Steinmetz & Brown, Ltd.

SB10161/SB10162
HP-IL Compatible Disk Drive

For use with the HP-41, HP-71, HP-75, HP-110
and other HP-IL computers
Congratulations!

In your SB10160 series disk drive you have perhaps the most versatile peripheral you can own. Your disk drive is a powerful enhancement to your HP-IL™ computer system offering the following features:

- Large storage capacity; over 368,000 bytes per disk.
- The most popular mass storage medium in the world.
- Fast access to all of your data; you're never more than 1/5 second away from your files—anywhere on the disk.
- If you own an HP-110, you can both read and write files for use on most IBM™ and other MS-DOS™ computers.
- If your drive is an SB10161, you have an affordable mass memory device and an economical upgrade path.
- If your drive is an SB10162, your advantages include the ability to directly backup your important files.
- Both models occupy less than one square foot of desk space and are stackable with the new generation of inkjet printers.
- Compatible with the full line of HP-IL™ computers.

HP-IL is a trademark of Hewlett-Packard.
IBM is a trademark of IBM. MSDOS is a trademark of Microsoft.
Table of Contents

Introduction

Getting started
  Connection To The Loop
  Power Requirements
  Inserting and Removing Disks

Using Your Drive with the HP-41
  General Operation
  Special Considerations
  Example programs

Using Your Drive with the HP-71
  General Operation
  Example program

Using Your Drive with the HP-75
  General Operation
  Example program

Using your Drive with the HP-110

Technical Description
  Disk Format and Physical Storage of Data
  Buffers and Disk I/O

HP-IL Messages
  Device Dependant Commands
  Retrieving Drive Status

Appendices
  Appendix A: Care, Warranty & Service
  Appendix B: Accessories & Specifications
  Appendix C: References & Further reading
  Appendix D: In case of difficulty
  Acknowledgements
Getting Started

Connecting The Drive To The Loop

In order to use your disk drive with an HP-IL controller, the drive must be properly connected to the loop.

If the drive is the only peripheral to be attached to the controller, you will need only two HP-IL cables. Connect one end of each cable to the drive and the other end to the controller.

Connecting Multiple Devices To The Loop

Many devices can be connected to the loop at the same time as long the cables connecting the devices form a complete loop.

The cables cannot be connected incorrectly but be certain that both ends of a cable are not connected to the same device.
Power Requirements

Your drive may be plugged into any 110/120 volt grounded AC outlet for normal operation. Plug the power cord firmly into the modular power jack. Be sure to use a grounded outlet for safest operation.

Turning The Drive On

The power switch is located at the top rear of the drive. After the drive has been plugged into a suitable power outlet it can be turned on by pressing the upper side of the power switch. Pressing the lower side of the power switch will turn the drive off.

When the drive is turned on, the motor(s) will operate for a few seconds and the drive will perform a self-test to check for proper operation (technical users may wish to refer to Retrieving Drive Status). When the motor stops, you may insert a disk and begin using the drive.
**Inserting And Removing Disks**

It is safe to insert or remove a disk whenever the select light is off on the drive affected. When the select light is on, the drive is accessing the disk.

Before Disks can be inserted or removed, the locking lever on the front of the drive must be in the horizontal position.

Once a disk has been inserted into the drive and the locking lever turned down to the vertical position, the drive will be ready for use.

For details on the operation of mass memory devices refer to your computer or HP-IL module owner's manual.
Using your drive with the HP-41

The SB10161 behaves exactly like a cassette drive and the SB10162 behaves like two sequential cassette drives on the loop (though they are much faster, of course). If you refer to the Mass Storage Operations section of your HP-IL module owner's manual, you should have no trouble operating your drive. The Extended I/O module and the HP-IL Development module contain functions which permit direct control over the full storage capabilities of your drive though the HP-41 will automatically use 131,072 bytes of each disk’s capacity. The HP-41 can typically move data to and from the drive at a rate of about 250 bytes per second. The next section details useful information about drive operation.

HP-41 Special Considerations

- Due to the design of floppy disk drives, the drive does not know when one medium has been removed and another inserted. Sophisticated controllers will always consult the directory before accessing the disk; however, the HP-41 does not always do this. In normal operation, the HP-41 uses buffer 1 to maintain part of the directory. It is possible to swap disks and use the wrong directory for a medium. This can result in a read of unexpected data, overwriting records inappropriately, or a memory lost condition. To avoid this problem after changing diskettes, either turn the drive off and then on or try to read a nonexistent file.

- The HP-41 may under some circumstances fail to recognize the end of the directory or misread some entries when entries written by another controller are present. This may cause an apparently endless directory when doing a DIR command. For this reason it is recommended that media for the HP-41 not be used to hold files created by other controllers.

- The AUTO/DUP module for the HP-41 creates timing problems with some mass storage devices. If more than two drives are present on the loop at a time, it is possible that the mass copy function of the AUTO/DUP module will not operate properly.
DDISK41—a program to display disk records with the HP-41

This program will permit an HP-41 to print the contents of disk records in both hexadecimal and character form. This permits viewing of the actual structure of stored information.

System requirements: Memory configuration:

HP-41C/CV/CX SIZE 007 (or greater)
Extended I/O Module at least 40 program registers
HP-IL Module
any printer

Running DDISK41:

1. Carefully key in the program or load it from the diskette provided.
2. XEQ ALPHA DDISK41 ALPHA.
3. When the display shows RECORD? enter the number of the record you would like to see printed and press R/S.
   (The record will be printed during the next several minutes.)

If the display shows an error message (e.g. ERROR 14), there has been a problem reading data from the drive (perhaps no disk was inserted). To determine the source of the problem see Retrieving Drive Status in the Technical Description section of this manual.

Program list: Comments:

01 LBL "DDISK41"
02 LBL 00
03 "RECORD?" Ask for the record# to be printed.
04 PROMPT
05 STO Y Convert the record# to two-byte form.
06 256
07 /
08 STO 01 High order byte in register 01.
09 CLX
10 LASTX
11 MOD
12 STO 02 Low order byte in register 02.
13 CF 10
14 FS? 34 Preserve addressing mode in flag 10.
Save 16 for quick future reference.

Find the first mass memory device. If none, drop out with NO DRIVE error.

Otherwise store its address in register 06.

Select the drive.

Prevent the 41 from screwing things up.

Make the drive a listener.

Prepare to seek the desired record.

Send high order byte.

Send low order byte.

Inform the user that we are seeking.

Make the drive a talker.

Ask for drive status.

Get status out of ALPHA.

Is the drive busy?

If so, repeat.

Has there been a drive error?

If so, go to the error display routine.

Otherwise make the drive a talker.

Read the desired record.

Reconstruct the record.

Call the number format routine.

Print the record.
64    ADV
65    32
66    STO 00
67    4
68    *
69    STO 03
70    55
71    STO 01
72    48
73    STO 02
74    LBL 02
75    ADROFF
76    RCL 06
77    TAD
78    CLX
79    DDT
80    8
81    INAN
82    FC?C 10
83    ADRON
84    1.008
85    STO 05
86    9
87    LBL 03
88    RCL Y
89    ATOXX
90    STO 07
91    RCL 04
92    /  
93    INT
94    X=Y?  
95    RCL 01
96    X=Y?  
97    RCL 02
98    +
99    ACCHR
100   RDN
101   RCL 07
102   RCL 04
103   MOD  
104   X=Y?  
105   RCL 01
106   X=Y?  
107   RCL 02
108   +
109   ACCHR
110   CLX
111   2
112   SKPCHR

Store outer loop counter.
Save 128 for quick access in the loop.
Save 55 for quick access in the loop.
Save 48 for quick access in the loop.
Make the drive a talker.
Send record in buffer 0.
Bring eight bytes into ALPHA.
Restore addressing in case the user gets bored and stops before we finish.
Use loop counter to point to character.
Get character#.
Save character# in register 07.
Get 16.
Divide to get the high order nibble.
Is nibble > 9?
If so, get 55 (ASCII table offset for A-F).
Is nibble <= 9?
If so, get 48 (ASCII table offset for 0-9).
Add appropriate offset.
Accumulate hex character.
Get 9.
Get character#.
Get 16.
Modulo to get the low order nibble.
Is nibble > 9?
If so, get 55 (ASCII table offset for A-F).
Is nibble <= 9?
If so, get 48 (ASCII table offset for 0-9).
Add appropriate offset.
Accumulate hex character.
Hold stack position.
Skip two character positions.
113  RDN       Restore stack order.
114  ISG Y
115  GTO Ø3
116  ADV
117  LBL Ø4
118  RCL Ø3
119  RCL Ø5
120  ATOXX    Get current character®.
121  RCL Y
122  X≤?Y?     Is character® >= 128?
123  -         If so, bring character® down by 128.
124  X>Y?      Is character® still in register Y?
125  X<Y       If so, bring it to register X.
126  ACCHR     Accumulate character representation.
127  2
128  SKPCHR    Skip two character positions.
129  ISG Ø5
130  GTO Ø4
131  ADV
132  DSE ØØ    Repeat for all eight characters.
133  GTO Ø2
134  ADV
135  ADV
136  ADV
137  ADV
138  ADV
139  CLST
140  CLA
141  RTN       Quit.
142  GTO ØØ    Start over at the beginning.
143  LBL Ø5
144  FC?C 1Ø   Number formatting routine.
145  ADRON
146  FIX Ø     Format number with no commas or points.
147  CF 29
148  ARCL X
149  FIX 2     Restore addressing in case user quits.
150  SF 29
151  RTN
152  LBL 99    Device error processing routine.
153  "  ERROR  
154  XEQ Ø5    Call the number format routine.
155  CF 21
156  AVIEW
157  FS? 55
158  SF 21
159  END       Display the drive error code.
160
161  Restore stack order.
162  Repeat for all eight characters.
163  Get 128.
164  Use loop counter to point to character.
165  Get current character®.
166  Get 128.
167  Is character® >= 128?
168  If so, bring character® down by 128.
169  Is character® still in register Y?
170  If so, bring it to register X.
171  Accumulate character representation.
172  Skip two character positions.
173  Repeat for all eight characters.
174  Repeat for all thirty two blocks
175  of eight characters.
176  Advance the paper for easy viewing.
177  Clean up.
178  Quit.
179  Start over at the beginning.
180  Number formatting routine.
181  Restore addressing in case user quits.
182  Format number with no commas or points.
183  Restore a reasonable display format.
184  Return to calling routine.
185  Device error processing routine.
186  Call the number format routine.
187  Display the drive error code.
188  Quit.
VOLID—a '41 program to view and change the disk volume ID

This program will display the six character volume ID on a disk and permit the ID to be changed at any time. When the '41 formats a disk, it does not normally put a meaningful ID on the disk. Using VOLID, any six character volume ID can be placed on the disk for future reference.

System requirements:

Memory configuration:

HP-41C/CV/CX SIZE 81 (or greater)
Extended I/O Module
HP-IL Module

Running VOLID:

1. Carefully key in the program or load it from the diskette provided.
2. XEQ ALPHA VOLID ALPHA.
3. When the display shows VOLID: followed by the current volume ID, you may enter a different volume ID (six characters or less) and press R/S to store the new ID on the disk.

Note that this program pays no attention to device errors and will appear to work properly even if no disk is in the drive. When using HP-IL commands the programmer must choose whether or not to do error checking and when. Unlike DDISK41, this program does no error checking.

Program listing: Comments:

01 LBL “VOLID”
02 ADROFF
03 -16
04 FINDAID
05 STO 00
06 LAD
07 4
08 DDL
09 CLX
10 OUTXB
11 OUTXB
12 RCL 00
13 TAD
14 2

Keep the 41 from mucking with us.
Find the first mass memory device.
Save its address in register 00.
Make the drive a listener.
Prepare to seek.
Seek record 0.
Make the drive a talker.
15  DDT
16  RCL @0
17  LAD
18  3
19  DDL
20  2
21  OUTXB
22  RCL @0
23  TAD
24  CLX
25  DDT
26  6
27  INAN
28  ATOX
29  ASTO @1
30  "YOLID: 
31  ARCL @1
32  AON
33  CF 23
34  ADRON
35  PROMPT
36  ADROFF
37  AOFF
38  FS? 23
39  ASTO @1
40  RCL @0
41  LAD
42  4
43  DDL
44  CLX
45  OUTXB
46  OUTXB
47  3
48  DDL
49  2
50  OUTXB
51  6
52  DDL
53  "D"
54  ARCL @1
55  OUTAE
56  8
57  DDL
58  ADRON
59  END

Read the record into buffer @0.
Make the drive a listener.
Prepare to set the byte pointer.
Set the byte pointer to position 2.
Make the drive a talker.
Send buffer @0 starting at byte 2.
Bring six characters into ALPHA.
Knock off the leading dummy character.
Store the volume ID in register @1.

Turn on ALPHA mode.
Restore addressing in case user quits.
Show the current volume ID.
Turn addressing off again.
Turn ALPHA mode off.
Did the user enter a new volume ID?
If so, store the new ID.

Make the drive a listener.
Prepare to seek.
Seek record* @0.
Prepare to set the byte pointer.
Set the byte pointer to position 2.
Go to partial write mode.
Dummy leading character.
Append the new volume ID.
Send the new volume ID to the drive.

Close the record (write to the disk).
Restore normal addressing.
Quit.
Using your drive with the HP-71

The SB10161 and SB10162 provide an excellent means for enhancing the speed and power of the HP-71. If you refer to the Mass Storage Operations section of your HP-IL module owner's manual, you will find that all mass storage functions work exactly as described there; including secondary addressing. The 368,640 byte capacity of each disk is immediately available for your storage needs. The HP-71 can typically move data to and from the drive at a rate of about 2000 bytes per second.

DDISK71—a program to display disk records with the HP-71

This program will permit an HP-71 to print the contents of disk records in both hexadecimal and character form. This permits viewing of the actual structure of stored information.

**System requirements:**

- HP-71 about 14088 bytes for program
- HP-IL Module about 588 additional bytes for data
- any HP-IL printer

**Memory requirements:**

- about 1400 bytes for program
- about 500 additional bytes for data

**Running DDISK71:**

1. Carefully type in the program or load it from the diskette provided.
2. Type RUN DDISK71 ENDLNE.
3. When the display shows RECORD *, enter the number of the record you would like to see printed and press ENDLNE.
   (The record will be printed.)

If the display shows an error message (e.g. Device error #14), there has been a problem reading data from the drive (perhaps no disk was inserted). To determine the source of the problem see Retrieving Drive Status in the Technical Description section of this manual.
Program list:

10 ! Program to print the contents of a disk record.
20 ! 9/13/84 Steinmetz & Brown, Ltd.
30 ! S - Status of the drive.
40 ! M1 - Address of the first mass memory device.
50 ! C - Number of bytes

100 DIM D$[256] ! Make D$ large enough to hold one record.
110 RESET HPIL @ ASSIGNIO * @ M1=DEVADDR("MASSMEM(1)") ! Use first mass memory
120 SFLAG = 23 ! Stop filling D$ when an ETO is received.
130 PRINTER IS:PRINTER ! Use the first printer on the loop.
140 ! 8 bytes per line if 8216A, else 16 per line.
150 IF DEVID$("PRINTER")="" THEN N=8 ELSE N=16
160 INPUT "RECORD# ~\";

170 SEND LISTEN M1 MTA DDL 4 DATA R DIV 256, MOD(R,256) ! Seek record.
180 S=SPOLL(M1) @ IF S<>32 THEN 180 ! Wait for drive not busy.
190 IF S>15 THEN 400 ! If device error, display error #.
200 SEND TALK M1 MLA DDT 2! Read the record into buffer 0.
210 ENTER :LOOP ;D$ ! Fill D$ with contents of record.
220 S=SPOLL(M1) @ IF S>15 THEN 400 ! Check if data is OK.
230 PRINT "Record# ~",R !
240 FOR J=1 TO 256 DIV N ! For each line...
250 PRINT DTH$((J-1)*N)[4,5],"\" ! Print relative address.
260 FOR J=1 TO N ! For each byte in this block...
270 PRINT DTH$(NUM(D$[(J-1)*N+J])[4,5]);"\" ; ! Print hex representation of byte.
280 NEXT J
290 PRINT
300 FOR J=1 TO N ! For each character in block...
310 C=NUM(D$[(J-1)*N+J]) ! Number of character.
320 IF C>127 THEN C=C-128 ! No upper half characters.
330 IF C<32 THEN C=32 ! Substitute a space for control characters.
340 PRINT "\",CHR$(C),"\" ;
350 NEXT J
360 PRINT
370 NEXT I
380 PRINT
390 END
400 PRINT "Device error #";S @ BEEP
410 END
Using your drive with the HP-75

The SB10160 series drives offer a fast and efficient means for enhancing the storage capacity of the HP-75. If you refer to your HP-75 owner’s manual, you find that all mass storage functions work exactly as described there. You may immediately use the full 368,640 byte capacity of each disk to rapidly store and retrieve your files. The HP-75 typically moves data to and from the drive at a rate of about 500 bytes per second.

**DDISK75—a program to display disk records with the HP-75**

This program will permit an HP-75 to print the contents of disk records in both hexadecimal and character form. This permits viewing of the actual structure of stored information.

**System requirements:**
- HP-75
- I/O Utilities LEX file
- any HP-IL printer

**Memory requirements:**
- about 1600 bytes for program
- about 500 additional bytes for data

**Running DDISK75:**

1. Ensure that the drive to be used is assigned as M1 (using ASSIGNIO).
2. Carefully type in the program or load it from the disk provided.
3. Type RUN DDISK75 RETURN.
4. When the display shows RECORD *, enter the number of the record you would like to see printed and press RETURN.
   (The record will be printed.)

If the display shows an error message (e.g. Device error #14), there has been a problem reading data from the drive (perhaps no disk was inserted). To determine the source of the problem see Retrieving Drive Status in the Technical Description section of this manual.
Program list:

10 ! Program to print the contents of a disk record.
20 ! 9/13/84 Steinmetz & Brown, Ltd.
30 ! This program presumes that the desired drive is called M1.
40 ! Note: to use this program, the I/O Utilities LEX file must be present.
50 DIM AS[256] ! Make A$ large enough to hold one record.
60 N=8 ! Number of bytes per printed line.
70 DEF FNU$(1) ! Function to generate upper hexadecimal nibble.
80 I=I DIV 16 @ IF I<9 THEN FNU$=CHR$(I+48) ELSE FNU$=CHR$(I+55)
90 END DEF
100 DEF FNL$(1) ! Function to generate lower hexadecimal nibble.
110 I=MOD(1,16) @ IF I<9 THEN FNL$=CHR$(I+48) ELSE FNL$=CHR$(I+55)
120 END DEF
130 INPUT "RECORD #?",R@  
140 R1=R@ DIV 256 @ R2=MOD(R@,256) ! Break record # into two bytes.
150 SEND ":M1","LAD* DDL4" CHR$(R1)&CHR$(R2) ! Seek record.
160 A$=ENTIO$(":M1","TAD* SST") @ IF NUM(A$)=32 THEN DISP "seeking" @ GOTO 210
170 IF NUM(A$)>15 THEN 380 ! If device error, display error #.
180 A$ =ENTIO$(":M1","TAD*,DDT2,SDA") ! Read the record into A$.
190 PRINT "Record:";R@
200 FOR B=1 TO 256 STEP N
210 FOR L=B TO B+N-1
220 A=NUM(A$[L,L]) @ PRINT FNU$(A)&FNL$(A)&" "; ! Print hexadecimal bytes.
230 NEXT L @ PRINT
240 NEXT B @ PRINT
250 FOR B=1 TO 256 STEP N
260 A=NUM(A$[L,L]) @ PRINT FNU$(A)&FNL$(A)&" "; ! Print hexadecimal bytes.
270 NEXT L @ PRINT
280 FOR L=B TO B+N-1
290 A=NUM(A$[L,L]) @ PRINT FNU$(A)&FNL$(A)&" "; ! Print hexadecimal bytes.
300 NEXT L @ PRINT
310 IF C=127 THEN C=C-128 ! No upper half characters.
320 IF C<32 THEN C=32 ! Substitute a space for control characters.
330 PRINT " ";CHR$(C);" "; ! Print character representation.
340 NEXT L @ PRINT
350 PRINT
360 NEXT B
370 GOTO 180
380 PRINT "Device error ";NUM(A$)
390 END
Using your drive with the HP-110

The SB10160 series drives can provide not only practical mass storage, but also the unique capability to read disks written by the IBM PC™ and write disks which can be read by the IBM PC™. Any double sided, nine sector per track IBM disk may be inserted into your drive and its files read by a compatible HP-110 application (e.g. a Lotus 1-2-3™ data file written on an IBM can be read by the Lotus 1-2-3™ application in the '110). The only limitations are that the disk must be in the format described above and, of course, you must have an application capable of reading the desired files.

Though it is technically possible to read applications programs written by IBM computers, this may not be practical in some cases. Applications programs usually vary subtly from one machine to the next and may not operate properly unless written explicitly for the HP-110.

Configuring SB10160 series drives into the HP-110 system

Up to eight SB10161s or four SB10162s may be connected to the HP-110 simultaneously. Each drive configures media as double density, double sided, nine sector per track disks. Refer to your HP-110 owner’s manual for details about configuring mass memory devices into your system.

IBM and IBM PC are trademarks of IBM. Lotus 1-2-3 is a trademark of Lotus Development Corp.
Technical Description

Disk Format and Physical Storage of Data

The SB10161 and SB10162 use 5 1/4", double-sided, double-density, soft-sectored disks.

Before a new disk can be used it must be "formatted". Formatting is normally started by the controller whenever you give a NEWM or INITIALIZE command. The format command can also be invoked by the HP-IL message DDL5 (see HP-IL Messages). When the drive receives a format command it destroys any existing information on the disk and creates forty "tracks" on each side of the disk.

A track is a ring-shaped area on the disk which stores information. Tracks are arranged concentrically on the disk from the outside in. Each track is divided into nine "sectors".

A sector holds 512 bytes of information. Whenever the drive stores or retrieves information it does so in whole sectors at a time. If only part of a sector needs to be modified the entire sector is read from the disk, the pertinent part is modified, and the entire modified sector is written back to the disk. Most HP-IL controllers use blocks of information smaller than sectors. These are called "records".

A record contains 256 bytes of information. Each sector holds two records. The disk contains 1440 records numbered from 0 to 1439. Frequently, the controller will send a series of sequential records to the drive to be stored on the disk. Since the disk buffer (see Buffers and Disk I/O) holds two records at a time, the disk is usually updated only once for every two records received. The disk is also updated when the controller ends the writing session. This ensures that the last information sent is saved on the disk even if it does not fill an entire sector.

The diagram on the following page illustrates how tracks, sectors, and records are physically arranged on the disk.
1 Sector (9 per track)
Each sector contains 512 bytes or 2 records.

Arrangement of sectors on a track

1 Track (40 each side)

Arrangement of tracks on a disk
Buffers and Disk I/O

When the controller needs to read from or write to the disk it uses memory areas in the drive called buffers. Buffers are blocks of memory which can temporarily hold information until it is needed. There are three buffers in each drive:

The disk buffer holds a 512 byte sector immediately after it has been read from the disk and while the sector is being modified before it is written back to the disk.

Buffer 0 is used to hold one of the 256 byte records from the disk buffer or information which will replace one of the records in the disk buffer.

Buffer 1 serves as a 256 byte workspace for the controller.

The controller can put information into or take information out of buffer 0 or buffer 1. The disk buffer is not directly accessible to the controller. This diagram illustrates how the buffers work.
The Byte Pointer

When the controller needs to modify only part of contents of a buffer or when it needs to read only a portion of a buffer, it uses the byte pointer to select the start of the desired segment.

Buffers and the Byte Pointer

![Diagram of Buffer 0 and Buffer 1 with Byte Pointer]

Record Addresses and Their Physical Locations

In order to minimize motion of the drive heads, the drive switches sides when accessing sequential tracks of data. Since each track contains eighteen records, this means that each consecutive block of eighteen records is on the side opposite the previous block:

Location of records on the disk
(cross-sectional view of the disk)

<table>
<thead>
<tr>
<th>Side 1:</th>
<th>Track 0</th>
<th>Track 1</th>
<th>Track 2</th>
<th>Track 3</th>
<th>Track 4</th>
<th>Track 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>records:</td>
<td>0-17</td>
<td>36-53</td>
<td>72-89</td>
<td>108-125</td>
<td>144-161</td>
<td>180-197</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Side 2:</th>
<th>Track 0</th>
<th>Track 1</th>
<th>Track 2</th>
<th>Track 3</th>
<th>Track 4</th>
<th>Track 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>records:</td>
<td>18-35</td>
<td>54-71</td>
<td>90-107</td>
<td>126-143</td>
<td>162-179</td>
<td>198-215</td>
</tr>
</tbody>
</table>
HP-IL Messages

Normally, technical details of drive operation are handled automatically by the controller. You need only give a command to move a file to or from the disk and the controller does the rest. It is possible, however, to control the drive using individual HP-IL messages.

HP-IL messages are far more primitive than the commands you normally use to operate mass storage devices. Such a message might do no more than send a single character to the drive or ask if the drive is busy. Collectively, they permit direct control over information and its placement on the disk. The controller and the drive exchange hundreds or thousands of HP-IL messages to transfer even a small file. They are the “words” in the language HP-IL devices use to communicate with one another. This language is called the HP-IL Protocol. A proper discussion of the HP-IL Protocol is beyond the scope of this manual. The protocol is presented more thoroughly in the documents listed in appendix C.

—Caution—
Improper use of HP-IL Messages can alter information on the disk or render files irretrievable by normal commands. This is true even of secured files. Before experimenting with HP-IL messages you should remove from the drive any disks containing important information.
Drive Response to HP-IL Messages

This section details the operation of HP-IL messages on the SB10161 and SB10162. Familiarity with the HP-IL protocol is a prerequisite for a thorough understanding of this material.

<table>
<thead>
<tr>
<th>HP-IL Message</th>
<th>Drive Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Command Group</strong></td>
<td></td>
</tr>
<tr>
<td>IFC Interface Clear</td>
<td>Removes the drive from talker or listener status.</td>
</tr>
<tr>
<td>DCL Device Clear</td>
<td>Record pointer is set to zero, recording mode cleared, and sending of data terminated.</td>
</tr>
<tr>
<td>SDC Selected Device Clear</td>
<td>If a listener, the drive is cleared as with DCL.</td>
</tr>
<tr>
<td>GTL Go To Local</td>
<td>No response.</td>
</tr>
<tr>
<td>LLO Local Lockout</td>
<td>No response.</td>
</tr>
<tr>
<td>REN Remote Enable</td>
<td>No response.</td>
</tr>
<tr>
<td>NRE Not Remote Enable</td>
<td>No response.</td>
</tr>
<tr>
<td>PPE Parallel Poll Enable</td>
<td>No response.</td>
</tr>
<tr>
<td>PPD Parallel Poll Disable</td>
<td>No response.</td>
</tr>
<tr>
<td>PPU Parallel Poll Unconfigure</td>
<td>No response.</td>
</tr>
<tr>
<td>GET Group Execute Trigger</td>
<td>No response.</td>
</tr>
<tr>
<td>LPD Loop Power Down</td>
<td>No response.</td>
</tr>
<tr>
<td>EAR Enable Asynchronous Requests</td>
<td>No response.</td>
</tr>
<tr>
<td>AAU Auto Address Unconfigure</td>
<td>Address set to two.</td>
</tr>
<tr>
<td>LAD Listen address 0-31</td>
<td>If address matches, the drive is removed from talker status &amp; made a listener.</td>
</tr>
<tr>
<td>UNL Unlisten</td>
<td>Drive is removed from listener status.</td>
</tr>
<tr>
<td>DDL Device Dependent Listener</td>
<td>Executes specified listener command (0-11).</td>
</tr>
<tr>
<td>TAD Talk address 0-31</td>
<td>If address matches, the drive is removed from listener status &amp; made a talker.</td>
</tr>
<tr>
<td>UNT UnTalk</td>
<td>Drive is removed from talker status.</td>
</tr>
<tr>
<td>DDT Device Dependent Talker</td>
<td>Executes specified talker command (0-7).</td>
</tr>
<tr>
<td>SAD Secondary Address</td>
<td>Drive uses SAD* as its secondary address, increments SAD* &amp; passes SAD to next device. A subsequent AAD provides the drive with its primary address.</td>
</tr>
<tr>
<td>ELN Enable Listener Not Ready</td>
<td>No response.</td>
</tr>
<tr>
<td>NOP No Operation</td>
<td>No response.</td>
</tr>
<tr>
<td>NUL NULL</td>
<td>No response.</td>
</tr>
</tbody>
</table>
**HP-IL Message**

<table>
<thead>
<tr>
<th>Message</th>
<th>Drive Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ready group</strong></td>
<td></td>
</tr>
<tr>
<td>TCT  Take Control</td>
<td>No response.</td>
</tr>
<tr>
<td>RFC  Ready For Command</td>
<td>Current command is completed &amp; RFC is passed to next device.</td>
</tr>
<tr>
<td>SDA  Send Data</td>
<td>If talker, begins sending data bytes as previously selected.</td>
</tr>
<tr>
<td>SST  Send Status</td>
<td>If talker, sends one status byte (refer to Testing Drive Status).</td>
</tr>
<tr>
<td>SDI  Send Device ID</td>
<td>If talker, sends SB10161A or SB10162A. Though the letter &quot;A&quot; may be replaced by a different revision code in some drives.</td>
</tr>
<tr>
<td>SAI  Send Accessory ID</td>
<td>If talker, sends one byte with the value 16.</td>
</tr>
<tr>
<td>NRD  Not Ready for Data</td>
<td>If talker, data transmission halts. Drive waits for last data byte to return before sending an End of Transmission OK (ETO) frame.</td>
</tr>
<tr>
<td>ETO  End Transmission OK</td>
<td>If talker, sent at end of data.</td>
</tr>
<tr>
<td>ETE  End Transmission Error</td>
<td>If talker, sent immediately if a data byte is received not as sent.</td>
</tr>
<tr>
<td>AAD  Auto Address 0-31</td>
<td>If not already addressed, the drive takes AAD* as its primary address, increments AAD* &amp; passes AAD to next device.</td>
</tr>
<tr>
<td>AEP  Auto Extended Primary 0-31</td>
<td>If not already addressed, if drive previously received AES, uses AEP* as its address.</td>
</tr>
<tr>
<td>AES  Auto Extended Secondary 0-31</td>
<td>If not already addressed, drive assumes AES* as its secondary address, increments AES* &amp; passes AES to next device.</td>
</tr>
<tr>
<td>AMP  Auto Multiple Primary 0-31</td>
<td>No response</td>
</tr>
<tr>
<td><strong>Identify Group</strong></td>
<td></td>
</tr>
<tr>
<td>IDY  Identify</td>
<td>No response</td>
</tr>
</tbody>
</table>

**Data Group**

<table>
<thead>
<tr>
<th>Message</th>
<th>Drive Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAB  Data byte</td>
<td>If talker, checks if frame received as sent &amp; sends next byte.</td>
</tr>
<tr>
<td>END  End</td>
<td>If listener, accepts byte &amp; passes it on to the next device.</td>
</tr>
</tbody>
</table>
Device Dependent Commands

Since HP-IL devices can have greatly varying functions from one another there is a need for messages by which the controller can access the specific features of each device. Device Dependent Commands are HP-IL messages which function differently depending the device receiving them. There are two kinds of Device Dependent Commands; Device Dependent Listeners (DDLs) which tell devices in listener mode to perform a task (e.g. Rewind), and Device Dependent Talkers (DDTs) which tell devices in talker mode to perform a task (e.g. Send Position). If the drive receives any DDL or DDT not listed here, it ignores all Data and End bytes until a subsequent DDL or DDT tells it to do otherwise. This prevents accidental data erasure.

Device Dependent Listener Commands

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Write Buffer 0</td>
<td>Subsequent data bytes are stored in buffer 0 starting at the byte pointer. When the buffer fills, its contents are copied to the disk buffer. After each odd-numbered record is copied, the disk buffer is automatically written to the disk according to the current recording mode. Additional bytes are stored in buffer 0 starting at position 0. An End byte is stored as a data byte and the contents of buffer 0 are copied to the disk buffer which is then written to the disk.</td>
</tr>
<tr>
<td>1</td>
<td>Write Buffer 1</td>
<td>Subsequent data bytes are stored in buffer 1 starting at the byte pointer. When the buffer fills, additional bytes replace those already in the buffer starting at position 0. End bytes are treated as data bytes. (DDL 1 also clears partial write mode)</td>
</tr>
<tr>
<td>2</td>
<td>Continuous Write</td>
<td>The byte pointer is set to position 0 of buffer 0. As subsequent data bytes fill buffer 0 its contents are copied to the disk buffer. After each odd-numbered record is copied, the disk buffer is written to the disk and the record pointer is updated to the next record. When an End or Close Record (DDLB) is received, the contents of buffer 0 are copied to the disk buffer which is then written to the disk.</td>
</tr>
</tbody>
</table>
3 Set byte pointer

Subsequent bytes redefine the byte pointer (from 0-255). The last byte received is used.

4 Seek

The next two bytes are interpreted as a record number (0-1439). The record pointer is set to that record and the sector containing the record is read into the disk buffer. Buffer 0 is not changed. (DDL4 also clears partial write mode.)

5 Format

The value 255 is written to all records of the disk. When the format function begins executing, the RFC frame is passed to the next device on the loop. After the format, the record pointer is set to zero. (DDL5 also clears partial write mode.) Additionally, due to the requirements of the HP118, HP71, and HP75 controllers, special information will be written to the disk during subsequent write commands. To prevent this from occurring, send the drive a Device Clear (DCL) or Selected Device Clear (SDC) command before performing any writes.

6 Partial Write

The drive is set to partial write mode. The current record is read from the disk buffer into buffer 0 and the record pointer remains unchanged. Subsequent data bytes replace the contents of buffer 0 starting at the byte pointer. When buffer 0 is full it is copied to the disk buffer. If the record copied is odd-numbered, the disk buffer is then written to the disk. The record pointer is then advanced, the next record is copied to buffer 0 and the byte pointer is set to 0. This continues until a Close Record (DDL8) or End byte is received. A Close Record causes buffer 0 to be copied to the disk buffer which is then written to the disk without advancing the record pointer. An End byte will be placed in buffer 0 which is then copied to the disk buffer which is written to the disk without advancing the record pointer—unless the End byte fills buffer 0 in which case buffer 0 is copied to the disk buffer which is written to the disk, the next record is copied to buffer 0 and the record pointer will be set to that record.
7  Rewind

The record pointer is set to record Ø.

8  Close Record

The contents of buffer Ø are copied to the disc buffer which is written to the disc. Following a Write command (DD2), Close Record advances the record pointer. Close Record doesn't advance the record pointer following a Partial Write command (DDL6).

9  Transfer Buffer

The contents of buffer Ø are copied to buffer 1 and the byte pointer is set to Ø.

10  Exchange Buffers

The contents of buffer Ø and buffer 1 are exchanged and the byte pointer is set to Ø.

11  Verify

The next two data bytes are used as the number of records to be verified. The drive starts at the current record pointer position and reads records until the number of records specified have been read or the end of the disk is reached or an error occurs while reading. If the number of records specified are read successfully, the drive stops and its status is Ø. If the end of the disk is reached first, the drive rewinds to record zero and its status is set to Ø. If an error occurs while reading, the drive stops, the record pointer is set to the record at which the error occurred, and its status is set to reflect the type of error.
### Device Dependent Talker Commands

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
</table>
| 0    | Send Buffer 0  
A subsequent Send Data message (SDA) will cause the contents of Buffer 0 to be sent. The data stream will begin with the byte pointed to by the byte pointer. When the end of the buffer is reached, the next record is copied from the Disk Buffer into Buffer 0 (if the next record is even-numbered, it and the following record are first read from the disk into the Disk Buffer) which is then sent on the loop. This continues until the end of the disk is reached, a Not Ready for Data message (NRD) is received, or any frame other than the transmitted data byte is received. (DDT0 also clears partial write mode.) |
| 1    | Send Buffer 1  
A subsequent Send Data message (SDA) will cause the contents of Buffer 1 to be sent. The data stream will begin with the byte pointed to by the byte pointer. When the end of the buffer is reached, data transmission is terminated and the byte pointer is set to 0. This continues until a Not Ready for Data message (NRD) is received or any frame other than the transmitted data byte is received. |
| 2    | Read  
The next record is copied from the Disk Buffer (if the next record is even-numbered, it and the following record are first read from the disk into the Disk Buffer). A subsequent Send Data message (SDA) will cause the contents of Buffer 0 to be sent starting with the first byte in the buffer. When the end of Buffer 0 is reached, the next record is copied to Buffer 0 and sent on the loop. This continues until the end of the disk is reached, a Not Ready for Data message (NRD) is received, or any frame other than the transmitted data byte is received. (DDT2 also clears partial write mode.) |
3  Send Position  
A subsequent Send Data (SDA) message will cause the drive to return three bytes: the first two bytes represent the record pointer (0-1439). The third byte represents the byte pointer.

4  Exchange Buffers  
The contents of Buffer 0 are exchanged with the contents of buffer 1 and the byte pointer is reset to 0.

5  Transfer Buffer  
The contents of buffer 0 are copied to buffer 1 and the byte pointer is set to 0.

6  Send Physical Attributes  
A subsequent Send Data (SDA) message will cause the drive to return twelve bytes; the first four represent the number of tracks per surface (0, 0, 0, 40), the second four represent the number of surfaces per medium (0, 0, 0, 2), and the third four represent the number of records per track (0, 0, 0, 18).

7  Send Highest Record*  
A subsequent Send Data (SDA) message will cause the drive to return two bytes representing the number of the last record on the medium (5, 159).
Retrieving Drive Status

The Send Status command (SST) tells the drive to return a byte indicating its current status (e.g. busy, idle, error has occurred). The SST frame is replaced by one Data Byte (DAB) representing the status of the drive at the time the Data Byte is sent on the loop. Very long running operations such as Format (DDL5) and Verify (DDL11) may delay the processing of a status request by a second or two. The drive only signals an error condition once after it occurs, so controllers must pay attention to error status indications for every status byte they read.

This table shows the meaning all status bytes which might be returned by the drive:

<table>
<thead>
<tr>
<th>Binary*</th>
<th>Decimal</th>
<th>Hex</th>
<th>Condition</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000***</td>
<td>0-15</td>
<td>0-15</td>
<td>Idle Condition</td>
<td>No error and not executing any command.</td>
</tr>
<tr>
<td>00010000</td>
<td>16</td>
<td>10</td>
<td>Protected Disk</td>
<td>Disk is physically write-protected.</td>
</tr>
<tr>
<td>00010001</td>
<td>17</td>
<td>11</td>
<td>Not used.</td>
<td></td>
</tr>
<tr>
<td>00010010</td>
<td>18</td>
<td>12</td>
<td>Not used.</td>
<td></td>
</tr>
<tr>
<td>00010011</td>
<td>19</td>
<td>13</td>
<td>Not used.</td>
<td></td>
</tr>
<tr>
<td>00010100</td>
<td>20</td>
<td>14</td>
<td>No Disk Error</td>
<td>No disk is in the drive.</td>
</tr>
<tr>
<td>00010101</td>
<td>21</td>
<td>15</td>
<td>Not used.</td>
<td></td>
</tr>
<tr>
<td>00010110</td>
<td>22</td>
<td>16</td>
<td>Device Error</td>
<td>Device may require service.</td>
</tr>
<tr>
<td>00010111</td>
<td>23</td>
<td>17</td>
<td>Not used.</td>
<td></td>
</tr>
<tr>
<td>00011000</td>
<td>24</td>
<td>18</td>
<td>Not used.</td>
<td></td>
</tr>
<tr>
<td>00011001</td>
<td>25</td>
<td>19</td>
<td>Record* Error</td>
<td>Record cannot be retrieved.</td>
</tr>
<tr>
<td>00011010</td>
<td>26</td>
<td>1A</td>
<td>Checksum Error</td>
<td>Computed checksum doesn't match stored checksum.</td>
</tr>
<tr>
<td>00011101</td>
<td>27</td>
<td>1B</td>
<td>Record Type Error</td>
<td>Unexpected record type found.</td>
</tr>
<tr>
<td>00011100</td>
<td>28</td>
<td>1C</td>
<td>Size Error</td>
<td>Attempt to access a record* greater than 1439.</td>
</tr>
<tr>
<td>00011101</td>
<td>29</td>
<td>1D</td>
<td>Lost Data Error</td>
<td>Data lost during current operation.</td>
</tr>
<tr>
<td>00011110</td>
<td>30</td>
<td>1E</td>
<td>Not used.</td>
<td></td>
</tr>
<tr>
<td>00011111</td>
<td>31</td>
<td>1F</td>
<td>Not used.</td>
<td></td>
</tr>
<tr>
<td>001*****</td>
<td>32-63</td>
<td>20-3F</td>
<td>Busy Condition</td>
<td>Drive is executing a command.</td>
</tr>
</tbody>
</table>

* The Eight bits shown are in order from the most significant (on the left) to the least significant (on the right). The symbol * indicates any binary digit (0 or 1).
Appendix A: Care, Warranty, & Service

Care of Your Disk Drive

Though it can be put in a briefcase, your disk drive was designed primarily for desk-top use. As with all disk drives, it should not be subjected to excessively dusty environments or mechanical shock. When you transport the unit, you should insert the protective cards into all drives present.

Care of Disks

Disks should be kept in their protective jackets away from dust, smoke, grease and strong magnetic sources. Be careful not to emboss disks while marking them. —i Always make backups of important information!—

Limited 90 Day Warranty

Your drive is warranted by Steinmetz & Brown, Ltd. against defects in materials and workmanship for a period of ninety days from the date of original purchase. During the warranty period we will repair or, at our option, replace a unit that proves to be defective, provided that you return the unit, shipping prepaid, to Steinmetz & Brown.

This warranty does not cover damage to the unit caused by accident or misuse or by service by other than an authorized Steinmetz & Brown service center.

Steinmetz & Brown, Ltd. makes no other express warranty. The repair or replacement of a unit is your exclusive remedy. Any other implied warranty of merchantability or fitness is limited to the ninety-day duration of this written warranty. Some states and provinces do not recognize limitations on the duration of an implied warranty, so the limitation above may not apply to you. In no event shall Steinmetz & Brown, Ltd. be liable for incidental or consequential damages. Some states and provinces do not permit the exclusion or limitation of incidental or consequential damages, so the above limitation may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which are interpreted differently from state to state and province to province.
Service

If your unit needs repair at any time, it may be returned to:

Steinmetz & Brown, Ltd.
Service Department
2675 University Ave
St Paul, MN 55114

There is a charge for repairs made after the ninety day warranty period. Costs and arrangements for shipping, and in the case of international service, reimportation and customs are your responsibility. If possible, repack your drive in its original packing materials and insure it as needed.

Potential for Radio/Television Interference

The SB10161A/5B10162A Disk Drive generates and uses radio frequency energy and, if not installed and used properly (that is, in strict accordance with the instructions in this manual), may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with protection against such interference in a residential installation. If the disk drive does cause interference to radio or television reception, which can be determined by turning the drive off and on, you are encouraged to try to correct the interference by one or more of the following measures:

- Reorient the receiving antenna.
- Relocate the disk drive away from the receiver.
- Move the drive away from the receiver.
- Plug the drive into a different outlet so it and the receiver are on different branch circuits.

If necessary, you should consult your dealer or an experienced radio/television technician for additional suggestions. You may find the following booklet helpful: How to Identify and Resolve Radio-TV Interference Problems. This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock Number 004-000-00345-4.
Appendix B: Accessories & Specifications

Single Drive to Dual Drive Upgrade

Single drive SB10161s can be upgraded to dual drive SB10162s at any time for a modest charge. To have your drive upgraded contact:

Steinmetz & Brown, Ltd.
2675 University Ave Suite 202
St Paul, MN 55114

Accessories

Steinmetz & Brown offers the following accessories for your drive:

- 9400-0004 Owner’s Manual
- 9000-0002 Dual Sided, Dual Density Diskettes
- 9300-0001 Detachable Power Cord
- 9200-0003 Fuse (3AG, 0.5 Amp, 250 Volt, slow blow)

Physical Specifications:

Dimensions:
- Width: 29.5 cm (11.65 in)
- Depth: 28.5 cm (11.25 in)
- Height: 9.5 cm (3.75 in)

Environmental limits:

<table>
<thead>
<tr>
<th></th>
<th>Operating</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature</td>
<td>10 to 40°C (50 to 104°F)</td>
<td>-40 to 60°C (-40 to 144°F)</td>
</tr>
<tr>
<td>Humidity (non-condensing)</td>
<td>20 to 80 %</td>
<td>1 to 95 %</td>
</tr>
</tbody>
</table>

Electrical specifications (powerline):

- Nominal: 115 VAC @ 60 Hz
- Maximum: 125 VAC @ 60 Hz
- Minimum: 105 VAC @ 60 Hz

Fuse type: 3AG, 0.5 Amp, 250 Volt, slow blow
Data rates *

Maximum seek time: 0.2 sec (motor on), 1.2 sec (motor off)

Frame transfer rate:

   Maximum: 2560 frames/sec (11 bits/frame, 256 byte burst)
   Average: 2160 frame/sec

File transfer rate:

   About 2,000 frames/sec (excluding directory lookups)

Typical transfer time:  

<table>
<thead>
<tr>
<th></th>
<th>OK file</th>
<th>8K file</th>
<th>16K file</th>
<th>32K file</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>1.5 sec</td>
<td>5.25 sec</td>
<td>9.5 sec</td>
<td>17.25 sec</td>
</tr>
<tr>
<td>Writing</td>
<td>2.25 sec</td>
<td>7 sec</td>
<td>11.25 sec</td>
<td>19 sec</td>
</tr>
</tbody>
</table>

*The HP-41 and the HP-75 cannot transfer data at the drive's peak rate.

Diskette type

5 1/4” Dual Density, Double Sided diskette (DD DS)
48 TPI

Diskette format

40 tracks per side, 9 sectors per track.  
Sectors are numbered 1-9 on each track.  
Records 0-17 on side 0, track 0.  
Records 18-35 on side 1, track 0 etc.

Storage capacity: (formatted)

SB10161A–368,640 bytes
SB10162A–737,280 bytes (using two disks)
Appendix C: References & Further Reading

The HP-IL System

by Gerry Kane, Steve Harper, and David Ushijima

Published by OSBORNE/McGraw-Hill

The HP-IL Interface Specification

(Part # 82166-90017)

Hewlett-Packard
1000 NE Circle Blvd.
Corvallis, OR 97330

The PPC Journal

The Personal Programming Center (PPC) was the first portable computer support group and remains the foremost organization of its kind. It comprises a diverse and dedicated worldwide membership. The monthly PPC Journal presents the most recent discoveries and techniques relating to portable computers and their applications.

For information send $1 or a 9"x12" envelope and postage for 3 ounces to:

Personal Programming Center
PO Box 9599
Fountain Valley, CA 92728-9599
Appendix D: In Case of Difficulty

Don't Panic.

**Symptom: drive does not come on;**
Check the following:

1. Is the power cable firmly connected to modular jack on the drive and to a working, grounded, 110/120 Volt outlet?

2. Is the drive power switch turned on (in the upper position)?

3. Is the fuse good?
   To check the fuse: turn off the drive, twist off the fuse cover (below the power switch), remove and examine the fuse.
   The fuse should be a 3AG 0.5 Amp 250 Volt Slo-blow fuse.
   If the fuse is not this type, appears smokey or does not show a strip of unbroken wire inside, replace it with a new one.

If all of these check out OK and the motors still do not operate or the drive select lights do not go on when the drive is first turned on, your drive may require service.

**Symptom: cannot store or retrieve data to or from the drive;**
Check the following:

1. Do the HP-IL cables form a complete loop from the controller to the drive and back. Be sure that neither device has both ends of a cable connected to itself and that all other devices are on and functioning (remove all other devices if there is any doubt).

2. Is the disk inserted properly (see Getting Started).

3. Was the disk formatted by a compatible controller?
   (HP Series 40/70 disks are not interchangeable with HP-110 disks)

4. Is the disk damaged or severely worn?

5. Are the correct commands being used? (see your computer owner's manual for syntax and usage)

If all of these check out OK and you still cannot access the disk, your drive may require service.

**Symptom: cannot write data to the disk;**
Check the procedures above; additionally check to ensure that the write-protect tab is removed.
If these check out OK and you still cannot write to the disk, your drive may require service.
Acknowledgements

We would like to express our thanks to Dave Guggisberg and Harry Pheney. They will always have a place to stay in the Twin Cities.

Our fullest gratitude to our friends at the St Paul office of Hewlett-Packard; if they tired of seeing us, they were tactful enough not to say so.

We extend our appreciation to Dennis Sweet for practical advice when we were drowning in esoterica.

Last but never least, we thank the staff and membership of PPC whose comments, complaints, and pipe dreams have inspired and guided us.