SB180 Technical Manual

Release 1.1

The Micromint Inc.
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TIP SHEET

10/23/85

First time users may find the following list of tips useful in setting up and using their system:

1) The system provided must be booted on a double-sided-double-density 48 tpi disk drive with the terminal set for 9600 baud. The system may later be configured by the user to boot from 96 tpi drives and at a different baud rate. (Use CONFIG to change the baud rate.)

2) ZCPR3 allows the use of up to 32 user areas on each disk. (The system provided has been set up to use areas 0 through 15 only. Should the user need more areas than this, the system source files on disk three must be modified and reassembled.) The different areas may be accessed by typing the desired area number followed by a colon and a return at the system prompt. For example, to move from area 0 to area 15 type '15:' at the 'A0:BASE>' prompt.

3) A user area may also have a name associated with it. When the 'System Master' disk is used to boot the system, user area 0 is named 'BASE' while area 15 is named 'ROOT'. To move between areas using their names, type the area name instead of its number, followed by a colon and a return. Another way to move to area 15 in the above example is to type 'ROOT:' at the 'A0:BASE>' prompt.

4) To see a list of currently defined named directories, type 'PWD' followed by a return. To get a list of all the files on a disk in all the user areas, put the disk in drive B: and type 'XDIR B: U' followed by a return. (SB180-20 software only.)

5) All of the files on disks two, three, and four may be found in user area 0. (SB180-20 software only.) However, most of the files on disk one are in user area 15. This is so the user doesn't have to see a list of system tools every time he does a directory.

6) As provided, the system uses a disk head step rate of 10ms. (If this means nothing to you, go on to the next paragraph.) A quicker step rate may be used with some drives to increase the overall disk access rate. Check your disk drive's manual to determine if a faster step rate can be used. (e.g. TEAC FD-55B-20-U drives can use a 6ms step rate.) Run CONFIG to make this change.

7) Besides the system tools on the 'System Master' disk, there are also a number of built-in commands. These include commands in the command processor (CP), which are GO, SAVE, GET, JUMP, and NOTE, and commands in the resident command package (RCP) such as TYPE and POKE. For a list of RCP commands, type H at the system prompt. For more details, see the ZCPR3 book.

8) If you plan to mount your SB180 in an enclosure, be sure to use nylon or plastic washers between any metal hardware and the SB180's circuit board. Any metal allowed to touch the board my cause short circuits and prevent the board from operating properly.

9) If you have a printer plugged into your system, be sure the power on the printer is turned on before booting the system. If the printer is turned off when the computer is turned on, the system may hang and refuse to boot until the printer is unplugged or turned on.

10) The table in the manual describing the correct jumpering for a TEAC 55B drive is for a TEAC FD-55B-20-U drive. We have found at least two other 55B drives which need different jumpers installed. Also, the TEAC 55F 80-track drive has its own set of required jumpers. These are listed below:

TEAC FD-55B-20-U
install ML, UR, DSx, and terminators
TEAC FD-55B-01-U
install HL, UR, PM, DSx, and terminators
TEAC FD-55BV-06-U
install HL, RY, DSx, and terminators

TEAC FD-55F-03-U
install HL, UR, PM, DSx, and terminators

(Terminators should be installed only on the last drive on your cable. The DSx designation above refers to the DS0, DS1, DS2, or DS3 jumper, depending on whether you are configuring drive A:, B:, C:, or D:.)

11) There are over 40 remote access systems (RAS), also called bulletin board systems, across the country which run Z-System as their operating system. Called Z-Nodes, they specialize in supporting Z-System with updates to existing tools, developing new tools, distributing useful public domain software, and in answering any and all questions dealing with Z-System. The main Z-Node, supported by Echelon, is Z-Node Central. The number there is (415) 489-9005. Located on that board is a list of all the other Z-Nodes so you can find the one closest to you.

12) Micromint also has a RAS called the Circuit Cellar BBS. Designed to support users of Micromint manufactured Circuit Cellar projects, it runs on an SB180 and its primary support is for the SB180. Call it anytime to obtain advise, ask questions, download useful public domain utilities, and read advance announcements of other Micromint products. The number is (203) 871-1988. It uses 8 bits, 1 stop bit, no parity, and runs 300 and 1200 baud. It is available 24 hours a day and, like Z-Node Central, makes the list of Z-Nodes across the country available to users.

13) There is an SB180 users' group being formed and is actively recruiting new members. The North American One-Eighty Group (N.A.O.G.) publishes monthly newsletters and will be making available to members disks full of useful utilities, programs, and hints for the cost of the media and shipping. More information plus a membership application is available on the Circuit Cellar BBS or write or call:

North American One-Eighty Group
P.O. Box #2781
Warminster, PA 18974
(215) 443-9031

Date of this release: August, 1985

* *

WARRANTY

The Micromint, Inc. extends the following warranty:

A factory manufactured circuit board or assembly caries with it a one year warranty covering both parts and labor. Any unit which is found to have a defect in materials or workmanship will be repaired or replaced at the option of The Micromint, Inc.

No credit will be given for units which show damage due to user modification or neglect.

Units returned for repair must have prior authorization from The Micromint, Inc. A return authorization number may be obtained by phone or letter. Please retain a record of the the return authorization number as most subsequent correspondence will refer to that number. Under no circumstances is any product to be returned to The Micromint, Inc. without prior authorization. The Micromint, Inc. will assume no responsibility for unauthorized returns.

All returns must be shipped prepaid. Insurance is recommended as losses by a shipping carrier are not the responsibility of The Micromint, Inc. Repaired units will be rturned with postage paid.

For repair of units which have expired their warranty, a minimum inspection fee must be prepaid. Contact The Micromint, Inc. for information on current minimum charges.

NO WARRANTY is extended on USER ASSEMBLED systems or kits. However, assebled kits will be inspected and repaired with charges based on the current minimum one hour charge. However, in the event that repair charges would exceed a reasonable amount, the user may be consulted for a determination. The Micromint, Inc. retains the right to refuse to repair any USER ASSEMBLED item. This right is at the sole discretion of The Micromint, Inc.

Repairs on USER ASSEMBLED items must be prepaid.

Return authorization must be obtained prior to any return.

The Micromint, Inc. reserves the right to change any feature or specification at any time.

* *

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RESISTORS

R1	10 K, 1/4 W, 5%
R2	4.7 K, 1/4 W, 5%
R3	100 OHM, 1/4 W, 5%
R4	4.7 K, 1/4 W, 5%
R5	470 K, 1/4 W, 5%
R6	4.7 K, 1/4 W, 5%
R7,R8	1.0 K, 1/4 W, 5%
R9	4.7 K, 1/4 W, 5%
R10	120 OHM, 1/2 W, 5%
SIP1-SIP3	4.7K, 9 ELEMENT, PIN 1 COMMON
SIP4	330 OHM, 7 ELEMENT, PIN 1 COMMON

MISCELLANEOUS

J1	1 X 2, .1 CTR, (HARDWIRE)
J2-J4	2 X 10, .1 CTR, ST, .230 L
J5	2 X 20, .1 CTR, ST, .320 L
J6 (OPTION)	1 X 8, .1 CTR, ST, .230 L
J7	1 X 4, .1 CTR, RT, .320 L
J8 (OPTION)	2 X 25, .1 CTR, SHROUDED, ST
J9	2 X 17, .1 CTR, SHROUDED, RIGHT
JP1-JP3 (OPT)	1 X 3, .1 CTR, ST, .230 L
JP4 (OPTION)	1 X 5, .1 CTR, ST, .230 L
JP5 (OPTION)	1 X 3, .1 CTR, ST, .230 L
JP6 (OPTION)	1 X 2, .1 CTR, ST, .230 L
JP7 (OPTION)	1 X 3, .1 CTR, ST, .230 L
JP8 (OPTION)	2 X 6, .1 CTR, ST, .230 L
JP9 (OPTION)	1 X 3, .1 CTR, ST, .230 L
JP10	1 X 3(2), "T", .1 CTR, ST, .230 L
JUMPER (2)	1 X 2 HEADER JUMPER
PB1	PUSHBUTTON, (RESET)
XTAL1	CRYSTAL, 12.2880 MHZ
XTAL2	CRYSTAL, 8.0000 MHZ

SOCKETS

1	8 PIN
8	14 PIN
14	16 PIN
3	20 PIN
1	28 PIN
1	40 PIN
1	64 PIN (SHRINK DIP)

The Micromint SB180 is a single board computer featuring a new generation 8-bit microprocessor which maintains software compatibility with the Zilog Z80 while incorporating advanced design features in a single 64 pin chip. The SB180 uses just 29 chips on a 4" by 7 1/2" printed circuit board to provide a powerful, low cost processing system which is well suited for a wide range of appliations - from dedicated process control computers to personal computer systems. Figure 1.0-1 shows the functional organization of the SB180:

central processing unit
memory interface
RS-232 interface
Centronics parallel interface
floppy disk interface
XBUS expansion bus
power supply

The SB180 has the following features:

* Hitachi HD64180 microprocessor running at 6.1 MHz. Supports a superset of the Z80 instruction set.
* 256K bytes on board RAM memory (can be partitioned as 64K byte system memory and 192K byte RAM disk or as paged system memory).
* Full 8K byte ROM monitor with disk support (format, read, write, copy, and boot). Can support up to 32K byte ROM on board.
* 2 RS-232 serial ports, one with auto-baud rate detect.
* 1 Centronics parallel printer port.
* Single/double density programmable floppy disk controller. capable of handling a mix of up to four 3 1/2", 5 1/4", or 8" drives. Different size drives can run concurrently.
* Supports 4 external and 8 internal interrupts.
* Requires just +5 V (and +12 V only for RS-232 operation).
* Has an I/O expansion interface

The SB180's ROM monitor is designed to use the (optional) Echelon Inc. Z-System disk operating system, an enhanced, compatible superset of Digital Research's CP/M 2.2 operating system. However, the SB180 can also use the CP/M 2.2, CP/M Plus, MP/M II, TurboDOS, or Oasis operating systems (if properly customized).

The SB180 is a virtually complete system on a single board. You need only add a power supply, a serial terminal, and one floppy disk drive (40 track or 80 track DS/DD) to form a complete functional system. To operate the system, simply turn on the power, insert a Z-System disk, and start the bootstrap operation.

Section 2 of this manual provides complete installation instructions, and Section 3 gives a complete description of the hardware logic components which comprise the SB180 board. The ROM monitor is described in Section 4.

1.1 Notational Conventions

Active low logic signals (those which are true when at a logic low level of Ø volts) are indicated in this manual in two ways. First, active low signals are denoted by the presence of a "*" character following the signal name (e.g., SYSMEMRD*). These signals are also shown with a bar over the signal name, particularly on the logic diagrams. Both notations mean exactly the same thing. On the other hand, active high logic signals (those which are true when at a logic high level of 2.4 volts) are indicated by just the signal name (e.g., READY).

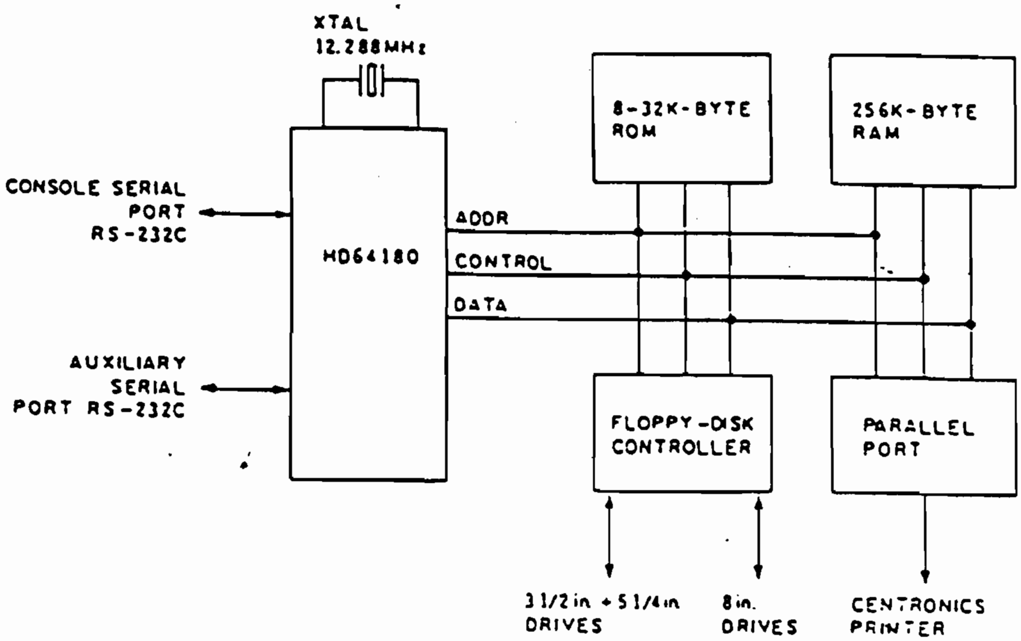


Figure 1.Ø-1 SB18Ø Functional Organization

2.0 SB180 Installation Instructions

The intent of this section is to be a guide to the installation of an SB180 system. Section 2.1 provides an overview of the installation process and should be read prior to the actual installation. Information presented in sub-sections 2.1 through 2.11 should be used to initially install the SB180 system including associated peripheral I/O devices. Section 2.4 provides a guide to follow when power is first applied if no disk drives are connected to the SB180 board and just the ROM monitor is being used. Section 2.11 assumes that a 40 track DS/DD 5.25" disk drive is connected to the SB180 and that you have the Z-System boot disk.

2.1 Installation Overview

The SB180 is designed to be relatively simple to set up and operate. A "bare bones" SB180 system consists of the following hardware components:

* SB180 system board with 256K RAM and 8K ROM monitor
* RS-232C compatible CRT terminal
* Power supply

A more complete system (and a more typical one) would add:

* one or more 5.25" 40 track (or 80 track) DS/DD floppy disk drives (or equivalent 3.5" drives) (Note: the SB180 monitor must have a 40 track double sided drive for Z-System boot up.)

* Centronics compatible parallel printer

Of course once the SB180 is operating in its minimum mode with at least one disk drive, other drives may be added. Additional information in Section 2.7 will detail the addition of 3.5" and/or double sided 8" drives.

It is suggested that the SB180 be initially installed and tested for proper operation without a disk drive. Once the operation of the ROM monitor has been verified, a floppy disk drive may be added to boot the operating system.

Although the SB180 has been designed to be compatible with "industry standard" peripheral interfaces, it is the responsibility of the user to ensure that any peripheral devices purchased separately meet the SB180 interface specifications. These are defined in the appropriate installation sections and by the actual peripheral devices themselves. Of particular importance, the interconnecting cables must match the interface at both ends. Improper cables will be the cause of system malfunctions in almost every instance, so the time spent in verifying the cable connections will be well worthwhile. The basic interface connectors of the SB180 were designed to use flat ribbon cable and insulation displacement connectors to simplify cable preparation.

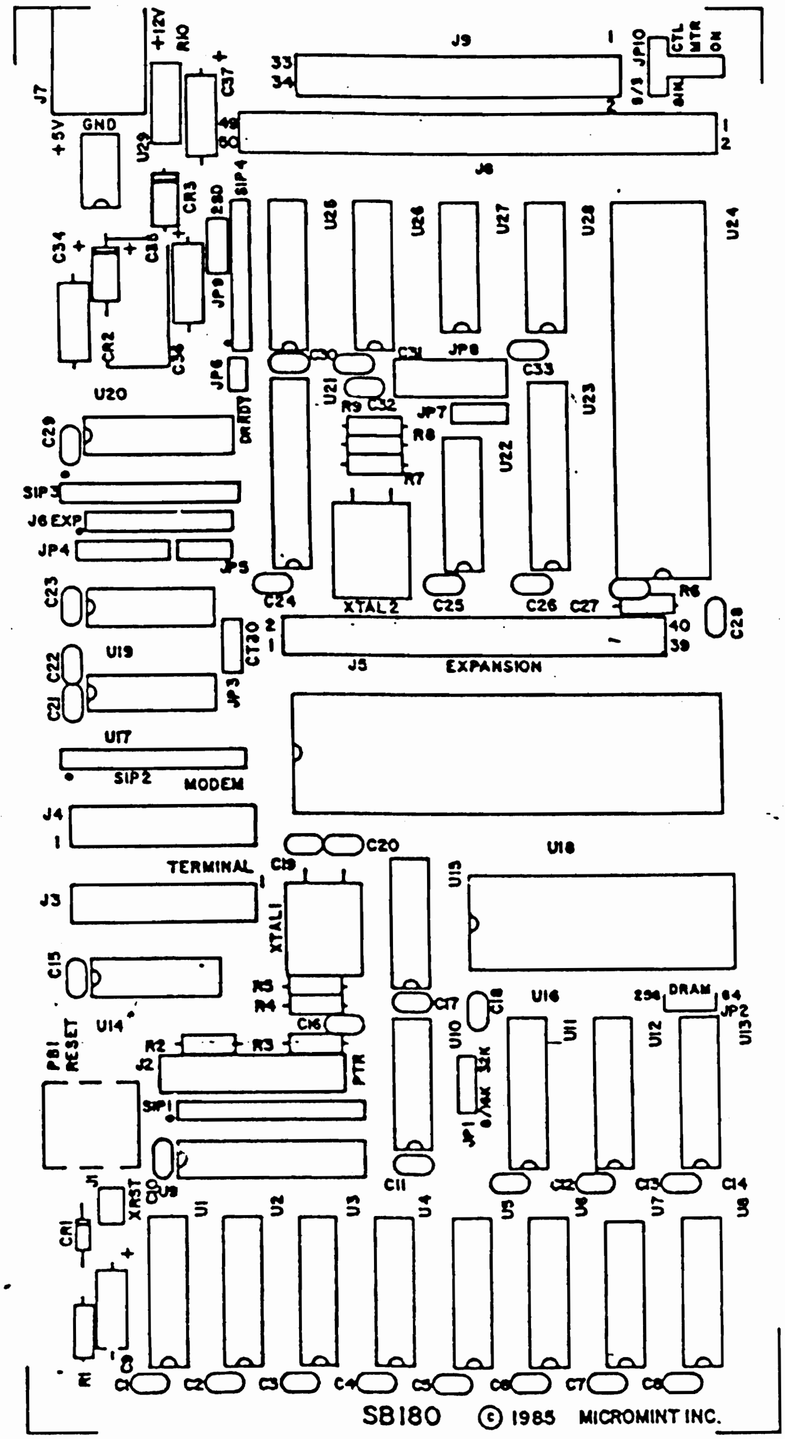


Figure 2.1-1 Silkscreen of SB180 Board

The information contained in each of the installation sections in this manual is geared towards the novice computer user. It is strongly suggested that all users, including those experienced in the installation of computer systems, should read the installation procedures completely before applying power to an SB180 system. Failure to follow the recommended procedures may potentially result in damage to components on both the system board and/or the peripheral devices. In particular, <u>reversal of the +5v and +12v power leads to the power connector results in permanent damage to all but one IC on the system board!</u> Figure 2.1-1 shows the silkscreen legend which appears on the SB180 system board. This picture should be referred to for all of the installation procedures as an aid in locating specified connectors, jumpers, IC sockets, etc. Figure 2.1-2 contains part numbers for recommended mating connectors for those on the SB180 system board. Connectors for the peripheral ends of interconnecting cables are dependent on each particular peripheral, and are specified in the manuals which should have come with them. A block diagram of a typical SB180 system using 5.25" floppies, a 3.5" floppy, and an 8" floppy is shown in figure 2.1-4

```
*****************************************************************
*                                                               *
*  CAUTION - DO NOT apply power to the SB180 system until the   *
*            Installation Checklist (Section 2.10) has been     *
*            completed and you are instructed to do so ! ! !    *
*                                                               *
*****************************************************************
```

SB180 CONNECTOR	DESCRIPTION	MATING CONNECTOR PART NO.	QTY.	MFG.
J1 Ext reset	2 pin solder pads	Hard wire norm. open pushbutton	-	-
J2-J4 Ser/Par	20 pin IDC flat cable connector	609-2000M	3	T&B ANSLEY
J5 Expan.	40 pin header receptacle	929975-01-20	1	APTRONICS
J6 Expan.	8 pin header receptacle	929974-01-04	1	APTRONICS
J7 Power	4 pin right angle pin header	22-01-2041 08-50-0114	1 4	MOLEX
J8 8" drive	50 pin IDC flat cable connector	609-5000M	1	T&B ANSLEY
J9 3/5" drive	34 pin IDC flat cable connector	609-3400M	1	T&B ANSLEY

Figure 2.1-2 RECOMMENDED MATING CONNECTORS FOR THE SB180 SYSTEM BOARD

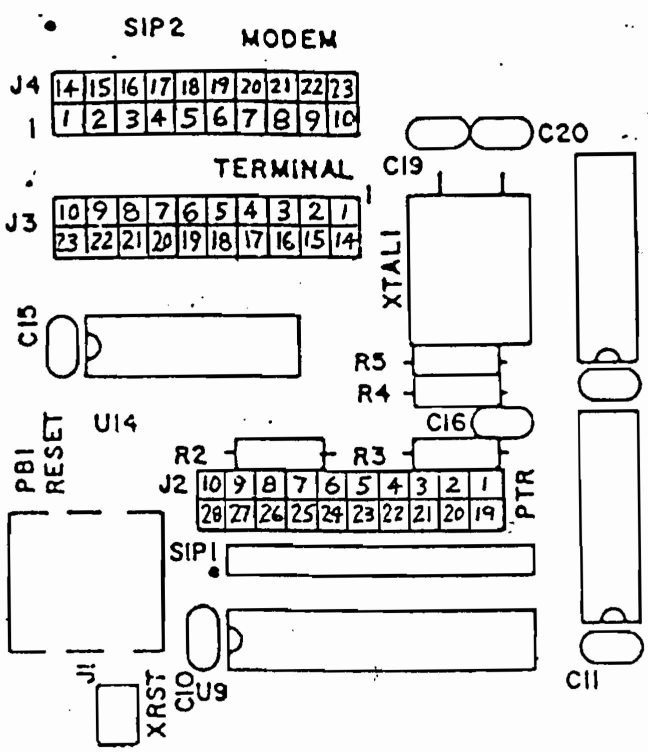


Figure 2.1-3 Orientation of 20-Pin Headers

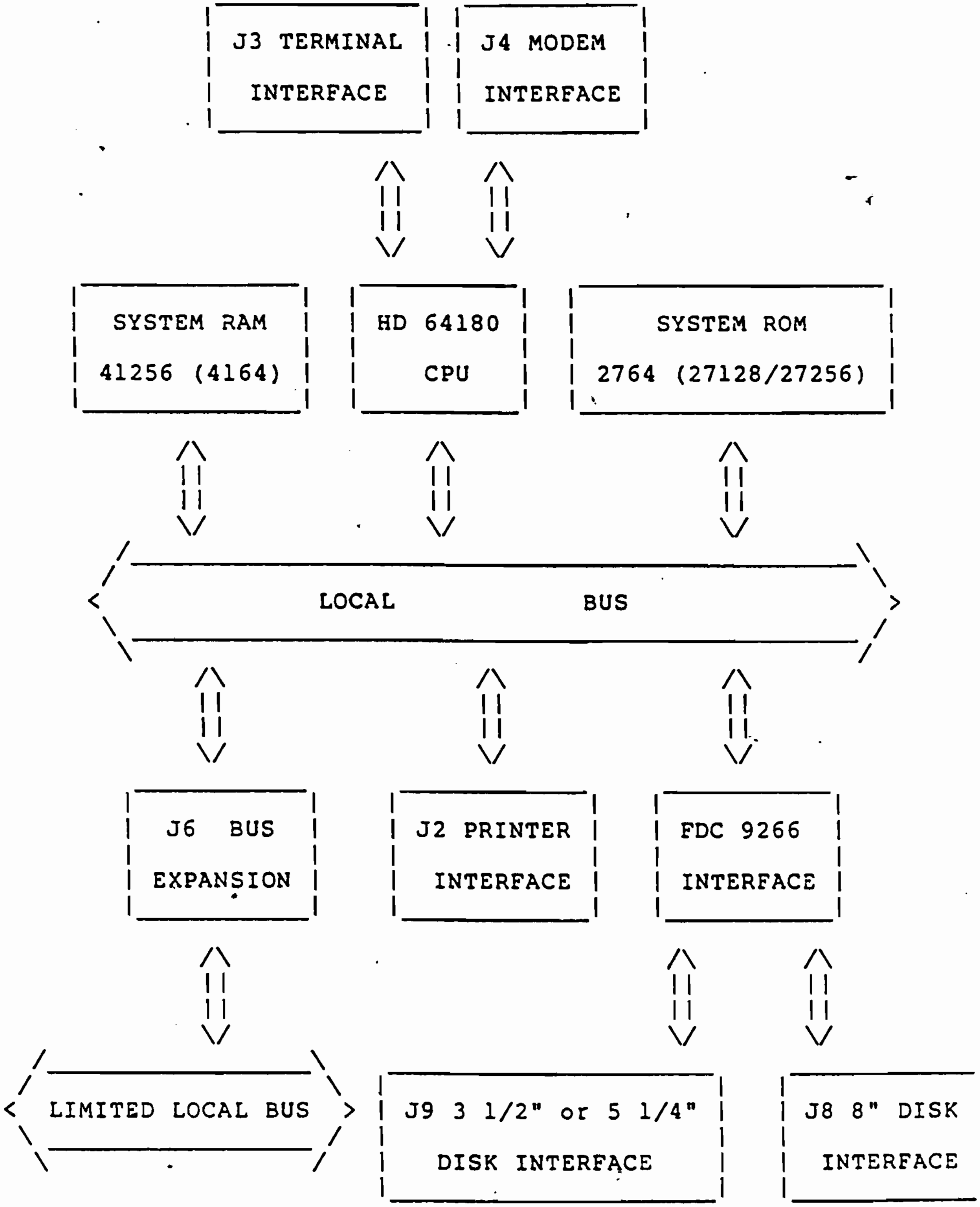


Figure 2.1-4 SB180 Block Diagram

2.2 Connecting the Power Supply

The information presented in this section is somewhat generalized since the actual installation of the power supply will be dependent upon several factors such as the number and type of disk drives, and the number of, and the power requirements of any expansion cards which will be installed. An example is given of a typical installation which uses a single power supply (available from Micromint) to power the SB180 system board and two 5.25" floppy disk drives. Recommended part numbers for mating power connectors are given in figure 2.1-2 for the SB180 and in figure 2.7-6 for typical flexible disk drives.

STEP 1 VERIFY THE POWER SUPPLY RATING

Before connecting a power supply to an SB180 system, verify that the supply is capable of providing enough current for all the devices which it will power. This is extremely important, since the SB180 system will probably not function correctly if the supply is operating at reduced output voltage due to overload. At a minimum, the power supply must be able to supply enough current for the SB180 system board. Figure 2.2-1 gives the power requirements for the system board. In addition, if the main power supply is to be used to power any floppy disk drives, then it must be large enough to handle the disk drives as well as the system board. Thus, the first step prior to connecting the power supply is to total up the current requirements for all of the loads. If the total current requirements exceed the rating of the power supply, it will be necessary to replace it with another one that is capable of handling the required load.

SUPPLY VOLTAGE	TYPICAL OPERATING CURRENT	ALLOWABLE VOLTAGE RANGE
+ 5 VDC	0.500 amperes	+4.75 to +5.25
+ 12 VDC	0.040 amperes	+11.4 to +12.6

Figure 2.2-1 SB180 SYSTEM BOARD POWER REQUIREMENTS

STEP 2 GET/MAKE UP A POWER CABLE

The power supply cable attaches to the SB180 system board at the 4 pin connector, J7. Part numbers for components of a recommended mating connector are given in figure 2.1-2. Signal specifications for the power pins are listed in figure 2.2-2 along with a suggested color coding scheme which will be helpful in avoiding the connection of a wire to an improper voltage level. WARNING! IF THE POWER CABLE IS CONNECTED BACKWARDS, IT WILL DESTROY ALL SYSTEM BOARD COMPONENTS! Figure 2.2-3 illustrates J7 from a side view with each pin identified with its corresponding voltage level.

PIN NO.	SIGNAL NAME	COLOR	NOTES
1	+12 V	YELLOW	40 ma power
2	+12 V RETURN	BLACK	ground
3	+ 5 V RETURN	BLACK	ground
4	+ 5 V	ORANGE	500 ma power

Notes:
1. All wires should be 24 AWG minimum
2. RETURN is the same as GROUND
3. BLACK can be used for both GROUNDs
4. Cable is available as Micromint P/N SB180-P

Figure 2.2-2 J7 POWER SIGNAL SPECIFICATIONS

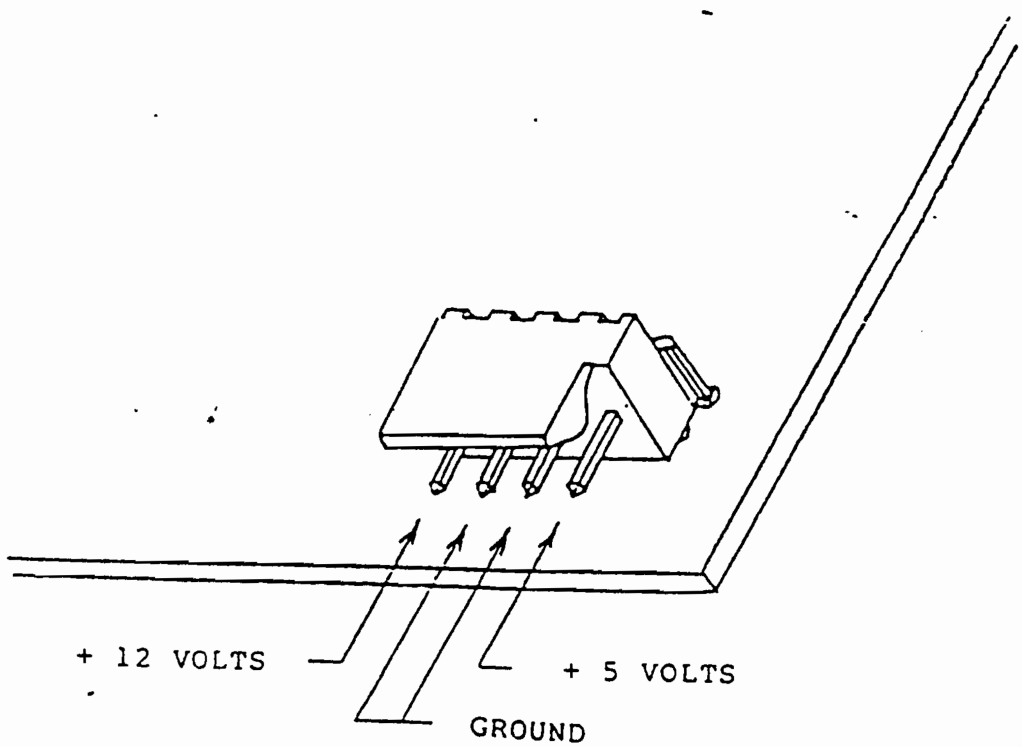


Figure 2.2-3 Side View of Power Connector J7

The type of connector, if any, which attaches at the power supply end of the cable depends upon the particular power supply to be installed. In general, each manufacturer tends to use a different connector, and in most instances a mating connector is not included with the power suply itself. If a mating connector cannot be acquired, the wires can usually be soldered directly to the connector pins, although this is not a recommended practice. In addition, some power supplies use screw type connectors which attach to automotive style spade lugs. These spade lugs would be soldered or crimped to the power leads, and can be used to form a good, reliable power connection which can be easily disconnected if necessary.

If your power supply will operate with no load (some switching supplies require a minimum load), this would be a good point to verify its proper operation. Checking voltages at the connector for the system board insures proper pin outs.

```
*****************************************************************
*                                                               *
*      CAUTION:  UNPLUG ALL AC POWER CORDS BEFORE PROCEEDING    *
*                                                               *
*****************************************************************
```

STEP 3 ATTACH THE POWER CABLE

Refer to figures 2.1-1 and 2.2-3 for the location and orientation and attach the 4-pin connector to J7 being sure to orient pin number 1 correctly. Make sure that all the pins in the connector and J7 are aligned properly before making the connection. Next, attach the opposite end of the cable to the power supply. Be sure that the correct wires are hooked up to the proper voltages. If a color coding scheme such as the one suggested was followed, this should not be a problem.

```
*****************************************************************
*                                                               *
*  CAUTION - MAKE SURE THAT THIS CONNECTOR IS INSTALLED IN THE  *
*            CORRECT ORIENTATION TO PREVENT DAMAGE TO THE       *
*            SYSTEM BOARD.                                      *
*                                                               *
*****************************************************************
```

This completes the SB180 system board power supply installation. Note: DO NOT plug in the AC power cord to a line outlet at this time.

2.3 Connecting the Main Console I/O Device

The main console I/O port on the SB180 is designed to attach directly to a standard RS-232C compatible CRT data terminal, such as a Televideo 950. The console serial device is attached to the SB180 system board at the 20-pin, dual row header, J3, which mates with standard 20-pin female flat cable connectors, such as the one recommended in figure 2.1-2. Signal pin assignments for J3 are listed in figure 2.3-1. The connector at the terminal end of the cable is typically a 25-pin DB-25 "D" style connector, and can be either a male or a female connector depending upon the requirements of the particular serial I/O device that is being used for the console.

The SB180 board as shipped is configured such that the console I/O port operates as Data Communications Equipment (DCE). In most instances where CRT (video display) data terminals are used, the serial device is set up to operate as Data Terminal Equipment (DTE), and no special configuration is needed. In this case, the pins on J3 tie directly to corresponding pins on the connector of the serial device. On the other hand, if the serial device is also operating as DCE, then the signal pins must be swapped in the cable assembly (reverse pin 2 with 3 at one end).

PIN#	EIA RS-232C SIGNAL NAME	I/O(DTE)	I/O(DCE)
2	TRANSMITTED DATA (TXD)	O	I
3	RECEIVED DATA (RXD)	I	O
7	SIGNAL GROUND (GND)	-	-
1,4-6,8-20	NOT USED		

Notes: 1. Signal direction at J3 is for DCE operation.
2. If hardware handshake is required for the console, J3 may be configured to provide an interface gate for pin 5 (CTS) by changing jumpers JP4 and JP5.
3. The console cable is available as Micromint P/N SB180-T

Figure 2.3-1 J3 SERIAL INTERFACE SIGNAL ASSIGNMENTS

In addition to the problem of matching the cable at each end to the correct interface signals, both the data terminal device and the SB180 system board must be set up to operate with the same set of parameters, such as number of data bits, number of stop bits, type of parity bit, baud rate, etc. This is accomplished via DIP switch settings on the terminal, though some older terminals may use hard-wired jumpers. The SB180 features auto baud rate detect for 300, 1200, 9600, and 19,200 baud, so the terminal may be set for any of these baud rates. The default values for the SB180 are: 8 data bits, 1 stop bit, and no parity. This code configuration may be changed after the SB180 is operating but must be adhered to for initial operation. Keeping these things in mind, you are now ready to configure and install the main communications device.

STEP 1 TURN OFF POWER

Disconnect power to both the SB180 system board and to the serial device which is being installed as the main console device. Removing power is best accomplished by unplugging all AC power cords.

STEP 2 CONFIGURE THE MAIN CONSOLE DEVICE

The first step is to read the installation instructions which should be included in the manual for the CRT data terminal (or other serial device if applicable). Follow the instructions given and set up the data terminal for operation with these parameters:

8 data bits
1 stop bit
no parity
baud rate: 300, 1200, 9600, or 19,200

If the serial device is configurable for either DCE or DTE operation, set it up as DTE according to the instructions given in the manual for the device. Most CRT terminals are already configured for DTE operation.

STEP 3 GET/MAKE UP THE CONSOLE CABLE

If a cable was not purchased with the SB180 system board, one must be constructed. The connector which mates with the J3 header should be a 20 pin (2x10) female flat cable connector on .100" centers. Refer to figures 2.1-1 and 2.1-4 for the location of J3 and the position of pin number 1. The connector which interfaces with the serial device will be specified in the manual for the device, but it is usually a 25-pin "D" connector. The actual construction of the cable depends on both the type of connectors and cable being used. The entire flat cable might be crimped at one time or individual pins may need to be crimped or soldered, and then inserted into a connector shell. Most serial terminals conform to the RS-232 DTE standards (i.e., they transmit data on pin 2 and receive on pin 3). The SB180 mates as a DCE device (receives data on pin 2 and transmits on pin 3). If the serial device is not operating as DTE equipment as previously mentioned, reverse pin 2 with pin 3 on one end of the cable.

STEP 4 ATTACH THE CONSOLE CABLE

Refer to figures 2.1-1 and 2.1-4 and connect the RS-232C cable at the SB180 system board, J3, which is a 20 pin dual row header. Be sure that pin number of the cable is oriented correctly with pin number 1 of J. . Now attach the cable to the serial device. If the connector is one of the the D style connectors, it will only go on one way. If not, use the information given in the manual for the device to verify that the connector is properly installed.

This completes the installation of the console device.

2.4 Turning On Power

This section describes the procedure for turning on power to the SB180 system for the first time. The SB180 board, if purchased fully assembled, has been "burned in" and fully tested prior to shipment. If any problems occur during the initial power up procedure and operational tests, the source of the problem will almost always be due to either an improper cable connection to the terminal or an incorrect option configuration on the terminal.

The information presented is intended to aid those users who have purchased a fully assembled and tested version of the SB180 system board. Due to the complexity of the circuitry on the board and the sophistication of some of the IC's, problems which are caused by errors in construction might require a full trouble-shooting effort with some sophisticated test equipment. Difficulties on this scale are beyond the scope of the text presented here. However Micromint does offer an inspection and repair service if needed.

STEP 1 SET UP THE POWER SYSTEM

The ideal arangement of the power system will have all AC power outlets associated with the SB180 system controlled by a single ON/OFF switch or circuit breaker. If this is the case, first turn off the main switch, and then turn on the power switches to the system power supply and the main console I/O device. Now the main switch can be used to turn the SB180 system on and off. Otherwise the individual components will have to be controlled independently of one another. This discussion assumes that this is the case.

Position the ON/OFF switch on the power supply and on the main console I/O device to the OFF position. Unplug any power supply or device which does not have an ON/OFF switch. Plug the AC power cords of all devices which are switched (e.g., have an ON/OFF switch) into a wall outlet. Do NOT apply power to the system at this time.

STEP 2 LAST MINUTE CHECKS!

Recheck all cable connections to the SB180 system board and to the main console I/O device. This includes both I/O interface connections, and power cable connections. Make sure that all connectors are installed correctly and are fully mated.

It would be a good idea at this time to verify that all IC's on the system board are fully inserted in their sockets and are oriented in the proper direction. Sometimes during shipping or during rough handling, ICs may work themselves loose in their sockets. Use your finger to press them all the way down in the socket. If you position the SB180 system board so that the label "SB180" is on the bottom edge of the board facing you, the power supply connector will be at the top left side of the board. With the board in this orientation, most of the ICs are oriented vertically with pin 1 being at the bottom right. The remaining ICs are oriented with pin 1 to the bottom left. The top of the IC is usually indicated either by a notch or by a small circular dot on the IC.

STEP 3 READY TO APPLY POWER!

Now you are ready to apply power to the system. This step is sometimes referred to as "smoke testing" the system, since components have been known to burn up due to improper installations. If any smoke is observed during this step, turn off power immediately and investigate the cause before proceeding. Possibilities here include incorrect cable connections, and ICs which are installed upside down in their sockets.

If you are at all unsure of the power supply connections, now is the time to check them for the proper voltages as listed in figure 2.2-2. First, read section 2.12, "Troubleshooting". Disconnect the power supply cable from J7, apply AC power to the system power supply only, and use a multimeter to ensure that the voltages are correct. If the voltages are correct, remove power to the power supply and reconnect the power supply cable to J7 on the SB180 system board.

It is assumed that a video display terminal has been installed in the system as the console I/O device. When power is first applied to the SB180 system, what is first seen on the main console I/O device depends upon a number of factors such as the type of terminal and baud rate. You may see a completely blank screen with a cursor in the upper left corner, or you may see a few random characters or letters on the screen.

Turn on power to the console I/O device first and then to the SB180. Normal responses will be:

1) A cursor should appear on the screen in 4 to 5 seconds.
2) As mentioned above, you may see one or more random characters on the terminal screen.
3) Press the RETURN or ENTER key on the terminal keyboard. This tells the SB180 the baud rate at which the terminal is operating.
4) On the screen will appear the message "Micromint ROM Monitor Version xx.xx"

These responses indicate that the SB180 system board has successfully completed initialization, recognized that no disk drives were attached to it, waited until a key was pressed on the terminal, analyzed it to determine the baud rate, set the baud rate, and then turned control over to the ROM monitor. If the system responded correctly as indicated above, go on to the next step. Otherwise, first try pushing the reset button, PB1, on the system board. If there is still no response, turn off power to the system, wait a few seconds, and try again. If the system still does not respond, go to the "IN CASE OF DIFFICULTY" section.

STEP 4 TESTING THE ROM MONITOR

The SB180 system should now be waiting for you to enter a command. The monitor prompt is "0>" where "0" denotes the fact that you are currently using the first 64K bank of memory. If you enter a "?", you will see displayed a full page "help" screen showing all of the monitor commands. Since a disk drive is not connected at this time, some of the commands will return an error status code when used. Using the information in Section 4.6 as a guide, you can try these commands:

A,B,D,F,H,M,Q,S,T,V,X, and Y

In particular, the "T" command (without additional parameters) performs a continuous memory test until terminated by a Control-C or Control-X. The SB180 could test memory until you are ready to attach disk drives, a parallel line printer, and an auxillary serial device such as a modem, as detailed in the next section of this manual.

2.5 Connecting an Auxillary Serial I/O Device

The auxillary I/O port is very useful in adding an external modem or serial printer to the SB180 system. Most modems usually operate as Data Communications Equipment, and J4 is set up as Data Terminal Equipment, so a standard pin-to-pin cable assembly should work fine. If you do not own an external modem, Micromint has an expansion board (COMM180) for the SB180 which contains a 300/1200 baud modem connected directly to the system data bus, thus it does not use the auxillary I/O port on the system board.

Installing an auxillary serial I/O device requires the same steps as the installation of the console serial device. The differences are that the interface connector is located in a different spot, has a different number, and that the pin numbers are oriented 180 degrees from the console serial interface connector. As such, refer to the information given in section 2.3 for installing the main console serial I/O device and follow those same procedures to install an auxillary device. Substitute J4 in place of J3 where ever it occurs. Figure 2.1-1 shows the location of J4. As you can see J3 and J4 are situated adjacently on the SB180 system board. If you have already installed the console device this step should be straight-forward. It is recommended that the entire procedure given in section 2.3 be read in its entirety prior to actually installing the auxillary serial I/O device.

2.6 Connecting a Parallel Printer

The SB180 system board supports a standard Centronics compatible parallel printer interface. The printer interface cable attaches to the SB180 system board at the 20-pin dual row header, J2. Refer to figures 2.1-1 and 2.1-4 for the location and orientation of J2. Figure 2.1-2 gives a part number for a mating connector. The connector at the printer end of the cable varies between different printers. A typical connector which is compatible with Centronics style printers is a 36-pin male Amphenol part number 57-40360. This connector is also designed to use flat ribbon cable with pin 1 connecting to pin 1 on J2; unused or open pins on the Centronics connector fall toward the pin 36 end of the connector. Many of the newer printers tend to use the 25-pin "D" style connectors similar to the ones used by the serial I/O devices. Figure 2.6-1 below lists the signal specifications for J2.

J2 PIN NO.	SIGNAL NAME	CENTRONICS PIN NO.	I/O
1	DATA STROBE*	1	O
2	DATA1	2	O
3	DATA2	3	O
4	DATA3	4	O
5	DATA4	5	O
6	DATA5	6	O
7	DATA6	7	O
8	DATA7	8	O
9	DATA8	9	O
10	ACKNOWLEDGE*	10	I
11-20	SIGNAL RETURNS	19-30	-

Note: This cable available as Micromint P/N SB180-PR

Figure 2.6-1 J2 PRINTER SIGNAL INTERFACE SPECIFICATIONS

STEP 1 DISCONNECT POWER

Check to make sure that power is not applied to either the SB18Ø system board, or to the printer device. Power should be removed by unplugging all AC power cords associated with the SB-18Ø system, including those of all peripheral devices.

STEP 2 VERIFY PRINTER INTERFACE SIGNALS

First, read the manual which came with the printer, particularly the section which discusses the installation of the printer in a computer system. Next, verify that the signals on each pin are the same as the signals available at J2 on the SB18Ø system board. Write down those which are on a different pin so that a printer cable can be constructed in a later step. In most cases the only signals needed are the data lines, the data strobe, the data acknowledge, and a signal return path (ground).

STEP 3 CONFIGURE THE PRINTER

Follow the instructions in the installation section of the printer manual, and set it up for operation as desired. Choices here may include options such as page size, type style, page margins, automatic line feed, character set, etc. (The SB18Ø monitor normally sends a line feed after each carriage reurn.) Also, if the printer can be configured for the polarity of the strobe and acknowledge signals, make them both active low. The polarity of the printer interface control signals can also be changed by writing a software routine if necessary. Source code for the ROM monitor is available on disk.

STEP 4 GET/MAKE UP A PRINTER INTERFACE CABLE

If a printer interface cable was not purchased with the SB18Ø system board, one must be constructed. If one is available, use the signal specifications listed in figure 2.6-1 and information from the printer manual to verify the wiring. Change any wires which are incorrect. You should have a list of these from Step 2 above. If a new cable must be constructed from scratch, first verify that the two connectors mate properly with both the 2Ø pin header at J2 and at the printer's interface connector. Next, wire the two connectors together such that each signal connects to the proper pin number at both ends of the cable. The J2 header pin layout mates directly with insulation displacement connectors and flat ribbon cable.

STEP 4 SELF-TEST THE PRINTER

Many printers have a self-test function which continuously prints all the printable characters in a line across the paper. If the printer has this capability, follow the instructions in the printer manual and run the self-test. Be sure to turn off power to the printer and to disconnect the AC line cord before proceeding.

STEP 5 ATTACH THE CABLE

Attach the cable to the appropriate connectors at each end. Be sure to align pin 1 on J2 correctly (see figures 2.1-1 and 2.1-4). If the printer connector is a "D" style connector, it will only go on one way. If it is not, refer to the printer manual for the proper orientation of the mating connector.

This completes the installation procedure for the parallel printer device.

2.7 Connecting Floppy-Disk Drives.

The SB180 system board has been designed to interface to the standard 5.25 inch flexible (usually called minifloppy) disk drive, to the 8 inch floppy disk drive, and to the newer 3.5 inch microfloppy disk drive. (Note: there are several different types of 3.5 inch floppy drives. The SB180 can use only the 40 or 80 track drive that is pin compatible with the 5.25 inch minifloppy.) A thirty-four pin flat cable connecter is installed on the system board to allow for up to four drives of either 5.25 inch and/or 3.5 inch type to be attached in a daisy-chained fashion at a time. Space is provided for the fifty pin flat cable connector needed for 8 inch double sided disk drives, but it is not installed since most users will not be using this size drive. This connector is available from Micromint (P/N SB180-8X). Although instructions are given for using 8 inch drives, the Z-System disk operating system is delivered only on 5.25 inch diskettes and a 5.25 **inch double sided drive (40 track) MUST be connected to the SB180 initially to start up.** Any 3.5 inch drives are considered equivalent to 5.25 inch drives and may be daisy chained along with them. Eight inch drives (double sided only) may be added simultaneously or later (but you must add the 8 inch connector (J8) as mentioned above).

The interface connectors for both types of drives support the "industry standard" interface specifications for floppy disk drives, and thus can attach directly to many of the standard 8 inch and minifloppy drives currently being used. It is the responsibility of the user to ensure that the particular drive to be installed adheres to the interface specifications of the SB180 flexible-disk controller interface. In addition, there are several jumpers on the system board which may be installed or removed depending on the size of the disk drives used. Figure 2.1-1 shows the location and orientation of connectors and jumpers associated with the floppy-disk interface. Refer to it as required during the installation procedures.

The installation of floppy-disk drives to an SB180 system can be complex. If at all possible, an OEM manual for the drives which are being installed should be obtained. Since manuals are not always readily available, the discussions which follow detail the installation of the Teac 55B 5.25 inch and Shugart SA850 8 inch disk drives as examples. The 3.5 inch drive is for this purpose the equivalent of a 5.25 inch drive. (Some manufacturers of 3.5 inch drives use a 34 pin header rather than the standard edge connector, but the pin assignments are identical.)

Figure 2.7-1 lists the jumpers associated with the floppy-disk drive interface section of the SB180 system board which are dependent on the drive size, 5.25 inch (or equivalent 3.5 inch) or 8 inch. The installation descriptions given are generalized for both types of floppy drives, and the user is directed to the appropriate figures and tables for each type of drive as needed.

In the following discussion, references to signals at the SB180 system board interface refer to disk drives as number 0, 1, 2 or 3. The Z-System DOS, however, refers to these drives as A, B, C and D, respectively. Sometimes disk drive manuals refer to the different drive selection options as drives 1, 2, 3 and 4.

JUMPER	PURPOSE
JP6	Required for drives without READY line. Generally older drives do not provide this line.
JP7	Hard wired on back of board for fixed write pre-compensation. Cut on circuit side and install a wire jumper for controlled pre-compensation. Controlled pre-comp is applied only on inner tracks while fixed pre-comp is applied during write operations on all tracks. 8" drives may require write pre-compensation.
JP8	Hard wired on back of board for NO write pre-comp. See SMC 9266 manual for full specifications.
JP9	Allows use of only single sided drives; in mixed systems, a single sided drive would have a jumper installed to enable use of this multiplexed status line. Z-System software does not support one side operation
JP10	For mixed drive size operation. Allows the processor TXS line to control 5.25" drive motors or selection of 5.25"/8" data transfer rates to disk controller.

Note: These jumpers are intended to implement all of the advanced features of the disk controller and for special configurations. No changes required for most standard drives.

Figure 2.7-1 JUMPER SELECTION FOR DISK DRIVES.

From one to four soft-sectored floppy-disk drives can be attached to one of the two SB180 system board flexible-disk interface connectors. J9, a 34-pin right angle flat cable connector, is used to attach 5.25 inch minifloppies (and 3.5 inch microfloppies). J8, a 50-pin cable connector (optionally installed by the user), is used to attach standard 8 inch floppy disk drives. Both connectors mate with standard flat cable connectors such as the ones recommended in figure 2.1-2. Interface signal definitions are shown below in figures 2.7-2 and 2.7-3 for 5.25 inch and 8 inch drives, respectively. Although the signal pin-outs have been designed to directly interface with many of the drives commonly in use today, the SB180 system installer must verify that all signals match the interface requirements for the particular drive which is being installed. In some instances, it may be necessary to change some of the wires on the drive interface cable in order to match up the interface signals between the drives and the SB180 system board. If the drives being installed are compatible with the Teac 55B minifloppy or the Shugart SA850 8 inch drive interfaces, there should be no problems associated with attaching the drives to the SB180 system board, and getting Z-System up and running.

STEP 1 TURN OFF POWER

Before doing anything else, ensure that all power is turned off to both the SB180 system board and to all of the floppy disk drives. The safest procedure to follow is to unplug all AC power cords associated with the SB180 system, including those of peripheral devices.

STEP 2 CONFIGURE FOR 5.25-INCH (AND 8-INCH DISK DRIVES)

Refer to figure 2.1-1 for a picture of the location of the SB180 system board jumpers associated with the flexible-disk drive interface, Next, use the table in figure 2.7-1 to select the appropriate jumpers for the type of floppy-disk drives which are to be installed. A diagram of the flexible-disk interface area of the SB180 system board with jumpers installed at JP10 for 5.25 inch, for 8 inch, and for mixed size drives is given in figure 2.7-4. Using the appropriate pictorial view as a reference, configure the SB180 system board for the desired drive type by installing the jumpers as indicated in the table. Note that these jumpers are configured based solely on the size of disk drive, and are the same regardless of which manufacturer's drive is used.

```
3"/5" Operation        3"/5"/8" Operation        8" Only

  o                      o                          o
                                                    |
  o   o---o   o          o---o---o    o             o   o---o   o
  |
  o                      o                          o
```

Figure 2.7-2 JP1Ø Jumper Setup

STEP 3 VERIFY DISK DRIVE INTERFACE SIGNALS

The next, and perhaps the most important step to take, is to verify that all of the signals at the floppy-disk drive match those of the SB18Ø floppy-disk drive interface specifications as listed in figure 2.7-2 for 5.25 inch drives, or in figure 2.7-3 for 8 inch drives. If such is not the case, the disk drive interface cable must be altered such that all signal names agree at both ends. Also noted are pins which are directly compatible with the Teac 55B or Shugart SA85Ø disk drives. Note that disk drives are generally connected with flat ribbon cable. Due to the pinouts of the connectors, adjacent signal lines have an interposing ground line between them in the cable. Failure to provide this grounding virtually guarantees problems!

PIN NO.	SIGNAL NAME
4	HEAD LOAD/IN USE*
6	DRIVE SELECT 3*
8	INDEX*
1Ø	DRIVE SELECT Ø*
12	DRIVE SELECT 1*
14	DRIVE SELECT 2*
16	MOTOR ON*
18	DIRECTION
2Ø	STEP*
22	WRITE DATA*
24	WRITE GATE*
26	TRACK Ø*
28	WRITE PROTECT*
3Ø	READ DATA*
32	SIDE SELECT (Ø/-1)
34	READY*
ALL ODD PINS	SIGNAL RETURNS (REQUIRED)

Note: This cable is available as Micromint P/N SB18Ø-DSK

Figure 2.7-3 J9 - 5.25" INCH DRIVE INTERFACE SPECIFICATIONS.

The head load function should be configured at the disk drive end of the interface cable according to instructions given in the drive manual. Use of this capability can greatly extend the useful life of the flexible diskettes. Not all drives support a head load option at the interface.

It is quite likely that the floppy disk drive does support a READY* control function. In case your drive does not support a READY* line, jumper JP6 on the SB180 system board must be installed for the disk controller to function. Most newer 5.25 inch drives do support a READY* control function. READY* generally indicates that a diskette is installed and seated in the drive. On some drives READY* only becomes active when index pulses indicate that the disk is up to speed.

PIN NO.	SIGNAL NAME	
2	LOW CURRENT*	
4	FAULT RESET*	(not used)
6	FAULT*	(not used)
8	MOTOR ON 2*	(not used)
10	TWO SIDED*	
12	MOTOR ON 1*	(not used)
14	SIDE SELECT	(0/-1)
16	MOTOR ON 0*	(not used)
18	HEAD LOAD 0*	
20	INDEX*	
22	READY*	
24	HEAD LOAD 1*	(not used)
26	DRIVE SELECT 0*	
28	DRIVE SELECT 1*	
30	DRIVE SELECT 2*	
32	DRIVE SELECT 3*	
34	DIRECTION	
36	STEP*	
38	WRITE DATA*	
40	WRITE GATE*	
42	TRACK 0*	
44	WRITE PROTECT*	
46	READ DATA*	
48	HEAD LOAD 2*	(not used)
50	HEAD LOAD 3*	(not used)
ALL ODD PINS	SIGNAL RETURNS (REQUIRED)	

Figure 2.7-4 J8 - 8" DRIVE INTERFACE SPECIFICATIONS

STEP 4 CONFIGURE THE DISK DRIVES

This step is highly dependent on the particular drive type to be installed. As an aid in configuring the disk drives, section 2.7.1 describes a typical configuration for the installation of two Teac 55B minifloppy disk drives, and section 2.7.2 discusses typical option selections for installing Shugart SA850 eight inch drives. Note that there are two main differences between the two drives in either case: each drive has a different drive select control line enabled (thus these are called "radial" lines), and only the drive which is physically located at the end of the interface cable has terminator networks (usually DIP resistor networks) installed for the "multiplexed" signals (those which share a single cable wire). The SB180 uses a 330 ohm terminator network allowing up to 1.5 meters of total cable length. For some of the newer low power (CMOS) drives, this termination may require a higher value terminator. Use of a 1k terminator reduces allowable cable length to 1 meter. Where longer cables are required, a 150 ohm terminator may be installed to allow up to 3 meters of cable. If SIP4 (the terminator) must be changed, it must be desoldered from the SB180 board.

STEP 5 CONFIGURE THE SB180 SYSTEM BOARD

Configuring the SB180 system board for disk drives consists of setting the appropriate jumpers. If only double sided 5.25 inch (and 3.5 inch) drives are being used, then no changes are required. Note that the operating system software supplied initially requires the use of 5.25 inch double sided drives; you may then change jumpers, modify the BIOS and monitor EPROM to boot from 8 inch drives. No BIOS or EPROM changes are required to add 8 inch double sided drives to a system which has 5.25 inch drives as well.

The connectors on the "T"-shaped block JP10 (upper right hand corner of the SB180 system board) must be set as shown in figure 2.7-4. Finally, if the disk drives do not support a multiplexed READY* control signal, then install a shorting jumper wire in JP6; this signal must be active before the floppy-disk controller will attempt to read a disk. Most 8 inch drives and newer 5.25 inch drives tend to support this control signal while some older 5.25 inch drives do not.

STEP 6 GET/MAKE UP DISK DRIVE CABLES

Floppy-disk drives require both a power cable (in some cases two of these are needed) and an interface cable. The typical 5.25 inch (or 3.5 inch) minifloppy drive uses a 34-pin dual row card edge type of connector for the interface, and a 4-pin power connector for +5 and +12 VDC power. The typical 8 inch disk drive requires a 50-pin dual row card edge type of connector for the interface signals, a 6-pin power cable for DC power, and a 3-pin cable for AC power. Figure 2.7-5 lists mating connector part numbers for the Teac 55B minifloppy and the Shugart SA850 8 inch floppy-disk drives. For other manufacturers' drives consult the drive manual to verify mating connector part numbers as well as signal specifications.

CONNECTOR TYPE	MFG.	3.5 INCH PART #	5.25 INCH PART #	8 INCH PART #
INTERFACE	ANSLEY	609-3400M	609-3415M	609-5015M
	3M	-	3463-001	3415-0001
	AMP	1-499566-9	1-499560-2	1-499566-2
DC POWER	AMP	-	1-480424-0	11-480270-0
AC POWER	AMP	N/A	N/A	1-480303-0

Notes: 1. Pins for the AMP housings are AMP number 60619-1
2. Part numbers given are typical, but may not match all drives. Consult the drive manual.

Figure 2.7-5 DISK DRIVE CONNECTORS SPECIFICATIONS.

If cables were not purchased with the SB180 system board, or are not already available, they will have to be constructed for the floppy-disk drives. When making the interface cable be sure that all of the signals are the same at the SB180 flexible disk interface connector as at the disk drives. The number of connectors needed which mate with the disk drives obviously depends on the number of drives which are being installed. Of course, a cable with connectors for all four drives can be made up even if all four drives will not be installed at this time. This would simplify later expansion of the system for additional drives.

STEP 7 ATTACH THE DISK INTERFACE CABLE

Attach the 34- or 50-pin flat cable connector, as appropriate, to the SB180 system board connector, J9 or J8, respectively. Make sure that pin 1 of the cable connector matches up with pin 1 of the disk interface connector on the SB180 system board. If the SB180 system board is held such that J9 and J8 are located at the top of the board, pin number 1 is the upper right pin. Now connect the edge card connectors to the floppy disk drives. The order in which drive numbers are attached does not matter, except that the last drive located at the far end of the interface cable must be the one which has the terminators installed for the multiplexed signals as previously described.

STEP 8 ATTACH THE DISK DRIVE POWER CABLE(S)

Depending on the requirements of the particular drive which is being installed, one or two power cables may be needed. Attach the DC power cables at both ends. These cables are usually constructed so that the wires are daisy-chained from one drive to the next. For small SB180 systems, the end of the DC power cable which attaches to the power supply may be part of the power connector for the system board, and may have already been installed from section 2.2. Next attach the AC power cable if one is required, but do not plug the AC source into a power outlet at this time. In most instances the power end of the AC line cord will probably tie into a terminal block and a single plug or power switch will be used to power the entire SB180 system.

2.7.1 Installation of Teac 55B 5.25 inch Disk Drives

This section describes the installation of two Teac 55B 5.25 inch flexible disk drives. These drives are double-sided, and can record in either single- or double-density formats. The two drives are set up for multiple drive operation. All interface signals are TTL compatible with a logic-low of +0.4V maximum and a logic-high of +2.4V minimum. A logic-low indicates a "true" or active condition, while a logic-high indicates a "false" or inactive condition. The maximum length of the interconnecting cable, from the SB180 system board connector, J9, to the last drive on the cable is 4.5 feet. The recommended cable is standard flat ribbon cable with a characteristic impedance of 100 ohms, or equivalent twisted pairs. Figure 2.7-6 lists option selections on the 55B's in a typical two-drive installation.

OPTION DESIG.	55B DESCRIPTION	DRIVE A	DRIVE B	SOCKET PINS
--	TERMINATOR NETWORK	R	I	(SOCKET J3)
HS	HEAD SOLENOID	R	R	1-16
DS0	DRIVE SELECT 0	I	R	2-15
DS1	DRIVE SELECT 1	R	I	3-14
HM	HEAD MOTOR CONTROL	R	R	4-13
DS2	DRIVE SELECT 2	R	R	5-12
DS3	DRIVE SELECT 3	R	R	6-11
MX	MULTIPLEX OPERATION	R	R	7-10
UR	LED OPTION 1 (SEL+RDY)	I	I	1-16
ML	MOTOR ON	I	I	2-15
IU	IN USE	R	R	3-14
HL	HEAD LOAD	R	R	4-13
SM	HM/HS ENABLE	R	R	5-12
U0	LED OPTION 2 (IN USE)	R	R	6-11
U1	LED OPTION 3	R	R	7-10
RE	RECALIBRATE	R	R	8- 9

Note: I=installed, R=removed

Figure 2.7-8 TEAC 55B CONFIGURATION GUIDE

2.7.2 Installation of Shugart SA85Ø 8 inch Drives

This section illustrates the installation of two Shugart SA85Ø 8 inch flexible-disk drives. Figure 2.7-7 lists the option selections which are typically installed on the disk drives. Note that jumper wires must be added at each drive to select the head load options since a common signal wire at pin number 18 on the interface cable is used for all drives.

TRACE DESIG.	SA85Ø DESCRIPTION	DRIVE Ø	DRIVE 1
T1	HEAD LOAD TERMINATOR	I	I
T2	DRIVE SEL. TERMINATOR	I	I
T3-T6	TERM. FOR MULTIPLEX INP.	R	R
DS1	DRIVE 1 SELECT INPUT	I	R
DS2	DRIVE 2 SELECT INPUT	R	I
DS3	DRIVE 3 SELECT INPUT	R	R
DS4	DRIVE 4 SELECT INPUT	R	R
R,RR	RADIAL READY OUTPUT	I	I
RI	RADIAL INDEX OUTPUT	I	I
X	HEAD LOAD OPTION	R	R
A,B	HEAD LOAD OPTIONS	I	I
C	HEAD LOAD OPTION	I	R
WP	WRITE PROTECT	I	I
NFO	STOP AT TRACK Ø	I	I
DDS	DRIVE DECODE OPTION	R	R
DC	DISK CHANGE OPTION	R	R
HL	STEPPER PWR-HEAD LOAD	R	R
DS	STEPPER PWR-DRIVE SEL.	R	R
NP	NO WRITE PROTECT	R	R
Y	IN-USE FROM HEAD LOAD	R	R
Z	IN-USE FROM DRIVE SEL.	I	I
TS	TRUE FM DATA SEPARATION	E	E

Notes: R = jumper removed, I = jumper installed,
E = removed or installed,

Figure 2.7-8 SHUGART SA85Ø CONFIGURATION GUIDE.

The SA85Ø 8 inch drives are double-sided, and can record in either the MFM mode (double-density) or in the FM mode (single-density). All signal lines are TTL compatible. Outputs are driven by open-collector drivers capable of sinking a maximum of 4Ø ma at a logic zero level (or true state) with a maximum voltage of Ø.4V at the driving device. Collector current when the driver is at a logic one (or false state) and thus off is a maximum of 25Ø microamperes. These specifications are typical of most drives as well as the devices in the SB18Ø system board flexible-disk interface area.

Installation of more than two drives is essentially the same as for two drives. Set up the drives for drive select numbers from Ø on up in ascending order, and install the resistor terminator jumpers in the drive which is physically the last drive in the daisy-chain. On mixed size drive systems (both 34 pin and 5Ø pin connector cables) install the drive terminator on the longer of the two cables.

Installation of newer models of 8 inch drives is generally simpler than for the SA85Ø.

Power requirements for the SA85Ø disk drives are +24 VDC at 1.3A, +5 VDC at Ø.8A, -5 VDC at Ø.Ø5A (newer drives do not use this), and 115 VAC at Ø.5 amperes. DC currents are typical values, while AC current is a maximum value.

2.8 The Expansion Bus

The SB18Ø system board can support expansion cards through its I/O expansion bus which is accessed through the 4Ø pin connector J5 and the 8-pin connector J6. Figure 2.8-1 illustrates the signal pin-out of these connectors. Because all of the major peripheral devices which are needed to support a high performance Z-System based microcomputer system are supported by on-board controllers, the expansion bus is only needed for expansion peripherals such as a hard disk controller, a "smart" modem, custom I/O interfaces such as data acquisition controllers, a local area network (LAN) interface, or graphics display controller. The only factor which might limit the use of the expansion connector is the rating of your system power supply, so be sure that your power supply capacity is adequate for continued reliable operation.

When designing custom interfaces, serious consideration must be given to the fact that the busses on the SB18Ø are operating at 6-9 MHz. Long extensions to the busses and bus overloading must be avoided.

As always, the first step to take prior to the insertion or removal of any expansion card(s) is to ensure that POWER HAS BEEN REMOVED from the SB18Ø system board.

The next step is to thoroughly read the installation procedures which come with the expansion card. Follow the procedures given and install the card using connector J5. If all goes well the card should now be up and running.

EXPANSION BUS

DESCRIPTION	PIN #		DESCRIPTION
+5V PWR	1	2	+5V PWR
GND	3	4	GND
-RD	5	6	PHI
-WR	7	8	-RESET
E	9	10	-LIR
-NMI	11	12	-EXP SEL (E0-FF)
-WAIT	13	14	NC
-INT0	15	16	-HALT
ST	17	18	NC
A0	19	20	A1
-TEND0	21	22	A2
A3	23	24	A4
-DREQ0	25	26	-I/O ENABLE
8.0 MHZ	27	28	RESET
D7	29	30	D6
D5	31	32	D3
D4	33	34	D2
D1	35	36	D0
GND	37	38	GND
NC	39	40	NC

J5

Notes: 1. Micromint expansion bus 40 pin header is P/N SB180-EX
2. J6 and its driver IC are generally not populated on the SB180. Expansion boards which require the address decode function will supply the chip and connector.

Figure 2.8-1 EXPANSION BUS SIGNALS

2.9 Installation of User EPROM

The SB180 contains a 28-pin socket for a capacity of up to 32K bytes of JEDEC standard ROM or EPROM devices. The standard SB180 system board is shipped with a stand alone monitor installed in a Erasable Programmable Read Only Memory (EPROM) device. This consists of one 8Kx8 2764 or 16Kx8 27128 type EPROM. This EPROM contains the power-on jump vector.

A single jumper is associated with the type of EPROM device which is installed on the system board. This is JP1. Refer to the silkscreen drawing of figure 2.1-1 for the location of this jumper. If the standard 2764 EPROM or a 27128 EPROM is used, the jumper should be in the factory wired position. If a 32K 27256 EPROM is ever installed, the jumper must be cut on the circuit side of the board and a wire installed in the opposite position.

2.10 SB180 Installation Checklist

This section is intended to serve as an overall guide to the sequence of steps which should be taken during the installation of an SB180 system. Before commencing the actual installation of the hardware components, sections 2.1 through 2.10 should be read to get an idea of the scope of the project about to be undertaken. Once this has been done, proceed to the checklist given below in figure 2.10-1. After all steps in the checklist have been completed, use section 2.11 to start up the SB180 system and verify correct operation.

2.11 Turning On Power With Disk Drives Attached

This section describes the procedure for turning on power to the standard SB180 system after the completion of the system installation procedures given in section 2.4 of this manual and after installation of disk drives as detailed in section 2.7 of this manual.

It is assumed in this section that the Z-System operating system has been purchased with the SB180 system board, and that the user is somewhat familiar with the terminology used by Z-System. Users who are not already conversant with Z-System should read the operating system user's guide before trying to use the SB180 system.

STEP	DESCRIPTION	DONE
1.	Read sections 2.1 through 2.1Ø.	( )
2.	Unpack the SB18Ø system board and inspect it for damage. If damage is evident, return to vendor.	( )
3.	Using section 2.2 as a guide, install the system power supply(s).	( )
4.	Using section 2.3 as a guide, install the system console RS-232C serial device.	( )
5.	Using section 2.4 as a guide, check out the SB18Ø ROM monitor with the console device connected.	( )
6.	Using section 2.5 as a guide, install the system auxillary RS-232C serial device if needed.	( )
7.	Using section 2.6 as a guide, install the system listing device (parallel printer) if needed.	( )
8.	Using section 2.7 as a guide, install the system flexible disk drive(s).	( )
9.	Using the information in section 2.9, verify the jumper configuration for the EPROM devices.	( )
1Ø.	Use section 2 to verify correct functional operation of the basic SB18Ø system.	( )
11.	Using section 2.8 as a guide, install expansion cards as required.	( )
12.	If expansion cards were added in step 11, repeat step 1Ø.	( )
13.	Now operate the SB18Ø under Z-System!!!	

Figure 2.1Ø-1 INSTALLATION CHECKLIST

STEP 1 & STEP 2 SAME AS SECTION 2.4, STEPS 1 & 2

Follow the instructions as given in section 2.4 of this manual, steps 1 and 2.

Open the door(s) of the flexible disk drive(s) and remove the piece of cardboard which may be inserted in place of a diskette for shipping, if not previously done.

If this is the first time the SB180 system is being powered up, it is recommended that any expansion board be removed until the basic system is up and running. If cards are to be installed on the expansion connector at this time, check them to ensure that they are seated properly into the 40 pin and (optionally 8 pin) connector(s) with the component side(s) facing up.

STEP 3: TURN ON POWER AND BACK UP THE Z-SYSTEM DISK

The SB180 system should now be ready for you to make back up copies of the Z-System system diskette using drive number 0 (or drive A as it is referred to by Z-System). Z-System is a disk operating system, or DOS as they are commonly referred to, which was designed by Echelon, Inc. to be fully compatible with CP/M 2.2. This is simply a collection of programs stored on the diskette which will enable you to create and execute (run) programs on the SB180 system.

A FEW WORDS OF CAUTION

Before proceeding any further, the flexible-diskettes which are used for program and data storage by the SB180 system will be discussed. Users familiar with the use and handling of diskettes should skip the next several paragraphs.

While diskettes can handle a large amount of information, they are somewhat fragile and need to be treated with respect. Although they are flexible, they can be easily damaged if they are bent or scratched, or if any foreign matter such as dust, hair, or grease from fingerprints is allowed to touch the surface of the diskette itself. Diskettes should only be handled by the black plastic cover which protects them, and should be stored in the paper covers they come in when not in use. Don't leave them lying around where they will collect dust or be dropped on the floor. In addition, diskettes should be kept away from extremes in temperature and away from magnetic fields. Always use felt-tip pens to write on the diskette labels to avoid damaging the surface of the diskette.

To insert diskettes into a disk drive, first open the drive door (different drives have slightly different door mechanisms). This is usually done by pulling outward on the edge of the door, or in some cases, by pushing in on a door release mechanism. Diskettes can then be inserted into the slot in the drive with the end of the diskette which has the oval cutout leading the way. The side of the diskette which has the manufacturer's label usually faces the drive door, and always enters the drive last. Diskettes should always be GENTLY pushed into the drive, taking caution not to bend them; this can result in permanent damage. Once the diskette is fully inserted into the drive, close the drive door by pushing it down. Removing diskettes is accomplished by opening the drive door and carefully pulling the diskette out of the drive, again taking caution not to bend the diskette in the process. Finally, it is never a good practice to remove a diskette when the drive is being accessed since this can accidentally destroy the programs which are stored on it. Most drives have an "in-use" light which indicates that they are being accessed.

Since you certainly don't want to accidentally erase any of the Z-System operating system programs which were just purchased, the Z-System master diskette should be "write protected". For the 5.25" disk on which the Z-System is supplied, this is done by installing a foil tab which is placed over a "write protect" notch in the upper right hand side of the diskette. When the foil tab is in place, the diskette is "write protected" and the diskette cannot be written on. Eight-inch drives, on the other hand, are write enabled when the foil tab is installed (on the lower right side of the diskette), and write protected when it is removed.

Since only one copy of the Z-System operating system master diskette is provided, it is advisable to make a back-up copy of the diskette to use when actually operating the SB180 system. It is a standard practice to operate microcomputer systems from back-up copies of diskettes instead of the originals, which are usually stored in a safe place. This is just a safety precaution in that a new copy can be made if the working diskette becomes damaged or worn out.

START THE SYSTEM FROM THE MONITOR ROM

Open the door of the disk drive, insert a blank diskette (make sure it is not write-protected), but **keep the door of the drive OPEN.** The SB180 system monitor which is stored in the on-board EPROM devices, will sense the baud rate of your attached console device only when the monitor mode is entered, and the SB180 will power up in the monitor mode only if it senses that the disk drive is NOT ready. **(If you close the disk drive door before applying power, the system assumes a 9600 baud rate for your console and will directly boot Z-System upon application of power.)** You will now use the monitor's "K" and "C" commands to format two blank disks and make two back up copies of your Z-System disk. You will then boot Z-System for the first time from one of the copies.

Turn on power to the console I/O device, to the flexible disk drive(s), to the printer if one is attached and to the SB180 system board, in that order. As described in section 2.4, the ROM monitor will be waiting for you to enter a character from the keyboard. Do so, and you will see the familiar monitor prompt, 0>. Enter "K0 40 <CR>" to format the blank disk in drive 0. The monitor will ask for confirmation and then format the disk.

After the first disk is formatted, remove it and repeat the operation with the second blank disk. Remove this disk and place the write protected Z-System disk in the drive and enter "C0 0" to tell the monitor to make a single drive copy. The monitor will prompt you to "swap" source (Z-System) and destination (the copy) disks as necessary. Repeat this operation so that you have two copies of the Z-System disk, one for back up and the other for a working master copy. Insert the working master copy into the drive.

STEP 4 BOOT THE OPERATING SYSTEM

You should still see the familiar monitor prompt. Close the disk drive door. Now enter the "Z" command to boot the Z-System operating system. If the Z-System operating system was successfully read from the diskette and loaded into system RAM, the following message will be printed on the screen:

SB180 56K Z-System Ver x.x

If the above message does not appear on the screen, open the door of the disk drive, turn power to the SB180 system off, wait a few seconds, and try to start the system up again. Sometimes the diskette will not center completely in the drive when the drive door is closed. If the Z-System prompt still does not appear, go to the "IN CASE OF DIFFICULTY" section. The x.x shown above represents the version number of the operating system. You will also see information relating to the terminal configuration program which will make available terminal-specific information to the operating system for use by utility programs.

You will be presented with a list of terminals. Use the + and - keys to move among the pages of terminal names. When you find the name of your terminal, enter the letter displayed next to it. This will create the file MYTERM.Z3T which contains information about your terminal to be used later by various system utilities. If you did not find your terminal on any list, press ESC to abort and enter TCMAKE. This allows you to describe your terminal to the system in detail for later use. (You should have your terminal manual available for this step.) Note: if at any time you wish to change your terminal description, use the ERAse command to destroy the MYTERM.Z3T file. Reboot the system and you again will able to select a new terminal.

After you have successfully configured Z-System to your terminal, you should then see "A0:BASE>"; this symbol is the Z-System system prompt that tells you that Z-System is ready to receive a command from the console device keyboard, and that drive A, user area 0 is the system default drive. Unless Z-System is told to do otherwise (with the PATH command), it will try to find all program and data files on drive A, user area 0.

At this point the basic SB180 system should be up and running. If it is not, run the SB180 system from the monitor, make a new copy of the master Z-System disk, and try again. If the back-up copy still will not boot up the system, refer to the "IN CASE OF DIFFICULTY" section. You might want to try running some of the example programs in the Z-System operating system users guide in order to become familiar with your SB180 system.

STEP 5 CHECK THE PARALLEL PRINTER DEVICE.

If your system does not have a printer device skip this step. The Z-System operating system will now be used to test the installation and operation of the printer device. We will use the printer toggle, CTRL-P (or ^P) to send all of the characters typed in at the console serial input device to the printer. To enter a CTRL-P, you use the key marked CTRL as if it were a Shift key, holding it down while pressing the "P" key next. From this point on, everything typed in at the keyboard will also appear on the printer. To "toggle" the printer off, enter another CTRL-P.

Type in several characters such as letters and numbers (try to avoid control keys which might be non-printing characters) and verify that they are echoed onto the printer device. If they are not, or if they do not match those which you have typed in go to the "IN CASE OF DIFFICULTY section. Characters will continue to be sent to the printer device until a second CTRL-P character is entered which tells Z-System that the printer should be toggled off.

2.12 In Case of Difficulty

If the SB180 system is not functioning correctly, this section may be useful in correcting the problem. The information given here is not intended to encompass full-fledged trouble-shooting of the SB180 system board. That is best left to technicians who have the necessary test equipment required because of the complexity of the logic on the system board. This section is meant to help you isolate common installation mistakes to get your system up and running for the first time. The information given in figure 2.12-1 should direct you to the appropriate step to go to for help.

SYMPTOMS	POSSIBLE CAUSES	STEPS
System appears to be totally dead.	1. Power problem.	2
	2. Console cable.	1,3
	3. Console configuration.	1,3
	4. Expansion cards.	1
	5. Defective console device.	3
Disk drive goes on but no characters appear on the display.	1. Console brightness adjust.	3
	2. Console cable.	1,3
	3. Console configuration.	3
	4. Defective console device.	3
Wrong/garbage characters appear on display.	1. Console configuration.	3
	2. Defective console device.	3
Correct power-on message but no Z-System prompt; disk I/O error messages.	1. Disk drive power problem.	2,4
	2. Diskette inserted wrong.	4
	3. Disk interface cable.	1,4
	4. Disk configuration.	4
	5. Bad system diskette.	4
	6. Defective disk drive(s).	4
	7. No termination resistor.	4
Printer types wrong characters or none at all.	1. Printer cable.	1,5
	2. Printer configuration.	5
	3. Defective printer device.	5

Figure 2.12-1. TROUBLESHOOTING CHART.

STEP 1: CHECK CONNECTIONS.

Most of the difficulties which will arise in the initial installation of an SB180 system can be traced to either an I/O interface cable with wires on the wrong pins, or to an improper configuration of the SB180 system board option jumpers or those of an external I/O device. In this step just check to see that all cables are properly attached to their mating connectors.

Turn off power to the SB180 system and attached peripherals, and check all cables for a good connection. Then repeat the procedure given in section 2 for starting up the system.

STEP 2: VERIFY POWER SUPPLY VOLTAGES.

It is always a good idea to verify that the system power supply voltages are in the required voltage range, usually plus or minus 5% of the nominal value. Sometimes systems will appear to work if the voltages are close to the required values, but will typically "crash" often, or act strangely during operation. A voltmeter or an oscilloscope will be needed to measure the power supply voltages.

Measure all DC voltages for both the SB180 system board and for the disk drives, and verify that the voltage levels are within the specified tolerances of the power supply. The voltages on the SB180 system board can be measured at the I/O expansion connectors. If voltage readings are OK, the problem lies elsewhere. If the power supply readings are incorrect, but within a volt or two of the nominal value, adjust the voltage adjustment potentiometer(s) on the power supply, if there is one, such that the output(s) is at the correct level. On switching type power supplies you may have to add more load to the +12 volt output to bring the +5 volt output into regulation. If this adjustment corrects the power supply readings, go back to section 2 and try to run the system again.

If voltages under full load are low, recheck the rating of your power supply to insure that it can handle both the average (normal) load as well as the peak load (see your disk drive manual).

If the power supply reading is way off, for instance, +12V instead of +5V, or 0V, the power supply cable is probably wired to the wrong pins. If this is the case, you may have destroyed the components on the SB180 system board. Recheck the power supply cable pin-outs and correct any wiring errors if any are found. Turn power back on and measure the voltages again. If the readings are now OK, go back to section 2 and try to run the system again. If the readings are still incorrect, the likely cause is the power supply itself. Disconnect the power cable(s) from the supply and measure the voltages under a no-load condition. If the supply will not regulate without a load (this should be stated on the specification sheet for the power supply) a "dummy load" which is usually just a power resistor of sufficient wattage must be placed across the output(s). If the voltage readings are still not correct, replace the power supply.

STEP 3: CHECK THE CONSOLE DEVICE.

Problems associated with a serial device are almost always due to an incorrect cable or jumper configuration. The important thing to remember is that the device at one end must be operating as Data Communications Equipment (DCE), and the device at the opposite end of the cable must be operating as Data Terminal Equipment (DTE), or the signals must be reversed in the cable assembly. If there is no response at all then suspect either the cable, or the configuration of the operating mode, DCE or DTE. If characters are appearing but make no sense, suspect one of the configuration settings such as baudrate, parity or stop bits.

Operation of the console serial device can be easily verified if it is placed into a local-echo mode of operation. In this mode, each keystroke is echoed back on the display screen as it typed. Turn off power to the terminal and put the terminal into a local-echo mode if it has one. Another way to accomplish this function is to make a test connector which has pin numbers 2 and 3 shorted together, pins 4 and 5 shorted, and pins 6 and 20 shorted. This test connector would be attached to the terminal instead of the console serial cable of the SB180 system.

First ensure that the terminal is plugged into an AC outlet and that power is turned on. At this point, even if the SB180 system board was not connected to the terminal, a cursor should appear somewhere on the screen. The cursor is typically a blinking box. If no cursor appears, try to adjust any brightness or contrast controls (these may be located on the rear of the terminal) until the cursor becomes visible. If no cursor appears at all, the problem is probably in the terminal. In that case refer to the manual for the terminal for troubleshooting procedures.

If a cursor is present on the display screen, and the terminal has been placed in a local-echo mode, try typing in some characters. These should be displayed somewhere on the terminal screen. If no characters appear, disconnect the serial cable attached to the SB180 console I/O connector if it is still attached, and try typing in some more characters. If characters now appear, there is probably an incorrect connection in the cable. If there still aren't any characters displayed, it is likely that there is something wrong with the terminal, so refer to the manual for the device and follow the troubleshooting procedures given there.

Now that characters are appearing on the display terminal in the local-echo mode, turn off power to the system and reconnect the console serial cable to the SB180 system board. Run the system again as described in section 2 of this manual. If the messages which should be displayed are a meaningless string of characters, or perhaps the terminal just does weird things including a lot of beeping, there is probably a mismatch between the SB180 and the terminal in one of the operating parameters (such as baud rate, parity, etc.). Turn off power to the SB180 system and check the switch/jumper settings on the display terminal device and ensure that the baudrate, parity and stop bits are correct. Correct any which are in the wrong position or setting.

Turn power back on and follow the start up procedure given in section 2. If the SB180 system is still not displaying the correct start-up messages at this point, there may be something wrong with the hardware, and the system board should be returned for repair. Call for a return authorization number prior to returning any equipment to Micromint.

STEP 4: CHECKOUT THE DISK DRIVE(S).

Problems in interfacing the SB180 system board with the flexible disk drives are usually attributed to four areas: a bad interface cable/configuration; wrong jumper/switch configurations on the disk drive(s), the SB180 system board, or both; incorrect power supply voltages; or non-functioning diskette (inserted wrong, or a damaged diskette). During initial installations, the first two areas will usually be the cause of the problem.

The first thing to do is to verify the power supply connections, and to measure the voltages to check that they are all within the prescribed tolerances, usually plus or minus 5% of the nominal value. This should have been done in step 2 above. If it wasn't, refer to step 2 again and make the voltage measurements and adjustments if needed. The actual voltages used depends on the type of disk drive as indicated in the disk installation section (2.7). If any adjustments were made, go back and repeat the procedures given in step 2.

No matter what kind of problem occurs in the disk drive interfacing, about the only thing which can be done to find and correct the problem is to once again recheck the wiring of the cable and the position of configuration switches and jumpers. Both of these are described in section 2.7. There are no user adjustments in the disk controller logic circuitry of the SB180 system board.

Avoid attempts at disk drive "adjustments" until you have a fully operational SB180 system and the proper calibration and test equipment.

Using the drive's manual or specification sheet, and the signal pin-out for the appropriate interface connector on the SB180 system board, verify signal connections on the disk drive interface cable. If any errors are found, correct them and go back and re-try the start-up procedures of section 2.

Using the drive's manual if it is available, and the example installation information of section 2.7.1 or 2.7.2 as a guide, verify that each disk drive is configured correctly. If a drive manual is not available, and the drive type is not the same as the one used as an example in the installation section, write the manufacturer of the drive to find out how to configure the drive. In general, the disk drives should be set up in the following manner:

1) Multiple drives attached in a "daisy-chain",

2) Terminators installed on all "radial" signals,

3) Terminators installed only on the drive at the end of the interface cable for "multiplexed signals,

4) Radial drive select signals,

5) All other signals must be multiplexed,

6) 8-inch drives must have stepper motor power on at all times unless a motor-on control function is available on the drive unit.

Radial signals are those for which a separate signal exists for each drive. Multiplexed signals are those which are shared by all of the disk drives in the system. The drive currently selected must be the only one to activate the multiplexed signal lines.

Now use the jumper configuration table for the SB180 system board given in section 2.6 to verify the option selections on the system board. Most of the jumper options are associated with the drive type, 5.25 inch (and 3.5 inch), or 8 inch, and have mandatory positions for each type as listed in figure 2.7-1. The only jumpers which you have to decide whether to install or remove are those numbered JP6-10. These jumpers are totally dependent on configuration of the drive units, and will vary from installation to installation. These jumpers are discussed in section 2.7. If any configuration errors were discovered, correct them and then retry the start-up procedures of section 2.11. If the disk circuitry is still not functioning correctly, it is time to get help!

STEP 5 CHECKOUT THE PRINTER DEVICE

There isn't a whole lot which can go wrong in the installation of a printer. Either the wiring of the interface cable is not correct, or the polarity of control signals is reversed.

First check to see if the printer is plugged into an AC wall outlet, and that the power is turned on. Now use the printer manual and check that any operational switches such as the printer select switch is in the correct position. Of course, the printer must have paper in it! If you found anything wrong up to this point, make the indicated corrections and then go back to step 7 of section 2 and test the printer again.

If the printer still does not work, use the printer manual and the installation notes of section 2.6 in this manual to verify printer cable wiring. If any errors are found, correct them and try the printer test procedure again.

The last area to check is the logic signal polarity of the printer control signals. Of particular importance is the DATA STROBE* and DATA ACKNOWLEDGE* signals, both of which are initialized by the SB180 as active low. If any corrections need to be made here, they must be done via a call to a software routine which must be written for that purpose.

3.0 Hardware Technical Descriptions

The information in this section provides technical descriptions of the SB180 hardware components. Schematics for the SB180 board hardware are included in Section 5. Separate hardware components such as disk drives, printers, or serial devices are not described in this manual. Refer to the technical or user manuals for other devices if technical data is required for them.

3.1 The Hitachi HD64180

The power of the SB180 is made possible by the Hitachi HD64180 - a microcoded execution unit based on advanced CMOS manufacturing technology. It provides the benefits of high performance, reduced system cost and low power operation while maintaining complete compatibility with the large base of standard CP/M software.

Performance is derived from a high clock speed (6 MHz now, 9 MHz in the near future), instruction pipelining, and an integrated Memory Management Unit (MMU) with 512K bytes memory address space. The instruction set is a superset of the Z80 instruction set; twelve new instructions include hardware multiply, DMA, and a SLEEP instruction for low power operation.

Considered to the Z-80 what the 80188 is to the 8088, system costs are reduced because many key system functions have been included on-chip. Besides the MMU, the HD64180 boasts a two channel Direct Memory Access Controller (DMAC), wait state generator, dynamic RAM refresh, two channel Asynchronous Serial Communication Interface (ASCI), Clocked Serial I/O port (CSI/O), two channel 16-bit Programmable Reload Timer (PRT), a versatile 12 source interrupt controller, and a "dual" (68xx and 80xx families) bus interface all on one 64 pin chip. Table 3.1-1 compares the HD64180 with other 8 bit processors.

	HD64180	8080/Z80	NSC800	Z800	80188
Process	CMOS	NMOS	CMOS	NMOS	NMOS
Power	100mw	1W	100mw	2W	2W
Max. Clock	10 MHz	8 MHz	4 MHz	10 MHz	8 MHz
Address Space	512 K	64 K	64 K	512 K	1 M
UARTs	2 ch.	no	no	1 ch.	no
DMAC	2 ch.	no	no	4 ch.	2 ch.
TIMERs	2 ch.	no	no	4 ch.	2 ch.
Clocked SIO	yes	no	no	no	no
CS/Wait Logic	yes	no	no	yes	yes
DRAM Refresh	yes	yes (Z80)	no	yes	no

Note: The availability of the Zilog Z800 at this time is unknown and specifications on the Z800 are subject to change.

Table 3.1-1 COMPARISON OF SOME 8-BIT PROCESSORS

The HD64180 CPU is comprised of five functional blocks:

o Central Processing Unit - The CPU is microcoded to implement an upward compatible superset of the Z80 instruction set. Besides the twelve new instructions, many instructions require fewer clock cycles for execution than on a standard Z-80.

o Clock Generator - The clock generator generates the system clock from an external crystal or external clock input. The clock is programmably prescaled to generate timing for the on-chip I/O and system support devices.

o Bus State Controller - The bus state controller performs all status/control bus activity. This includes external bus cycle wait state timing, RESET*, DRAM refresh, and master DMA bus exchange. It generates "dual-bus" control signals for compatibility with both 68xx and 80xx family devices.

o Interrupt Controller - The interrupt controller monitors and prioritizes the four external and eight internal interrupt sources. A variety of interrupt response modes are programmable.

o Memory Management Unit - The MMU maps the CPU's 64K byte logical memory address space into a 512K byte physical memory address space. The MMU organization preserves software object code compatibility while providing extended memory access and uses an efficient "common area - bank area" scheme. I/O accesses (64K bytes I/O address space) bypass the MMU.

The integrated I/O resources comprise the remaining four functional blocks:

o Direct Memory Access Controller - The two channel DMAC provides high speed memory-to-memory, memory-to-I/O, and memory-to-memory-mapped I/O transfer. The DMAC features edge or level sense request input, address increment/decrement/no-change, and (for memory-to-memory transfer) programmable burst or cycle steal transfer. In addition, the DMAC can directly access the full 512K bytes physical memory address space (the MMU is bypaseed during DMA) and transfers (up to 64K bytes in length) can cross 64K byte boundaries. At 6 Mhz, DMA is 1 Mbytes per second.

o Asynchronous Serial Communication Interface - The ASCI provides two separate full duplex UART's and includes programmable baud rate generator, modem control signals, and a multi-processor communication format. The ASCI can use the DMAC for high speed serial data transfer, reducing CPU overhead.

o Clocked Serial I/O Port - The CSI/O provides a half duplex clocked serial transmitter and receiver. This can be used for simple, high-speed connection to another microprocessor or microcomputer.

o Programmable Reload Timer - The PRT contains two separate channels each consisting of 16-bit timer data and 16-bit timer reload registers. The time base is divided by 20 (non-programmable) from the system clock, and one PRT channel has an optional output allowing waveform generation.

3.2 SB180 Design Criteria

With all this functionality on one chip, only a few additional chips are needed to implement a truly sophisticated 8-bit single board computer in a small space (less than 30 sq. in.). In terms of the original Altair micro of less than 10 years ago, the functionally equivalent machine would have taken about 35 S-100 boards for a total of 1750 sq. in. (using 8K memory boards!).

In order to reduce chip count further, an enhanced floppy disk controller chip from Standard Microsystems Corporation, the FDC 9266, was chosen. This 40-pin DIP chip is software compatible with the industry standard NEC 765A floppy controller and adds an on-chip digital data separator to the functions of the FDC 9229 floppy disk interface chip as well. It is compatible with single and double sided 3 1/2", 5 1/4" (40 and 80 track), and 8" drives; the data separator handles both single density (FM encoded) and double density (MFM encoded) data. This means that it can be programmed to read and write almost all soft-sectored CP/M disk formats (and MS-DOS disk formats).

With the HD64180's two channel ASCI built in, two serial ports were included into the design automatically, and provision was made for a Centronics parallel printer port as well. Since 256K DRAM chips are now plentiful and inexpensive, 8 of these were used for memory (64K DRAMs may also be used). Because only 64K bytes of this is usually used for the logical memory space, the user can optionally designate the other 192K bytes as a RAM disk in the operating system. Of course, it may also be used for other purposes (such as implementing banked memory for CP/M Plus).

3.3 The SB180 Hardware

Figure 5.1 is the schematic of the SB180 computer. Its design is primarily characterized by the high performance, high density MOS devices including 256 Kbyte DRAMs.

The SB180 system design implements the following functional blocks:

CPU
Memory Interface
RS-232 Interface
Centronics Printer Interface
Floppy Disk Interface
XBUS Expansion Bus
Power Supply

3.3.1 CPU

The HD64180 is a high system integration device which combines a CPU execution unit with a number of basic system and peripheral functional blocks. These include:

CPU
MMU - Supports 512KB address space
DMAC - 2 channels
ASCI - 2 channel UART with baud rate generator
CSI/O - 1 channel clocked serial I/O
PRT - 2 channel, 16 bit programmable reload timer
Wait State Generator
DRAM Refresh Controller
Interrupt Controller - 12 interrupt sources

The HD64180 requires operation at specific frequencies in order to generate standard baud rates. Standard operating frequency for the SB180 is 6.144 MHz (12.288 MHz crystal). Other operating frequencies which maintain standard baud rates are 3.072 MHz, 4.608 MHz and (later) 9.216 MHz.

3.3.2 RS-232 Interface

The HD64180 ASCI two channel UART is connected to 1488/1489 RS-232 line drivers/receivers to provide two separate ports. ASCI channel 1 is used for the CONSOLE, while ASCI channel 0 is used for AUXILIARY RS-232 devices such as printers, plotters and modems. This distinction is made because modems require the extra handshakes which are available with ASCI channel 0, while terminals do not. All primary RS-232 parameters (baud rate, handshaking, data format, interrupts) are software programmable.

3.3.3 Memory Interface

The SB180 incorporates a 28 pin JEDEC boot ROM socket which can be jumpered to hold 8Kx8, 16Kx8 and 32Kx8 memory devices. The boot ROM (contains disk boot and ROM monitor) occupies the bottom 256K bytes of the HD64180 physical address space since it is selected whenever A18/TOUT (note: the TOUT timer output function is not used) is LOW. Thus, the boot ROM contents (whatever its size) is simply repeated in the lower 256KB. The boot ROM output (OE*) is enabled by the HD64180 ME* (memory enable) signal. (As configured, the maximum RAM memory on the SB180 is 256K. To support larger memories, additional address decoding would be required to designated RAM and ROM areas in the current 256K boot ROM space.)

The critical ROM timing parameter is Tce (access time from CE*). 200ns (and marginally, 250ns) ROMs can operate with 1 wait state.

At RESET*, the HD64180 begins execution at physical address OOOOOH, the start of the boot ROM.

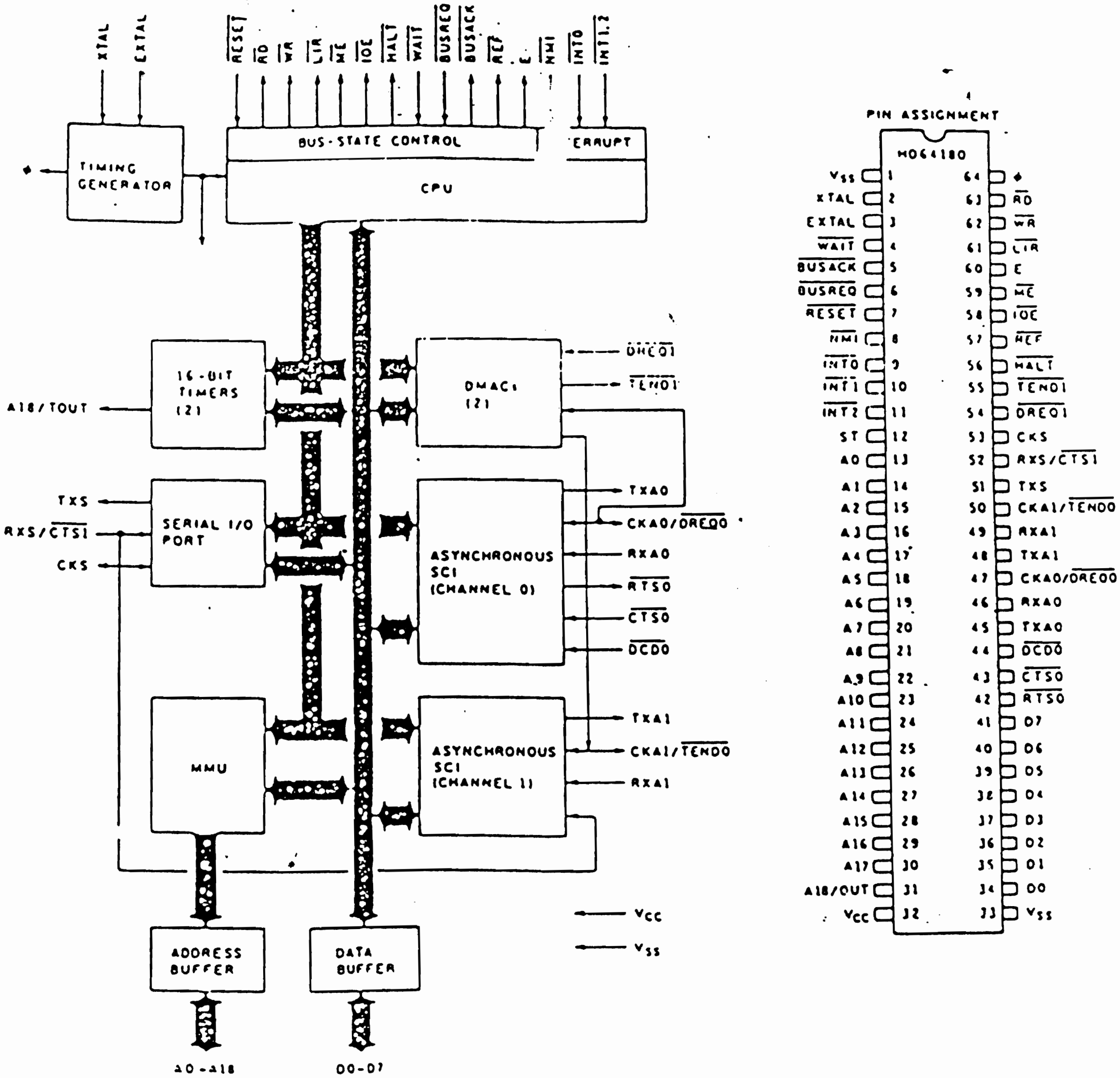


Figure 3.1-2 BLOCK DIAGRAM AND PIN-OUT OF THE HD64180

3.3.4 256K Bit Dynamic Ram

Standard 256 Kbit 15Ø nsec DRAMs, requiring 256 refresh cycles (8 bit refresh address) every 4 ms are used. These RAMs occupy the top 256K bytes of the HD6418Ø 512KB physical address space.

The interface is quite straightforward. Complete DRAM refresh control is provided by the HD6418Ø in conjunction with control logic U16 and U18 and address muxes U12, U13 and U17.

The HD6418Ø WR* output directly generates DRAM WE*. The HD6418Ø ME* output directly generates RAS*. During normal read/write cycles (A18 HIGH, REF* HIGH) CAS* goes LOW at the next rising edge of phi following the rising edge of E (Enable). This provides plenty of set-up time for the address muxes since the rising edge of E switches the address muxes from row to column addresses.

RAS* only refresh is used. The HD6418Ø generates the refresh addresses. During refresh cycles (REF* LOW), ME* generates RAS* while CAS* is suppressed at U16.

The HD6418Ø can be programmed to generate refresh cycles every 1Ø, 2Ø, 4Ø or 8Ø phi cycles as well as selecting two or three clock refresh. Since the DRAM requires a refresh cycle every 15.625us (4ms/256), the HD6418Ø is programmed for 8Ø cycle refresh request since 8Ø x (1/6.144 MHz) = 13.Ø2 us. Two cycle refresh is also programmed. Thus, refresh overhead is only 2.5% (2 cycles every 8Ø cycles).

3.3.5 Centronics Printer Interface

The Centronics printer interface is comprised of 8 bit latch U5 and F/F U15. The Centronics port is decoded at I/O address ØCØH by U4. To write to the printer, the following sequence is used:

Write data to port ØC1H.

This sets-up the data to the printer and asserts STB* LOW.

Write data to port ØCØH.

This de-asserts the printer STB* signal HIGH>

When the printer has processed the data, it will return the ACK* signal which generates an external interrupt (INT 1*) to the HD6418Ø. The interrupt handler clears the interrupt by performing a dummy output to port ØCØH.

Write (dummy) data to port ØCØH

This clears the INT 1* interrupt request.

The printer interface is not buffered, so compatibility with all printer/cable setups cannot be guaranteed. However, in practice, problems should be rare since the software scheme provides adequate data setup and hold times. Also, note that this printer interface is interrupt driven which allows high performance operation. In a more primitive polling design, excessive overhead limits acceptable performance in such applications as background print spooling.

3.3.6 Floppy Disk Interface

The SMC9266 FDC manages almost all details of the drive interface, including data separation and (with external logic U2Ø and U21) programmable write precompensation. The SMC9266 actually combines a NEC 765/Intel 8272 FDC with SMC's popular 9229 digital data separator. Thus, from the host CPU side, the SMC9266 looks just like these popular devices, including hardware and software compatibility.

The SMC9266 clock is generated by an 8 MHz oscillator comprised of a crystal and U2Ø. Jumpers are provided to select write precomp and allow 8" floppy disk drives to be interfaced.

On the CPU side, the key requirements are interfacing the SMC9266 with both programmed I/O (CS*) for initialization, status check, etc. and with DMA (DRQ, DACK*) for data transfer.

Programmed I/O is straightforward, with CS* generated for I/O address 8ØH and RD* and WR* directly generated by the HD6418Ø. This is the same scheme used to interface with other '8Ø family peripherals.

DMA is a little more involved. First, DMAC channel 1 is used for the FDC since dedicated handshake lines (DREQ1*, TEND1*) are provided on the HD6418Ø. Since DMAC channel Ø control lines are multiplexed (with ASCI clocks), DMAC channel Ø is used for memory-memory DMA. This means the ASCI clock functions are available although they are not currently used in this design.

For disk DMA, the 9266 asserts DRQ which in turn causes HD6418Ø DREQ1* assertion. The HD6418Ø performs DMA read/writes to I/O address ØAØH, which causes the 9266 DACK* to be asserted, completing the transfer cycle. After the DMAC programmed number of reads/writes has completed, the HD6418Ø TEND1* output is asserted, and after inversion, causes the 9266 TC (Terminal Count) input to be asserted, completing the DMA operation. This is typically followed by the 9266 generating an HD6418Ø INT 2* external interrupt. This interrupt service routine can read the 9266 status to determine if errors occurred, etc.

However, there is one 'gotcha', fixed by F/F U18 which conditions the 9266 DRQ output. It turns out that if 9266 DRQ directly generates HD6418Ø DREQ1* the HD6418Ø may respond too quickly. This is because HD6418Ø DREQ* input logic was designed to minimize latency, and thus DREQ* can be recognized at a machine cycle breakpoint. Unfortunately, the 9266 requires that

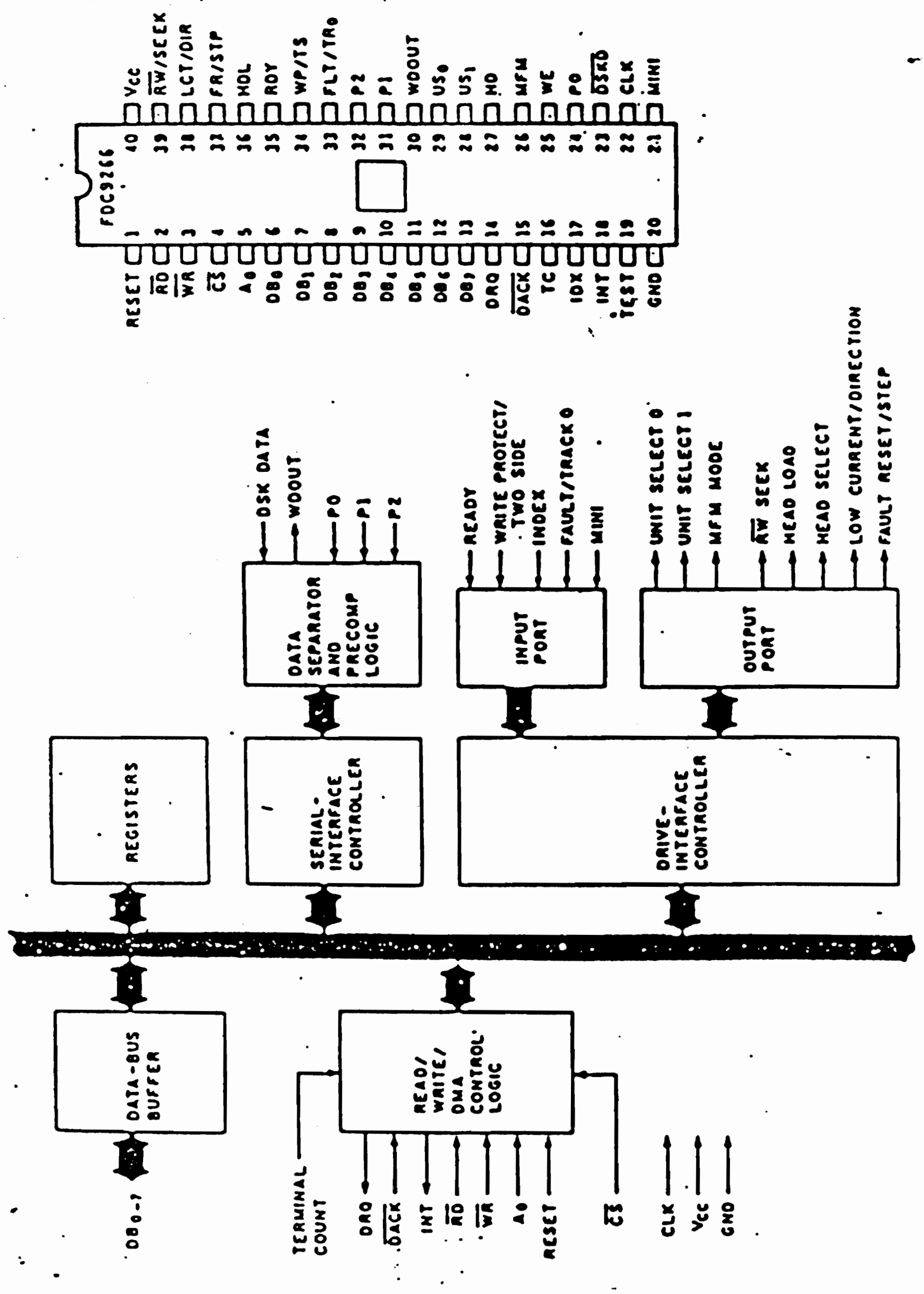


Figure 3.1-3 BLOCK DIAGRAM AND PIN-OUT OF THE 9266

at least 800ns elapse from the time it asserts DRQ before the DMA transfer (DACK*) actually occurs. In other words, when the 9266 'asks' for service, it really doesn't want it...yet! To prevent accessing the 9266 too quickly after DRQ, DRQ from the 9266 is delayed at U18 before issuing the DREQ1* to the HD64180. DRQ is delayed by one REF* cycle time.

Minifloppy double density (MFM) data transfers occur at a 250khz data rate. Thus, each byte must be read within 32us. The disk driver software reprograms the refresh request rate from every 80 phi cycles to every 40 phi cycles prior to disk DMA, and then reassigns it back to 80 phi cycles after the disk DMA is completed. The 9266 DRQ is delayed from between 40 phi clocks to 79 phi clocks. This is about 6-14us. Therefore, the 800ns delay and 32us data transfer constraint are both met. Note that 8" floppy double density (MFM) is twice as fast (500khz) and requires service every 16us. This may require refresh rate increase to every 20 phi cycles to be safe.

3.3.7 Expansion Bus

The spare CS* from address decoder U4 (I/O addresses 0E0H-0FFH), along with all major busses (address, data, control) are routed to the XBUS. This allows an I/O expansion board capability. The full complement of HD64180 control signals (IOE*, E*, RD*, WR*, etc.) allows easy interface to all standard peripheral LSI including 80XX, 68XX and 65XX devices. Example expansion boards could include a hard disk controller, 1200 baud modem, or a LAN interface (SIO, SCC or other LAN chips).

3.3.8 Power Supply

The SB180 requires +5V and +12V power. A negative voltage is generated on board which is only used by the RS232 driver. The negative voltage is obtained by using a Zener diode to obtain +9V from +12V, which is then inverted using an Intersil 7660 converter. The +12V power is also only used for the RS232 driver. Thus, the SB180 only uses significant power from the +5V supply. Typically, this may be from 0.8 to 1.5 A (depending on the proportion of the TTL and memory devices which are CMOS) - about the same as a 5.25" floppy.

4.0 SB180 Monitor

The SB180 monitor provides commands to assist the design and debugging of SB180 related hardware and software. The monitor also serves as a stand-alone training vehicle for the HD64180 high integration CPU.

4.1 I/O Devices

The monitor supports the following I/O 'devices':

CON: - Console RS-232 serial port
AUX: - Auxillary RS-232 serial port
CEN: - Centronics parallel printer port
DSK: - Floppy disk storage devices

4.2 Disk Format

The monitor supports two disk drive types with the following specification:

5 1/4", 48 TPI, 40 track, double sided, double density
5 1/4", 96 TPI, 80 track, double sided, double density

Note that equivalent double sided 3 1/2" drives can also be used.

During initial system check-out, a 40 track DS/DD drive must be connected to verify operation of the disk interface. After check-out, different disk drives (as supported by the SB180 Z-System DOS implementation) can be connected.

The high capacity format provides 5K bytes per track (10K bytes per cylinder) resulting in a formatted capacity of 400K bytes and 800K bytes for 40 and 80 track drives respectively. Differences in sector sizes between 40 and 80 track formats provides a simple method of drive identification.

4.3 RESET

The RESET sequence (from power-up or a reset switch) is as follows. The monitor first initializes the system and performs some diagnostics. Normally (diagnostics OK), the monitor then enters a loop waiting for a disk to be loaded in drive #0 or a carriage return to be entered from the console. If a disk is loaded, the DOS boot routine (same as the 'Z' command) is started. If a carriage return is sensed, the baud rate is determined (see the following section) and the monitor signs on.

Two diagnostic failures cause the above sequence to be changed. First, if a RAM failure is detected, the monitor waits for a carriage return to be entered. In response, a string of 8 bits will be displayed on the console (last displayed is LSB). Bit positions with a '1' represent bad RAM chips. After the display, the monitor HALTs and requires another RESET to restart.

Second, if a problem with the SMC 9266 FDC is detected, the monitor will wait for a carriage return to be entered. In response, the monitor will sign on. However, instead of the normal sign-on message, an error message will be printed.

In either of the above cases the monitor will not try to boot a disk, even if the drive is ready. Thus, if a disk doesn't boot when the system is RESET, enter a carriage return to see the diagnostics results.

4.4 Console Baud Rate

The auto baud rate selection described above requires the console baud rate to be either 19200, 9600, 1200, or 300 baud. Note that the baud rate auto-sense routine requires a CPU clock rate of 6.144 MHz.

The console should be configured for the following data format:

8 data bits, 1 stop bit, no parity

Note that the console CTS1* modem control input to the HD64180 is grounded by a trace on the board. CTS1* can be connected to the console by cutting and jumpering JP4-JP5. If so, CTS1* must be asserted by the console, or the system will appear inoperative since the monitor will be unable to transmit to the console.

4.5 Console I/O

The monitor prompt is "n>" where "n" represents the currently selected memory bank (see the "B" command).

Commands consist of a command code, followed by 0 to 4 parameters and terminated by a carriage return. Parameters are separated by a " " or a "," and leading blanks are ignored.

Numeric parameters are assumed to be in HEX (with the exception of the #-of-tracks parameter for the "K" disk format command and the baudrate specifier for the "E" terminal emulation command). Leading "0"'s are ignored. For commands which require 16 bit parameters, the last four hex digits are recognized. For commands which require 8 bit parameters, the last two hex digits are recognized.

Console entry may be upper or lower case.

For example, the following command lines have the same result.

```
0>D 0 F             ;Display memory from 0000 to 000F

0>d 0 f

0>DO,F

0>D12340000 5678000F

0>D    0,    F
```

4.6 Commands

The following table is a summary of the monitor commands; a complete description of each command follows.

ASCII Table	A
Bank Select	Bbank# (bank# = 0 to 3)
CopyDisk	Csource-drive# destination-drive#
Display Memory	D[start-addr] [end-addr]
Emulate Terminal	E[baudrate]
Fill Memory	Fstart-addr end-addr data8
Goto Program	G[go-addr] or GB break-addr [go-addr]
Hexmath	Hdata16 data16
Input Port	Iport-addr
Klean Disk	Kdrive# #-of-tracks (40 or 80)
Move Memory	Mstart-addr end-addr destination-addr
New Command	N[command#] (command# = 0-FF hex)
Output Port	Oport-addr data8
Printer Select	P
Query Memory	Qdata8 [data8] [data8] [data8]
Read Disk	Rdrive#,dest-addr,start-sect#,#-of-sects
Set Memory	Sstart-addr
Test System	Tdevice
Upload Hex File	U[C]
Verify Memory	Vstart-addr end-addr destination-addr
Write Disk	Wdrive#,start-addr,start-sec,#-of-secs
Examine CPU Regs	X
Yank I/O Regs	Y
Z-System Boot	Z[drive#]

Figure 4.6-1 MONITOR COMMAND SUMMARY

4.6.1 ASCII Table - >A

Prints an ASCII code table.

4.6.2 Bank Select - >Bbank# (bank# = Ø to 3)

Selects a 64K memory bank. The currently selected bank is indicated in the command prompt. All commands which reference memory operate on the currently selected bank. The bank offset is only applied to logical addresses between 2ØØØhex and EFFFhex. Addresses Ø-1FFFhex always refernce the monitor (based at physical address ØØØØØhex), while addresses FØØØ-FFFFhex always reference the monitor data/stack area (physical addresses 4FØØØ-4FFFFhex) This memory management scheme allows 56K of banked memory with a 4K common area at the bottom of ROM memory and a 4K common area at the top of RAM memory.

4.6.3 CopyDisk - >Csource-drive# destination-drive#

Source-drive# and destination-drive# can take the values Ø to 3 and correspond to the physical drive address (the jumper on the drive). Systems with 256K bytes RAM can perform single drive copies (i.e., CØ Ø), in which case a "swap disk" prompt will be issued. The Copy command requires that both disks be of the same type (i.e., 4Ø or 8Ø track).

4.6.4 Display Memory - >D[start-addr] [end-addr]

Displays memory in hex and ASCII. If start-addr is omitted, the display will start with the address following the last invocation's end address (or address Ø if the first invocation). If end-addr is omitted, the display will end 8Øhex bytes following the start address.

4.6.5 Emulate Terminal - >E[baudrate]

Console keyboard input is echoed to the AUX: RS-232 output, and AUX: RS-232 input is echoed on the console display. Baud rate is specified as 15Ø, 3ØØ, 6ØØ, 12ØØ, 24ØØ, 48ØØ, 96ØØ, 192ØØ, or 384ØØ. Note - the baud rate option only works if the CPU is operating at the standard (6.144 MHz) clock rate. If you have a non-standard clock rate configuration, use the "O" Output Port command to directly reprogram the baud rate or modify your monitor (EP)ROM (see the monitor ROM modification section). The command prompts for a key which will exit the terminal mode and return to the monitor. At system start up, the AUX: port is initialized to 192ØØ baud, 8 data bits, 1 stop bit and no parity.

The AUX: port supports RTSØ* modem control output and the DCDØ* and CTSØ* modem control inputs (inputs and output are relative to the HD6418Ø). The RTSØ* output is always asserted. The CTSØ* and DCDØ* inputs must be asserted by the connected device, or grounded on the board.

4.6.6 Fill Memory - >Fstart-addr end-addr data8

Memory from start-addr to end-addr is filled with data8 (8 bit data, Ø-ffhex). Care should be taken to avoid writing to the monitor program (Ø-1FFFhex) and stack/data (FFØØ-FFFFhex) areas.

4.6.7 Goto Program - >G[go-addr] or GB break-addr [go-addr]

CPU registers are initialized and program execution continues at go-addr. The GB format sets a breakpoint at break-addr. If go-addr is omitted, program execution continues at the saved PC (see the "X" command).

4.6.8 Hexmath - >Hdata16 data16

Prints the 2Ø bit sum and difference, and the 32 bit product of the two arguments. (data16 is Ø-FFFFhex)

4.6.9 Input Port - >Iport-addr

Prints the 8 bit data input from port-addr in hex and binary.

4.6.1Ø Klean (Format) Disk - >Kdrive# #-of-tracks (4Ø or 8Ø)

Asks for confirmation and then formats and verifies the specified disk.

4.6.11 Move Memory - >Mstart-addr end-addr destination-addr

Moves the memory block between start-addr and end-addr to destination-addr. Care should be taken to avoid writing to the monitor program (Ø-1FFFhex) and stack/data (FFØØ-FFFFhex) areas.

4.6.12 New Command - >N[command#] (command# = Ø-FF hex)

Loads the A register with the command# (Ø if no command# specified). If an extended (EP)ROM is installed (16KB or 32KB), the extended ROM space (2ØØØhex to 4ØØØhex or 8ØØØhex) is enabled. A CALL to address 2ØØØhex is executed. To return to the monitor, the new command should terminate with a RET instruction. If extended (EP)ROM was enabled, it is disabled upon return.

4.6.13 Output Port - >Oport-addr data8

Data8 byte is output to port-addr. Note that most aspects of the HD6418Ø operation (baud rates, data format, wait states, etc.) can be configured by output to chip registers.

4.6.14 Printer Select - >P

Toggles the printer selection between the Centronics parallel port and the Auxillary serial (RS-232) port. The initial value is Centronics.

4.6.15 Query (Search) Memory - >Qdata8 [data8] [data8] [data8]

Searches memory for the memory pattern comprised of one to four bytes and prints addresses at which the pattern is found.

4.6.16 Read Disk - >Rdrive#,dest-addr,start-sector#,#-of-sectors

Reads the specified sectors from drive# into memory at dest-addr. The first sector on the disk is "1" and the last sector on the disk is 190hex (400 decimal) and 320hex (800 decimal) for 40 and 80 track drives, respectively.

4.6.17 Set Memory - >Sstart-addr

Displays the memory contents at start-addr and allows new data to be entered. Entering carriage return proceeds to the next address. Entering "." terminates the command.

4.6.18 Test System - >Tdevice

Tests various system devices. TA specifies the Auxillary serial (RS-232) port which prompts for input or output test. If input, serial input is echoed on the console. For input, the DCD0* AUX: modem control input must either be asserted by the connected device or grounded with the jumper on the board - otherwise an error message is printed. If output, a test pattern is transmitted. For output, the CTS0* AUX: modem control input must either be asserted by the connected device or grounded with the jumper on the board - otherwise an error message is printed. TC specifies the Centronics parallel port to which a test pattern is transmitted. If the printer doesn't respond in a reasonable time (approx. 5 seconds) an error message is printed. TD specifies a disk seek and read (non-destructive) test. If a bad sector is found, the disk test is aborted and the contents of the 9266 status registers (identifying the type of error, track, head, sector, etc.) are displayed. If no device is specified, a memory test is performed. The memory test is non-destructive and will print a "." after each 256KB pass.

All tests can be terminated with CTL-X or CTL-C.

4.6.19 Upload Hex File - >U[C]

An Intel format hex file is uploaded. If the [C] option is specified, the data is uploaded from the Console serial port, otherwise the data is uploaded from the Auxillary serial port. Note that upload termination requires reception of a CTL-X (1A hex). Thus, if the PIP command were used to download a .HEX file for a CP/M system, the [H] option should be specified. The command terminates by printing the address of the last byte loaded.

4.6.20 Verify Memory - >Vstart-addr end-addr destination-addr

The contents of the memory block from start-addr to end-addr is compared with the block at destination-addr. When source and destination data differ, the addresses and data values are printed.

4.6.21 Write Disk - >Wdrive#,start-addr,start-sector,#-of-sectors

Writes the specified sectors to disk from memory at start-addr. The first sector on the disk is "1" and the last sector on the disk is 190hex (400 decimal) and 320hex (800 decimal) for 40 and 80 track drives respectively.

4.6.22 Examine CPU Registers - >X

Displays the main and alternate CPU registers and prompts for modification of the main registers. Entering a carriage return proceeds to the next register while entering a "." terminates the command.

4.6.23 Yank I/O Registers - >Y

Displays the HD64180 on-chip I/O register contents.

4.6.24 Z-System Boot - >Z[drive#]

Boots the Z-System DOS (or other suitably configured operating system) from the specified drive.

4.7 Error Messages

4.7.1 FDC Error

Displayed at RESET if the Monitor cannot correctly initialize the 9266 FDC. This indicates a hardware fault such as a bad FDC, bad address decoder, etc. Use the I and O commands to verify FDC input/output operations. The FDC status port is 80H, the data port is 81H.

4.7.2 Disk R/W Error

Following this message, the contents of the 9266 FDC status registers are printed along with id information (track, head, sector). Typically, this indicates the disk is not formatted correctly (i.e., non-"native" format), but may also result from faulty media or hardware. Corrective action includes retrying the operation, reformatting the disk, resetting the system, testing memory, swapping disk drives, etc.

4.7.3 Disk Seek Error

Explanation and correction - see above.

4.7.4 Disk Not Ready

The drive is not loaded with the door closed and the motor on. Check to insure your drive provides a "READY" signal. If not, connect the "No Drive Ready" jumper on the board. Check to insure your drive responds to the "Motor On" signal. If not, either connect the "Motor (always) On" jumper on the board, or jumper your drive to achieve the same effect. Note that some drives are typically jumpered to enable the stepper and spindle motor based on drive select. However, depending on the motor control circuit, these drives may not be able to tolerate the 9266 FDC "Scan" function which toggles drive select at high speed when the drive is otherwise idle. In this case, the drive must be jumpered so that the motors are always on.

4.7.5 Bad Command

An invalid command has been entered. Use the "?" command to see a list of available commands and their syntax.

4.7.6 Bad Parameter

An invalid parameter has been entered. Remember that most commands require hex parameters. Use the "?" command.

4.7.7 Not Enough Parameters

The command requires more parameters than were entered. Use the "?" command.

4.7.8 Invalid Interrupt

The HD64180 has received an internal or external interrupt for which no interrupt handler is provided. The only interrupts the HD64180 recognizes are external interrupts INT1* (Centronics interface) and INT2* (Disk interface). External interrupts INT0* and NMI* may be shorting to ground. Internal interrupts (DMAC, timers, etc.) may be inappropriately enable by a program crash or incorrect use of the "O" output port command.

4.7.9 Bad Opcode Trap

The HD64180 has encountered an invalid opcode. This may be the result of a user program crash - confirm your program. This may also occur due to slow or faulty memory - perform a memory test. In this regard, note that the HD64180 has stricter access time requirements for opcode fetch than other read/write cycles and this is not checked by the memory test. Try reprogramming the on-chip wait state generator (DCNTL register, I/O address 32hex) or using faster memory chips.

4.7.10 CTS0* HIGH

Displayed during the >TA (Test AUX: port) output command if the CTS0* modem control input is not LOW at the HD64180. Check the connected device and cable.

4.7.11 DCD0* HIGH

Displayed during the >TA (Test AUX: port) input command if the DCD0* modem control input is not LOW at the HD64180. Check the connected device and cable.

4.7.12 No ACK*

Displayed during the >TC (Test CEN: port) command if the printer does not return ACK* within about 5 seconds after a byte is sent to the printer. Check the printer state (on line/off line, etc.) and cable.

4.8 Disk Format

The monitor "R" and "W" (Read and Write disk) commands treat the diskette as containing "virtual" 1KB sectors. Actually the format for 40 and 80 track drives is defined as follows:

40 Track Double Sided, Double Density

The disk contains 40 cylinders, each consisting of two sides/tracks. Each track is made up of 10 sectors of 512 bytes. Thus, total formatted capacity is 512 bytes x 10 sectors x 2 sides x 40 cylinders = 400K bytes. Sector numbers start at 11hex, with an interleave factor of two. Actual order on the track is (hex) 11, 16, 12, 17, 13, 18, 14, 19, 15, 1A. During formatting the 9266 FDC GPL (gap length) parameter is 24 decimal, while GPL is 14 decimal during normal read/write operation.

80 Track Double Sided, Double Density

The disk contains 80 cylinders, each consisting of two sides/tracks. Each track is made up of 5 sectors of 1K bytes. Thus, total formatted capacity is 1K bytes x 5 sectors x 2 sides x 80 cylinders = 800K bytes. Sector numbers start at 11hex, with an interleave factor of two. Actual order on the track is (hex) 11, 14, 12, 15, 13. During formatting the 9266 FDC GPL (gap length) parameter is 99 decimal, while GPL is 14 decimal during normal read/write operation.

4.9 Monitor ROM Modification

The monitor is organized to allow easy modification to support non-standard CPU clock rates (standard is 6.144 MHz), unique console and auxillary port baud rates and data formats and optimized disk timing parameters. Also the monitor can be extended by using 27128 or 27256 devices in conjuction with the "N" new command. **Never reprogram or erase your original monitor EPROM!** Instead, read it on another system, save the object file, make a copy of the object file, modify that copy, and then burn a new (EP)ROM.

4.10 Key Variable Block

Nine bytes, located starting at address 35hex, in the monitor allow changing a number of operating parameters as defined below.

4.10.1 STARTBYTE - Address 3Dhex, default value = FFhex

Normally FFhex, the upper and lower nybbles of STARTBYTE control two aspects of the monitor start sequence.

Changing the upper nybble of STARTBYTE allows disabling the console baud rate autosense routine if either a non-standard baud rate (i.e., not 300, 1200, 9600 or 19,200) console baud rate is required or if a non-standard (6.144 MHz is standard) CPU clock is used. In either case, change the upper nybble of START-BYTE to 0. Note that STARTBYTE is related to CNTLB1 byte (see below). If STARTBYTE is not changed (i.e., equals Fx hex to use autosense) then CTTLB1 default value of 1 must also not be changed.

Changing the lower nybble of **STARTBYTE** to Ø allows disabling the DOS autoboot function so that the monitor will always sign on independent of whether a disk is loaded. This is especially useful if the "No Drive Ready" jumper is installed on the board to prevent hanging in the DOS boot loop if a disk is not loaded.

STARTBYTE	Meaning
FFh	Baud rate autosense, DOS autoboot (default value)
ØFh	Fixed baud rate (based on **CNTLB1** value), DOS autoboot
FØh	Baud rate autosense, DOS autoboot disabled
ØØh	Fixed baud rate (based on **CNTLB1** value), DOS autoboot disabled

4.1Ø.2 CNTLAØ - Address 3Ehex, default value = 64hex

Contains the value programmed into the HD6418Ø CNTLAØ register which defines, among other things, the AUX: port data format (i.e., # data bits, stop bits, parity, etc.). The default value also asserts RTSØ* low.

4.1Ø.3 CNTLA1 - Address 3Fhex, default value = 74hex

Contains the value programmed into the HD6418Ø CNTLA1 register which defines, among other things, the CON: port data format (i.e., # data bits, stop bits, parity, etc.).

4.1Ø.4 CNTLBØ - Address 4Øhex, default value = ØBhex

Contains the value programmed into the HD6418Ø CNTLBØ register which defines, among other things, the AUX: port baud rate. Note that the "E" emulate terminal command allows the baud rate to be set from the console. However, the "E" baud rate function only works when the CPU operates at the standard (6.144 MHz) clock rate.

4.1Ø.5 CNTLB1 - Address 41hex, default value = Ø2hex

Contains the value programmed into the the HD6418Ø CNTLB1 register which defines, among other things, the CON: port baud rate. If your console does not operate at the standard baud rates (3ØØ, 12ØØ, 96ØØ, 19,2ØØ are standard) or the CPU clock is non-standard (6.144 MHz is standard) both **STARTBYTE** (see above) and ZCNTLB1 must be changed. **STARTBYTE** must be set to Ø (disables the baud rate autosense routine) and CNTLB1 set to the appropriate value given your console baud rate and CPU clock rate.

4.10.6 STAT0 - Address 42hex, default value = 0

Contains the value programmed into the HD64180 STAT0 register which enable or disables AUX: port interrupts, which are normally disabled.

4.10.7 STAT1 - Address 43hex, default value = 4

Contains the value programmed into the HD64180 STAT0 register which enable or disables CON: port interrupts as well as enabling or disabling the CON: port CTS1* modem control input. CON: port interrupts should normally be disabled and the default value enables the CTS1* function. Thus, CTS1* must be grounded on the board (default case) or asserted by the console if connected.

4.10.8 DCNTL - Address 44hex, default value = 6Chex

Contains the value programmed into the HD64180 DCNTL register which defines, among other things, the number of memory and I/O wait states generated by the HD64180 on-chip wait state generator. Normally, the least significant four bits of this value should not change since they define DMA parameters associated with basic disk operation. Change the upper four bits to account for faster or slower CPU clock rate and/or memory-I/O devices.

4.10.9 RCR - Address 45hex, default value = 82hex

Contains the value programmed into the HD64180 RCNTL register which defines the interval and duration of HD64180 generated DRAM refresh cycles. Normally, this value needs to be changed only if the CPU clock rate is reduced below 3.072 MHz.

4.10.10 SPCF1 - Address 46hex, default = AFhex

Contains the value used as the first parameter of the 9266 FDC SPECIFY command which defines the step rate and head unload time for the floppy disk drive. This can be changed if your disk has higher performance than the conservative default value. Note that a DOS BIOS can reSPECIFY in a "soft" manner, so it may be wise to leave the conservative default in the ROM to allow for easy connection of drives with poor or unknown performance characteristics.

4.10.11 SPCF2 - Address 47hex, default value = 2Ehex

Contains the value used as the second parameter of the 9266 FDC SPECIFY command which defines the head load time and data mode for the floppy disk drive. As above, this can be changed, but change may not be required since the DOS BIOS can reSPECIFY. Note, the data mode must be "DMA".

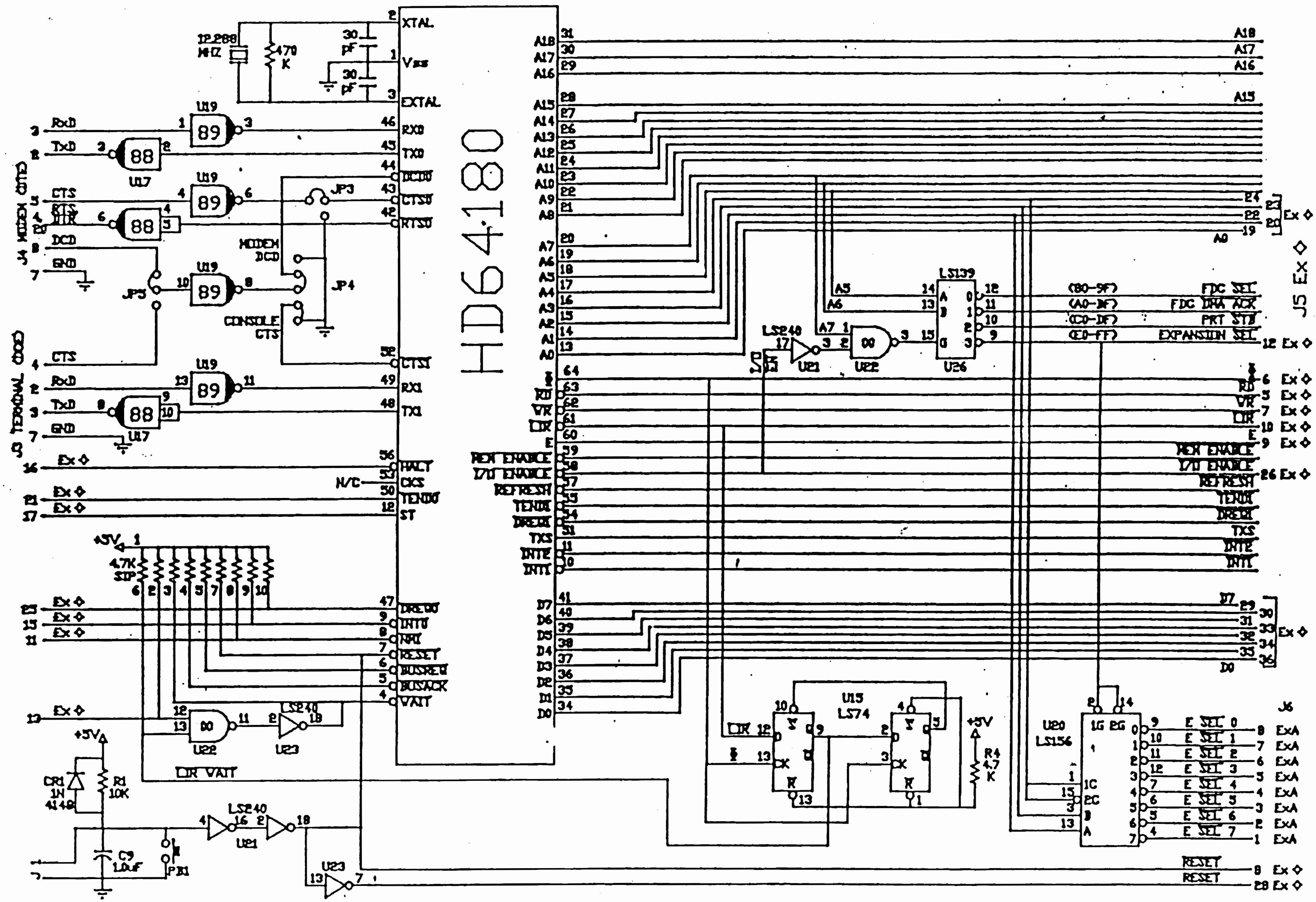
4.11 The "N" NEW Command

The monitor, which requires 8K bytes of (EP)ROM can co-reside with other system software in a larger 16K byte or 32K byte (EP)ROM. The extra 8K bytes or 24K bytes can contain additional software such as BASIC, Forth, a DOS, or ???

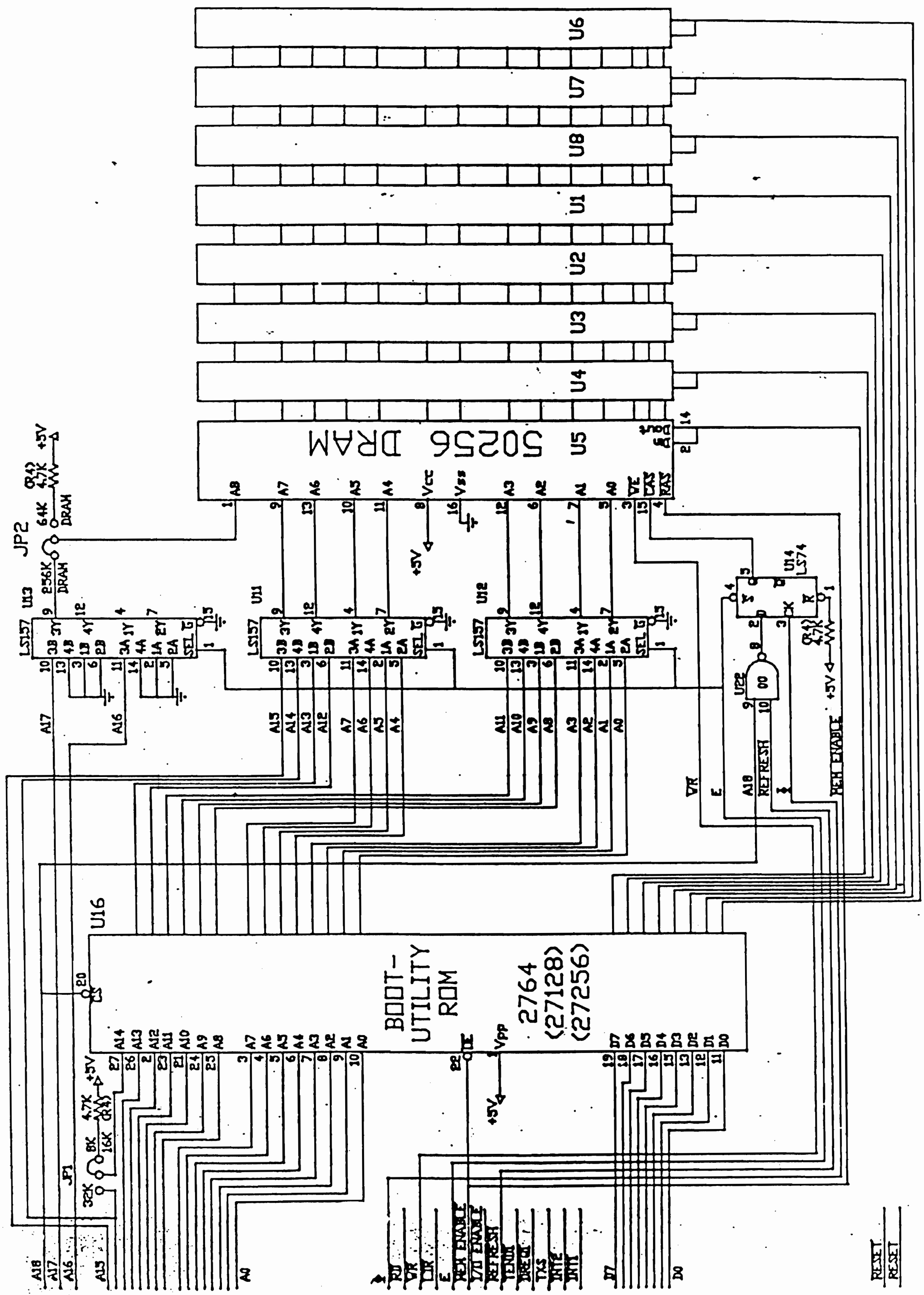
At RESET, the monitor determines how big the installed ROM is. The "N" NEW command can then "phantom" in an extended (EP)ROM. Also, an optional parameter on the "N" command line is loaded into the Accumulator (A) for passage to the extended routines. When the extended routine terminates with a RETurn instruction, the monitor regains control and "phantoms" out the extended (EP)ROM to allow access to overlayed RAM. Note that this return mechanism requires the extended routine to save the return address if it sets up a different stack. Also, the extended routine should avoid writing to the physical address area 4FF00-4FFFFhex since this area contains monitor data structures.

To implement an extended (EP)ROM simply requires assembling your routines to start at the "end" (address 2000hex) of the monitor. Developing the code is made easier by the fact that, with only the 8K byte monitor installed, the "N" command will jump to address 2000hex without performing the "phantom" function. After the code is tested in RAM, burn it and the monitor in a new (EP)ROM, install it (remember to adjust the ROM size on the SB180 system board), and operation will be exactly the same as during debug.

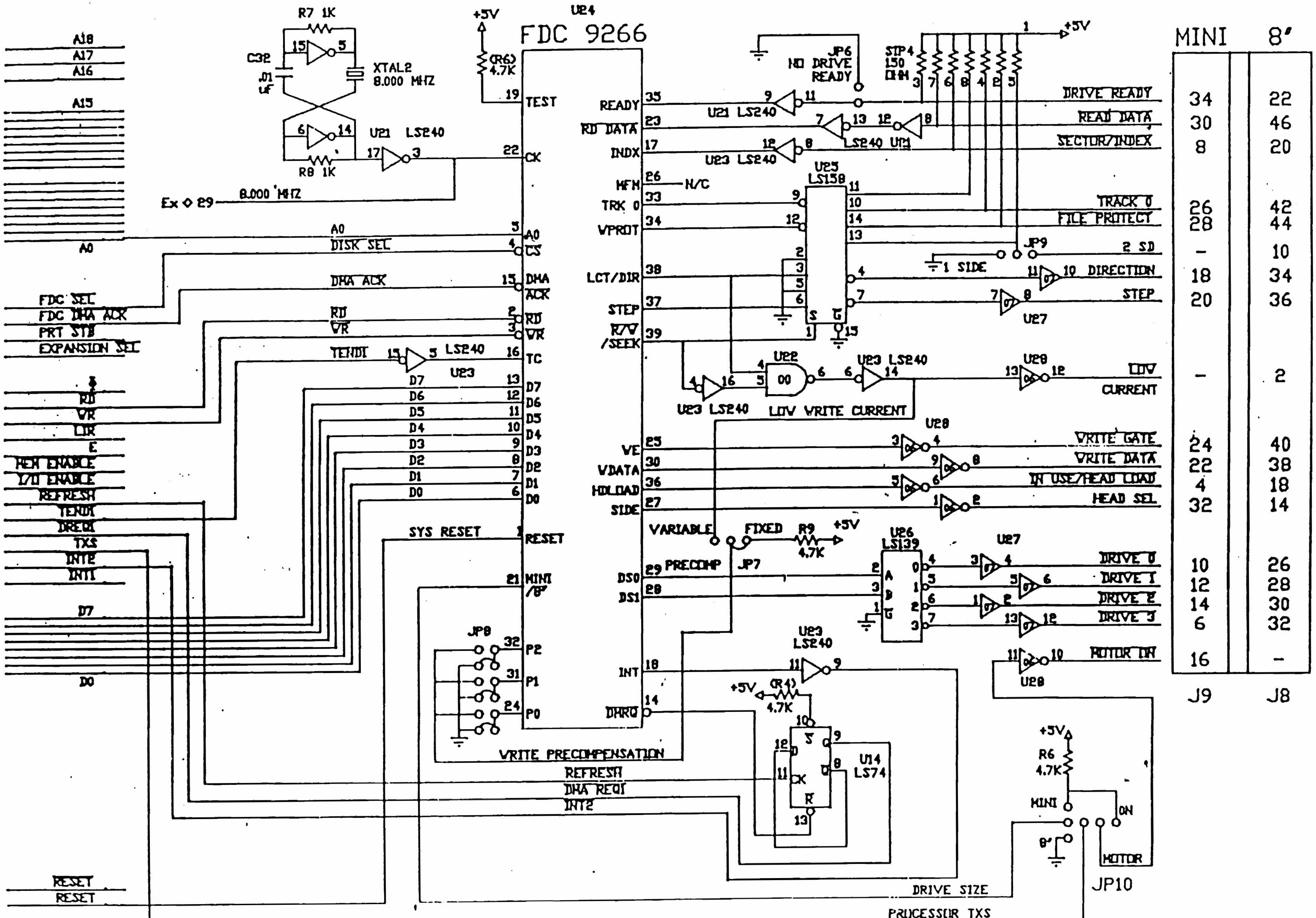
For further information on the ROM monitor, consult the monitor source code on the appropriate system disk.



SB180 COMPUTER PG 1 OF 4 (PROCESSOR) COPYRIGHT 1985, CIARCIA'S CIRCUIT CELLAR 7/23/85



SB180 COMPUTER PG 2 OF 4 (MEMORY) COPYRIGHT 1985, CIARCIA'S CIRCUIT CELLAR 6/6/85



SB180 COMPUTER PG 3 OF 4 COPYRIGHT 1985, CIARCIA'S CIRCUIT CELLAR 6/6/85

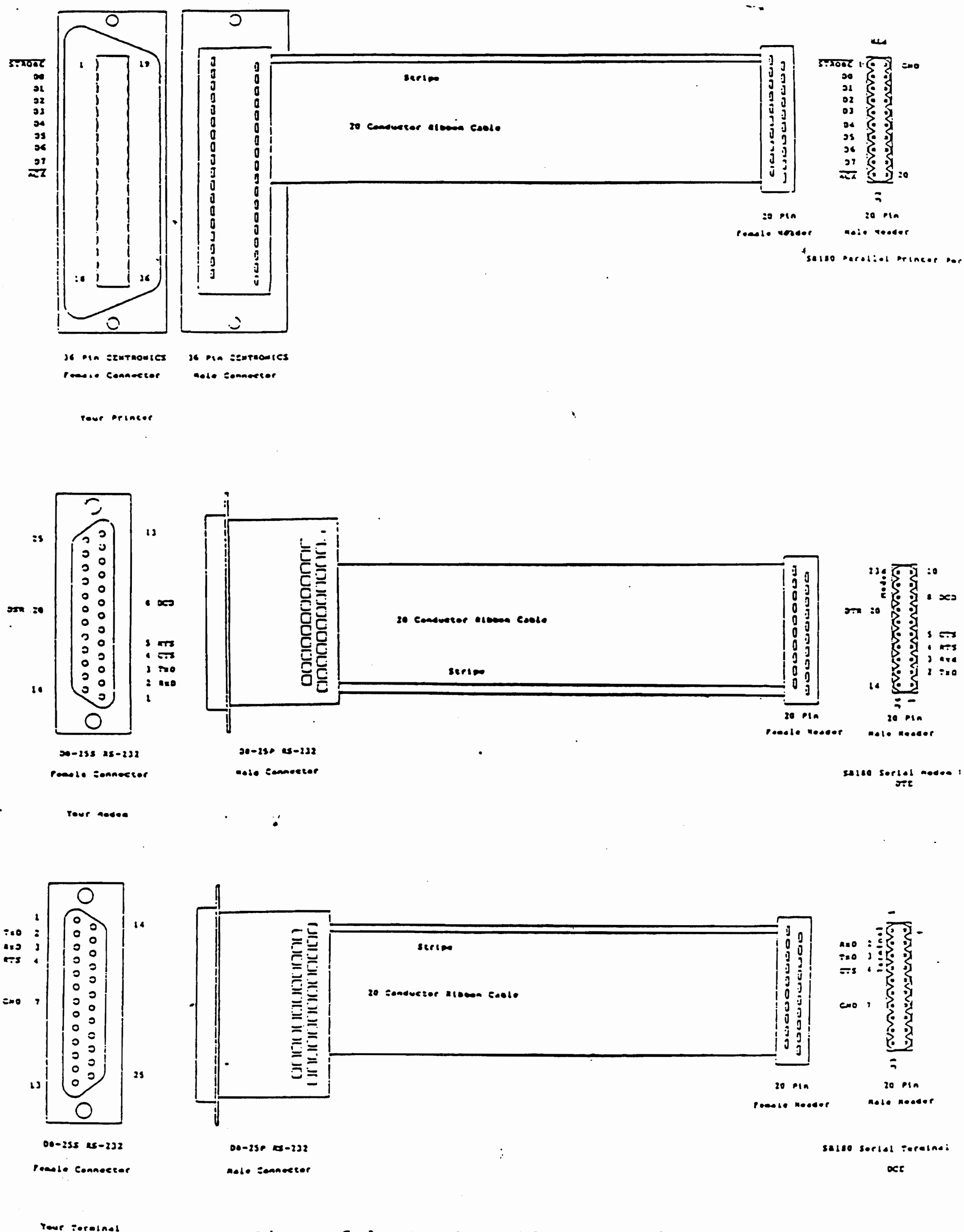


Figure 5.1 Sample Cable Assemblies

COMPONENT LIST
SB180 - SINGLE BOARD 64180 SYSTEM

CAPACITORS

C1-8	.1 MFD 50v MONOLITHIC
C9	1 MFD 25v ELECTROLYTIC
C10-15	.1 MFD 50v MONOLITHIC
C16	1500 PFD 50v MONOLITHIC
C17,18	.1 MFD 50v MONOLITHIC
C19,20	27 PFD 50v MONOLITHIC
C21-31	.1 MFD 50v MONOLITHIC
C32	.01 MFD 50v MONOLITHIC
C33	.1 MFD 50v MONOLITHIC
C34	10 MFD 25v ELECTROLYTIC
C35	100 MFD 25v ELECTROLYTIC
C36,37	10 MFD 25v ELECTROLYTIC

RESISTORS

R1	1/4w,	5%,	10K
R2	1/4w,	5%,	4.7K
R3	1/4w,	5%,	100 OHM
R4	1/4w,	5%,	4.7K
R5	1/4w,	5%,	470K
R6	1/4w,	5%,	4.7K
R7,8	1/4w,	5%,	1K
R9	1/4w,	5%,	4.7K
R10	1/2w,	5%	120 OHM
SIP1-3	4.7K, 9 ELEMENT, PIN 1 COMMON		
SIP4	330 OHM, 7 ELEMENT, PIN 1 COMMON		

SOCKETS

1	8 PIN
8	14 PIN
14	16 PIN
3	20 PIN
1	28 PIN
1	40 PIN
1	64 PIN (SHRINK DIP)

DIODES

CR1	DIODE, 1N4148A, SIL, SW
CR2	DIODE, 1N4001, SIL, BLOCKING
CR3	DIODE, 1N4739A, ZENER 9.1V 1w

INTEGRATED CIRCUITS

U1-8	41256 DRAM, 256Kx1
U9	LSTTL, 74LS374
U10	LSTTL, 74LS74
U11-13	LSTTL, 74LS157
U14,15	LSTTL, 74LS74
U16	EPROM, (8K STANDARD) 2764, 8Kx8 or 27128, 16Kx8 or 27256, 32Kx8
U17	XMIT RS232, 1488
U18	64180 MICROCOMPUTER
U19	RECV RS232, 1489
U20 **	LSTTL, 74LS156 ** OPTIONAL
U21	LSTTL, 74LS240
U22	LSTTL, 74LS00
U23	LSTTL, 74LS240
U24	DISK CTRL, FDC9266
U25	LSTTL, 74LS158
U26	LSTTL, 74LS139
U27	TTL, 7407
U28	TTL, 7406
U29	VOLTAGE INVERT ICL7660

MISCELLANEOUS

J1	1x2 .1CTR, HARDWIRE
J2-4	2x10 HEADER
J5	2x20 HEADER
J6 **	1x8 ** OPTIONAL
J7	1x4 RT ANGLE, .1CTR
J8 **	2x25 HEADER, SHROUDED ** OPTIONAL
J9	2x17 HEADER, SHROUDED
JP1-3	1x3 .1CTR
JP4 **	1x5 .1CTR ** OPTIONAL
JP5 **	1x3 .1CTR ** OPTIONAL
JP6	1x2 .1CTR
JP7 **	1x3 .1CTR ** OPTIONAL
JP8 **	2x6 .1CTR ** OPTIONAL
JP9 **	1x3 .1CTR ** OPTIONAL
JP10	1x3(2) "T"
JUMPER	1x2 SHUNT
PB1	PUSHBUTTON, (RESET)
XTAL1	CRYSTAL, 12.2880 MHZ
XTAL1 **	CRYSTAL, 18.4320 MHZ ** OPTIONAL (9MHZ)
XTAL2	CRYSTAL, 8.0000 MHZ