

Digicomp Research Corporation was founded in 1975 by several highly qualified engineers, all of whom are interested in astrology. The idea of creating the DR-70 astrology computer was the spark which set our company moving. We have expanded greatly since the DR-70 hit the market 3 years ago. Although many of our employees are involved in the DR-70 project, we have broadened our research and development activities into other areas of the electronic and computer science field. Among the most important are the following:

1. Development of "Trusted Computer Systems".
As any programmer knows, the development of absolutely reliable software is a very difficult and expensive process. (Digicomp spent several years designing software for the DR-70). No one wants a computer system that he cannot trust. This problem is really an acute one with regard to military systems. The military requires "secure" computer systems whose data cannot be tampered with by any unauthorized person. Digicomp has recently been awarded a million dollar contract by the Air Force to study and evaluate design techniques for developing reliable software. This will have a particular application to the design of secure operating systems and data bases.
2. Microcomputer Products.
Digicomp is active in designing and manufacturing "board-level" components for general purpose S-100 microcomputers. Among these products are Pascal-100, a plug-in central processing unit with a unique dual processor design, and the MFIO Multi-Function Input/Output controller. It utilizes the latest in large scale integrated circuitry to provide a large number of functions on a single board. Digicomp also packages these products into complete microcomputer systems that are typically used in small businesses and as "personal computers".
3. Use of modern computer technology to speed up radar signal processing algorithms.
Computer systems are now available that can process many different numbers simultaneously (e.g., perform arithmetic operations like add, subtract, multiply and divide) as opposed to previous "sequential" processing of one number at a time. These computers are called "parallel processing" or "array processing" systems. The analyzing of radar data consists of processing a very large quantity of numbers. The sequential processing of these signals takes an incredibly long time and thus limits their usage to only laboratory studies. Digicomp has been hired by the USAF to speed up these algorithms by using array processing techniques. The objective is to achieve real time speeds for tactical operations.
4. Air Force computer specification for the 1990's.
The US Army has published the specifications for computer architecture that is expected to serve its needs in the 90's. Because the USAF's needs are different than those of the Army, Digicomp will be studying the Army's specifications in light of the USAF's requirements.

The benefits to the astrology community of Digicomp's expansion are two-fold. The first is that Digicomp will continue to be on top of changes in the computer field and will apply the knowledge gained to the DR-70. Secondly, because Digicomp Research is not a one-product company, we will be able to support the DR-70 for many years to come.



The DR-70 is a stand-alone desktop microcomputer whose keyboard, display and firmware are entirely dedicated to astrological functions. This portable computer is manufactured by Digicomp Research Corporation, and is scheduled for delivery in March of this year. The heart of the DR-70 is a high speed 8-bit microprocessor CPU. The programs for this unit are resident on 28k bytes of metal-mask ROM, which is accompanied by 1 k bytes RAM scratch pad and user storage area. For the sake of speed and compactness, the majority of the programming was done in assembly language. Digicomp Research developed its own high speed floating point routines, which effectively reduced the planetary computation time. The DR-70 uses several different interrupt service subroutines that are conditional with respect to a keyboard status indicator. This allows the microprocessor to alternately refresh the LED display panel, parse the keyboard, continue projected calculations, and transfer information to the printer. By a complex parsing/interrupt interface, the DR-70 software is able to anticipate the key sequence in advance of the user, thus beginning the calculation requested before the user has finished entering it from the keyboard. This noticeably reduces turnaround time on most entries. Of course, this technique has a cross-check to the full keyboard entry, so that the user need never worry about the computer misreading the key sequence.

From the astrological point of view, the DR-70 keyboard and display have been designed to present results in an astrological framework by using the familiar signs and symbols of astrology wherever they are needed to identify values. If the position of the natal sun is desired, the user simply presses NATAL ☉; for the progressed sun, the entry becomes SECondary ☉ .

For persons familiar with computers and computer science, the keyboard offers a tremendous flexibility in accessing the available data. Since the history of the previous keyboard entries is maintained as long as the machine is on, the experienced user may minimize all key sequences so that they implicitly incorporate keys set in earlier sequences. On the other hand, for the astrologer who is unfamiliar with flags, bits, and bytes, all the internal information is easily available to him through straight-forward, common sense entries. In either case, the display panel is engineered to indicate the status of all internal banks and registers at the touch of a button.

Because of the wide range of uses, Digicomp Research has spent considerable time developing the instruction manual. This has been written in a self-teaching style, with the more complex possibilities being presented a step at a time. The astrological and computer terminologies are defined as introduced, and the techniques have been illustrated with example horoscopes. In the back of the manual, there are two reference sections, one for common key sequences, and one for the more complex entries.

The DR-70 weighs six pounds, is 10" x 13½ x 5½", and requires 115 Vac ± 10 V, 60 Hz connected through the supplied power cord. All internal components are powered by a single 5 volt supply and cooled by a small fan mounted in the rear of the case. It is shipped inside a specially designed luggage case, which can be adjusted to carry the printer as well.

The companion printer for the DR-70 is scheduled for production in July. This unit interfaces with the microcomputer through a single cable, and has its own power supply. Its functions range from sorting and listing all the various chart information to simply generating hard copy of all keyboard entries. Further information on the printer and its capabilities are available from Digicomp Research Corp., Ithaca, New York.

Dear DR-70 Owner,

This newsletter contains important information regarding the service of your DR-70 and printer. I have a number of different points to discuss with you so settle down with a cup of tea or coffee and give me about 15 minutes of your time.

1. When you call Digicomp please use 607-273-5900. We also have an 8779 number which was advertized for a long time but it is often busy now with our outgoing calls.

2. Whenever you call Digicomp with machine problems or questions about key sequences it will save time and money if you set up your computer by the phone before calling.

3. If you are having mechanical problems with your DR-70 it is best to call us before sending in your computer. Often the problem is not difficult to repair and can be done over the phone or by you or another local person. We will be able to determine this when you call.

4. When you return your machine, enclose a note which describes the problem you are having. Include return address and phone number so we can contact you if necessary. If you have print-outs which illustrate your problem, please enclose these with your package.

5. When you transport the DR-70 in its carrying case lay it on the seat of your car or in the trunk in its operating position. This will help prevent memory chips from jarring loose. To help you tell which side of your case is up you might mark it with some tape.

6. When machines come in to us for repair (and not under warrantee) our charges are as follows (as of 8/12/81):

- \$75 minimum
- \$25, \$35, or \$50 per hour labor depending on the level of engineer required.
- parts as needed

Most repairs are in the \$75-\$125 range but we are finding that some are well over \$100 and some over \$200. As your machine ages you should consider protecting yourself against costly repairs by obtaining one of two service contracts that we offer:

- a. \$35 per year and \$95 maximum per repair.
- b. \$180 per year for all repairs

Neither of these include shipping but both cover all parts and labor as specified. The contracts are only for the DR-70. All repairs are guaranteed for 2 months. If

a DR-70 is returned to you in non-operative condition, call us. We will cover return postage in this case. Sometimes machines develop problems during shipment.

7. We have established a relationship with several computer repair centers in the US. If you prefer, you may use them. They have our schematics which make it possible for them to repair DR-70s. However, they are independent of us in all other ways.

Chicago: Kaltronics
3665 Woodhead Dr.
Northbrooke, Ill. 60062 312-291-1220 attn. Gary Shideler

Los Angeles: Computer Service Center ^{415 0039}
4226 West 164th St. 213-557-1770 days
Lawndale, CA 90260 213-371-9662 nights attn. Roger Lewis ^{Mike Lewis}

^{Pages}
Dr. B. K. Roy
1785 N. Partridge
Anaheim, CA 92806

Va. Beach: Starborn Electronics
3707 Virginia Beach Blvd.
Suite 206
Va. Beach, VA 23452 804-486-5825 attn. Victor Winborn

8. I am enclosing a small repair manual that will be of some help to many DR-70 owners. There are some types of problems that you will be able to handle yourself. It would still be wise to contact Digicom before trying any of them yourself, however, because of the warrantee restrictions.

9. Please do not over oil the printer. Usually one drop of oil on the metal bar and a small amount of petroleum jelly in the groove (see manual) is all that is required. Also, it would be better if you did not re-ink the ribbons as it can make a mess in the printer.

Now for a couple of MINI - TRICKS: *see Key Sequence section*

1. If you press 0 + HSE 1 ENTER you will get house positions in degrees and decimal fraction.

If you press 60B 0 + HSE 1 ENTER you will get house positions in degrees, minutes, and seconds.

This also applies to planets:

0 + @ ENTER or/
60B 0 + @ ENTER

Also, you can cycle through houses and planets using the ENTER key.

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60B 0 + @ ENTER

Also, you can cycle through houses and planets using the ENTER key.

2. Declinations can NOT be calculated from sidereal positions. The sidereal positions are treated as if they were tropical by the DR-70. For example, the Sun at 0° Aries sidereal will give a declination of 0° which would be correct for tropical Aries only. To calculate the declinations of sidereal planets, first convert to tropical and then calculate them. Declinations of the planets should not change because the longitude is sidereal rather than tropical.

3. When entering a GMT what do you do when you subtract for DST or for time zones east of Greenwich and you arrive at a time which is on the previous day? Use CHS and enter a negative time! You won't have to change the date this way.

For example: Date 3.21.1981
 Time 3 AM LMT
 Lat 20N
 Long 60E

When you subtract 4 hours for the eastern time zone you get -1 hours GMT or 23 hours on the previous day. Instead of changing the day, all you type is:

1 CHS ENTER

Happy Computing!

Simple DR-70 Repair techniques

Recommended tools for DR-70 repair

- (1) #6 hex driver or Alan wrench
- (2) small flat screwdriver
- (3) chip extractors
- (4) soldering iron and solder
- (5) solder wick or solder removal tool
- (6) 1/4" socket wrench or spanner
- (7) wire cutters
- (8) Freon solvent
- (9) isopropal alcohol

Simple DR-70 Repair Techniques

NOTE - OPENING THE MACHINE WILL VOID YOUR WARRANTY UNLESS OTHERWISE INSTRUCTED BY DIGICOMP.

A. Opening the machine

1. The DR-70 is sensitive to static electricity, so when working on the machine do not wear sweaters, nylon shirts, rubber-soled shoes or material that creates static charges.
2. A #6 hex driver is used to undo the 6 stress bolts located around the aluminum valence and fan. (Note: 1 bolt located under warning sticker).
3. Tape over name plate to avoid scratching.
4. Lift top cover up and lean it towards the back - it should be stabilized in this position.

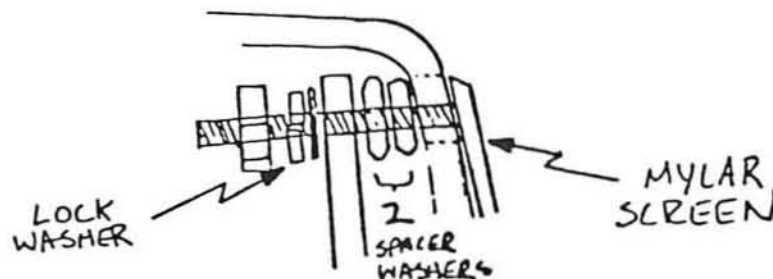
B. Techniques of repair for intermittant failures or lost data (but machine responds to reset).

1. Check operators manual for proper key sequence.
2. Follow opening instructions (#A). Once open, firmly press each chip to reseal their contacts in the sockets.
3. Replace cover and observe behavior. If intermittant behavior still occurs, repeat procedure #1.
4. If machine continues to behave intermittantly, purchase some spray contact cleaner (a freon solvent which leaves no residue or oil). Again open the machine. With chip extractors or a small screwdriver, lift the chips partially out of their sockets. Spray the contact cleaner on the chips legs and reseal the chips by pushing them in. Check that none of the chips legs are bent or out of the socket. (Note: if a chip should accidentally come out of its' socket, it must be replaced in the same direction).
5. Replace cover and observe machines behavior.

C. Replacement of LEDS

1. Disconnect 50 pin card edge connector from keyboard - avoid stressing cable. The epoxy seal can be broken with a small screwdriver or knife.

2. Lay top upside down. Four sets of 1/4" nuts should now be seen on the back side of the display PC board. Remove the nuts and washers. IMPORTANT: Note the number of, and order of the spacing washers. (See #5)
3. Turn top cover over. Mylar display screen may now be lifted off. Locate defective LED.
4. Now, unsolder old LED and discard. Noting that the direction of the notch in LED lens aligns with the other LEDs (towards the left, looking from the top). Solder LED in FLUSH to the PC board. Do not hold solder iron on the LED lead for longer than 2 seconds. Overheating will cause internal damage to the LED.
5. Screw the display screen and PC board back together with the same exact number of washers (see diagram below). If the LEDs get too close to the screen, heat from LED will cause the mylar to melt.



6. Replace ribbon cable, set top down on bottom in place. Turn machine on, then verify that new LED is working. Turn machine off, then close the machine (see "Sealing up the machine").

D. Replacement of keyboard switches

1. Disconnect 50 pin card edge connector from keyboard - avoid stressing the ribbon cable. (See C1).
2. Remove keytop on suspect key. Usually a small screwdriver working from the bottom of keytop, pulling up, will do.
3. After locating key on backside of PC board, remove the solder from the two contact holes. Free key by pulling from top. Make sure both the contact holes and the mounting guide holes (2) are free of obstructions.
4. Gently ease new key switch into hole and solder. It is important to note the following:
 - (i) the switch contacts should be centered in PC board holes and the switch must be seated flat to prevent the key tops from rubbing against one another.
 - (ii) Hold solder iron on switch leads for no longer than 2 seconds as the internal mechanism can overheat.

5. Replace ribbon cable and keytop. Verify proper functioning of keyswitch. Seal machine, if working.

E. Procedure if fuse blows repeatedly

1. Check that fuse is 3/4 amp AGC fuse.
2. Open machine (See #A). Carefully look for loose shards in +5v circuitry on motherboard. Check 120v wiring for loose or shorting connections. Check operation.
3. Cut 120v wire to fan. Check operation. If it works -- replace fan (all parts available through Digicomp). If not - reconnect wire.
4. Cut 120v wire to power supply. Check operation by observing fan.
 - (i) If fan runs, go to #5.
 - (ii) If fan doesn't run - disconnect line filter and bypass it. Reconnect power supply and check operation. Should it work, replace filter. If it doesn't, recheck wiring for shorts.
5. Cut yellow wire to 7805 regulator. Check operation of fan. If now working, replace 7805. If not, check power supply PC board and motherboard for shards in +5v power busses.
6. If the machine continues to blow fuses, call Digicomp at (607) 273-5900.

F. Sealing machines

PLEASE FOLLOW THIS CHECKLIST

1. Make sure power supply, motherboard, keyboard, and display are all screwed down tight.
2. Check power supply output. It should be +5.05v. If not, adjust pot.
3. Check master clock (only if you have a calibrated oscilloscope). It should have a period of 1.25 us. The clock pot is located on the power supply side of the CPU module.
4. Vacuum machine thoroughly to remove any loose debris. If inside is dusty, wipe it clean using isopropal alcohol.
5. While the machine is open an easy and helpful maintenance procedure is to push down on all the chips to ensure that they are seated firmly in their sockets.
6. Fit top and bottom together. Pick up and shake machine, meanwhile listening to hear loose material inside enclosure.
7. With cover still on, check for proper functioning. Then insert and tighten stress bolts.

MAINTENANCE AND REPAIR

1.0 The Model 7040 printers are designed to require a minimum of maintenance and service. This section provides instructions and procedures for both cleaning and maintenance of the printer as well as a troubleshooting guide to aid in problem analysis.

1.1 Required Tools and Supplies

The following items are recommended for printer maintenance and major repairs. Common hand tools are also required.

1. Volt-Ohm Meter
2. Feeler Gauges
3. Grease (IBM #23 or Lubriplate #70)
4. Isopropyl alcohol
5. Cleaning Rags
6. Cotton Swabs

2.0 Maintenance

The frequency at which normal maintenance (cleaning, lubrication and inspection) should be performed when the printer is installed in a clean office environment should normally be one year. However, if the printer is subjected to heavy usage and/or a dirty environment, the frequency should be increased as required.

2.1 Cleaning

- A. Clean printer thoroughly using alcohol, rags and cotton swabs to remove hardened grease, ink and dirt.
- B. Rotate platen and clean with an alcohol soaked rag.
- C. Remove head and clean head and head shaft with alcohol.
- D. Reassemble head to printer.
- E. Apply a small amount of recommended grease to head shaft.

2.2 Inspection

- A. Check for print wire movement on all seven solenoids by depressing wire end and noting return to rest position.
- B. Check for easy movement of the head assembly on the print head assembly shaft.
- C. Inspect the ribbon reverse mechanism for proper movement. Manually operate the ribbon feed pawl back and forth to check operation. Be sure that both springs are securely in place and of equal tension.
- D. Inspect the printer for any loose or missing screws.
- E. Check for excessive vertical movement of print head drive cam. Usual cause is a loose paper feed motor. Rotate the drive cam toward the platen and listen for an audible click of the home micro switch.
 - (1) The position of the switch arm roller at the click should be half-way up/down the high dwell ramp of the cam.
 - (2) The switch activating arm should be straight with no kinks.
- F. Check the paper feed cam for tightness on motor shaft (looseness may be a result of a bad cam or improper motor shaft configuration).

- G. Rotate the paper feed cam clockwise (toward platen) and check for smooth operation. Binding indicated bad fit between cam and pawl arm. Listen to the paper feed micro switch for an audible click.
 - (1) The position of the switch arm roller at the click should be half-way up/down the high dwell ramp of the cam.
 - (2) The switch activating arm should be straight with no kinks.
- H. Check that right end of print platen is not loose with regard to platen drum.
- I. Check that the platen spins freely when paper release lever is depressed and ratchet pawl is disengaged.
- J. Check that the plastic paper guide strip edge touches the platen drum over its entire length.
- K. Check that the plastic paper guide strip is secured to the extrusion mounting surface.
- L. Check that the print head moves freely along its shaft and within the drive cam groove while turning the drive cam toward the platen.
- M. Place the ribbon in place and check that it does not snag throughout its path. Check ribbon spool drag.
- N. Depress paper release lever and check that bar and feed roll leave the print platen.
- O. Check that two ply form may be loaded when paper release lever is depressed.
- P. Check that paper guides are not loose on main frame extrusion and that they may be moved with moderate pressure for adjustment.
- Q. Inside guide edges should be flush with inside edges of sides of supply mechanism.

2.3 Lubrication

Recommended lubricants are IBM #23 or Lubriplate #70. After cleaning, the following areas should require lubrication:

- a. Head shaft
- b. Groove in main drive cam
- c. Guide in extrusion in which the "tail" of the print head travels.

Only a small amount of lubricant, enough to create a film, is needed in each location.

The following areas may also require lubrication, if the area has been wiped free of lubricant:

- a. Paper feed cam and pawl
- b. Ribbon feed pawl
- c. Platen detent teeth
- d. Platen ratchet teeth
- e. Pressure roll release lever

3.0 Repair and Adjustments

3.1 Troubleshooting Guide

The Mechanism Troubleshooting Table should provide a means of determining the cause of any malfunction and the proper corrective action.

3.2 Repair Techniques

3.2.1 Head Replacement and Adjustments

Remove the old head by removing the two screws which hold the head shaft in place and then pulling the head shaft and head up out of the mechanism. To free the head cable the cable tie must be cut.

Remove shaft from old head and slide it into the bearings on the replacement head. The head assembly should move freely along the shaft. To check for free movement hold the head assembly with the shaft vertical and release the shaft. It should drop through the head assembly. If it does not move freely, hold the head assembly on one end of the shaft and tap the other end firmly on a hard surface. This will cause the head assembly bushings to seat perpendicular to the shaft. The replacement head can now be installed in the printer in the reverse manner of its removal. When tightening the screws in the head shaft, hold the shaft forward to minimize the distance between it and the platen. Insure that the drive pin on the bottom of the head mates with the groove in the drive cam and that the "tail" on the head is placed in the guide slot on the extrusion. Lubricate according to paragraph 2.3 prior to operation.

3.2.2 Switch Replacement

3.2.2.1 Line Feed Switch (FPF Mechanism Only)

To replace the line feed switch it is first necessary to remove the left side frame. This is done by first removing the twirler from the platen. Then remove the three screws which secure the side frame to the main extrusion as well as the screw in the left side of the head shaft. Once these screws are removed the left side frame can be pulled away from the printer. The line feed switch can now be removed from the side frame by lifting it off its mounting tabs. The replacement switch is then pressed onto those tabs and a piece of adhesive-backed foam is placed on the switch where it contacts the main extrusion. The side frame can now be replaced taking care to align the platen pressure roll support bracket, head shaft and main drive cam to their proper positions.

3.2.2.2 Print Switch

To replace the print switch it is first necessary to remove the right side frame. This is done by removing the three screws that secure the side frame to the main extrusion as well as removing the screw in the right hand side of the head shaft. The side frame can now be removed, taking care to disengage the motor pulley from the belt. Holding the detent lever down (forward) will aid in the removal of the frame. The print switch can now be removed by lifting it off its mounting tabs. The replacement switch is then pressed onto these tabs and adhesive-backed foam is applied to the switch where it contacts the main extrusion. The printer is then reassembled taking care to align the main drive cam and platen properly. During reassembly the detent lever must be held down to avoid interference with the ratchet teeth on the platen, and the motor pulley must have the belt placed back on it.

3.2.3 Belt Tension

Drive belt tension is adjusted by loosening the two motor mounting screws and moving the motor forwards or backwards to decrease or increase the belt tension. The belt tension should be set so that when the head is prevented from moving, the motor stalls and the belt does not cog over the motor pulley. Excessive belt tension will cause the drive cam to bind and the motor to stall. Too little belt tension will result in excessive variation in character widths.

3.2.4 Head to Platen Air Gap

If the printhead has been replaced due to solenoid failure or if the printer has been disassembled, the printhead to platen air gap should be checked prior to using the printer. Improper air gap can result in damage to the printhead. The printhead to platen air gap may be checked by using feeler gauges. Prior to checking the air gap it is necessary to remove the paper and ribbon from the printer.

The head to platen air gap should be .012" to .015". If the air gap is out of the allowable range, some adjustment can be made by loosening the screws in the head shaft and pushing it in the desired direction. If this does not yield sufficient change then it is necessary to loosen the side frames and move them upward or downward in relation to the main extrusion

MECHANISM TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Print motor starts but doesn't stop. No printing occurs.	<ol style="list-style-type: none"> 1. Broken print switch 2. Broken switch wire 3. Misadjusted print switch 	<ol style="list-style-type: none"> 1. Replace switch 2. Check all wires on print switch for electrical continuity 3. Verify switch transfers when roller on switch actuator transfers between high and low positions on the cam pulley.
2. Once started, the line feed motor never stops	<ol style="list-style-type: none"> 1. Broken line feed switch 2. Broken switch wire 3. Misadjusted line feed switch 	<ol style="list-style-type: none"> 1. Replace switch 2. Check all wires for electrical continuity 3. Verify switch transfers when roller on switch actuator transfers between high and low positions on switch eccentric.
3. Print Motor stalls	<ol style="list-style-type: none"> 1. Excessive Belt tension 2. Bad crimp on one or more A.C. motor wires 3. Bad A.C. motor 	<ol style="list-style-type: none"> 1. Adjust belt tension 2. Visually verify crimps are good 3. Replace motor
4. Occasional missed line feed	<ol style="list-style-type: none"> 1. Bad line feed switch 2. Misadjusted line feed switch 	<ol style="list-style-type: none"> 1. Replace switch 2. Verify switch roller rides on lower surface of paper feed eccentric when in the home position, and that switch transfers when switch roller moves from low surface of the paper feed eccentric
5. Uneven line feeds	<ol style="list-style-type: none"> 1. Paper slippage 2. Metal wear plate broken off line feed pawl 3. Platen not detenting properly 	<ol style="list-style-type: none"> 1. Clean platen and/or replace pressure roll springs 2. Replace pawl 3. Check for defective detent mechanism.

MECHANISM TROUBLESHOOTING GUIDE (Continued)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
6. Line feed motor stalls	<ol style="list-style-type: none"> 1. Bad A.C. motor 2. Line feed pawl binds on eccentric 3. Bad wire to pin connections on A.C. motor wires 4. Platen won't turn or turns with difficulty 	<ol style="list-style-type: none"> 1. Replace A.C. motor 2. Replace pawl or eccentric 3. Check crimp on wire 4. Inspect detent mechanism for source of jam and replace or repair as required
7. Missing dots	<ol style="list-style-type: none"> 1. Ribbon not properly installed 2. Bad print solenoid 3. Head to platen gap excessive 	<ol style="list-style-type: none"> 1. Install ribbon correctly 2. Replace head 3. Verify head to platen gap is $.015" \pm .003"$
8. Excessive variation in character size	<ol style="list-style-type: none"> 1. Belt tension too loose 2. Start to print distance (distance from 1st dot position to inside of side frame) is out of tolerance ($.965 \pm .060"$) 3. Head binding on shaft 	<ol style="list-style-type: none"> 1. Tighten belt tension 2. Adjust print switch to correct start to print location. 3. Align head bearings on shaft. Lubricate shaft.

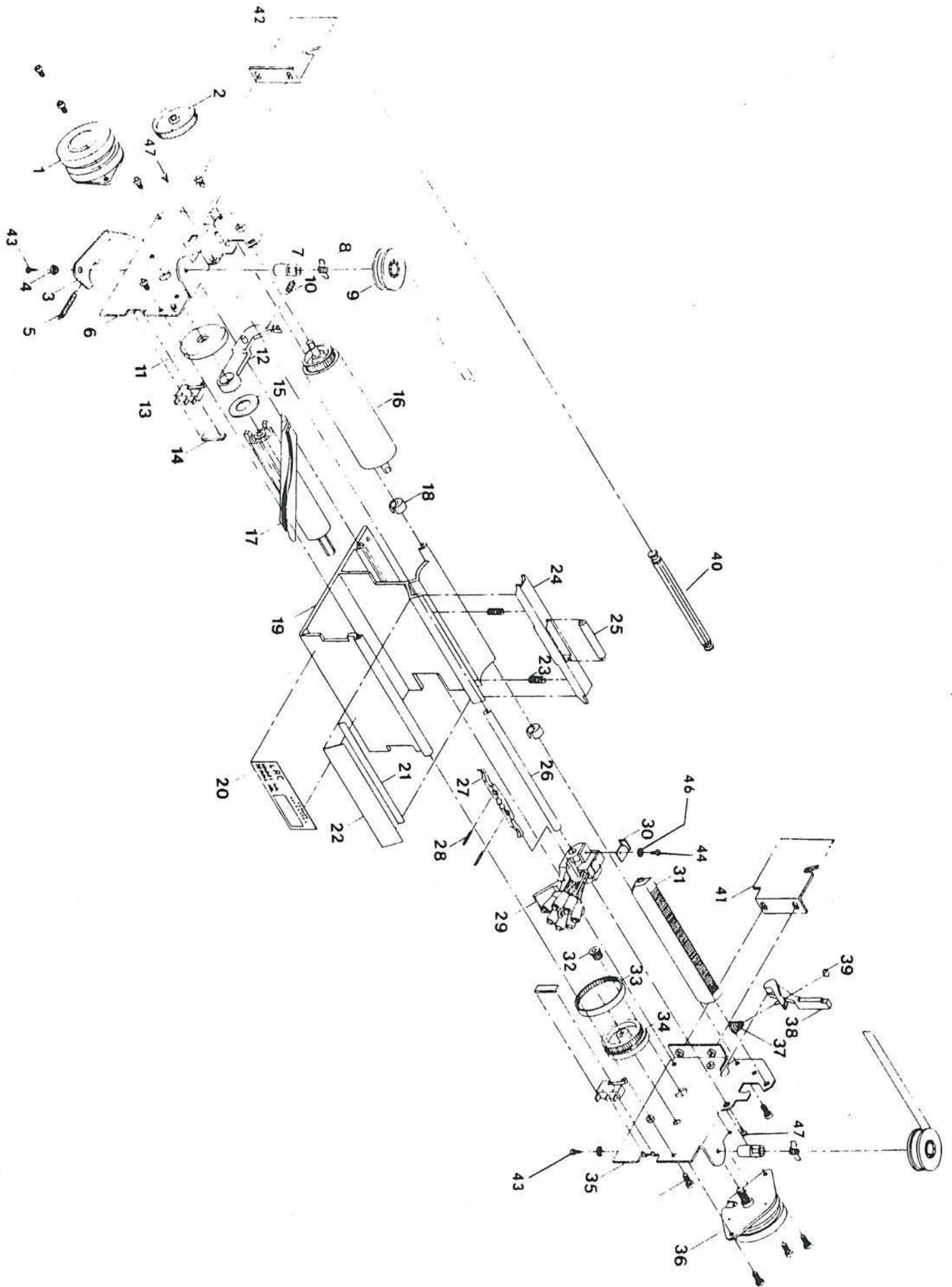
PART LIST 7040 J

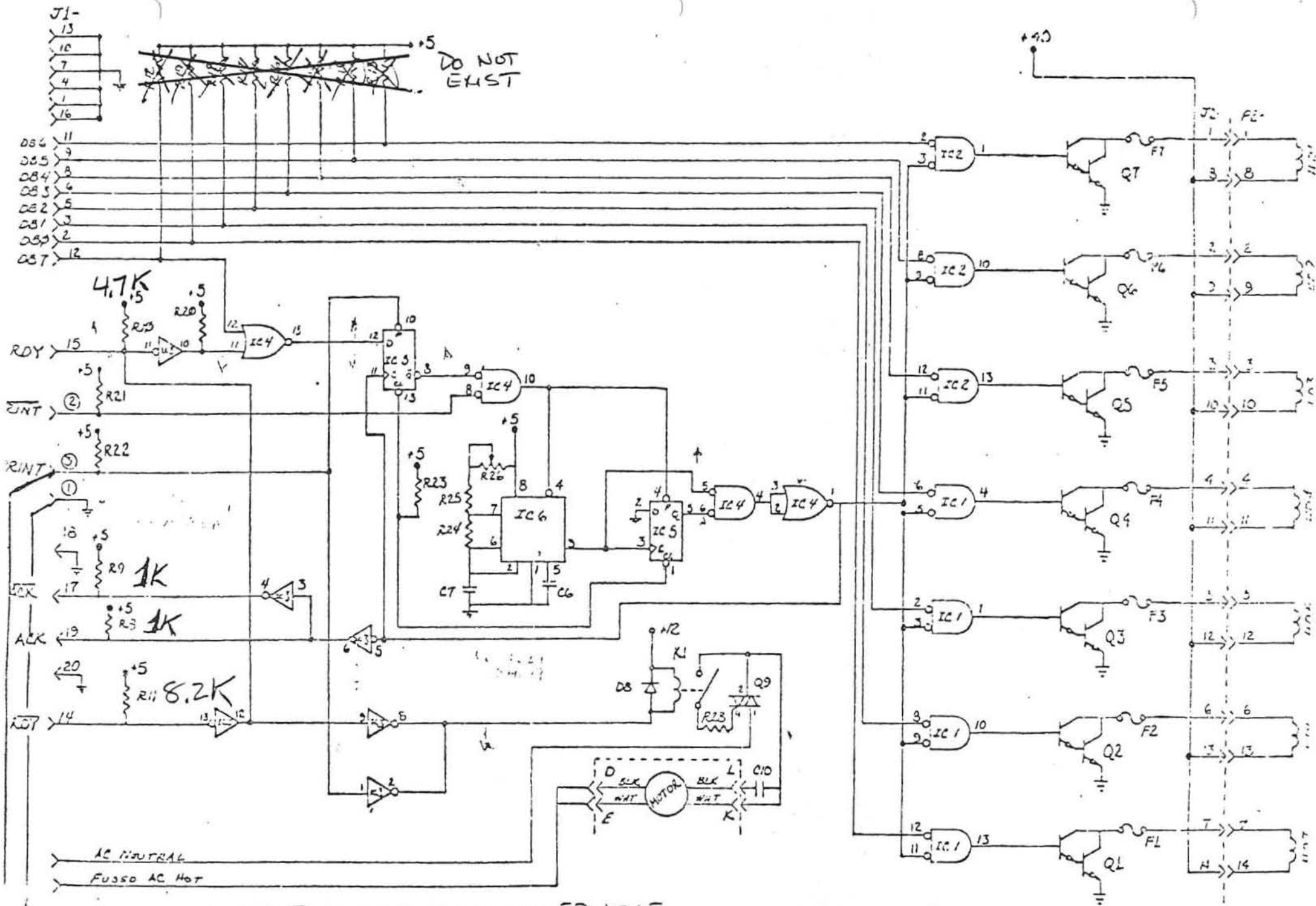
<u>ITEM NO.</u>	<u>PART NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>
1.	101411-004	ASSY-A.C. MOTOR*	1
2.	100576	TWIRLER	1
3.	101528	BRACKET-RIBBON TENSION	1
4.	101225	SPACER-RIBBON POST	2
5.	102378	SPRING-RIBBON TENSION	1
6.	101383	ASSY-FRAME LEFT SIDE	1
7.	100625	ASSY-RIBBON POST	2
8.	102539	SPRING-RIBBON SPOOL BRAKE	2
9.	101221	ASSY-RIBBON & SPOOLS	1
10.	101231-005	SPRING-EXTENSION	1
11.	101035	ECCENTRIC PAPER FEED & SWITCH*	1
12.	101077	ASSY-PAWL FEED	1
13.	100272-005	SWITCH-ELECTRICAL	2
14.	102414-001	FOAM-TAPE	A/R
15.	101349	SHIM WASHER	1
16.	101013	MODIFICATION-PLATEN	1
17.	101073	ASSY-CAM DRIVE	1
18.	101065	GUIDE-PAPER	2
19.	101051	MODIFICATION-EXTRUSION	1
20.	101392	DECAL	1
21.	100543-004	TAPE	A/R
22.	101057	GUIDE-PAPER	1
23.	101918	SPRING-PRESSURE ROLL	2
24.	101003	SUPPORT-PRESSURE ROLL	1
25.	101067	ASSY-ROLLER PRESSURE	1
26.	101525	SHAFT-HEAD	1
27.	101117	RIBBON FEED PAWL	1
28.	100559	SPRING-RIBBON FEED PAWL	2
29.	101137-002	ASSY-HEAD 7 WIRE	1
30.	102409	DEFLECTOR-RIBBON HEAD	1
31.	101005	BLADE-TEAR OFF 40 COL.	1
32.	101086	PULLEY-DRIVE MOTOR	1
33.	101229-001	BELT	1

PART LIST 7040 J
(CONTINUED)

<u>ITEM NO.</u>	<u>PART NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>
34.	101008	PULLEY CAM 1½ LPS	1
35.	101281	ASSY-FRAME RIGHT SIDE	1
36.	101411-001	ASSY-A.C. MOTOR	1
37.	102361	SPRING-CONICAL COMPRESSION	1
38.	101069	DETENT	1
39.	101068	ROLLER-DETENT	1
40.	101433	MANDREL-40 COLUMN SUPPLY	1
41.	3030-021	RIGHT PAPER BRACKET	1
42.	3030-020	LEFT PAPER BRACKET	1
43.	100173-042	SCREW (4-40 x .218)	2
44.	100173-050	SCREW (4-40 x .187)	1
45.	100173-076	SCREW (8-32 x .375)	1
46.	100172-002	WASHER (#4 EXT. LOCK)	1
47.	100173-081	SCREW (4-40 x .218)	4

* Use on Fast Paper Feed version only.



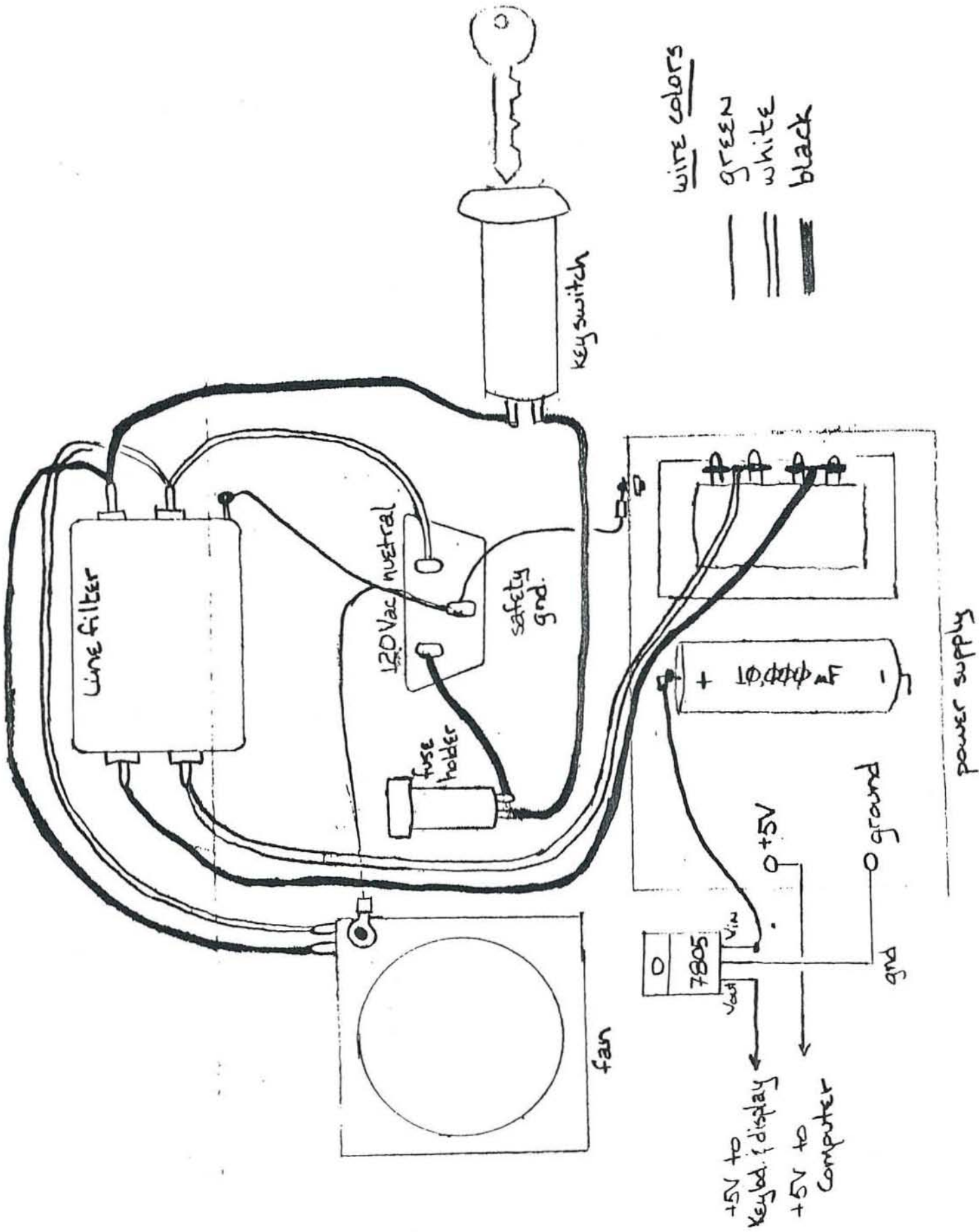


MOTOR POSITION SWITCH: FRONT OF PRINTER (-DIS ENAGED) (PRINT HIGH) WHENEVER PRINTED HEAD ON ACCEPTABLE PRINT

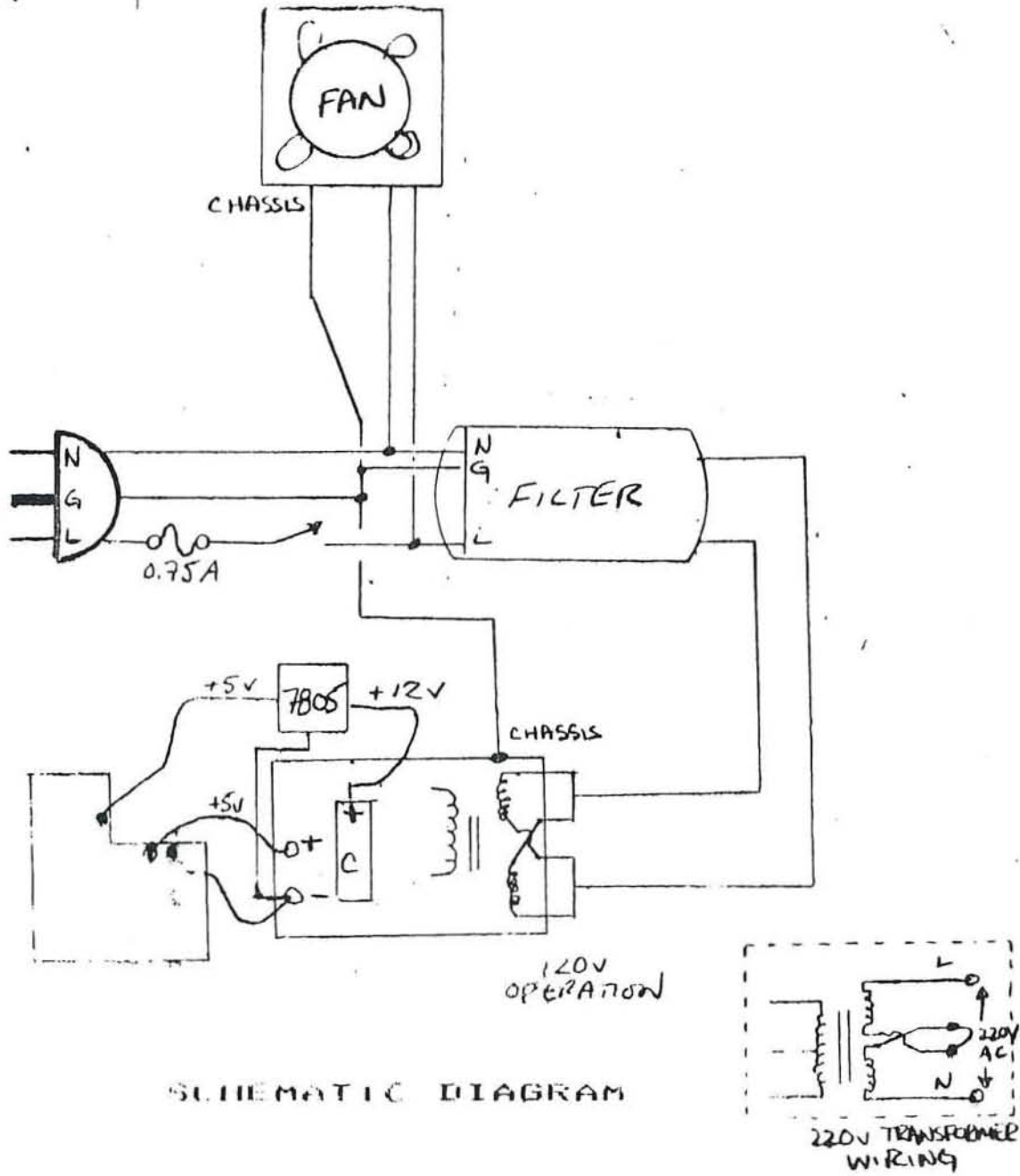
FIGURE 1 (SH 1 OF 2) ELECTRICAL SCHEMATIC

PHYSICAL POWER WIRING

FOR D. 1-70



DR-70 120V POWER WIRING



SCHEMATIC DIAGRAM

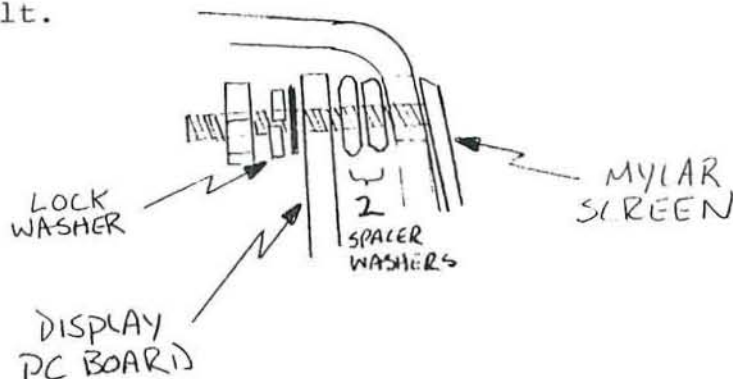
NOTE - OPENING THE MACHINE WILL VOID YOUR WARRANTY
Simple DR-70 Repair Techniques

Opening the machine

- (1) A #6 hex driver is used to undo the 6 stress bolts located around the aluminum valence. (Note: 1' bolt located under warning sticker).
- (2) Tape over name plate to avoid scratching.
- (3) Lift top cover up and lean it towards the back - it should be stabilized in this position.

Replacement of LEDS

- (1) Disconnect 50 pin card edge connector from keyboard - avoid stressing cable.
- (2) Lay top upside down. Four sets of $\frac{1}{4}$ " nuts should now be seen on the back side of the display PC board. Remove the nuts and washers. IMPORTANT: Note the number of, and order of the spacing washers.
- (3) Turn top cover over. Mylar display screen may now be lifted off. Locate defective LED.
- (4) Now, unsolder old LED and discard. Noting that the direction of the notch in LED lens aligns with the other LEDS (towards the left, looking from the top). Solder LED in FLUSH to the PC board. Do not hold solder iron on the LED lead for longer than 2 seconds. Overheating will cause internal damage to the LED.
- (5) Screw the display screen and PC board back together with the same exact number of washers (see diagram below). Should the LEDS get too close to the screen, heat from LED will cause the mylar to melt.



- (6) Replace ribbon cable, then verify new LED working. Then, close the machine (see "Sealing up the machine").

Changing keyboard switches

- (1) Disconnect 50 pin card edge connector from keyboard - avoid stressing the ribbon cable.
- (2) Remove keytop on suspect key. Usually a small screwdriver working from the bottom of keytop, pulling up, will do.
- (3) After locating key on backside of PC board, solder stuck the 2 contact holes clean. Free key by pulling from top. Make sure both the contact holes and the mounting guide holes(2) are free of obstructions.
- (4) Gently ease new key switch into hole and solder. It is important to note the following:
 - (i) the switch contacts should be well centered in PC board holes such that no side pressure is placed on the contacts
 - (ii) Hold solder iron on switch leads for no longer than 2 seconds as the internal mechanism is prone to overheating.
- (5) Replace ribbon cable and keytop. Verify proper functioning of keyswitch. Seal machine, if working.

Blown fuses

- (1) Check that fuse is 3/4 amp AGC fuse.
- (2) Open machine. Carefully look for loose shards in +5v circuitry on motherboard. Check 120v wiring for loose or shorting connections. Check operation.
- (3) Cut 120v wire to fan. Check operation. If it works - replace fan (all parts available through Digicomp). If not - reconnect wire.
- (4) Cut 120v wire to power supply. Check operation by observing fan.
 - (i) If fan runs, go to #5.
 - (ii) If fan doesn't run - disconnect line filter and bypass it. Reconnect power supply and check operation. Should it work, replace filter. If it doesn't, recheck wiring for shorts.
- (5) Cut yellow wire to 7805 regulator. Check operation of fan. If now working, replace 7805. If not, check power supply PC board and motherboard for shards in +5v power busses.

(6) if you still have no luck, call Digicom (607) 273-5900.

Sealing machines

PLEASE FOLLOW THIS CHECKLIST

- (1) Make sure power supply, motherboard, keyboard, and display are all screwed down tight.
- (2) Check power supply output. It should be +5.05v. If not, adjust pot.
- (3) Check master clock (only if you have a calibrated oscilloscope). It should have a period of 1.25 μ s. The clock pot is located on the power supply side of the CPU module.
- (4) Vacuum machine thoroughly to remove any loose debris. If inside is dusty, wipe it clean using isopropal alcohol.
- (5) Push all IC's down manually.
- (6) Fit top and bottom together. Pick up and shake machine, meanwhile listening to hear loose material inside enclosure.
- (7) With cover still on, check for proper functioning. Then insert and tighten stress bolts.

Simple DR-70 Repair techniques

Recommended tools for DR-70 repair

- (1) #6 hex driver or Alan wrench
- (2) small flat screwdriver
- (3) chip extractors
- (4) soldering iron and solder
- (5) solder wick or solder removal tool
- (5) 1/4" socket wrench or spanner
- (7) wire cutters
- (8) Freon solvent
- (9) isopropal alcohol

Simple DR-70 Repair Techniques

NOTE - OPENING THE MACHINE WILL VOID YOUR WARRANTY UNLESS OTHERWISE INSTRUCTED BY DIGICOMP.

A. Opening the machine

1. The DR-70 is sensitive to static electricity, so when working on the machine do not wear sweaters, nylon shirts, rubber-soled shoes or material that creates static charges.
2. A #6 hex driver is used to undo the 6 stress bolts located around the aluminum valence and fan. (Note: 1 bolt located under warning sticker).
3. Tape over name plate to avoid scratching.
4. Lift top cover up and lean it towards the back - it should be stabilized in this position.

B. Techniques of repair for intermittant failures or lost data (but machine responds to reset).

1. Check operators manual for proper key sequence.
2. Follow opening instructions (#A). Once open, firmly press each chip to reseat their contacts in the sockets.
3. Replace cover and observe behavior. If intermittant behavior still occurs, repeat procedure #1.
4. If machine continues to behave intermittantly, purchase some spray contact cleaner (a freon solvent which leaves no residue or oil). Again open the machine. With chip extractors or a small screwdriver, lift the chips partially out of their sockets. Spray the contact cleaner on the chips legs and reseat the chips by pushing them in. Check that none of the chips legs are bent or out of the socket. (Note: if a chip should accidentally come out of its' socket, it must be replaced in the same direction).
5. Replace cover and observe machines behavior.

C. Replacement of LEDS

1. Disconnect 50 pin card edge connector from keyboard - avoid stressing cable. The epoxy seal can be broken with a small screwdriver or knife.

2. Lay top upside down. Four sets of $\frac{1}{4}$ " nuts should now be seen on the back side of the display PC board. Remove the nuts and washers.
IMPORTANT: Note the number of, and order of the spacing washers. (See #5)
3. Turn top cover over. Mylar display screen may now be lifted off. Locate defective LED.
4. Now, unsolder old LED and discard. Noting that the direction of the notch in LED lens aligns with the other LEDs (towards the left, looking from the top). Solder LED in FLUSH to the PC board. Do not hold solder iron on the LED lead for longer than 2 seconds. Overheating will cause internal damage to the LED.
5. Screw the display screen and PC board back together with the same exact number of washers (see diagram below). If the LEDs get too close to the screen, heat from LED will cause the mylar to melt.



6. Replace ribbon cable, set top down on bottom in place. Turn machine on, then verify that new LED is working. Turn machine off, then close the machine (see "Sealing up the machine").

D. Replacement of keyboard switches

1. Disconnect 50 pin card edge connector from keyboard - avoid stressing the ribbon cable. (See C1).
2. Remove keytop on suspect key. Usually a small screwdriver working from the bottom of keytop, pulling up, will do.
3. After locating key on backside of PC board, remove the solder from the two contact holes. Free key by pulling from top. Make sure both the contact holes and the mounting guide holes (2) are free of obstructions.
4. Gently ease new key switch into hole and solder. It is important to note the following:
 - (i) the switch contacts should be centered in PC board holes and the switch must be seated flat to prevent the key tops from rubbing against one another.
 - (ii) Hold solder iron on switch leads for no longer than 2 seconds as the internal mechanism can overheat.

5. Replace ribbon cable and keytop. Verify proper functioning of keyswitch. Seal machine, if working.

E. Procedure if fuse blows repeatedly

1. Check that fuse is 3/4 amp AGC fuse.
2. Open machine (See #A). Carefully look for loose shards in +5v circuitry on motherboard. Check 120v wiring for loose or shorting connections. Check operation.
3. Cut 120v wire to fan. Check operation. If it works -- replace fan (all parts available through Digicomp). If not - reconnect wire.
4. Cut 120v wire to power supply. Check operation by observing fan.
 - (i) If fan runs, go to #5.
 - (ii) If fan doesn't run - disconnect line filter and bypass it. Reconnect power supply and check operation. Should it work, replace filter. If it doesn't, recheck wiring for shorts.
5. Cut yellow wire to 7805 regulator. Check operation of fan. If now working, replace 7805. If not, check power supply PC board and motherboard for shards in +5v power busses.
6. If the machine continues to blow fuses, call Digicomp at (607) 273-5900.

F. Sealing machines

PLEASE FOLLOW THIS CHECKLIST

1. Make sure power supply, motherboard, keyboard, and display are all screwed down tight.
2. Check power supply output. It should be +5.05v. If not, adjust pot.
3. Check master clock (only if you have a calibrated oscilloscope). It should have a period of 1.25 us. The clock pot is located on the power supply side of the CPU module.
4. Vacuum machine thoroughly to remove any loose debris. If inside is dusty, wipe it clean using isopropal alcohol.
5. While the machine is open an easy and helpful maintenance procedure is to push down on all the chips to ensure that they are seated firmly in their sockets.
6. Fit top and bottom together. Pick up and shake machine, meanwhile listening to hear loose material inside enclosure.
7. With cover still on, check for proper functioning. Then insert and tighten stress bolts.

DR-70 Printer - Mechanism

MAINTENANCE AND REPAIR

1.0 The Model 7040 printers are designed to require a minimum of maintenance and service. This section provides instructions and procedures for both cleaning and maintenance of the printer as well as a troubleshooting guide to aid in problem analysis.

1.1 Required Tools and Supplies

The following items are recommended for printer maintenance and major repairs. Common hand tools are also required.

1. Volt-Ohm Meter
2. Feeler Gauges
3. Grease (IBM #23 or Lubriplate #70)
4. Isopropyl alcohol
5. Cleaning Rags
6. Cotton Swabs

2.0 Maintenance

The frequency at which normal maintenance (cleaning, lubrication and inspection) should be performed when the printer is installed in a clean office environment should normally be one year. However, if the printer is subjected to heavy usage and/or a dirty environment, the frequency should be increased as required.

2.1 Cleaning

- A. Clean printer thoroughly using alcohol, rags and cotton swabs to remove hardened grease, ink and dirt.
- B. Rotate platen and clean with an alcohol soaked rag.
- C. Remove head and clean head and head shaft with alcohol.
- D. Reassemble head to printer.
- E. Apply a small amount of recommended grease to head shaft.

2.2 Inspection

- A. Check for print wire movement on all seven solenoids by depressing wire end and noting return to rest position.
- B. Check for easy movement of the head assembly on the print head assembly shaft.
- C. Inspect the ribbon reverse mechanism for proper movement. Manually operate the ribbon feed pawl back and forth to check operation. Be sure that both springs are securely in place and of equal tension.
- D. Inspect the printer for any loose or missing screws.
- E. Check for excessive vertical movement of print head drive cam. Usual cause is a loose paper feed motor. Rotate the drive cam toward the platen and listen for an audible click of the home micro switch.
 - (1) The position of the switch arm roller at the click should be half-way up/down the high dwell ramp of the cam.
 - (2) The switch activating arm should be straight with no kinks.
- F. Check the paper feed cam for tightness on motor shaft (looseness may be a result of a bad cam or improper motor shaft configuration).

- G. Rotate the paper feed cam clockwise (toward platen) and check for smooth operation. Binding indicated bad fit between cam and pawl arm. Listen to the paper feed micro switch for an audible click.
 - (1) The position of the switch arm roller at the click should be half-way up/down the high dwell ramp of the cam.
 - (2) The switch activating arm should be straight with no kinks.
- H. Check that right end of print platen is not loose with regard to platen drum.
- I. Check that the platen spins freely when paper release lever is depressed and ratchet pawl is disengaged.
- J. Check that the plastic paper guide strip edge touches the platen drum over its entire length.
- K. Check that the plastic paper guide strip is secured to the extrusion mounting surface.
- L. Check that the print head moves freely along its shaft and within the drive cam groove while turning the drive cam toward the platen.
- M. Place the ribbon in place and check that it does not snag throughout its path. Check ribbon spool drag.
- N. Depress paper release lever and check that bar and feed roll leave the print platen.
- O. Check that two ply form may be loaded when paper release lever is depressed.
- P. Check that paper guides are not loose on main frame extrusion and that they may be moved with moderate pressure for adjustment.
- Q. Inside guide edges should be flush with inside edges of sides of supply mechanism.

2.3 Lubrication

Recommended lubricants are IBM #23 or Lubriplate #70. After cleaning, the following areas should require lubrication:

- a. Head shaft
- b. Groove in main drive cam
- c. Guide in extrusion in which the "tail" of the print head travels.

Only a small amount of lubricant, enough to create a film, is needed in each location.

The following areas may also require lubrication, if the area has been wiped free of lubricant:

- a. Paper feed cam and pawl
- b. Ribbon feed pawl
- c. Platen detent teeth
- d. Platen ratchet teeth
- e. Pressure roll release lever

3.0 Repair and Adjustments

3.1 Troubleshooting Guide

The Mechanism Troubleshooting Table should provide a means of determining the cause of any malfunction and the proper corrective action.

3.2 Repair Techniques

3.2.1 Head Replacement and Adjustments

Remove the old head by removing the two screws which hold the head shaft in place and then pulling the head shaft and head up out of the mechanism. To free the head cable the cable tie must be cut.

Remove shaft from old head and slide it into the bearings on the replacement head. The head assembly should move freely along the shaft. To check for free movement hold the head assembly with the shaft vertical and release the shaft. It should drop through the head assembly. If it does not move freely, hold the head assembly on one end of the shaft and tap the other end firmly on a hard surface. This will cause the head assembly bushings to seat perpendicular to the shaft. The replacement head can now be installed in the printer in the reverse manner of its removal. When tightening the screws in the head shaft, hold the shaft forward to minimize the distance between it and the platen. Insure that the drive pin on the bottom of the head mates with the groove in the drive cam and that the "tail" on the head is placed in the guide slot on the extrusion. Lubricate according to paragraph 2.3 prior to operation.

3.2.2 Switch Replacement

3.2.2.1 Line Feed Switch (FPF Mechanism Only)

To replace the line feed switch it is first necessary to remove the left side frame. This is done by first removing the twirler from the platen. Then remove the three screws which secure the side frame to the main extrusion as well as the screw in the left side of the head shaft. Once these screws are removed the left side frame can be pulled away from the printer. The line feed switch can now be removed from the side frame by lifting it off its mounting tabs. The replacement switch is then pressed onto those tabs and a piece of adhesive-backed foam is placed on the switch where it contacts the main extrusion. The side frame can now be replaced taking care to align the platen pressure roll support bracket, head shaft and main drive cam to their proper positions.

3.2.2.2 Print Switch

To replace the print switch it is first necessary to remove the right side frame. This is done by removing the three screws that secure the side frame to the main extrusion as well as removing the screw in the right hand side of the head shaft. The side frame can now be removed, taking care to disengage the motor pulley from the belt. Holding the detent lever down (forward) will aid in the removal of the frame. The print switch can now be removed by lifting it off its mounting tabs. The replacement switch is then pressed onto these tabs and adhesive-backed foam is applied to the switch where it contacts the main extrusion. The printer is then reassembled taking care to align the main drive cam and platen properly. During reassembly the detent lever must be held down to avoid interference with the ratchet teeth on the platen, and the motor pulley must have the belt placed back on it.

3.2.3 Belt Tension

Drive belt tension is adjusted by loosening the two motor mounting screws and moving the motor forwards or backwards to decrease or increase the belt tension. The belt tension should be set so that when the head is prevented from moving, the motor stalls and the belt does not cog over the motor pulley. Excessive belt tension will cause the drive cam to bind and the motor to stall. Too little belt tension will result in excessive variation in character widths.

3.2.4 Head to Platen Air Gap

If the printhead has been replaced due to solenoid failure or if the printer has been disassembled, the printhead to platen air gap should be checked prior to using the printer. Improper air gap can result in damage to the printhead. The printhead to platen air gap may be checked by using feeler gauges. Prior to checking the air gap it is necessary to remove the paper and ribbon from the printer.

The head to platen air gap should be .012" to .015". If the air gap is out of the allowable range, some adjustment can be made by loosening the screws in the head shaft and pushing it in the desired direction. If this does not yield sufficient change then it is necessary to loosen the side frames and move them upward or downward in relation to the main extrusion

MECHANISM TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
<p>1. Print motor starts but doesn't stop. No printing occurs.</p>	<p>1. Broken print switch 2. Broken switch wire 3. Misadjusted print switch</p>	<p>1. Replace switch 2. Check all wires on print switch for electrical continuity 3. Verify switch transfers when roller on switch actuator transfers between high and low positions on the cam pulley.</p>
<p>2. Once started, the line feed motor never stops</p>	<p>1. Broken line feed switch 2. Broken switch wire 3. Misadjusted line feed switch</p>	<p>1. Replace switch 2. Check all wires for electrical continuity 3. Verify switch transfers when roller on switch actuator transfers between high and low positions on switch eccentric.</p>
<p>3. Print Motor stalls</p>	<p>1. Excessive Belt tension 2. Bad crimp on one or more A.C. motor wires 3. Bad A.C. motor</p>	<p>1. Adjust belt tension 2. Visually verify crimps are good 3. Replace motor</p>
<p>4. Occasional missed line feed</p>	<p>1. Bad line feed switch 2. Misadjusted line feed switch</p>	<p>1. Replace switch 2. Verify switch roller rides on lower surface of paper feed eccentric when in the home position, and that switch transfers when switch roller moves from low surface of the paper feed eccentric</p>
<p>5. Uneven line feeds</p>	<p>1. Paper slippage 2. Metal wear plate broken off line feed pawl 3. Platen not detenting properly</p>	<p>1. Clean platen and/or replace pressure roll springs 2. Replace pawl 3. Check for defective detent mechanism.</p>



MECHANISM TROUBLESHOOTING GUIDE (Continued)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
6. Line feed motor stalls	<ol style="list-style-type: none"> 1. Bad A.C. motor 2. Line feed pawl binds on eccentric 3. Bad wire to pin connections on A.C. motor wires 4. Platen won't turn or turns with difficulty 	<ol style="list-style-type: none"> 1. Replace A.C. motor 2. Replace pawl or eccentric 3. Check crimp on wire 4. Inspect detent mechanism for source of jam and replace or repair as required
7. Missing dots	<ol style="list-style-type: none"> 1. Ribbon not properly installed 2. Bad print solenoid 3. Head to platen gap excessive 	<ol style="list-style-type: none"> 1. Install ribbon correctly 2. Replace head 3. Verify head to platen gap is $.015" \pm .003"$
8. Excessive variation in character size	<ol style="list-style-type: none"> 1. Belt tension too loose 2. Start to print distance (distance from 1st dot position to inside of side frame) is out of tolerance ($.965 \pm .060"$) 3. Head binding on shaft 	<ol style="list-style-type: none"> 1. Tighten belt tension 2. Adjust print switch to correct start to print location. 3. Align head bearings on shaft. Lubricate shaft.

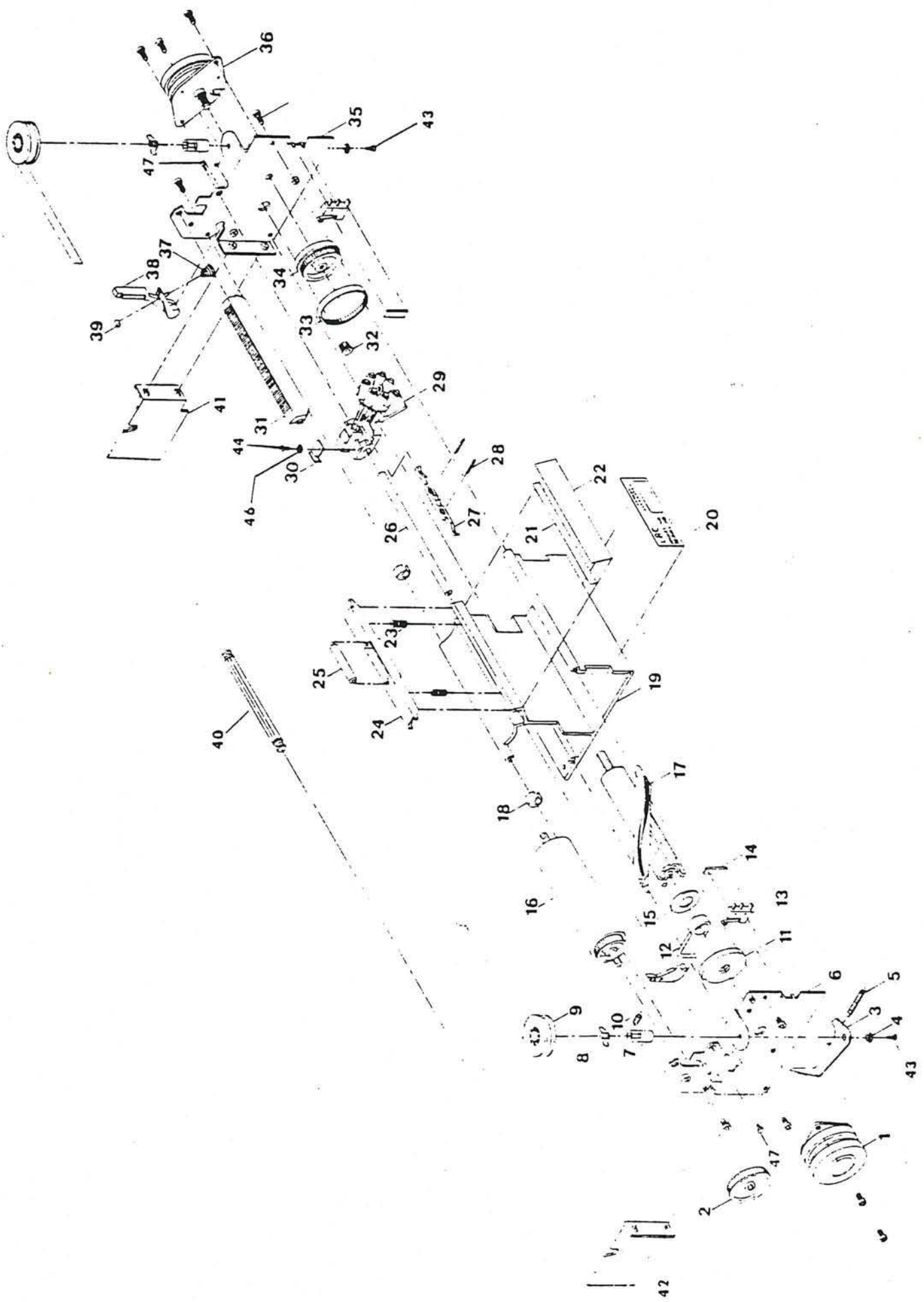
PART LIST 7040 J

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2.	100576	TWIRLER	1
3.	101528	BRACKET-RIBBON TENSION	1
4.	101225	SPACER-RIBBON POST	2
5.	102378	SPRING-RIBBON TENSION	1
6.	101383	ASSY-FRAME LEFT SIDE	1
7.	100625	ASSY-RIBBON POST	2
8.	102539	SPRING-RIBBON SPOOL BRAKE	2
9.	101221	ASSY-RIBBON & SPOOLS	1
10.	101231-005	SPRING-EXTENSION	1
11.	101035	ECCENTRIC PAPER FEED & SWITCH*	1
12.	101077	ASSY-PAWL FEED	1
13.	100272-005	SWITCH-ELECTRICAL	2
14.	102414-001	FOAM-TAPE	A/R
15.	101349	SHIM WASHER	1
16.	101013	MODIFICATION-PLATEN	1
17.	101073	ASSY-CAM DRIVE	1
18.	101065	GUIDE-PAPER	2
19.	101051	MODIFICATION-EXTRUSION	1
20.	101392	DECAL	1
21.	100543-004	TAPE	A/R
22.	101057	GUIDE-PAPER	1
23.	101918	SPRING-PRESSURE ROLL	2
24.	101003	SUPPORT-PRESSURE ROLL	1
25.	101067	ASSY-ROLLER PRESSURE	1
26.	101525	SHAFT-HEAD	1
27.	101117	RIBBON FEED PAWL	1
28.	100559	SPRING-RIBBON FEED PAWL	2
29.	101137-002	ASSY-HEAD 7 WIRE	1
30.	102409	DEFLECTOR-RIBBON HEAD	1
31.	101005	BLADE-TEAR OFF 40 COL.	1
32.	101086	PULLEY-DRIVE MOTOR	1
33.	101229-001	BELT	1

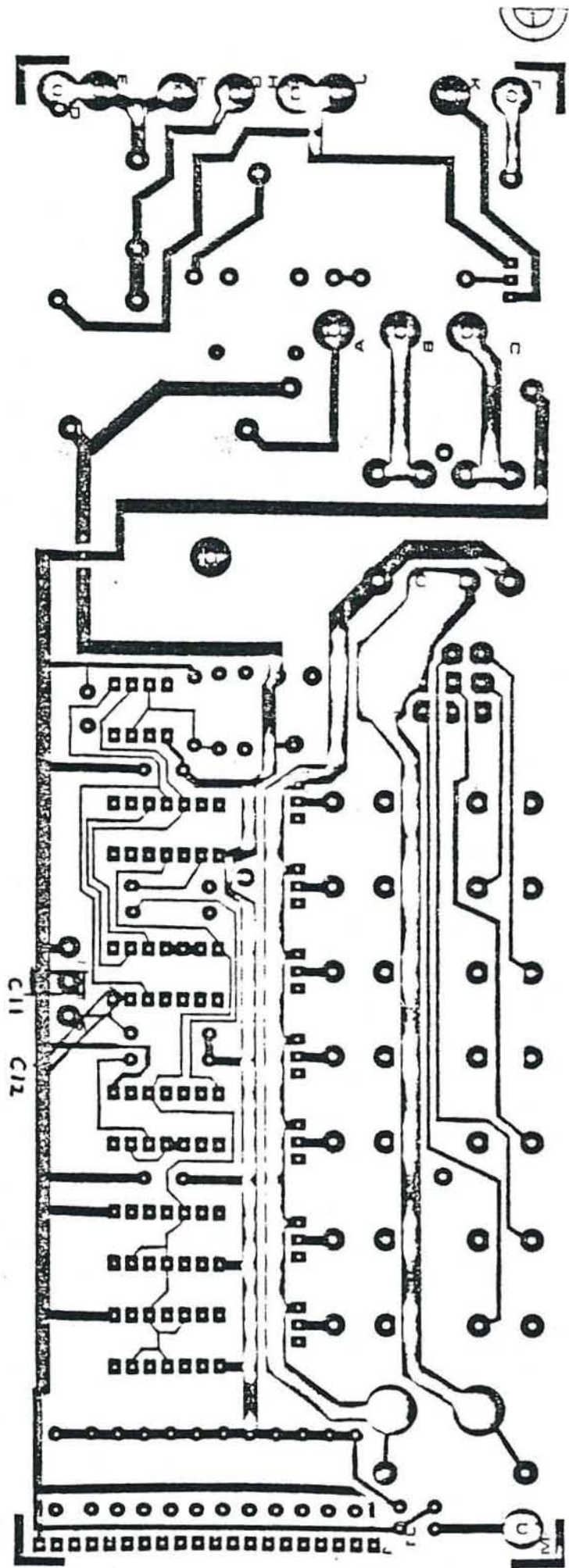
PART LIST 7040 J
(CONTINUED)

<u>ITEM NO.</u>	<u>PART NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>
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35.	101281	ASSY-FRAME RIGHT SIDE	1
36.	101411-001	ASSY-A.C. MOTOR	1
37.	102361	SPRING-CONICAL COMPRESSION	1
38.	101069	DETENT	1
39.	101068	ROLLER-DETENT	1
40.	101433	MANDREL-40 COLUMN SUPPLY	1
41.	3030-021	RIGHT PAPER BRACKET	1
42.	3030-020	LEFT PAPER BRACKET	1
43.	100173-042	SCREW (4-40 x .218)	2
44.	100173-050	SCREW (4-40 x .187)	1
45.	100173-076	SCREW (8-32 x .375)	1
46.	100172-002	WASHER (#4 EXT. LOCK)	1
47.	100173-081	SCREW (4-40 x .218)	4

* Use on Fast Paper Feed version only.



Older Printer Boards
REAR VIEW (reversed)



REDUCE TO 2.00 IN.

Resistors

Part #	Description
R8	1 K
R4	1 K
R10	4.7 K
R11	8.2 K
R20	4.7 K
R21	4.7 K
R22	4.7 K
R23	4.7 K
R24	62 K
R25	43 K
R27	16 Ω , 2W.
R28	100 Ω , 1/2W.
R29	2.2 K, 2W.

Semiconductors

Part #	Description
Q1-7	2N6039
Q8	LM 340
Q9	TQ4-00E3

Capacitors

Part #	Description
C1	4900 μ f, 50 VDC
C2	.01 μ f
C3	.01 μ f
C4	.01 μ f
C5	.1 μ f
C6	.01 μ f
C7	.01 μ f, 160 VDC
C8	220 μ f, 25 VDC
C9	.18 μ f, 600 VDC
C10	1.2 μ f, 400 VDC
C11-12	.1 μ f (on back)

Diodes

Part #	Description
D1-4	1N5401
D5	7749

I C's

Part #	Description
U1	7402
U2	7402
U3	7406
U4	7402
U5	7474
U6	555

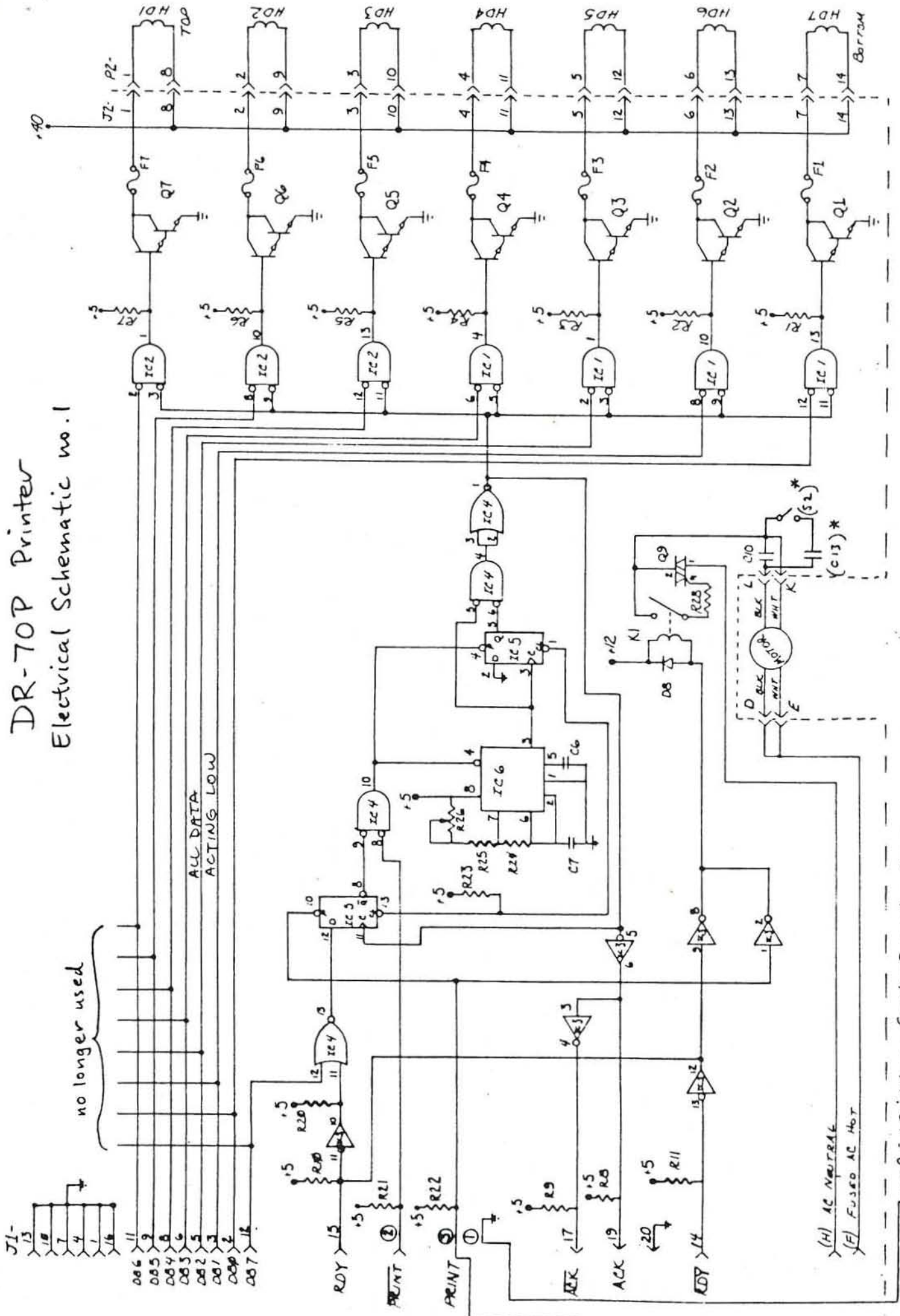
Fuses

Part #	Description
F1-7	1 amp
F8	1.5 amp

Misc.

Part #	Description
J1	20 pin header
J2	print connect
K1	relay

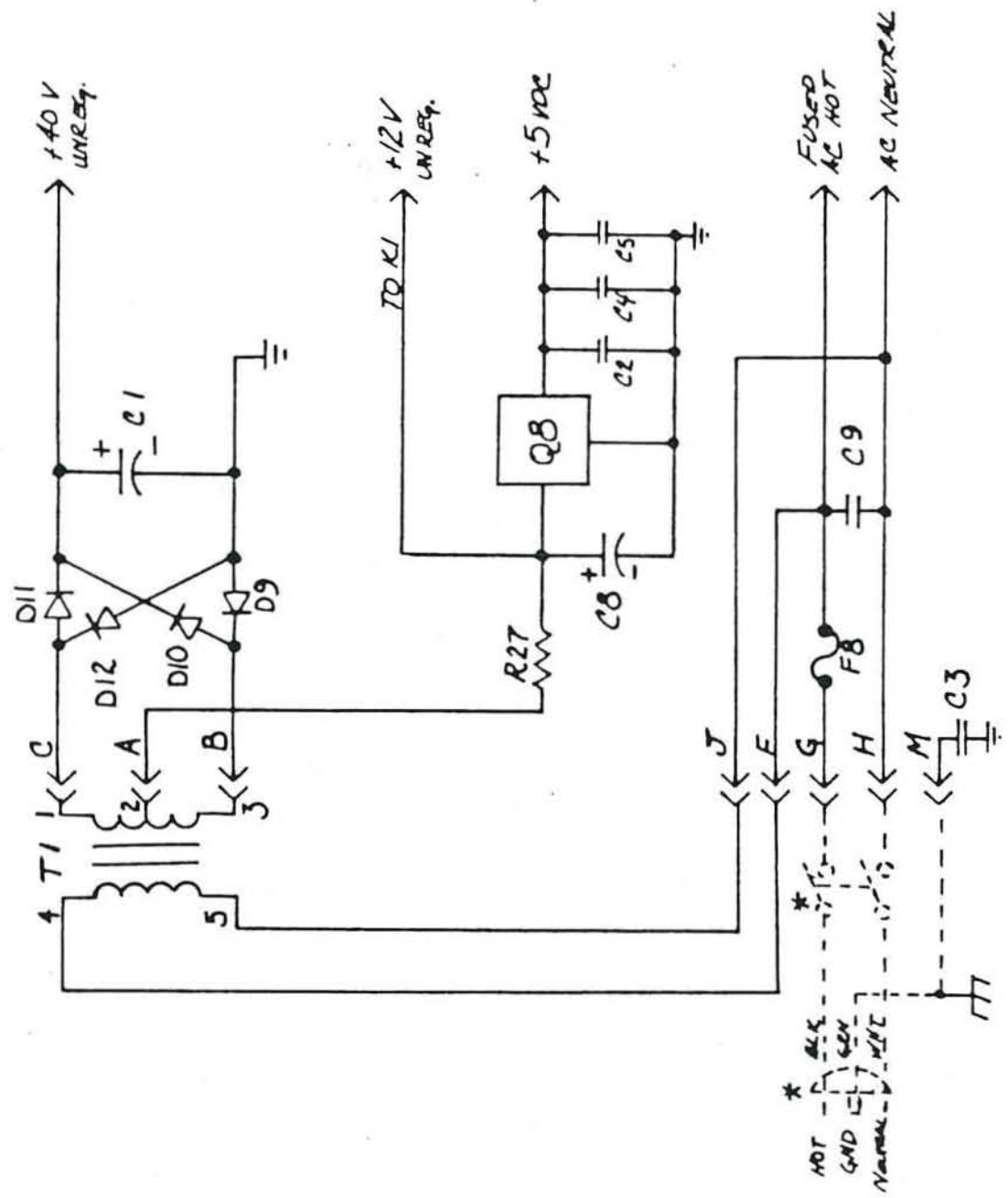
DR-70P Printer Electrical Schematic no. 1



Print Switch on front of mechanism.
Disengaged (u: print high) whenever print head in acceptable print position

* - C13 + S2 included only on printers to be used overseas @ 50 Hz

DR-70 P Printer : Schematic no. 2



* Plug & Switch
NOT INCLUDED

December 14, 1981

Dear DR-70 Owner,

I have a few reminders for you:

1. When you travel with the printer, be sure to remove the roll of paper. Otherwise, it can damage the PC board in the rear of the printer.
2. Try to avoid X-rays in the airport. When you go through the security area ask the inspector to "hand check please". I have found that they are usually happy to do it.
3. High humidity is detrimental to computers. It is safe and helpful to place a bag of crystals in the carrying case when you store the DR-70 or Printer.
4. Extra ribbons for the printer should be stored in an airtight can and placed in a cool place (refrigerator). This will prevent them from drying out.

Best wishes,



Jeffrey Cox

December 14, 1981

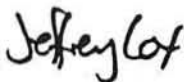
Dear DR-70 Owner,

Before you begin your DR-70 adventure, I would like to suggest a path for you to follow through the maze of instructions which are found in this manual. Your resources consist of a DR-70 User's Manual, Primer, a mini-manual called the BASICS, Fourth Quadrant Newsletters, your local representative (if you have one) and Digicomp. You will probably use all of them at one time or another. However, there is a logical order which if followed should make the learning process painless. I want to outline this for you. You will be using the DR-70 for a long time and it will become an important part of your astrological life. The effort you put into learning the DR-70's capabilities will make it possible to take full advantage of this powerful tool and to expand your astrological know-how.

1. First turn to Section II-01 of the User's Manual where you will learn how to hook up and test the DR-70. After checking the Sun position...
2. Turn to Section XIX-02 to 05 where you will find out how to set up the Printer. If you do not have a Printer go to step #4.
3. Now pull out the BASICS from the pocket of your User's Manual and work through it step-by-step. When you have completed all the steps go back to those techniques that interest you most and repeat them for other charts you have hand-calculated. If you have any questions, turn to the index in the rear of the Manual and go to those sections which further elucidate that technique. Even if you have a Printer, I highly recommend that you try step #4.
4. If you do not own a Printer, then I suggest that you work through the Primer. Then familiarize yourself with the structure of the Manual by reading page i & ii in the beginning of the Manual. Also check the index for specific techniques you would like to try.

By reading through the index, you will begin to appreciate all the different techniques the DR-70 performs and where to find them. To master the DR-70, you will want to work through as much of the learning resources as interests you. It is important that you appreciate why you are pressing certain keys if you want to learn how to use the DR-70 without simply memorizing the keys you have to press. Feel free to experiment, you may discover short-cuts. Use a familiar chart so you can quickly see when you have gone astray. If you run into any bottlenecks please feel free to contact your local representative or Digicomp. Happy computing!

Sincerely,



Jeffrey Cox
Astrological Sales

OLD Mother - Board v. 8B

Proms to be replaced are in yellow; * in pink

Nicki - I think your Proms will look like this

The (V) numbers will be different on your old Proms next page
 (Directors on next page of 2nd page)

TS mem. v. 14

Old Board arrangement

B ROM	AB v6.6	38 v2.8	9 ROM	18 v5.0	28 v2.5	D ROM
AD v5.0	C ROM	30 v5.2	4118 RAM	10 v4.3	E8 v4.7	E0 R2

→ some early sets have 88 RT over BOM have * Mem. v. 11 has 38 v2.4 and 10 v4.2 which allow a serious software bug in PRIMARY DIRECTIONS
 * Mem. v. 14 updated to v. 14 w/ 4 new of items

NEW
Mother-
Board v.9

But they may look like
this if you have a
'new board' :

(New Board Prom arrangement for)

TS mem. v.14

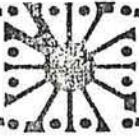
B ROM	C ROM	9 ROM	D ROM	18 v5.0	30 v5.2	418 RAM
A0 v5.0	28 v2.5	A8 v6.6	38 v2.8	10 v4.3	E8 v4.7	E0 R2

* = Four PROMS updated from mem. v.14

Installing PROMs

- 1) open machine
inspect board: which of 2 PROM maps
does it follow?
- 2) lift the old version
of ~~each~~ (yellow) PROM
out of its socket
carefully, alternately
prying up a little at
each end w/a
small screwdriver.
place old PROM in
black ~~conductive~~ ^{anti-static}
foam, replace
NEW PROM in socket
& push down.
Check to see that
PROM is in right
direction & all legs
are in sockets.
- 3) repeat for each of
the remaining 3
PROMs
- 3a) close machine
4) do short software
check: does it
calc. the \ominus ?
Does it do * 75.01 ENTER (r), ENTER

(P11)



Digicomp Research

INSTRUCTIONS FOR SPEEDING UP DR - 70 SYSTEM CLOCK

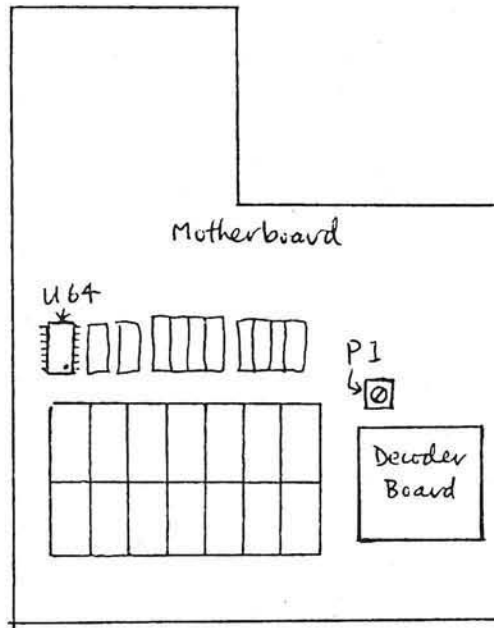
1. Open up the DR-70 by removing the 4 side screws and the two screws above the cooling fan in the rear, using a 5/64" hex wrench.
2. Plug in the DR-70 and turn on power.
3. Ground your oscilloscope to the Motherboard.
4. Touch the scope probe to pin 6 of chip U64 to get a readout of the DR-70 system clock.
(74LS04)
5. Tune the frequency of the clock to 1.5 MHz by adjusting pot P1.
Drop a piece of hot wax on the pot to seal it.
6. Remove the probe and replace the top of the case.
7. Try this test routine to check the speed of DR-70's calculations:

RESET
DATE RECALL (12.31.1899)
DATE ENTER (r12.31.1899)
(SHIFT) on: \odot ENTER

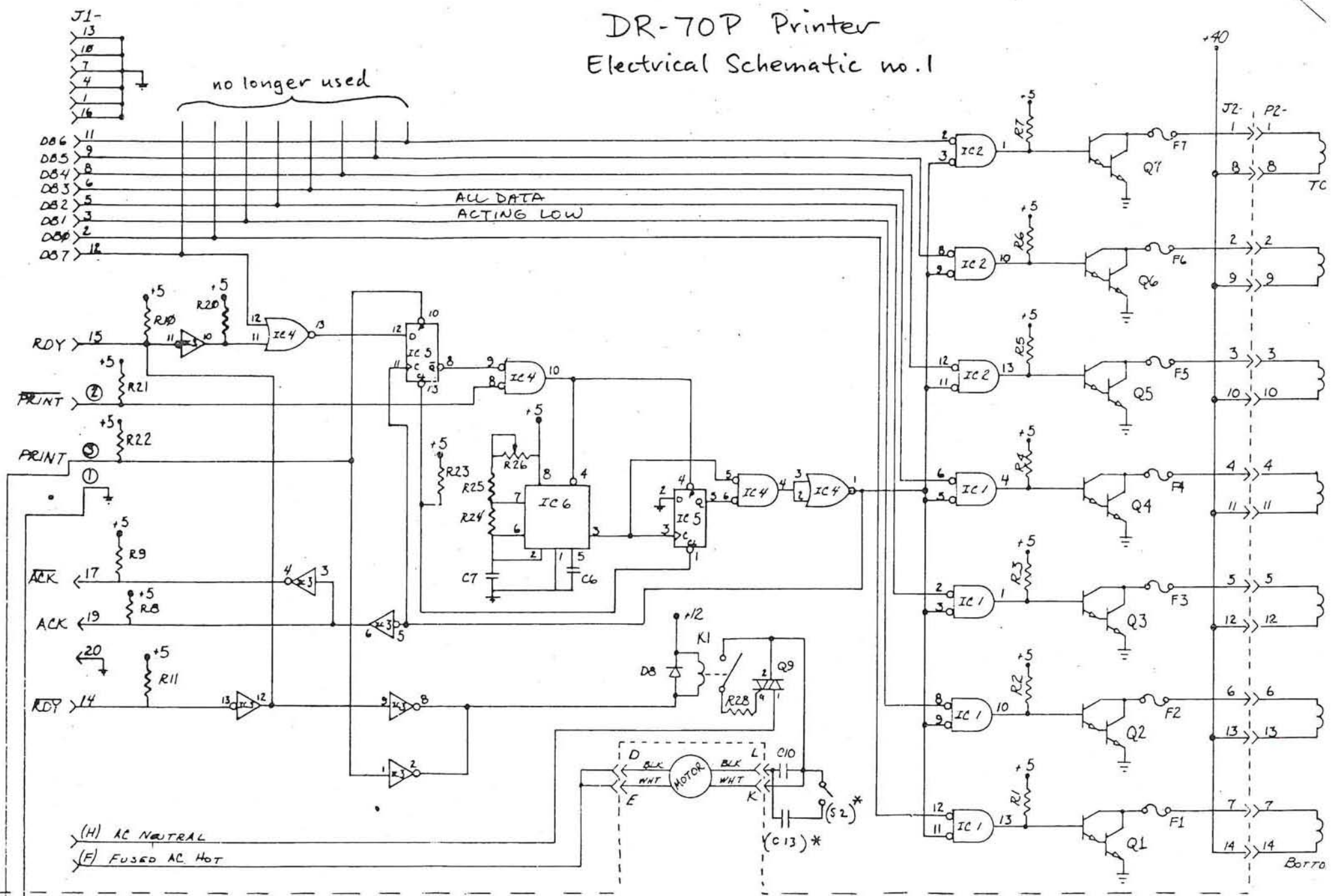
The answer (10.09.38.36) should appear in 5 or 6 seconds from the time you pressed \odot ENTER.

8. Replace the 6 screws.

*For complete
board layout map
see
Repair Manual*



DR-70P Printer Electrical Schematic no.1

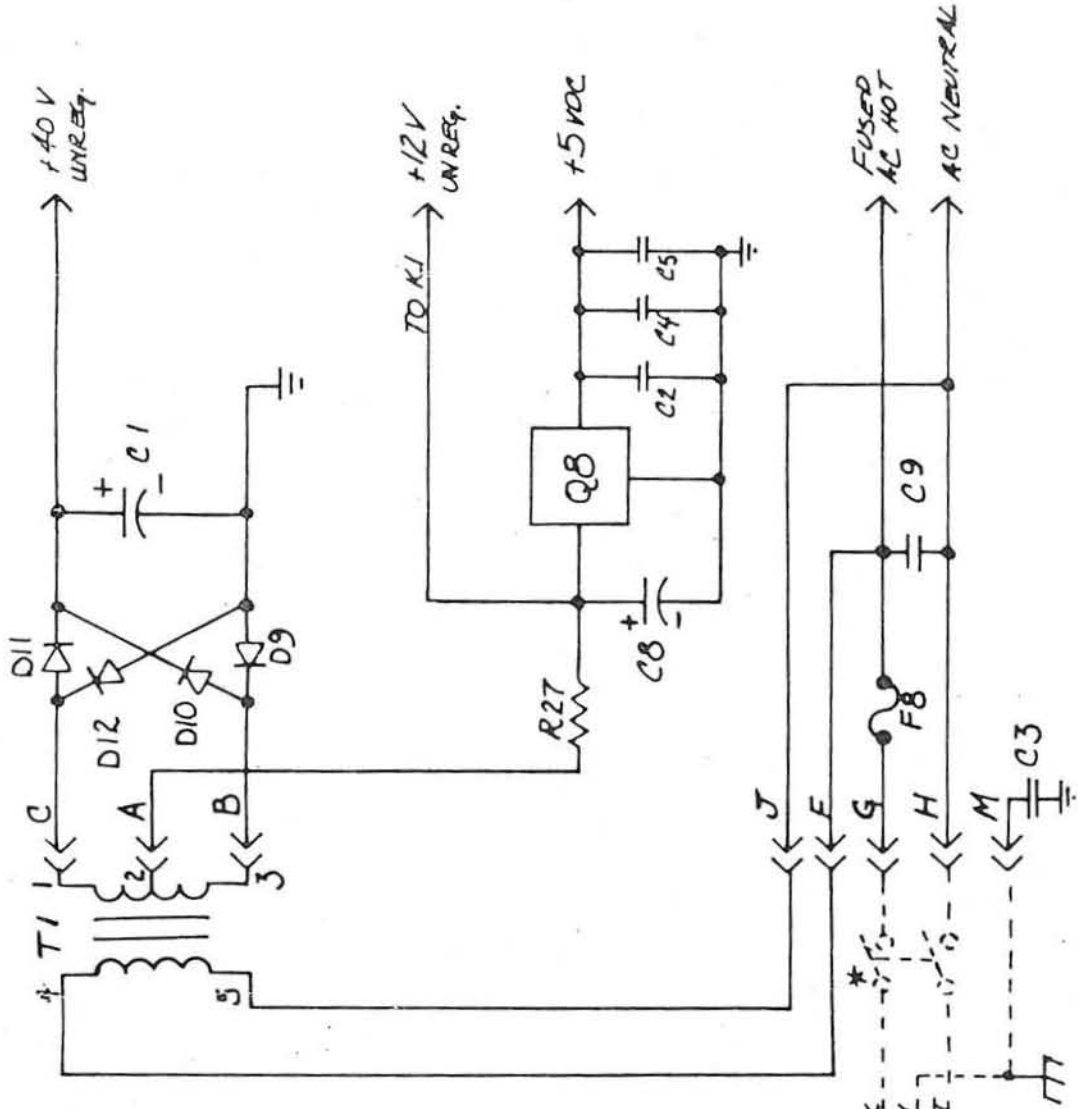


(H) AC NEUTRAL
(F) FUSED AC HOT

Print Switch on front of mechanism.
Disengaged (u: print high) whenever print head in acceptable print position

* - C13 + S2 included only on printers to be used overseas @ 50

DR-70 P Printer : Schematic no. 2



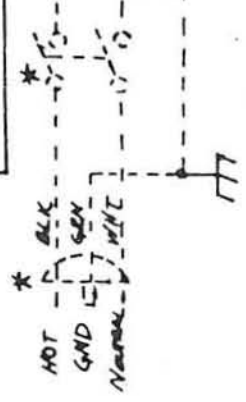
Additional Printer parts:

R26 100K Ω pot (adjusts print width)

C11* .47 MFD 400 VDC Capacitor

S2* Switch (completes C11 for 50 Hz operations)

C12-13 .1 μ f caps



* Plug & Switch NOT INCLUDED

* C11 & S2 are only added to printers to be used overseas
© 50Hz

Current DR-70 's 6/82

PROM map for 'NEW BOARD'

TS mem. v. 14 with Transit Search

Board v. 9

New Motherboard
with Transit Search
Option :

B ROM	C ROM	9 ROM	D ROM	18 v5.0	30 v5.2	418 RAM
A0 v5.0	28 v2.5	A8 v6.6	38 v2.8	10 v4.3	E8 v4.7	E0 R2

* * *
Four PROMs updated since mem. v. 11a

NTS mem. v. 12 without TS

Board v. 9

New Motherboard
without T Search :

B ROM	C ROM	9 ROM	D ROM	18 v4.8	30 v4.5	
AC v4.8		A8 v6.5		10 v4.2	E8 v4.7	E0 R2

*



**Digicomp
Research**

DR-70 COMPUTER & PRINTER
SERVICE MANUAL

Digicomp Research

Terrace Hill, Ithaca NY 14850
607 273-5900

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DR-70 Overview

I. Introduction

The DR-70 astrological computer is a MCS6502 based microcomputer. The MCS6502 is an eight bit microprocessor originally manufactured by MOS technology. It is an n-channel, single supply (+5V) device operated at 1.0 Mhz. It contains an eight bit, bi-directional data bus and a separate sixteen bit address bus capable of addressing 64K of memory. Input/output is memory mapped.

Program storage is on roughly 40K of Read Only Memory made up of ROM's and EPROM's (Electronic Arrays EA8316 2K X 8 ROM, MOS Technology 2332 4K X 8 ROM, Intel 2716 2K X 8 EPROM). 1K or 2K of Random Access Memory is used, depending on the program version (eight 2102 1K X 1 RAM and 4118 1K X 8 RAM). At 1.0 Mhz operation, the access time for these devices can be as long as 490 ns.

The keyboard and display are interrupt driven. The digital display is a ten digit display stick TI-TIL-804-10. The LED's are FLV-140. Keyboard key switches are manufactured by Mechanical Enterprises Inc. The keyboard and display are accessed through memory locations in the 6502's 64K address space.

The printer is operated through a parallel port within the 64K address space. The port is eight bits wide with two handshake lines and an additional line for examining if the printer is connected.

The +5V power source comes from a 3 amp power supply. The autotransformer input can be configured to operate with 110V or 230V line voltage, +/- 10%, 47-440 Hz. A separate +5V Lm7805 (or Lm340 T-5) is used to power the display.

II. Operation of the MCS6502

The MCS6502 is mounted on a small PC board connected to the Mother board via two, 20 pin SIP sockets. Also on this board are two bipolar PROMs used for encoding/decoding to offer some software protection. This board is also encased in thermally conductive epoxy for the same reason. By token of the

decoding/encoding PROMs, this board is referred to as a decoder board. This replacement part is available through Digicomp Reseach.

The clock for the 6502 is derived from a RC network (C1 and P1). The 100K potentiometer P1 is tuned until a 1 Mhz is achieved on pin 39 of the processor (pin 39 of the decoder board) or U64p6.

The keyboard and display are driven by an interrupt routine. The interrupt is initiated by a low level on the interrupt request pin (IRQ, decoder board pin 4). The display must be updated every 2.2 ms to provide flicker-free operation. To generate the periodic interrupt signal, a 556 is used. The 556 uses a RC network to achieve the timing. The 1M potentiometer P3 adjusts the frequency of the interrupts while the 100K potentiometer P2 adjusts the duty cycle. The potentiometer P3 must be adjusted to provide the required 2.2 ms interrupt timing and P2 must be adjusted so that the low level on the interrupt pin is at least 20 microseconds in duration. Failure to provide the minimum 20 microsecond duration will "bomb" the processor. The interrupt signal is also available on U65p6.

Since the MCS6502 microprocessor has no input/output instructions, all input/output must be done through memory addresses. This means that inputs from the keyboard and outputs to the display and printer are accessed through physical memory locations in the 64K address space. The exact locations of these are indicated on the DR-70 Address Map.

The data and address buses from the processor do not provide sufficient drive power for the entire data and address buses on the DR-70. The address bits A0 - A11 are buffered by three 74Ls125s (U5,6 & 7). The address buffers are always enabled. The data bus D0 -D7 is driven by four 74Ls125s (U8,9,10 & 11). Since the data bus is bi-directional, the 6502 Read/Write* (R/W* pin 34 or U20p5) signal is used to control the direction of data transfer. R/W* is used to enable individual 74Ls125 drivers so that the data transfer flows in the proper direction.

Resetting the processor (RESET*, decoder board pin 40) occurs in two manners: (1) a power on reset occurs when the mother board is initially powered up, and (2) a reset occurs when the RESET key on the keyboard is depressed. When +5V is applied to the board, pin 40 should be held low until all the transients settle. This will start the processor in a known state. The delay for this reset is done with C2 and a 47K resistor. When power is applied, C2 charges to +5V via the 47K resistor. Until C2 charges to the input threshold of U2p2, reset is asserted low.

When the keyboard RESET key is depressed, it is first debounced with a "NAND gate flip-flop" (U2). It is then gated with the

power on reset signal. The reset pin of the processor should be held low as long as the key is depressed.

III. Memory usage and address decoding

There are five different types of memory components in the DR-70: 4118, 2102, 2716, 8316, and 2332. The 4118 and 2102's are Random Access Memories (RAM) and are used in storing intermediary results and answers. 2716, 8316, and 2332's are Read Only Memories used for program storage. Address and physical location information is contained on the Address Map sheet.

The address decoding for all these devices is done with A11 - A15. This allows the 64K address space to be broken into 2K sections. A12 - A15 are fed unbuffered to a 74154 demultiplexer (U17p20-23). The demultiplexer breaks the address space into 4K segments. The addresses are further broken down with A11. The active low outputs of the 74154 are gated appropriately with A11 or A11* (U18,19,20, and 21). This produces active low chips selects (active in 2K segments). These signals are tied to the active low Chip Selects of the 2716 (pin 18 & 20), 8316 (pin 18 & 20), 4118 (pin 18 & 20), and 2102's (pin 13). The 4K 2332 (pin 20 & 21) are selected by the active low outputs of the demultiplexer.

The internal address requirements of each memory device are: A0 - A10 for 2716 and 8316, A0 - A9 for the 4118 and 2102, and A0 - A11 for the 2332.

Access time for memory and peripherals must be less than 490 ns. For a 6502 at 1Mhz, access time must be about 575 ns. However, the delay time in encoding/decoding PROMs and buffers bring the access time to 490 ns. If replacement parts are used they must have access times faster than 490 ns.

IV. Keyboard and Display

The keyboard is accessed through the address 90XX. The individual keys are arranged in rows and columns. Raising a particular address bit in the lower byte will enable a row of keys. Depression of a key in that row shorts the raised address bit to the data bus. The processor then knows which key is depressed by the raised bit in the data bus. Thus the entire keyboard is read by successively raising all the address bits, one by one. The house dial (the rotary switch) is treated as another row in the keyboard. The position of the switch shorts the address bit to the appropriate data bit. Inability to read this switch will produce an "Error" condition whenever

houses or charts are requested.

The display is managed in much the same way as the keyboard. A particular LED is lit by raising its associated address bit (in the address 40XX) and lowering the associated data bit. The digits are operated one digit at a time. By raising of a particular address bit in the address 50XX, a digit is grounded. The segments in that digit are lit by lowering data bits (a segment = bit 0, b segment = bit 1, c segment = bit 2,...). Thus the whole display is lit by writing the proper data to all the rows in the digits and LEDs.

V. DR-70 Printer interface

The DR-70 printer interface utilizes a 74100 (U33) eight bit latch and a flip-flop. Columns of dots are put in the latch. The printer prints one column at a time allowing any character to be assembled by outputting the proper sequence of columns. Handshaking is done with two lines: Ready and Acknowledge (marked RDY and ACK on schematic). The Ready line is a signal from the DR-70 telling the printer to start the motor, print a line, do a line feed, and stop at home. When the printer starts a line, it sends Acknowledge signals (active high) to indicate that it is ready to print a new column. Upon receipt of an Acknowledge, the DR-70 latches a new byte into the 74100. The latch control is enabled by writing to the address 6800. The Examine is a signal which is grounded when the cable is plugged into the printer. If Examine is high, the DR-70 will respond with "Error" if required to print. The Examine and Acknowledge signals are read by reading at the address 6800.

VI. +5V Power Supplies

DR-70 supplies are 3 amp linear power supplies. The line voltage input is wired to a autotransformer which permits the supply to be run with a 110V or 230V input. The transformer can be hard-wired to run at either voltage or run at both with the aid of a switch. If the DR-70 is wired for 110/230V operation, the line voltage must be known and the switch set appropriately before plugging in the machine. Failure to do so can result in damage to the supply's semiconductors, or a blown transformer. The 110/230V machines uses two fuses, one 1 amp fuse for 110V operation and one 0.317 used in 230V operation.

To reduce noise on the board, the display draws it's power from a separate regulator. Input power to the regulator is drawn from the secondary winding of the transformer (the actual wiring is connected to the plus side of the filter capacitor). Failure of this regulator will only stop power for the LEDs and digits

creating a situation where the computer is still running but no lights work.

The 110/230 VAC is first passed through a line filter before going to the power supply. The filter is a Corcom 8042L line filter, rated at 115/250 VAC 50-400 Hz. Power is turned to the filter when the power keyswitch is turned on. Power for the fan is not drawn from the filter.

General In Field Debug Overview

I. Power Failure

Power failure can occur in three ways. First, the machine can continuously blow fuses. Refer to section E of Simple DR-70 Repair Techniques if this is the problem. The last two power problems are failures in the +5V circuitry: a failure in the +5V to the mother board; or failure in the +5V to the display (on older machines this separate supply may not be present). To isolate which circuit is failing:

- i. Check to see if the shift key lights or measure the output of the Lm7805 mounted on the side of the power supply. If +5V is not present measure the input to the regulator, it should be 11-13V.

If input power is present, (1) check for power shorts in the display area and display board; (2) check that the Lm7805 is operating properly (disconnect the output and see if it holds the voltage at the rated 1 Amp load).

If input power is absent, (1) check that 115 VAC (or 230VAC) is present on the primary of the transformer, if not refer to section E of the Simple DR-70 Repair Techniques. (2) The primary or secondary winding of the transformer could be blown. The impedance of the secondary should be in the 1-5 ohm range. The primary should measure about 9-11 ohms.

- ii. If power is lacking or poor on the mother board, first disconnect the supply output from the board and check it's output at about 2.5 Amps. If the voltage drops, first check that the transformer is receiving a proper input voltage, if not, refer to (I.i) above. If the input voltage is acceptable, the power supply will have to be repaired or replaced. Contact Digicom for replacements or schematics.

If the supply holds +5V at near rated current, the mother board most likely has a short. Check for loose shards of wire or hardware. Also check if any components are getting excessively hot. A blown component can short out the whole board. Power can be cut to parts of the board at a time by noting the power patches on the List of Cuts and Patches.

I. Does Not Respond to Reset

The failure of the processor to reset properly can be the result of any number of problems. This particular condition can be indentified by:

- i. The display comes up in an improbable state and will not respond to keyboard requests.
- ii. No display at all, no responce from keyboard input but the shift key still lights when depressed.
- iii. If when the machine is open, the processor stalls at one address after a reset.

This symptom is associated with three conditions. (1) Improper adjustment of system and interrupt clocks. (2) Failure to properly access memory. (3) Component failure.

1. Adjust the clocks. The system clock (U64p5) must be adjusted to 1 Mhz by potentiometer P1. If a 1 Mhz signal can not be achieved, check C1 (50 pF) and P1 (100K) for proper value and function. Also check for shorts.

The interrupt clock (U65p6) must go low every 2.2 ms and MUST be low for at least 20 microseconds. P3 adjusts the frequency of the interrupts while P2 adjusts the duration of the low level. Failure to produce this signal may be the of failure in discreet components or the 555 (see schematic).

The clocks should be checked first upon the the occurance of this problem.

2. Improper memory use is harder to define. First clean/press down all sockets. Corrosion is the number one cause of this type of failure.

Check the R/W* signal to all RAMs. R/W* is "anded" with the system clock at U20p6. Make sure that at every RAM is getting this signal.

Check the gating of the data bus. Since the data bus is bi-directional, only half of the drivers in U8,9,10 & 11 should operate at a time (one half for either direction). The enable for these drivers comes from the R/W* (or inversion of R/W*) of the 6502. Check that R/W* makes it through the inverters on U65p13 & 12,11 & 10. Also check

the drivers U8,9,10 & 11.

Check the Chip Selects. Check that the 74154 (U17) is functioning. Make sure U17 receives proper and good levels on it's inputs A12 - A15 (which come directly from the processor). Also check that it lowers the proper output (see appendix on 74154).

Finally check that all the Chip Selects at the PROMs operate and trace any suspicious ones back to the 74154.

Sometimes slow or speed degraded 74Ls125s on the address bus A0 - A10 will cause problems (U5,6 & 7). Replace any suspicious drivers.

3. Component failures will usually occur in the memory components or the processor. Faulty 2102s should be replaced first and then check that all "unenabled" PROMs/ROMs are not trying to drive the bus (this can be done by removing all unenabled chips one by one until the proper data is seen on the bus).

The first eight bytes of every PROM/ROM are given on a separate sheet (see coded PROM contents). This can provide a useful test of the selection of memory components if it is possible for the tester to jam the appropriate addresses on the address bus.

Faulty 6502's are difficult to diagnose unless the debugger has a known working decoder board. Spare decoder boards are available to authorized servicers through Digicomp Research.

Other component failures will require diagnosing with the schematic.

III. Error condition when asked to print.

Error conditions which occur during printing arise from three main sources. "Error" will be displayed if:

- (1) the processor reads the Examine line high
- (2) or if there is some form of software error in the PROM/ROMs
- (3) or if the "house dial" (on the keyboard) cannot be read.

The ability to read the house dial can easily be checked. Many of the printing routines require the knowledge of which house system to use. Errors of this type are common if the rotary

switch which selects the house system cannot be read. To check this, first put in the key sequence: RESET PRINT DATE RECALL. This should print the date 12.31.1899. If this doesn't work refer, to the next paragraph. However, if it does work, then try the sequence: <Shift> CHART ENTER. If this produces an Error condition, then the processor was unable to read the house dail. Check wiring and action of the rotary switch. If it still won't print a chart (but will recall a date), then refer to the schematic.

The DR-70 uses a signal called "Examine" to determine if the cable to the printer is attached. The Examine line (pin 21) is pulled up on the DR-70 mother board. When this signal is low the DR-70 knows that the printer is connected; if its high, then it indicates with "Error" that the printer is not connected. This line is grounded when the printer cable is plugged into the printer (regardless to whether the printer is powered). The line is sensed on data bit 6 of the DR-70 by reading location 6800 (U16p9,8 & 10). Check that the 74Ls125 (U16p4,5 & 6;8,9 & 10) driver is being enable by the address and also check the driver for proper functioning.

The last possibility is a software error. Check that all the Chip Selects work. Contact Digicom for any possible software errors.

V. Bombs when Printing

Bombing during printing arises from four principal sources.

- (1) The DR-70 is receiving no Acknowledges from the printer.
- (2) The printer cable is broken
- (3) The Printer is not responding to the DR-70's Ready signal or the printer is broken.
- (4) Software problem

During printing, the display interrupts are masked. So it is possible that the DR-70 is in fact running normally if it appears to bomb when printing but that the DR-70 is trying to finish a line of print. Thus what may appear to be a problem with the DR-70 may in fact be a problem with the printer.

Check that the printer will do a line feed upon receipt of a ready signal from the DR-70. If it won't do the line feed, move the print head to the right of the home position and turn the power on. The printer should come to rest at the home postion.

Refer to the printer debug instructions if the printer will not do the line feed.

Next check that the acknowledge pulses are coming from the printer (U66p11). Meanwhile check that U16p5 & 6 are also receiving acknowledges.

Finally the software driving the printer could be in error. See if any of the print functions (i.e. PRINT DATE RECL, CHART ENTER, TABLE ENTER, etc.). All possible software problems will have to be fixed by Digicom.

IV. Display Jams in a Meaningful State when Reset

If the display jams into a meaningful state on Reset (see DR-70 Users Manual) a key is probably shorted. One way to isolate key is to turn on the DR-70 and Reset. Note the lights that come on. Now lock "ON" the shift key and Reset. By comparing the lights that come on when shifted and unshifted, usually the shorted key can be deduced (i.e. by noting the shifted and unshifted meaning of each key). Another method is to check each key with a meter or bug-light to see which key might be shorted.

Simple DR-70 Repair techniques

Recommended tools for DR-70 repair

- (1) #6 hex driver or Alan wrench
- (2) small flat screwdriver
- (3) chip extractors
- (4) soldering iron and solder
- (5) solder wick or solder removal tool
- (6) 1/4" socket wrench or spanner
- (7) wire cutters
- (8) Freon solvent
- (9) isopropal alcohol

Simple DR-70 Repair Techniques

NOTE - OPENING THE MACHINE WILL VOID YOUR WARRANTY UNLESS OTHERWISE INSTRUCTED BY DIGICOMP.

A. Opening the machine

1. The DR-70 is sensitive to static electricity, so when working on the machine do not wear sweaters, nylon shirts, rubber-soled shoes or material that creates static charges.
2. A #6 hex driver is used to undo the 6 stress bolts located around the aluminum valence and fan. (Note: 1 bolt located under warning sticker).
3. Tape over name plate to avoid scratching.
4. Lift top cover up and lean it towards the back - it should be stabilized in this position.

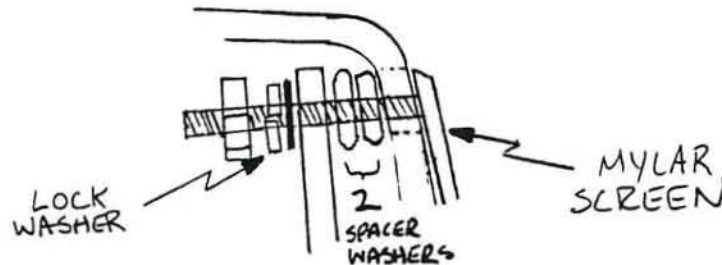
B. Techniques of repair for intermittant failures or lost data (but machine responds to reset).

1. Check operators manual for proper key sequence.
2. Follow opening instructions (#A). Once open, firmly press each chip to reseal their contacts in the sockets.
3. Replace cover and observe behavior. If intermittant behavior still occurs, repeat procedure #1.
4. If machine continues to behave intermittantly, purchase some spray contact cleaner (a freon solvent which leaves no residue or oil). Again open the machine. With chip extractors or a small screwdriver, lift the chips partially out of their sockets. Spray the contact cleaner on the chips legs and reseal the chips by pushing them in. Check that none of the chips legs are bent or out of the socket. (Note: if a chip should accidently come out of its' socket, it must be replaced in the same direction).
5. Replace cover and observe machines behavior.

C. Replacement of LEDS

1. Disconnect 50 pin card edge connector from keyboard - avoid stressing cable. The epoxy seal can be broken with a small screwdriver or knife.

2. Lay top upside down. Four sets of $\frac{1}{4}$ " nuts should now be seen on the back side of the display PC board. Remove the nuts and washers. IMPORTANT: Note the number of, and order of the spacing washers. (See #5)
3. Turn top cover over. Mylar display screen may now be lifted off. Locate defective LED.
4. Now, unsolder old LED and discard. Noting that the direction of the notch in LED lens aligns with the other LEDs (towards the left, looking from the top). Solder LED in FLUSH to the PC board. Do not hold solder iron on the LED lead for longer than 2 seconds. Overheating will cause internal damage to the LED.
5. Screw the display screen and PC board back together with the same exact number of washers (see diagram below). If the LEDs get too close to the screen, heat from LED will cause the mylar to melt.



6. Replace ribbon cable, set top down on bottom in place. Turn machine on, then verify that new LED is working. Turn machine off, then close the machine (see "Sealing up the machine").

D. Replacement of keyboard switches

1. Disconnect 50 pin card edge connector from keyboard - avoid stressing the ribbon cable. (See C1).
2. Remove keytop on suspect key. Usually a small screwdriver working from the bottom of keytop, pulling up, will do.
3. After locating key on backside of PC board, remove the solder from the two contact holes. Free key by pulling from top. Make sure both the contact holes and the mounting guide holes (2) are free of obstructions.
4. Gently ease new key switch into hole and solder. It is important to note the following:
 - (i) the switch contacts should be centered in PC board holes and the switch must be seated flat to prevent the key tops from rubbing against one another.
 - (ii) Hold solder iron on switch leads for no longer than 2 seconds as the internal mechanism can overheat.

5. Replace ribbon cable and keytop. Verify proper functioning of keyswitch. Seal machine, if working.

E. Procedure if fuse blows repeatedly

1. Check that fuse is 3/4 amp AGC fuse.
2. Open machine (See #A). Carefully look for loose shards in +5v circuitry on motherboard. Check 120v wiring for loose or shorting connections. Check operation.
3. Cut 120v wire to fan. Check operation. If it works -- replace fan (all parts available through Digicom). If not - reconnect wire.
4. Cut 120v wire to power supply. Check operation by observing fan.
 - (i) If fan runs, go to #5.
 - (ii) If fan doesn't run - disconnect line filter and bypass it. Reconnect power supply and check operation. Should it work, replace filter. If it doesn't, recheck wiring for shorts.
5. Cut yellow wire to 7805 regulator. Check operation of fan. If now working, replace 7805. If not, check power supply PC board and motherboard for shards in +5v power busses.
6. If the machine continues to blow fuses, call Digicom at (607) 273-5900.

F. Sealing machines

PLEASE FOLLOW THIS CHECKLIST

1. Make sure power supply, motherboard, keyboard, and display are all screwed down tight.
2. Check power supply output. It should be +5.05v. If not, adjust pot.
3. Check master clock (only if you have a calibrated oscilloscope). It should have a period of 1.25 us. The clock pot is located on the power supply side of the CPU module.
4. Vacuum machine thoroughly to remove any loose debris. If inside is dusty, wipe it clean using isopropal alcohol.
5. While the machine is open an easy and helpful maintenance procedure is to push down on all the chips to ensure that they are seated firmly in their sockets.
6. Fit top and bottom together. Pick up and shake machine, meanwhile listening to hear loose material inside enclosure.
7. With cover still on, check for proper functioning. Then insert and tighten stress bolts.

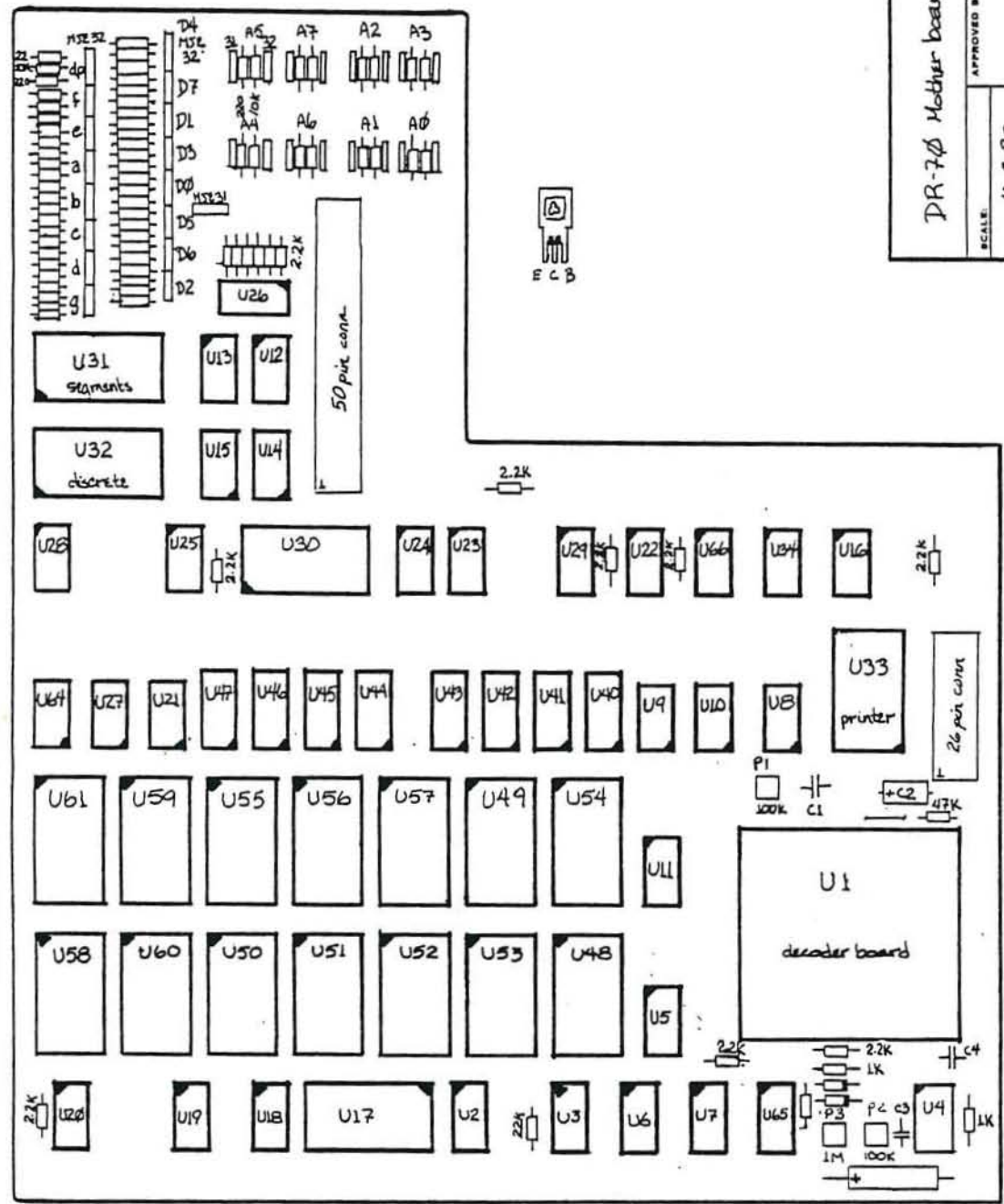
DR-70 Parts List
revision B

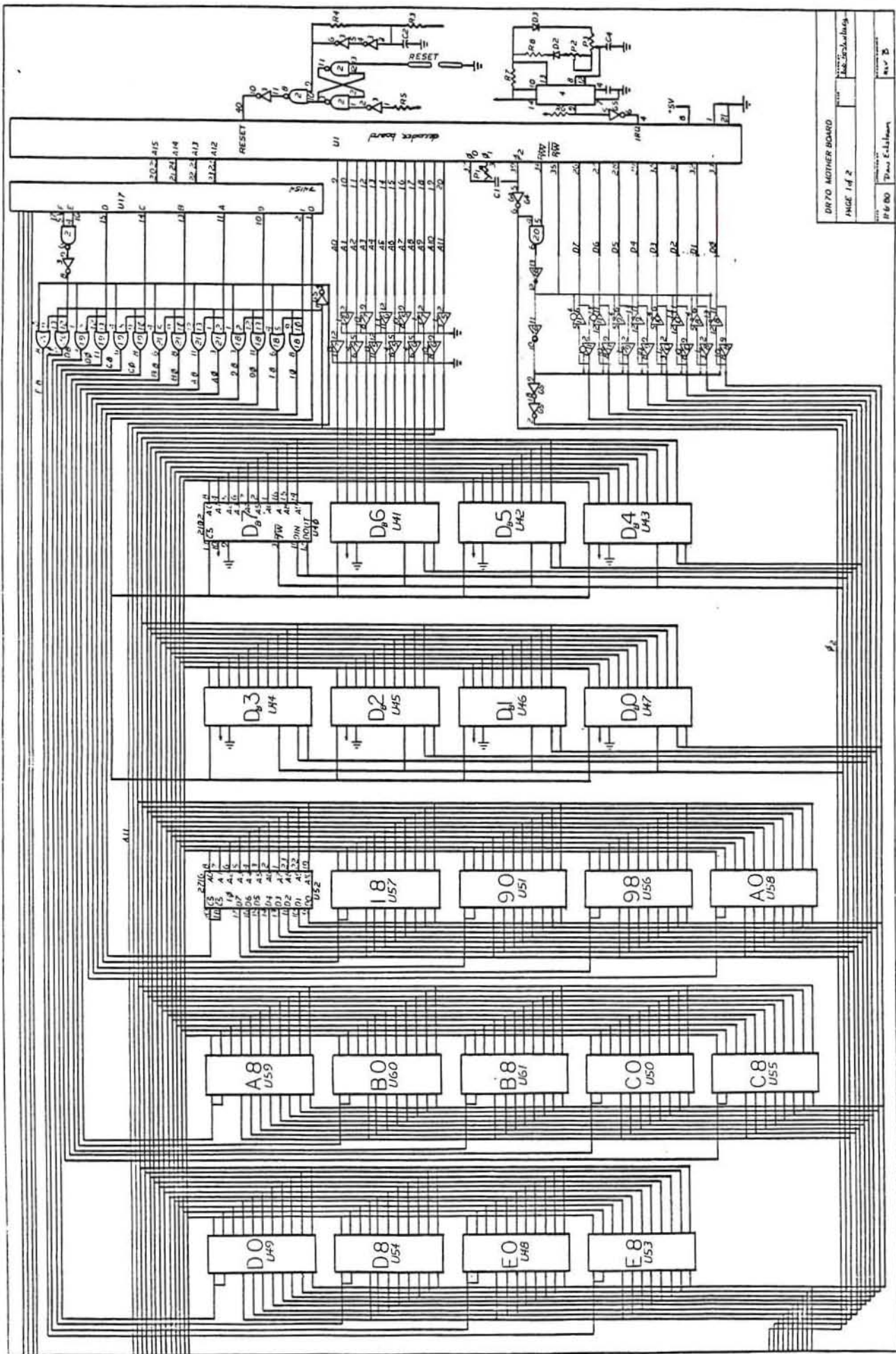
socket	part
U1	decoder board
U2	7400
U3	7414
U4	556
U5	74125
U6	74125
U7	74125
U8	74125
U9	74125
U10	74125
U11	74125
U12	74125
U13	74125
U14	74125
U15	74125
U16	74125
U17	74154
U18	7432
U19	7432
U20	7432
U21	7432
U22	7400
U24	7400
U25	7404
U26	7404
U27	7402
U28	74125
U29	74125
U30	74100
U31	74100
U32	74100
U33	74100
U34	7432
U40	2102
U41	2102
U42	2102
U43	2102
U44	2102
U45	2102
U46	2102
U47	2102
U48	2716
U49	2716
U50	2716
U51	2716
U52	2716
U53	2716
U54	2716
U55	2716

U56	.....	2716
U57	.....	2716
U58	.....	2716
U59	.....	2716
U60	.....	2716
U61	.....	2716
U64	.....	7404
U65	.....	7404
U66	.....	7414

PR-70 Mother board layout

SCALE	APPROVED BY
DATE: 4-3-80	REVIEWED
DRAWING NUMBER	





DR70 MOTHER BOARD
 PAGE 1 of 2
 11/8/80
 11/11/80
 11/11/80

Cuts and Patches to DR-70 rev B

All Versions

- (1) Cut trace from U1p3 to pot P1p3
Patch pot P1p3 to U64p6
- (2) Cut trace from U65p2 to U40-47p3
Patch U65p13 to U40-47p3
- (3) Cut trace from U15p13 to U15p11
Patch U15p13 to U15p7
- (4) Cut +5V trace to pin 1 of the 50 pin connector
Patch 22 Ohm resistor from +5V to pin 1 of the 50 pin connector
- (5) Cut trace to U16p6
Patch U9p3 to U16p6

Version 6B (non-Transit search)

- (6) Cut trace from U21p6 to U60p20 & 18
- (7) Cut trace to U21p9
Patch U21p9 to U21p10
- (8) Patch U17p4 to U60p20 & 18

Version 8B (Transit Search)

- (6) Cut trace from U21p6 to U60p20 & 18
- (7) Cut trace to U21p9
Patch U21p9 to U21p10
- (8) Cut trace from U54p20 to U54p18
Cut trace from U54p20 to U19p3
Cut trace from U54p21 to U54p24
Patch U17p15 to U54p20 & 21
- (9) Cut trace from U49p18 & 20 to U19p11
Patch U17p3 to U49p20 & 18
- (10) Cut trace from U17p1 to U43p13
Patch U43p13 to U19p11
- (11) Cut trace from U17p15 to U19p2 & 13
Patch U17p1 to U19p2 & 3

Version 8B Patches con't

- (12) Cut trace from U15p18 to U51p20
Patch U19p3 to U51p20
- (13) Cut trace from U51p24 to U51p21
Patch U43p3 to U51p21
- (14) Cut trace from U51p18 to U18p11
Patch U51p18 to U51p24
- (15) Cut ~~trace~~ from U56p24 to U56p21
Cut trace from U56p18 to U56p20
Patch U17p10 to U56p20 & 21
- (16) Cut ~~trace~~ from U61p21 to U61p24
Cut trace from U61p20 to U61p18
Patch U61p20 to U61p21
- (17) Cut trace from U60p21 to U60p24
Cut trace from U60p20 to U60p18
Cut trace from U17p14 to U19p5 & 10
Patch U17p14 to U60p20 & 21
- (18) Patch U17p4 to U19p5 & 10
- (19) Patch U18p12 to U60p18 to U61p18 to U56p18 to U54p18

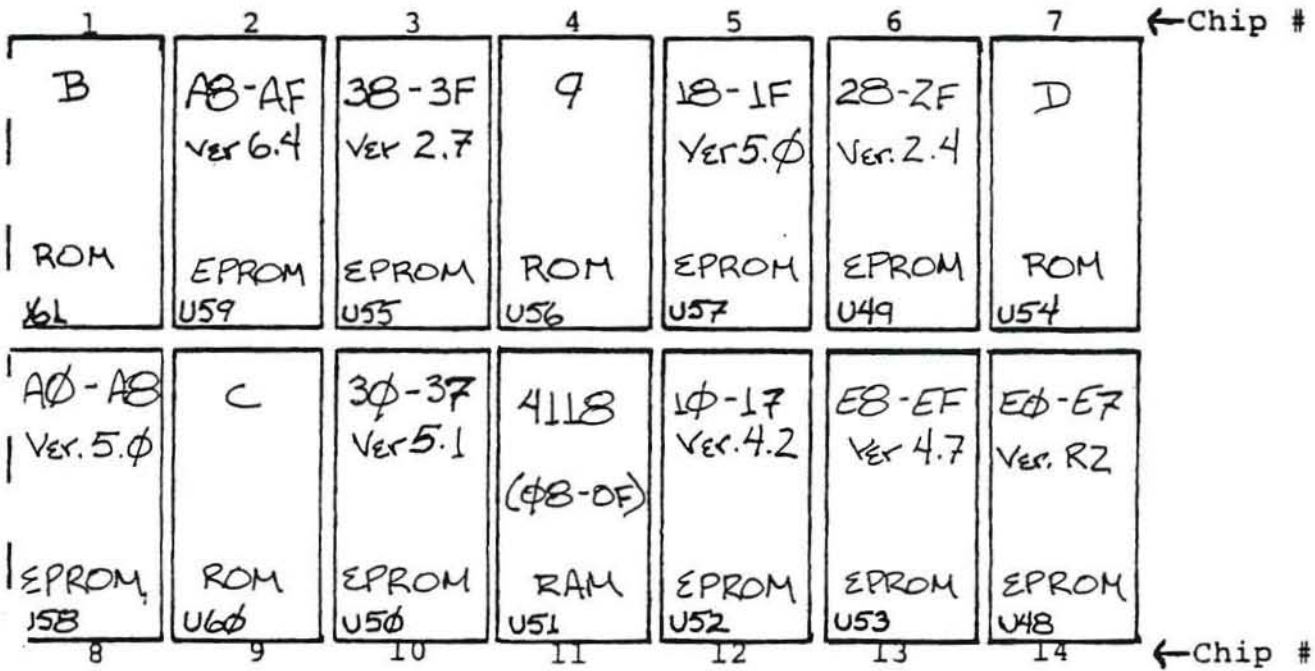
DR-70 address to PROM correlation
Version 8B (Transit Search)

Address	physical	assignment
0000-03FF	..... U40-47	RAM (2102)
0400-0BFF	..... unused	
0C00-0FFF	..... U51	RAM (4118)
1000-17FF	..... U52	PROM
1800-1FFF	..... U57	PROM
2000-27FF	..... unused	
2800-2FFF	..... U49	PROM
3000-37FF	..... U50	PROM
3800-3FFF	..... U55	PROM
4000-4FFF	..... display LED's	
5000-5FFF	..... display digits	
6000-67FF	..... unused	
6800-6FFF	..... printer	
7000-77FF	..... unused	
7000-7FFF	..... unused	
8000-8FFF	..... keyboard	
9000-9FFF	..... U56	ROM
A000-A7FF	..... U58	PROM
A800-AFFF	..... U59	PROM
B000-BFFF	..... U61	ROM
C000-CFFF	..... U60	ROM
D000-DFFF	..... U54	PROM
E000-E7FF	..... U48	PROM
E800-EFFF	..... U53	PROM
F000-FFFF	..... mapped into E000-EFFF	

DR-70 PROM Map

DR-70 Motherboard
Top View

VERSION 8.B
Transit Search



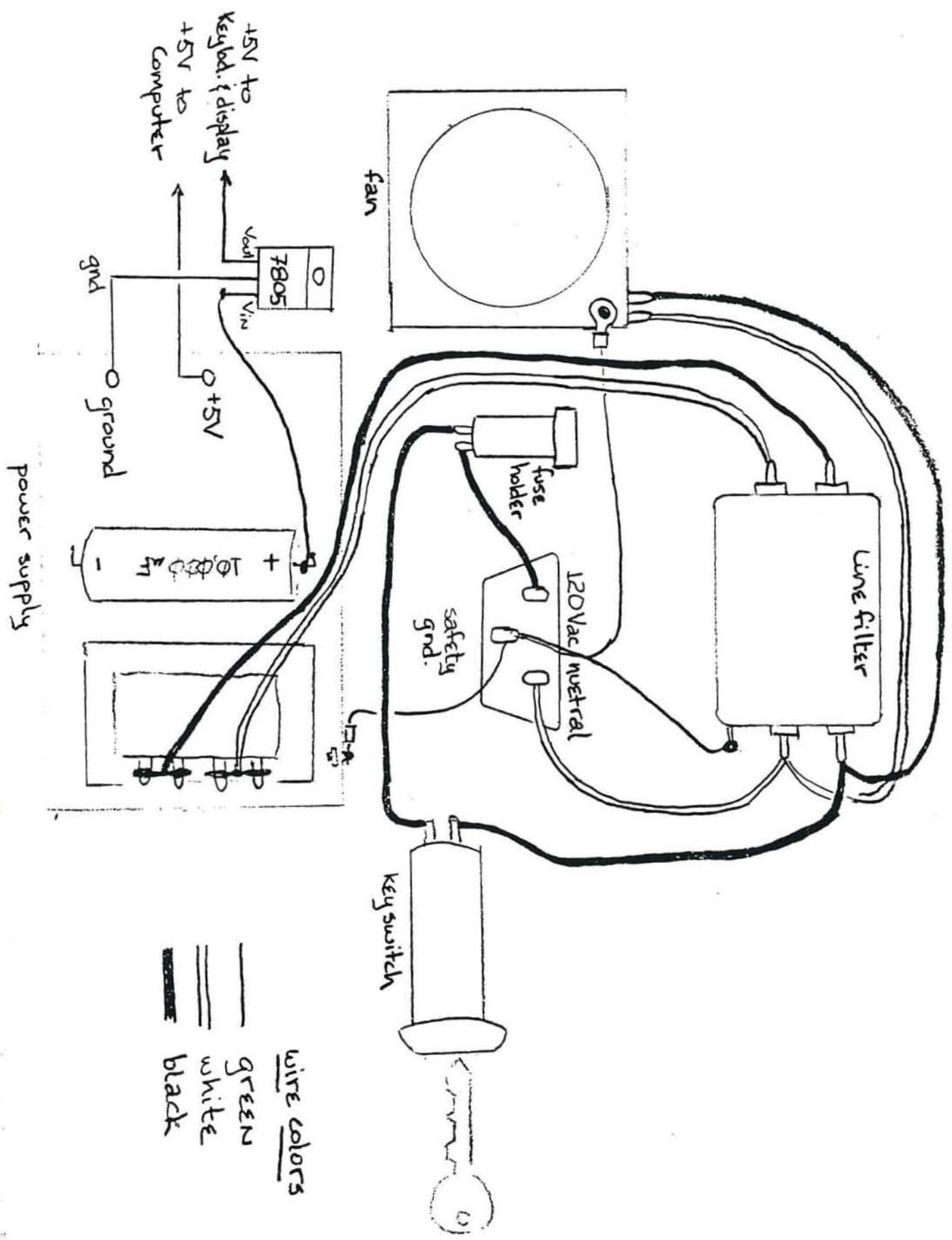
DR-70 PROM Map

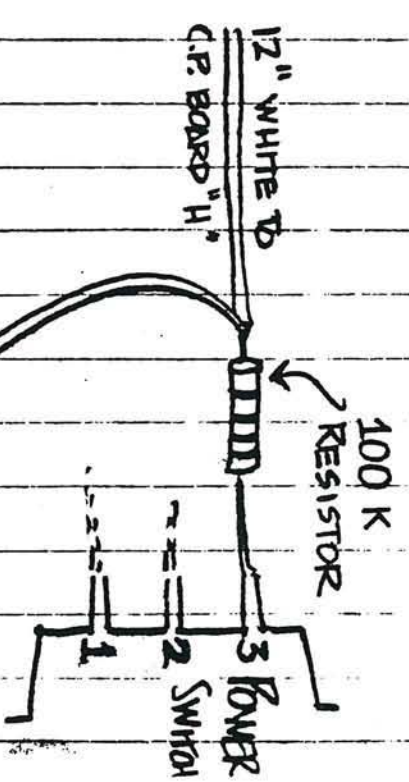
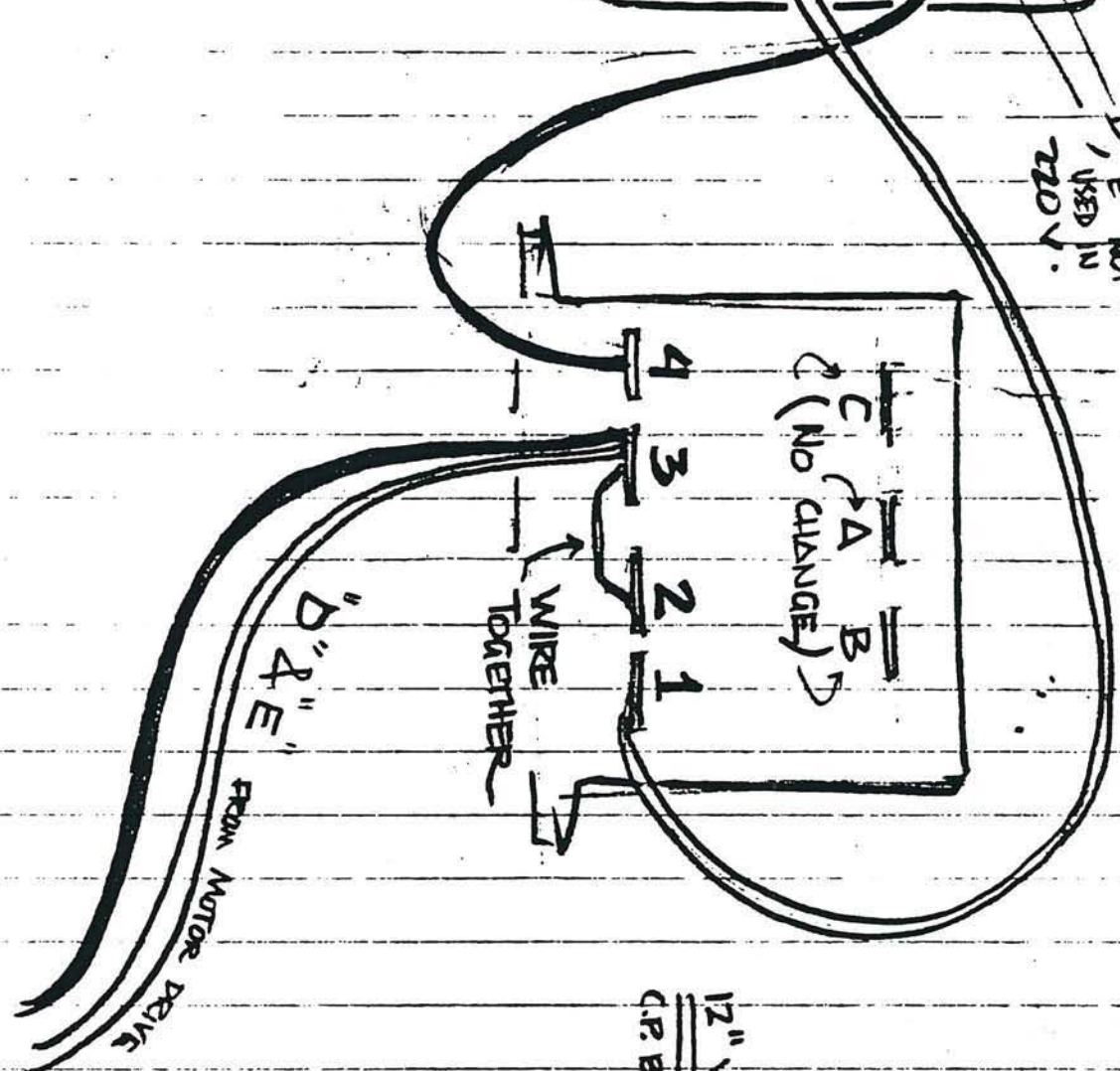
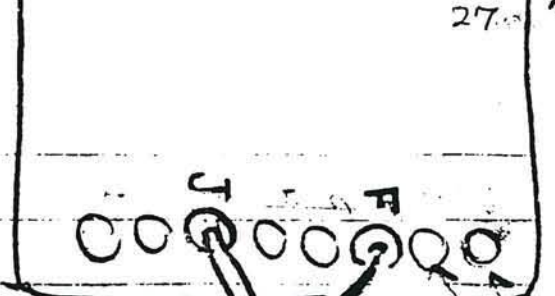
DR-70 Motherboard
Top View

Version 6.B

non-Transit Search

1	2	3	4	5	6	7	← Chip #
B0-BB Ver R4 over BB-BF Ver R5 ROM U6L	AB-AF Ver 6.0 EPROM U59	C8 Ver R1 ROM U55	98 Ver R6 ROM U56	18-1F Ver 4.8 EPROM U57	D0 Ver R9 ROM U49	D8 Ver R8 ROM U54	
A0-A7 Ver. 4.8 EPROM U58	30-37 Ver 4.5 EPROM U60	C0 Ver R3 ROM U50	90 Ver R7 ROM U51	10-17 Ver 4.2 EPROM U52	E8-EF Ver. 4.7 EPROM U53	E0 Ver R2 ROM U48	← Chip #
8	9	10	11	12	13	14	

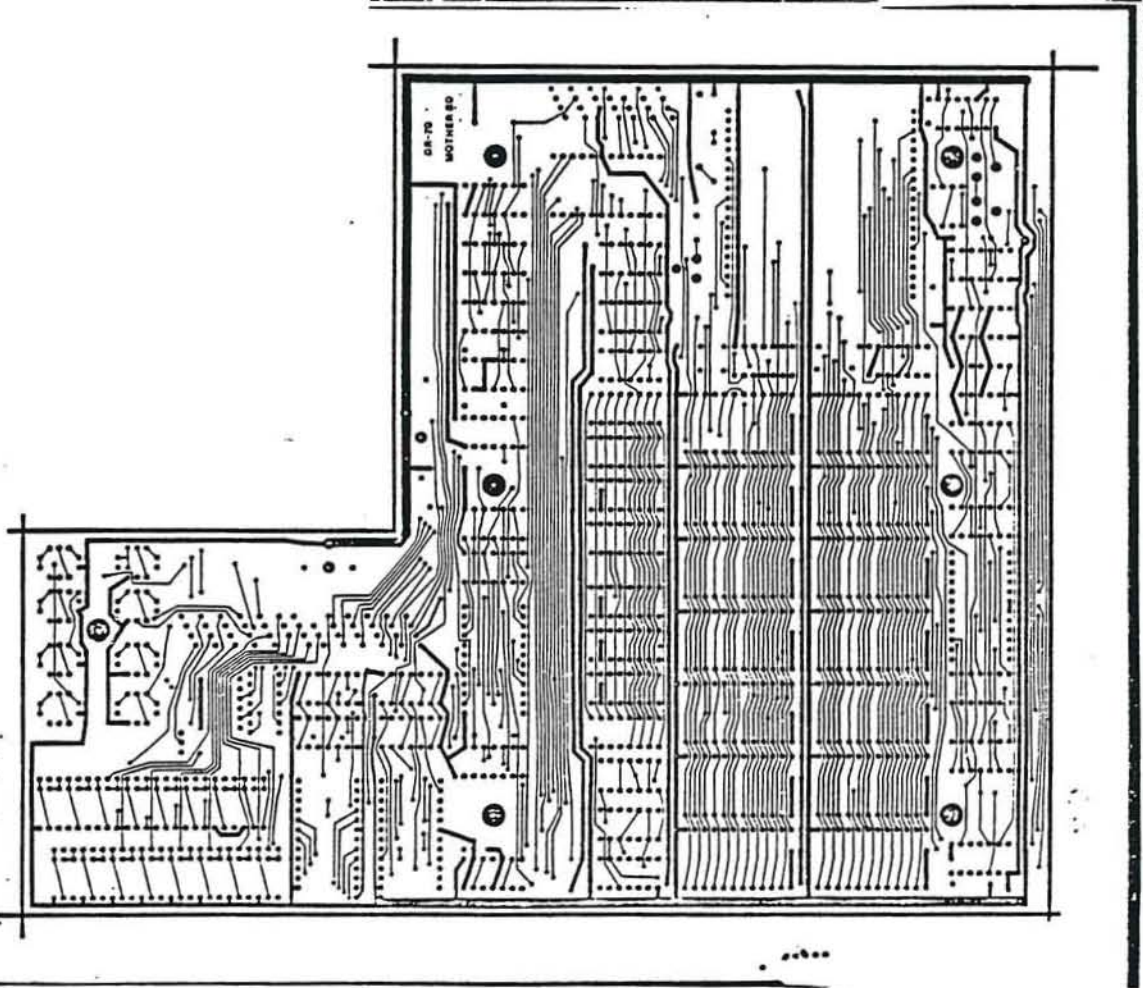
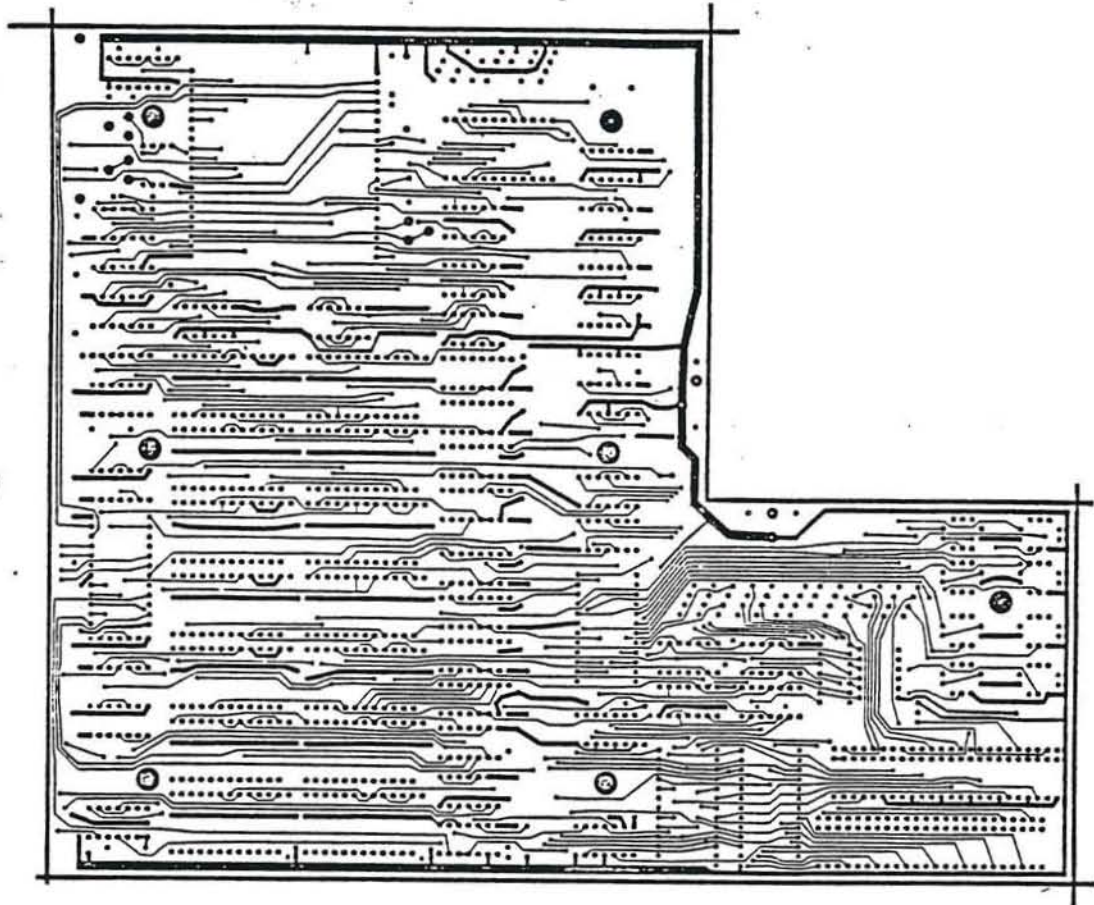




CHANGES REQUIRED FOR

220 V.

18" WHITE TO INTERLOCK



MAINTENANCE AND REPAIR

1.0 The Model 7040 printers are designed to require a minimum of maintenance and service. This section provides instructions and procedures for both cleaning and maintenance of the printer as well as a troubleshooting guide to aid in problem analysis.

1.1 Required Tools and Supplies

The following items are recommended for printer maintenance and major repairs. Common hand tools are also required.

- 1. Volt-Ohm Meter
- 2. Feeler Gauges
- 3. Grease (IBM #23 or Lubriplate #70)
- 4. Isopropyl alcohol
- 5. Cleaning Rags
- 6. Cotton Swabs

2.0 Maintenance

The frequency at which normal maintenance (cleaning, lubrication and inspection) should be performed when the printer is installed in a clean office environment should normally be one year. However, if the printer is subjected to heavy usage and/or a dirty environment, the frequency should be increased as required.

2.1 Cleaning

- A. Clean printer thoroughly using alcohol, rags and cotton swabs to remove hardened grease, ink and dirt.
- B. Rotate platen and clean with an alcohol soaked rag.
- C. Remove head and clean head and head shaft with alcohol.
- D. Reassemble head to printer.
- E. Apply a small amount of recommended grease to head shaft.

2.2 Inspection

- A. Check for print wire movement on all seven solenoids by depressing wire end and noting return to rest position.
- B. Check for easy movement of the head assembly on the print head assembly shaft.
- C. Inspect the ribbon reverse mechanism for proper movement. Manually operate the ribbon feed pawl back and forth to check operation. Be sure that both springs are securely in place and of equal tension.
- D. Inspect the printer for any loose or missing screws.
- E. Check for excessive vertical movement of print head drive cam. Usual cause is a loose paper feed motor. Rotate the drive cam toward the platen and listen for an audible click of the home micro switch.
 - (1) The position of the switch arm roller at the click should be half-way up/down the high dwell ramp of the cam.
 - (2) The switch activating arm should be straight with no kinks.
- F. Check the paper feed cam for tightness on motor shaft (looseness may be a result of a bad cam or improper motor shaft configuration).

- G. Rotate the paper feed cam clockwise (toward platen) and check for smooth operation. Binding indicated bad fit between cam and pawl arm. Listen to the paper feed micro switch for an audible click.
 - (1) The position of the switch arm roller at the click should be half-way up/down the high dwell ramp of the cam.
 - (2) The switch activating arm should be straight with no kinks.
- H. Check that right end of print platen is not loose with regard to platen drum.
- I. Check that the platen spins freely when paper release lever is depressed and ratchet pawl is disengaged.
- J. Check that the plastic paper guide strip edge touches the platen drum over its entire length.
- K. Check that the plastic paper guide strip is secured to the extrusion mounting surface.
- L. Check that the print head moves freely along its shaft and within the drive cam groove while turning the drive cam toward the platen.
- M. Place the ribbon in place and check that it does not snag throughout its path. Check ribbon spool drag.
- N. Depress paper release lever and check that bar and feed roll leave the print platen.
- O. Check that two ply form may be loaded when paper release lever is depressed.
- P. Check that paper guides are not loose on main frame extrusion and that they may be moved with moderate pressure for adjustment.
- Q. Inside guide edges should be flush with inside edges of sides of supply mechanism.

2.3 Lubrication

Recommended lubricants are IBM #23 or Lubriplate #70. After cleaning, the following areas should require lubrication:

- a. Head shaft
- b. Groove in main drive cam
- c. Guide in extrusion in which the "tail" of the print head travels.

Only a small amount of lubricant, enough to create a film, is needed in each location.

The following areas may also require lubrication, if the area has been wiped free of lubricant:

- a. Paper feed cam and pawl
- b. Ribbon feed pawl
- c. Platen detent teeth
- d. Platen ratchet teeth
- e. Pressure roll release lever

3.0 Repair and Adjustments

3.1 Troubleshooting Guide

The Mechanism Troubleshooting Table should provide a means of determining the cause of any malfunction and the proper corrective action.

3.2 Repair Techniques

3.2.1 Head Replacement and Adjustments

Remove the old head by removing the two screws which hold the head shaft in place and then pulling the head shaft and head up out of the mechanism. To free the head cable the cable tie must be cut.

Remove shaft from old head and slide it into the bearings on the replacement head. The head assembly should move freely along the shaft. To check for free movement hold the head assembly with the shaft vertical and release the shaft. It should drop through the head assembly. If it does not move freely, hold the head assembly on one end of the shaft and tap the other end firmly on a hard surface. This will cause the head assembly bushings to seat perpendicular to the shaft. The replacement head can now be installed in the printer in the reverse manner of its removal. When tightening the screws in the head shaft, hold the shaft forward to minimize the distance between it and the platen. Insure that the drive pin on the bottom of the head mates with the groove in the drive cam and that the "tail" on the head is placed in the guide slot on the extrusion. Lubricate according to paragraph 2.3 prior to operation.

3.2.2 Switch Replacement

3.2.2.1 Line Feed Switch (FPF Mechanism Only)

To replace the line feed switch it is first necessary to remove the left side frame. This is done by first removing the twirler from the platen. Then remove the three screws which secure the side frame to the main extrusion as well as the screw in the left side of the head shaft. Once these screws are removed the left side frame can be pulled away from the printer. The line feed switch can now be removed from the side frame by lifting it off its mounting tabs. The replacement switch is then pressed onto those tabs and a piece of adhesive-backed foam is placed on the switch where it contacts the main extrusion. The side frame can now be replaced taking care to align the platen pressure roll support bracket, head shaft and main drive cam to their proper positions.

3.2.2.2 Print Switch

To replace the print switch it is first necessary to remove the right side frame. This is done by removing the three screws that secure the side frame to the main extrusion as well as removing the screw in the right hand side of the head shaft. The side frame can now be removed, taking care to disengage the motor pulley from the belt. Holding the detent lever down (forward) will aid in the removal of the frame. The print switch can now be removed by lifting it off its mounting tabs. The replacement switch is then pressed onto these tabs and adhesive-backed foam is applied to the switch where it contacts the main extrusion. The printer is then reassembled taking care to align the main drive cam and platen properly. During reassembly the detent lever must be held down to avoid interference with the ratchet teeth on the platen, and the motor pulley must have the belt placed back on it.

3.2.3 Belt Tension

Drive belt tension is adjusted by loosening the two motor mounting screws and moving the motor forwards or backwards to decrease or increase the belt tension. The belt tension should be set so that when the head is prevented from moving, the motor stalls and the belt does not cog over the motor pulley. Excessive belt tension will cause the drive cam to bind and the motor to stall. Too little belt tension will result in excessive variation in character widths.

3.2.4 Head to Platen Air Gap

If the printhead has been replaced due to solenoid failure or if the printer has been disassembled, the printhead to platen air gap should be checked prior to using the printer. Improper air gap can result in damage to the printhead. The printhead to platen air gap may be checked by using feeler gauges. Prior to checking the air gap it is necessary to remove the paper and ribbon from the printer.

The head to platen air gap should be .012" to .015". If the air gap is out of the allowable range, some adjustment can be made by loosening the screws in the head shaft and pushing it in the desired direction. If this does not yield sufficient change then it is necessary to loosen the side frames and move them upward or downward in relation to the main extrusion

MECHANISM TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Print motor starts but doesn't stop. No printing occurs.	<ol style="list-style-type: none"> 1. Broken print switch 2. Broken switch wire 3. Misadjusted print switch 	<ol style="list-style-type: none"> 1. Replace switch 2. Check all wires on print switch for electrical continuity 3. Verify switch transfers when roller on switch actuator transfers between high and low positions on the cam pulley.
2. Once started, the line feed motor never stops	<ol style="list-style-type: none"> 1. Broken line feed switch 2. Broken switch wire 3. Misadjusted line feed switch 	<ol style="list-style-type: none"> 1. Replace switch 2. Check all wires for electrical continuity 3. Verify switch transfers when roller on switch actuator transfers between high and low positions on switch eccentric.
3. Print Motor stalls	<ol style="list-style-type: none"> 1. Excessive Belt tension 2. Bad crimp on one or more A.C. motor wires 3. Bad A.C. motor 	<ol style="list-style-type: none"> 1. Adjust belt tension 2. Visually verify crimps are good 3. Replace motor
4. Occasional missed line feed	<ol style="list-style-type: none"> 1. Bad line feed switch 2. Misadjusted line feed switch 	<ol style="list-style-type: none"> 1. Replace switch 2. Verify switch roller rides on lower surface of paper feed eccentric when in the home position, and that switch transfers when switch roller moves from low surface of the paper feed eccentric
5. Uneven line feeds	<ol style="list-style-type: none"> 1. Paper slippage 2. Metal wear plate broken off line feed pawl 3. Platen not detenting properly 	<ol style="list-style-type: none"> 1. Clean platen and/or replace pressure roll springs 2. Replace pawl 3. Check for defective detent mechanism.

MECHANISM TROUBLESHOOTING GUIDE (Continued)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
6. Line feed motor stalls	<ol style="list-style-type: none"> 1. Bad A.C. motor 2. Line feed pawl binds on eccentric 3. Bad wire to pin connections on A.C. motor wires 4. Platen won't turn or turns with difficulty 	<ol style="list-style-type: none"> 1. Replace A.C. motor 2. Replace pawl or eccentric 3. Check crimp on wire 4. Inspect detent mechanism for source of jam and replace or repair as required
7. Missing dots	<ol style="list-style-type: none"> 1. Ribbon not properly installed 2. Bad print solenoid 3. Head to platen gap excessive 	<ol style="list-style-type: none"> 1. Install ribbon correctly 2. Replace head 3. Verify head to platen gap is $.015" \pm .003"$
8. Excessive variation in character size	<ol style="list-style-type: none"> 1. Belt tension too loose 2. Start to print distance (distance from 1st dot position to inside of side frame) is out of tolerance ($.965 \pm .060"$) 3. Head binding on shaft 	<ol style="list-style-type: none"> 1. Tighten belt tension 2. Adjust print switch to correct start to print location. 3. Align head bearings on shaft. Lubricate shaft.

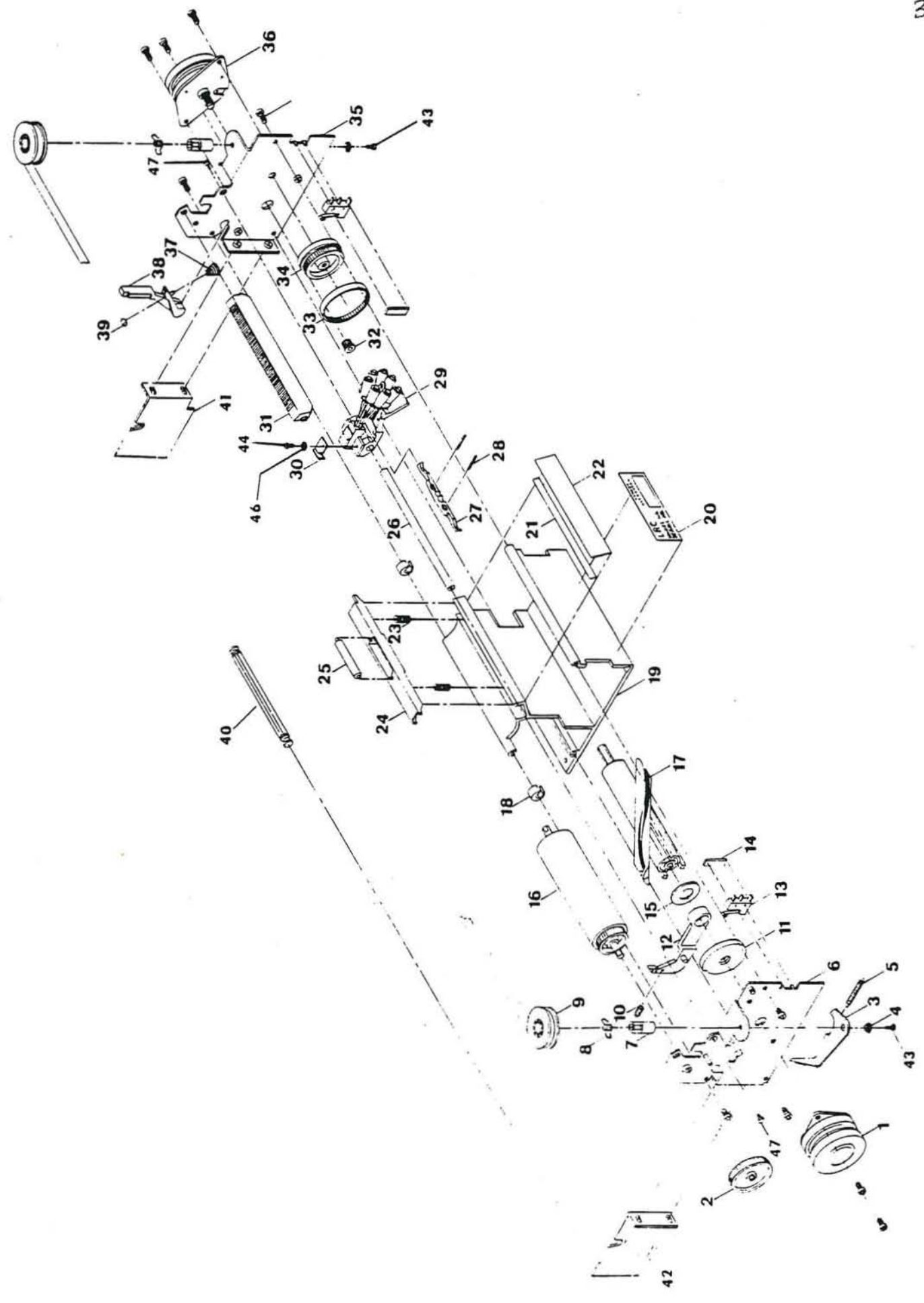
PART LIST 7040 J

<u>ITEM NO.</u>	<u>PART NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>
1.	101411-004	ASSY-A.C. MOTOR*	1
2.	100576	TWIRLER	1
3.	101528	BRACKET-RIBBON TENSION	1
4.	101225	SPACER-RIBBON POST	2
5.	102378	SPRING-RIBBON TENSION	1
6.	101383	ASSY-FRAME LEFT SIDE	1
7.	100625	ASSY-RIBBON POST	2
8.	102539	SPRING-RIBBON SPOOL BRAKE	2
9.	101221	ASSY-RIBBON & SPOOLS	1
10.	101231-005	SPRING-EXTENSION	1
11.	101035	ECCENTRIC PAPER FEED & SWITCH*	1
12.	101077	ASSY-PAWL FEED	1
13.	100272-005	SWITCH-ELECTRICAL	2
14.	102414-001	FOAM-TAPE	A/R
15.	101349	SHIM WASHER	1
16.	101013	MODIFICATION-PLATEN	1
17.	101073	ASSY-CAM DRIVE	1
18.	101065	GUIDE-PAPER	2
19.	101051	MODIFICATION-EXTRUSION	1
20.	101392	DECAL	1
21.	100543-004	TAPE	A/R
22.	101057	GUIDE-PAPER	1
23.	101918	SPRING-PRESSURE ROLL	2
24.	101003	SUPPORT-PRESSURE ROLL	1
25.	101067	ASSY-ROLLER PRESSURE	1
26.	101525	SHAFT-HEAD	1
27.	101117	RIBBON FEED PAWL	1
28.	100559	SPRING-RIBBON FEED PAWL	2
29.	101137-002	ASSY-HEAD 7 WIRE	1
30.	102409	DEFLECTOR-RIBBON HEAD	1
31.	101005	BLADE-TEAR OFF 40 COL.	1
32.	101086	PULLEY-DRIVE MOTOR	1
33.	101229-001	BELT	1

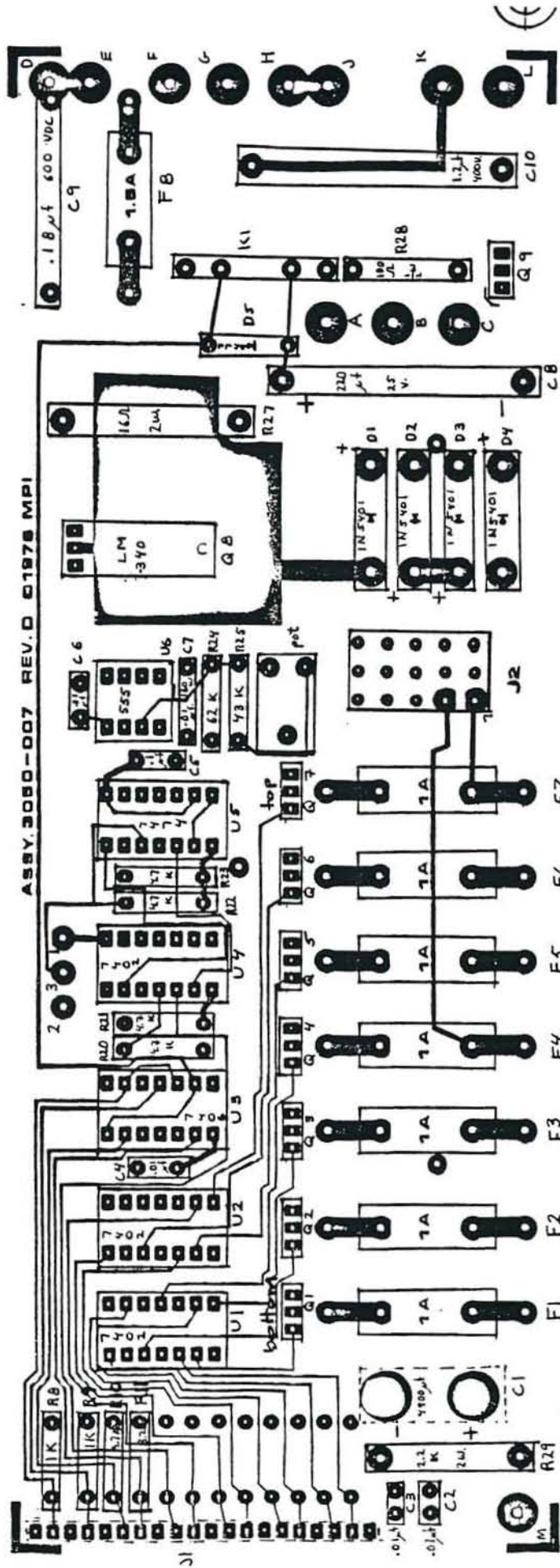
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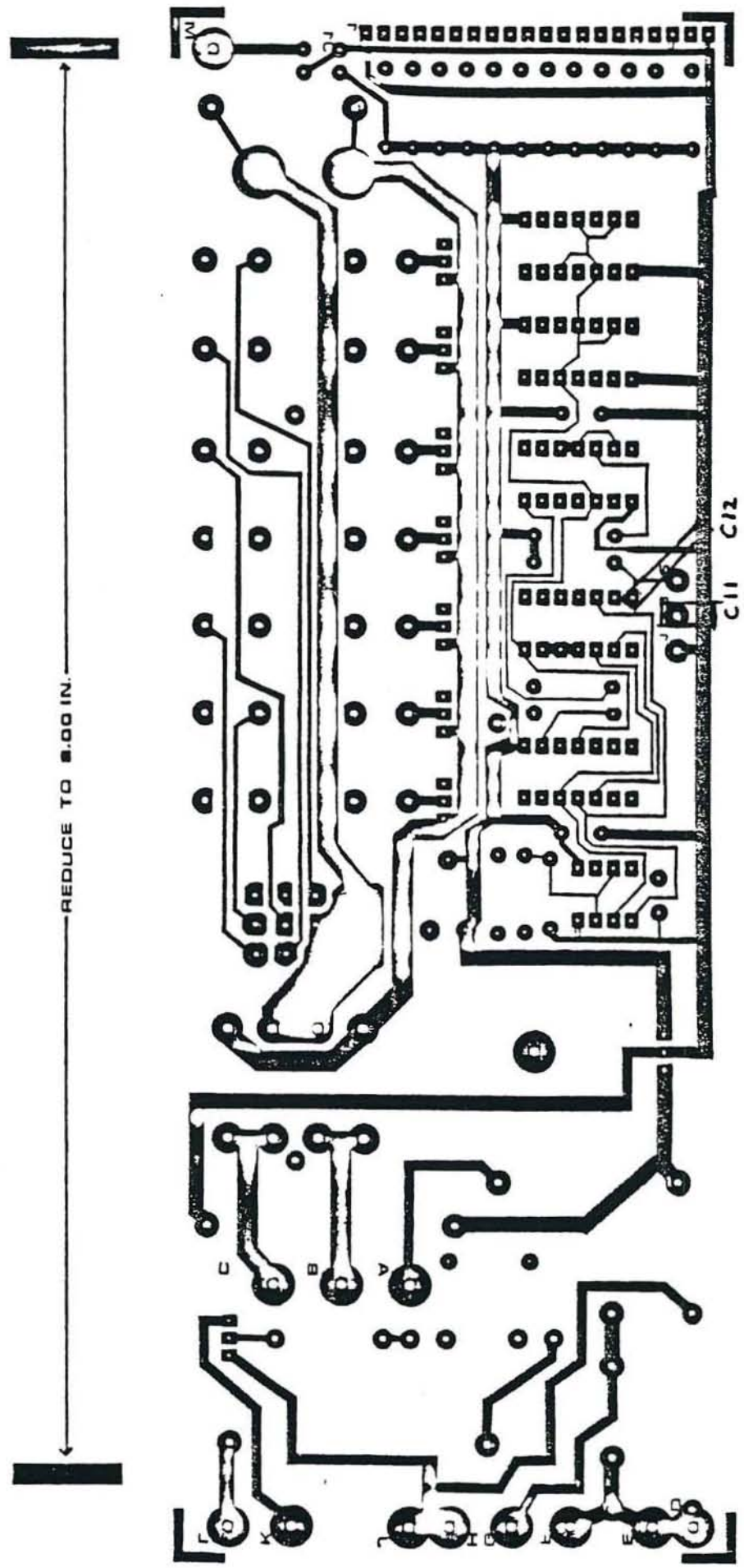
<u>ITEM NO.</u>	<u>PART NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>
34.	101008	PULLEY CAM 1½ LPS	1
35.	101281	ASSY-FRAME RIGHT SIDE	1
36.	101411-001	ASSY-A.C. MOTOR	1
37.	102361	SPRING-CONICAL COMPRESSION	1
38.	101069	DETENT	1
39.	101068	ROLLER-DETENT	1
40.	101433	MANDREL-40 COLUMN SUPPLY	1
41.	3030-021	RIGHT PAPER BRACKET	1
42.	3030-020	LEFT PAPER BRACKET	1
43.	100173-042	SCREW (4-40 x .218)	2
44.	100173-050	SCREW (4-40 x .187)	1
45.	100173-076	SCREW (8-32 x .375)	1
46.	100172-002	WASHER (#4 EXT. LOCK)	1
47.	100173-081	SCREW (4-40 x .218)	4

* Use on Fast Paper Feed version only.



ASSY. 3080-007 REV.D 01978 MPI





Resistors

Part #	Description
R8	1 K
R9	1 K
R10	4.7 K
R11	8.2 K
R20	4.7 K
R21	4.7 K
R22	4.7 K
R23	4.7 K
R24	62 K
R25	43 K
R27	16 Ω , 2W.
R28	100 Ω , 1/2W.
R29	2.2 K, 2W.

Capacitors

Part #	Description
C1	4900 μ t, 50 VDC
C2	.01 μ t
C3	.01 μ f
C4	.01 μ f
C5	.1 μ f
C6	.01 μ f
C7	.01 μ t, 160 VDC
C8	220 μ t, 25 VDC
C9	.18 μ f, 600 VDC
C10	1.2 μ t, 400 VDC
C11-12	.1 μ f (on back)

Diodes

Part #	Description
D1-4	1N5401
D5	7749

I C's

Part #	Description
U1	7402
U2	7402
U3	7406
U4	7402
U5	7474
U6	555

Fuses

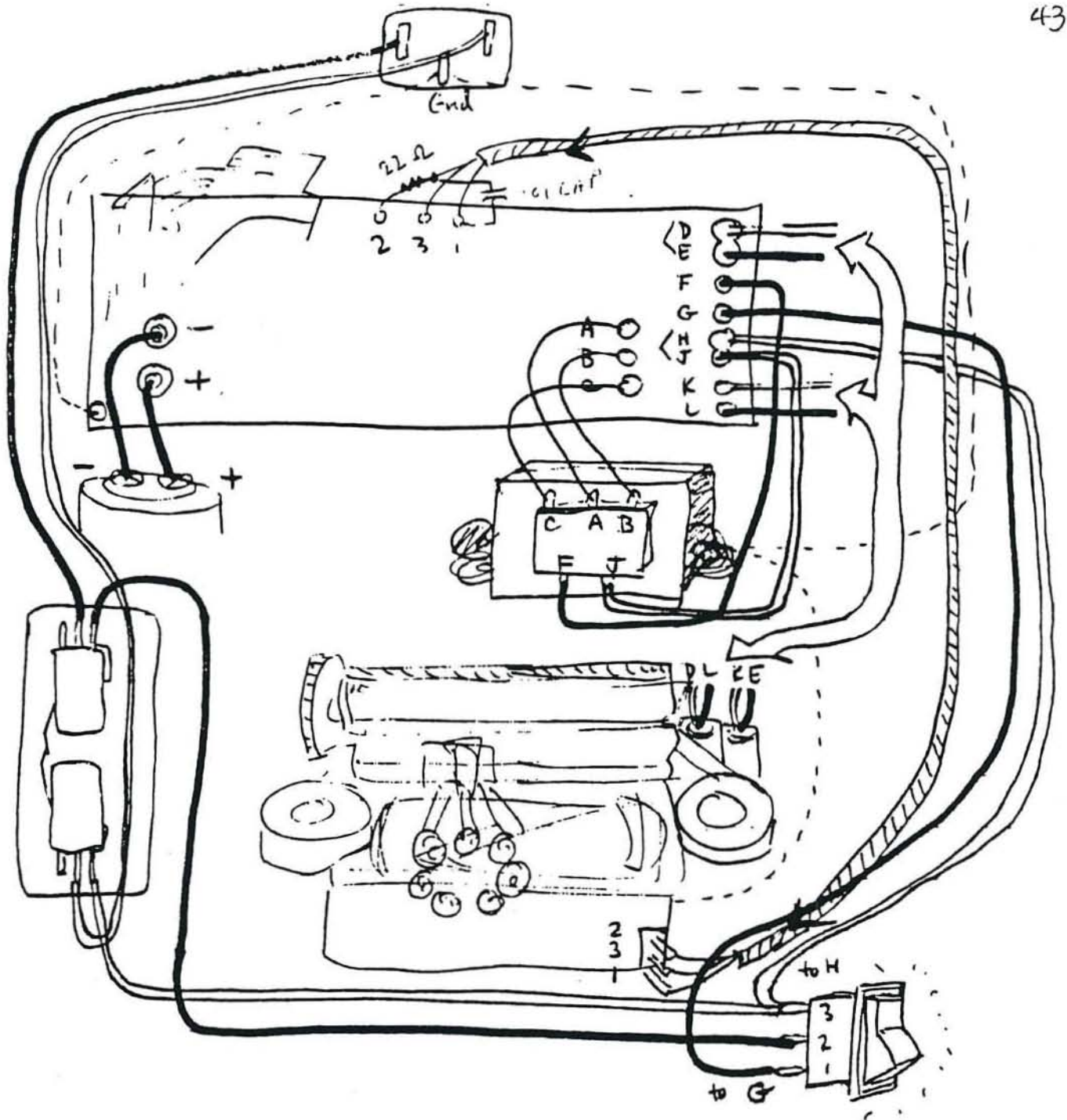
Part #	Description
F1-7	1 amp
F8	1.5 amps

Misc.

Part #	Description
J1	20 pin header
J2	print connector
K1	relay

Semiconductors

Part #	Description
1-7	2N6039
Q8	LM 340
Q9	TQ4-0063



Ken's Printer Wiring Diagram

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DATA SHEET

R6500 MICROPROCESSORS (CPU's)

SYSTEM ABSTRACT

The 8-bit R6500 microcomputer system is produced with N-Channel, Silicon Gate technology. Its performance speeds are enhanced by advanced system architecture which enables multiple addressing. Its innovative architecture results in smaller chips — the semiconductor threshold to cost-effectivity. System cost-effectivity is further enhanced by providing a family of 10 software-compatible microprocessor (CPU) devices which are described in this document. Rockwell also provides memory and I/O devices that further enhance the cost-effectivity of the R6500 microcomputer system . . . as well as low-cost design aids and documentation.

R6500 MICROPROCESSOR (CPU) CONCEPT

Ten CPU devices are available. All are software-compatible. They provide options of addressable memory, interrupt input, on-chip clock oscillators and drivers. All are bus-compatible with earlier generation microprocessors like the M6800 devices.

The family includes six microprocessors with on-board clock oscillators and drivers and four microprocessors driven by external clocks. The on-chip clock versions are aimed at high performance, low cost applications where single phase inputs, crystal or RC inputs provide the time base. The external clock versions are geared for the multiprocessor system applications where maximum timing control is mandatory. All versions of the microprocessors are available in 1 MHz and 2 MHz maximum operating frequencies.

MEMBERS OF THE R6500 MICROPROCESSOR (CPU) FAMILY

Microprocessors with On-Board Clock Oscillator

	Addressable Memory
R6502	65K Bytes
R6503	4K Bytes
R6504	8K Bytes
R6505	4K Bytes
R6506	4K Bytes
R6507	

Microprocessors with External Two Phase Clock Output

	Addressable Memory
R6512	65K Bytes
R6513	4K Bytes
R6514	8K Bytes
R6515	4K Bytes

FEATURES

- Single five volt supply
- N channel, silicon gate, depletion load technology
- Eight bit parallel processing
- 56 Instructions
- Decimal and binary arithmetic
- Thirteen addressing modes
- True indexing capability
- Programmable stack pointer
- Variable length stack
- Interrupt capability
- Non-maskable interrupt
- Use with any type or speed memory
- Bidirectional Data Bus
- Instruction decoding and control
- Addressable memory range of up to 65K bytes
- "Ready" input
- Direct memory access capability
- Bus compatible with M6800
- Choice of external or on-board clocks
- 1 MHz and 2 MHz operation
- On-the-chip clock options
 - External single clock input
 - RC time base input
 - Crystal time base input
- 40 and 28 pin package versions
- Pipeline architecture

Ordering Information

Order Number	Package Type	Frequency Option	Temperature Range
R65XXP	Plastic	1 MHz	0°C to +70°C
R65XXC	Ceramic	1 MHz	0°C to +70°C
R65XXAP	Plastic	2 MHz	0°C to +70°C
R65XXAC	Ceramic	2 MHz	0°C to +70°C

Where XX is 02, 03, 04, 05, 06, 07, 12, 13, 14, or 15 depending upon the features desired.

R650X's AND R651X's MICROPROCESSORS (CPU's)

R6500 Signal Description

Clocks (ϕ_1, ϕ_2)

The R651X requires a two phase non-overlapping clock that runs at the V_{CC} voltage level.

The R650X clocks are supplied with an internal clock generator. The frequency of these clocks is externally controlled. Details of this feature are discussed in the R6502 portion of this data sheet.

Address Bus (A_0-A_{15}) (See sections on each micro for respective address lines on those devices.)

These outputs are TTL compatible, capable of driving one standard TTL load and 130 pF.

Data Bus (D_0-D_7)

Eight pins are used for the data bus. This is a bidirectional bus, transferring data to and from the device and peripherals. The outputs are tri-state buffers capable of driving one standard TTL load and 130 pF.

Data Bus Enable (DBE)

This TTL compatible input allows external control of the tri-state data output buffers and will enable the microprocessor bus driver when in the high state. In normal operation DBE would be driven by the phase two (ϕ_2) clock, thus allowing data output from microprocessor only during ϕ_2 . During the read cycle, the data bus drivers are internally disabled, becoming essentially an open circuit. To disable data bus drivers externally, DBE should be held low.

Ready (RDY)

This input signal allows the user to single cycle the microprocessor on all cycles except write cycles. A negative transition to the low state during or coincident with phase one (ϕ_1) will halt the microprocessor with the output address lines reflecting the current address being fetched. This condition will remain through a subsequent phase two (ϕ_2) in which the Ready signal is low. This feature allows microprocessor interfacing with low speed PROMS as well as fast (max. 2 cycle) Direct Memory Access (DMA). If Ready is low during a write cycle, it is ignored until the following read operation.

Interrupt Request (\overline{IRQ})

This TTL level input requests that an interrupt sequence begin within the microprocessor. The microprocessor will complete the current instruction being executed before recognizing the request. At that time, the interrupt mask bit in the Status Code Register will be examined. If the interrupt mask flag is not set, the microprocessor will begin an interrupt sequence. The Program Counter and Processor Status Register are stored in the stack. The microprocessor will then set the interrupt mask flag high so that no further interrupts may occur. At the end of this cycle, the program counter low will be loaded from address FFFE, and program counter high from location FFFF, therefore transferring program control to the memory vector located at these addresses. The RDY signal must be in the high state for any interrupt to be recognized. A $3K\Omega$ external resistor should be used for proper wire-OR operation.

Non-Maskable Interrupt (\overline{NMI})

A negative going edge on this input requests that a non-maskable interrupt sequence be generated within the microprocessor.

\overline{NMI} is an unconditional interrupt. Following completion of the current instruction, the sequence of operations defined for \overline{IRQ} will be performed, regardless of the state interrupt mask flag. The vector address loaded into the program counter, low and high, are locations FFFA and FFFB respectively, thereby transferring program control to the memory vector located at these addresses. The instructions loaded at these locations cause the microprocessor to branch to a non-maskable interrupt routine in memory.

\overline{NMI} also requires an external $3K\Omega$ resistor to V_{CC} for proper wire-OR operations.

Inputs \overline{IRQ} and \overline{NMI} are hardware interrupts lines that are sampled during ϕ_2 (phase 2) and will begin the appropriate interrupt routine on the ϕ_1 (phase 1) following the completion of the current instruction.

Set Overflow Flag (S.O.)

A NEGATIVE going edge on this input sets the overflow bit in the Status Code Register. This signal is sampled on the trailing edge of ϕ_1 .

SYNC

This output line is provided to identify those cycles in which the microprocessor is doing an OP CODE fetch. The SYNC line goes high during ϕ_1 of an OP CODE fetch and stays high for the remainder of that cycle. If the RDY line is pulled low during the ϕ_1 clock pulse in which SYNC went high, the processor will stop in its current state and will remain in the state until the RDY line goes high. In this manner, the SYNC signal can be used to control RDY to cause single instruction execution.

Reset

This input is used to reset or start the microprocessor from a power down condition. During the time that this line is held low, writing to or from the microprocessor is inhibited. When a positive edge is detected on the input, the microprocessor will immediately begin the reset sequence.

After a system initialization time of six clock cycles, the mask interrupt flag will be set and the microprocessor will load the program counter from the memory vector locations FFFC and FFFD. This is the start location for program control.

After V_{CC} reaches 4.75 volts in a power up routine, reset must be held low for at least two clock cycles. At this time the R/W and (SYNC) signal will become valid.

When the reset signal goes high following these two clock cycles, the microprocessor will proceed with the normal reset procedure detailed above.

ADDRESSING MODES

ACCUMULATOR ADDRESSING – This form of addressing is represented with a one byte instruction, implying an operation on the accumulator.

IMMEDIATE ADDRESSING – In immediate addressing, the operand is contained in the second byte of the instruction, with no further memory addressing required.

ABSOLUTE ADDRESSING – In absolute addressing, the second byte of the instruction specifies the eight low order bits of the effective address while the third byte specifies the eight high order bits. Thus, the absolute addressing mode allows access to the entire 65K bytes of addressable memory.

ZERO PAGE ADDRESSING – The zero page instructions allow for shorter code and execution times by only fetching the second byte of the instruction and assuming a zero high address byte. Careful use of the zero page can result in significant increase in code efficiency.

INDEXED ZERO PAGE ADDRESSING – (X, Y indexing) – This form of addressing is used in conjunction with the index register and is referred to as "Zero Page, X" or "Zero Page, Y". The effective address is calculated by adding the second byte to the contents of the index register. Since this is a form of "Zero Page" addressing, the content of the second byte references a location in page zero. Additionally due to the "Zero Page" addressing nature of this mode, no carry is added to the high order 8 bits of memory and crossing of page boundaries does not occur.

INDEXED ABSOLUTE ADDRESSING – (X, Y indexing) – This form of addressing is used in conjunction with X and Y index register and is referred to as "Absolute, X", and "Absolute, Y". The effective address is formed by adding the contents of X or Y to the address contained in the second and third bytes of the instruction. This mode allows the index register to contain the index or count value and the instruction to contain the base address. This type of indexing allows any location referencing and the index to modify multiple fields resulting in reduced coding and execution time.

IMPLIED ADDRESSING – In the implied addressing mode, the address containing the operand is implicitly stated in the operation code of the instruction.

RELATIVE ADDRESSING – Relative addressing is used only with branch instructions and establishes a destination for the conditional branch.

The second byte of the instruction becomes the operand which is an "Offset" added to the contents of the lower eight bits of the program counter when the counter is set at the next instruction. The range of the offset is -128 to +127 bytes from the next instruction.

INDEXED INDIRECT ADDRESSING – In indexed indirect addressing (referred to as (Indirect, X)), the second byte of the instruction is added to the contents of the X index register, discarding the carry. The result of this addition points to a memory location on page zero whose contents is the low order eight bits of the effective address. The next memory location in page zero contains the high order eight bits of the effective address. Both memory locations specifying the high and low order bytes of the effective address must be in page zero.

INDIRECT INDEXED ADDRESSING – In indirect indexed addressing (referred to as (Indirect), Y), the second byte of the instruction points to a memory location in page zero. The contents of this memory location is added to the contents of the Y index register, the result being the low order eight bits of the effective address. The carry from this addition is added to the contents of the next page zero memory location, the result being the high order eight bits of the effective address.

ABSOLUTE INDIRECT – The second byte of the instruction contains the low order eight bits of a memory location. The high order eight bits of that memory location is contained in the third byte of the instruction. The contents of the fully specified memory location is the low order byte of the effective address. The next memory location contains the high order byte of the effective address which is loaded into the sixteen bits of the program counter.

INSTRUCTION SET – ALPHABETIC SEQUENCE

ADC Add Memory to Accumulator with Carry
AND "AND" Memory with Accumulator
ASL Shift left One Bit (Memory or Accumulator)

BCC Branch on Carry Clear
BCS Branch on Carry Set
BEQ Branch on Result Zero
BIT Test Bits in Memory with Accumulator
BMI Branch on Result Minus
BNE Branch on Result not Zero
BPL Branch on Result Plus
BRK Force Break
BVC Branch on Overflow Clear
BVS Branch on Overflow Set

CLC Clear Carry Flag
CLD Clear Decimal Mode
CLI Clear Interrupt Disable Bit
CLV Clear Overflow Flag
CMP Compare Memory and Accumulator
CPX Compare Memory and Index X
CPY Compare Memory and Index Y

DEC Decrement Memory by One
DEX Decrement Index X by One
DEY Decrement Index Y by One

EOR "Exclusive-or" Memory with Accumulator

INC Increment Memory by One
INX Increment Index X by One
INY Increment Index Y by One

JMP Jump to New Location
JSR Jump to New Location Saving Return Address

LDA Load Accumulator with Memory
LDX Load Index X with Memory
LDY Load Index Y with Memory
LSR Shift One Bit Right (Memory or Accumulator)

NOP No Operation

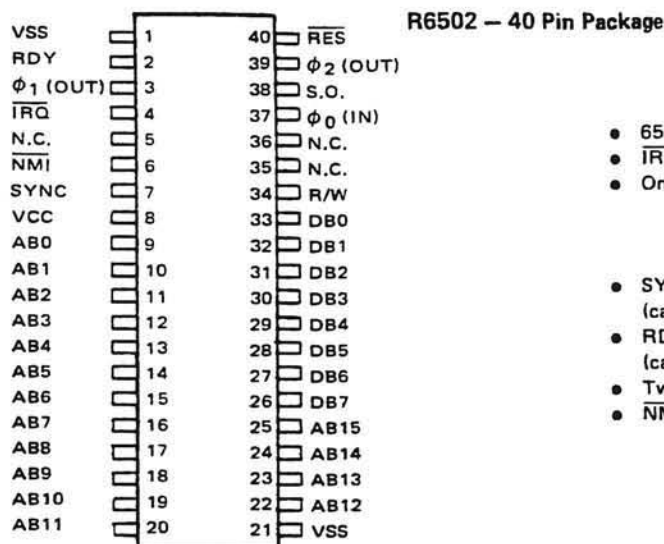
ORA "OR" Memory with Accumulator

PHA Push Accumulator on Stack
PHP Push Processor Status on Stack
PLA Pull Accumulator from Stack
PLP Pull Processor Status from Stack

ROL Rotate One Bit Left (Memory or Accumulator)
ROR Rotate One Bit Right (Memory or Accumulator)
RTI Return from Interrupt
RTS Return from Subroutine

SBC Subtract Memory from Accumulator with Borrow
SEC Set Carry Flag
SED Set Decimal Mode
SEI Set Interrupt Disable Status
STA Store Accumulator in Memory
STX Store Index X in Memory
STY Store Index Y in Memory

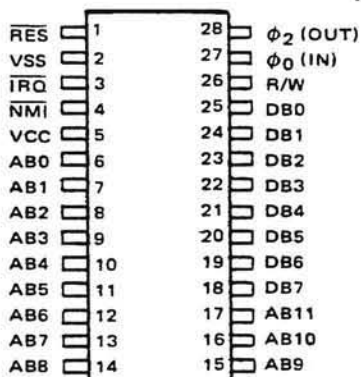
TAX Transfer Accumulator to Index X
TAY Transfer Accumulator to Index Y
TSX Transfer Stack Pointer to Index X
TXA Transfer Index X to Accumulator
TXS Transfer Index X to Stack Register
TYA Transfer Index Y to Accumulator



Features of R6502

- 65K Addressable Bytes of Memory
- \overline{IRQ} Interrupt
- On-the-chip Clock
 - TTL Level Single Phase Input
 - RC Time Base Input
 - Crystal Time Base Input
- SYNC Signal
(can be used for single instruction execution)
- RDY Signal
(can be used for single cycle execution)
- Two Phase Output Clock for Timing of Support Chips
- \overline{NMI} Interrupt

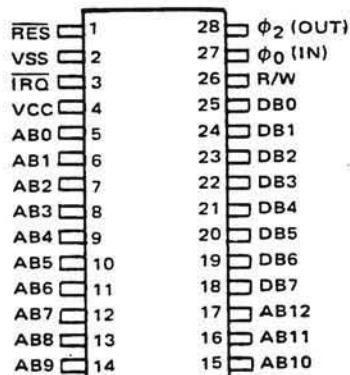
R6503 – 28 Pin Package



Features of R6503

- 4K Addressable Bytes of Memory (AB00-AB11)
- On-the-chip Clock
- \overline{IRQ} Interrupt
- \overline{NMI} Interrupt
- 8 Bit Bidirectional Data Bus

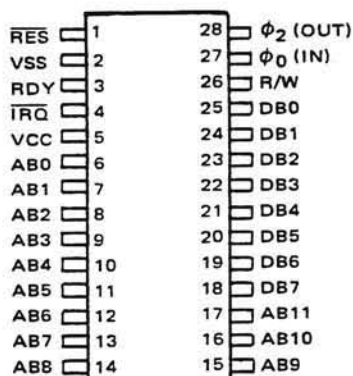
R6504 – 28 Pin Package



Features of R6504

- 8K Addressable Bytes of Memory (AB00-AB12)
- On-the-chip Clock
- \overline{IRQ} Interrupt
- 8 Bit Bidirectional Data Bus

R6505 – 28 Pin Package

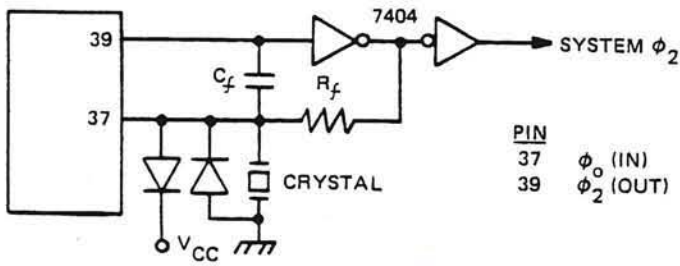


Features of R6505

- 4K Addressable Bytes of Memory (AB00-AB11)
- On-the-chip Clock
- \overline{IRQ} Interrupt
- RDY Signal
- 8 Bit Bidirectional Data Bus

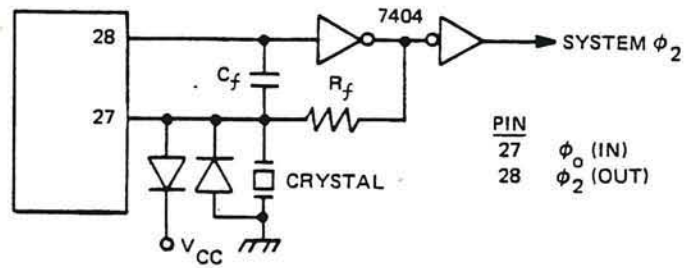
TIME BASE GENERATION OF INPUT CLOCK

R6502

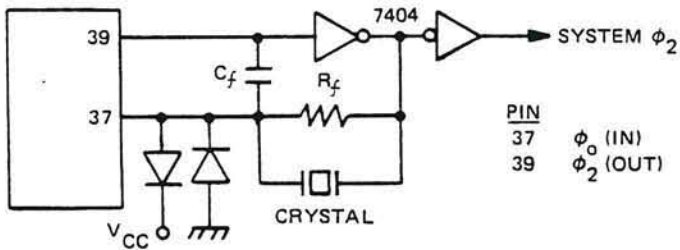


R6502 Parallel Mode Crystal Controlled Oscillator

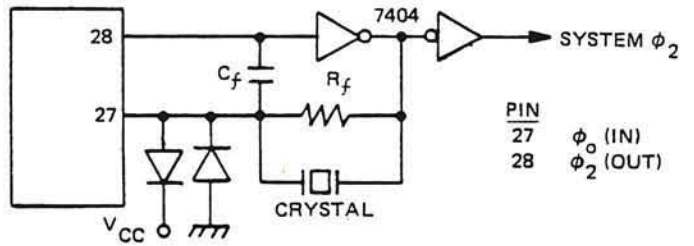
R6503, R6504, R6505, R6506, R6507



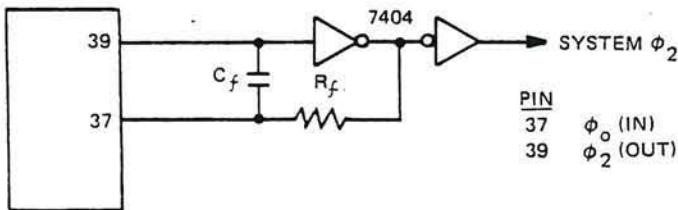
R6503, 04, 05, 06, 07 Parallel Mode Crystal Controlled Oscillator



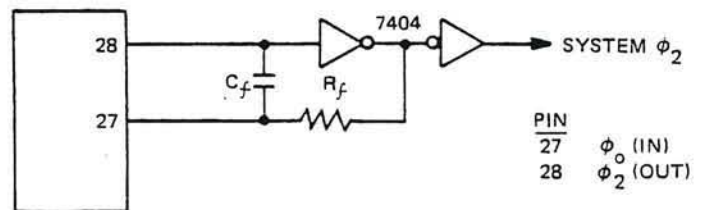
R6502 Series Mode Crystal Controlled Oscillator



R6503, 04, 05, 06, 07 Series Mode Crystal Controlled Oscillator



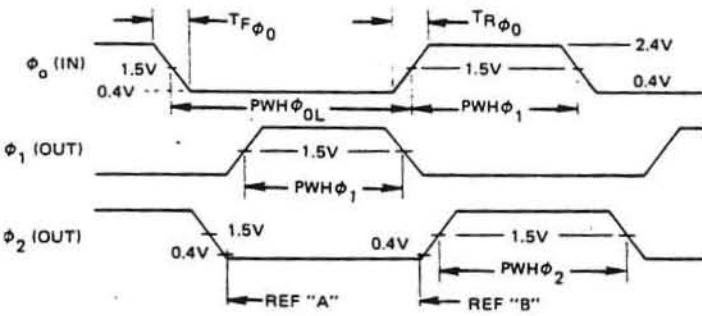
R6502 Time Base Generator - RC Network



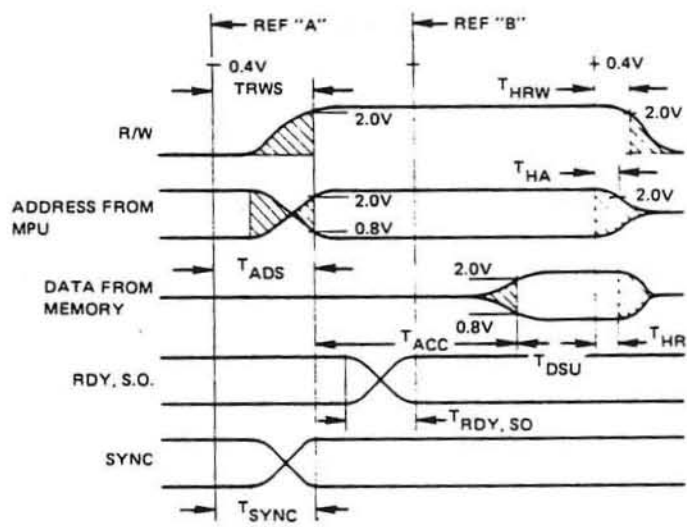
R6503, 04, 05, 06, 07 Time Base Generation RC Network

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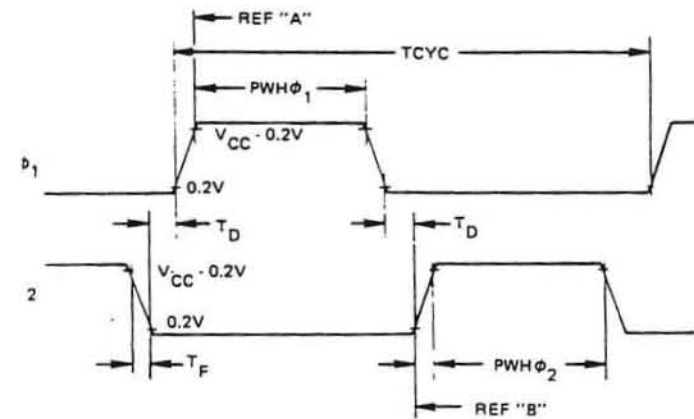
Clock Timing – R6502, 03, 04, 05, 06, 07



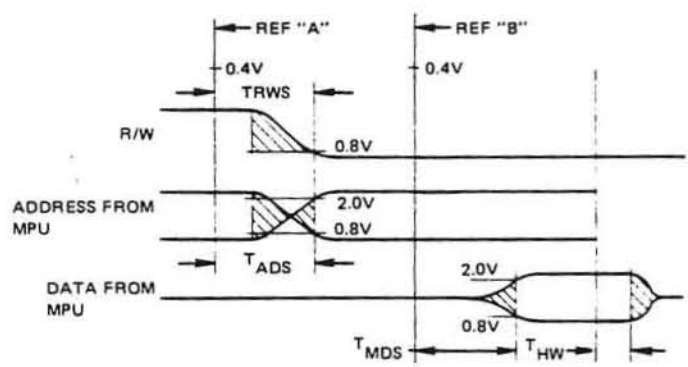
Timing for Reading Data from Memory or Peripherals



Clock Timing – R6512, 13, 14, 15

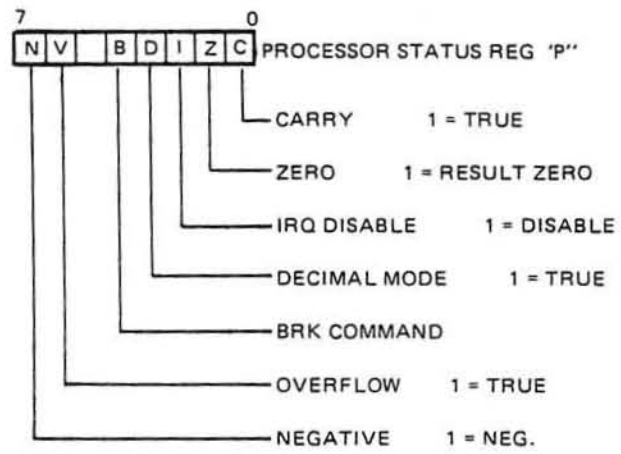
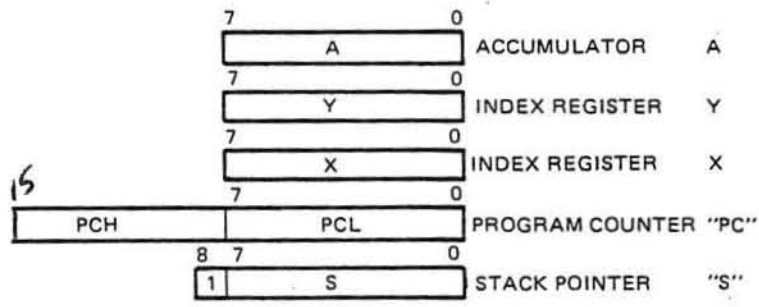


Timing for Writing Data to Memory or Peripherals



Note: "REF." means Reference Points on clocks.

PROGRAMMING MODEL



1 MHz Timing

2 MHz Timing

Clock Timing – R6502, 03, 04, 05, 06, 07

Characteristic	Symbol	Min	Typ	Max	Units
Cycle Time	T_{CYC}	1000	–	–	ns
$\phi_{0(IN)}$ Pulse Width (measured at 1.5V)	$PWH\phi_0$	460	–	520	ns
$\phi_{0(IN)}$ Rise, Fall Time	$TR\phi_0, TF\phi_0$	–	–	10	ns
Delay Time Between Clocks (measured at 1.5V)	T_D	5	–	–	ns
$\phi_{1(OUT)}$ Pulse Width (measured at 1.5V)	$PWH\phi_1$	$PWH\phi_{0L} - 20$	–	$PWH\phi_{0L}$	ns
$\phi_{2(OUT)}$ Pulse Width (measured at 1.5V)	$PWH\phi_2$	$PWH\phi_{0H} - 40$	–	$PWH\phi_{0H} + 10$	ns
$\phi_{1(OUT)}$ - $\phi_{2(OUT)}$ Rise, Fall Time (measured at 0.8V to 2.0V) (Load = 30 pF + 1 TTL)	T_R, T_F	–	–	25	ns

Clock Timing – R6502, 03, 04, 05, 06, 07

Characteristic	Symbol	Min	Typ	Max	Units
Cycle Time	T_{CYC}	500	–	–	ns
$\phi_{0(IN)}$ Pulse Width (measured at 1.5V)	$PWH\phi_0$	240	–	260	ns
$\phi_{0(IN)}$ Rise, Fall Time	$TR\phi_0, TF\phi_0$	–	–	10	ns
Delay Time Between Clocks (measured at 1.5V)	T_D	5	–	–	ns
$\phi_{1(OUT)}$ Pulse Width (measured at 1.5V)	$PWH\phi_1$	$PWH\phi_{0L} - 20$	–	$PWH\phi_{0L}$	ns
$\phi_{2(OUT)}$ Pulse Width (measured at 1.5V)	$PWH\phi_2$	$PWH\phi_{0H} - 40$	–	$PWH\phi_{0H} + 10$	ns
$\phi_{1(OUT)}$ - $\phi_{2(OUT)}$ Rise, Fall Time (measured at 0.8V to 2.0V) (Load = 30 pF + 1 TTL)	T_R, T_F	–	–	25	ns

Clock Timing – R6512, 13, 14, 15

Characteristic	Symbol	Min	Typ	Max	Units
Cycle Time	T_{CYC}	1000	–	–	nsec
Clock Pulse Width ϕ_1 (Measured at Vcc - 0.2V)	$PWH\phi_1$	430	–	–	nsec
ϕ_2	$PWH\phi_2$	470	–	–	nsec
Fall Time (Measured from 0.2V to Vcc - 0.2V)	T_F	–	–	25	nsec
Delay Time Between Clocks (Measured at 0.2V)	T_D	0	–	–	nsec

Clock Timing – R6512, 13, 14, 15

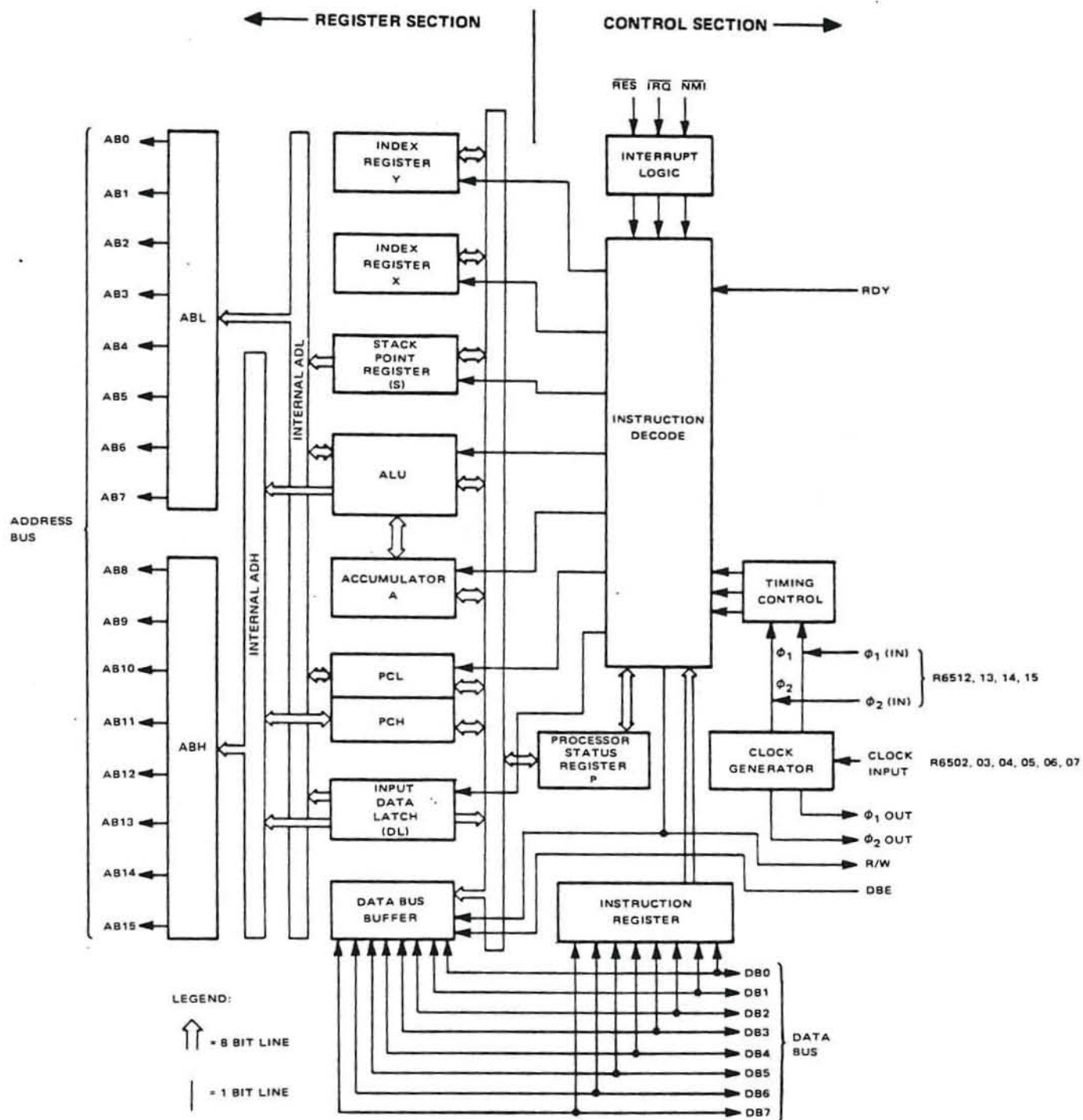
Characteristic	Symbol	Min	Typ	Max	Units
Cycle Time	T_{CYC}	500	–	–	nsec
Clock Pulse Width ϕ_1 (Measured at Vcc - 0.2V)	$PWH\phi_1$	215	–	–	nsec
ϕ_2	$PWH\phi_2$	235	–	–	nsec
Fall Time (Measured from 0.2V to Vcc - 0.2V)	T_F	–	–	12	nsec
Delay Time Between Clocks (Measured at 0.2V)	T_D	0	–	–	nsec

Read/Write Timing

Characteristic	Symbol	Min	Typ	Max	Units
Read/Write Setup Time from R6500	T_{RWS}	–	100	300	ns
Address Setup Time from R6500	T_{ADS}	–	100	300	ns
Memory Read Access Time	T_{ACC}	–	–	575	ns
Data Stability Time Period	T_{DSU}	100	–	–	ns
Data Hold Time – Read	T_{HR}	10	–	–	ns
Data Hold Time – Write	T_{HW}	30	60	–	ns
Data Setup Time from R6500	T_{MDS}	–	150	200	ns
RDY, S.O. Setup Time	T_{RDY}	100	–	–	ns
SYNC Setup Time from R6500	T_{SYNC}	–	–	350	ns
Address Hold Time	T_{HA}	30	60	–	ns
R/W Hold Time	T_{HRW}	30	60	–	ns

Read/Write Timing

Characteristic	Symbol	Min	Typ	Max	Units
Read/Write Setup Time from R6500A	T_{RWS}	–	100	150	ns
Address Setup Time from R6500A	T_{ADS}	–	100	150	ns
Memory Read Access Time	T_{ACC}	–	–	300	ns
Data Stability Time Period	T_{DSU}	50	–	–	ns
Data Hold Time – Read	T_{HR}	10	–	–	ns
Data Hold Time – Write	T_{HW}	30	60	–	ns
Data Setup Time from R6500A	T_{MDS}	–	75	100	ns
RDY, S.O. Setup Time	T_{RDY}	50	–	–	ns
SYNC Setup Time from R6500A	T_{SYNC}	–	–	175	ns
Address Hold Time	T_{HA}	30	60	–	ns
R/W Hold Time	T_{HRW}	30	60	–	ns



R6500 Internal Architecture

SPECIFICATIONS

Maximum Ratings

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	-0.3 to +7.0	Vdc
Input Voltage	V_{in}	-0.3 to +7.0	Vdc
Operating Temperature	T_A	0 to +70	°C
Storage Temperature	T_{STG}	-55 to +150	°C

This device contains input protection against damage due to high static voltages or electric fields; however, precautions should be taken to avoid application of voltages higher than the maximum rating.

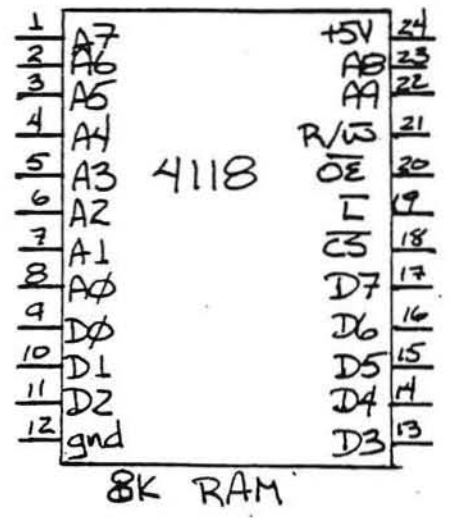
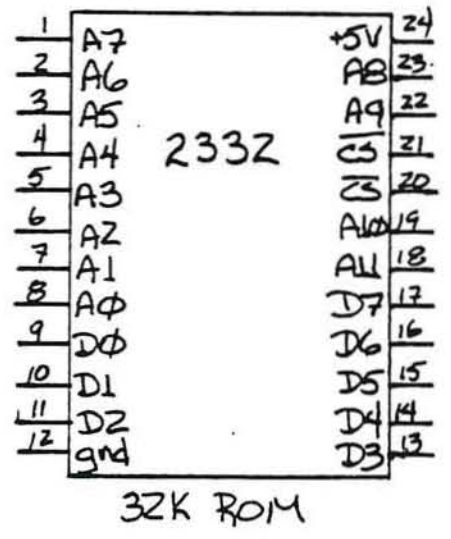
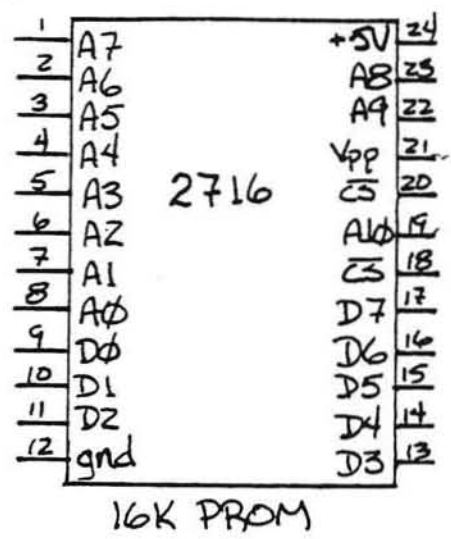
Electrical Characteristics

($V_{CC} = 5.0 \pm 5\%$, $V_{SS} = 0$, $T_A = 25^\circ\text{C}$)

ϕ_1 , ϕ_2 applies to R6512, 13, 14, 15, $\phi_{o(in)}$ applies to R6502, 03, 04, 05, 06 and 07.

Characteristic	Symbol	Min	Typ	Max	Unit
Input High Voltage Logic, $\phi_{o(in)}$ ϕ_1, ϕ_2	V_{IH}	$V_{SS} + 2.4$ $V_{CC} - 0.2$	- -	V_{CC} $V_{CC} + 0.25$	Vdc
Input Low Voltage Logic, $\phi_{o(in)}$ ϕ_1, ϕ_2	V_{IL}	$V_{SS} - 0.3$ $V_{SS} - 0.3$	- -	$V_{SS} + 0.4$ $V_{SS} + 0.2$	Vdc
Input High Threshold Voltage \overline{RES} , \overline{NMI} , RDY, \overline{IRQ} , Data, S.O.	V_{IHT}	$V_{SS} + 2.0$	-	-	Vdc
Input Low Threshold Voltage \overline{RES} , \overline{NMI} , RDY, \overline{IRQ} , Data, S.O.	V_{ILT}	-	-	$V_{SS} + 0.8$	Vdc
Input Leakage Current ($V_{in} = 0$ to 5.25V, $V_{CC} = 0$) Logic (Excl. RDY, S.O.) ϕ_1, ϕ_2 $\phi_{o(in)}$	I_{in}	- - -	- - -	2.5 100 10.0	μA μA μA
Three-State (Off State) Input Current ($V_{in} = 0.4$ to 2.4V, $V_{CC} = 5.25\text{V}$) Data Lines	I_{TSI}	-	-	10	μA
Output High Voltage ($I_{LOAD} = -100 \mu\text{Adc}$, $V_{CC} = 4.75\text{V}$) SYNC, Data, A0-A15, R/W	V_{OH}	$V_{SS} + 2.4$	-	-	Vdc
Output Low Voltage ($I_{LOAD} = 1.6 \text{mAdc}$, $V_{CC} = 4.75\text{V}$) SYNC, Data, A0-A15, R/W	V_{OL}	-	-	$V_{SS} + 0.4$	Vdc
Power Dissipation	P_D	-	0.25	0.70	W
Capacitance ($V_{in} = 0$, $T_A = 25^\circ\text{C}$, $f = 1 \text{MHz}$) Logic Data A0-A15, R/W, SYNC $\phi_{o(in)}$ ϕ_1 ϕ_2	C C_{in} C_{out} $C_{\phi_{o(in)}}$ C_{ϕ_1} C_{ϕ_2}	- - - - - -	- - - - 30 50	10 15 12 15 50 80	pF

Note: \overline{IRQ} and \overline{NMI} require 3K pull-up resistors.



2048 x 8-BIT PROM

Electrically Programmable/Ultraviolet Erasable ROM

MK2716 (T)-5/6/7/8

FEATURES

- Replacement for popular 2048 x 8 bit 2716 type EPROM
- Single +5 volt power supply during READ operation
- Fast Access Time in READ mode

P/N	Access Time
MK2716-5	300ns
MK2716-6	350ns
MK2716-7	390ns
MK2716-8	450ns

- Low Power Dissipation: 525 mW max active

- Power Down mode: 132 mW max standby
- Three State Output OR-tie capability
- Five modes of operation for greater system flexibility (see Table)
- Single programming requirement: single location programming with one 50 msec pulse
- Pin Compatible with Mostek's Wide Word Memory Family
- TTL compatible in all operating modes
- Standard 24 pin DIP with transparent lid

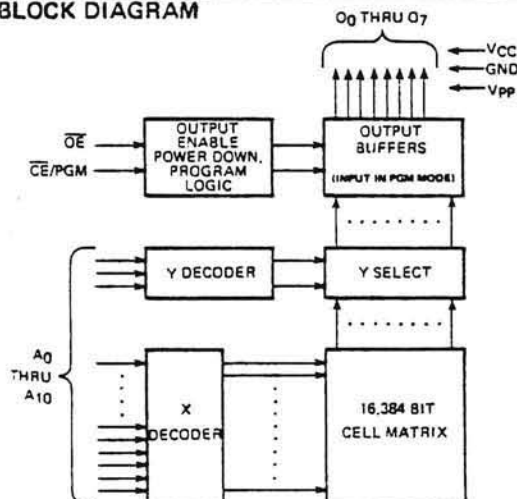
DESCRIPTION

The MK2716 is a 2048 x 8 bit electrically programmable/ultraviolet erasable Read Only Memory. The circuit is fabricated with Mostek's advanced N-channel silicon gate technology for the highest performance and reliability. The MK2716 offers significant advances over

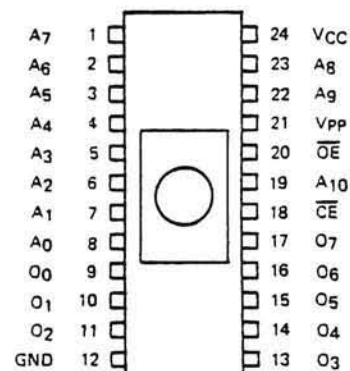
hardwired logic in cost, system flexibility, turnaround time and performance.

The MK2716 has many useful system oriented features including a STANDBY mode of operation which lowers the device power from 525 mW maximum active power to 132 mW maximum for an overall savings of 75%.

BLOCK DIAGRAM



PIN OUT



A₀ - A₁₀ ADDRESSES
 CE/PGM CHIP ENABLE/PROGRAM
 OE OUTPUT ENABLE

ABSOLUTE MAXIMUM RATINGS*

Voltage on any pin relative to VSS (Except VPP) -0.3V to +6V
 Voltage on VPP supply pin relative to VSS -0.3V to +28V
 Operating Temperature TA (Ambient) 0°C ≤ TA ≤ 70°C
 Storage Temperature (Ambient) -55°C ≤ TA ≤ +125°C
 Power Dissipation 1 Watt
 Short Circuit Output Current 50mA

*Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

READ OPERATION

RECOMMENDED D. C. OPERATING CONDITIONS AND CHARACTERISTICS^{1,2,4,8}
 (0°C ≤ TA ≤ 70°C) (VCC = +5V ± 5%, VPP = VCC)³

SYM	PARAMETER	MIN	TYP	MAX	UNITS	NOTES
V _{IH}	Input High Voltage	2.0		V _{CC} +1	Volts	
V _{IL}	Input Low Voltage	-0.1		0.8	Volts	
I _{CC1}	VCC Standby Power Supply Current ($\overline{OE} = V_{IL}; \overline{CE} = V_{IH}$)		10	25	mA	2
I _{CC2}	VCC Active Power Supply Current ($\overline{OE} = \overline{CE} = V_{IL}$)		57	100	mA	2
I _{VPP}	VPP Current (VPP = 5.25V)			6	mA	2,3
V _{OH}	Output High Voltage (I _{OH} = -400 μA)	2.4			Volts	
V _{OL}	Output Low Voltage (I _{OL} = 2.1 mA)			.45	Volts	
I _{IL}	Input Leakage Current (V _{IN} = 5.25V)			10	μA	
I _{OL}	Output Leakage Current (V _{OUT} = 5.25V)			10	μA	

AC CHARACTERISTICS^{1,2,5}
 (0°C ≤ TA ≤ 70°C) (VCC = +5V ± 5%, VPP = VCC)³

SYM	PARAMETER	-5		-6		-7		-8		UNITS	NOTES
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
t _{ACC}	Address to Output Delay ($\overline{CE} = \overline{OE} = V_{IL}$)		300		350		390		450	ns	
t _{CE}	CE to Output Delay ($\overline{OE} = V_{IL}$)		300		350		390		450	ns	6
t _{OE}	Output Enable to Output Delay ($\overline{CE} = V_{IL}$)		120		120		120		120	ns	10
t _{DF}	Chip Deselect to Output Float ($\overline{CE} = V_{IL}$)	0	100	0	100	0	100	0	100	ns	9
t _{OH}	Address to Output Hold	0		0		0		0		ns	

CAPACITANCE

(TA = 25°C)^a

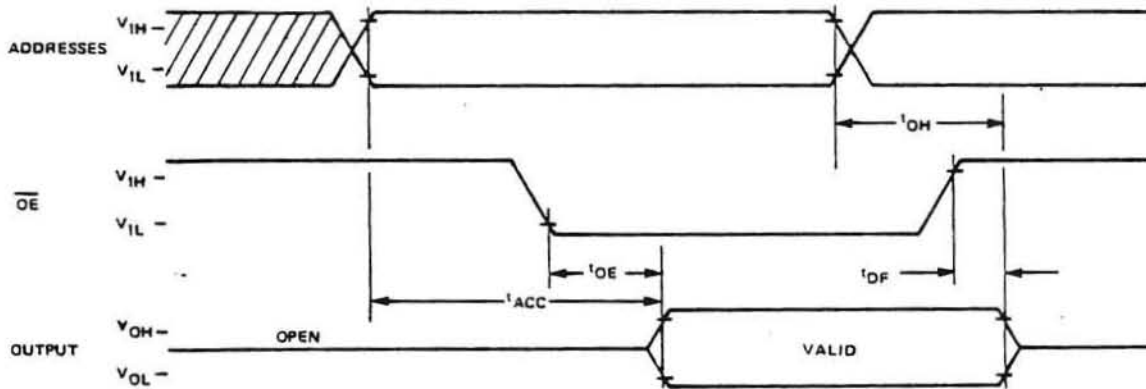
SYM	PARAMETER	TYP	MAX	UNITS	NOTES
C _{IN}	Input Capacitance	4	6	pF	7
C _{OUT}	Output Capacitance	8	12	pF	7

NOTES:

- VCC must be applied on or before VPP and Removed after or at the same times as VPP.
- VPP and VCC may be connected together except during programming, in which case the supply current is the sum of ICC and IPP1
- The tolerance on VPP is to allow use of a driver circuit to switch VPP from VCC to -25V in the READ and PROGRAM mode respectively.
- All voltages with respect to VSS.
- Load conditions = TTL load and 100pF, tr = tf = 20ns, reference levels are 1V or 2V for inputs and 8V and 2V for outputs
- tOE is referenced to CE or the addresses, whichever occurs last.
- Effective Capacitance calculated from the equation $C = \Delta \Delta V$ where $\Delta V = 3V$
- Typical numbers are for TA = 25°C and VCC = 5.0V
- tDF is applicable to both CE and OE, whichever occurs first.
- OE may follow up to tACC - tOE after the falling edge of CE without effecting tACC

TIMING DIAGRAMS

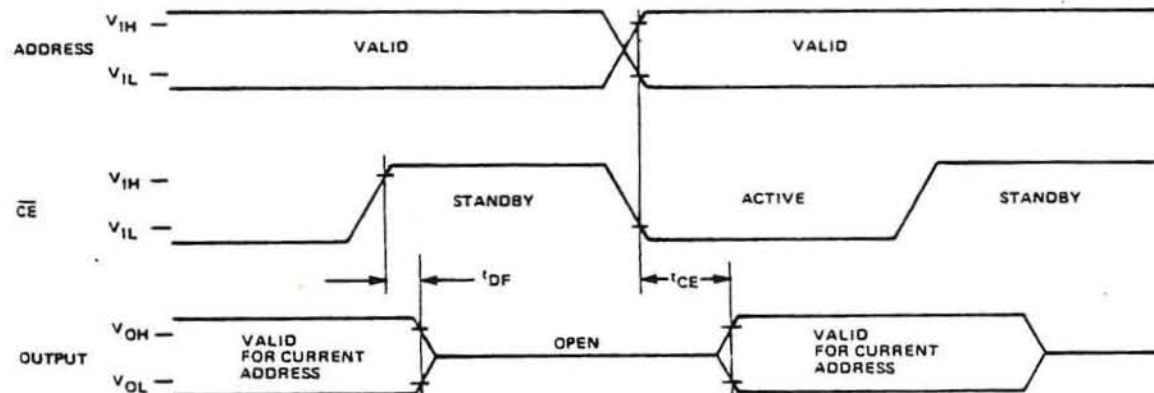
READ CYCLE (CE = V_{IL})



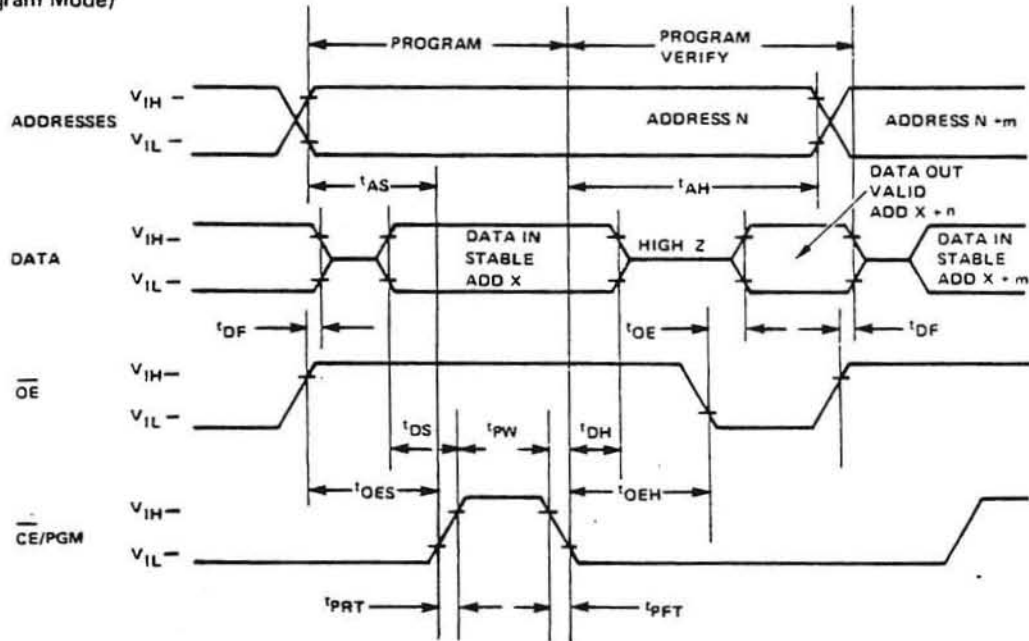
STANDBY POWER

DOWN MODE

(OE = V_{IL})



TIMING DIAGRAM (Program Mode)



MODE SELECTION

MODE	PIN	$\overline{\text{CE}}/\text{PGM}$ (18)	$\overline{\text{OE}}$ (20)	VPP (21)	OUTPUTS
READ		VIL	VIL	-5	Valid Out
STANDBY		VIH	Don't Care	-5	Open
PROGRAM		Pulsed VIL to VIH	VIH	-25	Input
PROGRAM VERIFY		VIL	VIL	-25	Valid Out
PROGRAM INHIBIT		VIL	VIH	-25	Open

VCC(24) = 5V all modes

DESCRIPTION CONTINUED

Programming can be done with a single TTL level pulse, and may be done on any individual location either sequentially or at random. The three-state output controlled by the $\overline{\text{OE}}$ input allows OR-tie capability for construction of large arrays. A single power supply requirement of +5 volts makes the MK2716 ideally suited for use with Mostek's new 5 volt only microprocessors such as the MK3880 (Z80). The MK2716 is packaged in the industry standard 24-pin dual-in line package with a transparent hermetically sealed lid. This allows the user to expose the chip to ultraviolet light to erase the data pattern. A new pattern may then be written into the device by following the

The MK2716 is specifically designed to fit those applications where fast turnaround time and pattern experimentation are required. Since data may be altered in the device (erase and reprogram) it allows for early debugging of the system program. Since single location programming is available the MK2716 can have its data content increased (assuming all 2048 bytes were not programmed) at any time for easy updating of system capabilities in the field. Once the data/program is fixed and the intention is to produce large numbers of systems, Mostek also supplies a pin compatible mask programmable ROM, the MK34000. To transfer the program data to ROM, the user need only send the PROM along with device information to MOSTEK, from which the ROM with the desired pattern can be generated. This means a reduction in the possibility of error when converting data to other forms (cards, tape, etc.) for this purpose. However, data may still be input by any of these traditional means such as paper tape, card deck, etc.

READ OPERATION

The MK2716 has five basic modes of operation. Under normal operating conditions (non-programming) there are two modes including READ and STANDBY. A READ operation is accomplished by maintaining pin 18 ($\overline{\text{CE}}$) at VIL and pin 21 (VPP) at +5 volts. If $\overline{\text{OE}}$ (pin 20) is held active low after addressing (A0 - A10) have stabilized then valid output data will appear on the output pins at access time t_{ACC} (address access). In this mode, access time may be referenced to $\overline{\text{OE}}$.

POWER DOWN operation is accomplished by taking pin 18 (\overline{CE}) to a TTL high level (V_{IH}). The power is reduced by 75% from 525mW maximum to 132mW. In power down VPP must be at +5 volts and the outputs will be open-circuit regardless of the condition of \overline{OE} . Access time from a high to low transition of \overline{CE} (t_{CE}) is the same as from addresses (t_{ACC}). (See STANDBY Timing Diagram).

PROGRAMMING INSTRUCTIONS

The MK2716 as shipped from Mostek will be completely erased. In this initial state and after any subsequent erasure, all bits will be at a '1' level (output high). Information is introduced by selectively programming '0's into the proper bit locations. Once a '0' has been programmed into the chip it may be changed only by erasing the entire chip with UV light.

Word address selection is done by the same decode circuitry used in the READ mode. The MK2716 is put into the PROGRAM mode by maintaining VPP at +25V, and \overline{OE} at V_{IH} . In this mode the output pins serve as inputs (8 bits in parallel) for the required program data. Logic levels for other inputs and the VCC supply voltage are the same as in the READ mode.

The program a "byte" (8 bits) of data, a TTL active high level pulse is applied to the \overline{CE}/PGM pin once addresses and data are stabilized on the inputs. Each location must have a pulse applied with only one pulse per location required. Any individual location, a sequence of locations or locations at random may be programmed in this manner. The program pulse has a minimum width of 45 msec and a maximum of 55msec, and must not be programmed with a high level D.C. signal applied to the \overline{CE}/PGM pin.

PROGRAM INHIBIT is another useful mode of operation when programming multiple parallel addressed MK2716's with different data. It is necessary only to maintain \overline{OE} at V_{IH} , VPP at +25, allow addresses and data to stabilize and pulse the \overline{CE}/PGM pin of the device to be programmed. Data may then be changed and the next device pulsed. The devices with \overline{CE}/PGM at V_{IL} will not be programmed.

PROGRAM VERIFY allows the MK2716 program data to be verified without having to reduce VPP from +25V to +5V. VPP should only be used in the PROGRAM/PROGRAM INHIBIT and PROGRAM VERIFY modes and must be at +5V in all other modes.

MK2716 ERASING PROCEDURE

The MK2716 may be erased by exposure to high intensity ultraviolet light, illuminating the chip thru the transparent window. This exposure to ultraviolet light induces the flow of a photo current from the floating gate thereby discharging the gate to its initial state. An ultraviolet source of 2537Å yielding a total integrated dosage of 15 Watt-seconds/cm² is required. Note that all bits of the MK2716 will be erased. The erasure time is approximately 15 to 20 minutes utilizing a ultra-violet lamp with a 12000μW/cm² power rating. The lamp should be used without short wave filters, and the MK2716 to be erased should be placed about one inch away from the lamp tubes. It should be noted that as the distance between the lamp and the chip is doubled, the exposure time required goes up by a factor of 4. The UV content of sunlight is insufficient to provide a practical means of erasing the MK2716. However, it is not recommended that the MK2716 be operated or stored in direct sunlight, as the UV content of sunlight may cause erasure of some bits in a short period of time.

1K x 8 STATIC RAM MK4118(P/N) Series

FEATURES

- Address Activated™ Interface combines benefits of Edge Activated™ and full static
- High performance

Part Number	Access Time	Cycle Time
MK4118-1	120 nsec	120 nsec
MK4118-2	150 nsec	150 nsec
MK4118-3	200 nsec	200 nsec
MK4118-4	250 nsec	250 nsec

- Single +5 volt power supply

- TTL compatible I/O
Fanout: 2 - Standard TTL
 2 - Schottky TTL
 12 - Low power Schottky TTL
- Low Power - 400mw Active
- \overline{CS} , \overline{OE} , and \overline{LATCH} functions for flexible system operation
- Pin compatible with Mostek's wide word memory family

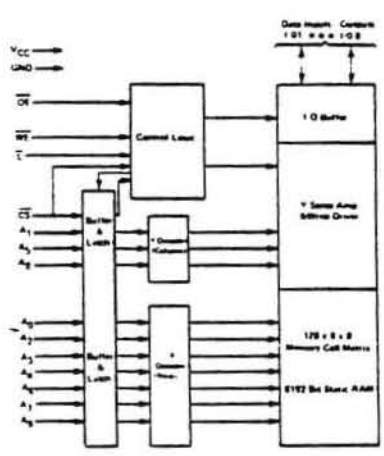
DESCRIPTION

The MK4118 uses Mostek's Poly R N-Channel Silicon Gate process and advanced circuit design techniques to package 8192 bits of static RAM on a single chip. Mostek's Address Activated™ circuit design technique is utilized to achieve high performance, low power, and easy user implementation. The device has a $V_{IH} = 2.2$, $V_{IL} = 0.8V$, $V_{OH} = 2.4$, $V_{OL} = 0.4V$ making it totally compatible with all TTL family devices.

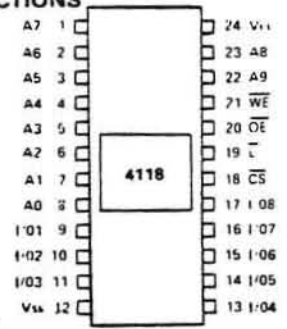
The MK4118 is designed for all wide word memory applications. The MK4118 provides the user with a

high-density, cost-effective 1K x 8-bit Random Access Memory. Fast Output Enable (\overline{OE}) and Chip Select (\overline{CS}) controls are provided for easy interface in microprocessor or other bus-oriented systems. The MK4118 features a flexible Latch (\overline{L}) function to permit latching of the address and \overline{CS} status at the user's option. Common data and address bus operation may be performed at the system level by utilizing the \overline{L} and \overline{OE} functions for the MK4118. The latch function may be bypassed by merely tying the latch pin to V_{CC} , providing fast ripple-through operation.

BLOCK DIAGRAM



PIN CONNECTIONS



PIN NAMES

A0 - A9	Address Inputs	\overline{WE}	Write Enable
CS	Chip Select	\overline{OE}	Output Enable
Vss	Ground	\overline{L}	Latch
Vcc	Power (+5V)	I/O ₁ I/O ₈	Data In/ Data Out

SYM	PARAMETER	MK4118-1		MK4118-2		MK4118-3		MK4118-4		UNIT	NOTES
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
t _{RC}	Read Cycle Time	120		150		200		250		ns	
t _{AA}	Address Access Time		120		150		200		250	ns	
t _{CNA}	Chip Select Access Time		60		75		100		125	ns	
t _{CSZ}	Chip Select Data Off Time	0	60	0	75	0	100	0	125	ns	
t _{OEA}	Output Enable Access Time		60		75		100		125	ns	
t _{OEZ}	Output Enable Data Off Time	0	60	0	75	0	100	0	125	ns	
t _{AZ}	Address Data Off Time	10		10		10		10		ns	
t _{ASL}	Address to Latch Setup Time	10		10		10		20		ns	
t _{AHL}	Address From Latch Hold Time	40		50		65		80		ns	
t _{CSL}	$\overline{\text{CS}}$ To Latch Setup Time	0		0		0		0		ns	
t _{CHL}	$\overline{\text{CS}}$ From Latch Hold Time	40		50		65		80		ns	
t _{LA}	Latch Off Access Time		155		200		260		320		ns
t _{WC}	Write Cycle Time	120		150		200		250		ns	
t _{ASW}	Address To Write Setup Time	0		0		0		0		ns	
t _{AHW}	Address From Write Hold Time	40		50		65		80		ns	
t _{CSW}	$\overline{\text{CS}}$ To Write Setup Time	0		0		0		0		ns	
t _{CHW}	$\overline{\text{CS}}$ From Write Hold Time	40		50		65		80		ns	
t _{DSW}	Data To Write Setup Time	20		30		40		50		ns	
t _{DHW}	Data From Write Hold Time	20		30		40		50		ns	
t _{WD}	Write Pulse Duration	35		50		60		70		ns	
t _{L, DH}	Latch Duration, High	35	DC	50	DC	60	DC	70	DC	ns	
t _{L, DL}	Latch Duration, Low		DC		DC		DC		DC	ns	
t _{WEZ}	Write Enable Data Off Time	0	60	0	75	0	100	0	125	ns	
t _{L, Z}	Latch Data Off Time	10		10		10		10		ns	
t _{WPL}	Write Pulse Lead Time	75		90		130		170			

PROGRAM OPERATION⁶D.C. ELECTRICAL CHARACTERISTICS AND OPERATING CONDITIONS^{1,2}

(TA = 25°C ± 5°C) (VCC = 5V ± 5%, VPP = 25V ± 1V)

SYMBOL	PARAMETER	MIN	MAX	UNITS	NOTES
IIL	Input Leakage Current		10	μA	3
VIL	Input Low Level	-0.1	0.8	Volts	
VIH	Input High Level	2.0	VCC + 1	Volts	
ICC	VCC Power Supply Current		100	mA	
IPP1	VPP Supply Current		5	mA	4
IPP2	VPP Supply Current during Programming Pulse		30	mA	5

A.C. CHARACTERISTICS AND OPERATING CONDITIONS^{1,2,4,7}

(TA = 25°C ± 5°C) (VCC = 5V ± 5%, VPP = 25V ± 1V)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS	NOTES
t _{AS}	Address Setup Time	2			μs	
t _{OES}	\overline{OE} Setup Time	2			μs	
t _{DS}	Data Setup Time	2			μs	
t _{AH}	Address Hold Time	2			μs	
t _{OEH}	\overline{OE} Hold Time	2			μs	
t _{DH}	Data Hold Time	2			μs	
t _{DF}	Output Enable to Output Float	0		120	ns	4
t _{OE}	Output Enable to Output Delay			120	ns	4
t _{PW}	Program Pulse Width	45	50	55	ms	
t _{PRT}	Program Pulse Rise Time	5			ns	
t _{PFT}	Program Pulse Fall Time	5			ns	

NOTES:

1 VCC must be applied at the same time or before VPP and removed after or at the same time as VPP. To prevent damage to the device it must not be inserted into a board with VPP at 25V.

2 Care must be taken to prevent overshoot of the VPP supply when switching to -25V.

3 0.45V < VIN < 5.25V

4 \overline{CE} = PGM = VIL

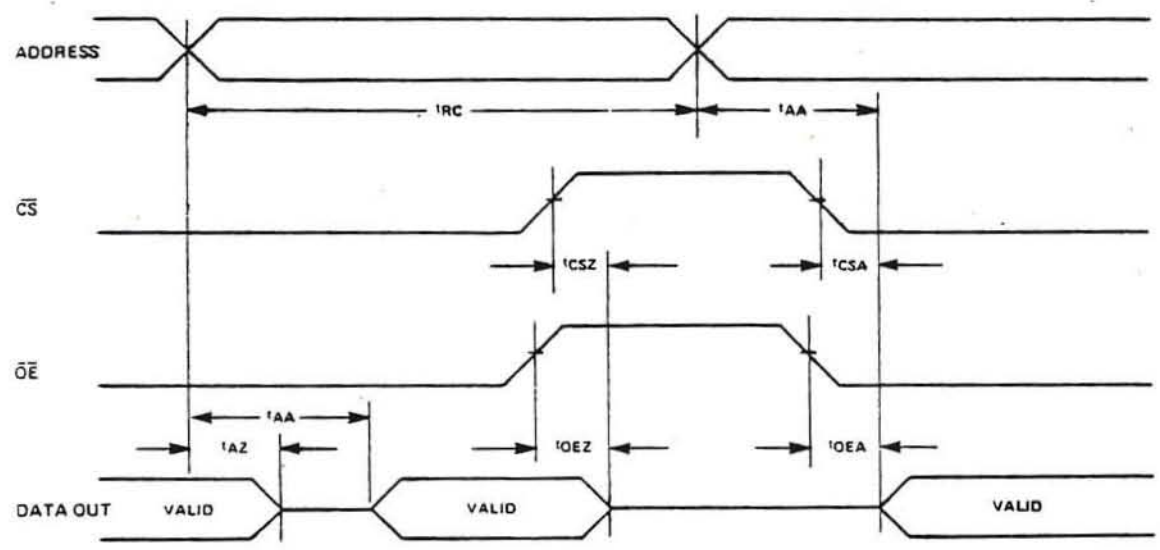
5 \overline{CE} = PGM = VIH

6 t_f = 20nsec

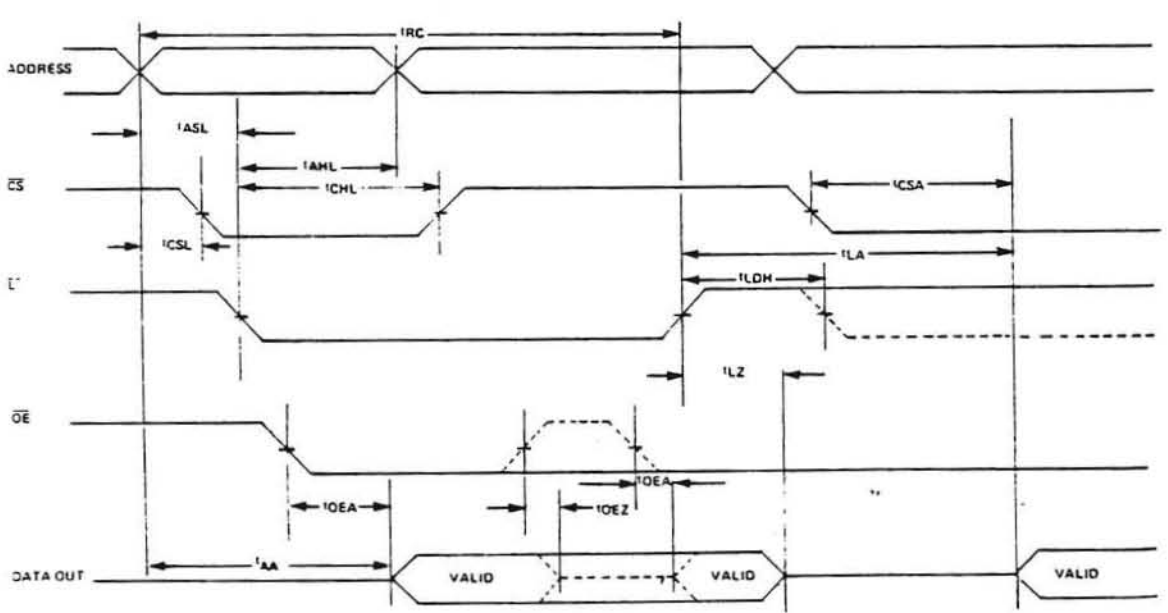
7 or 2V for inputs and 8V or 2V for outputs are used as timing reference levels.

8 The timing specifications are the same for all dash numbers.

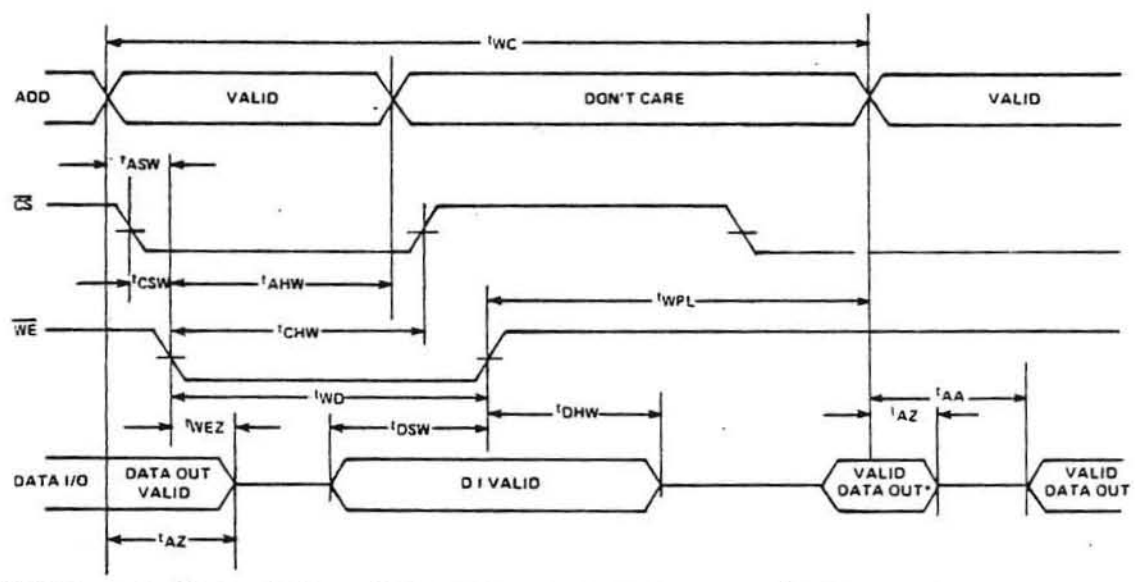
STATIC READ CYCLE
 $\overline{WE} = \overline{L} = \text{HIGH}$



LATCHED READ CYCLE
 $\overline{WE} = \text{HIGH}$



WRITE CYCLE
 $\overline{OE} = \text{LOW}, \overline{L} = \text{HIGH}$



*NOTE: Assumes $t_{WC} \geq t_T + t_{WD}(\text{min}) + t_{WPL}(\text{min})$. If not then output will remain open as $t_{AZ} < t_{AA}$ for an address change. Also \overline{OE} may be used to maintain DO open.

OPERATION

READ MODE

The MK4118 is in the READ MODE whenever the Write Enable control input (\overline{WE}) is in the high state. The state of the 8 data I/O signals is controlled by the Chip Select (\overline{CS}) and Output Enable (\overline{OE}) control signals. The READ MODE memory cycle may be either STATIC (ripple-through) or LATCHED, depending on user control of the Latch Input Signal (\overline{L}).

STATIC READ CYCLE

In the STATIC READ CYCLE mode of operation, the MK4118 provides a fast address ripple-through access of data from 8 of 8192 locations in the static storage array. Thus, the unique address specified by the 10 Address Inputs (A_n) define which 1 of 1024 bytes of data is to be accessed. The STATIC READ CYCLE is defined by $\overline{WE} = \overline{L} = \text{High}$.

A transition on any of the 10 address inputs will disable the 8 Data Output Drivers after t_{AZ} . Valid Data will be available to the 8 Data Output Drivers within t_{AA} after all address input signals are stable, and the data will be output under control of the Chip Select (\overline{CS}) and Output Enable (\overline{OE}) signals.

LATCHED READ CYCLE

The LATCHED READ CYCLE is also defined by the Write

Enable control input (\overline{WE}) being in the high state, and it is synchronized by proper control of the Latch (\overline{L}) input.

As the Latch control input (\overline{L}) is taken low, Address (A_n) and Chip Select (\overline{CS}) inputs that are stable for the specified set-up and hold times are latched internally. Data out corresponding to the latched address will be supplied to the Data Output drivers. The output drivers will be enabled to drive the Output Data Bus under control of the Output Enable (\overline{OE}) and latched Chip Select (\overline{CS}) inputs.

Taking the latch input high begins another read cycle for the memory locations specified by the address then appearing on the Address Input (A_n). Returning the latch control to the low state latches the new Address and Chip Select inputs internally for the remainder of the LATCHED READ CYCLE.

NOTE: If the 'LATCH' function is not used pin 19 (\overline{L}) must be tied high ($V_{IH} \text{ min}$).

WRITE MODE

The MK4118 is in the WRITE MODE whenever the Write Enable (\overline{WE}) and Chip Select (\overline{CS}) control inputs are in the low state. The status of the 8 output buffers during a write cycle is explained below.

ABSOLUTE MAXIMUM RATINGS*

Voltage on any pin relative to V_{SS}	-0.5V to +7.0V
Operating Temperature T_A (Ambient)	0°C to +70°C
Storage Temperature (Ambient) (Ceramic)	-65°C to +150°C
Storage Temperature (Ambient) (Plastic)	-55°C to +125°C
Power Dissipation	1 Watt
Short Circuit Output Current	20mA

*Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

RECOMMENDED DC OPERATING CONDITIONS³(0°C ≤ T_A ≤ +70°C)

SYM	PARAMETER	MIN	TYP	MAX	UNITS	NOTES
V_{CC}	Supply Voltage	4.75	5.0	5.25	Volts	1
V_{SS}	Supply Voltage	0	0	0	Volts	1
V_{IH}	Logic "1" Voltage All Inputs	2.2		7.0	Volts	1
V_{IL}	Logic "0" Voltage All Inputs	-0.3		0.8	Volts	1

DC ELECTRICAL CHARACTERISTICS^{1,2}(0°C ≤ T_A ≤ +70°C) (V_{CC} = 5.0 volts ± 5%)

SYM	PARAMETER	MIN	MAX	UNITS	NOTES
I_{CC1}	Average V_{CC} Power Supply Current (Active)		80	mA	
I_{CC2}	Average V_{CC} Power Supply Current (Standby)		60	mA	5
I_{IL}	Input Leakage Current (Any Input)	-10	10	μA	2
I_{OL}	Output Leakage Current	-10	10	μA	2
V_{OH}	Output Logic "1" Voltage $I_{OL} = -1$ mA	2.4		Volts	
V_{OL}	Output Logic "0" Voltage $I_{OH} = 4$ mA		0.4	Volts	

AC ELECTRICAL CHARACTERISTICS^{1,2}(0°C ≤ T_A ≤ +70°C) (V_{CC} = +5.0 volts ± 5%)

SYM	PARAMETER	TYP	MAX	NOTES
C_i	Capacitance on all pins except I/O	4pF		4
$C_{i(O)}$	Capacitance on I/O pins	10pF		4

NOTES:

- All voltages referenced to V_{SS} .
- Measured with 0 ≤ V_i ≤ 5V and outputs deselected ($V_o = 5V$).
- A minimum of 100 μsec time delay is required after application of V_i (+5V) before proper device operation can be achieved.
- Effective capacitance calculated from the equation $C = I \frac{\Delta t}{\Delta V}$ with $\Delta V = 3V$ and V_{i1} nominal.
- Standby mode is defined as condition with addresses, latch and WE remain unchanged.
- AC timing measurements made with 2 TTL loads plus 100pF.



2332 Static ROM (4096 x 8)

	2332	2332A	2332B
Maximum Access Time	450 ns	350 ns	300 ns

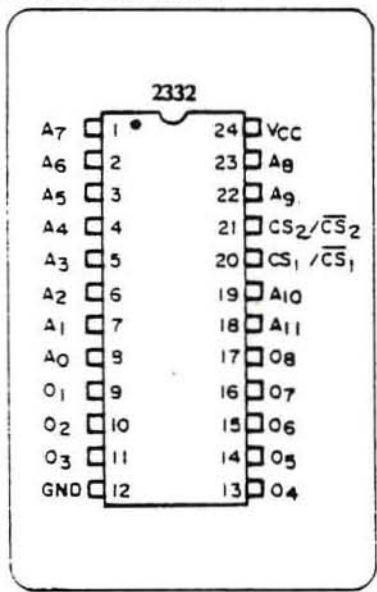
- Access Time Less Than 350ns
- Totally Static Operation
- Fully TTL Compatible
- Three-State Outputs for Wire-OR Expansion
- Two Programmable Chip Selects
- Single 5V Power Supply
- Pin Compatible With 2716 & 2732 EPROMs
- 400 mV Noise Immunity on Inputs
- 2708/2716 EPROMs Accepted as Program Data Inputs

DESCRIPTION

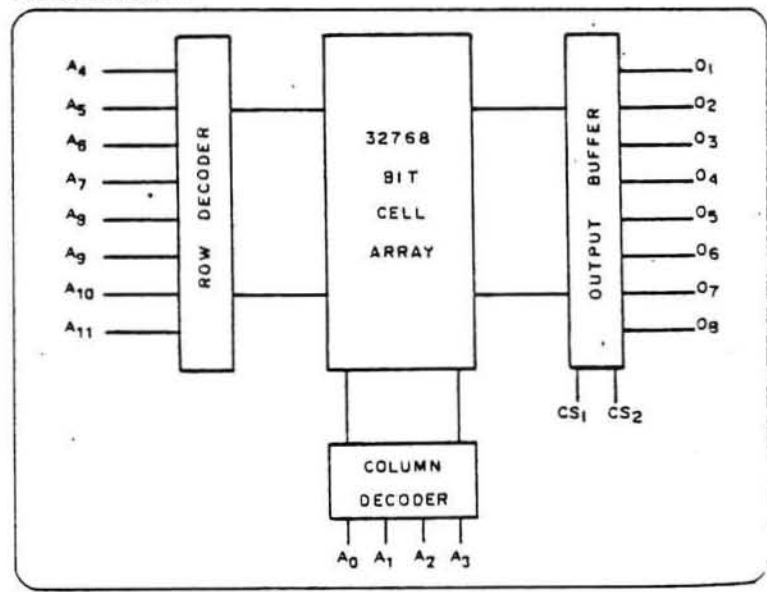
The MOS Technology 2332 is a 32,768-bit Static Read-Only Memory organized as 4096 x 8 bits. It features fast access time (450 ns maximum with the 2332, 350 ns maximum with the 2332A). The 2332 is designed to be compatible with all microprocessor and similar applications where high performance, large bit storage capacity and simple interfacing requirements are important design considerations.

The 2332 operates totally asynchronously; no clock input is required. With two programmable chip select inputs, four 32K ROMs can be OR-tied with no need for external decoding logic. Designed to replace two 2716 16K EPROMs, the 2332 can eliminate the need to redesign printed circuit boards for volume mask-programmed ROMs after prototyping is completed with EPROMs.

PIN CONFIGURATION



BLOCK DIAGRAM



2332

DC CHARACTERISTICS $T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$, $V_{CC} = 5.0\text{ V} \pm 5\%$ (unless otherwise specified)

Symbol	Parameter	Min	Max	Units	Test Conditions
I_{CC1}	Power Supply Current		125	mA	$V_{IN} = V_{CC}$, $V_O = \text{Open}$, $T_A = 0^\circ\text{C}$
I_{CC2}	Power Supply Current		120	mA	$V_{IN} = V_{CC}$, $V_O = \text{Open}$, $T_A = 25^\circ\text{C}$
I_O	Output Leakage Current		10	μA	Chip Deselected, $V_O = 0$ to V_{CC}
I_I	Input Load Current		10	μA	$V_{CC} = \text{Max}$, $V_{IN} = 0$ to V_{CC}
V_{OL}	Output Low Voltage		0.4	Volts	$V_{CC} = \text{Min}$, $I_{OL} = 2.1\text{ mA}$
V_{OH}	Output High Voltage	2.4		Volts	$V_{CC} = \text{Min}$, $I_{OH} = -400\ \mu\text{A}$
V_L	Input Low Voltage	-0.5	0.8	Volts	See note 1
V_H	Input High Voltage	2.0	$V_{CC}+1$	Volts	

AC CHARACTERISTICS $T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$, $V_{CC} = 5.0\text{ V} \pm 5\%$ (unless otherwise specified)

Symbol	Parameter	2332		2332A		Units	Test Conditions
		Min	Max	Min	Max		
t_{ACC}	Address Access Time		450		350	ns	
t_{CO}	Chip Select Delay		200		200	ns	See Note 2
t_{DF}	Chip Deselect Delay		175		175	ns	
t_{OH}	Previous Data Valid After Address Change Display	40		40		ns	

CAPACITANCE $T_A = 25^\circ\text{C}$, $f = 1.0\text{ MHz}$, See Note 3

Symbol	Parameter	Min	Max	Units	Test Conditions
C_{IN}	Input Capacitance		8	pF	All Pins except Pin under Test Tied to AC Ground
C_{OUT}	Output Capacitance		10	pF	

Notes

- Input levels that swing more negative than -0.5 V will be clamped and may cause damage to the device.
- Loading 1 TTL + pF, input transition time: 20 ns.
Timing measurement levels: input 1.5V, output 0.8V and 2.0V
 $C_L = 100\text{ pF}$.
- This parameter is periodically sampled and is not 100% tested.

ABSOLUTE MAXIMUM RATINGS

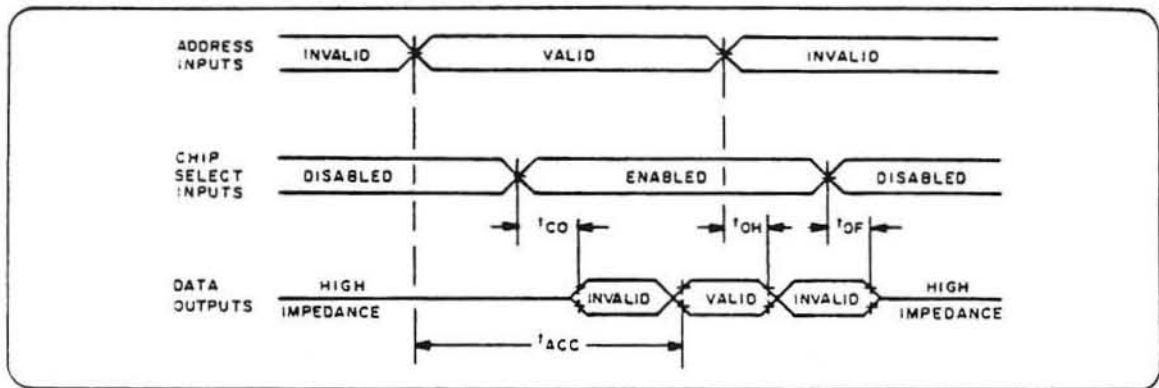
Ambient Operating Temperature	0° to $+70^\circ\text{C}$
Storage Temperature	-65°C to $+150^\circ\text{C}$
Supply Voltage to Ground Potential	-0.5 V to $+7.0\text{ V}$
Applied Output Voltage	-0.5 V to $+7.0\text{ V}$
Applied Input Voltage	-0.5 V to $+7.0\text{ V}$
Power Dissipation	1.0W

COMMENT

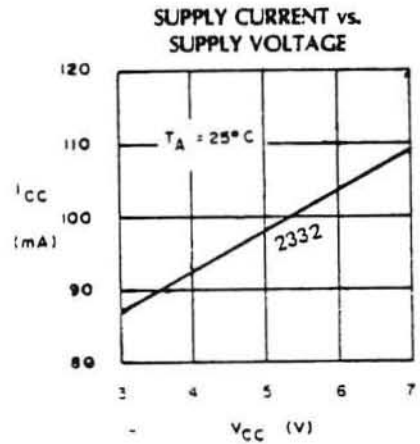
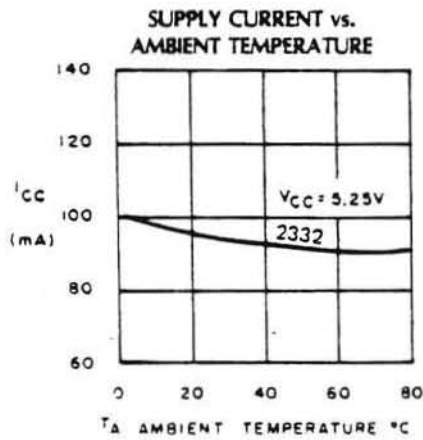
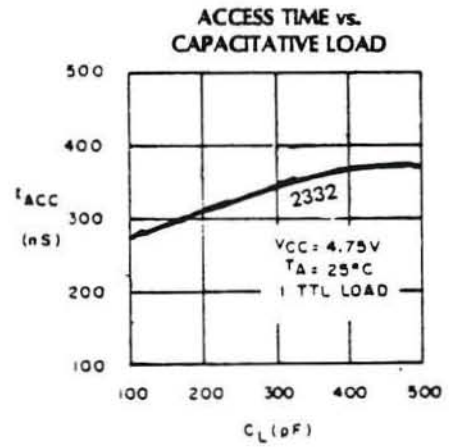
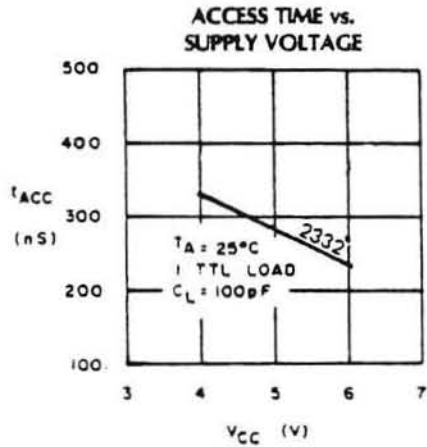
Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

2332

TIMING DIAGRAM



TYPICAL CHARACTERISTICS

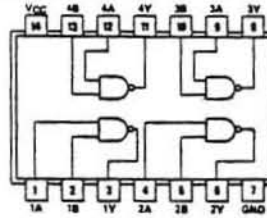


SSI GATES . . . LOGIC AND PIN ASSIGNMENTS, (TOP VIEWS)

00
 QUADRUPLE 2-INPUT
 POSITIVE-NAND GATES

positive logic:
 $Y = \overline{AB}$

See page 88

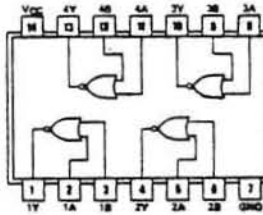


- SN5400/SN7400(J, N)
- SN54H00/SN74H00(J, N)
- SN54L00/SN74L00(J, N)
- SN54LS00/SN74LS00(J, N, W)
- SN54S00/SN74S00(J, N, W)

02
 QUADRUPLE 2-INPUT
 POSITIVE-NOR GATES

positive logic:
 $Y = \overline{A+B}$

See page 92

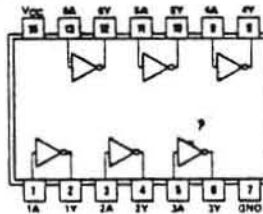


- SN5402/SN7402(J, N)
- SN54L02/SN74L02(J, N)
- SN54LS02/SN74LS02(J, N, W)
- SN54S02/SN74S02(J, N, W)

04
 HEX INVERTERS

positive logic:
 $Y = \overline{A}$

See page 95

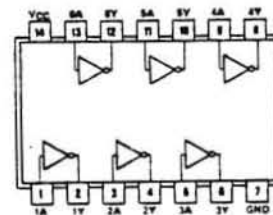


- SN5404/SN7404(J, N)
- SN54H04/SN74H04(J, N)
- SN54L04/SN74L04(J, N)
- SN54LS04/SN74LS04(J, N, W)
- SN54S04/SN74S04(J, N, W)

06
 HEX INVERTER BUFFERS/DRIVERS
 WITH OPEN-COLLECTOR
 HIGH-VOLTAGE OUTPUTS

positive logic:
 $Y = \overline{A}$

See page 106



- SN5406/SN7406(J, N, W)

30
HEX SCHMITT-TRIGGER INVERTERS

positive logic
 $Y = \bar{A}$

See page 68

SN5414/SN7414(J, N, W)

32
TRIPLE 2-INPUT POSITIVE-OR GATES

positive logic
 $Y = A + B$

See page 108

SN5432/SN7432(J, N, W)
 SN54LS32/SN74LS32(J, N, W)

74
QUAL D-TYPE POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR

FUNCTION TABLE

INPUTS		CLOCK	D	OUTPUTS	
PRESET	CLEAR			Q	\bar{Q}
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H [†]	H [†]
H	H	↓	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q ₀	\bar{Q}_0

CK = \downarrow : READ

See pages 120, 124, 128, 130, and 132

SN5474/SN7474(J, N)
 SN54H74/SN74H74(J, N)
 SN54L74/SN74L74(J, N)
 SN54LS74/SN74LS74(J, N, W)
 SN54S74/SN74S74(J, N, W)

SN5474/SN7474(W)
 SN54H74/SN74H74(W)
 SN54L74/SN74L74(T)

H = high level (steady state), L = low level (steady state), X = irrelevant
 \bar{L} = high-level pulse; data inputs should be held constant while clock is high; data is transferred to output on the falling edge of the pulse.
 † = transition from low to high level, † = transition from high to low level
 Q₀ = the level of Q before the indicated input conditions were established.
 TOGGLE: Each output changes to the complement of its previous level on each active transition (pulse) of the clock.
 *This configuration is nonstatic; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

TYPES SN54100, SN74100 8-BIT BISTABLE LATCHES

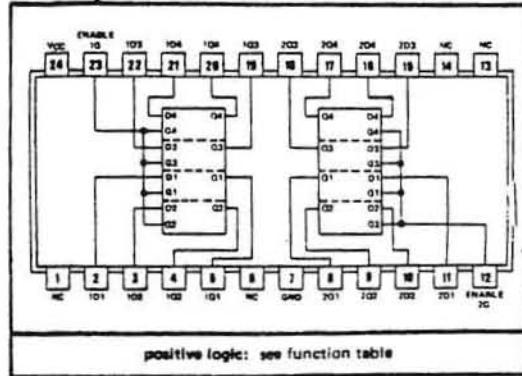
BULLETIN NO. DL-S 7211830, DECEMBER 1972

FUNCTION TABLE
(Each Latch)

INPUTS		OUTPUTS	
D	G	Q	\bar{Q}
L	H	L	H
H	H	H	L
X	L	Q_0	\bar{Q}_0

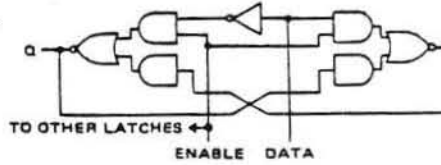
H = high level, X = Irrelevant
 Q_0 = the level of Q before the high-to-low transition of G

J OR N DUAL-IN-LINE OR
W FLAT PACKAGE (TOP VIEW)

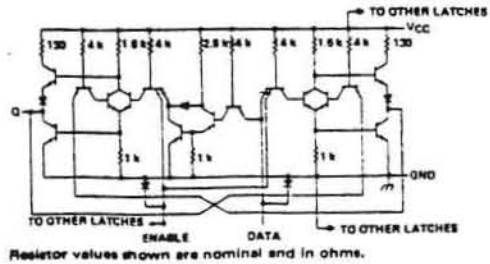


NC—No internal connection

functional block diagram (each latch)



schematic (each latch)



Resistor values shown are nominal and in ohms.

