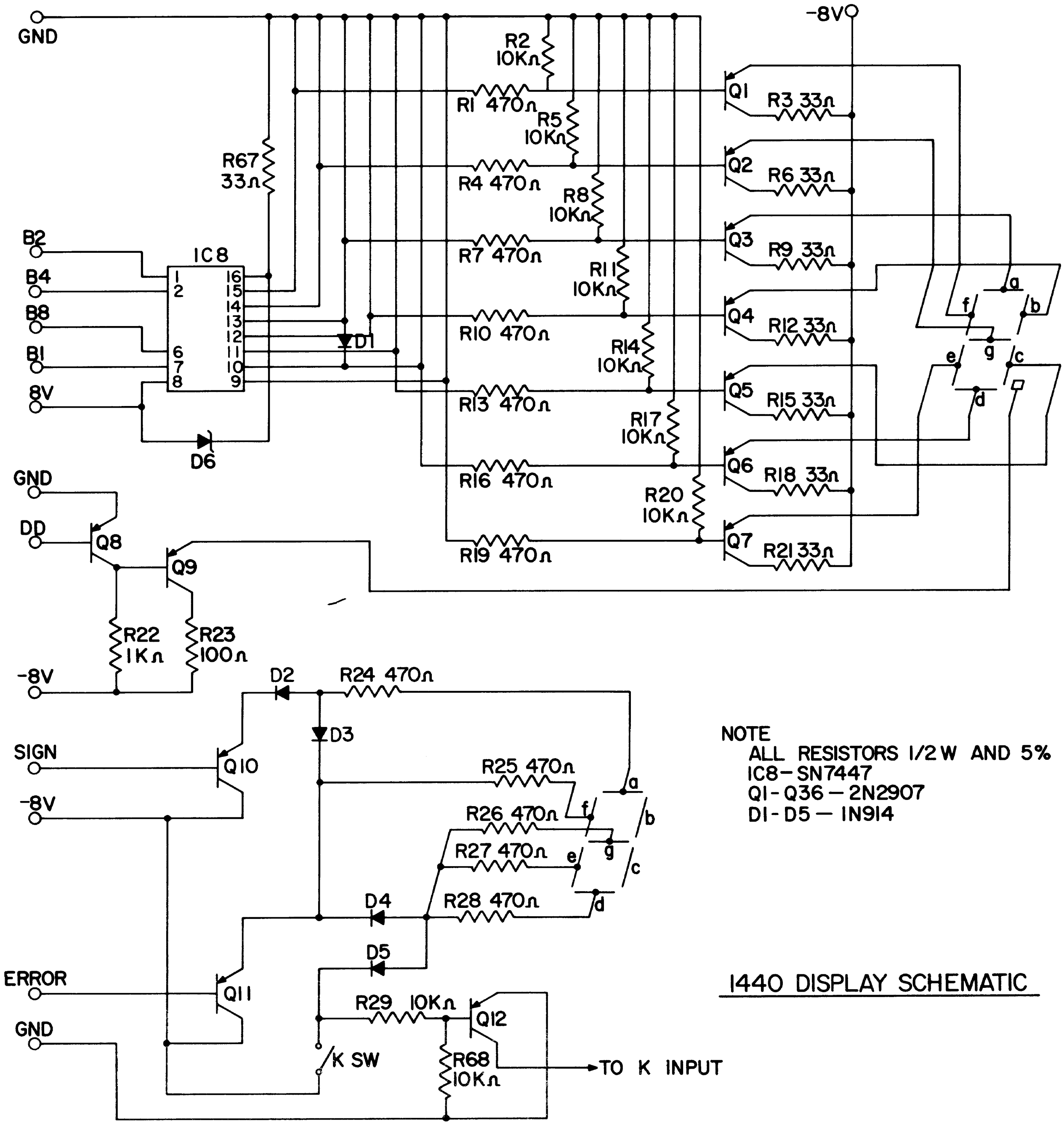


1440 KEYBOARD MATRIX



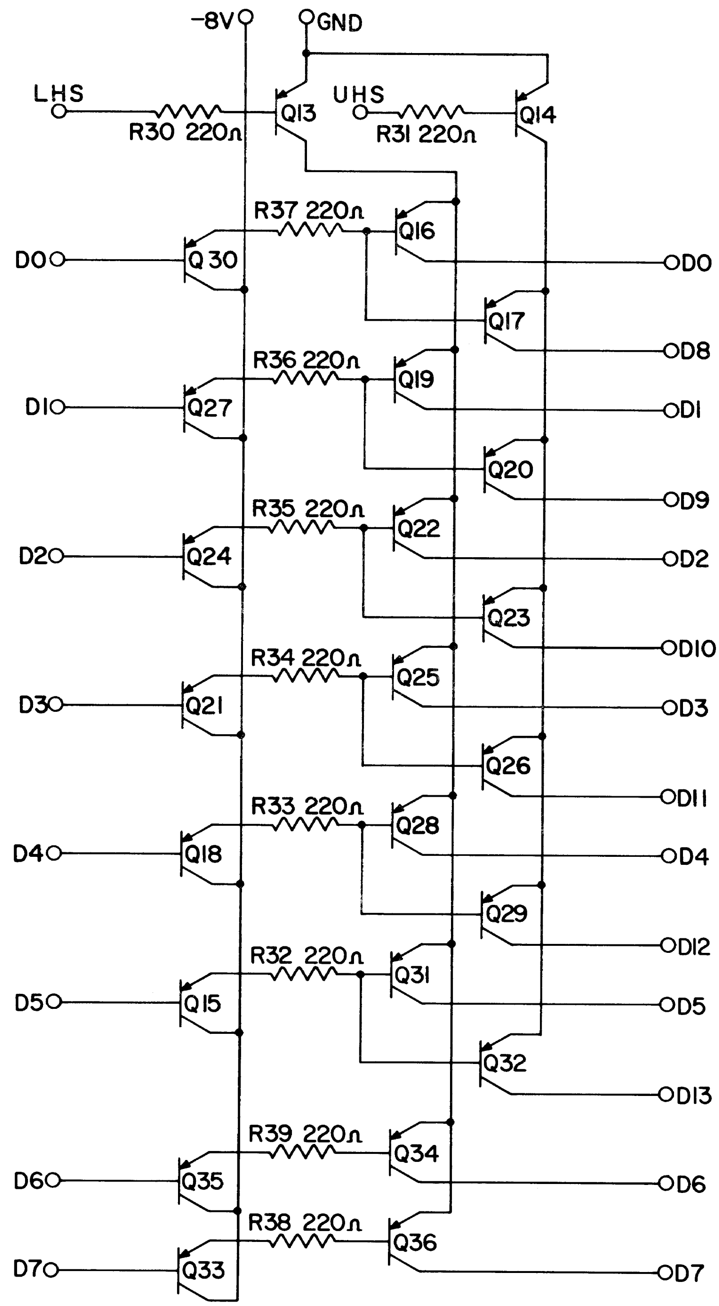
1440 CHIP INTERCONNECT DIAGRAM
✱ INDICATES A TEST POINT
5013
7014
7006
7002
5005
5001
BUSY
DTO
X3
X2
X1
X0
Y7
Y6
Y5
Y4
Y3
Y2
Y1
Y0
CONSTANT "K"
CLEAR
Ø
CLEAR POINT POS. ENTRY
GND.
V_{DD}
V_{GG}
OVER FLOW
SIGN
CLEAR "C"
M6
M7
P5
PD
P6
P3
P4
P0
P2
P7
P1
B1
B2
B4
B8
MEMORY


1440 ALTERNATE DISPLAY SCHEMATIC
UPPER HALF SELECT
LOWER HALF SELECT
M6
M̅6̅
M̅7̅
M7
IC12 SN7472
IC9 SN7490
Q37
Q38
Q39
Q40
Q41
R40 47KΩ
R41 100KΩ
R42 1KΩ
R43 10KΩ
R44 10KΩ
R45 47KΩ
R46 2.7KΩ
R47 10KΩ
R48 10KΩ
R49 2.7KΩ
R50 10KΩ
R51 10KΩ
R52 2.7KΩ
D7
D8
BUSY
CLEAR
DTO
-5V
-14V
NOTES
GATES 1A,2A,3A,4A—IC10—SN7402
GATES 1B,2B,3B,4B—IC11—SN7402
PIN 7 ON IC10,IC11 TO -5V
PIN 14 ON IC10, IC11 TO GND
ALL PNP TRANSISTORS 2N2907
ALL NPN TRANSISTORS TIS98
ALL DIODES 1N914
ALL RESISTORS 1/2W, 5 %



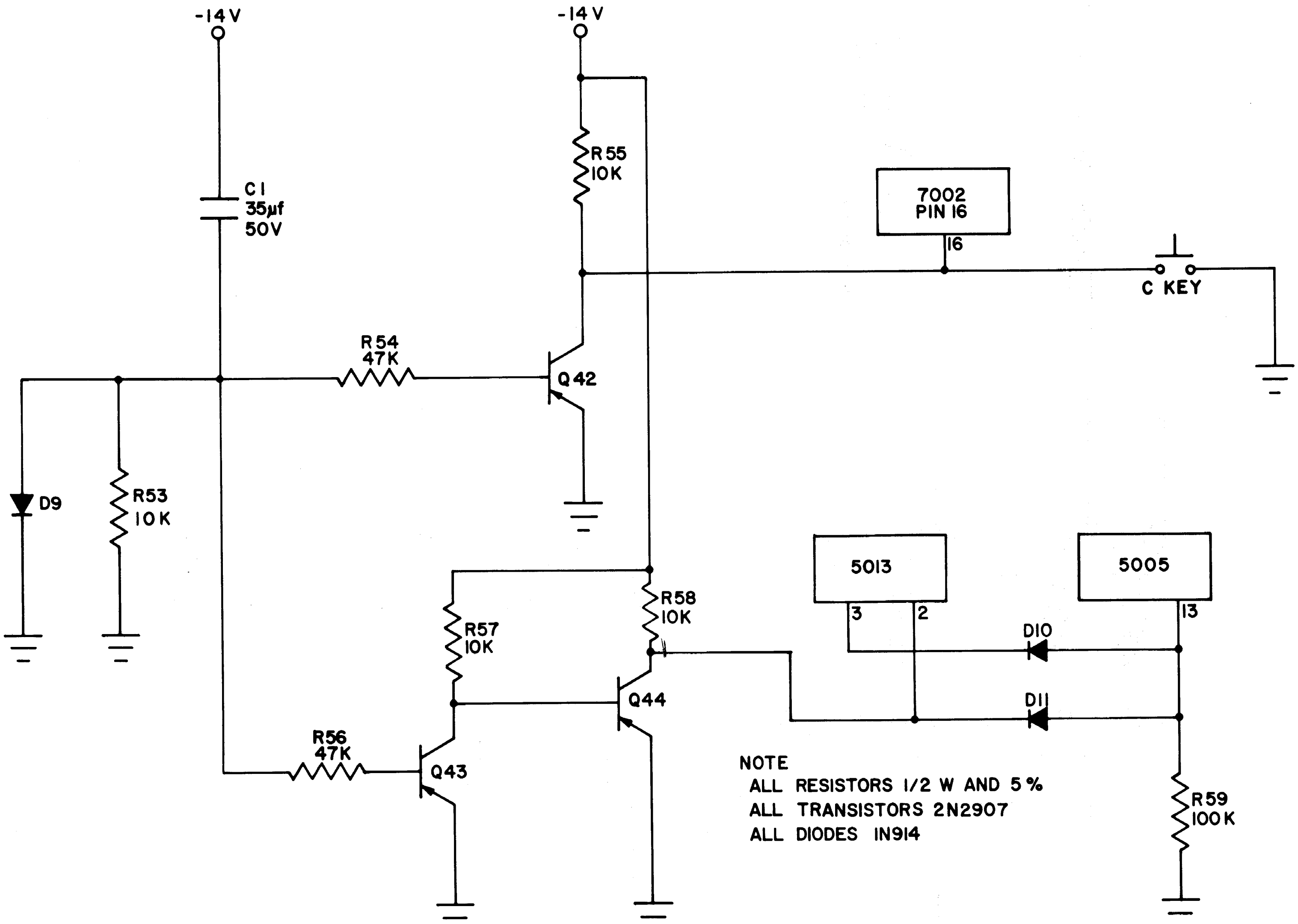
NOTE
ALL RESISTORS 1/2 W AND 5%
IC8 – SN7447
Q1 - Q36 — 2N2907
D1 - D5 — 1N914

1440 DISPLAY SCHEMATIC



NOTE
ALL RESISTORS 1/2 W AND 5%
IC8 - SN7447
Q1 - Q36 — 2N2907
D1 - D5 — 1N914

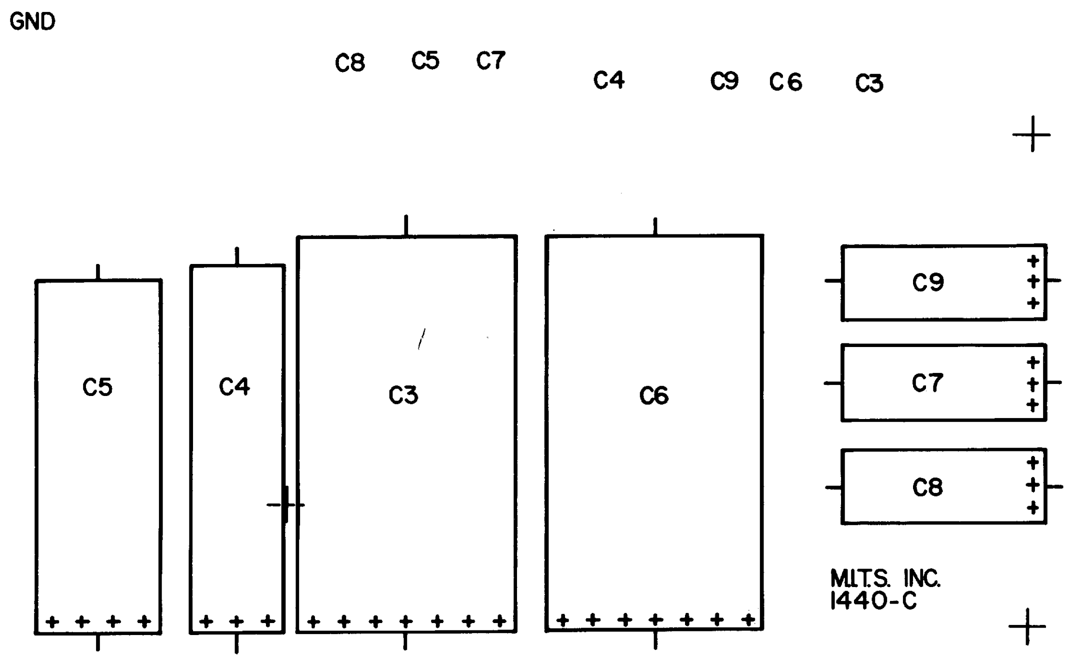
1440 DISPLAY SCHEMATIC



NOTE
ALL RESISTORS 1/2 W AND 5 %
ALL TRANSISTORS 2N2907
ALL DIODES IN914

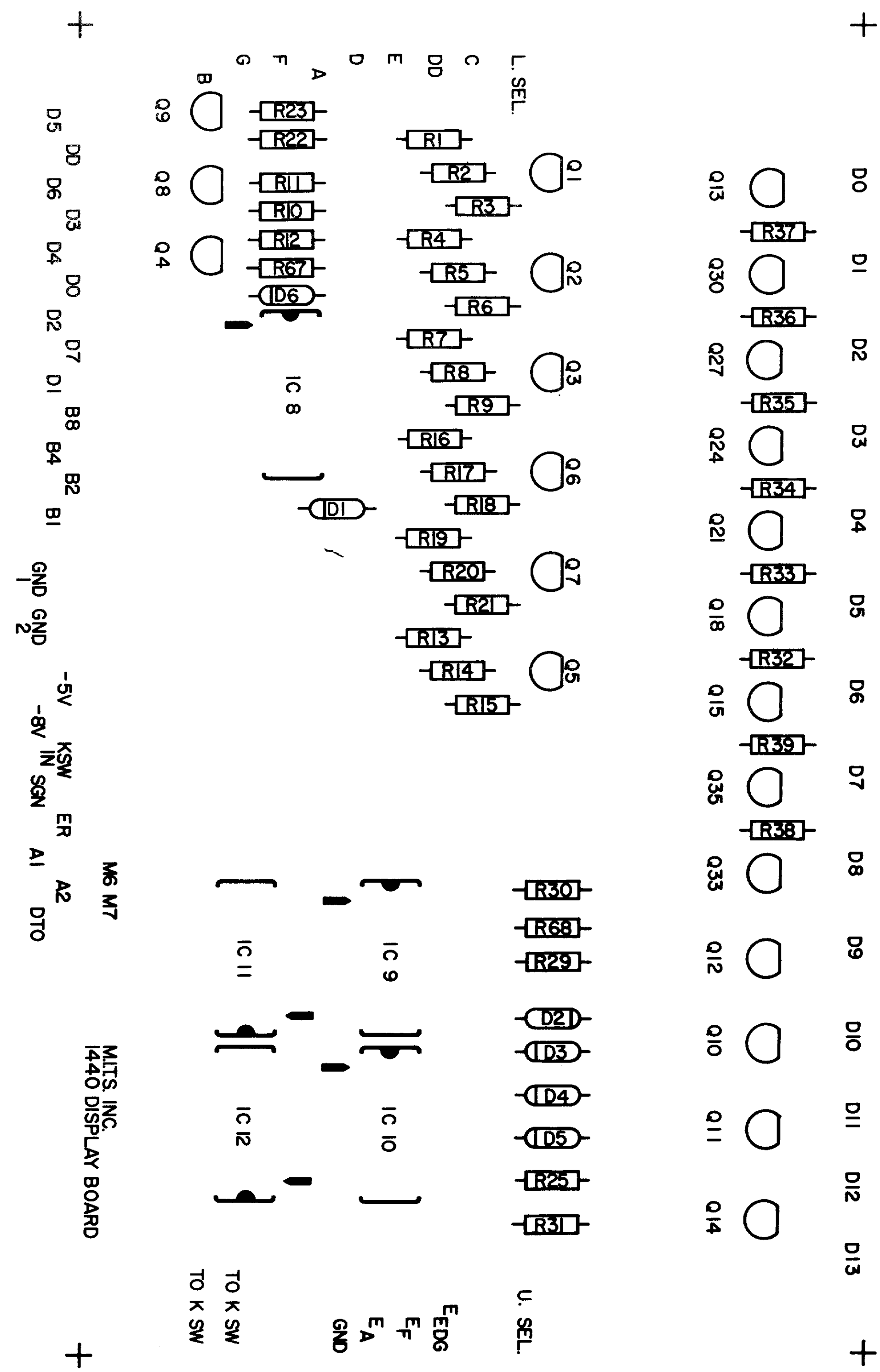
1440 AUTOMATIC CLEAR CIRCUIT

CAPACITOR BOARD ASSEMBLY



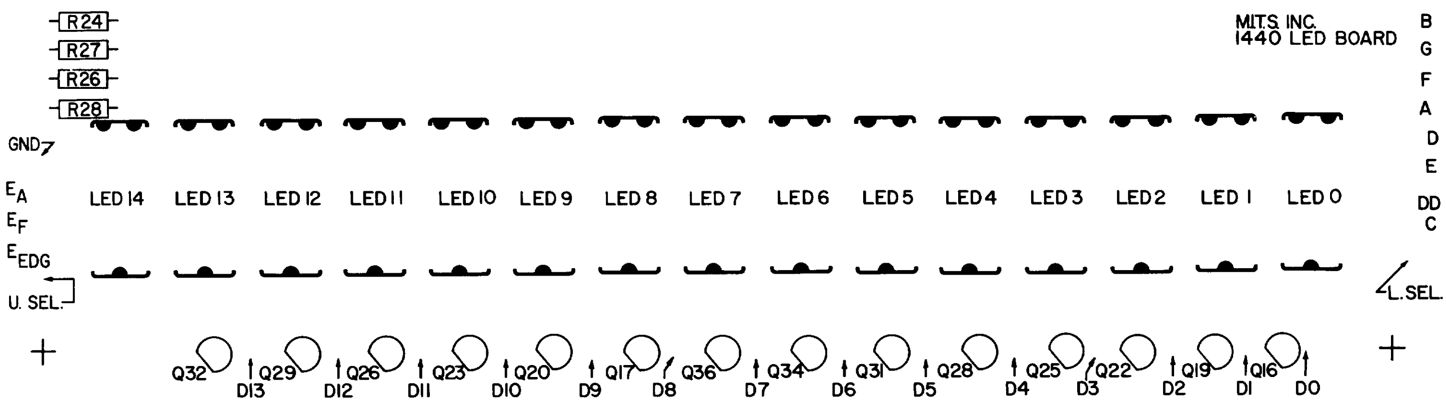
Component Layout

DISPLAY BOARD ASSEMBLY



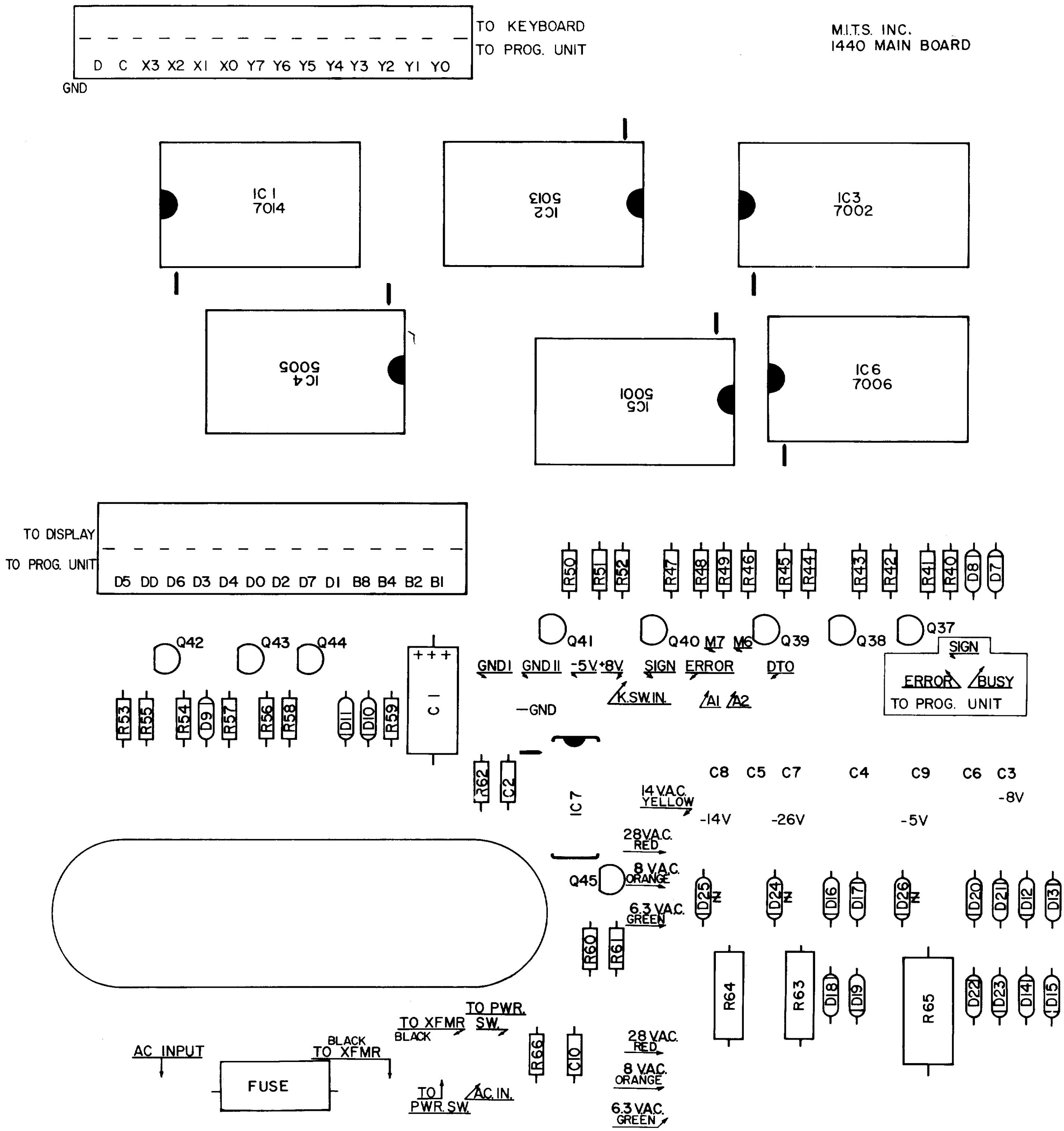
Component Layout

LED BOARD ASSEMBLY

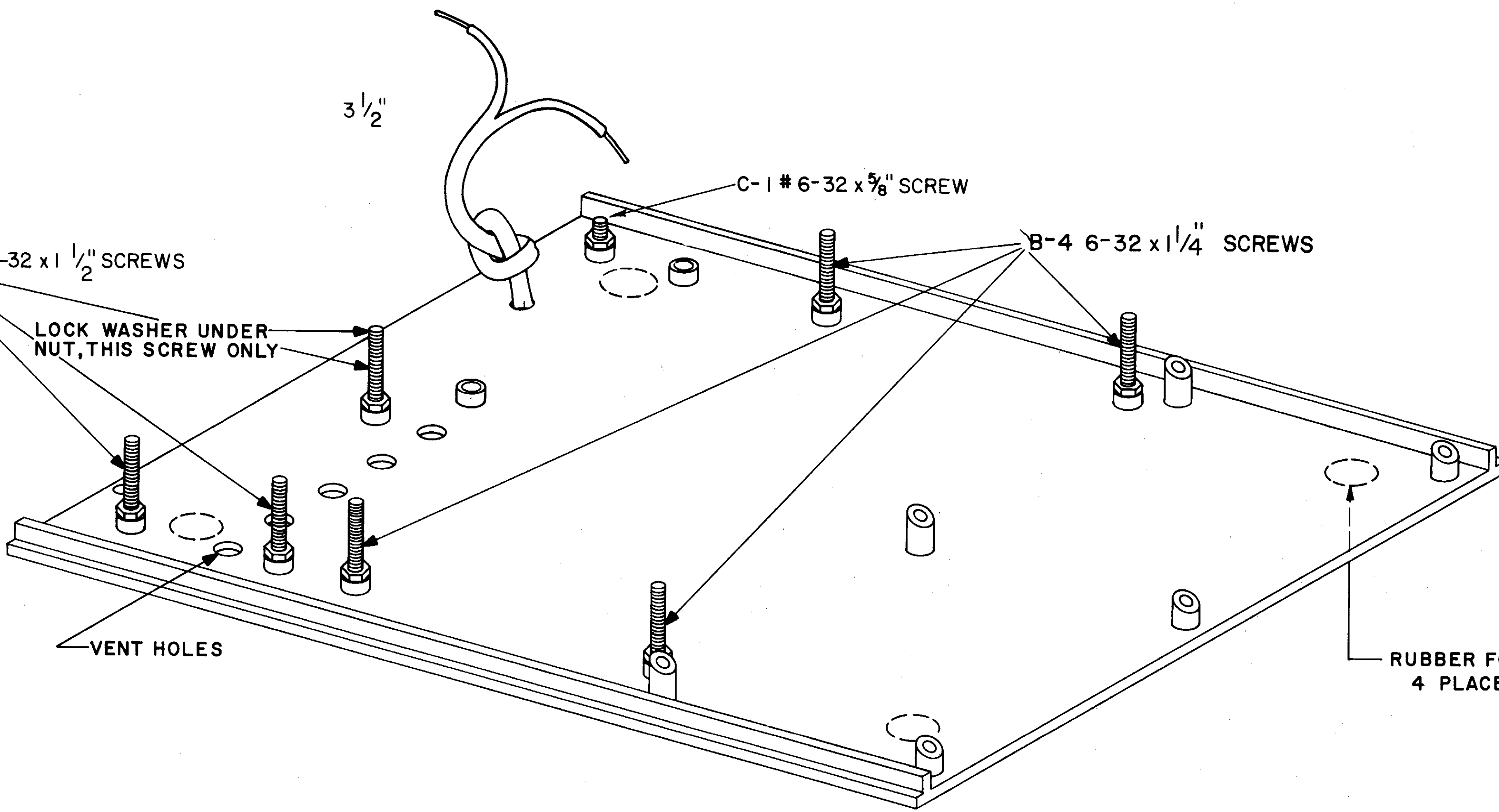


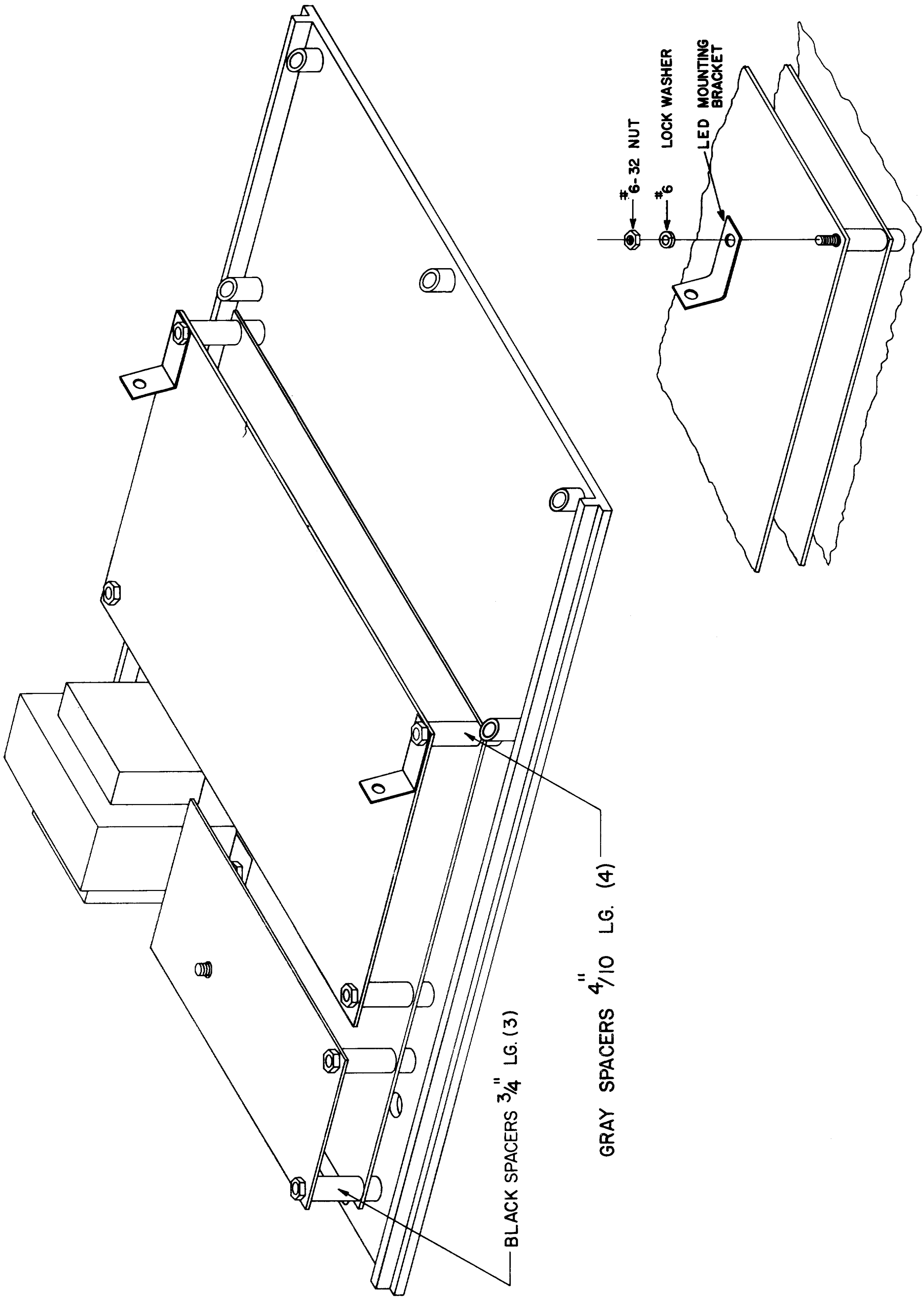
Component Layout

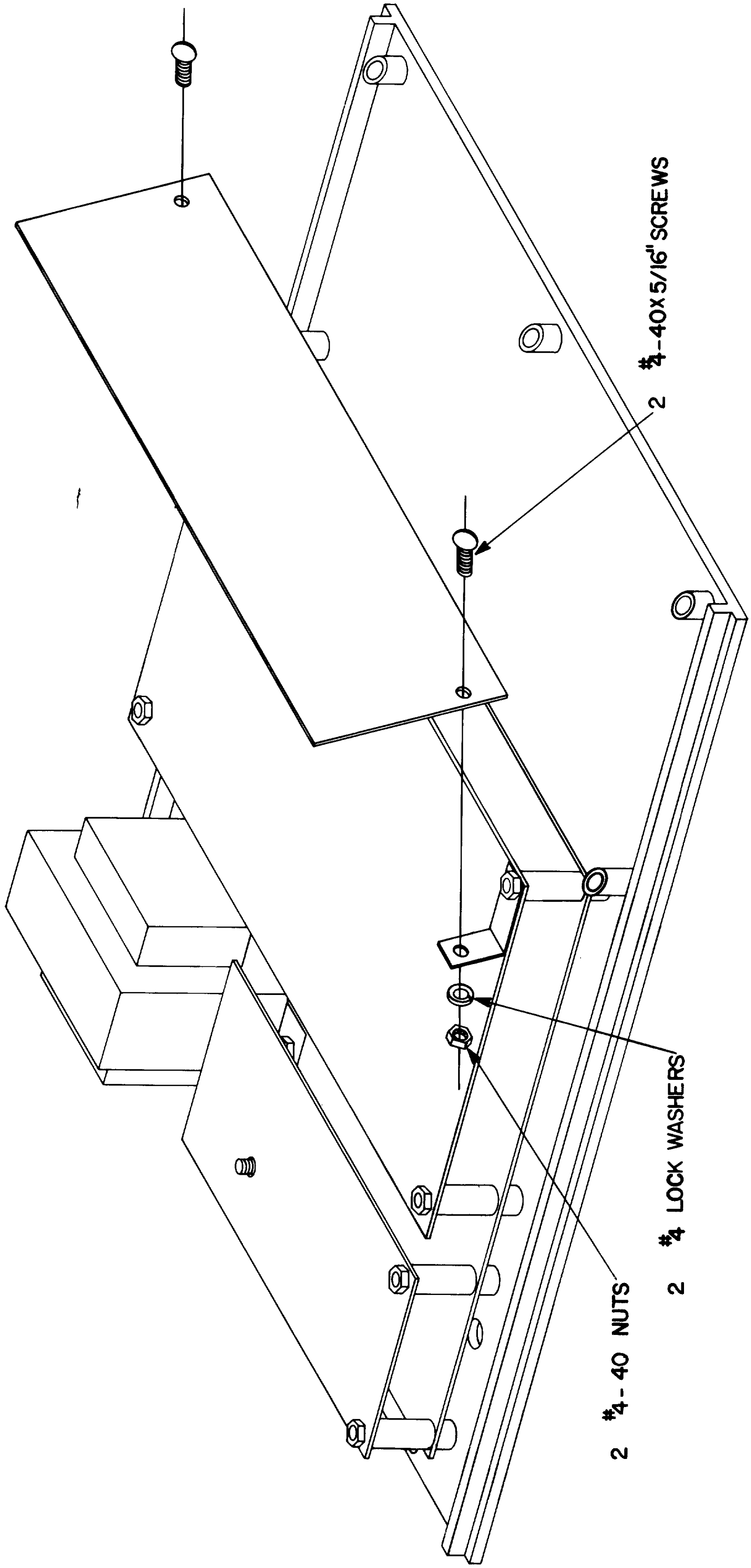
MAIN BOARD ASSEMBLY



Component Layout


3 1/2"
C-1 # 6-32 x 5/8" SCREW
A-3 #6-32 x 1 1/2" SCREWS
B-4 6-32 x 1 1/4" SCREWS
LOCK WASHER UNDER
NUT, THIS SCREW ONLY
VENT HOLES
RUBBER FOOT
4 PLACES


BLACK SPACERS 3/4" LG. (3)
GRAY SPACERS 4/10" LG. (4)
#6-32 NUT
#6 LOCK WASHER
LED MOUNTING BRACKET


2 #4-40 NUTS
2 #4 LOCK WASHERS
2 #4-40 X 5/16" SCREWS

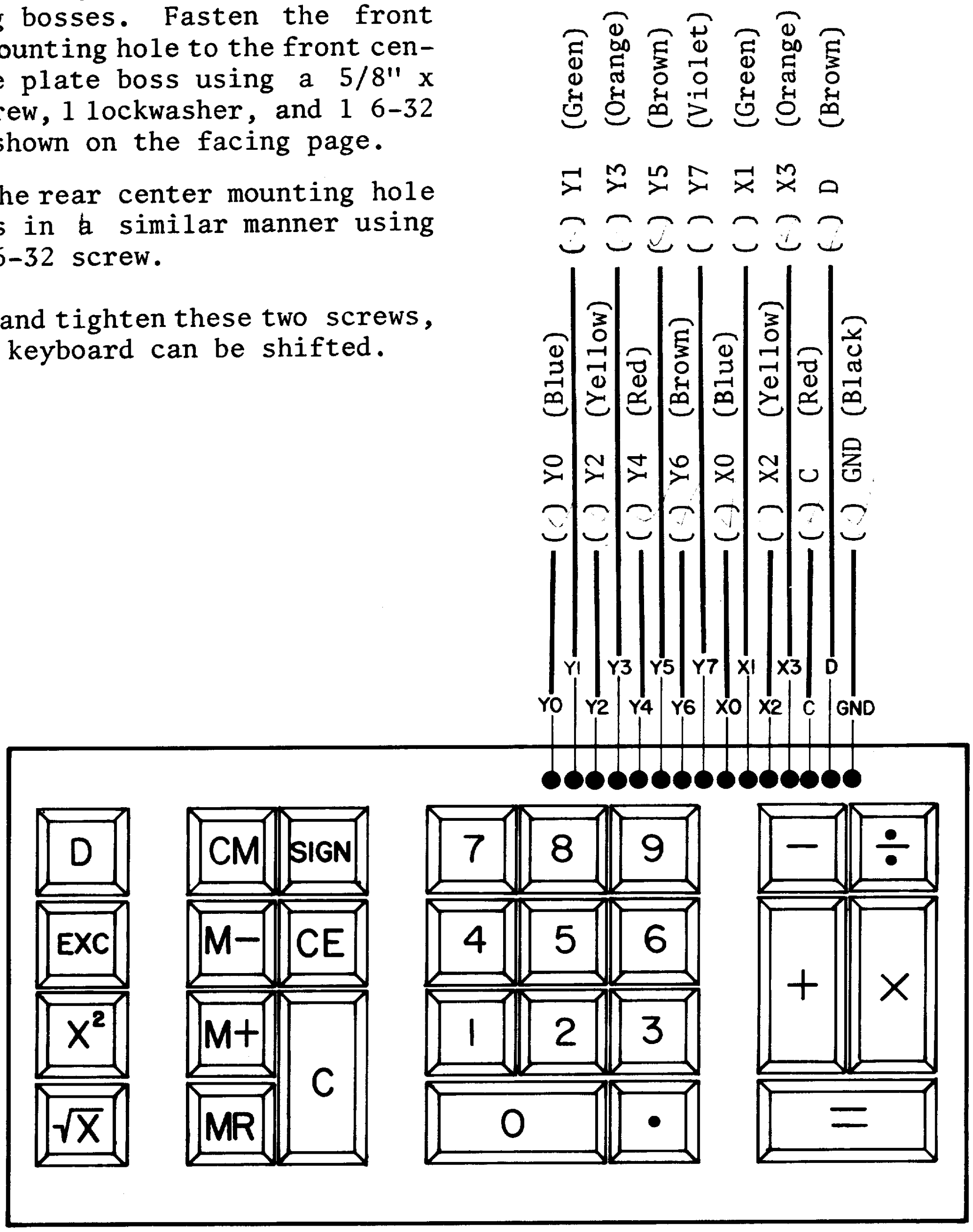
KEYBOARD INSTALLATION

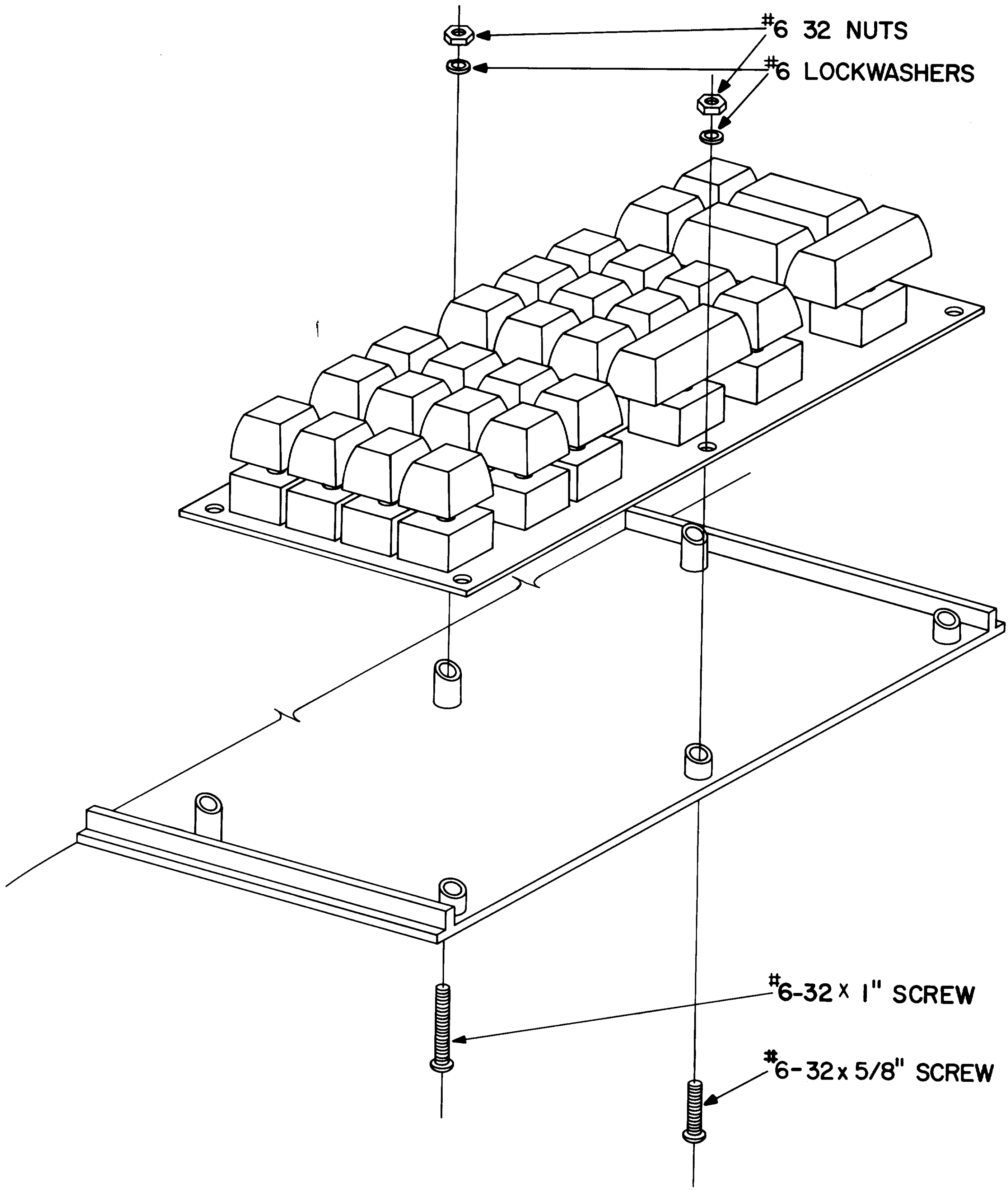
Connect the keyboard PC board to the 15 main board color coded interconnecting wires in order: GND to GND, D to D, C to C, etc.

( ) Place the keyboard on the mounting bosses at the front of the base plate with the six holes in the keyboard PC board aligned over the holes in mounting bosses. Fasten the front center mounting hole to the front center base plate boss using a 5/8" x 6-32 screw, 1 lockwasher, and 1 6-32 nut as shown on the facing page.

(✓) Attach the rear center mounting hole and boss in a similar manner using a 1" x 6-32 screw.

NOTE: Only hand tighten these two screws, so that the keyboard can be shifted.





#6 32 NUTS
#6 LOCKWASHERS
#6-32 X 1" SCREW
#6-32 x 5/8" SCREW

CHECKOUT PROCEDURE

The calculator must be given a detailed visual inspection before being turned on for the first time. Pay particular attention to the following points:

(a) Make sure the zener diodes (D24, D25, & D26) are installed and oriented properly.
(b) Check all remaining diodes for proper orientation.

(c) Inspect the interconnection wires which join the circuit boards to one another for proper orientation.

(d) Inspect the keyboard connection wires for proper installation.

(e) Carefully check for possible electrical shorts caused by solder bridges and wire scraps (especially around LED's, integrated circuit sockets, and transistors).

If possible, have a friend inspect the complete calculator also. A mistake found at this point is easily remedied, but once power is applied it may be very expensive to correct.

When the assembled calculator has been carefully inspected for possible errors, begin the checkout procedure given below. The left column gives the procedure to be followed, and the right column shows the status of the display. If the display does not show the same digits given in the checkout procedure, clear the machine by pressing the CLEAR key (C) and repeat the procedure. If the machine still operates incorrectly, turn it OFF and proceed to the Troubleshooting Section.

PROCEDURE	DISPLAY
( ) L. Turn ON-OFF Switch and CONSTANT switch to OFF. Plug the line cord into a receptacle delivering 110-120 volts, 60Hz.	(BLANK)
( ) 2. Turn the ON-Off switch to ON.	0.
CAUTION: If a "0" does not appear within 3 seconds, turn the switch off and proceed to the Troubleshooting Section.	
( ) 3. Press in sequence the keys for "1,2,3,4,5,6,7,8,9,0,1,2,3,4."	12345678901234.
( ) 4. Press the "SIGN" key.	-12345678901234.
( ) 5. Without clearing the machine, press the key for "5."	E
( ) 6. Clear the machine by pressing the key marked "C."	0.
( ) 7. Press the 8 key 14 times.	88888888888888.
( ) 8. Press the CLEAR key (C). This concludes the checkout of the input/output, LED drive and error circuits.	0.

( ) 9. Press the DECIMAL key (D). Hold the key down and press the following keys:	
1	0.0
2	0.00
3	0.000
4	0.0000
5	0.00000
6	0.000000
7	0.0000000
8	(BLANK)
7	0.0000000
( ) 10. Check the CONSTANT switch (K) next. First, clear the display by pressing C. Turn the K switch on. Hold the DECIMAL key (D) down and press the 4 key.	0.0000
( ) 11. Enter the following problem:	
1 x 3.1416	3.1416
(✓) 12. Without clearing the machine, press:	
2=	6.2832
3=	9.4248
( ) 13. The CONSTANT switch has been checked. Turn the K switch OFF, press the clear key (C), enter 1.2340.	1.2340
( ) 14. Press the CLEAR ENTRY key (CE).	0.0000
( ) 15. Check the arithmetic portion of the calculator by entering the following problem:	
9876543.21 - 876543.21	
x 12.3456 ÷ 12.3456 =	9000000.0000
( ) 16. Without clearing the machine, press	
$\sqrt{x}$.	30000.0000
Then press x^2.	9000000.0000

( ) 17. Clear the calculator by pressing the CLEAR (C) key. The decimal should still be in the fourth position. Check the EXCHANGE key (EXC) with the following problem:

2.0 x 4.0	4.0000
÷ 1.0	1.0000
EXC	8.0000
=	.1250

( ) 18. Without clearing the machine, the CLEAR ENTRY key (CE), and the SIGN key can be checked by this series of operations:

Enter 7.0	7.0000
Press CE	0.0000
Enter 8.0	8.0000
Press SIGN	-8.0000
Press =	-1.0000

( ) 19. The memory functions are checked next. Clear the calculator by pressing the CLEAR key (C). Set in four decimal positions by pressing the "D" key and the 4 key. Perform the following sequence:

ENTER	123.456	123.456
	M+	123.456
	987.654	987.654
	M-	987.654
	MR	-864.1980
	CM (CLEAR MEMORY)	-864.1980
	MR	0.0000

This concludes the calculator checkout procedure. If any of the procedures could not be properly performed, refer to the Troubleshooting Section. Be sure you followed these instructions properly before assuming the calculator is in need of troubleshooting and, if necessary, repeat a procedure which fails to give a correct display.

TROUBLESHOOTING

In the unlikely event the calculator fails to operate properly during the checkout procedure, a step-by-step visual inspection will usually locate the difficulty. The great majority of problems arise from:

(a) poor solder connections

(b) improper component installation

(c) solder bridges particularly between the transistor and IC pads.

The checklist below will help to pinpoint many possible trouble spots. Find the malfunction in the left column and inspect the items listed in the second column. Pay particular attention to possible shorts caused by excess solder or wire clippings.

Nearly all difficulties with electronic kits are caused by poor solder connection in the vicinity of the trouble spot. Even a connection which appears properly soldered may not be. If in doubt, reheat a questionable connection until the solder flows and, if necessary, add more solder.

If a wire or component must be removed, the plated through hole (connection between top and bottom of PC board) will sometimes pull out. Therefore, the reinserted wire or lead will then have to be soldered on both the top and bottom of the board separately.

If you have doubt as to whether there is a solder bridge, reheat the solder and brush with a piece of cloth or Q-tip.

Some errors may cause multiple or unusual malfunctions. If a check of the local problem area does not correct the problems, start in the beginning of this section and run through all the checks.

If a problem exists, try to run the calculator a minimum amount while measurements are being made. Prolonged operation with a malfunction could cause more serious problems.

MALFUNCTION	CHECK
1. No display	(a) Check ON-OFF switch and fuse. Make sure line cord is plugged into wall socket. (b) Inspect line cord installation and transformer wiring. (c) Check -8 volt power supply diodes D12, D13, D14 and D15 and wiring interconnect between main board and display board and to the LED board. (d) Insure all IC's are in correct socket and properly oriented; all IC leads must be in sockets and not bent, broken, or deformed.

(e) Check complete -26V, -14V and -5V power supplies, D16 through D23. Check connection between main board and capacitor board. Check capacitors on capacitor board for proper orientation.

(f) Check IC7 for proper installation and associated components.

2. Extra LED segments lighted or segment never lighted.

(a) Check LED's for proper soldering.

(b) Check interconnections between main board and display board (D0 through D7).

(c) Check transistors Q13 through Q36 for proper installation; check their associated components for good solder connections.

(d) Insure all leads of IC4 are in socket correctly.

3. Failure of an LED to light.

(a) Check IC8 for proper installation.

(b) Check B1, B2, B4 and B8 wiring interconnects between main board and display board.

(c) Check transistors Q1 through Q7 and all associated circuits.

(d) Make sure all of IC4's leads are correctly installed in the socket.

4. Displayed numbers appear in wrong half of display or half of display blank.

(a) Check transistors Q13 and Q14 for proper installation; check associated component solder connections.

(b) Check IC9, IC10, IC11, IC12 particularly for orientation, then for bent or deformed leads in the sockets.

5. Failure of minus sign to operate.

(a) Check LED14 for solder connections.

(b) Check "SIGN" interconnect between main and display boards and wire E_A between display board and LED board.

(c) Check components and connections on Q10, D2, R24.

(d) Make sure the pins of IC6 are properly inserted into the socket.

6. Failure of "E" to activate on LED14.

(a) Check "ERROR" interconnection wire between main and display boards.

(b) Check components Q11, D3, D4, and R25 R26, R27, R28 for solder connections and correct orientation.

(c) Check wires E_F and E_{EDG} between display board and LED board.

(d) Make sure the pins of IC3 are properly inserted into the socket.

7. Failure of a "C" to be displayed when "K" switch set.

(a) Check E_{EDG} interconnection wire from display board to LED board.

(b) Check "K" switch wiring.

(c) Check components D5, R26,

(d) Check components D5, R26, R27, R28.

8. Decimal point fails to operate properly.

(a) Check DD interconnection between main and display boards.

(b) Check keyboard wiring, particularly wires X_0 and Y_1.

(c) Inspect Q8, Q9, R22, R23.

(d) Check IC4 for proper lead insertion and make sure the leads are properly inserted into the socket.

9. Failure of a keyboard key to produce a correct operation.

(a) Check keyboard wiring.

(b) Check IC1 for proper installation.

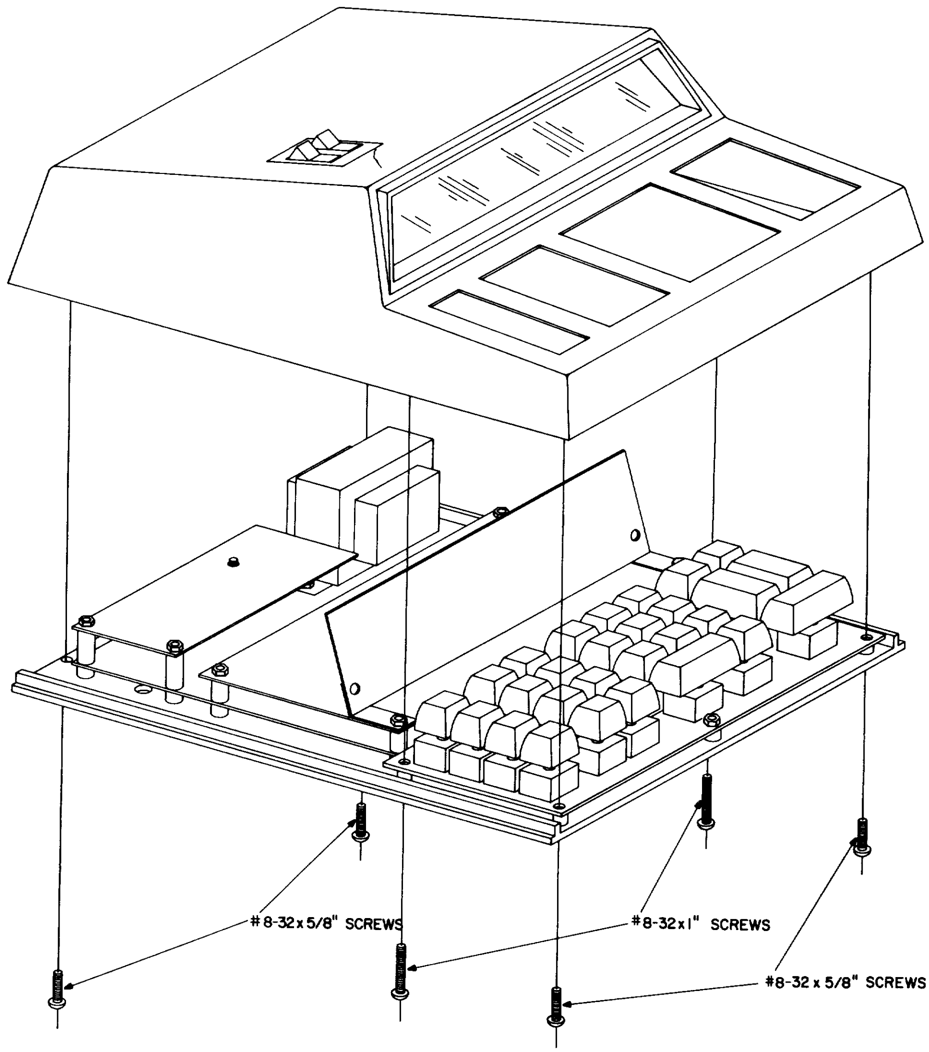
10. Improper arithmetic operation.

(a) Check IC1 through IC6 for proper installation.

(b) Verify that correct keyboard entries are being provided by operator.

(c) Check clock circuit IC7, C2, Q45, R60, R71 and R62.

MITS, Inc. maintains a complete repair department for servicing calculator kits which fail to operate properly when assembled. During the warranty period, any parts, materials, or components found to be inherently defective will be replaced free of any charge. Thereafter a reasonable charge for parts and labor will apply. If the troubleshooting procedures fail to correct any problems which may exist, refer to the Service Section.



#8-32x5/8" SCREWS
#8-32x1" SCREWS
#8-32 x 5/8" SCREWS

APPLICATIONS AND USE

All MITS electronic calculators have been engineered to make the operator's task as easy as possible. Most operations require only that the keys be pressed in the same sequence as a problem is written on paper. Additionally, there are several specialized key which greatly simplify many common problems:

1. The "D" key is used in conjunction with any of the keys labelled 0 through 7. This key allows the operator to program the decimal location into memory using the following procedure:

   a. Determine the required accuracy of a given set of calculations, i.e., the number of digits required to the right of the decimal point.

   b. Press the "D" key and hold it down while pressing the figure key corresponding to the number of digits selected. This will cause the decimal point to immediately move to this new position. It will remain in this position until the operator reprograms it to a new position.

An example will help illustrate this operation. Assume it is desired to locate the decimal point so that there are two significant digits to the right of the point.

> Press "D" and hold, then press figure
> key "2". The display will show 0.00.

NOTE: If any keys other than 0 through 7 are pressed, the display may turn off. It can be turned back on by simply pressing "D" and any figure from 0 through 7.

2. The "C" key clears all of the read/write memory in the calculator except the decimal programming. It should be pressed any time a new series of calculations is started.

3. The "CE" key is very useful to correct entry mistakes. Pressing this key will clear an entry without destroying the content of memory. This feature allows the correction of an entry error without having to re-enter a complete problem.

Error Indicator

Each MITS calculator has a powerful error detection system. If an impossible operation is attempted, such as division by zero, the leftmost digit will display the error signal "E".

If the error is detected, the calculator automatically locks out the keyboard to prevent further operation. In order to reactivate the calculator, the operator must press either the "C" key or the "CE" key. The "CE" key will only clear an entry which was caused by overloading the input register. The "C" key will clear any error.

Constant Operation

The 1440 can be made to store constants by simply pressing the rocker switch labelled "K". Whenever this switch is activated, a "C" will appear in the display.

NOTE: Never attempt to perform any operation other than a constant multiply or divide when the "K" switch is set.

To perform constant operations, simply enter the first problem into the calculator as if it were not a constant operation. The setting of the "K" switch programs the calculator to remember the operation and the second number entered as the constant.

Some actual problems will illustrate the operation of the calculator and the usefulness of the specialized keys. The problems can be solved with your personal calculator to become better acquainted with its operation.

Special Features

The special features of the MITS six-function 1440 electronic calculator allow it to out perform all other calculators in its price range and many calculators priced much higher. These features include the following:

1. Square root key $\sqrt{X}$ which automatically computes, in less than one second, the square root of any number appearing in the display.

2. Square key (X^2) which automatically computes the square of any number appearing in the display in a fraction of a second.

3. Additional memory capability coupled with the ability to add to (M+), subtract from (M-), and recall memory (MR) greatly increase the power of this machine.

4. "Sign" key allows direct entry of a negative number.

5. Exchange key (EXC) which greatly enhances the ability to do calculations utilizing the memory, square and square root capability of the 1440.

The 1440 automatically calculates the square root of any positive number appearing in the display when the $\sqrt{X}$ key is pressed.

If the operator attempts to take the square root of a negative number (which is an "illegal" operation in the real number system), the calculator automatically blanks out the display and displays an error signal (E).

Any number, positive or negative, appearing in the display (calculated, recalled from memory, or entered directly from the keyboard) is automatically squared by the machine and the results displayed when the operator presses the X^2 key.

The M+ key is used to add a number to the calculator memory. Pressing this key will add the number appearing in the display to memory. A few simple examples will illustrate how this works:

Suppose the number 16.52 appears in the display (either a new entry or the result of a calculation, and the memory contains 22.37. Pressing the M+ key adds 16.52 to 22.37 and stores the sum (39.89) in the calculator's memory.

The M+ operation computes the algebraic sum of the number in the display and the number in memory.

Suppose the number in the display is -17.52 and the number in memory is 22.37. Pressing the M+ key adds -17.52 to 22.37 and stores the sum (4.85) in the calculator memory.

The M- key is used to subtract a number from the calculator memory. Pressing this key will subtract the number appearing in the display from the calculator memory and automatically store the results in memory. A few simple examples will illustrate how this works:

Suppose the number 27.51 appears in the display (either a new entry or the result of a calculation) and the memory contains 29.50. Pressing the M- key subtracts 27.51 from 29.50 and stores the difference (1.99) in the calculator memory.

The M- operation is algebraic subtraction, i.e., if the number in the display is -5.0 and the number in memory is 4.7. Pressing the M- key subtracts -5.0 from 4.7 and stores the difference (9.7) in the calculator memory (4.7 - (-5.0) = 4.7 + 5.0 = 9.7).

Suppose 7.0 appears in the display and memory contains 3.2. Pressing the M- key subtracts 7.0 from 3.2 and stores the difference (-3.8) in memory.

The "Sign" key allows one to enter a negative number in the display or change a positive number (either calculated or entered by the keyboard) to a negative number.

The "Sign" key allows one to enter a negative number in the display or change a positive number (either calculated or entered by the keyboard) to a negative number. The following example illustrates how this works.

To multiply 29.473 x -3.812. Enter 29.473 in the usual manner, push the multiply ("X") key, enter 3.812. Push the sign key (which makes the number -3.812) and push the equals key ("="). The resulting answer is -112.351.

The Exchange (EXC) key exchanges the relative position of two numbers with respect to an operation entered. For example:

Suppose one enters 2 ÷ 1. Pressing the exchange key changes this to 1 ÷ 2.

This feature is extremely important when used in conjunction with the $\sqrt{X}$ and MR keys.

1. Calculate $\frac{1}{\sqrt{2}}$

Solution: Enter 2 $\sqrt{X}$ ÷ 1 EXC = <u>0.7071</u>

2. Suppose one wants to divide 2 by the square of the number, say 4, appearing in memory.

Solution: MR X^2 ÷ 2 EXC = <u>0.1250</u>

- MR: Displays Memory
- X^2: Squares the number that was in memory.

NOTES:

MITS ®
Micro Instrumentation & Telemetry Systems, Inc.
2016 San Mateo NE, Albuquerque, New Mexico 87110 505 - 266-2330