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# ATON CP/M 2.2 REFERENCE MANUAL

## LEVELS I and II

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# CHAPTER I

## INTRODUCTION

## ATON CP/M(R) 2.2

ATON International has implemented CP/M 2.2 for the Radio Shack TRS-80(R) Model II, Model 12, Model 16 and Model 16-B. ATON CP/M is a highly sophisticated version of the popular, time-proven CP/M 2.2 operating system created by Digital Research. ATON CP/M takes full advantage of the many powerful hardware features available in the Radio Shack TRS-80 Model II.

The standard ATON CP/M includes two support levels. Level II support speeds disk access by adding disk track buffering to the Level I support.

The key features of ATON CP/M 2.2 are:

- Dramatically improves speed of diskette operations by buffering multiple disk tracks in RAM memory. (Level II only)
- User programs can be as large as 62K. This is 6K to 8K more memory than is usually available under CP/M. (Level II only)
- Allows user programs to access other 32K memory banks for data and program code storage. (Both levels)
- Offers over 600,000 bytes of usable file storage on a one sided diskette and over 1.2 megabytes of usable file storage on a two sided diskette used in two sided expansion drives. (Both levels)
- Automatically performs a readback check on disk write operations for improved data reliability. (Level I optional; Level II standard)

The standard TRS-80 Model II contains memory bank switching hardware, and up to 256K bytes of RAM can be installed using standard Radio Shack memory boards. Level I support is available for machines with the basic 64K RAM memory option. Level II support is available when at least one additional RAM memory board (Radio Shack catalog #26-4105) is installed in the machine.

The Model 16 or the Model II with the 16 bit enhancement option has at least 128K of additional memory associated with the 68000 processor that can also be accessed by the Z-80. Level II takes advantage of this extra memory so that no additional memory boards need to be installed.

Level I support includes:

- Keyboard/Screen driver fully emulates the Lear Siegler ADM-3A and SOROC IQ-120 CRT terminals and includes the "erase to end of line/screen" functions from the Televideo TVI 910/912/920. Thus, popular CP/M application programs can be used without special customization for CRT/Keyboard characteristics.

- The keyboard key codes and CRT codes may be remapped to emulate other display terminal types or to accommodate foreign languages.

- Allows user program direct access to video display memory (memory mapped video) which can greatly improve performance of screen oriented programs.

- An additional (25th) status line is displayed on the CRT. The status line displays system status such as time of day and active disk drive as well as status information generated by user programs.

- System error messages are displayed when a disk not mounted, disk write protect, or printer offline/paper out status occurs.

- The line printer driver (parallel or serial port) can, at the user's option:

    - Automatically space over form break.
    - Support printers with AUTO-LF by suppressing line feed characters which occur immediately after a carriage return character.
    - Support printers without the form feed function (e.g., Radio Shack printers) by emulating a form feed with multiple line feeds.
    - Expand horizontal tab characters into multiple space characters.
    - Cause line wrap around if the number of characters in a line exceeds a predetermined line length.
    - Force lower case characters to be printed as upper case.

- Each serial port can be configured by the user for baud rate (45 through 9600 baud asynchronous), parity, stop bits, and handshaking protocol. Four commonly used protocols are implemented:

    - CTS/DCD signal line
    - DC1/DC3 (X-ON, X-OFF)
    - ETX/ACK
    - No protocol

- The time of day and date are maintained by the system and are available for user programs. A precision real time clock (10 msec resolution) is available for timing segments of user programs.

- As a standard software feature, both one and two sided disk drives are supported. In double density mode, a single sided diskette can contain over 600,000 bytes of usable file storage space and the two sided diskette mounted in a two sided drive can contain over 1.2 megabytes of usable file storage space.

- The system automatically and dynamically configures itself for one sided/single density, one sided/double density, or two sided/double density diskettes whenever a drive is accessed. Automatically adapts to Lifeboat or Pickles & Trout double density disk formats or the "standard" CP/M 1.4 single density format whenever a diskette with one of those formats is accessed by the system. Thus, the operator doesn't normally have to be concerned with the type of diskette being used.

- Automatically self configures for the optimum seek rate on each drive. Extensive disk error detection and recovery routines, coupled with read after write checks, combine to give the user the highest confidence in floppy disk operations. ATON CP/M uses the IBM standard 1024 byte per record double density diskette format as it's standard. This format is very conservative and has great tolerance for individual hardware variations while at the same time offering the highest processing speed because of the large block size. A read back check is always performed after directory writes and may optionally be performed after every disk write. These features promote the highest level of disk reliability.

- ATON CP/M supports single drive systems by allowing the operator to swap diskettes whenever a different drive is selected by the user's program.

- User programs can access the disk driver directly to perform disk operations on diskettes which do not have the CP/M file structure.

- A high-speed disk format and mirror-image copy program is included to facilitate backup and archiving procedures. This utility can also format and copy diskettes used with TRSDOS.

- A utility program is included which allows program or data files to be retrieved from a TRSDOS disk and copied to the CP/M disk.

- A separately priced utility program is available that allows the Radio Shack BASIC interpreter supplied with the Model II to be operated under ATON CP/M.

Level II support includes:

- All Level I features.

- The user area is 6K to 8K bytes larger (62K TPA) than the user area normally available in other implementations of CP/M. Depending on the application, this can allow improved performance, larger symbol tables, and less BASIC string "garbage collection".

- The user may designate one or more of the 32K memory banks as reserved for user programs so that ATON CP/M will not use these banks for disk buffering. The user program may be coded to load code or data into any part of these reserved banks. The user program selects memory banks using simple assembly language routines.

- The TrackMode$^{TM}$ BIOS feature of ATON CP/M reads and writes an entire 8K byte track in about one diskette revolution and buffers from 2 to 22 tracks of disk data in RAM memory. This means dramatically improved disk throughput that can rival hard disk performance. For many applications, floppy disk throughput ceases to be the major limiting factor to system performance. Whenever a track is written, it is immediately read back to help ensure that no write errors have occurred. Also, the heads are loaded much less often. These features greatly improve system reliability and allow two sided disk drives to be used with confidence.

# CHAPTER II

## GETTING STARTED

The first thing to do is to make a working copy of the master diskette you have received. The master diskette has a write protect notch which will (barring hardware failure) prevent the computer from writing on the master diskette. **Never cover the write protect notch on the master diskette!**

The working copy can be created as follows:

1. Install the master diskette in the integrated drive (the drive next to the CRT, drive A:) and raise the reset switch.

2. After the A) prompt appears, key in COPY and press the ENTER key.

3. The Model II COPY/FORMAT program will list it's menu on the screen and wait for a response.

4. Enter "1" for single sided format and the drive code for the drive in which the working copy will be written.

5. After the format/verify operation has successfully completed and the copy/format program has relisted its menu, press the ENTER key to start the copy operation. Follow the instructions given by the copy/format program on the CRT. (If you have a single drive system, see Single Drive Operation on on the bottom of page 15 as well as the release notes for additional instructions.)

6. After the copy operation has been successfully completed, save the master diskette in a safe place and use the working copy for all future operations. **Be sure to put the ATON International and Digital Research copyright notices on all working copies and any backup copies you may make under the terms of the ATON International and Digital Research software license agreements.**

If you have a Model 16 or have replaced the one sided drive in the Model II with a two sided drive and wish to make a two sided working copy, do the following:

1. Use the copy/format program to write a two sided format on the diskette - use option 2 from the menu. Note that a two sided diskette has its index sensor hole placed in a slightly different position on the jacket than a one sided diskette, and two sided drives will often detect this fact and will (if appropriately strapped) refuse to allow access to the second side of a single sided diskette. The copy/format program detects this condition and reports it to the operator. There are diskettes available that have two index sensor holes punched in the jacket that allow them to be used in either single or two sided drives. We do not recommend their use because they can confuse the automatic density select routines (see Chapter III, "Diskette" section).

2. After the two sided format operation is complete, execute the SYSGEN program which copies the system tracks. In response to its queries, tell it which drive the single sided working copy is in and which drive the two sided diskette is in. They may be the same drive.

3. At this point you have a two sided diskette which will boot in a Model II having a two sided drive as drive A:. Use PIP to copy whatever files are needed from the single sided working copy to the two sided working copy.

## Reference Material

The manual you are reading and the Digital Research manual for CP/M 2.2 are technical reference manuals, which means they are useful if you have a good understanding of CP/M and programming. If you are unfamiliar with these areas, it would help to obtain one of the tutorial guidebooks written for CP/M and assembly language. Ones that we recommend are:

1. Osborn CP/M User Guide by Thom Hogan, Osborne/McGraw-Hill, Berkeley, California 1981.

2. The CP/M Handbook with MP/M by Rodnay Zaks, Sybex, Berkeley, California 1980.

3. Z-80 and 8080 Assembly Language Programming by Kathe Spracklen, Hayden Book Company, Inc., Rochelle Park, New Jersey 1979.

4. Programming the Z-80, Second Edition, by Rodnay Zaks, Sybex, Berkeley, California 1980.

The Radio Shack TRS-80 Model II Operation Manual, which is part of the TRS-80 Model II Owner's Manual delivered with the computer, gives detailed information on how to set up and operate the computer.

Radio Shack has an excellent technical reference manual (Catalog Number 26-4921) for the Model II which gives much detail about the Model II hardware design.

## Memory Boards

If the 16 bit enhancement option is not installed, then at least one additional board must be installed for Level II operation on the Model II. A total of up to four 64K boards (256K) may be installed on the Model II. The memory boards may be purchased and installed at a Radio Shack computer center (Radio Shack catalog #26-4105) or can be obtained from Radio Shack National Parts (phone 817-870-5664) as Radio Shack part #AXX0503. They are also available from some Radio Shack franchise dealers.

The jumper connectors for the board are as follows:

| | | |
|---|---|---|
| | 32K | J15-18, J16-17 |
| First | 64K | J15-18, J16-17, J9-13, J10-14, J27-26 |
| Add on | 64K #1 | J7-11, J8-12, J9-13, J10-14, J28-25 |
| Add on | 64K #2 | J7-11, J8-12, J9-13, J10-14, J29-24 |
| Add on | 64K #3 | J7-11, J8-12, J9-13, J10-14, J30-23 |

The 64K board is normally delivered jumpered as the first 64K board. You can swap the existing 64K board with a new board and boot up TRSDOS to check the memory. Then it is simply a matter of rearranging the slip-on jumpers to convert the board to an "Add on" 64K board.

## Disk Drive Hardware

No explicit definition needs to be made to ATON CP/M for step rate, drive type, or media type.

The seek speed for a drive is automatically and continuously determined by ATON CP/M. It is the fastest step rate that will provide reliable performance. The step rate will be reduced by ATON CP/M any time it detects excessive seek errors.

ATON CP/M automatically determines the type of drive (one or two sided) and the type of media installed in the drive (one or two sided, single or double density, record size, and format).

The Model 16 already contains two sided drives and it is possible to use two sided disk drives (Shugart 850 compatible) with the Model II. If you replace the built-in drive (drive A:) with a two sided drive, then:

1. The AC power connector of a two sided drive is different than that of a one sided drive. An adaptor cable can be built to accommodate this problem.

2. Two sided drives often have a door lock which can become an operational nuisance. The two wires from the door lock magnet can be removed from the connector to the logic board, taped, and put aside.

3. A special termination wiring arrangement is used with some built-in drives (see item 9 below).

4. Radio Shack repair centers may refuse to service machines with non-Radio Shack drives installed. You may want to retain the original one sided drive for repair purposes.

There are many strapping options available in the popular Shugart and Shugart compatible drives on the market. ATON CP/M CP/M has been designed to accommodate many of these options. The guidelines for proper jumping are:

1. No strapping changes need to be made on standard Radio Shack drives.

2. The disk change (DC-pin 12) status is ignored by ATON CP/M.

3. The two sided (2S-pin 10) status is not required by ATON CP/M and should not be jumpered or driven by the drive as pin 10 is also connected to direction select in the termination arrangement (see item 8 below).

4. The side select line (pin 14) is activated when ATON CP/M selects side 1 on a two sided drive (direction select is not used as side select).

5. The in-use line (pin 16) is not connected to anything in the Model II.

6. The head load line (pin 18) is activated before step pulses (pin 36) are issued by ATON CP/M. However, some versions of the bootstrap ROM program do not activate the head load line when doing the restore command.

7. Write protect (pin 44) status is monitored by ATON CP/M and the Model II hardware. Write protect status usually disables Model II write operations.

8. The write current line (pin 2) is activated whenever tracks 43-76 are accessed. This should be used as a signal to reduce write current for those drives having the write current option.

9. The built-in drive must have four wire wrap connections made to accommodate the Radio Shack expansion drive. Pins 4, 6, 8, and 10 are each tied to a 150 ohm terminator to +5 volts. In the expansion drive, pin 4 is tied to pin 40, pin 6 to pin 38, pin 8 to pin 36, and pin 10 to pin 34. This arrangement allows the expansion box power to be off when the Model II power is on and still have the built-in drive A: be correctly terminated. Pin 10 is terminated twice: once in the floppy disk card and once in the built-in drive. This appears to be an oversight. Pin 10 is connected to both direction select (pin 34) and to 2S status output of a two sided drive. Thus, the 2S jumper must not be installed or problems will occur when two sided diskettes are used in the drive. Failure to properly terminate these four lines can cause the computer to write undesired data on the diskette in Drive A: during bootstrap.

10. The drive must be able to be selected by pins 26, 28, 30, or 32 (to examine status) without loading the head. The head is loaded when both a drive select pin (26, 28, 30, or 32) and the head load pin (18) are active. This can be accomplished by proper drive strapping.

11. Two sided drives must disable ready status if the second side is accessed when a single sided diskette is installed in the drive. This is accomplished by using the "Ready Standard" RS plug on a Shugart 850 or the PJ2 closed option on a Mitsubishi drive. If this option is not correctly selected, the automatic density select option may fail. (See Chapter III, Diskette section, for more details.)

12. On the Shugart 850 (modification level MLC 10 or greater) two sided drive, the following jumper connections should be made - leave the others open.

    - DS1, DS2, DS3, DS4 - pick one to select drive number.
    - On programmable shunt use the following: R, I, S, A, B
    - These are slip on jumpers: 850, DC, DS, HL, C, Y, S2, FS, IW (IWI), RS, IT, AF (MFM), M
    - These are traces on the board: WP, DD
    - If you use the Radio Shack Expansion drives, you must make provision for terminations as detailed in item 8 above.

13. For the Qume Data Track 8 two sided drive, the following jumpers should be closed. Leave the rest open.

    These are on the DIP shunt:

    A, B, R, I, unused. Cut X, Z, HL

    These are slip-on jumpers:

    2S, C, Y, DL, DS

14. For the Mitsubishi M2894 two sided drive, the following jumpers should be closed. Leave the rest open.

    These are on the DIP shunt:

    PJ1, PJ2, PJ3, PJ4, PJ6, PJ7, PJ8

    These are slip-on jumpers:

    IW, S2, R, I, IT, Z, E, 2-0, Select one: DS1, DS2, DS3, DS4

    These are solder pads on board: (Be sure to disconnect STM2)

    SF, DLM1, STM1, HUD, WP, C, RI, RR

## Line Printers

The Model II or Model 16 with ATON CP/M can accommodate up to three line printers: one on the parallel port and one on each of the two serial ports.

ATON CP/M has the ability to emulate form feed (FF) and horizontal tab (HT) characters as well as convert all data to upper case, operate with printers having automatic line feed (AUTO-LF), and cause automatic line wrap if the line length is exceeded. The ability to select these options and define page lengths is given by the SYSDEF utility program. Follow the instructions given in the menu when the SYSDEF program is executed.

For the printer attached to the parallel port, the printout will stop if printer fault status (pin 28) is active, the printer selected status (pin 25) is not active, or the paper empty status (pin 23) is active. An appropriate message to the operator is generated on the status line. If the printer busy status (pin 21) is active more than 10 seconds, a message is also generated to the operator. Printout can resume after the operator has remedied the problem.

For a printer attached to a serial port, one of three mechanisms to control the data flow to the printer may be used. These are the CTS signal (pin 5), DC1/DC3 (X-ON/X-OFF) software protocol, or the ETX/ACK protocol. The latter protocol generates an ETX character after 120 characters have been sent to the printer and then transmission ceases until an ACK character is received from the printer.

## Serial Data Communications

Asynchronous serial data communications at rates up to 19200 baud are supported by ATON CP/M. Serial port configuration for baud rate, parity, etc., is possible with the SYSDEF utility program. Note that the 19200 baud speed option is generally useful only for Model II to Model II communication because of a 7% speed error. This speed error is unavoidable due to hardware design. No speed error occurs in the case of Model II to Model II communication because they are both "off" by the same amount. The speed error is generally more than other devices operating at 19200 baud will tolerate reliably.

The serial port connectors on the back of the Model II are RS-232C type DB-25 connectors with the data terminal equipment (DTE) pinouts. The DTE pinout arrangement is designed to be directly connected with a modem (Data Set, Data Communication Equipment - DCE). If no modem is used, when for example, two Model II's are directly connected with each other or the Model II is directly connected to a serial printer, a wiring arrangement known as a "Null Modem" is required for data communication to occur. In addition, when the Model II is directly connected to a serial printer, some means for controlling data flow to the printer is usually required so the printer's data buffer will not overflow. This can be done in the null modem wiring arrangement (connecting the "reverse channel" output from the printer to the "clear to send" input of the Model II) or by a software protocol such as ETX/ACK or DC1/DC3 (X-ON/X-OFF). Any one of the three data flow control techniques can be selected by SYSDEF.

The null modem wiring arrangement for Model II to Model II communications is:

| From Pin | | To Pin |
|---|---|---|
| 1 | Chassis Ground | 1 |
| 2 | Transmitted Data | 3 |
| 3 | Received Data | 2 |
| 4 | Request to Send | 5 |
| 5 | Clear to Send | 4 |
| 6, 20 | Data Set Ready, Data Terminal Ready | 8 |
| 7 | Signal Ground | 7 |
| 8 | Carrier Detect | 6, 20 |

When using the Model II with a serial printer and the hardware reverse channel technique is to be used to control data flow to the printer, connect pin 19 (rather than pin 4) of the printer (Reverse Channel, Secondary Request to Send) to pin 5 on the Model II (Clear to Send). With the TI-810 printer, use pin 11 instead of pin 19 for reverse channel.

# CHAPTER III

## OPERATOR'S GUIDE

In this chapter we give information about operational details of the software that are peculiar to this implementation of CP/M on the Model II and Model 16. More general operating information on CP/M is given in the Digital Research manual (particularly Chapter 1, "CP/M FEATURES AND FACILITIES") and the tutorial books listed in the "Reference Material" section of Chapter I of this manual.

The custom operating features of CP/M are documented here:

### Logical I/O Device Assignment

There are four logical I/O devices in CP/M referenced by BDOS calls and system programs:

CON: Command input/output device
RDR: Reader input device
PUN: Punch output device
LST: List output device

Each logical device can be assigned to one of four physical devices by the STAT utility command. The PIP utility command can reference logical or physical device names, whereas user programs can only directly reference logical devices via BDOS calls to location 5. The possible logical to physical device assignments that can be made by the STAT utility command are:

| | | | | | |
|---|---|---|---|---|---|
| CON: | = | TTY: | CRT: | BAT: | UC1: |
| RDR: | = | TTY: | PTR: | UR1: | UR2: |
| PUN: | = | TTY: | PTP: | UP1: | UP2: |
| LST: | = | TTY: | CRT: | LPT: | UL1: |

The default assignments at bootstrap time are:

CON: = CRT:
RDR: = TTY:
PUN: = TTY:
LST: = LPT:

The meaning (unique to each implementation of CP/M) of each of the 12 physical device names is now described:

TTY: Serial Port A
CRT: Keyboard/CRT
BAT: Input from RDR: device (whatever device is mapped to RDR:)
Output to LST: device (whatever device is mapped to LST:)
UC1: Serial Port B
PTR: Keyboard
UR1: Keyboard
UR2: Serial Port B

PTP: CRT
UP1: Parallel Line Printer Port
UP2: Serial Port B
LPT: Parallel Line Printer Port
UL1: Serial Port B

Keyboard

Four ASCII printable codes are generated by the use of CTRL key in conjunction with another key.

| Key | Character |
|---|---|
| CTRL 6 | Tilde (7E) |
| CTRL 9 | Backslash (5E) |
| CTRL 0 | Vertical Separator (7C) |
| CTRL - | Accent Grave (60) |

Three CTRL codes can be used by the operator to indicate top of form to the printer (see the Printer section below).

Six CTRL codes are reserved to ATON CP/M and are ignored (cause no action) in Levels I and II. These are CTRL 1 through 5, and 7.

Several keys have their assignments changed to be compatible with the Lear Siegler ADM-3A and can also be redefined by the SYSDEF program.

| Key | Character |
|---|---|
| HOLD | DC3 - 1EH also known as HOME |
| BACKSPACE | DEL - 7FH also known as RUBOUT |
| CTRL { | FS - 1CH |
| CTRL } | GS - 1DH |
| CTRL ; | US - 1FH |
| CTRL ' | NUL - 00H |
| Left Arrow | BS - 08H |
| Right Arrow | FF - 0CH |
| Up Arrow | VT - 0BH |
| Down Arrow | LF - 0AH |

As delivered (changeable with SYSDEF), the BACKSPACE key generates a RUBOUT code (7F) and the left arrow key generates the BACKSPACE code (08). The RUBOUT normally eradicates a character and the BACKSPACE code (08) normally just repositions the cursor. You need to remember this when using programs like WordStar or dBASE II. The BDOS line edited input (function 10) allows both RUBOUT and BACKSPACE as a CRT oriented eradicate character function. Programs like WordStar and dBASE II use the single character BDOS input (function 1) which allows RUBOUT and BACKSPACE to be treated differently.

## CRT

ATON CP/M can utilize the full 25 line by 80 character per line capability of the CRT rather than the usual 24 line format used by other operating systems. The extra line is used as a status line in the uppermost position on the screen. The status line is fixed and is never scrolled off the screen. The rightmost 40 positions of the status line are used by the system to display system status such as time of day, date, disk activity, and partition activity information. The leftmost 40 characters of the status line are available for use by user programming system. In 40 character per line mode, only the rightmost 40 characters (system status) of the status line are displayed. In Level III the leftmost 20 positions of the status line are unique to each partition, while the other 20 positions of the user area of the status line are global and do not change when another partition is selected.

If the 24 x 80 CRT display format is selected by SYSDEF rather than the usual 25 x 80 format, the operator requests the status line by entering the CTRL-8 key. The display will shift down one line and display the status line on top. The bottom line is not then displayed. When the CTRL-8 key is again entered, the display is shifted back to its original position. Neither the status line nor the bottom line of the display is disturbed when the CTRL-8 key is activated; the only difference is operator visibility. The CTRL-8 key can be activated at any time, regardless of other activity in the system. As delivered, the CRT/ keyboard combination emulates the ADM-3A terminal by Lear Siegler with some additional functions from the SOROC IQ-120 or Televideo 910/912/920 series. The user can remap both the CRT command sequences and the keyboard mapping with the SYSDEF program.

The CRT hardware can display 128 unique graphic characters in normal (white on black) or reverse (black on white) video. See the Appendix of the Model II Disk Operating System Reference manual or Chapter 7 of the Model II Operating Manual for the codes of the CRT screen graphics.

## Printer

The Model II with ATON CP/M can accommodate up to three line printers: one on the parallel port and one on each of the two serial ports.

ATON CP/M has the ability to emulate form feed (FF) and horizontal tab (HT) characters as well as convert all data to upper case, operate with printers having automatic line feed (AUTO-LF), and cause automatic line wrap if the line length is exceeded. The ability to select these options and define page length is given by the SYSDEF utility program. Follow the instructions given in the menu when the SYSDEF program is executed.

For the parallel printer (only), status messages are generated on the status line for error conditions:

| Message | Condition |
|---|---|
| PAPER OUT | Paper empty status (pin 23 active) |
| PTR ERR | Printer fault status (pin 28 active) |
| PRINTER OFFLINE | Printer deselected (pin 25 not active) |
| PTR BUSY | Printer busy for more than 10 seconds (pin 21 active) |

After correcting the problem, strike the "ENTER" key to continue the printout, or strike the "BREAK" key to abort the program in progress and return to CP/M command level.

If the form feed emulation by line feed option is used, the operator indicates to the operating system when the printer paper is at top of form by pressing one of three CTRL keys, one for each possible printer connection.

| Key | Function |
|---|---|
| CTRL , | Set top of form on Serial Port A |
| CTRL . | Set top of form on Serial Port B |
| CTRL / | Set top of form on Parallel Printer Port |

These three keys are monitored continuously, regardless of other activity in the system (operating system or user program), and thus top of form may be set at any time convenient to the operator.

Diskettes

ATON CP/M has several sophisticated algorithms for automatically determining the type and format of diskette installed in a drive. These techniques reduce the amount of attention required by the operator to disk format types.

ATON CP/M will automatically accommodate the following diskette types:

1. Single sided-single density
   26 records of 128 bytes per track
   This is the "standard" CP/M 1.4 data interchange format.

2. Single sided-double density
   1024 byte records, 8 records per track
   512 byte records, 16 records per track
   or 256 byte records, 26 records per track

3. Two sided-double density
   1024 byte records, 8 records per track

ATON CP/M will only format double density diskettes with 1024 byte records. The ability to read and write data files on double density disks with 512 byte records is provided as a convenience for those using other CP/M systems.

To gain the maximum speed from Level I and Level II disk operations, be sure to use the ATON disk format. If you have files on a P&T format disk (512 byte records), they can be processed by ATON CP/M but at a slower rate. Use PIP to copy the files from the P&T format disk to an ATON format disk. Lifeboat uses the IBM standard 1024 byte per record format which is interchangeable with the ATON format.

The number of directory entries on a two sided diskette is 192. The single sided, double density diskette has 128 directory entries, and the single sided single density diskette has 64 directory entries.

A two sided diskette normally has its index hole punched in a slightly different position on the jacket than a single sided diskette. There exist diskettes with two index holes punched in the jacket, and we strongly discourage their use because there is one case in which the automatic density select system will fail. If a diskette with two index sensor holes punched in the jacket or a single sided diskette is formatted as a two sided diskette on a two sided drive and then subsequently used in a single sided drive, incorrect operation will occur. If the same type of diskette is formatted as a single sided diskette on a two sided drive, it will work correctly in a single sided drive. For this reason, diskettes with two index sensor holes punched in the jacket are not recommended for use with ATON CP/M. **No confusion can occur when diskettes have only one index sensor hole and two sided drives are strapped to disable access to the other side of single sided diskettes.**

In Level I, the automatic density determination is made after a warm start or when requested by user programs. In Level II the density determination is made automatically just before the first program access whenever a diskette is changed in the drive, or whenever requested by user programs.

Diskettes may be changed in the drives at any time when the in-use LED in the diskette drive door latch is off and the disk activity indicator on the status line is off. Double sided drives may lock the door when the in-use LED is on. The CP/M BDOS does a checksum on the directory whenever it performs a directory scan (to open or close a file for example). If the checksum does not match the previous scan, it marks the drive "read only" until the next warm start. STAT on a "read only" drive will always return zero bytes available since the allocation map is unreliable. If an attempt to write on a drive marked "read only" is made, the BDOS will issue the message "BDOS error on x: R/O" and wait for operator response. When the operator strikes the "ENTER" key, a warm start (jump to zero) occurs which causes the drive to be marked read/write enabled. This BDOS error message should occur only if the disk is changed between two accesses to the same drive by the same program when the second access is a write or if the disk is changed between CP/M commands which do not do a warm start on exit. These commands are: ERA, REN, TYPE, DIR, and STAT. Typing a Control-C at command level forces a warm start and avoids the BDOS error message.

To avoid the "BDOS Error On x: R/O" message:

1. If you are at CCP command level (A> prompt is displayed), enter Control-C or BREAK whenever you change a diskette.

2. If a disk is changed during user program execution, the EIOS disk function code 0D0H (redetermine disk format - required for Level I only and then only if a density change is possible) and the BDOS function call 13 (reset disk system) or 37 (reset drive) must be used after changing the disk to inform ATON CP/M of the disk change. See Chapter IV, "Assembly Language Programming" section, for more details.

## Single Drive Operation

An operating feature has been incorporated to allow several logical drives to be used with a single drive system. It can be used if desired in a multiple drive system as well.

If an attempt is made to access a drive that is not ready (non-exsistant, door not closed, disk not inserted, etc.), the BIOS issues a message "MOUNT DRIVE x:" on the status line. If the operator enters a Control-C, warm boot is made. If anything else is entered, the operation is retried.

If the Letter A is entered, the operator may remove the current diskette in the built-in drive next to the CRT and put in the diskette for the requested drive. The system will again prompt for a diskette change when another diskette is selected.

If an attempt is made to write on a diskette that does not have the write enable slot covered, BIOS issues a message "WRITE ENABLE x:". If the operator enters a Control-C, then a warm boot occurs. If anything else is entered, the operation is retried.

Status and Error Messages

Diskette operational status and error messages are displayed on the status line. Whenever the Model II is actively reading or writing on a diskette, the rightmost three characters of the status line display the drive code (e.g., A:) and an "R" for reading or "W" for writing. **Never** open the diskette door or activate the RESET switch when a read or write function is in progress. To do so may destroy the data on the disk and also may leave the computer in a mode where a false bootstrap error code is displayed on the screen and the computer must be powered off and then on before proper operation can resume.

The time of day, the date, and the day of the week (Sunday = 0) are displayed in columns 53 through 70 of the status line.

Columns 40 through 50 of the status line display the most recent disk error since the last warm bootstrap operation. The format of the error message is:

| Column | Meaning |
|---|---|
| 40-41 | Drive code (e.g., A:) |
| 43-44 | Track number in hex. Low order bit is side number for two sided drives. |
| 46-47 | Record (Sector) number in hex. |
| 49-50 | Error code in hex. |

| Bit | Meaning |
|---|---|
| 0 | No DMA terminal count (buffer not completely transferred) |
| 1 | Attempt to select side one of a single sided diskette in a two sided drive |
| 2 | Lost data (buffer smaller than track segment requested) |
| 3 | CRC error in address field or data record |
| 4 | Record not found on track |
| 5 | Record type is deleted. Read sector operation only. |
| 6 | Illegal drive or cylinder number |

Bits 0, 1, 2, or 5 by themselves are not considered errors and will not force display of an error message.

# CHAPTER IV

## PROGRAMMER'S REFERENCE

In this chapter we give information about programming details that are peculiar to this implementation of CP/M on the Model II/Model 16. More general programming information on CP/M is given in the Digital Research manual (particularly Chapter 1, "CP/M FEATURES AND FACILITIES" and Chapter 5, "CP/M 2 SYSTEM INTERFACE").

The custom programming features of CP/M are documented here:

### Logical I/O Device Assignment

There are four logical I/O devices in CP/M referenced by BDOS calls and system programs:

```
CON: Command input/output device
RDR: Reader input device
PUN: Punch output device
LST: List output device
```

Each logical device can be assigned to one of four physical devices by the STAT utility command. The PIP utility command can reference logical or physical device names whereas user programs can only directly reference logical devices via BDOS calls to location 5. The possible logical to physical device assignments that can be made by the STAT utility command are:

```
CON: = TTY:  CRT:  BAT:  UC1:
RDR: = TTY:  PTR:  UR1:  UR2:
PUN: = TTY:  PTP:  UP1:  UP2:
LST: = TTY:  CRT:  LPT:  UL1:
```

The default assignments at bootstrap time are:

```
CON: = CRT:
RDR: = TTY:
PUN: = TTY:
LST: = LPT:
```

The meaning (unique to each implementation of CP/M) of each of the 12 physical device names is now described:

```
TTY: Serial Port A
CRT: Keyboard/CRT
BAT: Input from RDR: device (whatever device is mapped to RDR:)
     Output to LST: device (whatever device is mapped to LST:)
UC1: Serial Port B
PTR: Keyboard
UR1: Keyboard
UR2: Serial Port B
```

PTP: CRT
UP1: Parallel Line Printer Port
UP2: Serial Port B
LPT: Parallel Line Printer Port
UL1: Serial Port B

## Low Memory Locations

Most of low memory locations 0 through 5B are reserved for use by the operating system. Modifying any of these locations except as described below can easily cause system failure.

| Location | Function |
|---|---|
| 0-2 | Jump to warm start entry of BIOS |
| 3 | I/O Byte (Logical to Physical Map) |

| Bits | |
|---|---|
| 0-1 | CON: Assignment<br>0 - TTY:<br>1 - CRT:<br>2 - batch<br>3 - UC1: |
| 2-3 | RDR: Assignment<br>0 - TTY:<br>1 - PTR:<br>2 - UR1:<br>3 - UR2: |
| 4-5 | PUN: Assignment<br>0 - TTY:<br>1 - PTP:<br>2 - UP1:<br>3 - UP2: |
| 6-7 | LST: Assignment<br>0 - TTY:<br>1 - CRT:<br>2 - LPT:<br>3 - UL1: |

| | |
|---|---|
| 4 | Current Drive Number<br>0 = A, 1 = B, ...,15 = P |
| 5-7 | Contains a JMP instruction to the BDOS and serves two purposes: JMP 5 provides the primary entry point to BDOS, as described in the Digital Research manual, Chapter 5, "CP/M 2 SYSTEM INTERFACE" and LHLD 6 brings the address field of the instruction to the HL register pair. This value is the lowest address in memory used by CP/M (assuming CP/M is being overlayed). Note that DDT or SID will change the address field to reflect the reduced memory size in debug mode. |

8-A — Available to user programs as RST 8 (Z-80) or RST 1 (8080-/8085).

B — CPU memory control I/O port shadow: used for memory mapped video (see "High Speed Memory Mapped Video" section) and allows user programs direct use of bank switched memory (see "Direct Use of Bank Switched Memory").

| Bit | Function |
|---|---|
| 0-3 | Bank number |
| 4 | Set by operating system, do not modify |
| 5 | Always must be zero |
| 6 | Set by operating system, do not modify |
| 7 | Enable Video RAM to addresses 0F800H-0FFFFH |

C-37 — Used by ATON CP/M

38-3A — Debugger Vector

3B-3F — Used by ATON CP/M

40-42 — Available to user programs

43-5B — Used by ATON CP/M

5C-7F — Default FCB produced for a transient program by the CCP (standard CP/M definition)

80H-0FFH — Default disk buffer (standard CP/M definition)

100H-D7FFH — Transient program area (Level I)

100H-F7FFH — Transient program area (Level II)

D800H-FFFFH — BDOS/BIOS (Level I)

F800H-FFFFH — BDOS/BIOS (Level II)

FD00H-FF7FH — Available to user programs as communication region or for user I/O drivers. Not disturbed by warm starts. (Level II only)

Locations 18H through 4FH can be freed for user programs by relocating the data in those locations to another page in the lower 32K of the user's program. ATON CP/M will automatically relocate the data back to page 0 whenever a warm start occurs. The exact code to relocate to page 1 (for example) is:

```
PAGE    DEFL  1  ;Any value between 1 and 127 inclusive
;
        DI
        LD    HL, 0CH
        LD    DE, PAGE*256+0CH
        LD    BC, 50H-0CH
        LDIR
        LD    A,PAGE
        LD    (PAGE*256+0DH),A
        LD    (PAGE*256+0FH),A
        LD    (PAGE*256+4DH),A
        LD    (PAGE*256+4FH),A
        LD    I,A
        EI
```

The I register and the locations "PAGE*256+018H" through "PAGE*256+4FH" inclusive must be in the same state when the next warm start occurs as they are following the EI instruction above so that the data may be properly relocated back to page 0 when the warm start occurs.

## Assembly Programming Notes

All user programs must allow 4 bytes of stack for interrupt processing by ATON CP/M.

The index registers IX and IY, as well as the alternate register set, are preserved by operating system functions and thus will be unchanged after BDOS or EIOS system calls.

The maximum interrupt lockout time is established at 250 microseconds. If user programs exceed this time limit, serial data communications and timekeeping functions can be adversely affected. The Z-80 block instructions, such as LDIR, check for interrupts after each byte is processed so long block moves when interrupts are enabled pose no problems in meeting the interrupt lockout time limit.

Direct access to the disk is provided by the EIOS function call RST 16. Complete and unobstructed direct access to the disk, including reading and writing track formats, is provided by the EIOS function call so the BIOS disk entries SELDSK, SETTRK, SETSEC, SECTRN, READ or WRITE are not required.

If a diskette is to be changed during program execution, an EIOS redetermine disk format function call (code 0D0H) and a BDOS reset drive function call (function 37) must be used immediately after the diskette is changed to inform ATON CP/M of the change. The EIOS call is needed only if a density change is expected in Level I. The density change is handled automatically by Level II.

## Direct Use of Bank Switched Memory

Bank switched memory may be used directly by user programs if certain guidelines are followed. Use of bank switched memory is available in both levels of ATON CP/M. The hardware of the Model II allows the upper 32K of the CPU to be associated with one of several 32K banks of memory in the machine.

The lower 32K is fixed. Thus a routine can be written to reside somewhere in the lower 32K which will switch banks and allow access to data or code residing in the upper 32K. Several 32K banks may be utilized. Bank switching must be coordinated with the operating system or system failure will occur.

To operate on code or data in another bank, the bank switching routine (located in the lower 32K) must do the following:

1. Disable interrupts (DI instruction).

2. Location 0BH contains the shadow for the CPU memory control I/O port 0FFH. Load location 0BH, save the low order 4 bits of it for step 5 below, set the new bank number in the low order 4 bits (do not modify the high order 4 bits), output to I/O port 0FFH, store location 0BH.

3. Enable interrupts (EI instruction). Never disable interrupts for more than 250 microseconds as this will interfere with the operating system activities.

4. You may now manipulate data in this new bank or execute code in it (the entire 32K) in any way desired. Your program must load whatever data or code is desired into this bank - it is not accessed by the operating system. Any interrupts that occur while memory is bank switched are properly handled by the operating system if steps 1 through 3 are performed.

5. When you are finished with the bank you have selected, you may select a different bank or return to the CP/M bank (saved in step 2 above) by again executing steps 1 through 3.

Bank numbers 0 and 1 are the only banks in a 64K machine and are reserved for ATON CP/M in machines with more memory. Banks 2 through 15 are normally available for the operating system for disk buffering and foreground partitions. The CP/M bank must be selected before calling any operating system function (BDOS, BIOS, or EIOS). The CP/M bank is the bank number saved in Step 2 above.

"User" banks may be defined with SYSDEF to be available for user programs and not be accessed by the operating system. The bank number is determined by straps on the memory board (see the "Getting Started" chapter under the heading "Memory Boards").

## High Speed Memory Mapped Video

In memory mapped mode, the data for the CRT screen can be directly manipulated much faster than with the normal BDOS function calls.

The advantages of memory mapped video are available with both levels of ATON CP/M. With memory mapped video, the program alters a memory location and the result immediately appears on the screen. If a 41H is stored in memory location 0F800H when the memory mapped video is selected, the letter "A" will appear in the leftmost position of the uppermost data line. Memory location 0F801H is associated with the second position of the first data line, and so on until location 0FF7FH is associated with the rightmost character of the bottom data line.

The leftmost position of the status line (beginning of the user portion of the status line) is associated with 0FFB0H and the leftmost position of the system portion of the status line (rightmost 40 characters) is associated with 0FFD8H.

In 40 character/line mode, the lines are still contiguous in memory so the last location of the bottom line is associated with 0FBBFH, and the beginning of the system portion of the status line (which is all that gets displayed on the status line) remains at 0FFD8H.

The addresses from 0F800H through 0FFFFH are used both for the CRT RAM and for normal RAM memory. A portion of BIOS resides in the normal RAM memory in the address range 0F800H through 0FFFFH, so use of the CRT RAM by a user program **must** be carefully coordinated with ATON CP/M. Failure to follow these guidelines for programming the CRT RAM will result in system failure.

1. CRT RAM is disabled upon entry to a program and must be disabled before any BDOS (location 5), BIOS (vectored through locations 1-2), or EIOS (RST 16) monitor calls are made by the program.

2. The video continues to display whether or not CRT RAM is enabled.

3. Interrupts are enabled while CRT RAM is enabled and must not be disabled for more than 250 microseconds at any one time. Block move instructions (LDIR, LDDR, etc.) are interruptable so they may be used for scrolling and erasing.

4. To enable CRT RAM

    1. Disable interrupts (DI instruction).

    2. Location 0BH contains the shadow for the CPU memory control I/O port 0FFH. Load location 0BH, set bit 7 (080H), output to I/O port 0FFH, store location 0BH.

    3. Enable interrupts (EI instruction).

    4. You may now manipulate video screen data (read or write to locations 0F800H through 0FF7FH and 0FFB0H through 0FFD7H. Locations 0FF80H through 0FFAFH are reserved for ATON CP/M.) as long as you desire but you **must** disable CRT RAM before calling any operating system function (BDOS, BIOS, or EIOS).

5. To disable CRT RAM

    1. Disable interrupts (DI instruction).

    2. Load location 0BH, clear bit 7, output to I/O port 0FFH, store location 0BH.

    3. Enable interrupts.

    4. You may now call operating system functions (BDOS, BIOS, or EIOS). The cursor can be controlled by the ESC = row column sequence with BDOS functions 2, 6, or 9.

## Extended I/O System (EIOS)

Besides the usual character by character I/O system provided by BDOS, ATON CP/M provides a monitor which allows user programs to directly access the disk and clock.

### EIOS Monitor Functions

The call sequence for the EIOS monitor functions of ATON CP/M is:

```
LD   DE, address of function control block (FCB)
RST  16
```

The monitor performs the functions described in the FCB and returns status in the status block. The registers AF, BC, DE, and HL may be altered by EIOS call processing. The IX and IY registers as well as the alternate register set will not be modified by EIOS call processing.

The FCB is composed of a portion standard to all I/O devices followed by I/O device specific information. The FCB format is:

| Byte | Description |
|---|---|
| 0 | Device code<br>1 - Floppy disk<br>7 - Clock |
| 1 | Function code<br>0 - Definition<br>1 - Read<br>2 - Write<br>3 - Status<br>4 - Control |
| 2 | Reserved |
| 3-4 | Status block address |
| 5-n | Device/function Dependent |

The status block contains the current status of the operation. If the operation is incomplete (status = 080H) the remainder of the status block is in an undefined state.

The status block format:

| Byte | Description |
|---|---|
| 0 | Status<br>080H = Incomplete<br>0 = Complete - no errors<br>1 = Complete - illegal or undefined function<br>2 = Timeout occurred |

| | |
|---|---|
| 1-2 | Actual number of bytes transferred in current operation, set to zero for status sense operations. |
| 3-6 | Device/Function Dependent |

Floppy Disk Function (Device Code 1)

The ability to program any of the disk transfers that the FD-1791 disk controller is capable of is provided by this function. On a one sided diskette, track number and cylinder number are identical. On a two sided diskette a distinction must be made between track and cylinder number. Track zero is side (head) zero of cylinder zero. Track one is side (head) one of cylinder zero. Track two is side (head) zero of cylinder one, and so on. These operations bypass the track and record buffering schemes used for BDOS disk functions. Thus if a different drive is selected by an EIOS call, a BDOS select disk operation (function 14) must be done before resuming BDOS read and write functions.

| Function Code | Description |
|---|---|
| 1 | Disk Access. The device dependent area of the FCB is: |

| Byte | Description |
|---|---|
| 5 | Opcode |

0 - Restore - recalibrate to cylinder 0
010H - Seek to track number
080H - Read record (sector)
0A0H - Write record (sector)
0C0H - Read address (sector ID field)
0E0H - Read track format (some versions of the FD-1791 controller do not perform this operation as documented in the Western Digital Literature)
0F0H - Write track format
0D0H - Redetermine disk format type

Opcode modifiers can be added to modify the function of certain opcodes. A modifier of 010H can be added to read or write record commands to cause multiple consecutively numbered records to be read or written. This modifier must be set if the starting and ending record numbers are not identical and more than one record is to be read or written.

A modifier of 1 can be added to the write record command to cause the deleted data mark to be written with the record. A subsequent read record operation on this record will return deleted data record status.

A modifier of 8 can be added to the read address, read track format, and write track format operations (only) to allow the caller to override the automatic side number and density selection. With this modifier the low order bit (bit 0) of the opcode is the side number and bit 1 of the opcode is density (1 = double density).

Use of opcodes other than described above is illegal and may produce unpredictable (destructive) results.

The redetermine disk format function call is used after a format operation or (in Level I) any time that a diskette is changed in a drive to force ATON CP/M to reexamine the disk to determine its format type for automatic density select purposes.

| | |
|---|---|
| 6 | Drive number: 0 = A:, 1 = B:, 2 = C:, 3 = D: |
| 7 | Track/Cylinder number. Track/side number unless modifier 8 is added to read address, read track format, or write track format operations when it becomes cylinder number. |
| 8 | First record number. Only relevant to read and write record operation. |
| 9 | Final record number. Only relevant to read and write record operation. Must be same as first record number on single record operations. |
| 10-11 | Buffer address. Buffer must be entirely contained in lower 32K in Level II. |
| 12-13 | Buffer size in bytes |
| 14 | Number retries without moving heads - normally use one for this value. |
| 15 | Number of error recovery restore operations - normally use ten for this value. Maximum total number of attempts to perform operation before return is (number in byte 14 plus one) times (number in byte 15 plus one). |

Disk Access Status Block

| Byte | Description |
|---|---|
| 3 | Auxiliary Status (Zero if no errors detected) |

| Bit | Description |
|---|---|
| 0 | No DMA terminal count (entire buffer not transferred) |
| 1 | Attempt to select side one on single sided diskette (only returned for appropriately strapped two sided drives. Single sided drives ignore side selection.) |
| 2 | Lost data (buffer smaller than disk segment requested) |
| 3 | CRC error in record address or data |
| 4 | Record not found on track |
| 5 | Record type is deleted (read record operation) |
| 6 | Illegal drive or track/cylinder address |

Auxiliary status bits 0 through 5 can occur simultaneously.

4 Final record number. If record not found, record number of record not found. If read/write record without multiple record modifier, then number of record found. If multiple record modifier, then number one beyond last record number transferred. Undefined for operations other than read/write record.

5-6 Zero

Clock Functions (Device Code 7)

| Function Code | Description |
|---|---|
| 1 | Read Clock (7 bytes) |

| Byte | Description |
|---|---|
| 5-6 | Address of buffer |

2 Write Clock (7 bytes)

| Byte | Description |
|---|---|
| 5-6 | Address of buffer |

The clock has the following format in the buffer:

| Byte | Description |
|---|---|
| 0 | Seconds (0-59) |
| 1 | Minutes (0-59) |
| 2 | Hours (0-23) |
| 3 | Day of week (0-6, 0 = Sunday) |
| 4 | Day of month (1-31) |
| 5 | Month (1-12) |
| 6 | Year (0-99, 81 = 1981) |

Clock Status Block Auxiliary Status

| Byte | Description |
|---|---|
| 3-6 | 4 byte (32 bit) real time clock. Is set to zero on cold bootstrap and is incremented by one every 10 milliseconds thereafter. Will run for about a year before incrementing back to zero again. |

## CRT Programming Considerations

In the 25 x 80 format, the status line is displayed as the uppermost line of the display. The rightmost 40 positions of the status line are used by the system to display system status such as time of day, date, disk activity, and partition activity information. The leftmost 40 characters of the status line are available for use by user programming systems. In 40 character per line mode, only the rightmost 40 characters (system status) of the status line are displayed. For Level III the leftmost 20 positions of the status line are unique to each partition, while the other 20 positions of the user area of the status line are global and do not change when another partition is selected.

In the 24 x 80 format, the operator requests the status line by entering the CTRL-8 key. The display will shift down one line and display the status line on top. The bottom line is not then displayed. When the CTRL-8 key is again entered, the display is shifted back to its original position. Neither the status line nor the bottom line of the display is disturbed when the CTRL-8 key is activated; the only difference is operator visibility. The CTRL-8 key can be activated at any time, regardless of other activity in the system.

As delivered, the CRT/keyboard combination emulates the ADM-3A terminal by Lear Siegler with some additional functions from the SOROC IQ-120 or Televideo 910/912/920 series. The user can remap both the CRT command sequences and the keyboard with the SYSDEF program.

The CRT hardware can display 128 unique graphic characters in normal (white on black) or reverse (black on white) video. See the Appendix of the Model II Disk Operating System Reference Manual or Chapter 7 of the Model II Operation Manual for the codes of the CRT screen graphics. Both of these manuals are part of the Model II Owner's Manual delivered with the computer. If the high order bit of a character is set, it goes straight to the screen (in normal or reverse video as defined by previous control codes or definition function) without the code table lookup. This allows use of the graphics even if the equivalent ASCII code is used as a control code.

A number of screen functions are available, and the codes that activate these functions are determined by a screen code table. The screen code table consists of a list of byte pairs. The first byte (low numbered address) of the pair is on ASCII code, and the second byte of the pair is the associated screen function number. The first byte pair must define the escape character (usually 01BH), and the last byte pair of the table has 0FFH as the ASCII code to indicate end of table. The ASCII code has the high order bit set if it is to be preceded by the escape character. The mapping table applies to characters received through BDOS or BIOS calls.

The second byte of the table, rather than being a function code for the escape character, is a mask value which can be set to 0FFH to allow full graphics or set to 07FH to ignore the high order bit as may be required by some application programs.

The available screen functions (and the "warm start" default unless default is changed by SYSDEF) are:

0 - Start escape sequence (ESC - 01BH)
1 - Cursor left (BS - 008H)
2 - Cursor down (LF - 00AH)
3 - Cursor up (VT - 00BH)
4 - Cursor right (FF - 00CH)
5 - Cursor to beginning of line (CR - 00DH)
6 - Not assigned - do not use
7 - Not assigned - do not use
8 - Erase screen (SUB - 01AH or ESC + or ESC *)
9 - Sound beeper - flash screen (BEL - 007H)
10 - Cursor home (RS - 01EH)
11 - Cursor to beginning of line and cursor down (new line) (US - 01FH)
12 - Position cursor to line and column number. Line is next character, and column follows line. Line and column numbers start from 020H (ESC = L C)
13 - Erase (blank fill) from cursor to end of line - do not move cursor (ESC T or ESC 074H)
14 - Erase (blank fill) from cursor to end of screen - do not move cursor (ESC Y or ESC 079H)
15 - Start inverted video field (ESC ) )
16 - End inverted video field (ESC ( )
17 - Ignore character (NUL - 00H)

A SYSDEF option is available to cause the CRT driver to ignore the high order bit of ASCII characters.

If you have a P&T clock/calendar/beeper card installed in your machine with port address 0BEH-0BFH, it will beep when a BEL code (07) is encountered by the CRT driver. The screen flash can be disabled, if desired, with the SYSDEF program.

## Keyboard Programming Considerations

The keyboard has a mapping table associated with it so that different terminals may be emulated. The mapping table consists of a list of byte pairs. The first byte of the pair is the code generated by the keyboard, and the second byte of the pair is the code that is returned to the caller for read functions. Certain control key codes are reserved for the operating system and cannot be mapped. These are indicated in the following hexadecimal key code table. The last byte pair of the table has 0FFH as the first (keyboard code) of the pair and the mask value as the second byte. Normally the mask value is 07FH which causes the CAPS key to force only the letter A-Z keys to their shifted codes. If the mask is 0FFH, unique key codes can be obtained from many of the keys when the CAPS key is active. The mapped values shown in the table are those established by "warm start" unless modified by SYSDEF. The mapping table applies to BDOS as well as BIOS function calls.

## Hexadecimal Key Code Table

| Key Legend | Unmapped Code | | | | Default Control Mapped Code |
|---|---|---|---|---|---|
| | Unshifted | Caps | Shift | Control | |
| A-Z | 61-7A | C1-DA | 41-5A | 01-1A | |
| Space bar | 20 | 20 | 20 | 20 | |
| ESC | 1B | 1B | 1B | 1B | |
| TAB | 09 | 09 | 09 | 09 | |
| 1 ! | 31 | B1 | 21 | A1 | Control Code (Reserved for monitor) |
| 2 @ | 32 | B2 | 40 | C0 | Control Code (Reserved for monitor) |
| 3 # | 33 | B3 | 23 | A3 | Control Code (Reserved for monitor) |
| 4 $ | 34 | B4 | 24 | A4 | Control Code (Reserved for monitor) |
| 5 % | 35 | B5 | 25 | A5 | Control Code (Reserved for monitor) |
| 6 | 36 | B6 | 5E | 7E | |
| 7 & | 37 | B7 | 26 | A6 | Control Code (Reserved for monitor) |
| 8 * | 38 | B8 | 2A | AA | Control Code (Reserved for monitor) |
| 9 ( | 39 | B9 | 28 | 5C | |
| 0 ) | 30 | B0 | 29 | 7C | |
| - _ | 2D | AD | 5F | 7F | 60 (Control only) |
| = + | 3D | BD | 2B | AB | AB (Control only) |
| Backspace | 08 | 08 | 08 | 08 | 7F |
| Break | 03 | 03 | 03 | 03 | |
| Hold | 00 | 00 | 00 | 00 | 1E |
| Enter | 0D | 0D | 0D | 0D | |
| { [ | 7B | FB | 5B | DB | 1C (Control only) |
| } ] | 7D | FD | 5D | DD | 1D (Control only) |
| ; : | 3B | BB | 3A | BA | 1F (Control only) |
| ' " | 27 | A7 | 22 | A2 | 00 (Control only) |
| , < | 2C | AC | 3C | BC | Control Code (Reserved for monitor) |
| . > | 2E | AE | 3E | BE | Control Code (Reserved for monitor) |
| / ? | 2F | AF | 3F | BF | Control Code (Reserved for monitor) |
| ← | 1C | 1C | 1C | 1C | 08 |
| → | 1D | 1D | 1D | 1D | 0C |
| ↑ | 1E | 1E | 1E | 1E | 0B |
| ↓ | 1F | 1F | 1F | 1F | 0A |
| 0-9 | 30-39 | 30-39 | 30-39 | 30-39 | |
| . | 2E | 2E | 2E | 2E | |
| Enter | 0D | 0D | 0D | 0D | |
| F1 | 01 | 01 | 01 | 01 | |
| F2 | 02 | 02 | 02 | 02 | |

If both SHIFT and CAPS are depressed, the SHIFT Code is used. If CTRL and SHIFT or CTRL and CAPS are depressed, the CTRL Code is used.

# CHAPTER V

## UTILITY PROGRAMS

This chapter describes all the files included on the master diskette. Further information on many of these programs is included in the Digital Research manuals as indicated below.

ASM.COM — This is an assembler providing conditional assembly but not macro facilities and handles 8080 mnemonics only. See Digital Research manual, Chapter 1, "CP/M FEATURES AND FACILITIES," section 1.6.2, page 15 and Chapter 3, "CP/M ASSEMBLER".

AUTOEXEC.COM — This program allows the user to specify a program or SUBMIT file to be executed whenever a cold or warm start occurs. The user has the option to specify:

1. Level I or Level II.
2. Cold start only (i.e., RESET switch is activated) or on cold and warm start (jump to 0, or BREAK key entered).
3. A command to be executed.

Follow instructions on screen when program is executed.

COPY.COM — This is a high speed disk formatting and image copy program designed specifically for ATON CP/M. It is very easy to use. Follow the directions given on the screen when it is executed.

DDT.COM — This is an interactive debugger program for 8080 instruction set programs. See Digital Research manual, Chapter 4, "CP/M DYNAMIC DEBUGGING TOOL"..

DUMP.ASM — This is a sample assembly language program to illustrate programming techniques used in interfacing with CP/M. See Digital Research manual, Chapter 1, "CP/M FEATURES AND FACILITIES," section 1.6.8, page 27 and Chapter 5, "CP/M 2 SYSTEM INTERFACE," section 5.4, page 113.

DUMP.COM — This is the executable version of DUMP.ASM described above.

ED.COM — This is the Digital Research text editor used to create or modify source files. See Digital Research manual, Chapter 1, "CP/M FEATURES AND FACILITIES," section 1.6.5, page 23 and Chapter 2, "ED".

LEVEL2.COM — Contains code for the extended memory version of ATON CP/M. May be deleted on data-only diskettes.

LOAD.COM — This is a utility program to translate a HEX file into a COM file. See Digital Research manual, Chapter 1, "CP/M FEATURES AND FACILITIES," section 1.6.3, page 16.

MOVCPM.COM — This program allows generation of various sizes of Level I CP/M systems. It is a modified version of the Digital Research version with the following two major changes:

1. The first parameter may be stated as a decimal; thus 63.75 represents a system one page (256 bytes) less than the largest that could be used by the system. The fractional part may take only the values .00, .25, .50, or .75 because CP/M can only be relocated to a page boundary.

2. The second parameter is ignored, the system is always left in memory at location 900H and following for a subsequent SAVE or SYSGEN operation.

See Digital Research manual, Chapter 1, "CP/M FEATURES AND FACILITIES," section 1.6.9, page 27.

OMNI.COM — If you purchased the OMNIWRITER file editor program, it will be on the disk under this name. The user's guide text is included under the name GUIDE.C12. See the OMNIWRITER User's Guide, for details.

PIP.COM — This program allows data files to be transferred from disk to disk or device to device. See Digital Research manual, Chapter 1, "CP/M FEATURES AND FACILITIES," section 1.6.4, page 17.

RSCPM.COM — This program allows data files to be transferred from Radio Shack TRSDOS disks to CP/M disks. It does not move files in the other direction. Follow the directions given on the screen when the program is executed.

STAT.COM — This program lists an alphabetically ordered directory list which includes file sizes. It also allows reassignment of devices and setting disk file attributes. See Digital Research manual, Chapter 1, "CP/M FEATURES AND FACILITIES," section 1.6.1, page 10.

SYSDEF.COM — This is a comprehensive, menu-driven system configuration utility that allows modification of the following parameters:

1. CON:, RDR:, PUN: and LST: I/O assignments at cold bootstrap.

2. Read after write check on all Level I disk transfers.

3. Definition of 32K memory banks reserved for user programs.

4. Power line frequency (50/60 hertz).

5. CRT line size (40/80 characters per line).
6. CRT screen size (24/25 lines per screen).
7. CRT black on white or white on black characters.
8. CRT split screen mode (partial screen scroll).
9. CRT cursor size and blink rate.
10. Time display update rate.
11. Parallel port printer parameters: characters per line, page length, lines per page, etc.
12. Serial port printer parameters: characters per line, page length, lines per page, etc.
13. Serial port parameters: transmit data flow control protocol, parity, stop bits, data bits/character, transmit and/or receive baud rate.
14. Keyboard mapping table.
15. CRT function mapping table.

SYSGEN.COM — This program can copy the system tracks from one diskette to another or copy the new system generated by MOVCPM to the system tracks on the disk. See Digital Research manual, Chapter 1, "CP/M FEATURES AND FACILITIES," section 1.6.6, page 24.

SUBMIT.COM — This program allows CP/M commands to be executed from a disk file. See Digital Research manual, Chapter 1, "CP/M FEATURES AND FACILITIES," section 1.6.7, page 25.

TIME.COM — This program allows the date and time to be set. Follow the directions listed on the CRT screen when it is executed.

XSUB.COM — This program extends the SUBMIT facility so that command lines to processors such as DDT, XDT, PIP, and ED can be included in the command file on disk.

# CHAPTER VI

## LEVEL II USER'S GUIDE

Level II of ATON CP/M allows you to take advantage of additional RAM memory installed in your Model II. The additional memory is used for the disk cache memory system and to store most of the operating system. The result is greatly increased disk throughput and 6K to 8K more memory for your programs. Total user program area available becomes 62K which is 8K more than is available with Level I and is at least 6K more than is available under any other CP/M implementation that we know of. A lot of effort has been invested to tune the disk cache memory system (Track Mode$^{tm}$ BIOS) to optimize its performance for business applications such as data base processing.

The 8K of additional RAM (made available within Level II) can significantly improve MicroSoft BASIC execution times even when no disk activity occurs because the need for string "garbage collection" is reduced. In general, when using Level II, the disk ceases to be the limiting factor to system performance and the Z-80 or printer then becomes the bottleneck.

The design goal for Level II was to dramatically speed up disk processing speed and give 6K to 8K more memory space for user programs without requiring any changes in user programs or operating procedures. This goal has been met with very little exception. In most cases, simply plugging in an additional memory board will dramatically improve system processing speed, particularly in disk intensive business applications such as data base or sorting. Significant speed improvements are also realized in program development applications involving heavily overlaid compilers and SUBMIT files.

Level II usually offers the most economical way to improve system performance:

- No reprogramming required to make use of extra memory
- $399 for additional memory vs $1500+ for a 16 bit upgrade
- No need to buy new compilers and other development software for a 16 bit processor

Level II offers the speed of a "memory disk" without the cost and space limitations and the change in operations required by the memory disk. Level II takes advantage of the physical characteristics of the floppy drive and offers superior performance over the various logical file queuing schemes on the market.

The Level II cache memory disk system is almost completely transparent to user programs which means that user program modifications are rarely required. As an additional feature, Level II ATON CP/M automatically detects when a diskette is changed in a drive and redetermines the density. The BREAK key should still be entered when changing disks at the CCP command level to avoid the "BDOS ERROR R/O" message.

## Non Transparent Features

There are two small classes of programs that can run into difficulties when using ATON CP/M Level II.

User programs which modify the BIOS JMP table may not get the expected results since BDOS, located in another bank, does not go through this table to reach BIOS.

Some compilers and interpreters for high level languages such as BASIC or PASCAL make use of RST instructions to call run time library routines and will sometimes conflict with ATON CP/M usage of low memory locations. Since these RST instructions were designed for interrrupt processing, a function normally handled by the operating system, the compiler or interpreter will often allow the user to specify which, if any, of the RST instructions are available for the compiler's use. With ATON CP/M, only RST 8 (RST 1 in 8080 terms) and RST 38H (RST 7 in 8080 terms) are available for a compiler's use. If possible, activate the compiler switches to use RST 1 or 7 to avoid conflict with ATON CP/M. Refer to Chapter IV, "Low Memory Locations" for a discussion of low memory usage and a possible way to allow certain additional low memory locations to be used by transient programs.

## Disk Buffering

Level II buffers a large amount of disk data in memory. If a program writes a sector to disk using a BDOS call, the actual writing of the data to the diskette will occur some time later. The time of writing the data to disk must be deferred long enough for efficient processing but all data must be written to the diskette before the operator removes the diskette from the drive. To satisfy these requirements, all modified buffers are written to disk when one of the following events occurs.

1. 250 milliseconds have elapsed since a character I/O request (CRT, keyboard, parallel or serial port) occurred and no intervening read or write request has been made to a drive having a modified data buffer. For example, modified buffers will be written within 250 milliseconds after a disk change request is written to the CRT by the user program or within 250 milliseconds of a console read request.

2. 2 seconds have elapsed since a different drive read or write request occurred and no intervening read or write request has been made to the drive having the modified data buffer.

3. 30 seconds have elapsed since the first disk data was modified in memory. This means that no modified data will remain in memory longer than 30 seconds unless a disk is not mounted or a write protect error occurs requiring operator attention.

4. An EIOS redetermine disk format function call (code 0D0H) causes all modified data for the drive specified in the EIOS call to be written to disk before erasing all buffered data for that drive and causing a density redetermination on that drive. Only the specified drive is affected in this case.

EIOS disk requests are executed directly and bypass the BDOS buffering scheme. A BDOS select disk function (code 14) must be used before a BDOS disk request if BDOS and EIOS requests are intermixed for multiple drives.

Since all of the diskette data cannot usually be contained in memory at one time, ATON CP/M makes decisions on which data will be overlaid based on a "learning" algorithm. You may notice that benchmark programs will sometimes run faster each consecutive time they are executed because of this learning effect.

## Keyboard Buffer

Because the user program is not active when a disk transfer actually occurs and because the disk transfers occur asynchronously, a 64 character keyboard buffer has been added to Level II so that no keyboard input data will be lost. The keyboard buffer can be used to "key ahead" if the user or system program in progress allows it. The prompt character in Level II has been changed from a "greater than" sign to a right curly bracket to provide an indication of which level (I or II) is currently in operation.

## User Area Above BIOS

No "MOVCPM" program is available to relocate the Level II BIOS. However, the 640 byte memory area from 0FD00H through 0FF7FH inclusive has been set aside as a communication area for user programs or for user designed and loaded I/O device handlers.

## Getting the Most Performance from Level II

After much updating, files can become fragmented on the disk, which means sections of the file are located on largely different parts of the disk. This means much more head travel and buffer swapping is required than if the file were contiguously recorded. The fragmentation can be easily eliminated:

1. Format a disk.

2. Use SYSGEN to copy ATON CP/M onto the disk if the disk is to be a system disk.

3. Use PIP to copy the files from the fragmented disk to the newly formated disk. PIP will record the file in contiguous blocks if no intervening ERA commands are executed.

Also, be sure to use the ATON format rather than a P&T formatted disk in order to get maximum processing speed.

## Appendix A

## USER NOTES FOR RSCPM

RSCPM is an ATON CP/M utility program which converts Radio Shack Model II TRSDOS files to CP/M files. The program runs on a TRS-80 Model II microcomputer with one or more disk drives.

### TRSDOS File Types

TRSDOS files may be classified as either **program** or **data** files. Program files are directly-executable files such as BASIC or VisiCalc but do **not** include BASIC programs. Program files are copied over as CP/M HEX format files and may be converted to executable .COM files with LOAD or may be read by DDT. Remember that a program using TRSDOS facilities will not work directly on CP/M without some changes. Data files include BASIC programs in either compressed or ASCII format and miscellaneous random and sequential data files.

### Using RSCPM

1. Boot the TRSDOS disk directly and look at the directory, using the DIR command. You may wish to print out the directory for later reference. Select the files you wish to transfer.

2. Load the CP/M disk on drive A, then type RSCPM.

3. The program tells you that the CP/M **destination** disk will be on drive A, though it won't necessarily be the disk that's there now. You are asked to select the TRSDOS **source** drive. If you have a one-drive computer, answer A; otherwise answer B, C or D. Load the disks when directed, then key (ENTER) to continue.

4. The program asks you for the CP/M file name. Enter any name, following CP/M file name conventions. This name doesn't have to be the same as the corresponding TRSDOS file name.

5. Next you are asked for the TRSDOS file name. Follow TRSDOS file name conventions, using all upper case and a slash (/) between name and extension.

6. The program finds the file and tells you whether it is program or data and how long it is. Key (ENTER) to accept and continue.

7. The program copies the file, prompting you for disk swaps if you are using a one-drive system. For each data file, it asks you if you want linefeeds. Key U for BASIC ASCII programs and sequential data files, and key N for BASIC compressed programs and random files containing binary data.

8. If you want to copy more files on the disk, key (ENTER) to continue, else key (BREAK).

### Error Checking

The program checks to see that disks have been loaded properly and that the source disk is really a TRSDOS disk. If these conditions are not met, the program aborts. If, while reading the TRSDOS disk, the program encounters hard read errors, a message is printed and the read continues. No checking is done for a full destination disk, so make sure you have enough room before starting (use STAT).

Appendix B

## USER NOTES FOR OMNI

Make special note of these operation details:

1. In order to accommodate long lines, OMNI inserts a NUL (0) character every 80 characters if a line (delimited by CRLF) is longer than 79 characters. These additional NUL characters can cause spurious error messages in some language processors, so they should be removed from the file before closing it. This can be accomplished by entering ESC S and F1 before entering the CTRL Z to close the file. See the "File Read/Write" section on page 7 of the OMNIWRITER User's Guide.

2. If you find the display of visible characters on the screen annoying in positions where TAB or CR characters occur, these may be suppressed by using DDT to patch OMNI. Change locations 309H (for TAB) and/or 30DH (for CR) to a blank (20H).

3. When characters in a line are deleted, particularly TABs, the characters in the line may be out of position with respect to TAB boundaries. Depress the Previous Page (F1), then the Next Page (F2) buttons to readjust the line on the screen. The action of the Previous Page and Next Page keys does not affect the text buffer, only the CRT display.

4. If the line on the CRT containing the cursor has some non-NUL characters and no CR, a CR will be appended to it when the F2 Next Page key is struck. To combine two lines it is necessary to erase or backspace over the CR in the first line, the Previous Page (F1), and then Next Page (F2) to observe the change. If the page keys are struck in the opposite order (F2, then F1), the CR will be reinserted, thus making it impossible to combine the lines.

Appendix C

## EXAMINING AND UPDATING THE DIRECTORY USING DDT

This appendix gives an example of how to use the EIOS disk function to examine or update the directory track. Be sure to copy the disk you are working with before beginning since it is very easy to accidentally destroy the data on the disk using the techniques described below.

To read the disk, enter the following program at 100H using A100 command.

```
100   LXI   D,200       ;Address of FCB
103   RST   2           ;Read or write track
104   RST   7           ;Return to DDT
```

Enter the FCB at location 200H using S200 command.

```
200   1     ;Device code
201   1     ;Disk access function
202   0     ;Reserved
203   0     ;LSB status block address
204   3     ;MSB status block address
205   90H   ;Read multiple records
206   0     ;Drive A
207   2     ;Track 2
208   1     ;First record number
209   8     ;Last record number (use 1AH for single density)
20A   0     ;LSB buffer address (1000H)
20B   10H   ;MSB buffer address
20C   0     ;LSB buffer size (2000H)
20D   20H   ;MSB buffer size (use 0BH for single density)
20E   1     ;Number of retries without moving head
20F   0AH   ;Number of retries moving head
```

Check for proper data entry, then start at 100H using G100 command. The disk will be briefly accessed, then DDT will again prompt.

At location 300 through 306 will be the status block.

```
300   0     ;Complete - no errors
301   0     ;LSB number of bytes transferred
302   20H   ;MSB number of bytes transferred (0BH for single density)
303   0     ;No errors
304   9     ;Final record number (01BH for single density)
305   0     ;Reserved
306   0     ;Reserved
```

At location 1000H through 2FFFH (0AFFH for single density) will be the directory track. You can observe the directory entries using the D1000 command. You can "unerase" a file by changing the E5 in the first byte of the directory entry to the USER number (0 if you aren't using USER numbers) using the S command. There may be multiple extents (directory entries) if the file is over 16K large so be sure to scan the entire directory to change all directory entries with the file name in question. Note that the directory sectors (128 bytes) may be interspersed with program files because of the interleaving, so scan the entire 2000H bytes of the directory track for directory entries. Once the directory is modified as desired, write it back to disk by changing location 205 from 90H to 0B0H and then issuing a G100 command.

Unerasing a file is a risky procedure since in some cases conflicting disk allocations are inadvertently made. It is best to use PIP to copy whatever files you need to another disk and then reformat the disk you performed the unerase operation on. If you continue to use a disk that you un-erased a file on, the system may mysteriously destroy a file you need at some point down the road!!