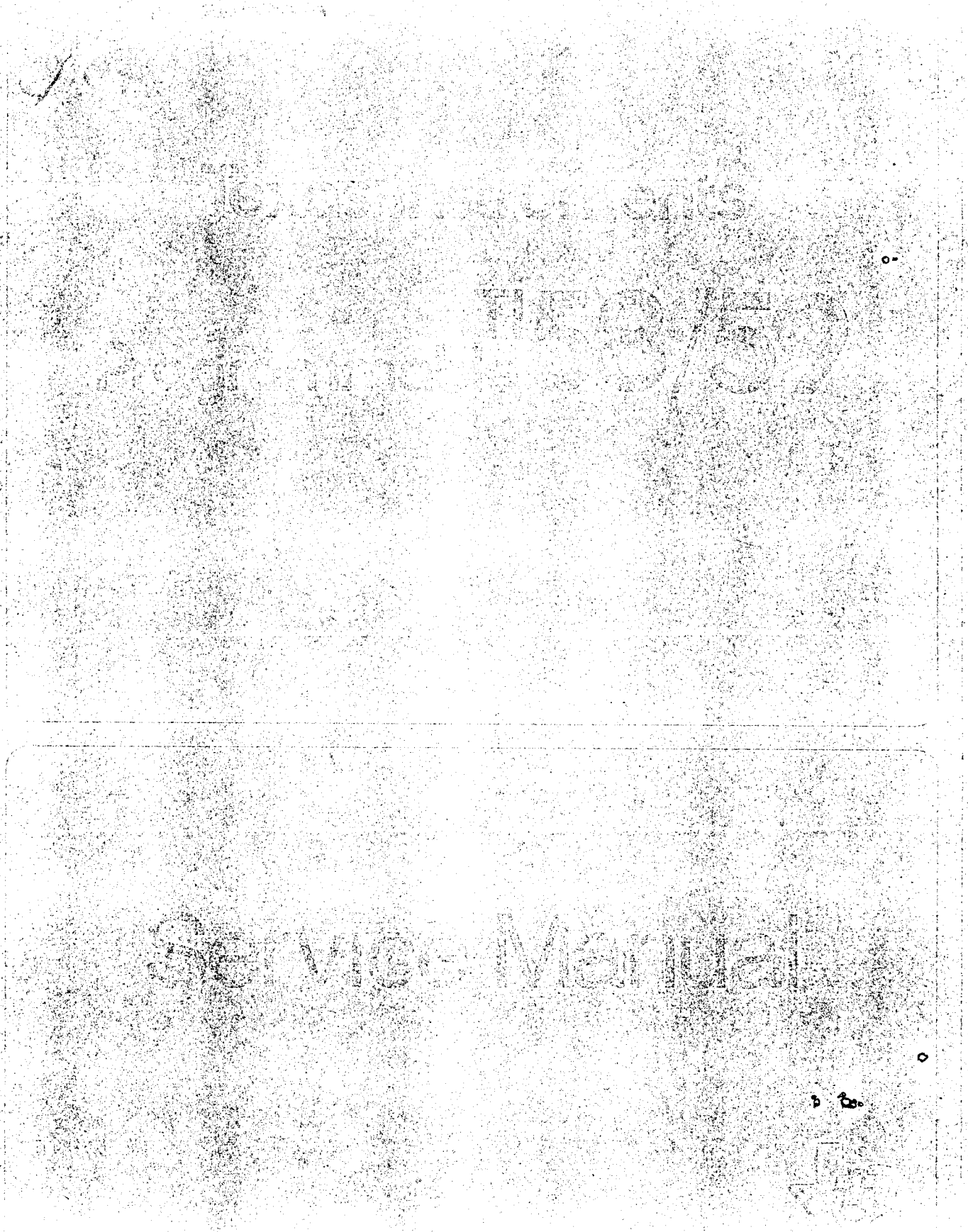


TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

THEORY OF OPERATION

GENERAL

The construction of the TI-58 and TI-59 is identical except for the obvious lack of a magnetic I/O system in the TI-58. The TI-59 also has two more 598 chips than the TI-58. The remaining circuitry and components are identical for the two calculators.

Figure 1 shows the major functional blocks of the calculators. The following description provides an overview of the functions of each block. Detailed operation is provided where feasible for the purpose of troubleshooting assistance. However, specific calculation-event timing between each MOS chip is not provided in this manual.

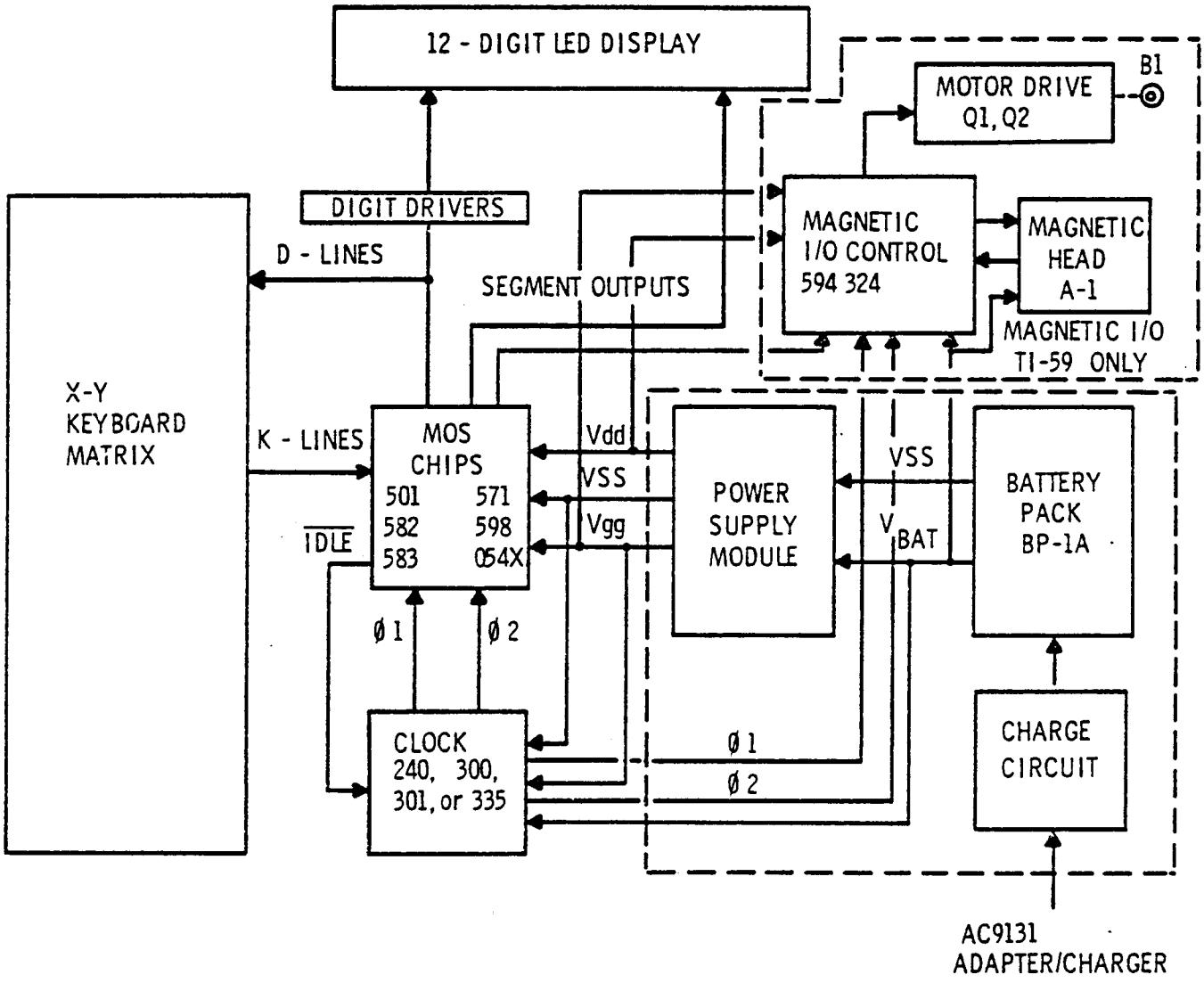


Figure 1. Calculator Block Diagram

POWER SUPPLY

The calculator uses a power supply module to convert the battery voltage to the necessary operating voltages of the calculator. It provides a regulated Vdd and Vgg to the MOS chips and the clock system.

The worse case voltage limits are as follows:

Parameter	MIN (Volts)	MAX (Volts)
Vss (SYSTEM GROUND)	0	0
-V Batt	-3.3	-4.5
Vdd	-9.5	-10.5
Vgg	-15.3	-16.3

The worse case output load sink currents are as follows:

	MAXIMUM	MINIMUM
Idd	40 (milliamps)*	10 (milliamps)
Igg	18	10

*Except during a write operation

Under full load, the ripple on Vdd and Vgg is less than or equal to 200 millivolts peak-to-peak and the rise time is less than or equal to 10 milliseconds (when measured from 0% to 90% of final value).

The batteries are charged by an AC charger and charging circuit. The charging circuit consists of full-wave bridge CR1 through CR4, battery pack BP-1A, and R1. The full-wave bridge converts the AC voltage supplied by the AC9131 charger to DC. Resistor R1 limits the charge current through the batteries (BP-1A) when the calculator is turned off to approximately 150mA. R1 is shorted by the ON/OFF switch when the calculator is on, so the charge current will be the same whether the calculator is on or off. The BP-1A should always be in place when the charger is plugged in because it acts as the rectifier filter. NOTE: The charging circuit can't supply enough power to the calculator to permit writing or reading.

CLOCK GENERATOR

The two-phase clock required to drive the MOS circuitry is generated by U11, a CMOS integrated circuit. The ceramic resonator Z1 resonates at a frequency of 455 Khz± 1%, which establishes a stable frequency source for the clock circuit. U11 divides the 455 kHz by two to produce a 227.5 kHz± 1% two-phase clock with a 20% "active" time(The TI-58 can use a 384KHz resonator which is the preferred part.)

To conserve power, the clock frequency is divided by 4 to produce 57 kHz during non-calculating periods thus reducing "active" time to 5%. A high-speed clock (calculator calculating) is obtained when the $\overline{\text{IDLE}}$ line from any MOS chip is sensed to be high by the CMOS clock. If the clock speed is low, it will switch to high two clock pulses after the $\overline{\text{IDLE}}$ line goes high. A low-speed clock (calculator not calculating) occurs when the $\overline{\text{IDLE}}$ lines from all MOS chips are sensed to be low by the CMOS clock. If the clock speed is high it will switch to low two clock pulses after the $\overline{\text{IDLE}}$ line goes low.

	Min.	Max.
High speed =	225.2 kHz	229.8 kHz
Low speed =	56.3 kHz	57.5 kHz

Please note that there are presently four different clock chips which will function in the calculator: TP0240, TP0300, TP0301, TP0301A, and TP0335, as indicated by Figure 2a through 2d. If it is necessary to change the clock chip, the TP0335 is the preferred replacement chip. BE SURE TO CHANGE COMPONENTS AND HOOKUP APPROPRIATE TO THE CHIP INSTALLED.

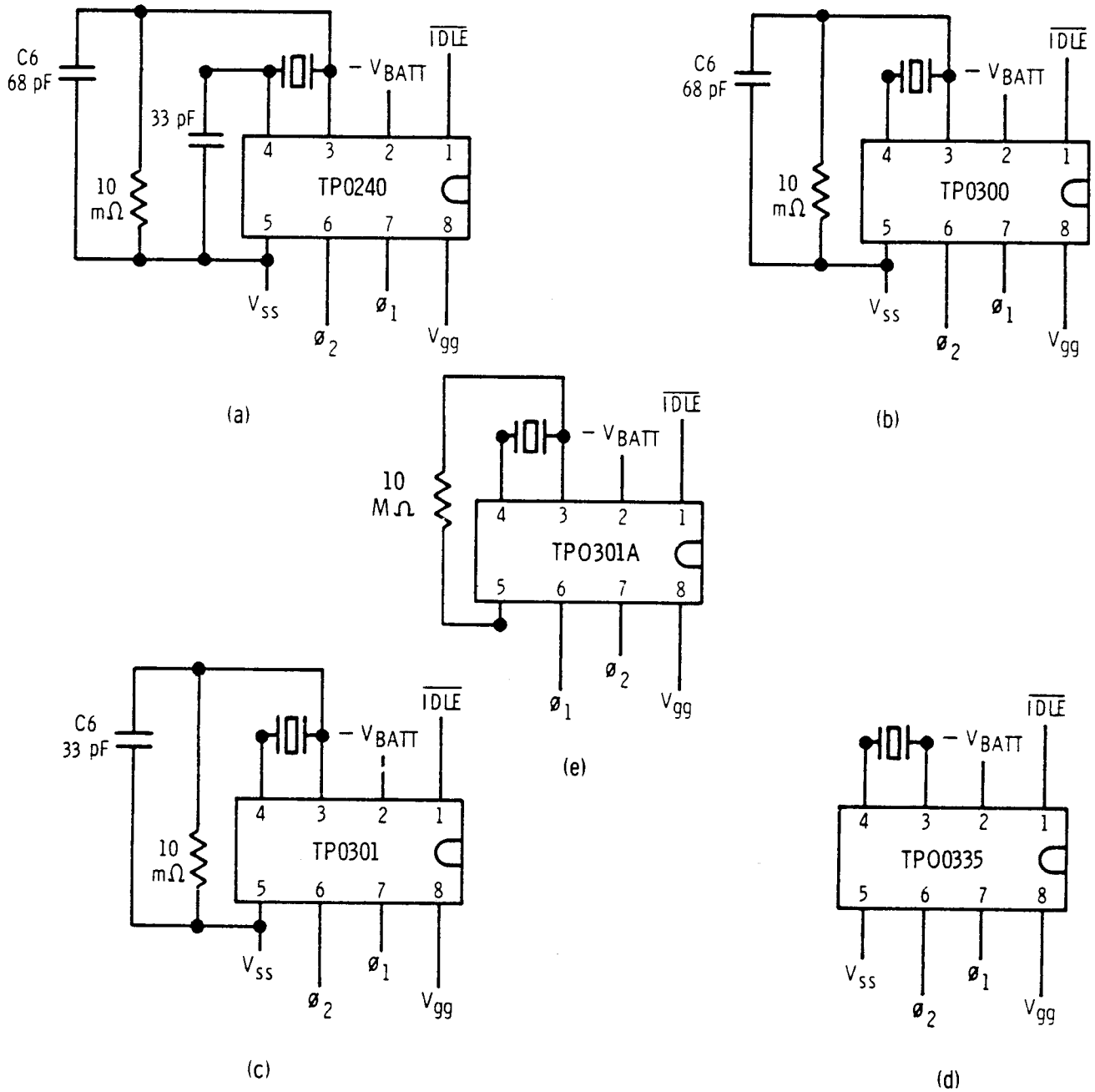


Figure 2. Clock Generator Circuits

MOS CHIP SET

The MOS chip set consists of seven MOS devices. They are:

ARITHMETIC LOGIC CHIP (TMC0501ES)
DSCOM's (TMC0582/0583) - Double Scanning Read-Only Memories
BROM (TMC0571) - Bare Read Only Memory
MULTI-REGISTER CHIPS (TMC0598) (Two in TI-58 or four in TI-59)
CROM (TMC0541) Constant Read Only Memory (Library Module)
MAGNETIC I/O CHIP (TMC0594 / LM324-not a MOS device)

Arithmetic Logic Chip (TMC0501ES)

The arithmetic logic chip, U1, performs the required mathematical operations using instructions from the DSCOM's and BROM. The I/O, IRG, IDLE, and EXT lines are the communication links between these units. The arithmetic logic chip also monitors the "K"lines from the keyboard to see which "K" + "D" lines are shorted by a keypush. It also drives the display segments SA thru SH, and DPT lines.

DSCOM's (TMC0582/0583)

The DSCOM's (U2 & U3) each consists of a 2500 word ROM used to store necessary functions used by the arithmetic logic chip. The DSCOM's also create the display digit select signals (D-lines) and contain a special ROM which stores constants used in logarithmic and trigonometric functions.

BROM (TMC0571)

The BROM (U4) provides a ROM extension of 1024 words for the DSCOM and uses the IRG, IDLE, and EXT lines to communicate with the DSCOM's and arithmetic logic chip. It also controls partitioning and printer alpha/numeric functions.

Multi-Register Chips (TMC0598)

The multi-register chips (U5 & U6 for the TI-58, also U7 & U8 for the TI-59) provide program storage and user memory storage. Each chip stores 1920 bits of data which can be 30 Data registers or 240 program steps.

CROM (TMC0541)

The CROM consists of 5000 program steps preprogrammed (masked) on the chip. The IRG, IDLE and EXT lines are the communication lines. The CROM is contained in the library module which may be interchanged with other modules.

Magnetic I/O Chip (TMC0594) TI-59 Only

The Magnetic I/O chip (U9) provides the interface between the four-track magnetic card read/write mechanism and the arithmetic logic chip. Communications between the Magnetic I/O chip and arithmetic logic are carried on the IDLE, EXT, and IRG signal lines. The Magnetic I/O chip also conditions the signals to and from the magnetic card read/write mechanisms (e.g., motor, CSI, & CH1-4) to make them compatible with MOS logic levels.

KEYBOARD

The keyboard consists of a plastic board with metallic discs serving as switches to connect one of the D-line outputs from the 582 MOS chip to one of the K-Line inputs to the 501 ALU chip. The schematic of the keyboard matrix is as shown in Figure 3.

Numbers 1-14 refer to actual pin out of keyboard.
(left to right when keyboard is facing out)

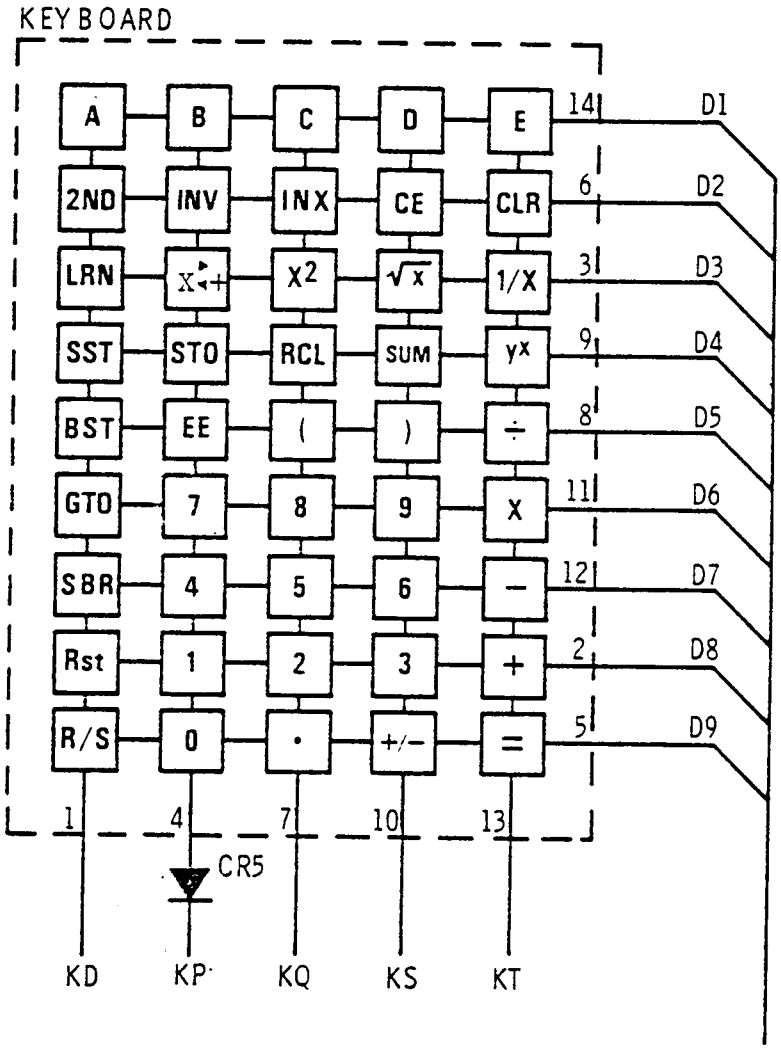


Figure 3. Keyboard Matrix

DIGIT DRIVERS

The D-line outputs from the 582 DSCOM Chip (D2 through D13) are connected to the inputs of the 12 digit drivers. The outputs of which are connected to each of the 12 display digits. Thus the display digits are turned on sequentially by the D-lines. At each D-time the segment drivers on the 501 Arithmetic chip present a new seven-segment pattern to all of the segment inputs of the 12 digits. As each new character is generated, only the proper digit is switched on by the D-line to display that character in the correct digit position. Each digit is switched sequentially to display the proper sequence of numbers.

All segments are connected according to the configuration shown in Figure 4, pin numbers are shown below each digit, and next to each segment letter, except for digit 12, where segments A, D, E and F are connected together to form a "C" indicating calculate mode. This letter is brought out via pin 21. Segment G and DPT of digit 12 are connected the same as other digits.

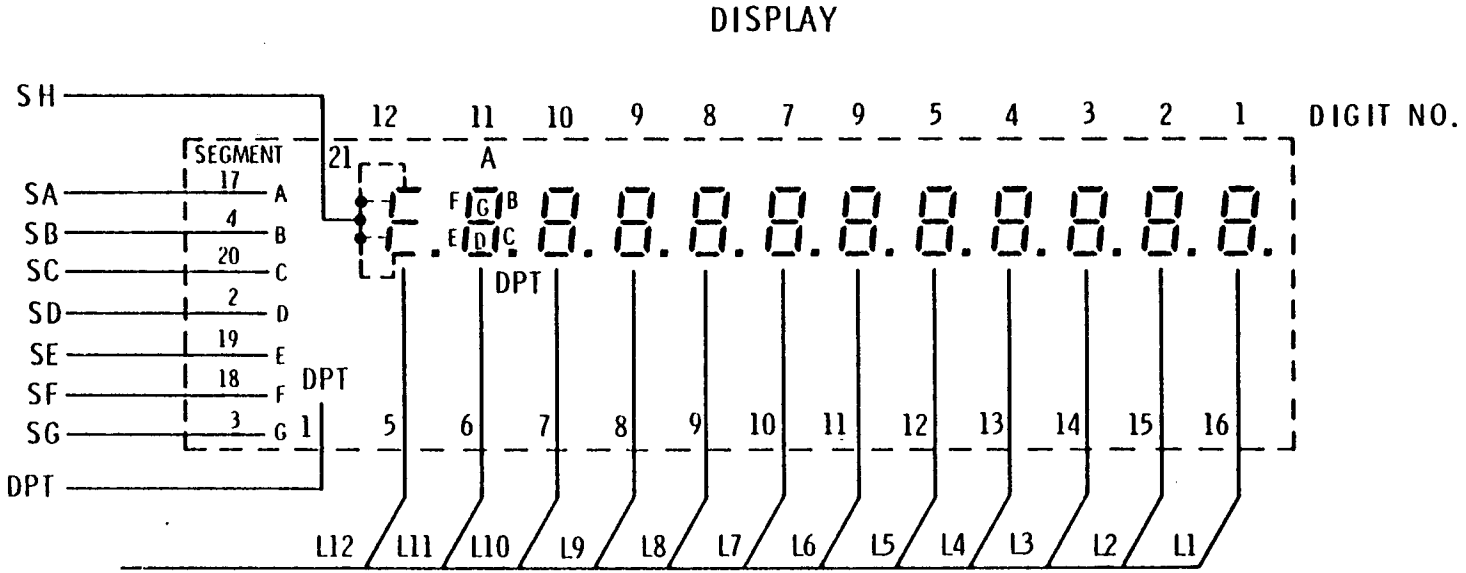


Figure 4. Display Configuration

MAGNETIC READ/WRITE MECHANISM (TI-59 ONLY)

Information transfer between the calculator and the program card is accomplished by the magnetic read/write mechanism. The mechanism consists of a four-track magnetic tape head, two normally closed switches, a pinch roller, a drive roller/motor, a pressure pad and plastic housing.

The magnetic head is driven by four TRI (As opposed to BI) state buffers on U9 when writing. When reading, the output of the magnetic head (each track) is a series of pulses with alternating polarity approximately three to four millivolts peak. Each track is amplified about 500 times by a preamplifier in U10 (LM324). Capacitors C2 through C5 decouple common mode voltage caused by the DC bias supplied to the magnetic heads. The write signal out of the MOS is a square wave switching $\pm$ 1.5V either side of -V Bat as shown in photo L. In both the read and write case, the frequency of the pulses/square wave varies depending upon the particular program (to include no signal on one or two tracks). The magnetic head is oriented such that track one is closest to the edge of the card. The magnetic read/write mechanism has a pressure pad which maintains contact between the magnetic head and the program card. Because the magnetic surface of the card must be in contact with the head throughout reading and writing, it is imperative that the pressure pad is functioning properly. Too much pressure produces skew, too little pressure allows the card to lift off the head.

The nominal card speed is set at 2.3 inches per second (IPS) by adjusting R2. The calculator will function at a card speed of 2.0 IPS to 2.5 IPS. At any speed below 2.0 IPS, the magnetic head cannot generate the required output voltage for reliable reading. At any speed above 2.5 IPS, the write length exceeds the usable length of the card. (It should be noted that the card speed increases with card wear.) A set up procedure for the card speed is to adjust R2 until the X in Texas on the card is split by the left edge of the calculator case when writing on a used card. A new card can be made to simulate a used card by buffing it on the printed side with a course cloth.

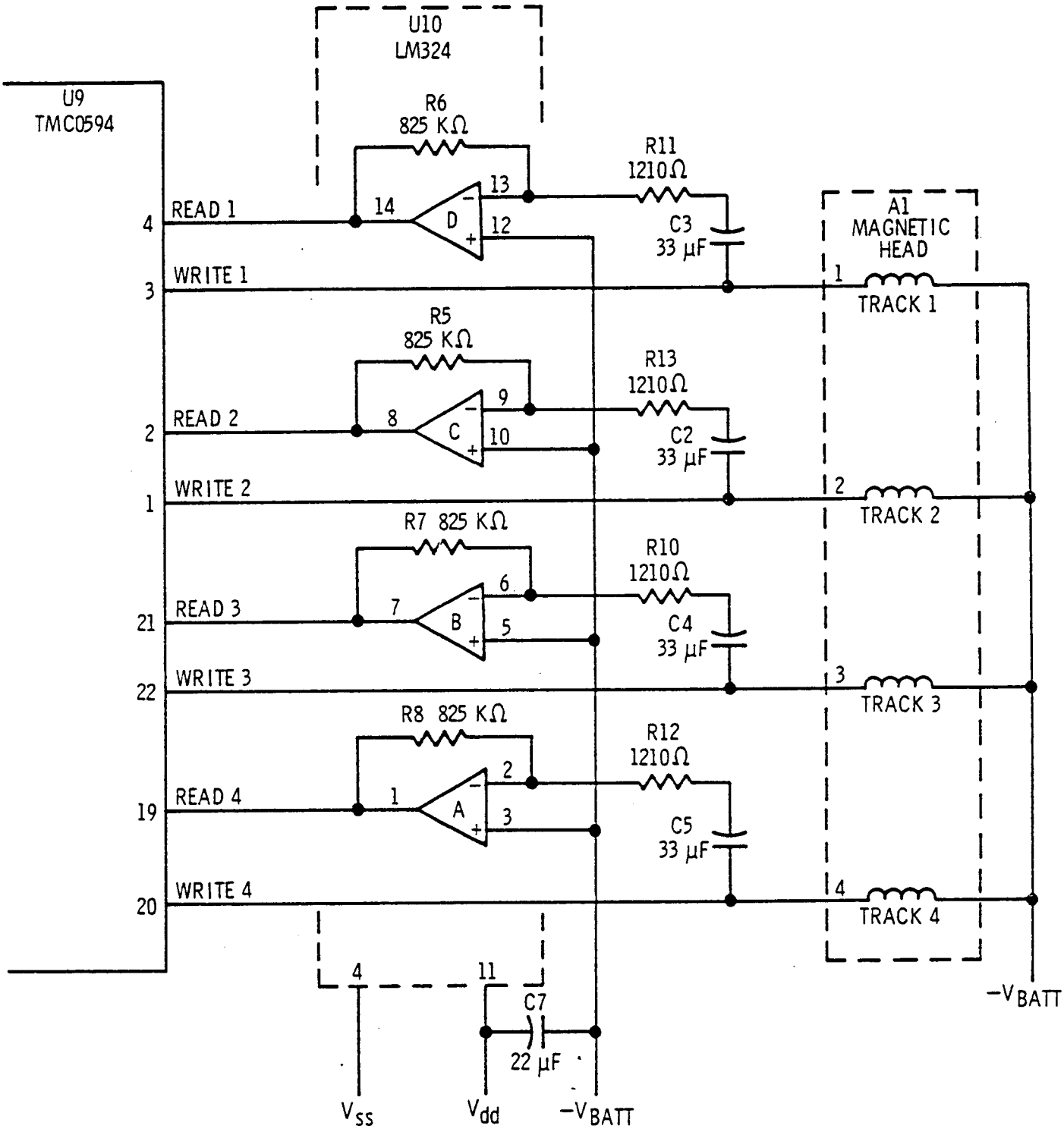


Figure 5. Magnetic Card I/O Circuit

The motor drive circuit is a constant voltage circuit capable of driving the magnetic program card at a constant speed across the magnetic head (2.3 IPS nominal). When a program card is slipped into the read/write mechanism, the card sense switch is opened and contact is broken between D10 and KR, which is sensed by U1. If the 501 is programmed to read or write, it tells U9 to turn on the motor. When this occurs, U9 pin 9 which is normally at Vdd, switches to Vss. Resistors R2 and R4 constitute a voltage divider which sets up the motor voltage. As you increase R2, Q1 conducts more, causing Q2 to conduct more, increasing motor speed. As you decrease R2, the opposite occurs, decreasing motor speed. CR8 forces the motor voltage to equal Q1 base voltage. If the load (motor) changes, a differential current is sensed by Q1 and the gain changes to bring motor voltage back to Q1 base voltage. Diodes CR7 and CR10 provide temperature compensation for the circuit. CR10 is not in older units. R2 in older units will be either 2.5 K or 5K . If motor speed adjustment is too critical, R2 should be replaced with a 1.5 K pot and a PG 1992 diode should be placed in series with CR7.

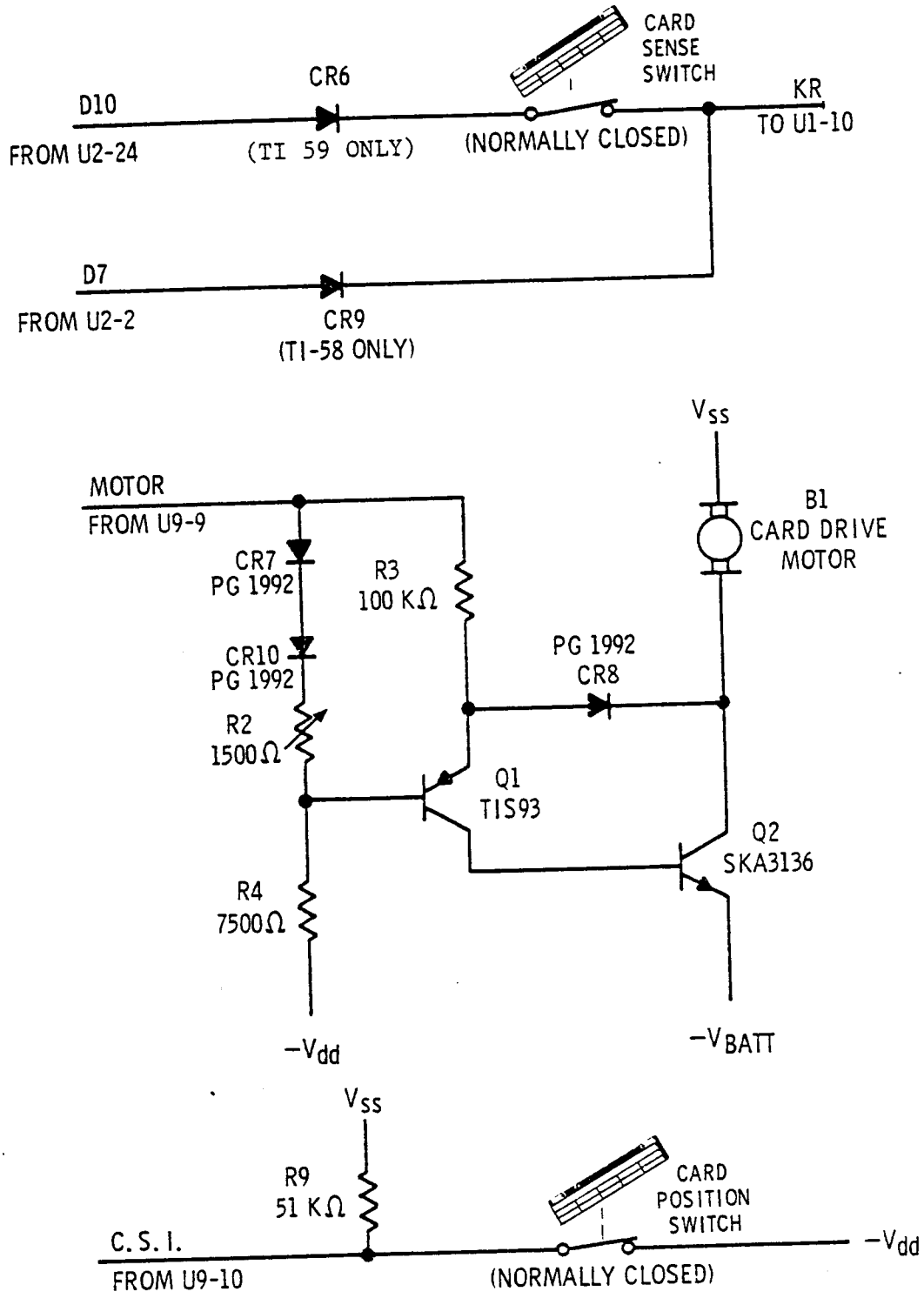


Figure 6. Card Sense Circuit

PRINTER INTERFACE DESCRIPTION

The PC-100A printer has a 14-contact connector which allows calculator interface. Since the calculator battery pack is removed when attached to the printer, the printer provides power to the calculator through the two large contacts. Figure 7 shows the pin assignments for the interface connector.

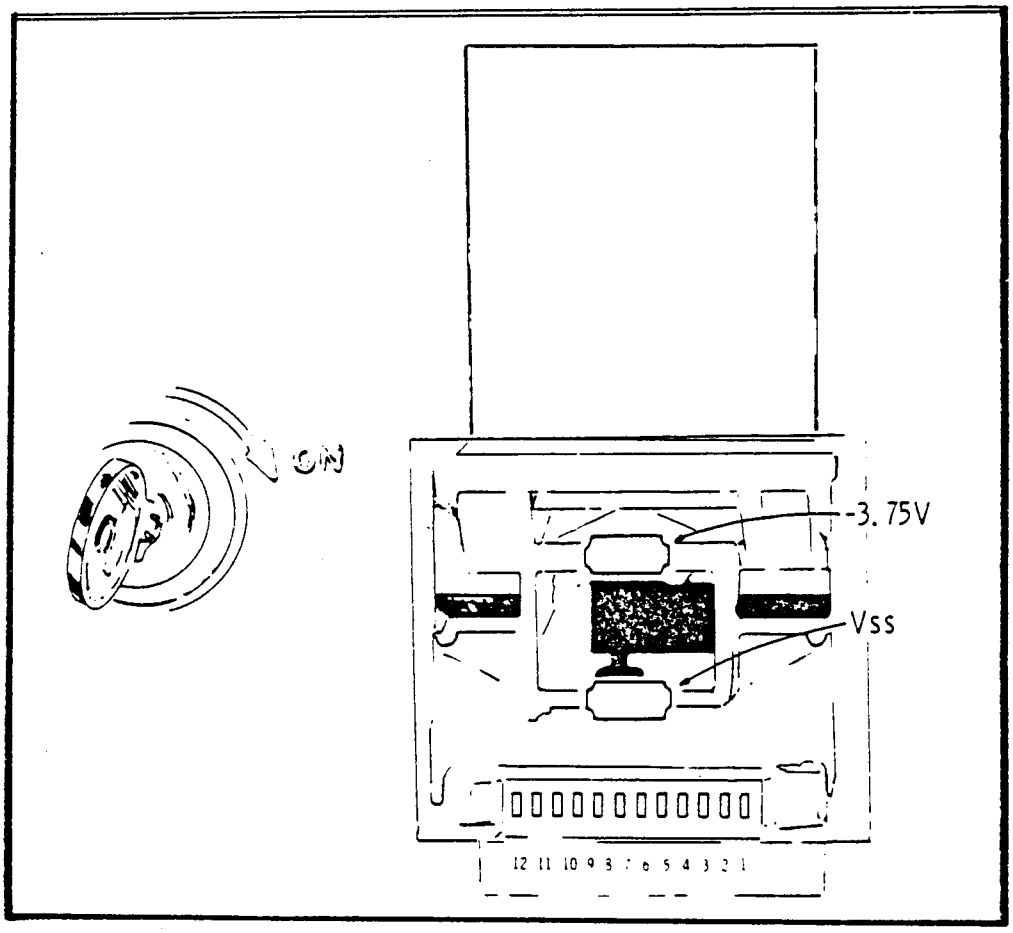
INTERFACE OVERVIEW

Two clock signals, ϕ 1 and ϕ 2, are used by the printer in the same manner as the calculator. Internally these clocks are further grouped into 16 state times, S_0 - S15, and are defined as existing from the leading edge of ϕ 1 to the leading edge of the next ϕ 1. A full cycle of 16 state times is defined as an instruction cycle, approximately 70 usec long as shown at the top of Figure 8.

The various calculator chips and printer chips must be in sync, or in the same state time in order to communicate. This function is provided by the IDLE signal, an output from the calculator. IDLE is a logic signal that switches between V_{ss} and V_{dd}. The negative transition of IDLE (V_{ss} to V_{dd}) sets the leading edge of S_0 as shown in Figure 8. When the positive transition of IDLE occurs at S_1 (leading edge) and remains high (V_{ss}) until S_0, the calculator is in the calculate mode. When IDLE occurs at the leading edge of S_{15} the calculator is in the display mode and is scanning the keyboard. The printer must monitor the negative transition of IDLE and set its state-time counter accordingly.

All calculator instructions are transmitted serially on the IRG line. Each instruction is 16 bits long, one per state time. See Figure 9 for instruction codes. Each bit is clocked onto IRG at ϕ1 and devices monitoring IRG clock it in with ϕ2. IRG bits at state times S_0 thru S_2 are "don't cares". The LSB is clocked onto IRG at S_3 and the MSB at S_{15}.

Data is transmitted between calculator chips and from the calculator to the printer on the EXT line. EXT is a logic signal with one bit of data each state time. S_3 thru S_9 are the state times when data is sent to the printer. The LSB is sent during S_3 and MSB during S_9 as shown in Figure 8. See Figure 10 A&B for Function and Character Codes.



Contact #	Calculator Function
1	Busy (KR)
2	KP*
3	KN*
4	ø1
5	DO*
6	D15*
7	IRG
8	IDLE
9	EXT
10	ø2
11	D12*
12	N/A

* Involved with PRINT, PAPER ADVANCE, and TRACE on PC-100A.

Figure 7. Printer Interface Connector

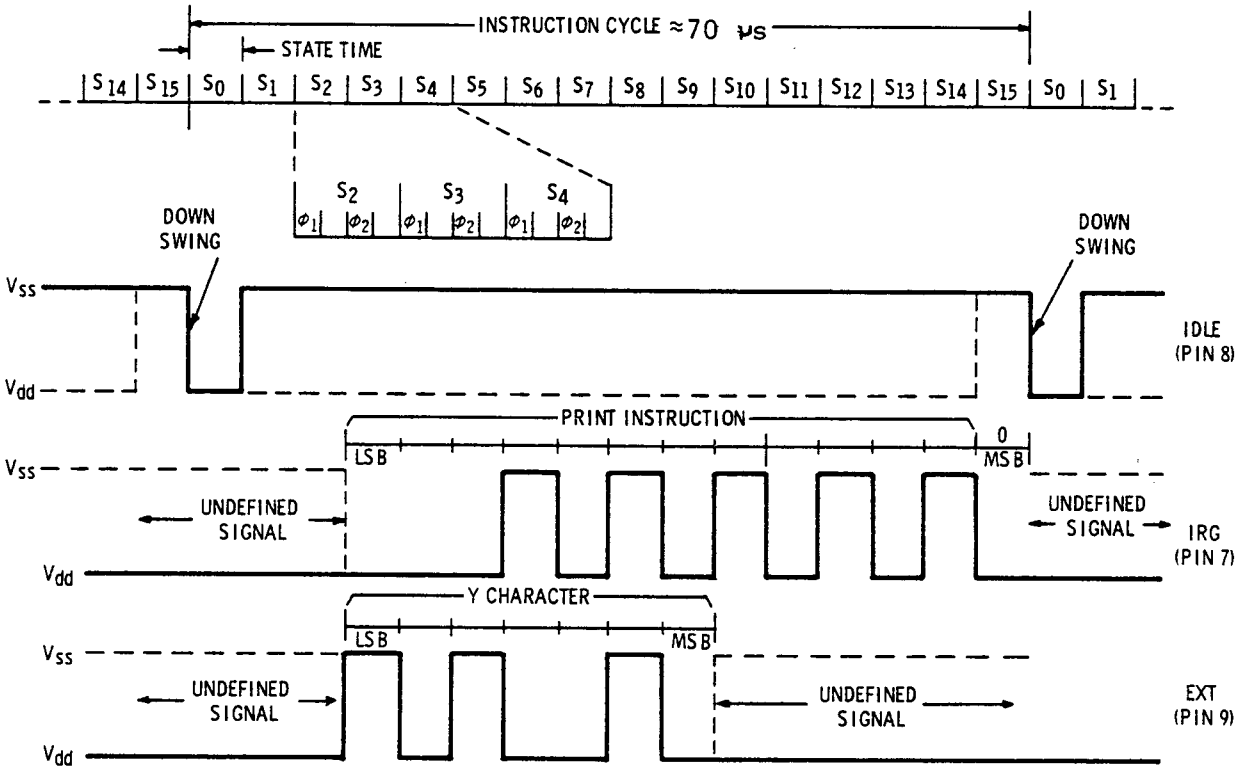


Figure 8. Identification Code Cycle Timing Diagram

INSTRUCTION CODES

STATE TIME	IRG CODE S_{15}	S_{14}	S_{13}	S_{12}	S_{11}	S_{10}	S_9	S_8	S_7	S_6	S_5	S_4	S_3	S_2	S_1
LOAD	0	1	0	1	0	0	1	1	0	1	0	0	0	X	X	X	
FUNCTION	0	1	0	1	0	0	1	1	1	1	0	0	0	X	X	X	
CLEAR	0	1	0	1	0	1	0	0	0	1	0	0	0	X	X	X	
STEP	0	1	0	1	0	1	0	0	1	1	0	0	0	X	X	X	
PRINT	0	1	0	1	0	1	0	1	0	1	0	0	0	X	X	X	
PAPER ADVANCE	0	1	0	1	0	1	0	1	1	1	0	0	0	X	X	X	

Figure 9. Printer Instruction Codes

A status line called BUSY (KR) is provided so the printer can communicate various levels of activity to the calculator. This BUSY line is common to many chips and thus each unit lets the line float when not active. The printer indicates an active status by pulling the BUSY line to V_{ss} (there is a pull down to V_{dd} in the calculator).

DETAILED TIMING

The printer recognizes six distinct instructions on IRG as shown in Figure 9. These instructions enable the print buffer to be cleared or loaded, a line of loaded characters to be printed and a paper advance to be actuated. The data on EXT (Figure 10) is clocked into a shift register each instruction cycle and selectively loaded into a memory upon apporpriate IRG command. When the printer decodes a Clear command the print buffer is set to all zeros (blanks on printout) and the character load pointer is set on the right most position. When the first LOAD command is decoded, the data from EXT is loaded into the right most print position of the memory and the character load pointer is moved one position to the left. Each character load command received thereafter loads the current EXT into the memory and moves the character load pointer one position left. If this sequence is repeated for more than 20 character loads, the pointer wraps around to the initial position and the right most character is written over. A full twenty characters can be loaded by this character load sequence and subsequently printed. When the left-most character in the desired output has been loaded no further character loads are required; the Clear instruction loaded the entire memory with the code for a blank. The Print instruction causes the printer to initiate printing of the current contents of the memory. The Paper Advance command will cause the paper to advance one half a line. The Step command has two distinct functions. If Step is decoded during the character load sequence it moves the pointer one position left and leaves the memory unchanged (if a Clear was used to begin the sequence a blank will be in the memory) regardless of the code on EXT. The second function of the Step command occurs when the printer is printing a line, i.e., in a print cycle. During a print cycle the Step command causes the printer to pull the BUSY status line to V_{ss} at S_2 of the instruction cycle following the Step command. A loop is used by the processor controlling the printer to find when the

print or paper advance sequence is finished. The FUNCTION command causes the EXT code to be converted by the printer into three character codes for easy loading of often used alpha strings like SIN, COS, PRT etc.,. There are 40 fixed three-character codes available as shown in Figure 10. The character load pointer is moved over three places by the FUNCTION command. This instruction should only be used in the right most positions of the printout.

An example of a typical load - print sequence is shown below:

Desired Output

T H E S I N O F 3 0 D E G
0 . 5

Note: Each line represents one instruction cycle.

IRG	EXT		PRINT	X
CLEAR	X	IF BUSY = 1 ⟶	STEP	X
X	S CODE		X	X
LOAD	S CODE	BUSY = 0 ⟶	CLEAR	X
X	I CODE		PAPER ADVANCE	X
LOAD	I CODE	IF BUSY = 1 ⟶	STEP	X
STEP	X		X	X
X	G CODE	BUSY = 0 ⟶	CLEAR	X
LOAD	G CODE		PAPER ADVANCE	X
X	E CODE	BUSY = 1 ⟶	STEP	X
LOAD	E CODE		X	X
X	D CODE	BUSY = 0 ⟶	CLEAR	X
LOAD	D CODE		STEP	X
STEP	X		STEP	X
X	0 CODE		STEP	X
LOAD	0 CODE		STEP	X
X	3 CODE		X	5 CODE
LOAD	3 CODE		LOAD	5 CODE
STEP	X		X	· CODE
X	F CODE		LOAD	· CODE
LOAD	F CODE		X	0 CODE
X	0 CODE		LOAD	0 CODE
LOAD	0 CODE		PRINT	X
STEP	X	BUSY = 1 ⟶	STEP	X
X	N CODE		X	X
LOAD	N CODE	BUSY = 0 ⟶	CLEAR	X
X	I CODE			
LOAD	I CODE			
X	S CODE			
LOAD	S CODE			
STEP	X			
X	E CODE			
LOAD	E CODE			
X	H CODE			
LOAD	H CODE			
X	T CODE			
LOAD	T CODE			

FUNCTION CODES

EXT CODE (Sg … S3)	PRINTED CHARACTERS
1 1 1 1 1 0 0	I F
0 0 1 0 0 0 1	=
1 0 1 0 1 1 1	S I N
1 0 1 0 1 1 0	C O S
1 0 1 1 1 0 1	T A N
1 1 0 0 0 0 1	S U M
1 1 0 1 0 0 1	Σ +
1 1 0 0 1 1 0	S T O
1 1 0 1 0 0 0	R C L
1 0 1 0 0 1 1	P R M
1 0 1 0 0 0 1	L N X
0 1 1 1 1 0 0	√ X
0 1 1 1 1 0 1	X ⇄ Y
0 0 1 0 0 1 0	−
0 0 1 0 0 1 1	+
0 0 1 0 1 1 0	÷
0 0 1 0 1 1 1	x
0 0 1 1 0 1 0	x √‾ Y
0 0 1 1 0 1 1	Y x
0 1 0 0 0 0 1	C L R
0 1 0 0 0 1 0	I N V
0 1 0 0 0 1 1	D P T
0 1 0 0 1 1 1	+ / −
0 1 0 0 1 1 0	C E
0 1 0 1 1 0 1	E E
0 1 1 0 0 0 1	e x
0 1 1 0 0 1 1	x 2
0 1 1 0 1 1 0	1 / x
1 0 1 0 1 0 0	o / o
1 1 0 0 1 1 1	π
1 1 1 0 0 0 0	E R R
1 1 1 0 0 0 1	(
1 1 1 0 0 1 0	)
1 1 1 0 0 1 1	L R N
1 1 1 0 1 0 0	R U N
1 1 1 0 1 1 0	H L T
1 1 1 1 0 0 0	S T P
1 1 1 1 0 1 0	G T O

Figure 10a. Function & Character Codes

CHARACTER CODES

EXT CODE Sg S3	CHARACTER PRINTED
0000000	(blank)
0000001	0
0000010	1
0000011	2
0000100	3
0000101	4
0000110	5
000111	6
001000	7
0001001	8
0001010	9
0001011	A
0001100	B
0001101	C
0001110	D
0001111	E
0010000	-
0010001	F
0010010	G
0010011	H
0010100	I
0010101	J
0010110	K
0010111	L
0011000	M
0011001	N
0011010	O
0011011	P
0011100	Q
0011101	R
0011110	S
0011111	T
0100000	.
0100001	U
0100010	V

EXT CODE Sg S3	CHARACTER PRINTED
0100011	W
0100100	X
0100101	Y
0100110	Z
0100111	+
0101000	x
0101001	*
0101010	
0101011	
0101100	e
0101101	(
0101110	)
0101111	,
0110000	
0110001	
0110010	
0110011	/
0110100	=
0110101	
0110110	x
0110111	
0111000	2
0111001	?
0111010	
0111011	!
0111100	
0111101	
0111110	
0111111	

Figure 10b.

MODIFICATIONS

If the calculator has a -3 thru -6 board, the following modifications must be performed:

- Add a 10 Meg resistor across pins 3 and 5 of the clock chip
- Check CR7- must be two PG 1992 diodes in series
- Check resonator:

  Replace if yellow, uncoated resonator is found. If rectangular resonator is used, perform "drop test" by: starting diagnostic program, dropping calculator approximately 6 inches onto a hard surface while program is still running. If calculator goes into pre-load or gets wrong answer to diagnostic program, replace resonator.
- Check Pot - must be 1.0K, 1.5K or 2.5K with a 1.21K resistor in parallel
- Check C7 - add 22 μF 15v capacitor if missing
- Check for proper capacitor(s) for each clock chip.

  for: 240 - 75pF between pins 4&5 of clock chip.
  75pF between pins 3&5 of clock chip.
  300 - 75pF between pins 3&5 of clock chip.
  301 - 33pF between pins 3&5 of clock chip.
- If any part of old card reader assembly is changed, entire assembly must be changed
- If unit has extra decimal, remove lead frame from pin 21 of the display and the PCB. Replace with PG 1992 diode with cathode toward the display.
- If unit does not read consistently:
  Add 82pF to 100pF capacitors across pins 1&2, 6&7, 8&9, and 13&14 of LM324.

  Replace 200K resistors with 825K resistors and add a 1.21K resistor in series with 33 μF capacitors.

-7 Board Modifications

- If unit won't read consistently, add 82pF to 100pF between pins 1&2, 6&7, 8&9, and 13&14 of LM 324.

-1, -2 Board Modifications

- Replace PCB

Handling procedures for MOS

All handling of devices must be performed on benches with conductive surface.

Wear Static Strap at all times when repairing TI-58 or TI-59.

Ground test equipment and tools. -- Except oscilloscopes

Devices should not be handled by their leads. Handle by ends only.

Devices should be stored in conductive foam, or in aluminum or antistatic magazines.

Eliminate the use of plastic, rubber, or silk at or near work stations where MOS devices are handled.

Maintain relative humidity above 50% if practical.

Assembled modules, PC boards, etc., should be stored in conductive bags, if possible.

CALCULATOR FUNCTION TEST

Reason for Test	Enter	Display
Check for missing segments and digits	CE, 8, 8, 8, 8, 8, 8, 8, 8, -/+, EE, 8, 8, -/+.	-.88888888-88
Check all the components in the calculator. Also check CROM.	CLR, 2nd, PGM, 1, SBR, =	1
To check PC100A contacts and 571	CLR, 2nd, PGM, 1, SBR, =	Print out: Master 1
Check to insure PC100A contacts are being made.	Adv	Paper Advances
Check Keyboard	PWR On, LRN, A, 2nd, LRN, SST, BST, GTO, SBR, RST, R/S, 0, 1, 4, 7, EE, STO, x⇆t, INV, B, C, Inx X^2, RCL, C, 8, 5, 2, ., +/-, 3, 6, 9,), SUM, $\sqrt{x}$, CE, D, E, CLR, 1/x, y^x, ÷, x, -, +, =	042 00
Check 571	6, 2nd, OP, 1, 7	479.59 PGM steps. Registe
+		
Check 598's	7, 7, 7, 7, 7, 7, 7, 7, 7, 7, STO, 0, 0, STO, 5, 9, CLR, RCL, 5, 9	7777777777
Check 582-3	5, 0, x⇆t, 5, 0, INV, 2nd, P→R, x⇆t	45. 70.71067812
Test all components plus CROM	PWR On, LRN, 2nd, PGM, 1, SBR, =, 2nd, PAUSE, 8, ., 8, 8, 8, 8, 8, 8, 8, +/-, EE, 88 +/-, 2nd, PAUSE, RST, LRN, RST, R/S	Flash 1 then flash -8.88888888 -88
Check card Read/Write ability (59 only)		

EQUIPMENT

Scope--any good 10mHz dual trace scope. A differential preamp is desired.

Regulated P.S.

VOM

DVM

Good battery pack

Charger

DISASSEMBLY

1. Remove Battery Pack and CROM
2. With a small-tip Phillips screwdriver remove the two hold-down screws in the center of the calculator base.
3. Holding the calculator keyboard down, separate the topcase and bottom case (at display end only) approximately 1 inch.
4. Slide the bottom case down off the hooks securing it to the top case.

5. To remove card reader, unplug strips from connectors noting carefully the routing scheme of the longer of the two strips. Remove the four small screws holding the reader assembly to the top case. Lift out the card reader.
6. To remove the PC board assembly, insert a flat-blade screwdriver beneath the keyboard and pry gently, releasing the keyboard.

IMPORTANT: Keep the calculator face-down on the workbench while performing this operation, because the keys are loose and will become displaced causing you unnecessary work to replace them.

7. Now, carefully remove the P.C. board and the keyboard by lifting up the display end of the P.C. board first. Make sure the foam "key buffer" is not stuck to the keyboard as it may pull keys out of position as the keyboard is removed.

TO RE-ASSEMBLE

1. Place the bottom of the keyboard under the hold-down tabs at the bottom side of the topcase and snap the top of the keyboard into place using a small screwdriver.

2. Replace the card reader and attach it to the topcase with the four hold-down screws.

3. Route the card reader strip cables as shown in Figure 11. Be sure the longer of the two cables is routed to the lefthand (inside) side of the trim pot. After plugging the strip into the connector, push the lower edge of the strip up against the connectors as shown in figure 11.

4. Pick up the topcase and hook the bottom end of the bottomcase into the hooks at the base of the topcase. Slide the bottomcase forward while watching through the battery compartment hole to make certain that the card reader strip does not become damaged by the bottomcase during assembly.

5. Replace the two large screws that hold the calculator together along with the battery pack and CROM.

6. Perform checkout sequence again.

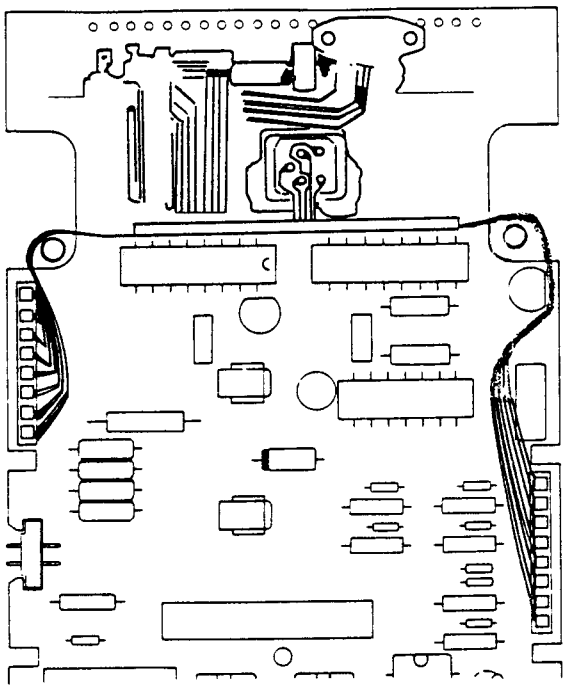


Figure 11. Card Reader Wire Routing

COMMON TROUBLES

Calculator won't enter (Off PC-100A)

Calculator won't enter while on PC-100A/Enters when off of PC-100A.

Double Entry

Won't call up Program from CROM

Calls up CROM/wrong answer on CROM diagnostic

Calculation Errors

PC-100A Compatibility

Erratic Display

Calculator will not read

Calculator will Read/Write off PC-100A, but not on PC-100A

Calculator will read, will not write

Calculator is dead

Memory/Data Register problems

CALCULATOR WON'T ENTER (OFF PC-100A)

ACTION	CAUSE	CURE
1. Check K-lines for normal conditions (No D-line signals mixed in) scope photo K. With exception of KR line which should have a d-pulse superimposed on a VK-line.		
• If "D" line signal is mixed in, 501 locks up;	• Key making contact • Short form "D" line to "K" line	• Replace keyboard • Remove short
2. While holding key down, check other "K" lines for an extra "D" line signal.		
• If signal is present on another "K" line, that "D" line is shorted to another "K" line	• Short	• Repair
• If signal is <u>not</u> present on its respective "K" line	• Bad keyboard • Open etch • Bad solder joint	• Replace • Repair • Repair
3. When key is pressed, "K" line has "D" line signal, but when released "K" line signal goes away	• Bad 501	• Replace

WON'T ENTER WHILE ON PC-100A/ENTERS WHEN OFF OF PC-100A

CHECK	CAUSE	REMEDY
1. Check CR5 for short or open	• Shorted/opened	• Replace
2. Check 582/583 for presence of DO signal. If no signal present, check for short between DO & Vss	• Shorted 582/583 stack	• Replace/ remove short
3. Check print cradle contact pins for proper contact with PCB pads.	• Mis-aligned pins	• Straighten/ Replace

DOUBLE ENTRY

Check	Cause	Cure
1. Check "D" lines out of 582/583 for multiple signals on single "D" line.	• Solder Shorts • Shorted 582/583 stack	• Remove • Replace stack
2. Check 27882 input and output for multiple "D" line signals on single "D" line. If found, remove 27882 and check to see if signals still exist.	• Shorted KB line	
If signals exist,	• 582/583 faulty	• Replace
If signals go away,	• 27882 faulty	• Replace

WON'T CALL UP PROGRAM FROM CROM

Check	Cause	Cure
Press: CLR, 2nd, PGM, 01		
• If display blinks;	• Bad CROM • Mis-aligned CROM contacts	• Replace • Straighten
• If display still blinks;	• Bad 571	• Replace
• If display still blinks;	• Bad 582/583 stack	• Replace

CALLS UP CROM/WRONG ANSWER ON CROM DIAGNOSTIC

Action	Cause	Cure
Press [CLR] [2nd] [PGM] 01 [SBR] [=]		
Display should show "1", if it does not;	• Bad CROM	• Replace
	• Mis-aligned CROM contacts	• Straighten
	• Bad 571	• Replace
	• Bad 582/583 stack	• Replace
	• Bad 501	• Replace

CALCULATION ERRORS

Action	Cause	Cure
Check trig, log & arithmetic routines. If errors exist;	• Bad 501	• Replace
If errors still exist;	• Bad 582/583 stack	• Replace
If trig and log routines are right but arithmetic routines are incorrect, enter following problems: 78-1= or ¯07 + 0 =		
If incorrect answer results;	• Bad 582/583 stack	• Replace

PC-100A COMPATIBILITY

(Works off/won't work on)

Action	Cause	Cure
1. Check PC 100 contacts	• Bent/misaligned	• Straighten
2. Use scope to check PC board print cradle contacts for proper signals;	• Missing or incorrect signal	• Locate source of incorrect or missing signal. Replace bad component.
KN missing/incorrect	• Bad 501	
DO " "	• Bad 582	
D12 " "	• Bad 582	
D15 " "	• Bad 582	
KR " "	• Bad 501	
(Note: If signal exists at the proper device pin, check for an open etch)		
3. If above steps fail to locate problem:	• Bad 571	• Replace
	• Bad 582/583	• Replace

ERRATIC DISPLAY

Action	Cause	Cure
1. Scope clock output, check for presence of proper waveform	• Bad clock chip • Bad resonator • Bad MOS device	• Replace • Replace • Locate & Replac
2. Check Vdd and Vgg with VOM or DVM	• Bad power supply module	• Replace
	• Heavily loaded power supply due to shorted MOS device.	• Locate bad MOS & Replace
3. Check I/O lines if improper waveform is observed	• Bad 501	• Replace
	• Bad 582/583	• Replace
4. Check Vdd and Vgg with scope for noise	• Bad Power Supply Module	• Replace

CALCULATOR WILL NOT READ

Action	Cause	Cure
1. Try original card then	• Bad card	• Try good card
Write new card CLR 1 2nd Write Then check card speed (see page 11)	• Incorrect card speed	• Adjust
Check to see if card will read		
2. Check pins 4 and 21 of 594 for a 2 v peak signal during a card read. If signal is incorrect;	• Bad head • Bad Amplifier	• See Step 4 • Replace 324
3. If signal is 2 v. p.p. or higher from step 2, replace 594	• Bad 594	• Replace
4. Remove & disassemble head mechanism (note routing of flex cables)		
Inspect head and pressure pad for contamination	• Dirty head or pressure pad	• Clean with alcohol
Inspect flex cable for damage with Ohmmeter (270Ω should be measured from V batt to each respective channel)	• Flex cable open • Head open circuited	• Replace • Replace

CALCULATOR WILL READ/WRITE OFF PC-100A

BUT NOT ON PC-100A

Action	Cause	Cure
• Replace 47 μF cap	• 47 μF cap bad	• Replace

WILL READ, WILL NOT WRITE

Action	Cause	Cure
1. Check motor speed	• Improper adjustment	• Adjust
2. Take a card, write a program on it, then check read amplitude on pins 4 and 21 of 594. If no signal appears;	• Defective 594	• Replace

CALCULATOR IS DEAD

Action	Cause	Cure
1. Check Vgg and Vdd at CROM contacts. If bad, check battery, power supply, battery contacts, on/off switch.	• Bad battery	• Replace
	• Bad power supply	• Replace
	• Bent/broken battery contacts	• Replace
	• Bad on/off switch	• Replace
2. Check clock waveform if bad; Check pin 4 of clock chip for resonator output. If missing;	• Bad clock chip	• Replace
	• Bad resonator	• Replace
If signal is present at pin four;	• Bad clock chip	• Replace
3. If problem persists, check "D" lines from 582/583. If no signal is found;	• Bad 582	• Replace
	• Bad 501	• Replace
4. If calculator is in "Pre-load" check "K" lines from 501 for "D" line signals. If found, remove keyboard, if problem goes away;	• Bad keyboard	• Replace
if problem does not go away;	• External short	• Find and remove

MEMORY/DATA REGISTER PROBLEMS

Action

Enter the following program. (Enter by hand, then record on mag card for later use.)

Program will check all memory locations available in the calculator. If a problem is found, the calculator will print out the number of the faulty memory location. (Program must be used in conjunction with the PC-100A.)

To run the program, press [A]

Cause

Bad 598 stacks

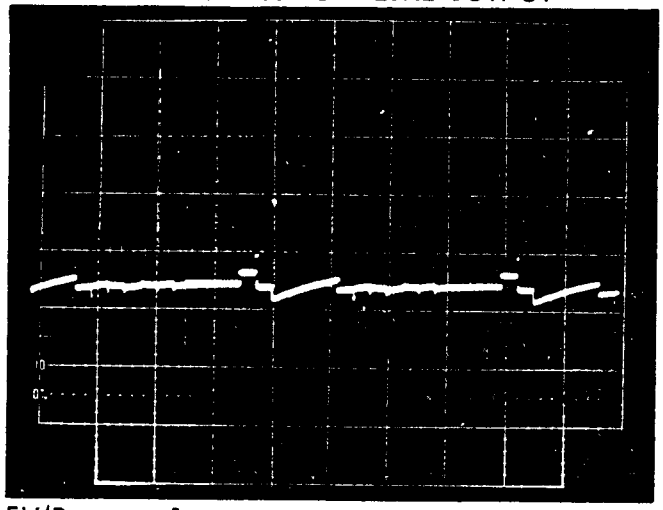
Cure

If memory register from 00 to 59 is bad, replace left stack.

If program register from 00 to 479 is bad, replace right stack.

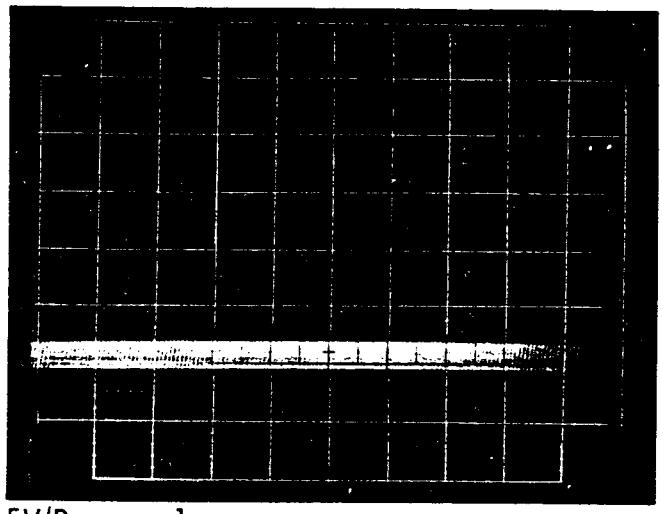
000	76	LBL
001	11	A
002	00	0
003	06	6
004	01	1
005	02	2
006	01	1
007	01	1
008	02	2
009	00	0
010	03	3
011	07	7
012	69	□P
013	02	02
014	01	1
015	07	7
016	03	3
017	06	6
018	03	3
019	07	7
020	02	2
021	00	0
022	00	0
023	02	2
024	69	□P
025	03	03
026	69	□P
027	05	05
028	01	1
029	00	0
030	69	□P
031	17	17
032	47	CMS
033	03	3
034	42	STO
035	00	00
036	09	9
037	35	1/X
038	42	STO
039	01	01
040	09	9
041	06	6
042	42	STO
043	02	02
044	42	STO
045	03	03
046	69	□P
047	00	00
048	76	LBL
049	12	B
050	69	□P
051	20	20
052	43	RCL
053	01	01
054	72	ST*
055	00	00
056	97	DSZ
057	02	02
058	12	B
059	76	LBL
060	13	C
061	43	RCL
062	01	01
063	94	+/-
064	74	SM*
065	00	00
066	73	RC*
067	00	00
068	69	□P
069	10	10
070	67	EQ
071	14	D
072	43	RCL
073	00	00
074	65	×
075	93	.
076	01	1
077	54	)
078	22	INV
079	59	INT
080	65	×
081	01	1
082	00	0
083	75	-
084	07	7
085	54	)
086	77	GE
087	15	E
088	85	+
089	08	8
090	54	)
091	42	STO
092	02	02
093	43	RCL
094	00	00
095	65	×
096	93	.
097	01	1
098	54	)
099	59	INT
100	75	-
101	07	7
102	54	)
103	77	GE
104	10	E'
105	85	+
106	08	8
107	54	)
108	65	×
109	01	1
110	00	0
111	00	0
112	54	)
113	44	SUM
114	02	02
115	43	RCL
116	02	02
117	69	□P
118	04	04
119	73	RC*
120	00	00
121	69	□P
122	06	06
123	76	LBL
124	14	D
125	69	□P
126	30	30
127	97	DSZ
128	03	03
129	13	C
130	06	6
131	69	□P
132	17	17
133	91	R/S
134	76	LBL
135	15	E
136	85	+
137	01	1
138	00	0
139	54	)
140	61	GTO
141	00	00
142	91	91
143	76	LBL
144	10	E'
145	85	+
146	01	1
147	00	0
148	54	)
149	61	GTO
150	01	01
151	08	08

A (NON CALC) SEGMENT LINE OUTPUT



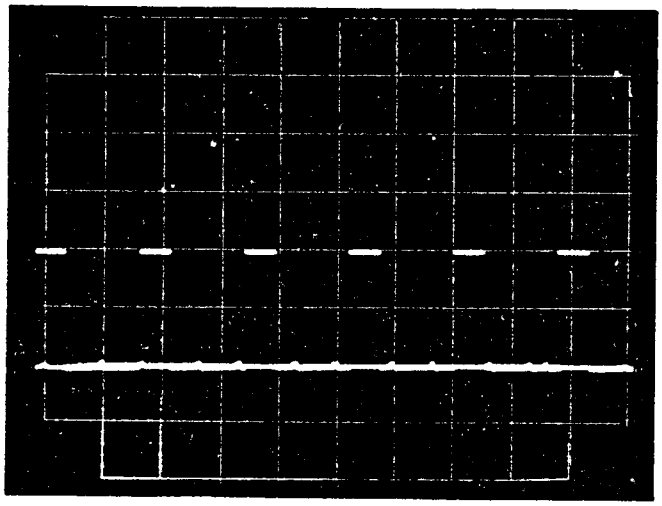
5V/D 1ms

C' (CALCULATING) K-LINE



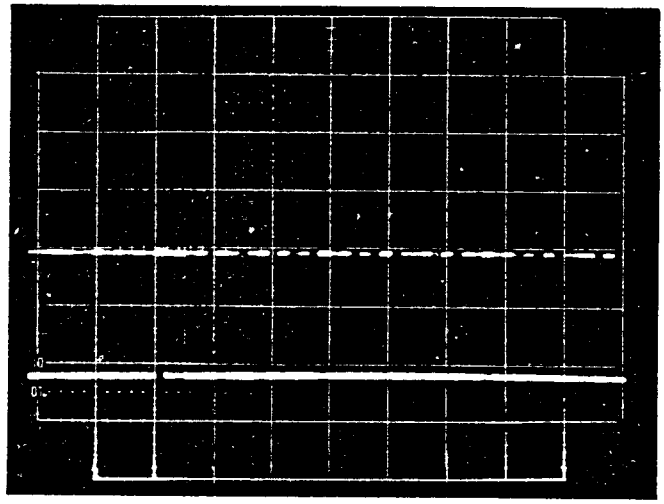
5V/D 1ms

B I/O LINE



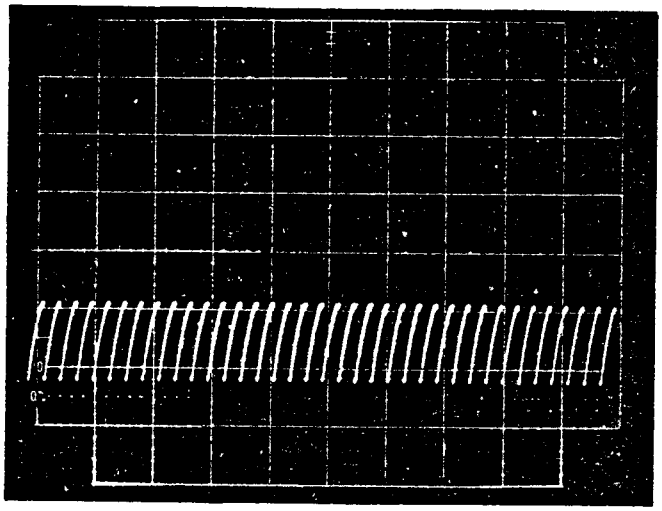
5V/D 5ms

D IRG



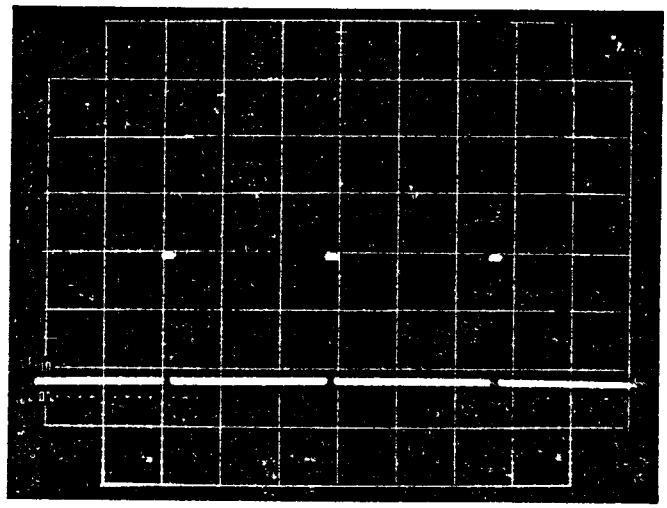
5V/D .1ms

C (NON CALC) K-LINE



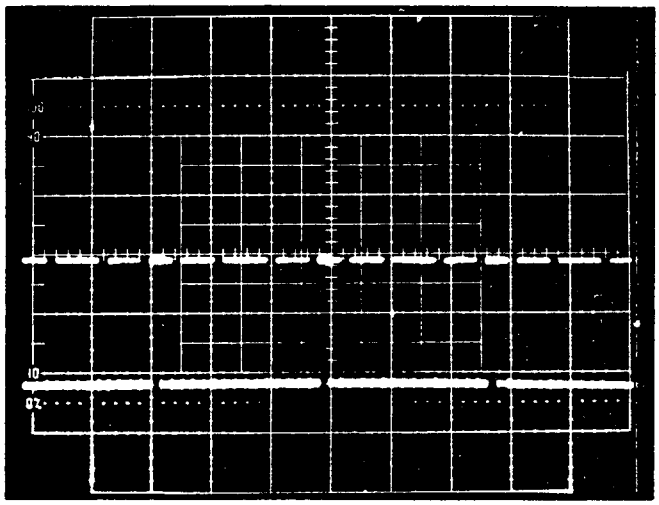
5V/D 1ms

E IDLE (LOW = CALCULATOR IN DISPLAY MODE)



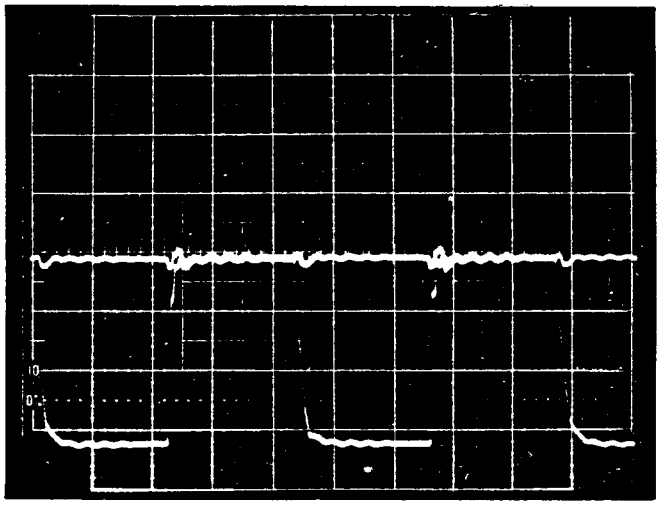
5V/D .1ms

F EXT



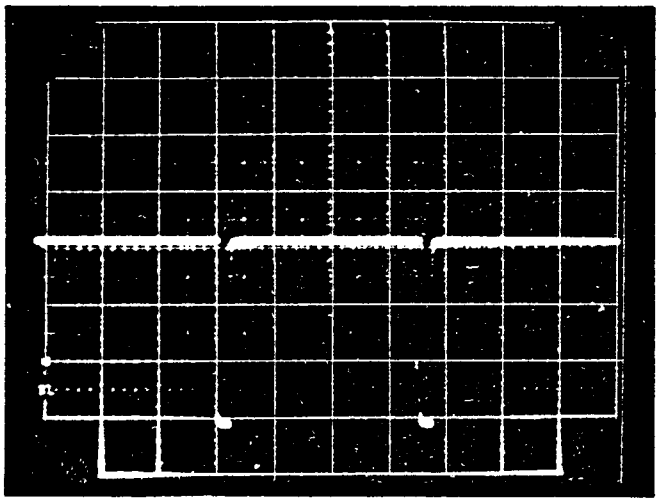
5V/D .1ms

H TIMING RELATIONSHIP OF Ø1 & Ø2



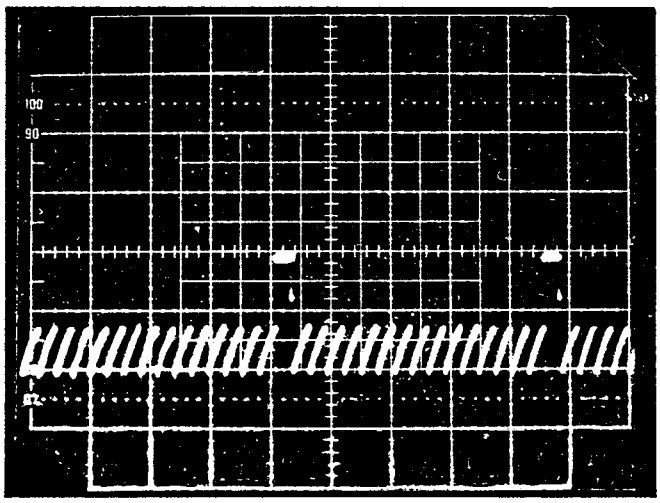
5V/D .5µs

G CLOCK IN IDLE MODE (DISPLAY)



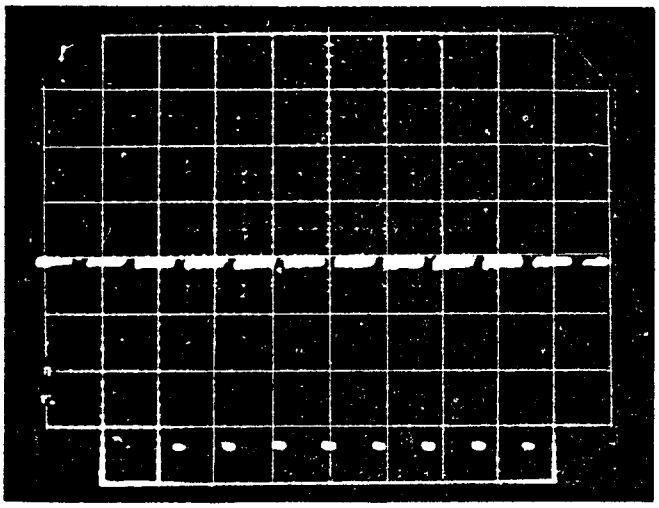
5V/D 5µs

I (NORMAL) KR-LINE



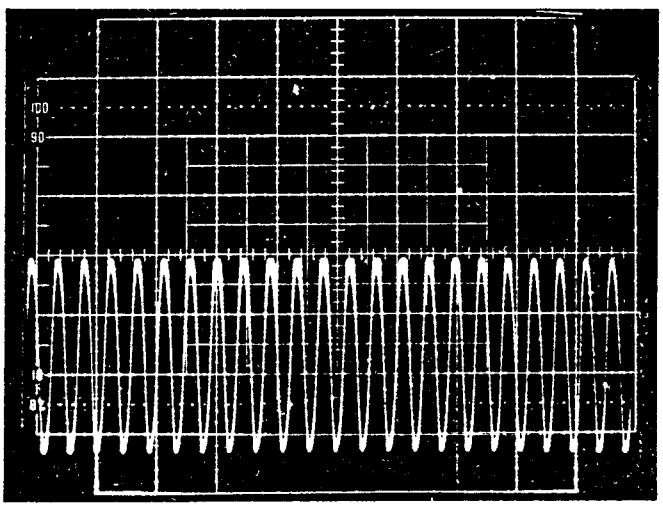
5V/D 1ms

G' CLOCK IN HIGH SPEED MODE (CALCULATE)



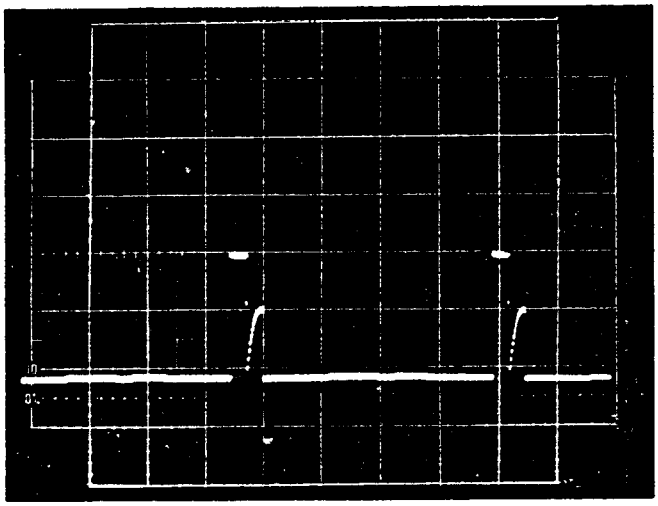
5V/D 5µs

J RESONATOR OUTPUT



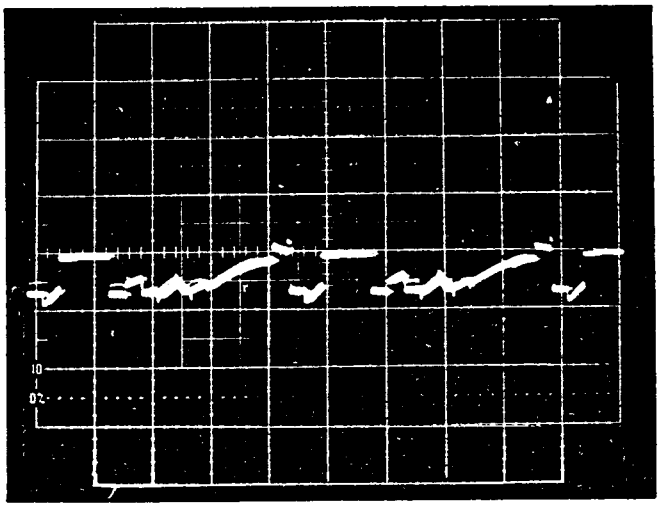
5V/D 5µs

K (NON CALC) D-LINE PULSE



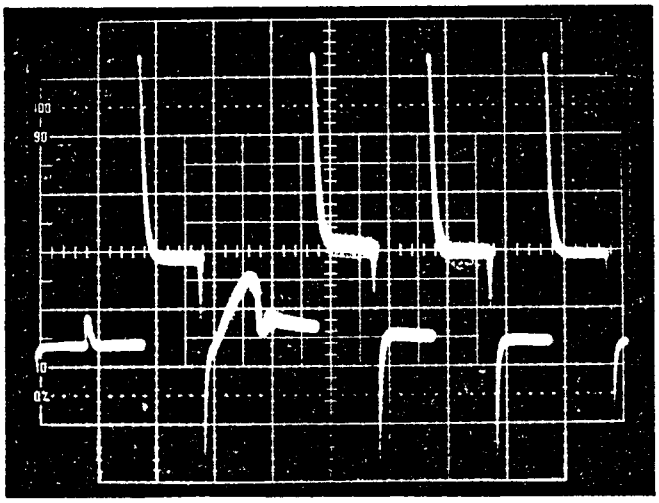
5V/D 1ms

N DIGIT DRIVER OUTPUT



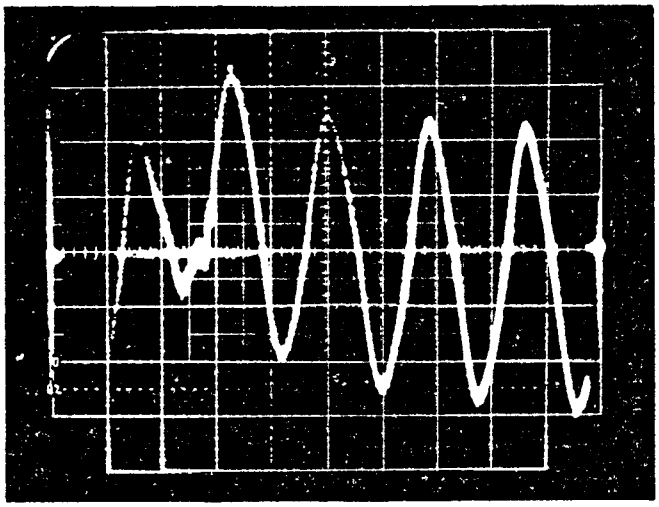
5V/D 1ms

L (WRITING) 594 OUTPUT

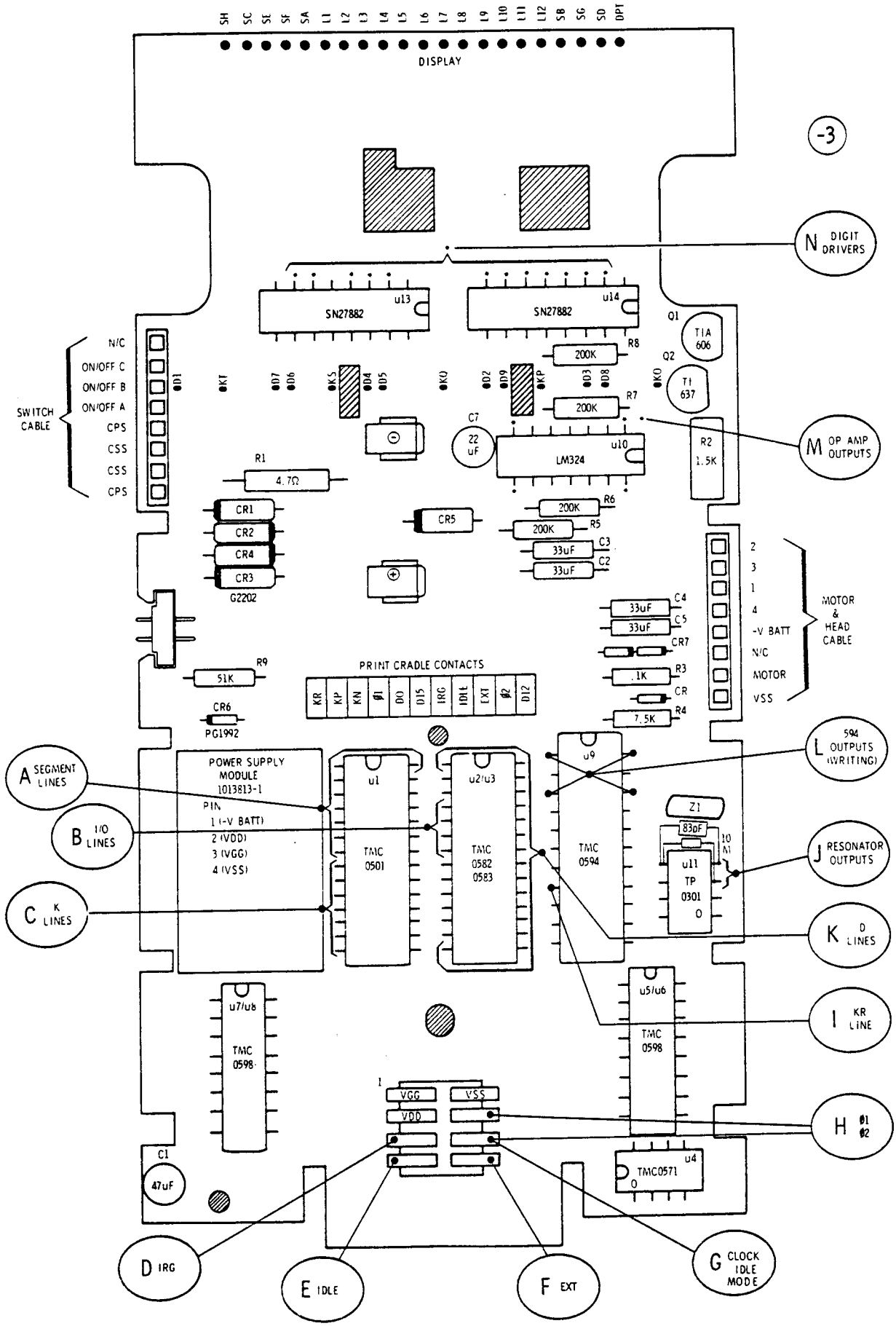


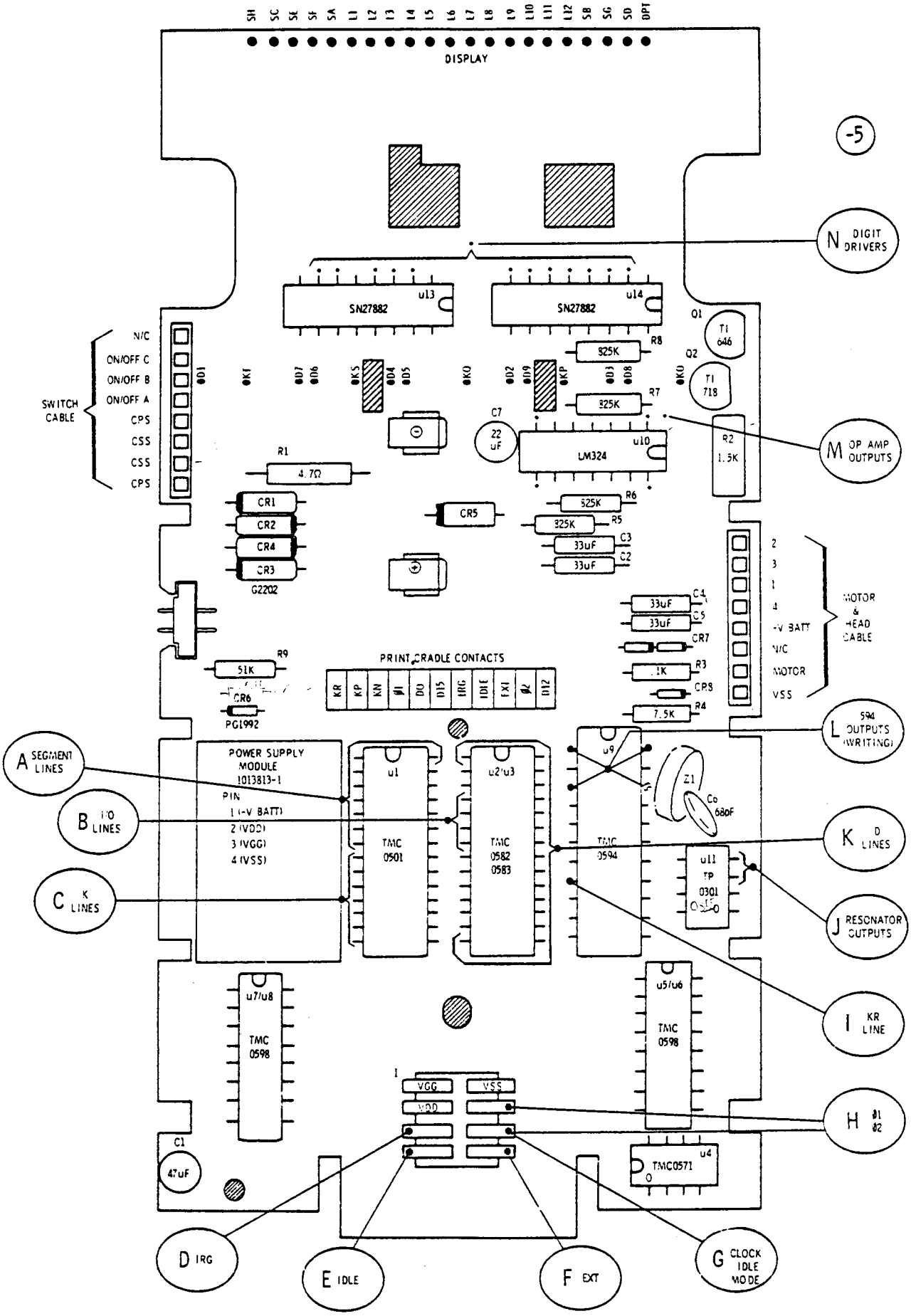
1V/D 1ms

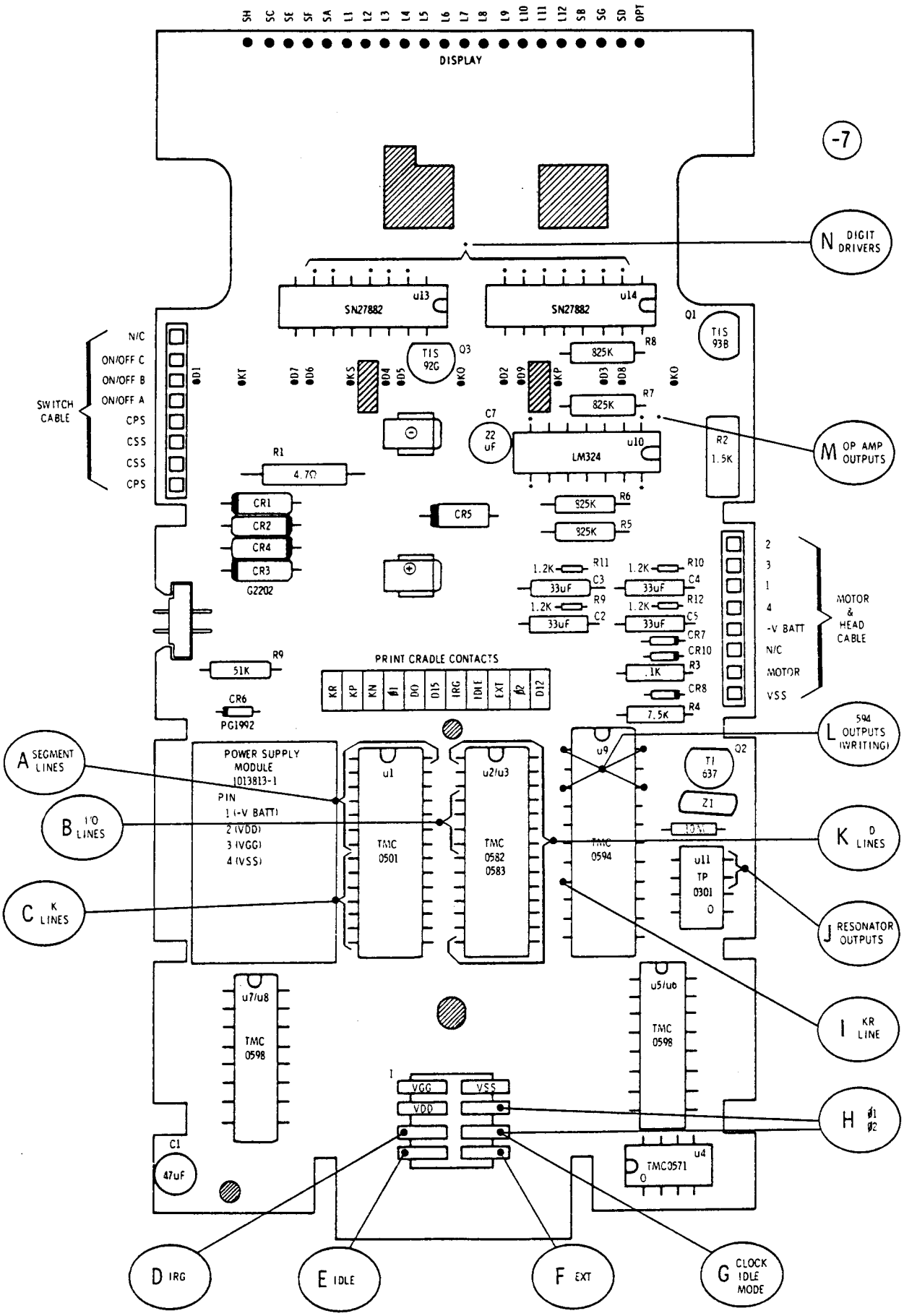
M OP AMP OUTPUT

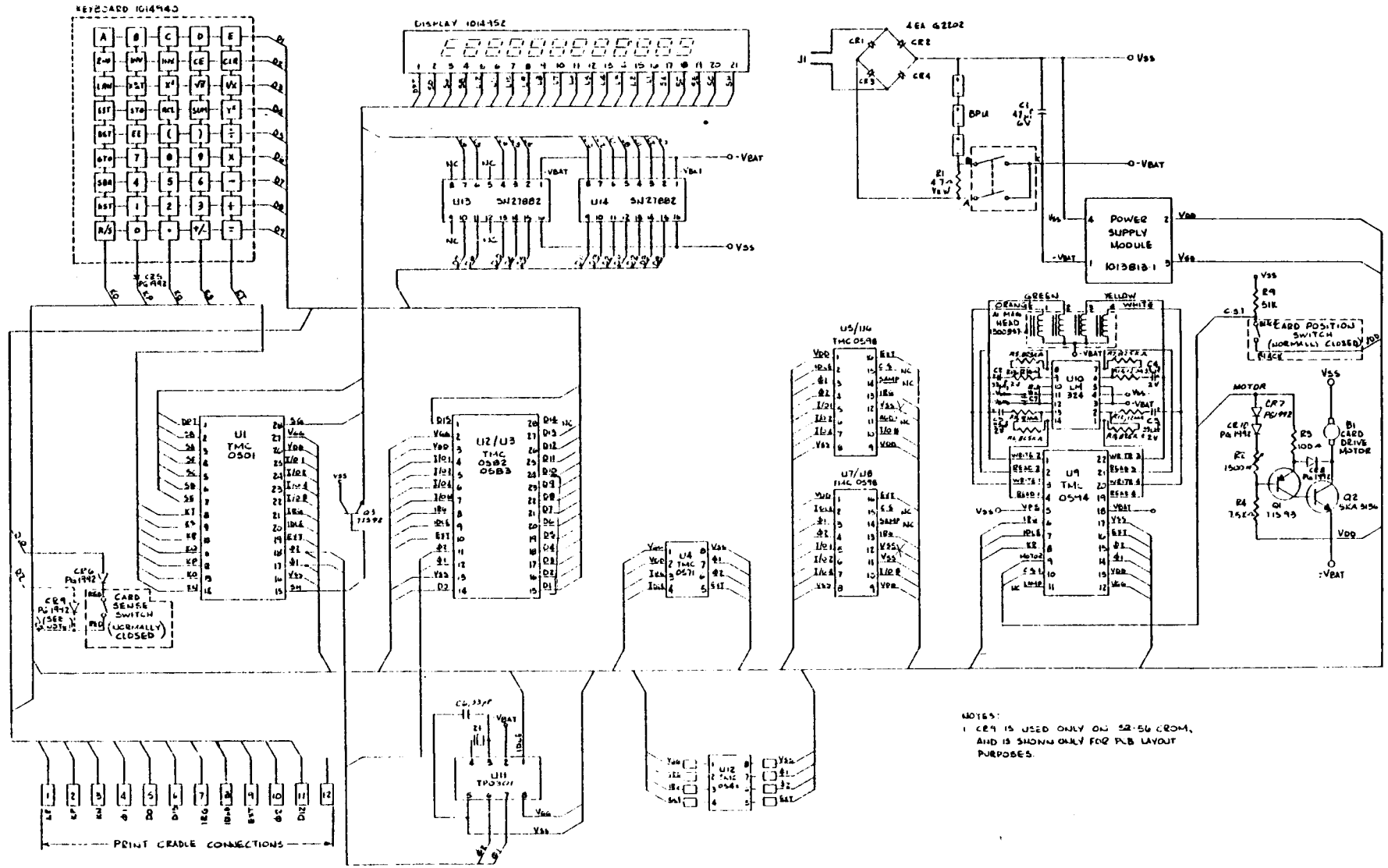


.5V/D 1ms


SH SC SE SF SA L1 L2 L3 L4 L5 L6 L7 L8 L9 L10 L11 L12 SB SG SD DPT
DISPLAY
-3
N DIGIT DRIVERS
SN27882 u13
SN27882 u14
Q1 T1A 606
Q2 T1 637
200K R8
200K R7
M OP AMP OUTPUTS
R2 1.5K
C7 22 uF
LM324 u10
R1 4.7Ω
CR1
CR2
CR4
CR3
G2202
CR5
200K R6
200K R5
33uF C3
33uF C2
SWITCH CABLE
N/C
ON/OFF C
ON/OFF B
ON/OFF A
CPS
CSS
CSS
CPS
MOTOR & HEAD CABLE
2
3
1
4
-V BATT
N/C
MOTOR
VSS
33uF C4
33uF C5
CR7
.1K R3
CR
7.5K R4
51K R9
CR6
PG1992
PRINT CRADLE CONTACTS
KR KP KN ø1 DO DIS IRG IDLE EXT ø2 DI2
A SEGMENT LINES
B I/O LINES
C K LINES
POWER SUPPLY MODULE 1013813-1
PIN
1 (-V BATT)
2 (VDD)
3 (VGG)
4 (VSS)
u1
TMC 0501
u2/u3
TMC 0582 0583
u9
TMC 0594
L 594 OUTPUTS (WRITING)
Z1
83pF
u11 TP 0301 0
J RESONATOR OUTPUTS
K D LINES
u5/u6
TMC 0598
I KR LINE
u7/u8
TMC 0598
VGG
VDD
VSS
H ø1 ø2
C1
47uF
TMC0571 u4
D IRG
E IDLE
F EXT
G CLOCK IDLE MODE


SH SC SL SF SA L1 L2 L3 L4 L5 L6 L7 L8 L9 L10 L11 L12 SB SG SD DPT
DISPLAY
-5
N DIGIT DRIVERS
SN27882 u13
SN27882 u14
Q1 TI 646
Q2 TI 718
R8 325K
R7 325K
R2 1.5K
M OP AMP OUTPUTS
C7 22 uF
LM324 u10
R1 4.7Ω
R6 325K
R5 325K
C3 33uF
C2 33uF
CR1
CR2
CR4
CR3
G2202
CR5
SWITCH CABLE
N/C
ON/OFF C
ON/OFF B
ON/OFF A
CPS
CSS
CSS
CPS
C4 33uF
C5 33uF
CR7
R3 1K
CR8
R4 7.5K
MOTOR & HEAD CABLE
+V BATT
N/C
MOTOR
VSS
R9 51K
CR6
PG1992
PRINT CRADLE CONTACTS
KR KP KN ø1 DO DIS IRG IDLE EXT ø2 DI2
L 594 OUTPUTS (WRITING)
A SEGMENT LINES
B I/O LINES
C K LINES
POWER SUPPLY MODULE 1013813-1
PIN
1 (-V BATT)
2 (VDD)
3 (VGG)
4 (VSS)
u1
TMC 0501
u2/u3
TMC 0582 0583
u9
TMC 0594
Z1
Co 680pF
u11 TP 0301
K D LINES
J RESONATOR OUTPUTS
I KR LINE
u7/u8
TMC 0598
u5/u6
TMC 0598
VGG
VSS
VDD
H ø1 ø2
C1 47uF
u4
TMC0571
D IRG
E IDLE
F EXT
G CLOCK IDLE MODE


SH SC SE SF SA L1 L2 L3 L4 L5 L6 L7 L8 L9 L10 L11 L12 SB SG SD DPT
DISPLAY
-7
N DIGIT DRIVERS
SN27882
u13
SN27882
u14
Q1
TIS 93B
TIS 92G
Q3
825K
R8
825K
R7
C7
22 uF
LM324
u10
R2 1.5K
M OP AMP OUTPUTS
SWITCH CABLE
N/C
ON/OFF C
ON/OFF B
ON/OFF A
CPS
CSS
CSS
CPS
R1
4.7Ω
CR1
CR2
CR4
CR3
G2202
CR5
925K
R6
925K
R5
1.2K R11
33uF C3
1.2K R9
33uF C2
1.2K R10
33uF C4
1.2K R12
33uF C5
CR7
CR10
.1K R3
CR8
7.5K R4
2
3
1
4
-V BATT
N/C
MOTOR
VSS
MOTOR & HEAD CABLE
R9
51K
CR6
PG1992
PRINT CRADLE CONTACTS
KR KP KN Ø1 DO DIS IRG IDLE EXT Ø2 DI2
L 594 OUTPUTS (WRITING)
A SEGMENT LINES
B I/O LINES
C K LINES
POWER SUPPLY MODULE 1013813-1
PIN
1 (-V BATT)
2 (VDD)
3 (VGG)
4 (VSS)
u1
TMC 0501
u2/u3
TMC 0582 0583
u9
TMC 0594
TI 637
Q2
Z1
10M
K D LINES
u11 TP 0301 0
J RESONATOR OUTPUTS
u7/u8
TMC 0598
u5/u6
TMC 0598
I KR LINE
VGG
VDD
VSS
H Ø1 Ø2
C1
47uF
TMC0571
u4
D IRG
E IDLE
F EXT
G CLOCK IDLE MODE



ELECTRONIC SCHEMATIC DIAGRAM, TI PROGRAMMABLE 58/59

INTEGRATED CIRCUITS

REF DESIG	DASH NUMBER	PART #	
	All		
U1	TMC0501	1500924-0002	
U2	TMC0582	1501198-0001	
U3	TMC0583	1501199-0001	
U4	TMC0571	1501200-0001	
U5	TMC0598	1500896-0002	
U6	TMC0598	" " "	
U7	TMC0598	" " "	
U8	TMC0598	" " "	TI 59 Only
U9	TMC0594	1501210-0001	
U10	LM 324	1501211-0001	
U11	TP0335	1501192-0005	
U12	TMC 054	1501248-0001	
U13	SN 27882	1210013-0012	
U14	SN 27882	1210013-0012	

TRANSISTORS (TI 59 Only)

REF DESIG	ALL DASH#	PART#
Q1	TIS 93	1500578-1
	SKA 1872	1501062-1
Q2	SKA 3136	1501091-1
Q3	TIS 92	1500501-1 (-7 board only)

DIODES

REF DESIG	DASH NUMBERS -1,2,3	-4,5,-6	7	PART #	
CR1	G 2202	G 2202	G 2202	1500528-0001	
CR2	G 2202	G 2202	G 2202	" " "	
CR3	G 2202	G 2202	G 2202	" " "	
CR4	G 2202	G 2202	G 2202	" " "	
CR5	PG1992	PG1992	PG1992	" " "	
CR6	PG1992	PG 1992	PG 1992	1500575-0001	(TI-59 only)
CR7	PG1992 Two in series	PG1992 Two in series	PG 1992	" " "	(TI-59 only)
CR8	PG 1992	PG 1992	PG 1992	" " "	(TI-59 only)
CR9	-	-	-		(TI-58 only)
CR10	-	-	PG 1992	" " "	(TI-59 only)

CAPACITORS

REF DESIG	DASH NUMBERS			PART #
	-1,2,3	-4,5	-6,7	
C1	47µF	47µF	47µF	1500701-0003
C2	33µF	33µF	33µF	1500628-0016
C3	33µF	33µF	33µF	" " "
C4	33µF	33µF	33µF	" " "
C5	33µF	33µF	33µF	" " "
C6	-	-	-	
C7	22µF	22µF	22µF	1501311-1
C clock*	75pF	75pF	75pF	1500745-30
C clock*	33pF	33pF	33pF	1500745-23

*Refer to clock section (Figure 2) for proper configuration/hook-up information.

RESISTORS

REF DESIG	DASH NUMBERS -1,2,3	-4,5	-6,7	PART #	
R1	4.7	4.7	4.7	1500600-0017	
R2	1.5K pot	1.5K pot	1.5K pot	1501060-0014	
R3	.1K	.1K	.1K	1500598-0039	
R4	7.5K	7.5K	7.5K	1500598-0084	
R5	200K*	200K	825K	1501312-0473	
R6	200K*	200K	825K	" " "	
R7	200K*	200K	825K	" " "	TI-59 only
R8	200K*	200K	825K	" " "	
R9	51K	51K	51K	1500773-0098	
R10	-	-	1.21K	1501312-0201	
R11	-	-	1.21K	" " "	
R12	-	-	1.21K	" " "	
R13	-	-	1.21K	" " "	
R clock	10M**	10M**	10M**	1500773-153	

*200K P.N. - 1501312-0414

** Optional

MISC ELECTRONICS

PCB	1014957-0007
Power Supply Module	1013813-0001
Battery Contact	1014962-0001
XStr, Resonator	1500969-0005
Crom Contacts	1014963-0002
Prog 59 insert	1014961-2500
Connector Pin	1030299-0001
VLeD Display	1014952-0001
Lead Frame	1010727-0006
Keyboard	1014940-0001
Keyboard Spacer	1015746-0001
Recpt	1014320-0001

CARD READER (Not used on TI-58)

DESCRIPTION	PART NUMBER
MOTOR	1014971-0003
MAG HEAD ASY	1015741-0001
MAG HD. ASY	1015741-0002
PRESSUR ROLLER	1014969-0002
SWITCH CONT	1220466-0002
PRESSURE PAD	1014970-0001
HOUSNG UPR CRD	1014967-0001
SWITCH SPRING	1220465-0004
SPRNG MAGHEAD	1014975-0001
CLMP SPRNG CNTR	1014974-0002
SCREW PN H	0418293-0002
INSERT SONIC	1500516-0003
LOWER HOUSNG	1014968-0001
DRIVE ROLLER	1014972-0002
FLEX CABLE	1015749-0002
SWITCH	1501222-0003
PAD RESILIENT	1220815-0001

FINAL ASSEMBLY

DESCRIPTION	PART NUMBER
BTM CASE	1014944-0001
BP 1A BATT. PK	1015767-3950
SR59 CROM DOOR	1014949-0002
SPACER CROM	1015747-0001
SCREW CASE	1501223-1409
TS REP	1014961-5400
SFTWR ASY TI59	1014961-5350

PER PACK

DESCRIPTION	PART NUMBER
WINDOW	1014945-0003
TOPPER	1014946-0001
BEZEL	1014951-0003
BAG PLAST	1220009-0001
BLACK FEET	1020093-0002
DIAG CARD	1014956-0003

DESCRIPTION	PART NUMBER	
AC 9131A	1501119-0001	
MANUAL	1014983-0005	
CHARGE CAR	1015756-0001	
EXCHANGE LETTER	1500936-0010	
POUCH	1014950-0001	
BOX TOP	1014964-0001	
MANUAL	1014984-0021	
CODING FORMS	1014966-0001	
HD CLN CRD	1014956-0001	TI-59 only
BLANK CRDS	1014956-0002	
CRD RLR CLN	1015740-0001	
CASE	1014953-0001	
ENVELOPE	1014977-0002	
STUFFER	1501213-0001	
OVERLAY	1015009-0002	
OVERPK BOX	1010762-0102	
CARD,PROG. LIB.	1014978-0001	
ACC. PACK	1015754-0000	
MANUAL	1015755-0011	
BAG POLY	1220813-0001	
CUST. INFO CARD	1501301-0030	
PRODUCT BULLETIN	1015752-0001	
TAPE POLY	1210162-0001	
INSERT	1019298-0001	

TOP CASE ASSEMBLY

DESCRIPTION	PART NUMBER
TOP CASE	1014943-0001
KEYSET NUMERIC	1014372-0001
KEYSET FUNCTION	1014371-0001
KEY SET COMPLX	1014415-0002
KEY 2ND	1014948-0001
KEY CLR	1014948-0003
KEYSET ABCDE	1014947-0001
PAD RESILIENT	1220476-0001
SCREW MECH.	1501223-1205
TS REP	1014961-4090

TI-58 UNIQUE PARTS

DESCRIPTION	PART #
PWB	1014957-0006 (Do not use -0007)
WIRE	1500708-0023
WIRE	1500708-0021
WIRE	1500708-0022
TOP CASE	1014943-0002
BEZEL	1014951-0004